CALIFORNIA LEGISLATURE

JOINT INFORMATIONAL HEARING OF THE

SENATE COMMITTEE ON HEALTH AND HUMAN SERVICES

AND

SENATE COMMITTEE ON NATURAL RESOURCES AND WILDLIFE

AND THE

ASSEMBLY COMMITTEE ON
ENVIRONMENTAL SAFETY AND TOXIC MATERIALS

"HEALTH EFFECTS OF CHROMIUM VI CONTAMINATION OF DRINKING WATER"

Tuesday, October 24, 2000 • 10:00 am - 1:00 pm

Burbank City hall
275 E. Olive Avenue, Burbank

1069-S

MEMBERS
RAY HAYNES, VICE-CHAIR
LIZ FIGUEROA
TERESA HUGHES
BILL MORROW
RICHARD MOUNTJOY
RICHARD POLANCO
HILDA SOLIS
JOHN VASCONCELLOS

California Legislature

SENATE COMMITTEE ON HEALTH AND HUMAN SERVICES

DEBORAH V. ORTIZ
CHAIR

COMMITTEE ADDRESS
STATE CAPITOL
ROOM 2191
SACRAMENTO, CA 95814

STAFF DIRECTOR
JOHN MILLER

AMOFIA (MOE) KATSIMBRAS
COMMITTEE ASSISTANT

Joint Informational Hearing of the

Senate Committee on Health and Human Services
Senate Committee on Natural Resources and Wildlife
and the
Assembly Environmental Safety and Toxic Materials Committee

"Health Effects of Chromium VI Contamination of Drinking Water"

Tuesday, October 24, 2000
10:00 a.m. to 1:00 p.m.
Burbank City Hall
275 E. Olive Avenue, Burbank

Agenda

I. **Opening Remarks**: Committee Chairs and Host Members

II. **Chromium VI and its Human Health Implications:** research findings and unanswered questions

- ***George Alexeef,*** Deputy Director, Scientific Affairs, Office of Environmental Health Hazard Assessment
- ***John R. Froines,*** Director, Center for Occupational and Environmental Health, Professor, UCLA School of Public Health
- ***Joseph R. Landolph,*** Associate Professor, USC/Norris Comprehensive Cancer Center

III. **Chromium and California's Drinking Water:** California's drinking water standards, their adequacy and enforcement; extent and distribution of Chromium/Chromium VI contamination in California.

- ***Yoram Cohen,*** Director, Center for Environmental Risk Reduction, Professor, UCLA Department of Chemical Engineering
- ***David P. Spath,*** Chief, Division of Drinking Water and Environmental Management, California Department of Health Services
- ***Dennis Dickerson,*** Executive Director, Los Angeles Regional Water Quality Control Board
- ***Joseph K. Lyou,*** Director of Programs, California League of Conservation Voters Education Fund

IV. San Fernando Valley's Water Supply and Chromium VI: the extent and nature of Chromium VI contamination; current efforts to manage or mitigate contamination; and potential costs and options for providing uncontaminated valley water.

- ***S. David Freeman,*** General Manager, City of Los Angeles Department of Water and Power
- ***Ron Davis,*** General Manager, City of Burbank Public Service Department
- ***Dan Waters,*** Director, City of Glendale Public Service Department
- ***Michael Drake,*** Director, City of San Fernando Public Works Department

V. Public Policy Options for Chromium VI: related contamination sites and public policy recommendations for Chromium VI.

- ***Erin Brockovich and Edward Masry***, Masry and Vittitoe
- ***David P. Spath***, Chief, Division of Drinking Water and Environmental Management, Department of Health Services
- ***John R. Froines,*** Director, Center for Occupational and Environmental Health, Professor, UCLA School of Public Health
- ***Joseph R. Landolph,*** Associate Professor, USC/Norris Comprehensive Cancer Center
- ***Joseph K. Lyou,*** Director of Programs, California League of Conservation Voters Education Fund
- ***S. David Freeman,*** General Manager, City of Los Angeles Department of Water and Power

BACKGROUND

INFORMATION

California Legislature

SENATE COMMITTEE
ON
HEALTH AND HUMAN SERVICES

DEBORAH V. ORTIZ
CHAIR

COMMITTEE ADDRESS
STATE CAPITOL
ROOM 2191
SACRAMENTO, CA 95814

STAFF DIRECTOR
JOHN MILLER

AMOFIA (MOE) KATSIMBRAS
COMMITTEE ASSISTANT

Background

Health Effects of Chromium VI Contamination of Drinking Water

Chromium VI is one of a number of toxic elements that has recently captured public attention and triggered serious popular concern. The source metal is widely used for industrial purposes and has the potential to contaminate drinking water sources. Two fractions of chromium - chromium III and chromium VI - are considered toxic and only chromium VI is considered a human carcinogen. When inhaled, chromium VI can irritate the nose, throat and lungs; perforate the wall separating the nasal passages; or cause lung, stomach or liver cancer. Scientists disagree about the carcinogenicity of chromium VI when orally ingested. The Office of Environmental Health Hazard Assessment (OEHHA) concluded that orally ingested chromium VI should be considered carcinogenic. Research indicates that at high levels orally ingested chromium VI has caused mouth sores, diarrhea and is associated with a higher rate of lung and stomach cancer. Chromium and its variants are unusually persistent and mobile in the environment. Chromium and chromium VI are very widely dispersed throughout California and the United States.

The release of the film *Erin Brockovich* in March of 2000 made chromium VI a common household word. The film is based on the town of Hinkley, California and its residents who were exposed to high levels of chromium VI and suffered a wide variety of health conditions including various types of cancer. The diligent work of a paralegal and the determination of residents who came forward resulted in a class action lawsuit and a $333 million settlement between the plaintiffs and Pacific Gas and Electric. The Hinkley story, the film "Erin Brockovich" and the press coverage of chromium VI contamination has vastly increased public awareness about chromium VI and its health effects.

Chromium VI and California's Drinking Water
A recent investigation found chromium VI in 30 of 80 San Fernando Valley area water wells. The amount of chromium in these wells ranged from small amounts to 110 parts per billion. At least two of the wells have levels of chromium above the state's standards of 50 parts per billion. Residents of Los Angeles, Glendale and Burbank consume the water in these wells. The city of Burbank relies heavily on these wells which provide over 60% of the city's water supply. Currently, through a combination of treatment and water blending the chromium VI contamination is being managed. Although the effects of the contamination are being mitigated

and the water meets the state standards for drinking water when distributed to consumers, these findings have fueled public interest on chromium VI contamination.

The presence of detectable levels of total chromium in California's water is not unique to the San Fernando Valley. According to the Department of Health Services, water sources in 48 out of California's 58 counties have detectable levels of total chromium. The Department of Health Services' compliance monitoring database reflects that 1,000 drinking water sources in California reported total chromium between August of 1982 and 1999. The majority of chromium detections were in groundwater sources, but a few surface water sources also had chromium detections. The majority of water sources with detectable levels of total chromium were located in Southern California.

In 1999 the Office of Environmental Health Hazard Assessment, the entity charged with establishing public health goals that consider current scientific evidence and the public health, developed a public health goal of 2.5 parts per billion for total chromium in California's drinking water. The current standard or maximum contaminant level established by the Department of Health Services is 50 parts per billion. Unlike the public health goals, maximum contaminant levels consider both public health goals and the economic and technical feasibility of achieving these goals. The difference between the OEHHA public health goal and the state's current standard has raised concerns about the appropriateness of the current standard and the safety of California's drinking water. The recommended public health goal also concerns water officials who estimate that lowering the current standard to the recommended goal may cost more than $47 million a year for replacement water to serve the City of Los Angeles alone. Alternatives to mitigate the effects of chromium VI contamination and meet the state's standard include ionization, reverse osmosis and water blending.

The Department of Health Services, the entity responsible for setting California's drinking water standards, established a five-year timeline to review the OEHHA recommendation and revise the standard for chromium VI. The regulatory process will now be expedited due to the discovery of chromium VI in water sources across the state at levels higher than those expected, growing political pressure and the approval of legislation authored by Senator Adam Schiff. Senate Bill 2127 requires the Department of Health Services to report to the Governor and the Legislature by January 1, 2002 on the level of chromium VI in the drinking water systems in the San Fernando Basin and assess the exposures and risks to the public due to the levels of chromium VI.

California has established a drinking water standard for total chromium. This standard is based on assumptions about the fraction of total chromium that chromium VI represents. The OEHHA public health goal for chromium VI is based on an assumption that only 7.2 percent of total chromium in water is chromium VI. However, recent tests of California's water reveal that chromium VI may constitute between 44 to 100 percent of total chromium in California's water. Therefore, Californians may be exposed to higher levels of chromium VI than what was initially estimated. Some experts believe that the chlorination process may also result in higher levels of chromium VI. According to a study sponsored by the United States Environmental Protection Agency, free chlorination readily converts chromium III to chromium VI, thereby increasing the chromium VI fraction. These recent developments have triggered an examination of the state's drinking water safety standard and whether it adequately protects the public health.-

Chromium: Properties, Uses and Presence in The Environment

Chromium is a transition metal that is widely used for the production of metal alloys and other industrial purposes. Metals and alloys that contain chromium are frequently used to manufacture automobiles, appliances and other consumer products. Chromium is used to harden steel, in the manufacture of stainless steel and the production of industrially important alloys. It is also used in the making of pigments, in leather tanning and for welding. Chromium is a common element; it ranks 21^{st} in natural abundance among the elements in earth's core.

While there are natural sources of chromium in the environment, the majority of chromium, particularly the majority of chromium VI, originates from industrial activities. There are many different oxidation states of chromium existing in the environment. However, chromium III and chromium VI are the most chemically stable and most common. These two species of chromium are considered toxic elements and are regulated accordingly. Chromium VI is more water-soluble, more easily enters living cells, and is much more toxic than chromium III. Chromium VI is considered a human carcinogen by the National Toxicology Program, the International Agency for Research on Cancer, the United States Environmental Protection Agency, and the Office of Environmental Health Hazard Assessment.

Humans are exposed to chromium through skin contact, inhalation, ingestion and ingestion following inhalation. Chromium VI, which can act as an oxidant directly on the skin surface or can be absorbed through the skin, frequently irritates the skin in the form of skin ulcerations and allergic sensitization. When absorbed into the blood system through the skin, chromium VI is quickly reduced to the less toxic chromium III. However, absorption of large doses of chromium VI into the blood stream can result in severe kidney and liver damage.

Overview of Research on Chromium VI and its Health Effects

While public concern about chromium VI contamination grows, many questions about the extent of chromium contamination and its human health effects remain unanswered. Scientists continue to debate the carcinogenicity of chromium VI when orally ingested. Some argue that chromium VI is not a carcinogen when orally ingested, others argue that existing research is insufficient to make a determination on this matter, and still others believe that chromium VI is a carcinogen when ingested. Available research appears insufficient to ascertain the specific health effects caused by determinate levels of exposure to chromium VI. Although it is clear that some individuals have died as a result of chromium poisoning, it is unclear what the dose/responses are.

Health Effects of Chromium VI When Inhaled

The toxicity and carcinogenicity of chromium VI when inhaled has been studied by scholars all over the world and is well documented. Evaluations by the California Department of Health Services, the U.S. Environmental Protection Agency, and the U.S. Agency for Toxic Substances and Disease Registry indicate that the risk of lung cancers to workers exposed to chromium VI is extremely high. When inhaled chromium VI has been found to irritate the nose, throat and lungs. It can cause such severe damage as a perforation of the wall separating the nasal passages. Chromium VI has been found to cause cancer of the upper airways and upper gastrointestinal tract. Specifically, when inhaled Chromium VI may cause lung, stomach or liver cancer.

Health Effects of Orally Ingested Chromium VI

Research on the health effects, toxicity and carcinogenicity of Chromium VI when ingested orally is less conclusive. Scholars disagree about the carcinogenicity of orally ingested chromium VI. Chromium VI is converted into Chromium III in the stomach when it comes into contact with gastric acids and other organic reducing agents. Because of the reduction of chromium VI to chromium III in the stomach, some scientists believe that the rate of absorption of orally transmitted chromium VI is low and therefore doubt that orally ingested chromium VI is carcinogenic. Other scholars argue strongly that chromium VI should be regarded as carcinogenic by the oral route. Max Costa, a toxicologist and chromium VI scholar has reviewed evidence that supports the conclusion that chromium VI is taken up by the gastrointestinal tract and transported to all tissues of the body. Costa also reviewed epidemiological evidence that exposure to chromium VI causes increased risk of cancer in bone, prostate, stomach and other organs.

A study of people exposed to 20 parts of chromium VI per one million parts of water found that the exposure to chromium VI caused mouth sores, diarrhea, stomachache, indigestion and vomiting. Chromium VI also caused elevated levels of white blood cells and a higher per capita rate of lung and stomach cancer. Some studies of the health effects of Chromium VI on animals have found severe developmental and reproductive effects, adverse effects on fertility and reproduction. These studies have also found that chromium VI causes contact site tumors in laboratory animals and that ingested chromium VI has been associated with stomach tumors in mice. Other animal studies have found no significant health effects.

The U.S. Environmental Protection Agency believes that presently, the carcinogenicity of chromium VI by oral ingestion cannot be determined because of a lack of sufficient epidemiological or toxicological data. The World Health Organization also concluded that the data available is insufficient to show evidence of carcinogenicity via the oral route. The Office of Environmental Health Hazard Assessment (OEHHA) concluded that chromium VI should be assumed to be carcinogenic by the oral route. OEHHA reached this conclusion because chromium VI is known to be a human carcinogen by the inhalation route, non-respiratory cancers have been found in workers exposed to chromium VI by inhalation, and chromium VI causes contact site tumors in laboratory animals. In addition, ingested chromium VI has been associated with stomach tumors in mice and chromium VI has been positive in a number of assays for genotoxicity.

Joint Informational Hearing of the

Senate Committee on Health and Human Services
Senate Committee on Natural Resources and Wildlife
and the
Assembly Environmental Safety and Toxic Materials Committee

"Health Effects of Chromium VI Contamination of Drinking Water"

Tuesday, October 24, 2000
10:00 a.m. to 1:00 p.m.

Witness List

Chromium VI and its Human Health Implications

George Alexeef	Deputy Director, Scientific Affairs Office of Environmental Health Hazard Assessment
John R. Froines	Director, Center for Occupational and Environmental Health Professor, UCLA School of Public Health Chair, Office of Environmental Health Hazard Assessment Science Advisory Board
Joseph R. Landolph	Associate Professor, USC/Norris Comprehensive Cancer Center Member, Office of Environmental Health Hazard Assessment Science Advisory Board

Chromium and California's Drinking Water

Yoram Cohen	Director, Center for Environmental Risk Reduction Professor, UCLA Department of Chemical Engineering
David P. Spath	Division of Drinking Water and Environmental Management Department of Health Services
Dennis Dickerson	Executive Director Los Angeles Regional Water Quality Control Board.
Joseph K. Lyou	Director of Programs California League of Conservation Voters Education Fund.

San Fernando Valley's Water Supply and Chromium VI

S. David Freeman	General Manager City of Los Angeles Department of Water and Power
Ron Davis	General Manager City of Burbank Public Service Department
Dan Waters	Director City of Glendale Public Service Department
Michael Drake	Director City of San Fernando Public Works Department

Chromium VI Contamination and Public Policy Options

Erin Brockovich	Director of Environmental Research Masry & Vititoe
Edward Masry	Partner Masry and Vittitoe

Experts Available for Questions

Bruce A. Macler	National Microbial Risk Assessment Expert, Water Division United States Environmental Protection Agency
Mel Blevins	Court Appointed Water Master San Fernando Valley
Kimi Klein	Toxicologist Department of Toxic Substances Control

STATE CAPITOL, ROOM 2080
SACRAMENTO, CA 95814
(916) 445-1353
(916) 324-4823 FAX

10951 W. PICO BLVD., #202
LOS ANGELES, CA 90064
(310) 441-9084
(310) 441-0724 FAX

Senate
California Legislature

TOM HAYDEN
SENATOR
TWENTY-THIRD DISTRICT

CHAIR:
NATURAL RESOURCES AND WILDLIFE
SELECT COMMITTEE ON HIGHER EDUCATION
SUBCOMMITTEE ON COASTAL AND OCEAN PROTECTION AND RESTORATION
COMMITTEES:
BUDGET AND FISCAL REVIEW
EDUCATION
ENVIRONMENTAL QUALITY
TRANSPORTATION

October 20, 2000

David Freeman, General Manager
Department of Water and Power
Los Angeles, California

Transmitted by fax: (213) 367-1455

Dear David,

Thanks for your call this morning. I propose we follow up our September 13 conversation by rolling up our sleeves and determining how the City might establish its own independent agency to monitor, advocate, educate and enforce more protective and proactive drinking water measures.

Today's headlines about a "breakup" of the Department of Water and Power (DWP) are misleading and unhelpful. However, I believe it is time to place the monitoring function on an independent footing to end any appearance of conflict of interest and build greater public confidence.

As you yourself indicate, the current situation creates an appearance of the fox guarding the chicken coop. The DWP knows that tougher standards or enforcement might lead to closing wells, forcing the city to import scarce water from other sources. Therefore, the DWP is caught between water supply and health considerations. It cannot be an aggressive watchdog, as some council members have urged, without undermining its cost and supply priorities. At the same time, as I indicated in my letter to Joel Wachs, the City has no other unit guarding the public interest in clean drinking water. Combined with the absence of standards for Chromium 6 at the state level, this means the public has substantial reason to feel unprotected, particularly parents of school children.

I believe the Governor should make the improvement of our drinking water protection an immediate priority. It is outrageous that the state's inhouse experts at OEEHA have considered Chromium 6 an oral carcinogen for ten years, and have proposed a public health goal of 2.5 ppb (0.2 ppb for Ch 6) and yet the DHS has set no enforceable standard. The next Legislature must end this regulatory embarrassment. This will be no easy task, since state law permits standards to include consideration of costs and feasibility, not simply what is necessary for public health. Because of that ambiguity in statute, the worry of many will be that DHS may "dilute" the standards to "acceptable" levels to accommodate the interests of water agencies.

In the meantime, however, the concerned public has a right to expect local authorities to fight for clean drinking water. The state is more likely to act in the interest of Los Angeles residents if there is independent monitoring, enforcement and advocacy from the local level. Such an independent unit could be created immediately in the City's environmental affairs department and funded by the DWP. Its mandate should be to observe precautionary principles of public health. Its staff should be public health professionals. To further restore public confidence, there should be an advisory committee composed of independent public health experts from UCLA and citizen advocates like Erin Brokovich. In addition, the City (and state) should possess the independent analytic capacity to assess the costs of various scenarios for water clean up, including monitoring costs, treatment plant fixes, or the projected costs of closing wells and obtaining imports. The relative costs and savings of conservation measures need to be factored into our analysis as well. These economic issues simply cannot be left to water agencies with a perceived conflict of interest.

These are simply my preliminary suggestions. I await our meeting, if possible before next Tuesday's legislative hearings.

Sincerely,

Tom Hayden

Senator Tom Hayden

California Department of Health Services

Hexavalent Chromium [Chromium (VI)] in Drinking Water

Last Update: September 14, 2000

Background

Total chromium in drinking water is regulated by the Department of Health Services (DHS), in Title 22, California Code of Regulations, Section 64431 (22 CCR §64431). California's drinking water standard, or maximum contaminant level (MCL), is 50 micrograms per liter (µg/L), lower than the federal MCL of 100 µg/L. The World Health Organization uses 50 µg/L as a guideline for total chromium (WHO, 1996). These standards are considered protective of public health, both for trivalent chromium [Cr(III)] and for the more toxic hexavalent chromium, also known as chromium (VI), or Cr(VI).

Health Concerns about Cr(VI)

Chromium is a required nutrient. As Cr(III), it is relatively innocuous as a toxicant (see **The Chromium PHG**, below). On the other hand, Cr(VI) is considered to pose risks to people, primarily since exposures to certain airborne Cr(VI) compounds in occupational situations have resulted in cancer (NTP, 2000).

Despite the concerns about the carcinogenicity of inhaled Cr(VI), the US Environmental Protection Agency (US EPA) doesn't consider Cr(VI) to pose a cancer risk by ingestion (US EPA, 1998a,b). Rather, US EPA considers the accumulation of Cr(VI) by tissues in orally exposed laboratory animals to be the toxicological endpoint for determination of a Reference Dose (RfD), and includes an additional "modifying factor" to take into account possible human effects [**see Appendix 1**].

The WHO does not consider the limited data available to show evidence for carcinogenicity of Cr(VI) via the oral route (WHO, 1993).

The Office of Environmental Health Hazard Assessment (OEHHA) lists Cr(VI) as a carcinogen for purposes of **the Safe Drinking Water and Toxic Enforcement Act of 1986 ("Proposition 65")**. However, it is not considered to pose a significant risk by ingestion, provided that its standards are being met (Title 22, California Code of Regulations, Section 12707(b).

The Chromium PHG

OEHHA established a 2.5-µg/L **Public Health Goal (PHG)** for total chromium in March 1999 (OEHHA, 1999). The PHG reflects OEHHA's review of the toxicity of chromium in drinking water. [**Click here for more about PHGs**]

Noncancer Effects of Chromium in Drinking Water

Chromium III. In its documentation for a **Public Health Goal (PHG)** for total chromium (OEHHA, 1999), OEHHA determined that no human health risk from non-cancer effects would be anticipated at Cr (III) levels of 200,000 µg/L. This value is derived from a two-year feeding study of rats given Cr(III) as chromium oxide, in which no effect was observed following treatment at a single dose level of ~1,500,000 µg Cr(III) per liter per kilogram of body weight per day (5% of diet by weight) (Ivankovic and Preussmann, 1975).

Chromium IV. OEHHA determined, further, that no human health risk would be anticipated at Cr(VI) levels of 70 µg/L. This value is derived from a study in rats given Cr(VI) as potassium chromate at concentrations up to 25,000 µg/L for one year (MacKenzie et al., 1958). At that level, there was no effect. (However, water consumption was reduced ~20 percent.)

[From this same study, US EPA's evaluation and default risk assessment assumptions yield a Cr(VI) level of 20 µg/L as one that would not pose noncancer risks to human health. (**see Appendix 1**)].

Carcinogenic Effects of Chromium in Drinking Water

Chromium III. OEHHA does not consider Cr(III) to be carcinogenic when ingested.

Chromium VI. OEHHA assumed Cr(VI) to be carcinogenic when ingested, based on the carcinogenicity of certain Cr(IV) compounds when inhaled, and on a study of laboratory mice. In that study (Borneff et al. 1968), 2 of 66 female mice exposed to drinking water containing 500,000 µg of potassium chromate per liter for an unspecified time developed malignant tumors of the forestomach, compared to an absence of malignancies in controls. Though this was not a significant difference, there was a significant increase in the sum of malignancies and non-malignant papillomas in treated versus control animals (11/66 vs 2/79).

While acknowledging the uncertainty surrounding the issue of Cr(VI)'s carcinogenicity by the oral route, OEHHA calculated a cancer potency from the mouse study and determined that a drinking water concentration of Cr(VI) of 0.2 µg/L equates to a *"de minimis"* cancer risk, that is, theoretically up to one excess case of cancer per million people over a 70-year lifetime.

In the PHG process, the more restrictive concentration to protect from cancer or noncancer dominates, where both effects occur. Most often this is the level based on cancer risk. For chromium the 0.2-µg/L level, based on cancer risk for Cr(VI), provides the basis for the PHG. For determination of a total chromium PHG, OEHHA assumed that 7% of chromium in drinking water is Cr(VI), based on data from two lakes in North Carolina. The resulting PHG was 2.5 µg/L (OEHHA, 1999).

Cr(VI) Sampling in Drinking Water

Limited information about Cr(VI) in drinking water supplies is available. Data collected by a consultant in 1999 for nine wells in southern California show total chromium concentrations of from 5.3 to 15 µg/L and Cr(VI) concentrations of from 3.6 to 11 µg/L (58 to 100% of the total chromium). These levels of Cr(VI) correspond to an estimated excess lifetime cancer risk of up to 1.8×10^{-5} to 5.5×10^{-5} (**see Table 1**).

Following preliminary sampling in northern and southern California that found 0-91% of total chromium to be Cr(VI), in 2000 DHS sampled and analyzed 14 northern California ground water sources and 4 surface water samples for total chromium and Cr(VI). Total chromium in ground water samples ranged from 11 to 54 µg/L. Cr(VI) accounted for 44 to 100% of the total chromum, and ranged from 7.4 to 34 µg/L. Based on the PHG's assumed carcinogenicity of ingested Cr(VI), these concentrations correspond to an estimated excess lifetime cancer risk from Cr(VI) of up to 3.5 $\times 10^{-5}$ to 1.7×10^{-4}.

Total chromium in the surface water samples ranged from 1.2 to 8.7 µg/L. No Cr(VI) was detected in analyses by DHS laboratories, using a 0.5-µg/L reporting limit. The corresponding estimated excess lifetime cancer risk from Cr(VI) is less than 2.5×10^{-6}.

Future Regulation of Cr(VI)

Following OEHHA's establishment of the chromium PHG (OEHHA, 1999), DHS identified chromium as a contaminant for possible MCL revision. DHS intends to add Cr(VI) to the list of unregulated chemicals for which monitoring is required when it amends the existing "unregulated chemicals" regulation. [see **status report of the MCL review**].

This will enable water systems to collect data on the presence of Cr(VI) in drinking water, which DHS needs to be able to estimate costs of treatment to comply with a Cr(VI)-specific MCL, should one be required. Costs of laboratory analyses will need to be considered, as well.

Table 1. Estimates of potential cancer risk from hexavalent chromium in drinking water. Cancer risk estimates are derived from OEHHA (1999).

Cr(VI) Concentration	% of Chromium MCL	Cancer Risk from Cr(VI) [a]
0.2 µg/L [b]	0.4 %	1×10^{-6}
0.5 µg/L [c]	1 %	2.5×10^{-6}
2 µg/L	5 %	1×10^{-5}
5 µg/L	10 %	2.5×10^{-5}
10 µg/L [d]	20 %	5×10^{-5}
20 µg/L	40 %	1×10^{-4}
50 µg/L	100 %	2.5×10^{-4}

[a] Cancer risk is a theoretical estimate for a 70-year lifetime. The usual range of cancer risks typically allowed by regulatory agencies is from 10^{-6} to 10^{-4} for a lifetime exposure. This corresponds to an excess of up to 1 - 100 cases of cancer per million people over 70 years. The "excess" cancer cases are beyond the 250,000 - 300,000 that would be expected to occur normally in that population.

[b] 0.2 µg/L is the estimated *de minimis* (10^{-6}) cancer risk level for Cr(VI) in drinking water (OEHHA 1999).

[c] 0.5 µg/L is the reporting limit used by DHS' Sanitation and Radiation Laboratories for the Cr(VI) studies mentioned in the text.

[d] 10 µg/L is the detection limit for purposes of reporting (DLR) for chromium, as set forth in 22 CCR §64432(c). The DLR is the level at which DHS is confident about the quantitation of the chromium reported by commercial laboratories using standard methods.

APPENDIX 1.

Calculation of a public health protective concentration (C) of Cr(VI) in drinking water (for non-cancer effects), following the approach used for DHS' **Action Levels** and OEHHA's **Public Health Goals**.

C = (NOAEL x BW x RSC)/(MF x UF x DWC)

Where:

NOAEL	=	the No Observed Adverse Effect Level, in milligrams per kilogram body weight per day (mg/kg-day).
BW	=	body weight, 70 kilograms (kg), the default adult value
RSC	=	the Relative Source Contribution, 0.2 to 0.8. The default value is 0.2 (assumes that 20 percent of the exposure is from drinking water, 80 percent from other sources).
UF	=	Uncertainty Factor, the product of several factors, often 10 for interspecies extrapolation, 10 for differences in individual human sensitivity, 10 for use of a less-than-chronic study, and 10 for inadequacy of data, so that the UF may be from 1 to 10,000, depending on available information.
MF	=	modifying factor, to take into account other factors that are appropriate. Unless specifically stated, MF = 1.
DWC	=	Drinking Water Consumption rate (2 liters per day, L/day)

Based on:		**US EPA, 1998a**	**OEHHA, 1999**
C	=	$\frac{2.5\ \text{mg/kg-day} \times 70\ \text{kg} \times 0.2}{3 \times 300 \times 2\ \text{L/day}}$	$\frac{2.4\ \text{mg/kg-day} \times 70\ \text{kg} \times 0.4}{1 \times 500 \times 2\ \text{L/day}}$
	=	0.019 mg/L, rounded to 0.02 mg/L	0.067 mg/L, rounded to 0.07 mg/L
	=	**20 µg/L**	**70 µg/L**
NOAEL	=	2.5 mg/kg-day*	2.4 mg/kg-day*
BW	=	70 kg	70 kg
RSC	=	0.2	0.4
UF	=	300 (= 10 x 10 x 3)	500 (= 10 x 10 x 5)
MF	=	3**	1
DWC	=	2 L/day	2 L/day

*based on tissue levels of Cr(VI) in rats given Cr(VI) in drinking water for one year

**to account for concerns raised by a study in China that suggested effects in people exposed to ~20,000 µg/L Cr(VI) in drinking water (Zhang and Li, 1987). Other effects (both non-cancer and cancer) were also suggested by that study, though US EPA considered there to be too many uncertainties in the exposures and other confounding factors to identify a NOAEL based on the human data.

References

Borneff, I, K Engelhardt, W Griem, *et al.*, 1968, Carcinogenic substances in water and soil. XXII. Mouse drinking study with 3,4-benzpyrene and potassium chromate [in German], *Arch. Hyg.* 152, 45-53. Cited by OEHHA, 1999.

Ivankovic, S and R Preussmann, 1975, Absence of toxic and carcinogenic effects after administration of high doses of chromic oxide pigment in subacute and long-term feeding experiments in rats. *Food Cosmet. Toxicol.* 13, 347-351. Cited by OEHHA, 1999.

MacKenzie, RD, RU Byerrum, CF Decker, CA Hoppert, RF Langham, 1958, Chronic toxicity studies, II. Hexavalent and trivalent chrommium administered in drinking water to rats. *Am. Med. Assoc. Arch. Ind. Health* 18, 232-234. Cited by OEHHA, 1999.

NTP, 2000, **Chromium Hexavalent Compounds**, *Ninth Report on Carcinogens*, National Toxicology Program, Department of Health and Human Services.

OEHHA, 1999, **Public Health Goal for Chromium in Drinking Water**, Office of Environmental Health Hazard Assessment, February, 1999.

US EPA, 1998a, **Chromium (VI)**, Integrated Risk Information System (IRIS). The last revision for the oral RfD was September 3, 1998.

US EPA, 1998b, **Toxicological Review of Hexavalent Chromium, in Support of Summary Information on the Integrated Risk Information System (IRIS)**, August, 1998.

WHO, 1993, **Guidelines for drinking-water quality**, 2nd ed. Vol. 1. Recommendations, Geneva, World Health Organization, pp. 45-46.

WHO, 1996, **Guidelines for drinking-water quality**, 2nd ed. Vol. 2. Health criteria and other supporting information, 1996 (pp. 940-949), and Addendum to Vol. 2, 1998 (pp. 281-283), Geneva, World Health Organization.

Zhang, J and X Li, 1987, Chromium pollution of soil and water in Jinzhou. *J Chinese Preventive Med* 21: 262-264. Cited by US EPA, 1998a.

Return to PHG Index

Home

Revised June 1992

Hazard Alert	Hazard Evaluation System and Information Service
DEPARTMENT OF HEALTH SERVICES	2151 Berkeley Way, Annex 11 Berkeley, CA 94704 510-540-3138

Hexavalent Chromium

(chromium six, chromium-VI, Cr-VI, Cr-6 - e.g., chromates, chromic acid)

TABLE OF CONTENTS

Hexavalent chromium causes lung cancer in humans. Evaluations by the California Department of Health Services, the U.S. Environmental Protection Agency, and the U.S. Agency for Toxic Substances and Disease Registry indicate that the risk of lung cancer to exposed workers is extremely high. The best estimate of the excess risk of lung cancer from exposure to hexavalent chromium compounds at California's current Permissible Exposure Limit, every working day for 40 years, is 8 cases of lung cancer in every 100 workers exposed.

This Hazard Alert has been issued to warn employers, workers, worker representatives, and others about the serious risk of lung cancer and to provide these groups with information on how to control exposures. A less technical version of this Alert is also being issued.

CHROMIUM IN THE WORKPLACE

Chromium is a metal. It exists in several different forms: divalent, trivalent, and hexavalent. Only hexavalent chromium is recognized as a human carcinogen. **Only hexavalent chromium is discussed in this Alert.**

Hexavalent chromium has many uses. It is used as a pigment in paints, inks, and plastics; as an anti-corrosion agent in protective coatings; and in chrome plating. See the table on page 2 for the names of some common hexavalent chromium compounds and their uses. Workers in many different occupations are exposed to hexavalent chromium. Occupational exposures in California occur mainly among workers who: a) handle dry chromate-containing pigments; b) spray chromate-containing paints and coatings; c) operate chrome plating baths; and d) weld or cut chromium-containing metals such as stainless steel.

HOW CHROMIUM ENTERS THE BODY

Hexavalent chromium enters the body in two ways: by being inhaled or by being swallowed. Chromium can be inhaled when chromium dust, mist, or fumes are in the air. Chromium dust can also get on cigarettes. If contaminated cigarettes are smoked, the smoker inhales additional chromium along with the tobacco smoke.

Particles of chromium can be swallowed if the dust gets on hands, clothing, or beard, or in food or beverages.

HOW CHROMIUM AFFECTS THE BODY

Cancer: Hexavalent chromium causes lung cancer in humans. Workers exposed to hexavalent chromium in workplace air had much higher rates of lung cancer than workers who were not exposed. Studies of workers in the chromate production and pigment industries consistently show increased rates of lung cancer. Studies of chrome platers also generally show increased rates. Studies of stainless steel welders are inconclusive, but stainless steel welders have not been studied adequately. Evaluations by the California Department of Health Services and the U.S. Environmental Protection Agency (EPA) indicate that the risk for workers is extremely high. *The best estimate of the excess risk of lung cancer from exposure to hexavalent chromium compounds at California's current Permissible Exposure Limit (PEL), every working day for 40 years, is 8 cases of cancer in every 100 workers exposed.* An individual worker's actual risk depends on how much hexavalent chromium is in the workplace air and how long the exposure goes on. The lower and briefer the exposure, the less the risk of lung cancer. That's why it is important to take steps to reduce worker exposure immediately.

Respiratory Tract: Hexavalent chromium can irritate the nose, throat, and lungs. Repeated or prolonged exposure can damage the mucous membranes of the nasal passages and cause ulcers to form. In some cases, the damage is so severe that the septum (the wall separating the nasal passages) develops a hole in it.

Skin: Hexavalent chromium is very irritating to the skin. Prolonged contact can cause ulcers to form. Some workers develop an allergic sensitization to chromium. In sensitized workers, contact with even very tiny amounts can cause a serious skin rash.

Eyes: Hexavalent chromium is an eye irritant. Direct eye contact with chromic acid or chromate dusts can cause permanent eye damage.

TESTS FOR EXPOSURE OR MEDICAL EFFECTS

There are no routine medical tests to measure the amount of hexavalent chromium that has been absorbed into the body. Excreted chromium can be measured in urine. However, this test is only useful for measuring recent exposure to stainless steel welding fumes. In most situations, air monitoring gives the best measure of worker exposure. Therefore, measuring hexavalent chromium in blood or urine is not recommended or legally required. However, we recommend that workers who are frequently exposed to hexavalent chromium or other hazardous substances receive a complete physical examination, including an occupational and medical history, at the beginning of employment. Periodic follow-up examinations are also recommended.

SOURCES OF CHROMIUM EXPOSURE

Hexavalent chromium materials are used in many jobs, but three jobs in particular involve frequent and/or heavy chromium exposure. These jobs are spraying anti-corrosion coatings, welding and cutting stainless steel, and chrome plating.

Spraying: In spraying anti-corrosion coatings, a liquid that contains zinc chromate or lead chromate is applied to metal surfaces through a high-pressure spray gun. The spray nozzle creates a mist that can be inhaled. Spraying coatings without adequate control measures can lead to exposure more than twenty times above the legal exposure limit.

Plating: In chrome plating, metal parts are immersed in a liquid solution of chromic acid through which an electric current flows. The electroplating process creates gases that bubble to the tank surface and carry liquid particles of chromic acid solution into the air. This mist can be inhaled. Hard chrome plating, which uses a stronger electric current and a higher tank temperature than bright chrome plating, creates the most chromic acid mist. Hard chrome plating without adequate control measures can lead to exposure several times above the legal exposure limit.

Welding: In welding or cutting, the intense heat of the arc or flame vaporizes the base metal and/or the electrode coating. This vaporized metal condenses into tiny particles called fumes. These fume particles can be inhaled. Chromium fume is created by welding or cutting on stainless steel or metals that are coated with a chromium material. Welding on stainless steel without adequate control measures can lead to exposure at least several times above the legal exposure limit.

Where is Hexavalent Chromium Found?

USES	TYPES OF HEXAVALENT CHROMIUM CHEMICALS
pigments for paints, inks, and plastics	lead chromate (chrome yellow, chrome green, molybdenum orange), zinc chromate, barium chromate, calcium chromate, potassium dichromate, sodium chromate
anti-corrosion coatings (chrome plating, spray coatings)	chromic trioxide (chromic acid), zinc chromate, barium chromate, calcium chromate, sodium chromate, strontium chromate
stainless steel	hexavalent chromium is given off when stainless steel is cast, welded, or torch cut
textile dyes	ammonium dichromate, potassium chromate, potassium dichromate, sodium chromate
wood preservation	chromium trioxide
leather tanning	ammonium dichromate

HOW TO CONTROL CHROMIUM EXPOSURE

The two best ways to prevent inhaling or ingesting chromium-containing particles are substituting chromium-free materials and using local exhaust ventilation. If a substitute cannot be found, a mechanically powered local exhaust hood should be placed at the point where chromium is released into the air, or the entire process should be contained within the hood. Properly designed and maintained local exhaust ventilation draws off most of the chromium before it can be inhaled.

Using local exhaust is far better than relying on dilution of chromium-contaminated air by natural ventilation through open windows and doors, or general ventilation with fresh air brought in through a duct. With the dilution approach, overexposure can still occur at the point of chromium release into the air, or if the dilution air does not mix well with the room air.

Wearing an air-purifying respirator such as a paper mask or rubber mask with screw-in filters is the least effective way to control exposure. In fact, the Cal/OSHA respirator standard (General Industry Safety Order [GISO] 5144 in Title 8 of the California Code of Regulations) allows respirator use to prevent overexposure only as the last resort. This restriction exists because the use of respirators is complex and prone to error, often resulting in inadequate protection.

First, the respirator must be approved for the type of particles in the air; for example, a paper dust mask designed for removing powder particles will not remove the fume particles created by welding. Next, the respirator must be fit-tested to ensure that it fits the wearer's face, and the respirator must be kept in good condition. The fit should be regularly checked. Workers should also be medically examined for their ability to wear a respirator. Even when these and other requirements are met, leakage of contaminated air into the respirator may still occur.

SPECIAL CONTROL MEASURES FOR SPRAYING, WELDING, AND PLATING

Cal/OSHA enforces standards to control workplace exposures to hazardous substances. Cal/OSHA has developed special standards for some workplace processes, including spraying, welding, and plating. These standards are designed to control worker exposure to toxic substances, including chromium. If the provisions of these standards are followed, workers' exposure to chromium will be greatly reduced.

Spraying: Cal/OSHA standard GISO 5153 requires that spray coating operations be confined to properly designed and ventilated spray booths or spray rooms whenever possible, and sets minimum inward air velocities at the spray booth faces. If you must work in a large spray booth downstream from the part being sprayed, an approved respirator must also be worn.

For large-scale spraying of chromium-containing coatings that involves a lot of back-spray, or that is done outside of a spray booth as in construction work, wearing an approved positive-pressure airline respirator with a full facepiece provides the best protection. This respirator delivers fresh air through a high-pressure hose to a tightly-fitting rubber facepiece that seals from the hairline to under the chin. Some airline respirators replace the facepiece with a loose-fitting hood that covers the entire head; however, these hooded respirators tend to allow some inward leakage of contaminated air.

Plating: Cal/OSHA standard GISO 5154 sets minimum air control velocities for local exhaust ventilation systems for chrome plating tanks. Although any chrome plating tank should be equipped with local exhaust ventilation, chromium exposure can be further reduced by placing full or partial covers over the tank. Although covers must be removed to load and unload the parts being plated, covers improve the function of the local exhaust hood. For example, covers prevent strong drafts from windows or fans from carrying chromic acid mist off the tank surface away from the local exhaust hood. Using covers is an effective way to reduce chromium exposure in chrome plating.

Welding: Cal/OSHA standards GISO 5150 and GISO 1536 require the use of local exhaust ventilation where possible for all "indoor" welding and cutting operations. Further, if stainless steel welding or cutting is done in an "enclosed space" where using local exhaust ventilation is impractical, approved airline respirators *must* be worn. For "outdoor" stainless steel welding or cutting, approved respirators *must* be worn; again, an airline respirator rather than an air-purifying fume respirator provides the best protection.

Cal/OSHA construction standard GISO 1537 also regulates the welding and cutting of metals coated with toxic substances, including chromium. The chromium coating must be stripped for at least four inches from the area of heat application before welding or cutting. If the coating is not stripped, approved airline respirators *must* be worn.

LEGAL EXPOSURE LIMITS

Cal/OSHA's current Permissible Exposure Limit (PEL) for water-soluble and certain water-insoluble hexavalent chromium compounds is 0.05 milligrams of chromium per cubic meter of air (0.05 mg/m3). The PEL for zinc chromate is 0.01 mg/m3. The PEL for chromyl chloride is 0.15 mg/m3.

Legally, exposure may be above the PEL at times, but only if it is *below* the PEL at other times, so that the *average* exposure for any 8-hour workshift is no greater than the PEL. Measuring the amount of hexavalent chromium in the air is the only reliable way to determine the exposure level.

The current Permissible Exposure Limit does not adequately protect against lung cancer. We recommend that the amount of hexavalent chromium in the air a worker breathes be kept as low as possible.

If a worker thinks that he may be overexposed, he should talk to his supervisor and/or union representative, or other people listed in the "Resources" section at the end of this Hazard Alert. If any worker might be exposed to a substance at more than the legal exposure limit, the employer must measure the amount of the chemical in the air in the work area (Cal/OSHA standard GISO 5155). Workers have the right to see the results of monitoring relevant to their exposure (Cal/OSHA standard GISO 3204). Workers also have the right to see and copy their own medical records and records of their exposure to toxic substances. These records are important in determining whether a worker's health has been affected by the job. Employers who have such records must keep them and make them available to employees for at least 30 years after the end of employment.

RIGHT TO KNOW

The Hazard Communication Standard (GISO 5194) requires employers to provide workers with information about the hazardous substances to which they may be exposed and to train them to use these substances safely. Employers are also required to have a Material Safety Data Sheet (MSDS) for any workplace product that contains a hazardous substance, and must make the MSDS available to workers or to a treating physician on request. An MSDS is a standard form that lists the chemical contents of a product, describes its health and safety hazards, and gives methods for using and storing it safely. This Hazard Alert is an aid for worker training programs. It does not take the place of a Material Safety Data Sheet or the required employer training.

Failure to comply with GISO 5194 may also constitute failure to comply with the Safe Drinking Water and Toxic Enforcement Act of 1986, popularly known as Proposition 65. Proposition 65 prohibits employers from exposing workers to certain chemicals (including hexavalent chromium) above specified levels without first warning them. These chemicals are on a list of substances "Known to the State of California to Cause Cancer or Reproductive Toxicity." Proposition 65 allows workers to sue an employer for large civil penalties for not providing appropriate warning about listed chemicals.

INJURY AND ILLNESS PREVENTION PROGRAM

SB 198 requires that employers establish an effective Injury and Illness Prevention Program, as described in Cal/OSHA standard GISO 3203. All employers are required to establish a written program for preventing workplace injuries and illnesses, and assign an identified person with real authority and responsibility to administer the program.

Sunday, August 20, 2000
Valley Edition
Section: Metro
Page: B-1

Calls for Reducing Chromium Levels in Water Go Unheeded

■Health: A state agency wants to raise the threshold for acceptable amounts in Valley wells. But not all agree the chemical poses a real risk.

By: ANDREW BLANKSTEIN and CHIP JACOBS
SPECIAL TO THE TIMES

Two years after the state called for slashing levels of a suspected cancer-causing agent in drinking water, authorities have yet to implement the proposal--even though local officials fear the chemical is turning up in greater quantities in San Fernando Valley wells.

Chromium 6--an odorless chemical that has taken center stage in several toxic suits--has been detected in two dozen Valley ground-water wells, including ones operated by the cities of Los Angeles, Burbank and Glendale, officials say.

The chemical also has been detected in 30 of 80 Valley-area federal ground-water monitoring sites, according to U.S. Environmental Protection Agency tests.

Even so, it could take five more years before the state moves to adopt tougher standards for chromium 6, said David Spath, drinking water chief for the state Department of Health Services.

Part of the reason for the delay, according to Spath and others, is that the health risk of chromium 6 in water is still being debated and studied--as are the costs and benefits of stricter standards. Some water officials contend the threat has been exaggerated. Others say there is ample evidence of danger and the state should act more quickly.

"Chromium 6 is a carcinogen in numerous animal species and humans--and is not supposed to be present in water at all," said James Dahlgren, an assistant professor of clinical medicine at UCLA. "It's very unfortunate, but I think the only justification of not lowering the standard seems to be economics: It's a pure cost-benefit calculation. That's what's holding this up."

Local water utility officials, however, say the risks of chromium 6 in water are not proven.

"For many, many years, people have been drinking the water," said Mel Blevins, watermaster for the upper Los Angeles River area, a court-appointed position that oversees ground-water pumping rights in the San Fernando Valley. "I don't see a lot of people sick."

Spath said state officials have spent the last two years developing a test for chromium 6 and sampling wells around the state to determine the extent of the problem.

"Chromium 6 is not something that's routinely analyzed," he said. "You have to develop the method, capability and then do the sampling and analysis."

An analysis of those samples is expected to be completed within weeks, Spath said. The state must then complete a series of rigorous steps before it can mandate new chromium 6 standards for local water utilities, he said.

Those steps include reviews of the health threat posed by chromium 6, also known as hexavalent chromium, and a cost-benefit analysis, since a new standard would increase costs to water agencies.

"It's obvious that hexavalent chromium is on the radar screen," Spath said. "But there's a paucity of data about it, and we think it's appropriate to define the universe." Chromium Used in Manufacturing

Today's chromium 6 problem can be traced to the Valley's legacy as an aerospace and industrial center. Relied on to harden steel, make paint pigments and other tasks, chromium has been used by everyone from warplane makers to electroplating shops.

Chromium itself is a benign element found in nature. But when used in some manufacturing activities, it can transform into the toxic chromium 6.

In concentrated manufacturing areas like the East Valley, chromium 6 can get into soil and ground water by intentional discharges or accident.

Water agencies aren't required to test for chromium 6, and instead monitor for total chromium. But heightened levels of chromium can indicate the presence of its dangerous hybrid, chromium 6.

Currently, the state allows a maximum of 50 parts chromium per billion parts of drinking water. That standard assumes that chromium 6 makes up about 7.2% of any chromium sample--a percentage some officials say is far too low.

In 1998, the state Office of Environmental Health Hazard Assessment issued a draft recommendation to cut the allowable levels of chromium to 2.5 parts per billion. The recommendation, which was made formal in 1999, was based on studies suggesting that chromium 6 could cause cancer when ingested with water, said Dr. David Morry, a state toxicologist who was the main author of the proposal.

Max Costa, who chairs the Department of Environmental Medicine at New York University School of Medicine, said chromium 6 isn't an immediate threat to life. Instead, chromium 6 kills over time, causing cancer decades later.

"If you have the genetic makeup to get cancer and you're exposed to environmental carcinogens like chromium 6, you're going to get cancer," Costa said.

"In an ideal world there should not be any amount of chromium 6 in drinking water," he added. "The state should set the standard as low as possible, and they shouldn't wait to change it."

Changing the standard would be costly, water officials contend.

"I think it would be devastating to water agencies throughout the state and consumers as a result of the rate increases," said Harold Tighe, a public works manager with the city of San Fernando. "People feel they are paying enough for water now."

The Los Angeles Department of Water and Power and the cities of Burbank and San Fernando all pump ground water from Valley wells, which helps reduce reliance on costly imported water. Glendale also has plans to begin pumping well water to mix with imported supplies. New Standards Could Be Costly

Chromium in local water wells currently varies from trace amounts to concentrations as high as 110 parts per billion in Burbank, said Dixon Oriola, a senior engineer with Regional Water Quality Control Board.

San Fernando Valley wells pumped by the Department of Water and Power range from trace amounts of chromium to 30 parts per billion, or more than 12 times the proposed state standard, Oriola said.

Oriola said other local manufacturing centers such as the San Gabriel Valley and the South Bay have pockets of chromium 6 contamination, but said the problems there aren't as bad as the Valley because of the nature of manufacturing, the ground hydrology and other factors.

Valley-area water officials insist tap water is already safe because California chromium standards are more than twice as strict as the federal government's. And they say the impact of a 2.5-part-per-billion health standard for chromium would be an economic tsunami. The potential repercussions include:

* Shutting dozens of local water-supply wells in northern Los Angeles, Burbank and San Fernando.

* Forcing DWP customers to swallow $47 million in added costs annually for imported water from the Metropolitan Water District, said Pankaj Parekh, the DWP's director of water quality compliance. That amounts to $5 a month for the typical customer.

* Putting the brakes on a $2-million well-pumping facility planned by Glendale.

* Requiring Burbank to reopen complex water-pollution agreements negotiated between the city and a slew of industrial polluters such as defense colossus Lockheed Martin. Those polluters paid $60 million to maintain and operate a water treatment plant near Burbank Airport under a federal consent decree.

Burbank would be hit especially hard, since it relies on ground water for 63% of its overall supply. Burbank officials say cutting the chromium standard to 2.5 parts per billion would force them to spend $3 million a year--double the current outlay--for imported water.

"A 2.5 standard would be a crippling blow to all ground-water pumping activities in the Valley," said Blevins, the area watermaster.

Spath said the economic impact will be one of the key issues considered as the state decides whether to adopt a tougher chromium standard or an entirely new standard for chromium 6.

"It's one of the elements the law says you have to evaluate," he said, citing the state's 1996 Safe Drinking Water Act, the law responsible for triggering the state's review of chromium 6 in water.

Currently, the 2.5-parts-per-billion benchmark is a "public health goal" adopted by the Office of Environmental Health Hazard Assessment. In order for that goal to become a legal standard, it must be adopted by the state Department of Health Services. Levels May Be Increasing

Burbank resident Lynnell Murray-Madrid says the state should not take any chances with drinking water, and should adopt the standard immediately.

Murray was raised on Pass Avenue near the old Lockheed Aircraft factory at Burbank Airport. Today, she says five family members are sick--and Murray, a 44-year-old receptionist, believes it stems from their long-term exposure to toxic pollutants, including chromium 6, generated by the company's Cold War operations.

Her mother has Crohn's disease, a gastrointestinal disorder. Her sister, seriously ill in Florida, may have it as well. In 1978, Murray was diagnosed with Hodgkin's disease, a form of cancer.

"Had I known we were exposed to these chemicals, instead of people telling me I was crazy with my symptoms, my cancer could've been caught much earlier," Murray said.

There are also signs that chromium 6 concentrations are increasing.

Gary Yamamoto, chief of technical programs for the state Department of Health Services, said recent tests show that chromium levels--which are presumed to include chromium-6--have increased in the Valley.

"Two local wells in Glendale and Burbank currently exceed allowable levels for total chromium, where two years ago no Valley wells were above the state standard," Yamamoto said. "The problem is, in a year or two, evidence shows more of those wells will exceed the drinking water standard."

A well near the old Lockheed factory in Burbank, for example, went from 15 parts per billion in 1995 to 110 parts per billion in 1999, he said. It fell back to 25 parts per billion in samples taken earlier this year, Yamamoto said.

Water officials point out that the U.S. government and California currently classify chromium 6 as a carcinogen when inhaled, but not when ingested through water.

In his report recommending a new public health goal for chromium, Morry relied heavily on a 1968 German experiment that found two of 66 mice given chromium 6-tainted water developed malignant stomach cancer. An additional nine rodents grew benign tumors.

Morry said his recommendation is based on the assumption that chromium 6 comprises 7.2% of total chromium. But samples taken by state and local officials have found sharply higher concentrations of chromium 6--in some cases more than 50%.

The 7.2% assumption was based on a study of water in North Carolina, he noted.

"Now we're getting data from the California drinking water services," said Morry, the state toxicologist. "If chromium 6 is higher than 7.2% of total chromium, it would suggest having a lower public health goal in the future.

"This health goal has at least caused people to go out and test for chromium 6 when they hadn't done it before," Morry said. "We proceed with the data we have available. And from there, the data only improves." Leaking Tanks Sparked Lawsuit

Chromium 6 has been blamed as a cancer-causing agent in several high-profile lawsuits. In a case made famous by the film "Erin Brockovich," residents of the San Bernardino County town of Hinkley won a $333-million settlement from Pacific Gas & Electric when its underground tanks leaked chromium 6 into ground-water supplies.

Brockovich, a legal assistant on the case who was catapulted to fame by the movie, says she cannot understand why state officials would take so long to deal with its threat to water supplies.

"When you take all of the technical, scientific and legal hoopla out of it, it really comes down to the fact chromium 6 is a poison," Brockovich said. "Do you really want to drink it? I'll tell you I'm not going drink it. And I don't know many people who would."

A final decision on adopting a new standard on chromium will be made by the state Department of Health Services. The agency's director, Diana Bonta, declined to be interviewed, but in a statement defended the time it will take to complete the review.

"These issues are extremely complex and there are no easy fixes," she said. "I am anticipating analysis and recommendations from department scientists on the best actions to protect public health."

* * *

Blankstein is a Times staff writer; Jacobs is a freelance writer.

GRAPHIC: Chromium in the Water
PHOTO: Water utility operator Augustin Tan walks past well near treatment plant.
PHOTOGRAPHER: GEORGE WILHELM / Los Angeles Times
PHOTO: A higher chromium standard would be "crippling" to ground-water pumping activities in the Valley, says watermaster Mel Blevins.
PHOTOGRAPHER: GEORGE WILHELM / Los Angeles Times
Descriptors: Chromium, Water, Hazardous Materials

January 11, 2001

Senate Health and Human Services Committee
State Capitol, Room 2191
Sacramento, CA 95814

TO WHOM IT MAY CONCERN:

The Senate Health and Human Services Committee has our permission to reprint in their October 24, 2000 transcript on Chromium VI an article by Andrew Blankstein and Chip Jacob ***"Calls for Reducing Chromium Levels in Water Go Unheeded"*** published in the Los Angeles Times on August 20, 2000. Copyright 2000 must be visible in the article.

SIGNED,

Lupe Salazar

(LUPE) **LOUPÉ SALAZAR**
Permissions Manager
L.A. Times and Permissions

"Copyright 2000, Los Angeles Times. Reprinted by permission."

0163-4984/00/7401-0041 $13.25

Rats Retain Chromium in Tissues Following Chronic Ingestion of Drinking Water Containing Hexavalent Chromium

JESSICA E. SUTHERLAND,[1] ANATOLY ZHITKOVICH,**,[1] TOMASZ KLUZ,[1] AND MAX COSTA*,[1,3]

[1]Nelson Institute of Environmental Medicine and [2]Kaplan Comprehensive Cancer Center, New York University School of Medicine, 550 First Avenue, New York, NY 10016

Received May 18, 1999; Revised July 7, 1999; Accepted July 15, 1999

ABSTRACT

Humans have sometimes been exposed to as much as 10 ppm Cr(VI) in drinking water from contaminated wells. The risks to these individuals are not well understood because the digestive tract reduces some of the Cr(VI) to the less bioavailable Cr(III) prior to absorption, and the disposition of the remaining Cr(VI) has not been well studied. We determined tissue Cr concentrations in rats after chronic ingestion of Cr(VI) in drinking water at concentrations relevant to human exposure levels. Adult male and female Fischer 344 rats consumed *ad libitum* 0, 0.5, 3, or 10 ppm Cr(VI) as K_2CrO_4 in drinking water for 44 wk. Rats then were given deionized water 4–6 d prior to sample collection. Females given 3 or 10 ppm Cr(VI) consumed more Cr(VI) per unit of body weight than did males. Bone Cr concentrations were significantly elevated in rats that drank 10 ppm Cr(VI). Renal Cr concentrations were significantly elevated in male rats that drank 3 or 10 ppm Cr(VI) and in female rats dosed with 10 ppm Cr(VI). Female rats had elevated liver Cr concentrations after drinking 3 or 10 ppm Cr(VI). Testicular Cr concentrations were slightly elevated in rats that drank 10 ppm Cr(VI). Brain, ovarian, and whole-blood Cr concentrations were below detection limits in all exposure groups. Although tissue Cr accumulation may have resulted from absorption of Cr(III), it is poorly absorbed. Therefore,

*Author to whom all correspondence and reprint requests should be addressed.
**Current address: Department of Pathology and Laboratory Medicine, Brown University, Providence, RI 02912.

the increased tissue retention may also have resulted, in part, from increased absorption of Cr(VI) and its subsequent uptake from the systemic circulation.

Index Entries: Chromium; drinking water; metals; rats.

INTRODUCTION

Of the two stable valence states of chromium (Cr) found in biological systems, hexavalent Cr[Cr(VI)] is much more toxic than trivalent Cr[Cr(III)] *(1–3)*. Less than 1% of ingested trivalent Cr is absorbed in the gastrointestinal tract *(4)* and its entry into cells is negligible. Hexavalent Cr enters cells readily via an anion transport channel *(5)* and is eventually reduced to Cr(III) via several reactive intermediates. Several genotoxic defects result from cellular uptake of Cr(VI). These include sister chromatid exchanges, chromosomal aberrations, DNA strand breaks, and DNA–DNA and DNA–protein crosslinks *(1–3)*. The most abundant forms of Cr–DNA adducts are DNA crosslinks of glutathione or amino acids *(6)*.

Hexavalent Cr is a human and animal carcinogen *(7)*. Increased risk of lung cancer is the primary carcinogenic hazard that has been etiologically linked to chronic Cr exposure. However, epidemiological evidence suggests that Cr exposure is also positively associated with other types of cancers (i.e., sinonasal, esophageal, stomach, intestinal, pancreatic, prostate, and bladder) *(3,8)*. Workers at the highest risk for these Cr-induced cancers are those who inhale Cr(VI) during chromate production, welding, chrome pigment manufacture, chrome plating, stainless-steel production, spray painting, or leather tanning *(7,8)*.

Ingestion of contaminated drinking water is another route by which humans are sometimes exposed to Cr(VI). The United States Environmental Protection Agency (US EPA) drinking water standard for total Cr is currently 100 ppb *(9)*. In some instances, humans have drunk water with Cr levels greatly exceeding this standard. Some residents of Hinkley, CA drank well water that contained as much as 10 ppm total Cr *(10)*. Durant et al. *(11)* estimated that between 1964 and 1979, some residents of Woburn, MA may have consumed water containing 240 ppb total Cr. A subsequent hair analysis failed to confirm this *(12)*, but hair may not be a sensitive indicator of past Cr exposure. In the JinZhou area of LiaoNing Province, China, residents drank groundwater containing as much as 2.6 ppm Cr(VI) *(13)*.

The fate of ingested Cr(VI) in humans has been explored in several recent studies *(14–18)*. The major conclusion reached in all of these studies was that Cr(VI) was reduced in the gastrointestinal tract to Cr(III) prior to absorption, which supports the hypothesis of De Flora et al. *(19)* that virtually all Cr(VI) is reduced to Cr(III) prior to systemic distribution. The human studies measured urinary, plasma, and erythrocyte Cr concentrations to gauge apparent Cr absorption. These methods do not account for Cr present in soft tissues or bone and hence probably underestimate true Cr absorption. This would not be a limitation if Cr(III) was the only form of Cr that was absorbed, because it enters cells poorly and substantial tissue uptake would not be expected. On the other hand, tissue uptake of Cr would occur if Cr(VI) was bioavailable to cells or if Cr(III) was bound to organic complexes that enhanced its entry into cells. Another potential limitation of the human studies is that exposure to Cr(VI) has always been studied using relatively short exposure intervals. The longest exposure period employed was 17 d *(18)* and that study utilized only one test subject.

Rats exposed chronically to Cr(VI) in drinking water accumulated Cr in tissues *(20–23)*. In 1958, MacKenzie et al. *(20)* employed drinking water Cr(VI) concentrations relevant to human exposure (0–25 ppm) and a 1-yr exposure period, but modern analytical techniques had not yet become available. Moreover, total Cr concentrations were measured in only four tissues (i.e., liver, kidney, bone, and spleen) and the results were not subjected to statistical analysis. The other studies exposed rats to very high concentrations of Cr(VI) (range: 100–750 ppm) in drinking water for 4 wk to 3 mo. The high Cr(VI) concentrations used are not typically associated with human Cr(VI) exposure from drinking water.

The purpose of our study was to measure total Cr concentrations in liver, kidney, blood, bone, brain, and testis or ovaries in male and female rats exposed to Cr(VI) at drinking water concentrations of 0, 0.5, 3, or 10 ppm that were relevant to human exposure levels.

METHODS

Animals and Chemicals

Male and female Fisher 344 rats (187.5 ± 1.6 and 128.3 ± 0.6 g, respectively) were obtained from Charles River (Kingston, NY). They were housed singly in stainless-steel wire-bottomed cages, exposed to a 12-h light/dark cycle, and allowed free access to food [Purina Rodent Laboratory Chow 5001, containing 1.8 ppm Cr(III)] and drinking water. The water was first deionized and then 0, 0.5, 3, or 10 ppm Cr(VI) as potassium chromate (K_2CrO_4) (Fisher Scientific, Pittsburgh, PA) was added. Freshly prepared water was supplied to the rats on a weekly basis. Previous experience indicated that the Cr(VI) concentrations in water remained stable over this time interval. There were seven males and seven females per treatment and they were exposed to Cr(VI) for 44 wk. Total water consumption rates were recorded on a weekly basis.

Tissue Cr Analysis

Four to 6 d prior to sacrifice, rats were switched to deionized water [0 ppm Cr(VI)] so that tissue measurements would not be influenced by very recent exposure. Rats were sacrificed by ip injection of 80 mg/kg sodium pentobarbital and exsanguinated. Kidneys, liver, brain, tibias, testes, and ovaries were removed, cleaned of adherent matter, rinsed with deionized water, weighed, and frozen in acid-washed polypropylene centrifuge tubes.

Kidneys (0.6–1.4 g) were placed in an acid-washed graphite-bottom Teflon beaker, covered with an inverted watch glass, and digested overnight at room temperature in 1 ml of nitric acid (HNO_3) (Optima, Fisher Scientific, Pittsburgh, PA). On the following day, 1 ml of additional HNO_3 was added and the tissue/acid mixture was heated to boiling. Approximately 5–6 ml of a 3 : 1 hydrogen peroxide (30%; Mallinckrodt AR Select, Mallinckrodt Baker, Paris, KY)/HNO_3 solution was added and the samples were boiled to dryness and reconstituted with 3 mL deionized water and diluted further as needed for analysis. Samples were analyzed for total Cr content using graphite-furnace atomic absorption spectrophotometry with deuterium background correction (Thermo Jarrell Ash, Franklin MA).

Liver (0.7–1.2 g), brain (0.8–1.1 g), bone (0.5–1.0 g), whole blood (1.5–2 ml), testis (0.7–1.3 g), and ovarian (0.1–0.2 g) samples were weighed, placed in new 20 × 125-mm borosilicate glass culture tubes with polypropylene screw caps, and digested in a low-trace-metal-reagent grade $HNO_3/HClO_4$ mixture until complete dissolution and destruction of organic matter occurred. Samples were then diluted up to 20 ml final volume with deionized water (final $HClO_4$ content was 10% [v/v]) and were analyzed in triplicate for total Cr by inductively coupled plasma (optical)–atomic emission spectrophotometry (ICP-AES) or inductively coupled plasma–mass spectrometry (ICP-MS). Chromium was measured by ICP-AES using the emission line 267.716 as part of a simultaneous 30-element analysis with a modified Thermo-Jarrel Ash Model EnvironScan 36 instrument. Bone samples were instrumentally optically saturated with calcium and phosphorus and, hence, were reanalyzed with ICP-MS using a Perkin-Elmer Model ELAN 5000 instrument and monitored for the Cr-52 and Cr-53 isotopes. Because of low sample weights (e.g., ovaries), ovarian and testicular Cr values were also measured using ICP-MS because this method has lower detection limits. Detection limits for ICP-AES and ICP-MS were 5 and 2.5 ppb Cr in solution. These procedures were conducted by personnel at Huffman Laboratories (Golden, CO).

Analytical accuracy was assessed by measuring total Cr in liver, bone, brain, and testis samples spiked with a known amount of Cr(VI). Recovery of Cr in these spiked samples was 101.7 ± 2.9% (range = 92.3–116.4%). In addition, spikes of Cr from a National Institute of Standards and Technology (NIST) source independent of the instrument calibration standards were added to empty digestion tubes and processed and analyzed as unknowns along with the samples. Average Cr recovery in these spikes was 95.7 ± 1.3% (range = 86.5–100.6%).

Estimation of Cr Body Burden

The total mass of Cr in each of the organs analyzed was calculated by multiplying the measured organ weights by their respective organ Cr concentrations. We assumed bone and liver masses to be 5% and 4% of rat body weight, respectively *(24)*. The total Cr body burden was the sum of kidney, bone, and liver Cr in females and kidney, bone, liver, and testes Cr in males.

Statistics

Whenever necessary, data were log-transformed to reduce heteroscedasticity. Water consumption, Cr consumption, and tissue Cr concentrations were analyzed for the effects of Cr(VI) dosage and rat gender by analysis of variance (ANOVA) *(25)*. When ANOVA indicated a significant overall dose and/or gender effect ($p \leq 0.05$), tests of least significant difference (LSD) were used to compare individual treatment means.

RESULTS

Water Consumption and Cr Ingestion

Rats receiving Cr(VI) drank the same volume of water as control rats throughout the study. Male rats given 0, 0.5, 3, or 10 ppm Cr(VI) drank 7.3 ± 0.2, 7.2 ± 0.3, 7.4 ± 0.2, and 6.9 ± 0.2 (mean ± SE) of water, respectively. Female rats dosed with 0, 0.5, 3, or 10 ppm Cr(VI) drank 6.8 ± 0.2, 6.8 ± 0.3, 6.7 ± 0.1, and 6.9 ± 0.3 L of water, respectively. There were no differences in water consumption between male and female rats. Accordingly, the total amount of Cr(VI) ingested was directly proportional to the Cr(VI) concentration of the water. Male rats were given 0, 0.5, 3, or 10 ppm Cr(VI) ingested 0, 3.6 ± 0.1, 22.1 ± 0.6, or 69.3 ± 2.0 mg (mean ± SE) of Cr(VI), respectively. Females dosed with 0, 0.5, 3, or 10 ppm Cr(VI) consumed 0, 3.4 ± 0.1, 20.0 ± 0.4, or 68.8 ± 1.2 mg (mean ± SE) of Cr(VI), respectively. Throughout the study, females weighed less than males. Therefore, females given 3 or 10 ppm Cr(VI) consumed significantly more Cr(VI) per gram of body weight than did males (ANOVA, $p \leq 0.0001$). (Fig. 1).

Chromium Concentrations in Tissues

Bone Cr concentrations were only significantly elevated above control levels in rats that had ingested 10 ppm Cr(VI) in their drinking water (Fig. 2). This was true for both male and female rats. In bone, Cr concentration varied significantly with Cr(VI) dose (ANOVA, $p \leq 0.0001$). There were no significant differences in bone Cr concentrations between male and female rats that had consumed 10 ppm Cr(VI).

Kidney Cr concentrations varied significantly with water Cr(VI) concentration (ANOVA, $p \leq 0.0001$) (Fig. 3). In females, renal Cr concentrations

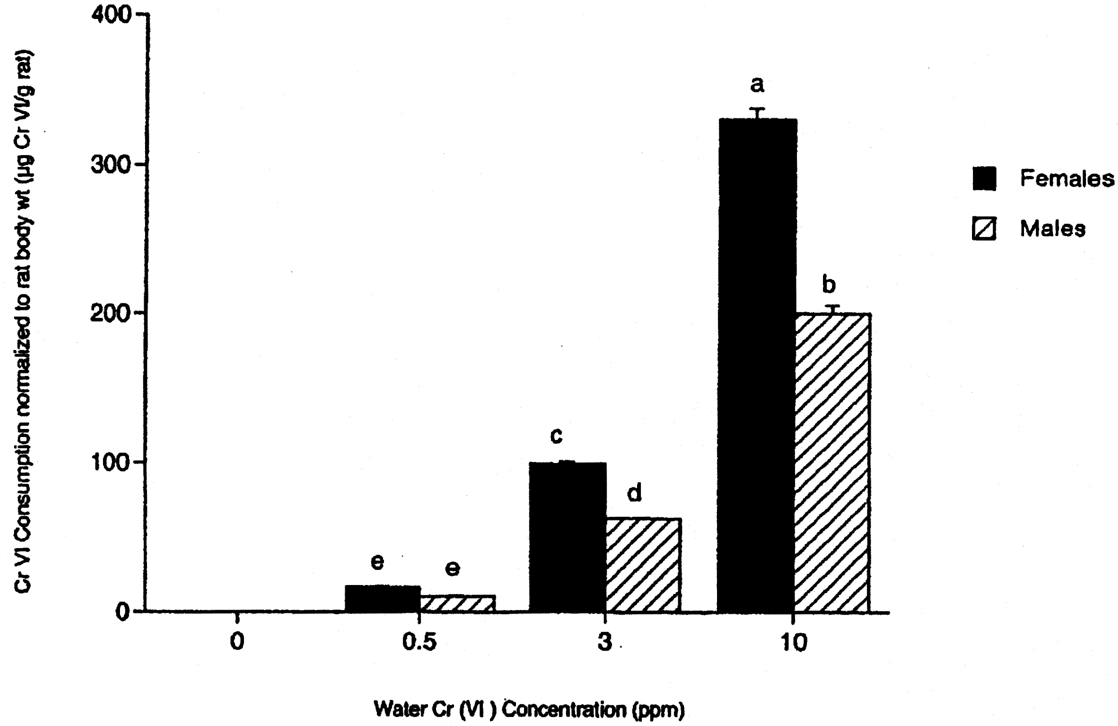


Fig. 1. Total Cr(VI) consumption normalized to body weight in male and female rats. Values are means ± SE. Total Cr(VI) consumption normalized to body weight varied significantly with water Cr(VI) concentration and with rat gender ($p \leq 0.0001$). Means that do not share a common superscript are significantly different ($p \leq 0.05$).

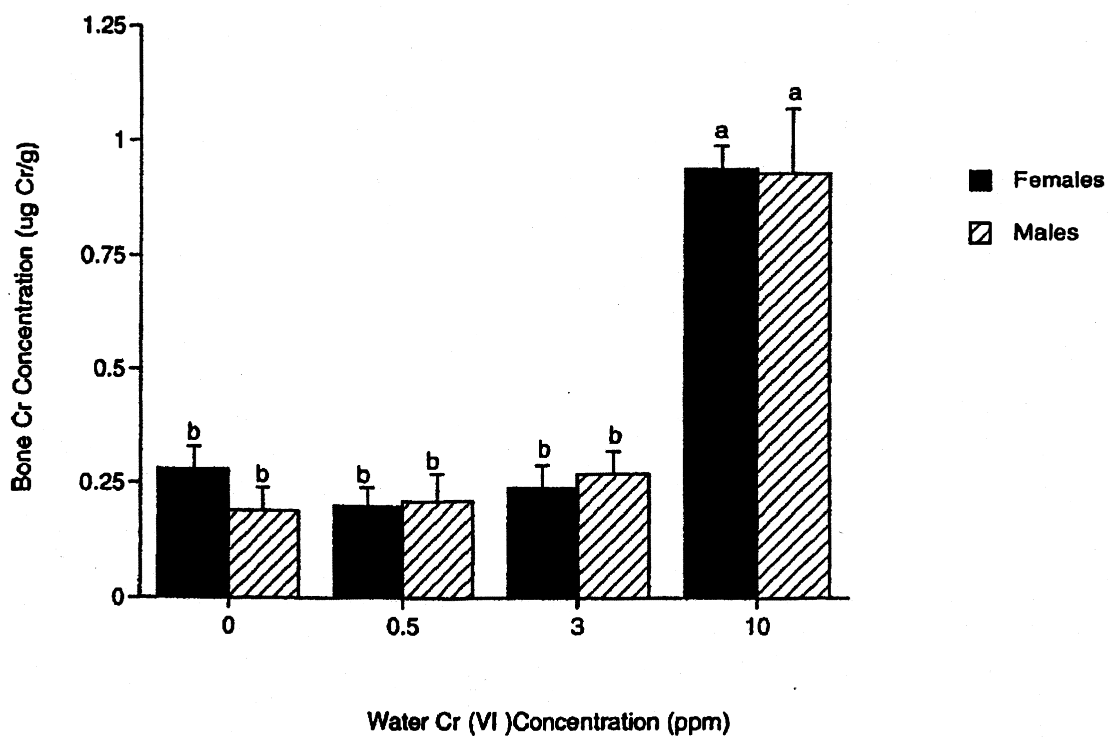


Fig. 2. Bone Cr concentrations in male and female rats following chronic ingestion of water containing Cr(VI). Values are means ± SE. Bone Cr concentrations varied significantly with water Cr(VI) concentration ($p \leq 0.0001$). Means that do not share a common superscript are significantly different ($p \leq 0.05$).

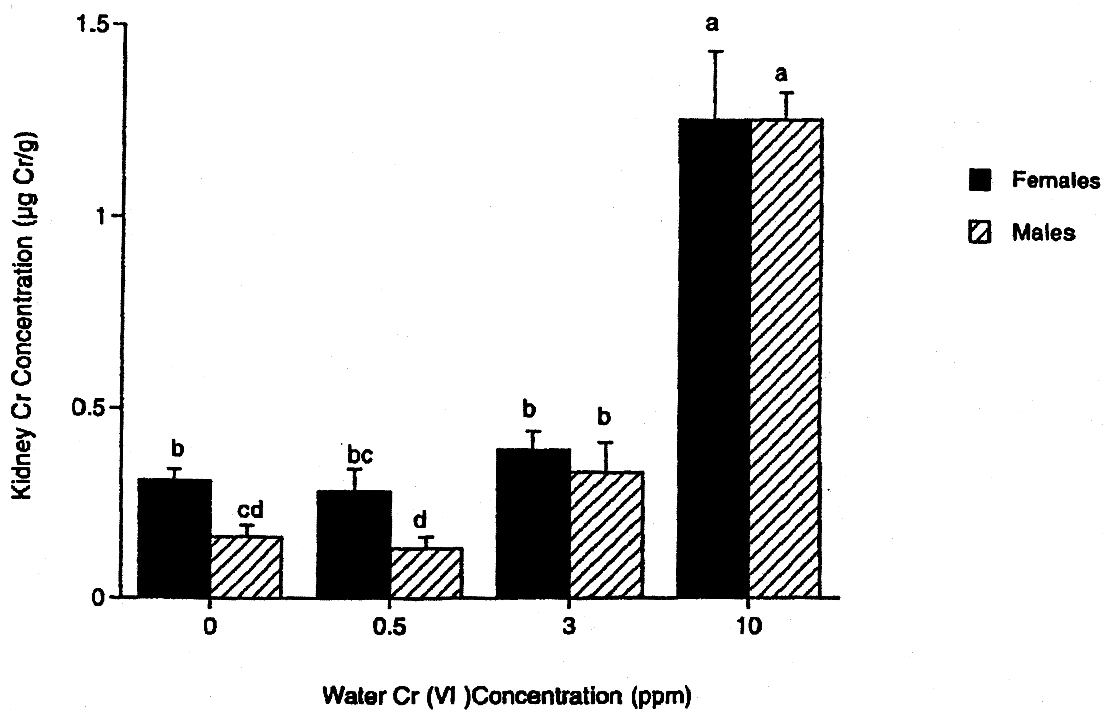


Fig. 3. Renal Cr concentrations in male and female rats following chronic consumption of water containing Cr(VI). Values are means ± SE. Renal Cr concentrations varied significantly with water Cr(VI) concentration ($p \leq 0.0001$) and with rat gender ($p \leq 0.001$). Means that do not share a common superscript are significantly different ($p \leq 0.05$).

were only significantly elevated above controls in the animals that had drunk water containing 10 ppm Cr(VI). Male rats, on the other hand, had significantly elevated renal Cr concentrations following ingestion of 3 or 10 ppm Cr(VI) in drinking water.

Liver Cr concentrations did not vary significantly with Cr(VI) dose in male rats (ANOVA, $p \leq 0.4$) (Fig. 4). Male rats also had higher baseline liver Cr concentrations than females. In female rats, liver Cr concentrations varied significantly with Cr(VI) dose (ANOVA, $p \leq 0.01$). Females that ingested 3 or 10 ppm Cr(VI) had significantly higher liver Cr concentrations than controls.

Testis Cr concentrations were below detection limits (0.05–0.1 µg Cr/g) in rats that consumed 0, 0.5, or 3 ppm Cr(VI). Rats that drank 10 ppm Cr(VI) had an average testiscular Cr concentration of 0.2 µg Cr/g wet weight. Chromium concentrations in brain, whole blood, and ovaries were below detection limits in all rats.

Calculated Body Cr Burden

The estimated total-body burden of Cr varied significantly with Cr(VI) dose (ANOVA, $p \leq 0.0001$) (Fig. 5). In both males and females, body Cr burdens among rats dosed with 0.5 or 3 ppm Cr(VI) did not differ significantly from those of control animals. Estimated body Cr

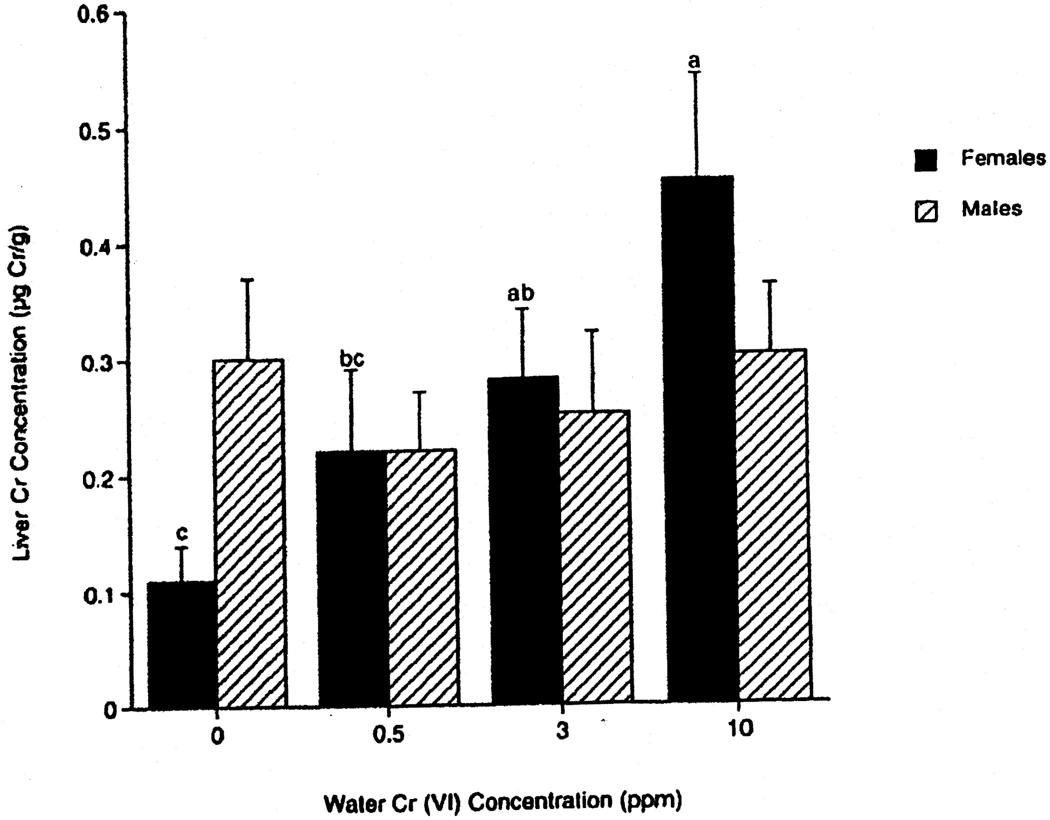


Fig. 4. Hepatic Cr concentrations in male and female rats following chronic consumption of water containing Cr(VI). Values are means ± SE. Chromium concentrations in liver varied significantly with water Cr(VI) concentration in female rats only ($p \leq 0.01$). Tests of least significant difference were therefore only used to compare mean hepatic Cr in female rats. Means that do not share a common superscript are significantly different ($p \leq 0.05$).

burdens were significantly greater than controls in male and female rats that ingested 10 ppm Cr(VI) in drinking water.

DISCUSSION

Significant tissue accumulation of Cr occurred following chronic ingestion of water containing 3 or 10 ppm Cr(VI). This observation confirms that a portion of the ingested Cr(VI) was bioavailable (i.e., Cr was absorbed and taken up from the systemic circulation by a variety of tissues).

Chromium was most highly concentrated in kidney and bone in our rats. This pattern of disposition is similar to those observed by MacKenzie et al. *(20)* in rats given similar concentrations of Cr(VI) in water and in rats that drank 100 ppm Cr(VI) in water for 6 wk *(22)*. Witmer et al. *(26,27)* also reported these tissues to be significant Cr repositories in rats following gavage doses of Cr(VI). Of interest was our finding that renal

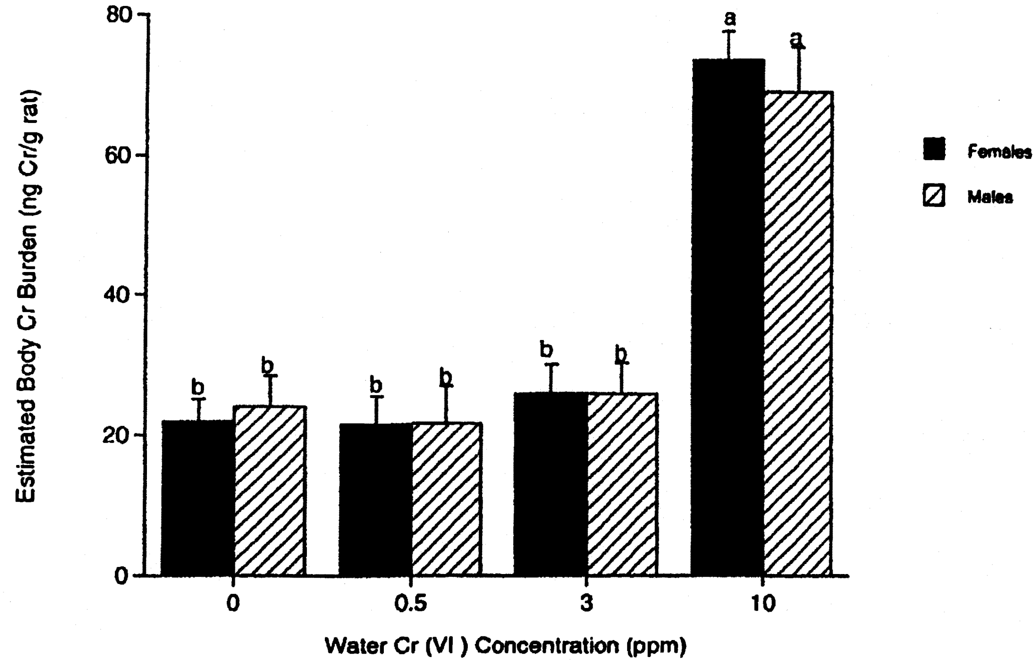


Fig. 5. Estimated total-body burden of Cr normalized to body weight in male and female rats following chronic consumption of water containing Cr(VI). Values are means ± SE. Body burdens of Cr varied significantly with water Cr(VI) concentration ($p \leq 0.0001$). Means that do not share a common superscript are significantly different ($p \leq 0.05$).

Cr concentrations were significantly elevated in male rats following exposure to water containing only 3 ppm Cr(VI). The fact that females did not show similar renal Cr accumulation at this dose is surprising, given the fact that they consumed more Cr per gram body weight than males. The deposition of Cr in kidney is not surprising in light of its well-documented nephrotoxicity *(28,29)*.

Female rats that drank water containing 3 or 10 ppm Cr(VI) had significantly higher hepatic Cr concentrations than controls. This finding agrees with that of Mackenzie and co-workers *(20)* who utilized Cr(VI) concentrations and exposure conditions similar to those in our study. The liver was the only tissue in female rats in which significantly elevated Cr concentrations could be observed following ingestion of 3 ppm Cr(VI). Although the liver is the first organ to receive absorbed Cr via the portal circulation, apparently it did not retain Cr as well as kidney or bone. In this study, male rats did not exhibit a dose-related increase in hepatic Cr concentrations. Males exhibited three times greater baseline Cr concentrations in liver than females. However, after drinking water with 0.5, 3, or 10 ppm Cr(VI), they did not retain significant amounts of Cr in liver. The only known source of Cr exposure in control rats was Cr(III) via the diet. Male and females were given the same diet *ad libitum;* therefore, the differences between baseline male and female hepatic Cr concentrations cannot be attributed to dietary intake. To our knowledge, only one other study reported baseline hepatic Cr levels for male and female rats. No differences were found *(20)*.

We were not able to detect any Cr in whole blood or brain in any of the rats given Cr(VI). The absence of detectable Cr in whole blood is probably the result of rapid Cr delivery to tissues and clearance of plasma Cr by the kidneys. Once taken up by cells, Cr is bound to intracellular ligands and is very slow to leave; therefore, whole-blood Cr levels are not a good indicator of tissue Cr levels *(30)*. Moreover, the ICP-AES technique is fairly insensitive in the low range of expected blood Cr values in this study; therefore, we would not have been able to reliably detect small elevations in blood Cr had they occurred following Cr(VI) exposure. A lack of Cr accumulation in the brain was puzzling because CrO_4^{-2}, like phosphate, should be taken up by all tissues of the body including the brain. Witmer et al. *(26)* did not observe Cr accumulation in the brains of rats following 14-d gavage treatments of 240 µmol Cr(VI)/kg rat which is a much higher Cr(VI) dose than what we employed.

Male rats that drank water containing 10 ppm Cr(VI) had elevated testicular Cr concentrations at the conclusion of our study. The Cr concentrations in testes were modest compared to those found in bone and in kidney. This suggests that the blood–testis barrier was somewhat effective in limiting testicular uptake of Cr. Other investigators, using much higher oral or ip Cr(VI) doses, reported testicular atrophy, reduced sperm counts, and reduced sperm motility in male rats *(31–33)*.

Despite consuming significantly more Cr than males during the study period, females did not have higher estimated body burdens than males. This lack of differences can be explained, at least in part, by the contribution of testicular Cr to male-body Cr burdens. In addition, these data suggest that ingested Cr may have been less bioavailable to females or that females may have more effectively cleared the ingested Cr.

Many investigators have postulated that ingestion of Cr(VI) is relatively harmless because the Cr(VI) is reduced in the gastrointestinal tract, liver, and/or blood to Cr(III), a form which is poorly absorbed and enters cells poorly *(15–17,19)*. We have demonstrated that significant tissue uptake of Cr occurred in rats chronically exposed to 3 or 10 ppm Cr(VI) via drinking water with the effect being most pronounced at the 10 ppm Cr(VI) exposure level. There are at least two possible nonmutually exclusive explanations. A portion of the ingested Cr(VI) may have escaped reduction, entered the systemic circulation, and was available for cellular uptake. The other possibility is that the Cr(III) that was formed in the gut and absorbed was not cleared by the kidneys and was taken up by the cells. Olin et al. *(34)* demonstrated cellular uptake of Cr(III) in several tissues following a gavage dose to rats. Moreover, there may be differences in the pharmacokinetics of newly reduced Cr(III) that has not found optimal ligands for coordination compared with Cr(III) that was reduced prior to ingestion.

Regardless of the mechanism, the possible toxicological implications of this finding warrant attention. Once inside cells, Cr(III) binds to intracellular ligands and is capable of inducing DNA damage *(30,35)*. Two recent investigations have not found evidence of genotoxicity following acute exposure to oral Cr(VI) in mice, rats, or humans *(36,37)*. In these studies *(36,37)*, the investigators hypothesized that genotoxic levels in the target tissues had not accumulated as a result of the short-term exposure periods. The current data suggest that the possible toxic effects associated with tissue Cr accumulation following chronic oral exposure to Cr(VI) should be further investigated.

ACKNOWLEDGMENTS

This study was supported by grants ES05822, ES04895, ES05512, and ES00260 from the National Institute of Environmental Health Sciences and grant CA16087 from the National Cancer Institute. We thank Ron Keil, Huffman Laboratories, for supervision of the chemical analyses and helpful discussions.

REFERENCES

1. C. B. Klein, Carcinogenicity and genotoxicity of chromium, in *Toxicology of Metals*, L. W. Chang, ed., CRC, Boca Raton, FL, pp. 205–219 (1996).
2. J. Singh, D. L. Carlisle, D. E. Pritchard, and S. R. Patierno, Chromium-induced genotoxicity and apoptosis: relationship to chromium carcinogenesis (review), *Oncol. Rep.* 5, 1307–1318 (1998).
3. M. D. Cohen and M. Costa, Chromium compounds, in *Environmental and Occupational Medicine*, W. Rom, ed., Lippincott-Raven, Philadelphia, pp. 1045–1055 (1998).
4. R. A. Anderson, M. M. Polansky, N. A. Bryden, K. Y. Patterson, C. Veillon, and W. H. Glinsmann, Effects of chromium supplementation on urinary Cr excretion of human subjects and correlation of Cr excretion with selected clinical parameters, *J. Nutr.* **113**, 276–281 (1983).
5. S. Kitagawa, H. Seki, F. Kametani, and H. Sakurai, Uptake of hexavalent chromium by bovine erythrocytes and its interaction with cytoplasmic components; the role of glutathione, *Chem. Biol. Interact.* **40**, 265–274 (1982).
6. A. Zhitkovich, V. Voitkun, and M. Costa, Glutathione and free amino acids form stable complexes with DNA following exposure of intact mammalian cells to chromate, *Carcinogenesis* **16**, 907–913 (1995).
7. IARC, Chromium, Nickel and Welding, *IARC Mongraph on the Evaluation of Carcinogenic Risks to Humans*, Vol. 49, International Agency for Research on Cancer, Lyon, France (1990).
8. M. D. Cohen, B. Kargacin, C. B. Klein, and M. Costa, Mechanisms of chromium carcinogenicity and toxicity, *Crit. Rev. Toxicol.* **23**, 255–281 (1993).
9. U.S. Environmental Protection Agency, *National Interim Primary Drinking Water Regulations*, EPA publication 570/9-76/003, U.S. Government Printing Office, Washington, DC (1976).

10. M. Costa, Toxicity and carcinogenicity of Cr(VI) in animal models and in humans, *Crit. Rev. Toxicol.* **27**, 431–442 (1997).
11. J. L. Durant, J. Chen, H. F. Hemond, and W. G. Thilly, Elevated incidence of childhood leukemia in Woburn, Massachusetts: NIEHS Superfund Basic Research Program searches for causes, *Environ. Health Perspect.* **103(Suppl 6)**, 93–98 (1995).
12. C. E. Rogers, A. V. Tomita, P. R. Trowbridge, J. K. Gone, J. Chen, P. Zeeb, et al., Hair analysis does not support hypothesized arsenic and chromium exposure from drinking water in Woburn, Massachusetts, *Environ. Health Perspect.* **105**, 1090–1097 (1997).
13. J. D. Zhang and S. Li, Cancer mortality in a Chinese population exposed to hexavalent chromium in water, *J. Occup. Environ. Med.* **39**, 315–319 (1997).
14. B. L. Finley, P. K. Scott, R. L. Norton, M. L. Gargas, and D. J. Paustenbach, Urinary chromium concentrations in humans following ingestion of safe doses of hexavalent and trivalent chromium: implications for biomonitoring, *J. Toxicol. Environ. Health* **48**, 479–499 (1996).
15. B. L. Finley, B. D. Kerger, M. W. Katona, M. L. Gargas, G. C. Corbett, and D. J. Paustenbach, Human ingestion of chromium (VI) in drinking water: pharmacokinetics following repeated exposure, *Toxicol. Appl. Pharmacol.* **142**, 151–159 (1997).
16. B. D. Kerger, D. J. Paustenbach, G. E. Corbett, and B. L. Finley, Absorption and elimination of trivalent and hexavalent chromium in humans following ingestion of a bolus dose in drinking water, *Toxicol. Appl. Pharmacol.* **141**, 145–158 (1996).
17. B. D. Kerger, B. L. Finley, G. E. Corbett, D. G. Dodge, and D. J. Paustenbach, Ingestion of chromium(VI) in drinking water by human volunteers: absorption, distribution, and excretion of single and repeated doses, *J. Toxicol. Environ. Health* **50**, 67–95 (1997).
18. D. J. Paustenbach, S. M. Hays, B. A. Brien, D. G. Dodge, and B. D. Kerger, Observation of steady state in blood and urine following human ingestion of hexavalent chromium in drinking water, *J. Toxicol. Environ. Health* **49**, 453–461 (1996).
19. S. De Flora, A. Camoirano, M. Bagnasco, C. Bennicelli, G. E. Corbett, and B. D. Kerger, Estimates of the chromium(VI) reducing capacity in human body compartments as a mechanism for attenuating its potential toxicity and carcinogenicity, *Carcinogenesis* **18**, 531–537 (1997).
20. R. D. MacKenzie, R. U. Byerrum, C. F. Decker, C. A. Hoppert, and R. F. Langham, Chronic toxicity studies. II. Hexavalent and trivalent chromium administered in drinking water to rats, *AMA Arch. Industr. Health* **18**, 232–234 (1958).
21. B. Kargacin, K. S. Squibb, S. Cosentino, A. Zhitkovich, and M. Costa, Comparison of the uptake and distribution of chromate in rats and mice, *Biol. Trace Element Res.* **36**, 307–318 (1993).
22. R. V. Thomann, C. A. Snyder, and K. S. Squibb, Development of a pharmacokinetic model for chromium in the rat following subchronic exposure. I. The importance of incorporating long-term storage compartment, *Toxicol. Appl. Pharmacol.* **128**, 189–198 (1994).
23. R. K. Kanojia, M. Junaid, and R. C. Murthy, Embryo and fetotoxicity of hexavalent chromium: a long-term study, *Toxicol. Lett.* **95**, 165–172 (1998).
24. H. V. Rao, R. P. Beliles, G. M. Whitford, and C. H. Turner, A physiologically based pharmacokinetic model for fluoride uptake by bone, *Regul. Toxicol. Pharmacol.* **22**, 30–42 (1995).
25. SAS Institute, *User's Guide: Statistics*, 5th ed., SAS Institute, Cary, NC (1985).
26. C. M. Witmer, R. Harris, and S. I. Shupack, Oral bioavailability of chromium from a specific site, *Environ. Health Perspect.* **92**, 105–110 (1991).
27. C. M. Witmer, R. Harris, and S. I. Shupack, Chromium content of bone after oral and intraperitoneal (ip) administration of chromium (VI) to rats, *Toxicologist* **11**, 41 (1991).
28. A. D. Baines, Cell renewal following dichromate induced renal tubular necrosis. An enzyme histochemical study, *Am. J. Pathol.* **47**, 851–876 (1965).
29. W. O. Berndt, Renal chromium accumulation and its relationship to chromium-induced nephrotoxicity, *J. Toxicol. Environ. Health* **1**, 449–459 (1976).
30. D. M. Stearns, J. J. Belbruno, and K. E. Wetterhahn, A prediction of chromium(III) accumulation in humans from chromium dietary supplements, *FASEB J.* **9**, 1650–1657 (1995).

31. H. Bataineh, M. H. al-Hamood, A. Elbetieha, and I. Bani Hani, Effect of long-term ingestion of chromium compounds on aggression, sex behavior and fertility in adult male rat, *Drug Chem. Toxicol.* **20,** 133–149 (1997).
32. E. Ernst, Testicular toxicity following short-term exposure to tri- and hexavalent chromium: an experimental study in the rat, *Toxicol. Lett.* **51,** 269–275 (1990).
33. E. Ernst and J. P. Bonde, Sex hormones and epididymal sperm parameters in rats following sub-chronic treatment with hexavalent chromium, *Hum. Exp. Toxicol.* **11,** 255–258 (1992).
34. K. L. Olin, D. M. Stearns, W. H. Armstrong, and C. L. Keen, Comparative retention/absorption of ^{51}chromium (^{51}Cr) from ^{51}Cr chloride, ^{51}Cr nicotinate and ^{51}Cr picolinate in a rat model. *Trace Elements Electrol.* **11,** 182–186 (1994).
35. A. Zhitkovich, V. Voitkun, and M. Costa, Formation of the amino acid–DNA complexes by hexavalent and trivalent chromium in vitro: importance of trivalent chromium and the phosphate group, *Biochemistry* **35,** 7275–7282 (1996).
36. J. C. Mirsalis, C. M. Hamilton, K. G. O'Loughlin, D. J. Paustenbach, B. D. Kerger, and S. Patierno, Chromium (VI) at plausible drinking water concentrations is not genotoxic in the in vivo bone marrow micronucleus or liver unscheduled DNA synthesis assays, *Environ. Mol. Mutagen.* **28,** 60–63 (1996).
37. J. R. Kuykendall, B. D. Kerger, E. J. Jarvi, G. E. Corbett, and D. J. Paustenbach, Measurement of DNA–protein cross-links in human leukocytes following acute ingestion of chromium in drinking water, *Carcinogenesis* **17,** 1971–1977 (1996).

January 11, 2001

Senate Health and Human Services Committee
State Capitol, Room 2191
Sacramento, CA 95814

TO WHOM IT MAY CONCERN:

The Senate Health and Human Services Committee has our permission to reprint in their October 24, 2000 transcript on Chromium VI the following:

ARTICLE: **Rats Retain Chromium in Tissues Following Chronic Ingestion of Drinking Water Containing Hexavalent Chromium**

AUTHORS: Jessica E. Sutherland, Anatoly Zhitkovich, Tomasz Kluz, and Max Costa

PUBLISHED IN: Biological Trace Element Research, Vol 74, 2000 (see attached)

Copyright 2000 must be visible in the article.

SIGNED,

PERMISSION GRANTED
Wendy Wa— 1/15/01
THE HUMANA PRESS, INC.

~~**CRAIG ADAMS**~~
~~**Rights and Permissions**~~
~~**Humana Press, Inc.**~~
~~**999 Riverview Drive**~~
~~**Totowa, NJ 07512**~~

973-256-1699

32 - 0153

SCHOOL OF MEDICINE
NEW YORK UNIVERSITY
Max Costa, Ph.D., Professor and Chairman
Department of Environmental Medicine
NYU School of Medicine
57 Old Forge Road
Tuxedo, NY 10987
Telephone: (845) 731-3515 Fax: (845) 351-2118
E-mail: costam@env.med.nyu.edu

December 21, 2000

Senate Health and Human Services
State Capitol
Room 2191
Sacramento, CA 95814
Attention: Moe

As requested, I hereby give my permission to copy the article entitled "Rats Retain Chromium in Tissues Following Chronic Ingestion of Drinking Water Containing Hexavalent Chromium" which was published in Biological Trace Element Research. You may also have to request permission from Humana Press, Inc. who is the publisher.

Sincerely,

Max Costa, Ph.D.
Professor and Chairman

TRANSCRIPT OF

HEARING

JOINT INFORMATIONAL HEARING
OF THE
SENATE COMMITTEE ON HEALTH & HUMAN SERVICES
Senator Deborah Ortiz, Chair
SENATE COMMITTEE ON NATURAL RESOURCES & WILDLIFE
Senator Tom Hayden, Chair
AND THE
ASSEMBLY ENVIRONMENTAL SAFETY & TOXIC MATERIALS COMMITTEE
Assemblymember Hannah-Beth Jackson, Chair

"Health Effects of Chromium VI Contamination of Drinking Water"

October 24, 2000
Burbank, California

SENATOR DEBORAH V. ORTIZ, Chair: I'd like to start this hearing. I am Senator Ortiz. I'm the chair of the Senate Health and Human Services Committee, and I'm joined here today by the chair of the Senate Committee on Natural Resources and Wildlife -- actually, Senator Hayden is not with us today, but hopefully he'll be joining us soon -- as well as the chair of the Assembly Environmental Safety and Toxic Materials Committee, Assemblymember Hannah-Beth Jackson. I'm also joined here today by Assemblymember Jack Scott, Senator Adam Schiff, staff from the Senate and Assembly, I understand, and there will be other members joining us shortly.

Just a couple of announcements. Because we cannot have anybody standing, and we do have the Fire Marshal here, I understand that there is spillover seating in the basement, which is the employee area, so feel free to find a seat in that other location. I understand we're going to have everything televised.

Our hope is to spend about three hours here today, move through the testimony, and gather as much information as possible on a very important issue. We are hoping not to arrive at final decisions to public policy, but rather, search through the data.

I appreciate the time and effort you've devoted to the issue of chromium VI contamination and its health effects. Your participation in this hearing today will contribute to better public policy. By sharing the wealth of information that our witnesses are going to present today, we will hopefully gather the essential information to arrive at sound public policy.

Special welcome to the members that I have introduced. They will have a moment to provide opening comments as well.

The public system which is intended to protect us through analysis, evaluation, and deliberation and action, does not, and perhaps cannot, keep up with the variety of environmental threats present in our state. As public officials, we have a responsibility to protect the health of the public as well as gather the science necessary to arrive at those sound decisions.

Today we're here to consider the issue of chromium VI and contamination of California's drinking water, and how to adequately protect the public health from environmental threat. With us, again, is an impressive panel of health experts, governmental officials, and advocates, whose presentations will enhance our knowledge of this issue.

This hearing, hopefully, will provide us with the information, once again, to arrive at a sound public policy. As much as we want to come to final decisions and develop standards, I think it's a bit premature to do so.

We structured the hearing in this manner to ask the following questions:

- What are the health effects of chromium VI contamination in drinking water? We do know that as it is airborne, it is certainly a serious carcinogen. We need to ask the question, once it's ingested what the health effects are.
- Does California's current drinking water standard adequately protect the public health?
- How pervasive is chromium VI contamination in California's drinking water?
- What is the specific threat to the San Fernando Valley? And
- How should we address the issues of chromium VI contamination of drinking water in California?

As you can see from the agenda, our first panel will speak to the issues of chromium VI and its human health implications. They'll provide us an overview of the research to date and the health effects of chromium VI, and identify the gaps in knowledge that certainly we need to fill before we come to any final conclusions.

Our second panel will provide us on the background of chromium VI and will discuss the pervasiveness of chromium contamination in California. They'll address California's current standard for chromium, its adequacy, and its enforcement.

The third panel will give us a chance to examine how chromium VI contamination is currently affecting the San Fernando Valley and how this contamination is being addressed.

Finally, the fourth panel will discuss the public policy options for addressing the chromium VI contamination and how we should respond to substances in our environment that threaten our public health.

At this time I'm going to allow other members to provide statements, and once again, thank you for being with us today.

SENATOR ADAM SCHIFF: Thank you, Senator Ortiz. I want to thank my Senate and Assembly colleagues for coming to Burbank this morning and exploring the health consequences of hexavalent chromium in the water.

Late in the legislative session it became apparent that a lot of the assumptions that we were operating under about the level of hexavalent chromium were, in fact, not correct. That, in fact, when there was chromium, there was a much higher level of hexavalent chromium than anticipated, and it looked like in our particular region the levels of hexavalent chromium were very high: in excess of the standards that we had set and in excess of what many people believe is necessary to protect the public health.

I introduced legislation at the end of the session on an urgency basis to require the state to act on this information in a much quicker fashion. It was the expectation, I think, of the Department of Health Services that it might take five years to do an analysis of the impacts, the health consequences of hexavalent chromium, prior to setting any new standard, and that length of time was simply unacceptable.

The urgency legislation -- and I want to thank my colleagues for their strong support of it -- passed on a strong bipartisan basis and was recently signed by Governor Davis. That will accelerate the state's timetable, and I think it has had a salutary effect already with some of the state agencies acting on emergency regulations to require testing of the water and to expedite our analysis of whether we need to adopt a new standard.

Since those actions have taken place, there's been a great deal of discussion and debate about just what is the state of scientific knowledge of the health consequences of hexavalent chromium. And we have the opportunity today to hear from some of the foremost experts on just what is the situation. We know it's a carcinogen when ingested through the air. We don't know what the effect is when ingested through the water.

Today we're going to take a strong look at that question. The whole intention of both the hearing and this process is to determine:

- What is the state of scientific knowledge and the health consequences?
- What steps have to be taken to ensure that the drinking water is pure and safe?
- What will the costs be in moving to that standard? And
- How can we get this done in the most expeditious fashion possible?

I think we are all committed here to making sure that we don't let the saving of a few dollars mean that we're drinking water that is not healthy. And I know that for those of us that live in this region, and I live here in Burbank along with my wife and our two-year-old girl, since these revelations came about, I don't think any of us put a glass to the tap without thinking twice about what we're drinking. And I think it really incumbent on us to move swiftly but thoughtfully into analysis of what are the health consequences, what can be done to make sure that our drinking water is safe, so that we have that confidence when we go to the tap that what we're drinking will not cause health consequences as significant as a cancer.

So that's why we're here today. And again, I want to thank Senator Ortiz and my colleagues for convening this hearing here in Burbank and letting us hear from the pros.

ASSEMBLYMEMBER HANNAH-BETH JACKSON: Thank you.

On behalf of the Assembly Environmental Safety and Toxics Committee, I'm very anxious to hear what the experts have to say and what steps they consider are necessary and appropriate to address this threat to both environmental and public health.

I would like to say that over the last several years we have, in fact, identified and acknowledged that there are things in our drinking water that have been sources of concern for us, and because of state and federal law, we have been addressing these problems. But we do have a great deal more to do.

This is a hearing that I'm looking forward to so that we can identify -- I know specifically we're talking about chromium VI, but we need to start establishing good policy in this state to deal with the issues related to what is in our drinking water to ensure that our water is safe and that we do not have these kinds of contaminants and toxins and carcinogens in our drinking water, because we rely on this water, and as Senator Schiff pointed out, not only that we drink but that our children drink. We need to address this as a question of public health, and we need to look at this rationally and logically so that we can identify with the new technologies we have today.

I'm very confident that we can address these issues and clean the water so that we are safe as we drink it. And I think it's incumbent upon us to ensure and assure the public that that is, in fact, what they're drinking.

I know we have experts from throughout the state. This is something that I want to take back to the Legislature and work on so that sound public policy will identify these sources of contaminants so that we can develop the best technologies to address them in the most financially expeditious and reasonable way and assure everyone that the water they drink is going to be healthy for them.

So I thank you all for the opportunity, and thank you, Senator, for setting this up.

SENATOR ORTIZ: Jack?

ASSEMBLYMEMBER JACK SCOTT: Yes, I, too, want to thank the three committees that are meeting today and the chairs of those committees, particularly Senator Ortiz, and Senator Hayden, and Assemblymember Jackson, for calling today's hearing.

I don't think we can overemphasize how important the safety of drinking water is. It's propitious that we're meeting here in Burbank where, unfortunately, the highest concentration of chromium was found in the water. A city in my district, the city of Glendale, for instance, recently asked the USEPA for a delay in using groundwater from the San Fernando Basin.

So we've got to ask some questions. Fortunately, we have the experts here who can do as well as anyone in the state in answering those questions. Questions like: What happens when you chlorinate water? Does it make a difference in terms of the production of chromium VI? In figuring out the percentage of chromium in the water, how much of that is chromium VI? which in areas like Hinkley, for instance, did prove to be a very serious health threat.

So I'm anxiously looking forward to the answers because I think as serious public officials, our job is to act upon the data that we have and to be the instrument by which the safety, the health, of the citizens of the state of California is protected. So we're going to hear that evidence today.

We will also be involved in determining what kind of resources are necessary in order to help in that regard. And that's where we, as legislators, can be particularly productive in determining if, indeed, we need to accelerate this testing and if, indeed, we need more resources in order to do that. Let's act to do it because, when you get down to human health, the dollar sign becomes a little less significant because that's important to us.

So I look forward to being here today. I thank those who set up this meeting, and I'm anxiously awaiting the testimony of the witnesses.

SENATOR ORTIZ: Thank you.

Assemblymember Kuehl?

ASSEMBLYMEMBER SHEILA KUEHL: Thank you, Senator.

Not to put too fine a point on it, but I think the reason that we attend these hearings -- and I thank the chairs for convening this hearing -- is threefold: One is to indicate the concern of those of us who are representatives in California and who can affect state law, that we take these concerns seriously and that we not only will listen but we'll do something about them. Certainly, there are people here from the 23rd Senate District, from Sherman Oaks, from Studio City, from other areas, which, in and of itself, is enough for me to be concerned.

But beyond that, it's our responsibility, and we have taken it seriously. I think we have made great strides in terms of cleaning up the drinking water and making certain that it is as high quality as we want it to be throughout the state. This is a new concern and a new piece of evidence for us, and we will move quickly to do what we can and should do to make certain that the drinking water is safe.

So again, I thank not only the chairs who have called the hearing but those of you who will testify and those of you who are here to show your concern.

Thank you, Senator.

SENATOR ORTIZ: Thank you.

All right. I'd like, if I may, to let members know how I think we should have the hearing proceed. Certainly, our hope is to have an ongoing dialogue among the experts and with the members on the panel. I would like to ask the witnesses to limit their testimony to ten minutes or less, if they can. I know that's difficult at times, but

I think what we want to encourage here is that the members have an opportunity to ask the questions that your testimony generates.

And with that, generally speaking, we'd like to try to complete the hearing within three hours, which would be roughly thirty to forty minutes per each section, and there are four sections.

With those general guidelines, I'd like to ask our first witness to come forward, Mr. George Alexeef, who is the Deputy Director, and he'll certainly identify himself again, from the Office of Environmental Health Hazard Assessment.

DR. GEORGE ALEXEEF: Good morning, Madam Chair, members of the Legislature, and members of the public.

My name is Dr. George Alexeef. I am Deputy Director for Scientific Affairs of the Office of Environmental Health Hazard Assessment. That's a department in the Environmental Protection Agency of California. I'm also the state's Chief Scientist on Risk Assessment.

I received a bachelor's degree in chemistry from Swarthmore College and a Ph.D. in pharmacology and toxicology from UC Davis. I worked as a toxicologist for Weyerhauser(?) Company for three years, and then I joined the State of California, first Department of Health Services, and then with the Office for the past fourteen years. Over those years, I've had increasing responsibility up and to my current position of Deputy Director. I've been working on the issue of hexavalent chromium in the air and the water over the past twelve years.

The purpose of my presentation is to discuss the toxicity of chromium. I'll explain the general process for developing the public health goals, or PHGs, and I will discuss why we have based its PHG for chromium on the basis to protect against cancer. And I'll also describe the meaning of the PHG.

First, there are two primary forms of chromium: trivalent, or chrome III; and hexavalent, or chrome VI. Trivalent is the less toxic; and in fact, trivalent is also an essential dietary nutrient. The other form, hexavalent chrome, or chrome VI, is more toxic. I'll be referring to it as hexavalent chromium. The basis of our PHG is on the health effects of the hexavalent form.

Second, I'd like to discuss the process for developing PHGs in drinking water. The requirement for OEHHA to develop the PHG was established by the California Safe

Drinking Water Act in 1996. This law requires OEHHA to publish PHGs for those chemicals within established maximum contaminant level, or MCL.

In this case, an MCL exists for total chromium, not hexavalent chromium. For that reason we have a PHG for total chromium. There is no PHG for hexavalent chromium at this time.

Public health goals are estimates of the levels of chemicals in drinking water that pose no significant health risk over a lifetime of exposure. PHGs must consider sensitive populations, pregnant women, fetuses, children, the elderly. If information isn't adequate to establish a safe level, the PHG may be set at zero.

Now, PHGs are nonregulatory values. They're goals. In developing the PHGs, our office only considers the health effects information. We do not consider cost or technical feasibility.

Now, the next part of my presentation concerns the basis for the current PHG. It was developed in 1998 and published in 1999. The intent of our PHG was to identify a level, and if chromium in drinking water, that would not cause a significant cancer risk to people consuming drinking water for their lifetime.

Our first step in developing a PHG is to review the scientific information in published studies. Now, hexavalent chromium is a known human carcinogen. This is based primarily on the over twenty-five studies that have reported hexavalent chromium causes lung cancer in people working in those industries, such as chromate pigment production, chrome plating, or chromic production.

Dr. Froines will discuss other types of cancers that have been reported.

There are also numerous studies that show that hexavalent chromium is mutagenic and damages DNA. And in fact, there are a few studies which show that there was genetic damage in the workers that were exposed to hexavalent chrome.

Now, animal studies, including one drinking water study, found that hexavalent chromium causes tumors after various types of exposures.

After considering all of these studies, we calculated the cancer potency; or, that is, the ability of ingested hexavalent chromium to cause cancer. We calculated the potency by using the number of both benign and malignant tumors reported in female mice after they developed it from being exposed to 500,000 parts per billion of hexavalent chromium in drinking water.

Exposing animals to these types of high doses is standard practice in cancer research. It's due to the shorter lifetime of the animals, the long latency to produce the cancer, and also the small number of animals that are used in these types of experiments.

Using standard methods in risk assessment, we took the tumor data in mice at these high doses and calculated the risk in humans at the low doses in drinking water. The risk we estimated -- that is, a PHG risk -- is one cancer case in a million people consuming the water over a lifetime. In this way, we identified a health protective level of hexavalent chromium in drinking water of 0.2 parts per billion.

Now, the level would protect not only against cancer risk but all other non-cancer effects as well with an adequate margin of safety.

Now, the risk value does have limitations and uncertainties about it, and I think Dr. Froines will discuss that as well. But based on the data that we have and the methods that we use, the actual risk of ingesting hexavalent chromium in drinking water is unlikely to be any greater than what we calculated and could be less.

To obtain the PHG for total chromium, we had to consider how much of the hexavalent form was in the water. Based on the best data we had at the time in 1998, we assumed it was 7.2 percent. This resulted in a PHG of 2.5 parts per billion. Of course, now we have data, I'm sure we'll hear today, about higher percentages of hexavalent chromium in the water.

Just to keep in mind, the safe level for the trivalent chromium is 50 parts per billion, which is the maximum contaminant level.

After we developed the draft PHG, it was peer reviewed both internally in our department and externally by other scientists. We had public comment periods and a workshop. We received comments, reviewed them, revised the document, and then published it in 1999.

Since the publication of our PHG, there have been a number of monitoring studies in California, and I know that the Department of Health Services and Dr. Spath will talk about this, is investigating the concentration of hexavalent chromium.

Now, I'd like to answer the question of: What if the public health goal is exceeded?

SENATOR SCHIFF: Doctor, can I ask you just a quick question?

DR. ALEXEEF: Yes.

SENATOR SCHIFF: Why is the goal set for the level of total chromium if hexavalent chromium is the problem?

DR. ALEXEEF: The reason it's set is because, in developing the legislation, or the actual law, requires us to develop PHGs for existing maximum contaminant levels, and the current maximum contaminant level is for total chromium. That's the reason.

ASSEMBLYMEMBER JACKSON: But doesn't that beg the question: Why is it for total chromium, and why aren't we dividing it up if we know that chromium III, in some measure, is a human nutrient? Obviously, that's less detrimental than chromium VI, which we know is a known carcinogen. Why have we done it in such a generalized basis rather than isolate out chromium VI and try to establish goals for chromium VI?

DR. ALEXEEF: Well, we did isolate out hexavalent chromium and we did develop the health level, but in terms of the actual official PHG, we had to develop it to be similar to the MCL.

SENATOR ORTIZ: Mr. Alexeef, if you could finish your testimony, our hope was to have the three panelists--

DR. ALEXEEF: Be happy to.

SENATOR ORTIZ: --provide their testimony and then open it up to questions from members. Otherwise, we will not get through the first section.

DR. ALEXEEF: So our PHG is set at an extremely low risk level that would not be expected to result in no more than one cancer case in a million of people who were drinking water at 2.5 parts per billion for their lifetime.

Now, slight increases above the PHG still pose a small risk. We take a health protective approach, as required by law, in our assumptions about hexavalent chromium. The PHG is not a bright line but more of a guidepost. They're not recommended MCLs. They're one of the factors that Department of Health Services takes into account when they establish the MCLs, and Dr. Spath will talk about that later.

So, just to briefly summarize, we developed the PHG because it is required under the Safe Drinking Water Act of '96. The draft chromium PHG was developed in '98, finalized in '99. The estimated health level for total chromium was 2.5 parts per billion, and it's based on not more than one additional cancer case in a million of people drinking it for a lifetime. And we used the hexavalent to trivalent chromium ratio data that we had available at that time. And finally, the PHG includes an adequate margin of safety to protect against all other health defects.

That concludes my testimony.

SENATOR ORTIZ: Thank you.

I neglected to invite the other participants in this section, John Froines as well as Joseph Landolph, forward. Please feel free to take a seat, Mr. Alexeef, and if the others could come forward, feel free to sit at the front here as you either provide your testimony or as you're waiting to come forward.

But the next speaker is Mr. John Froines, and after that it'll be Joseph Landolph.

DR. JOHN FROINES: Thank you very much.

My name is John Froines, and I'm Professor of Toxicology at the UCLA School of Public Health. I chair the Scientific Review Panel under the Air Resources Board. And you have my testimony, so I'm not going to go through the long list of credits to my background.

SENATOR ORTIZ: Members, Mr. Froines provided printed testimony. It should be in your materials.

DR. FROINES: I'm going to go directly into the testimony.

One of the things I want to say at the outset is that I'm going to be presenting some data to you today that has not been seen before. This is work that we've been doing at UCLA over the past ten years. We have not published it in the peer reviewed literature, but I called the *Journal* and asked them if I could present the data because, usually, journals don't like to have people present data in hearings like this before it gets published. The *Journal* editor said they believe in public health so go ahead.

SENATOR ORTIZ: We thank the editors.

DR. FROINES: I'm going to be talking to you about data that we've developed over the last ten years, and I have a report that we've done which I'll make available to your staff to take a look at. I think it's relatively comprehensive. And what I'm not going to talk about is the use of chromium in California. We spend a lot of time on that, and if you want to ask some questions, I can talk about it.

I think in California it's clear that the current uses of chromium VI is in the primary uses in the aerospace industry. The second use is in the electroplating. And you might be surprised to note that there's a fair amount of chromium VI that's actually used in the marine boat industry; again, for corrosion resistance. So there are a number of sites, but I think that the aerospace and electroplating represent the largest use of the chemical.

But in any case, let me go ahead and try and give you some background about what we think about chromium.

What I'm going to do is talk about chromium VI as a carcinogen via inhalation. However, Joe Landolph and George Alexeef have already talked about -- well, Joe will, and George did -- so I'm not going to go through (1). I'm going to just assume that everybody in this room understands and believes that chromium VI is a carcinogen via inhalation.

The key issue that I want to talk about is what is the evidence for chromium VI being a carcinogen via the oral route?

Thirdly, I want to talk about, what are some of the issues associated with chromium VI carcinogenesis via the oral route?

Fourth, what are the implications of the evidence of chromium VI carcinogenicity for risk assessment, and how should California address chromium VI contamination?

Now, I'm supposed to talk later, so some of that may get pushed over to the end of the last session on policy.

I'm not going to follow my notes so it doesn't do any good to follow them. For you anyway.

What I want to say is, we got into this business because many years ago we discovered that chromium VI as a spray paint is very widely used and particularly widely used in the aerospace industry in California. And we looked at some data from OSHA and found that the exposures in those industries was actually quite high in the past, and I emphasize the past.

So we began to look at occupational exposure to chromium VI, and one of the things we looked at was the size of the paint particles that are generated when you spray chromium VI spray paints. And what we found, in fact -- and there's an awful lot of work I'm leaving out -- is that 60 percent of the chromium VI that you find in spray paints is greater than 10 microns in diameter.

Now, what does that mean to the average citizen? What that means is all that chromium VI are in large particles. What they do is they deposit in the nose, in the nasal pharyngeal region, and the upper airways. What happens to that chromium then is that it's cleared from the nose, is cleared from the upper airways by mucociliary clearance by moving the particles up and into the mouth and then you swallow them.

So what that means is most of the chromium VI particles that workers tend to breathe end up being swallowed. They don't get into the deeper lung. That raises, then, an immediate question that when you're swallowing chromium VI -- the question for us -- does it create a risk of gastrointestinal cancer? Because you've got a lot of chromium VI now in your gut, not because you drank it in drinking water but because you've breathed large particles.

All right. So that's what we did. We then went and we conducted what's called a meta-analysis. We took all the studies in the literature, and we looked at them in epidemiologic studies, and we looked at them in terms of whether or not there was evidence of increased risk of gastrointestinal cancer.

Now, a meta-analysis is sort of like if you flip a coin a hundred thousand times, it ends up you get 50 percent heads, 50 percent tails. You flip it ten times, it doesn't always turn out that way. A meta-analysis allows us to hopefully get closer to the truth of an issue by combining all the studies in the literature. So a meta-analysis is simply a way of combining studies to see what the ultimate overall impact is of those studies and to determine whether or not we have a better sense, in this case, of the risk of chromium from all those studies.

And let me just put the obligatory disclaimer there. A meta-analysis cannot prove or disprove causality per se. However, it can explore the basis for differences among studies and in doing so provide evidence bearing on causal inference. And that's what I really want to do.

So we basically conducted a meta-analysis, and when everything was said and done, we found a total of about 59 papers. I should say one thing that you might find interesting. All these papers were about lung cancer because everybody studies lung cancer in chromium VI, because that's the nature of the studies. So that's good from the point of view of this study because what this means is we went back and looked at GI tract cancer, but since none of these studies were about GI tract cancer, there's not something in them called "publication bias." Nobody's biased because they think that there may be chromium VI in GI tract cancer.

So in a sense, the studies that we're looking at, then, have a certain lack of bias associated with them precisely because of that.

In the end, we found 22 studies, 22 human studies, which I might say is an enormous amount of literature. With diesel, for example, we used about 30 studies. With chromium VI and gastrointestinal cancer, we have 22. That's not trivial by any means.

Now, this overhead isn't going to help you much. It's what we're going to publish in the *Journal.* The relative risk is one, and you can see that anything above one therefore constitutes an increased risk of GI tract cancer. So you see that most of the studies appear to have values above one.

You see those lines that are very wide? That means there's a lot of heterogeneity in the studies, that the studies aren't as precise as you would prefer. It also shows when you're below one that some of the studies are not statistically significant. And it also shows you that a few have relative risk below one.

Don't worry about all the things on this chart; just look at "All Studies." All studies, there were 22. We found 15 with increased risk of GI tract cancer. Of those, 7 of the 15 were statistically significant. When we take Type A studies, which are the ones we consider to be the best studies, then, in fact, you find that there are 11 of the highest quality studies and 8 with increased risk of cancer, and 5 of those are significant.

Now, in the scientific community one would conclude that there appears to be a fair amount of evidence then for GI tract cancer associated with chromium in the gut. And I'll show you one other overhead which relates to that.

And you can see what's called the "Pooled Relative Risk" is about 1.45. What that means is that there's a 45 percent increase in gastrointestinal cancer over a person in the average population. So think of it just as a 45 percent increase.

Now, I'd prefer it was over 1.5, but it's not. This is the same kind of data you see with diesel.

Now, if you look at the best quality studies that we talked about, good quality of exposure assessment -- that is, where somebody actually worked hard to assess exposure -- then you find that the relative risk actually goes up to 1.9, and in both cases these are statistically significant studies.

So having said all that, this data is -- all scientists say data is preliminary. I won't say that. This data is the best we have. It's the best we're going to get for a long period of time. It demonstrates to me that there is an increased risk of gastrointestinal cancer associated with at least occupational exposure to chromium. It does not demonstrate that there is an increased risk of gastrointestinal cancer associated with drinking 5 to 10 parts per billion in drinking water. That I don't know. I don't know if the risk at that level is meaningful.

All I can tell you is that in the studies that exist in the literature, there is obviously an increased risk of gastrointestinal cancer associated with chromium.

Now, I'll say just a couple of other things and then stop for the moment.

First, there's been a lot of debate about this notion of chromium VI going to chromium III in the gut. It does. In fact, if you drink orange juice with your drinking water, all the chromium VI will go to chromium III. So if you want to have maximum protection, everybody should drink orange juice.

But that's not the point. The point is, people drink water.

The issue with chromium VI is that there's two things that can happen. The chromium VI can go to chromium III, right? And chromium VI can get into the cells of your GI tract and cause cancer. So you have two different processes that are in competition.

Now, if I was to tell you that everything went that way, what does that mean? That means either that process is infinitely fast, or the other process is zero. It doesn't happen in biology. Those two processes are in competition. Understand them in competition. Since it's an election year, they're both going to get votes. The relative rate constancy will define whether or not how much goes one way and how much goes the other.

There's also a wide degree of human variability. People who are taking antacids may reduce the chromium VI to chromium III more slowly than somebody with a high acid content. You have to remember that there's a wide human heterogeneity.

The fact of the matter is, that all the chromium VI is not reduced to chromium III. Some of that chromium VI gets absorbed into cells. Some of that chromium VI can pass into the systemic circulation. And there is evidence in some work by Max Costa at New York University of some other cancers that are in excess, and I can go through them if you want. But there are other internal cancers that people are possibly at risk of, but the data is much slimmer in nature.

But there is no question that chromium VI can be taken up into the systemic circulation, and there's no question that chromium VI will be taken up in GI tract cells.

So think about it as a competitive process. Max Costa at NYU has also shown that chromium VI is in fact bioavailable.

Now, I want to say just a couple more things and I'll stop. There has been an enormous debate about these risk numbers, and I want to emphasize this overhead. Quantitative risk assessment is an integrated discipline to achieve a fair synthesis of all available information about the likely magnitude of a hazard. Risk assessors are well-accustomed to the presence of imperfection in the information input. Characterization of uncertainty often discloses uncertainties of at least an order of magnitude and frequently two orders of magnitude or more.

That means that Dr. Alexeef's PHG for chromium VI could be as low as .002, could be as high as 20. We don't know. Lawyers like specific facts that are very well defined. Scientists have to live in a world of uncertainty. And I can say without any doubt whatsoever that that range of .002 to 20 is what we're dealing with. Not .2. Forget .2. Point two may be a useful number for you to use for control purposes but it is not the goal standard. We have to think in terms of uncertainty within the context of the limited science of risk assessments.

Now, having said that, as I say on here, the goal of modern risk assessment is not to arrive at a single precise number but to allow decision-makers to face the possible consequences of a range of not clearly incorrect answers and decide on protective policies that are warranted on the range of possible future outcomes of alternative policies.

My view is given that uncertainty, the decision about which numbers you pick are yours; they're not mine. They're not a scientific decision; they're a public policy decision. It's your decision; it's the Governor's decision; it's the state agencies' decision. That's the correct range of numbers, I think. So therefore, it becomes not a scientific question but a public policy question. And I think, however, that given the level of uncertainty, I think that we have to still act in a prudent public health fashion. And I'll say later that, in my view, we need to take steps to reduce the levels of chromium VI now, absolutely now -- not wait five years -- move now; but I'll talk later about how one might go about that in a way that makes sense.

SENATOR ORTIZ: Thank you so much, Mr. Froines, for your valuable testimony.

I would like to encourage speakers, once again, to try to adhere to the ten minutes, just because I think it's important that members of the panel have an opportunity to ask you the questions so you can translate a lot of your presentation into English for those of us who are not scientists.

So thank you for your presentation.

Mr. Joseph Landolph is our next speaker. Welcome.

DR. JOSEPH R. LANDOLPH: Good morning, Chairman Solis and members of the committee.

SENATOR ORTIZ: Actually, it's Ortiz.

DR. LANDOLPH: Ortiz. Sorry. I didn't see that name there. And particularly Mr. Schiff and Mr. Scott, who represent my district.

It's well-known for a long time that chromium's been mined from natural deposits, so it starts out as a good thing. It's humans converting chromium into useful economic products that lead to chromium getting into the air and the water. And as has already been discussed, there are many epidemiological studies which indicate that chromium causes carcinogenesis in the nasal area and in the respiratory area. That's a pretty subtle question. The state department Office of Environmental Health Sciences has published a document on this, and they calculate a high slope: 512 for cancer at those groups.

What we're discussing here, of course, is water, and I'll get to that in a second.

In addition, there are really four types of chromium. There's the hexavalent, the plus six and the plus three, and there are soluble and insoluble forms. Both the soluble and the insoluble chromium VI are believed to cause cancer of the nasal sinuses and respiratory tract in humans, and they're also carcinogens in animals. So that's a settled issue.

The soluble chromium III is thought to be a detoxification product. It's less toxic than chromium VI. The insoluble chromium III we don't know too much about. It may have a carcinogenic potential. It needs to be studied further. But clearly, the chromium plus six is the bad actor in this situation.

And as was already discussed, chromium VI can get into the cell actually in two ways. If it's insoluble, the cell can gobble it up by a process we call phagocytosis. If it's soluble, it comes in on a nonspecific carrier which is used to take up phosphate and sulfate which are necessary for life. So that's how it gets into cells.

The recognition of this by Dr. Max Costa and others suggested it has more of a potential danger than we thought in the past, simply because all cells have this anion carrier, which can take up sulfate and phosphate and therefore chromium.

There have been suggestions, particularly from a review article by Dr. Costa, that cancers at other sites may be induced by ingestion of chromium. This data is shaky, it's inconsistent. It's not as strong as the data for lung and nasal/sinus, which is very strong. But the fact that all cells in the body have this anion transport carrier means, in terms of public health, we should be careful about regulating it because that poses a greater potential.

This excellent document on chromium was prepared by Dr. David Morry, who's sitting behind us, and signed off by Dr. Joan Denton, who runs the OEHHA for the state of California and CalEPA. And in this document, they did a very nice job in taking all the available data to calculate a slope for ingestion which indicates a risk.

So if the slope for cancer through the inhalation route is like so at 500, for ingestion it's pretty small. It's about .5. It's about a thousand-fold less. And the explanation that has been put forward is that the gastrointestinal tract has a lot of reductive capability, reduces the plus six down to the plus three, and that protects us, fortunately. And that's occurred over many hundreds of thousands of years of evolution.

So what's important now is to shore up, I think, the database in this document. I think Dr. Morry and Dr. Denton and the others did a great job. It's a good document. The weakness in this whole business in this number is derived from one paper which was published in 1968, and it's a German study where they fed sodium potassium chromate to animals and it's been translated into the English.

So one recommendation I'd like to make to you now and later is that your committee should nominate hexavalent chromium compounds to the National Toxicology Program and ask them to do some studies -- they take nominations from citizens, regulatory agencies, scientists -- and ask them to do a very solid, modern drinking water study, and get very good data, because that number could go up or down based on what that result is. We don't know what it'll be, and we need to do a modern study so we have very good data, so they can continue to make very good calculations on the existing data.

I'll be brief. Chromium is a complicated agent. It gets into cells in the plus-six form. It then is reduced and generates hydrogen peroxide in site cells. That attacks DNA. It's also reduced to chromium III that binds to DNA covalently in a tight way and causes mutations. So we know a lot about what hexavalent chromium does. It's very important to regulate this material. It's important also to do so in a deliberate and careful fashion, and I'd like to see you get some more data, particularly on the ingestion route and the drinking water route so we know exactly how that public health goal should be set.

Some other recommendations I could make, I certainly agree that the state should continue the excellent job they have done at the Department of Environmental Health Hazard Assessment, continuing to search the literature for new studies that come out on the mutagenicity and carcinogenicity of chromium compounds. And they should also, I think in my opinion, if they can get the data, look at sites like Hinkley and Kettleman where water was contaminated with chromium as a corrosion inhibitor at high concentrations and conduct some scientific study of that data if it's possible, and build us a modern database such as the database Dr. Froines is beginning to build, if that data is available. It may not be, depending on the legal procedures as well.

And I think in addition, if there are high levels of contamination at sites around the state, they should be remediated rapidly before they get into the water. That's the first thing that can be done and easily done so you don't have to worry about smaller levels first.

And, of course, the public health goal that Dr. Alexeef and Dr. Froines referred to is a calculation. That calculation is one which asks the question, if we set the risk at one and a million, one person in a million getting cancer, that's considered acceptable, and if you back-calculate what's the concentration, you get .2 parts per billion for chromium VI. So that's here. And the maximum contaminant level of 50 in the state of California is here, and 100 at the EPA of the United States is higher. So, of course, the thing you'll wrestle with is how close can you get to the PHG and not put all the businesses in California and industrial firms out of business? So that's a difficult thing that you'll have to struggle with. It's a risk versus benefit calculation.

And I also agree with Senator Ortiz completely that I would like to see measurements made of chromium VI rather than total chromium because that's an assumption. But there are complications in the measurements. This is done by atomic absorption, which is real easy. It's a little bit more difficult, maybe not as sensitive, to do chromium VI, but the science needs to be pushed in that area.

Thank you very much.

SENATOR ORTIZ: Thank you so much, and thank you for being brief.

This is really an opportunity for members to ask questions of the three panelists, and also provide Senator Hayden the opportunity. He joined us a bit late, and I'd like to offer him an opportunity to an opening comment and open questions probably.

Did you want to do an opening statement first?

SENATOR TOM HAYDEN: I just have some questions.

SENATOR ORTIZ: Okay, go ahead. Go ahead and lead with it.

SENATOR HAYDEN: Thank you. I'm sorry that I'm late, and I'll forego the opportunity to pontificate.

Dr. Alexeef, my questions are for you.

We had a conversation by telephone. Is that correct?

DR. ALEXEEF: Yes, we did.

SENATOR HAYDEN: And we've not met other than that.

DR. ALEXEEF: That's correct.

SENATOR HAYDEN: All right. And you knew that I was taking notes on the conversation.

DR. ALEXEEF: I presumed you were taking notes.

SENATOR HAYDEN: Was Dr. Denton in on some of that conversation as well?

DR. ALEXEEF: She walked in while we were talking.

SENATOR HAYDEN: All right. I just have, I think, four questions, just to follow up from that conversation.

The first is, you've worked on this issue since 1989. Is that correct?

DR. ALEXEEF: Yes.

SENATOR HAYDEN: Starting as an air toxics issue?

And you told me that since 1989, which is 11 years ago, we considered it an oral carcinogen, but it hadn't become a drinking water issue.

Is that correct?

DR. ALEXEEF: Yes. Would you like me to elaborate a little bit?

SENATOR HAYDEN: Sure.

SENATOR ORTIZ: Quickly.

DR. ALEXEEF: Yes, we had a working group of scientists, and we looked at this data, which is, for the most part, the data we saw here today; except, of course, for Dr. Froines' data. And it was our judgment that weighing the data, that we should consider a potential oral carcinogen.

SENATOR HAYDEN: And do you need to elaborate on what an oral carcinogen is, or was that covered in the earlier--?

DR. ALEXEEF: Well, if ingested, it can pose a cancer risk.

SENATOR HAYDEN: All right. And then, nothing happened from that until the Safe Drinking Water Act of 1996, which required these PHGs to be set.

DR. ALEXEEF: Well, can I? It's not that nothing happened to it.

SENATOR HAYDEN: You said you didn't have the resources, I believe.

DR. ALEXEEF: Right. We didn't have the resources, and also, there was no specific regulatory process to feed that information.

SENATOR HAYDEN: Right. Then, when your first draft came out that identified a hex chromium standard, a chromium VI standard, the opposition was from the water districts.

Is that correct?

DR. ALEXEEF: The water districts raised most of the questions, yes.

SENATOR HAYDEN: And one of the things they argued is that it's not even something you should be doing?

DR. ALEXEEF: Correct. They told us we should be focusing on total chromiums.

SENATOR HAYDEN: Did they say that under Proposition 65, you had no business looking at chromium VI, because there'd been an exemption adopted?

DR. ALEXEEF: No one has actually told me that. There's been some discussions internally about various issues about that. So I don't know who actually raised that issue about how Prop. 65 fits in.

SENATOR HAYDEN: Have you ever been told that Mr. Blevins raised the issue?

DR. ALEXEEF: I don't know if Mr. Blevins raised the issue, no.

SENATOR HAYDEN: On inhalation, as I recall our conversation from my notes, you haven't seen data but you said that you believe that "as you breathe it in, it will be like drinking it again."

Is that correct?

DR. ALEXEEF: Yes. As Dr. Froines expressed it, the larger particles get trapped in the airway, and as you all know, we can all swallow things that get trapped in there.

SENATOR HAYDEN: All right. Then one last question.

I had conveyed to you what Mr. Freeman of the DWP had said and been quoted as saying, that "This is like having a couple of eye drops of something in two swimming pools. There's no cause for alarm," and you said, "I guess he's entitled to his opinion. You often get the criticism 'it is a small amount,' but still, it is a known carcinogen which mutates cells, and our public health goal is a de minimis risk level."

Is that correct?

DR. ALEXEEF: Yes.

SENATOR HAYDEN: Thank you.

ASSEMBLYMEMBER SCOTT: I just have a brief question, Dr. Froines. You talked about gastric cancers. Is there evidence that it goes beyond gastric cancers such as bladder cancer, prostate cancer, kidney cancer? I'm just curious as to how widespread that net is in terms of -- and I got the impression that maybe what you were talking about was largely stomach cancer or maybe also colon cancer. I'd like to know how broad that is.

DR. FROINES: Well, we got into it initially because of our concern about occupational exposures, so we were worried about workers ingesting chromium VI. We didn't start out looking at the issue broadly. There are others who have.

I think there are two things to say. One is, does chromium VI pass through the gut, enter the systemic circulation, and can it deposit in internal organs? And the answer is: yes.

The second question is--

ASSEMBLYMEMBER SCOTT: Do you mean like the liver or--?

DR. FROINES: Liver, the kidney, the bladder. In other words, there are lots of carcinogens like arsenic or like chromium that we generally think affect us where they touch the body. You know, we breathe it so it causes lung cancer. We get it on our skin so it causes skin cancer.

The difference between what we would call local carcinogens and systemic cancers are when the offending agent is taken up by the body and goes through the circulation, and so if it's taken up by red blood cells, or what have you, and passes through the body, it can deposit in various organs. So it can deposit in the brain, the kidney, the liver, the bladder, the spleen, and so on and so forth.

So the first question is: Is there a certain amount of chromium VI that's bioavailable to the systemic circulation? And the answer is: yes. The second question [sic] is: Although not as much because some of it has been reduced. So keep that in mind, that there are the competing processes.

I wanted to say one other thing, by the way -- I forgot -- which is there's lots of evidence of stomach irritation, ulcers, and other noncancer effects in the gut of workers as well. So our findings are not without merit.

But in the Costa paper, he talks about evidence that chromium is involved in causing human prostate lymphoma, leukemia, and bone cancer; evidence that chromate is involved in causing human cancers of the urinary tract, renal, bladder, and testicles, so that there is some evidence. I think most scientists would say that that is not wholly defined, to where it is not a hundred percent causally defined. But there are hints.

And the reason I mention the bioavailability is, if you can have exposure in those organs, and if you have a carcinogen like chromium VI, which, by the way, I hope you know that chromium VI is the second most potent carcinogen identified by the Scientific Review Panel under AB 1807. Chromium VI is an extremely potent carcinogen. So that if it's bioavailable, if you have chromium VI in your internal organs, then there's certainly a potential risk. Whether there's a real risk is another issue to be proved.

SENATOR SCHIFF: Doctor, I want to thank you for your testimony. I think all of us after the hearing are going to go out to the doctor.

I wanted to touch on a couple of the issues that you talk about and see if there's a consensus on this, and that is, if I understood you correctly, there is adequate data out there for us to conclude that hexavalent chromium is a carcinogen when ingested in an occupational setting. There is not -- or at least there hasn't been an analysis undertaken about whether it is also carcinogenic when ingested through the water.

So we know in the occupational setting, we can all agree it is carcinogenic when ingested. Is that correct?

DR. FROINES: Well, I think that our data indicates that there is evidence for an increased risk. I would not take our data and say we have established causality. No, I wouldn't say that. But I would say that this is the strongest data that exists in the United States today on that issue.

But I think that, again, emphasize these were occupational studies. They were not drinking water studies. And so yes, there is evidence, and I think it's reasonable evidence, but I would not say it's causally defined at this point.

I didn't answer your question, did I?

SENATOR SCHIFF: No, I think you did answer it, although I'm not sure all of us appreciate the distinction between evidence that there is a greater propensity but not necessarily causally related.

But what I'm more interested in, frankly, is, is it reasonable to assume on a scientific basis that if there is an increased risk of cancer when ingested in an occupational context, that it's also reasonable to assume that that would be the case in drinking water? Is there any reason why the method of ingestion would have a different effect?

DR. FROINES: Yeah, I think there is a little bit.

I think the answer to your question is, I presented our data precisely to indicate that there is at least a potential risk of cancer associated with oral ingestion of chromium VI in the water. That was clearly the point of what I was trying to get at.

But let me go one step further and say, if you had a very heavy exposure as a worker in the '50s or '40s or '60s in an aerospace plant, for example, you're breathing a lot of chromium VI, so you're getting a lot of that down into your gut. Now, think of it in terms of that competition I described. If you've got a lot of that chromium VI in your gut, it doesn't go away very fast, so more of the chromium VI may be absorbed into cells and therefore cause the risk of cancer. You can have what we would call saturation effects that basically overload the system, if you will. And if that's the case, one might argue, and we have to do calculations and we'll do them, because I think it's really important to take some of the occupational studies and actually do the kinds of calculations that I'm talking about, but the point is that you may have what some might call an overload phenomena such that the risk in an occupational setting may be greater than a member of the public. That doesn't mean the member of the public is off scot-free clearly, but it may mean that the risk is greater to the worker.

SENATOR SCHIFF: Well, what I'm, I guess, most interested in is this, and that is, is it appropriate for us as a legislative body to act on information about the carcinogenic impacts in the occupational setting as applied to a drinking water situation? Or, if that is not a solid enough scientific basis to act, what would be required? Is there enough existing data or, as I think Dr. Landolph is suggesting, do we need to undertake a specific study if there isn't sufficient data already out there on the impacts on drinking water before we act? And if you could address that and also tell us, if that's necessary, how long does it take to do an analysis like this?

SENATOR HAYDEN: Could I ask a supplementary question just to simplify this as well?

SENATOR ORTIZ: Sure.

DR. FROINES: I have an answer.

SENATOR HAYDEN: Do you have a problem with whatever the research was that went into OEHHA's setting the public health goal for chrome VI in drinking water?

DR. FROINES: I'll answer that, but let me just do this question first.

I don't think you have a choice. I think you have to assume that there's a risk of chromium VI in water based on the existing research that you have before you. Nobody has come here and said forget chromium VI in water. Everybody who stood up here said you have to be concerned about it, and I, quite frankly, think you do.

I think that the issue of what you then do -- I personally am opposed to spending five years doing standard setting before you get to doing anything about the problem. I think we need to gather together hydrageologists, engineers, people who know about cleanup -- and I think most of the work comes from exposures from the past, as I think I said -- and I think we need to go out and figure out what is the best technology we can use right now to get levels down, and we need to implement it now. I think we then need to go back and look at what we might call residual risk and over five years or so decide if the risk is still high, higher than one would like with new scientific evidence, and then based on the residual risk calculations develop new technology that might be implemented.

I think you have to have a twofold strategy. I think you have to have an immediate strategy that addresses as quickly as possible with existing technology what can be done, and then I think you want to continue and use residual risk calculations and then improve it over the next five years so that you really feel fully confident that you've addressed the problem fully.

The answer to the question about the science, you should forget epidemiologic studies at this point. I don't think that you can do a chromium human study in any reasonable period of time that would give you a clear answer to the issue. I agree with Joe Landolph that there's lots of animal and what we would call in vitro studies that can be done that will help clarify the information. It will add to the information you have available. But there's no new human studies that you can do within a reasonable time frame that's going to give you the answer that becomes the goal standard.

I do think that there's more research that could be done. I serve on the Board of Scientific Counselors of the National Toxicology Program. You do a chronic animal bioassay -- we just finished an 18-month chronic animal bioassay for arsenic -- it takes five years to do that study. It doesn't happen overnight, as Joe knows. So that we do need to do more research, but I frankly think that we also need to do the best we can now to try and ameliorate the situation in a reasonable way with basically existing technology that we can implement on a fairly rapid basis.

Did I answer your question?

SENATOR HAYDEN: Well, my side question had to do with, as opposed to thinking does the workplace study transfer to the drinking water, have you looked at the drinking water analysis done by OEHHA, which is the state agency in charge of the issue, and is their science sufficient from your point of view?

DR. FROINES: Sorry.

SENATOR ORTIZ: Before you answer that question, Mr. Froines, let me just remind members, we're kind of hopping to the tail-end of the hearing, which is policy recommendations, and I do want to acknowledge Assemblymember Kuehl who's been very patiently waiting for her turn.

DR. FROINES: I'll save you some time later.

SENATOR ORTIZ: Yeah, we may cut your time off at the end. So I just want to remind members we have members in sequence here.

DR. FROINES: I think the interesting thing, if I'm correct about what the PHG did, is that it actually used a study that looked at GI tract-related issues. The interesting thing about the study that George Alexeef and OEHHA used is that you might say that it has some confirmatory elements between the animal study and the human studies that I reported. So they are not in any way contradictory. Now, I don't know whether that means we're looking at apples and oranges or whether it adds to the level of security that we feel. But the data are reasonably consistent within that respect.

SENATOR ORTIZ: Assemblymember Kuehl.

ASSEMBLYMEMBER KUEHL: Thank you. Just two follow-up questions to any of the esteemed doctors.

Just to clarify, any studies that have been done about the potential effects of ingestion of chromium VI have all been workplace-related and therefore respiratory tract-related in the way that you describe?

DR. FROINES: By and large, there are studies of large particles that -- one animal study, George says.

ASSEMBLYMEMBER KUEHL: Okay.

In terms of the testimony that there is conversion from chromium VI to chromium III in the digestive process, what study or studies does that data come from? I mean, is this just basic sort of physiology or anatomy, or whatever?

DR. LANDOLPH: There's a plethora of studies from Silvio De Flora in Italy. He's published many, many papers on this and he's taken--

ASSEMBLYMEMBER KUEHL: Is this all animal studies though?

DR. LANDOLPH: Mostly animal studies, yeah.

ASSEMBLYMEMBER KUEHL: Mostly or all?

DR. LANDOLPH: Mostly animal studies.

ASSEMBLYMEMBER KUEHL: Okay. Then "mostly" means there were some human studies?

DR. LANDOLPH: I can't recall.

DR. FROINES: There's one study that was reported in the journal *Carcinogenesis* that looked at the bioavailability of chromium VI in humans by oral ingestion, and that's a study--

ASSEMBLYMEMBER KUEHL: But again, through the workplace studies?

DR. FROINES: No, no, no, no. This is basically a chamber study.

ASSEMBLYMEMBER KUEHL: You mean, "Here, swallow some chromium VI. We'd like to see if it goes to chromium III"?

DR. FROINES: You got it. Exactly right.

ASSEMBLYMEMBER KUEHL: Because that seems to me to be an additional source of data that would be of interest to us if we're looking at anything beyond these workplace studies where there was ingestion; you know, in what quantity, perhaps with water. I mean, I don't know.

DR. FROINES: That's the study that I referred to in my testimony where I said that basically they did two things: They looked at ascorbic acid and chromium VI, and they looked at chromium VI alone in water, and the ascorbic acid, the vitamin C basically eliminated the chromium VI. The chromium III was not wholly eliminated. It was down to 6 to 10 percent.

There's no question that chromium VI can be reduced, but it's not--

ASSEMBLYMEMBER KUEHL: But nothing in that study will help us ascertain sort of the effects, and I understand you're talking propensity not cause and effect. But still, these are really sort of separate in terms of -- we had human subjects that had participated in this, but we don't have any relationship there between that and any cancer in those subjects.

DR. FROINES: No, but chromium VI is such a potent carcinogen--

ASSEMBLYMEMBER KUEHL: I understand, Doctor.

DR. FROINES: --that if you find that not a hundred percent of that chromium VI goes to chromium III, then you're stuck with that result.

ASSEMBLYMEMBER KUEHL: Well, it turns out Dr. Pauline once again was probably right about that.

Thank you.

ASSEMBLYMEMBER JACKSON: I'd just like to ask of Mr. Landolph -- Dr. Landolph, is it? -- I may have misunderstood what you had said, but I got the sense that you disagree with Dr. Froines; that you feel that we need to do a study.

So I'd like to ask you, the sense I get from Dr. Froines is that because this is such a highly toxic or highly intense carcinogen, that we can't afford to wait to do a whole lot more studies before taking action. I heard you say that you feel that we need to do a study that will probably take five years.

Am I misunderstanding, or do you agree with Dr. Froines?

DR. LANDOLPH: I agree with him to the effect that, yes, we should remediate and not wait where there are toxic hotspots. That's clear. We agree on that.

The point that I was trying to make is I think OEHHA did a very good job -- and this is in answer to Mr. Hayden's question too -- with the data that was available.

The ingestion study is based on this one study conducted by German workers in the archives of toxicology called *Borneff* in 1968. It's just one study, and it's an older study, and the technology is newer now.

The National Toxicology Program is testing hundreds of substances and they ask for nominations, and since this ingestion slope is only based on one study, and it's a study about 32 years ago, I would recommend in parallel to what Dr. Froines has suggested, that you nominate hexavalent chromium compounds to be studied by the National Toxicology Program so that you have more confidence in the slope for carcinogenesis caused by ingestion. That's my point.

ASSEMBLYMEMBER JACKSON: And when you talk about remediation of hotspots, is that also with Dr. Froines that you're talking about?

DR. LANDOLPH: Yes.

ASSEMBLYMEMBER JACKSON: And how do we define a hotspot?

DR. LANDOLPH: Anywhere where we're going to have a very high concentration of chromium in the air or in the water far in excess of the MCLs.

ASSEMBLYMEMBER JACKSON: The MCL? Okay.

DR. FROINES: I think it's extremely important to gather as much data as possible on what the problem is and the scope of the problem out there. I don't think we have enough information on how much chromium is in water, and we really need to find that out. Maybe we'll hear it later today.

I'm fully in favor of doing an animal study on chromium via the oral route. What I'm saying is that if you nominate it, it's going to take two or three years to get nominated, it's going to take two or three years to do, and it's going to take two or three years to analyze the data.

What we need to do is take some of the epidemiologic studies, and George can do that, and do calculations and predict theoretically the internal dose of the chromium VI in the gut and the subsequent uptake. There's a lot of research that can be done besides the "one big animal study" that answers everything, but doesn't answer everything because people don't agree with it when you're finished with it.

SENATOR ORTIZ: Unless there are no other questions for this panel, I want to thank you, and certainly others will be asked to come forward, depending on how much time we have later, on this section that deals with direction for public policy.

But at this point I'd like to ask that we move forward to the second part of the agenda, which is "Chromium and California's Drinking Water," and I'm sure that we will have ample numbers of questions here from members.

Let me invite all the members of that panel to come forward and have a seat up front. Maybe we can save some time.

But our first speaker is Mr. Yoram Cohen. Welcome.

PROFESSOR YORAM COHEN: Thank you, Senator Ortiz, and ladies and gentlemen.

SENATOR ORTIZ: You might want to pull the mike down just a bit.

And let me just remind the witnesses to try to adhere to ten minutes. I know that we will take more than our time to ask the questions that we want to ask.

Thank you.

PROFESSOR COHEN: I'd like to tell you very briefly about who I am and how I got to be here today.

I'm from the Chemical Engineering Department at UCLA, and over the years have been involved with a number of centers that have to do with the fate and transport of chemicals in the environment, an EPA center and a state center, both of which I've directed.

A number of years back we were asked to look at airborne chromium as part of a study on air toxics by the Air Resources Board. Well, we found ourselves a number of years later looking at the issue of chromium in the environment as a whole. I've been fortunate to work with a number of people, both from the School of Public Health, the state of California, and one of my co-authors, in fact here. David Kimbrough is sitting in the back, and I hope that if there are questions later that I cannot answer, he'll jump to my help.

In any event, one of the things that I think is important to stress at the outset, you've heard a lot about the issues of toxicity, the fact that we need to remediate, but what I'm really concerned with is what is the source of chemicals in the environment, where do they go, and can we really reduce the problem at the source?

And I think that this is a key, because based on what I will tell you briefly, and I will try and keep my remarks short, I think that you could say that even if you were able to eliminate instantaneously by some magic all the chromium VI that there is in the environment, chromium VI will not disappear, okay? It will come back.

And so the issue that you have to deal with is, of course, that of cleaning groundwater right now or drinking water supplies in order to reduce the immediate problem, but at the same time we have to figure out, where is this chromium VI coming from?

Now, with that in mind, I'd like to just briefly give you a background. You've heard a little bit previously, and there is some in the material that has been handed out. And by the way, for those of you who might be interested, I do have a report -- actually, it's a paper, and I'm not sure if it's been made available -- which was published last year on "Critical Assessment of Chromium in the Environment," which deals with a lot of details, issues, that I will not go over today.

But basically, the majority you've heard, the majority of chromium VI, is from industrial activities. However, as I will point out, in fact, we have to worry about interconversions of chromium, both in the environment and during treatment processes. About 70 percent of chromium usage is in the production of metal alloys. While we typically think that chromium in a metal alloy is not a problem, you have to recognize that if it's oxidized, if there is dissolution, then in fact there can be a conversion to chromium VI, and that may be a problem.

While we talk about chromium VI and we talk about chromium III, we have to remember -- perhaps many of us know it but I think it's important to emphasize -- chromium VI doesn't really exist as a freak action but it actually exists in the form of oxides, both chromates, dichromates.

Chromium III can be oxidized to chromium VI. You've heard about chromium VI going to chromium III in the body, but it's also possible for chromium III to be oxidized to chromium VI in the presence of a variety of oxidation agents: oxygen, ozone, hydrogen peroxide, magenese dioxide.

In the environment, typically many of these are not, with the exception of oxygen, are not present at very high concentrations. In the presence of oxygen, one has to go to fairly high temperatures for the interconversion to occur.

But in the presence of water, it's very possible, if there is sufficient concentrations of these oxidents, for the interconversion to occur. So you can go from chromium III to VI. It is possible. Of course, pH conditions are also important in that regard.

And that goes to the question of sample handling when you do the analysis. That's why sometimes it very difficult to reach very definitive values with regard to percentage of chromium VI versus chromium III, because, depending on how you handle the sample -- what is the pH -- you can, in fact, have interconversions that occur during the analysis. So usually the safest is total chromium because this is what you do know.

The other issue that I think is important for us to recognize is that chromium can exist in many forms in the environment -- III, VI -- but it also exists as salts, some of which are insoluble salts. And depending on environmental conditions, in the soil for example, some of it can be solubilized. So, for example, chromium III salts, while by themselves may not pose a problem, if you have an interconversion, as small as it may be, to chromium VI, and if that is mobilized, then this is a dynamic situation. Equilibrium conditions have to exist, or equilibrium dictates that you would move in a direction of additional chromium III conversion at that point. Of course, the opposite can also happen on the reducing conditions.

What I'm trying to tell you is that the situation is complex. The situation is complex because what it means is that we really need to understand for specific systems, for specific locations, what is the chemistry in the environment so that we can really understand how those interconversions occur. We cannot unilaterally assume that a certain percentage of all chromium that you determine in groundwater is going to be chromium VI. It may be true for a given location, and it may be, statistically speaking, you might say that in a given period of time, that was the percentage. But this is a dynamic situation, because those are reactions that occur and those reactions are affected by the actual chemical conditions that may prevail in the soil and in groundwater. So we really need to understand that and realize that the problem in many cases may be, to some degree, site specific.

The other issue that I think is important to realize is that chromium species may also bind to organics, and as they bind to organics, the question is, of course, to my toxicologist friends, what is the issue of bioavailability at that point? In water treatment, if they're bound to organics -- humics, for example -- it may be possible under some conditions that those chromium species may be removed. On the other hand, in the environment, in fact they may be mobilized as colloidal species and may reach groundwater. So we need to realize that.

And I will close by saying that I do urge you that whatever public policy decision is made is that you extend the range of decisions or actions that are taken to consider the identification of the source of chromium VI and don't just assume that chromium VI arises out of industrial emissions. In some places it may and in some places it may not. So you have to consider the totality of this picture.

I hope that I kept my remarks short.

SENATOR ORTIZ: You did, and I thank you for that. I'm sure there are going to be questions.

In your opening, did you say that 70 percent of all sources of chromium are--

PROFESSOR COHEN: I said approximately 70 percent of chromium usage is in production of metal alloys, just to give you an idea of the range of the activities.

SENATOR ORTIZ: That's helpful, thank you, particularly for sticking to the ten minutes.

Our next speaker is David Spath.

DR. DAVID SPATH: Respective chairs and members, my name is David Spath. I'm the Chief of the Division of Drinking Water and Environmental Management at the State Department of Health Services. In that capacity, I'm responsible for managing the state's drinking water regulatory program. That responsibility includes making recommendations to the director of the Department of Health Services on appropriate standards for chemicals in drinking water.

I do appreciate the opportunity to come before you and discuss the issue of chrome VI in drinking water, particularly what we at the Department have done in reviewing the appropriateness of the present drinking water standards for chromium and also assessing the need for the possible separate drinking water standard for chrome VI.

Before I begin, I would like to compliment you for the interest you've taken in chrome VI and the issues associated with it. Hopefully, this hearing will provide the public with a better understanding of the complexities associated with setting drinking water standards and the efforts undertaken by the respective state agencies to ensure that high quality drinking water is provided to the citizens of California.

You've already heard briefly about the standard setting process and the role that public health goals play in that process. You've heard that there is no drinking water standard for chrome VI. There is a drinking water standard for total chromium. California has a standard of 50 parts per billion. Federal EPA has a standard of 100 parts per billion, and that standard at the federal level was revised in the early '90s from 50 to 100. The Department chose not to revise the standard at that time.

You're obviously aware that there is a public health goal for total chromium of 2½ parts per billion. It was adopted in February of 1999.

There is some confusion, I think -- there certainly has been in the press -- there's a difference between a public health goal and a drinking water standard, and I'd just like to very quickly elaborate on that.

Standards are the levels that public water systems are required to meet in the drinking water that they provide to their customers. California law mandates that the Department set drinking water standards as close to the corresponding public health goal as is technologically and economically feasible.

Public health goals are those levels that are solely based on health risk considerations. And as Dr. Alexeef indicated, they do not take into consideration cost or tactical feasibility. And he did indicate the basis for public health goals. They're either based on acute toxicity or long-term and carcinogenic effects, and under those conditions the level is set that does not pose any significant risk to health.

In crafting the Safe Drinking Water Act for California, the Legislature intended that the public health goal be the starting point for the Department when determining the most appropriate standard. While acknowledging that and setting a drinking water standard, there is a balance that must be reached between the cost to the public and the benefit the public receives in risk reduction. As a result, there are cases where the public health goal and the drinking water standard are at different levels.

The Legislature also intended that the public be allowed to make local decisions regarding compliance with the public health goal. The law requires public water systems to hold periodic hearings to inform their customers of the cost of complying with public health goals and respond to public comment.

The customers, for example, could then request a referendum on paying for the additional cost of meeting the public health goal or staying with the drinking water standard. Now, we're not aware of any instance to date where customers have opted to pay the additional costs to meet a public health goal where there is a difference between the goal and the standard.

I'd like to just take a moment also to briefly describe what we have done at the Department of Health Services since the public health goal for total chromium was adopted in February of 1999.

In March of '99, the Department gave notice that we would be evaluating the total chromium drinking water standard to determine if the standard should be revised. And after initial review, we determined that there needed to be a better understanding of the distribution of chromium III and chromium VI in the drinking water of the state.

The public health goal for total chromium was based on national data on the distribution of chromium III and chromium VI and assumes that the average chromium III makes up about 7 percent of the total chromium in drinking water. To test that assumption, we collected information from a number of water systems and sampled for chromium VI, and we began that in August of 1999 and we completed the study in January 2000. The information that we found, looking at a few water systems, indicated that chrome VI made up a much larger percentage of the total chrome in drinking waters that we looked at, and by and large, it was greater than 50 percent.

The other thing I think it shows, both the data that we have from the study and also the data we have on total chrome, that the principal source of chromium in drinking water is naturally occurring chromium. Now, certainly there are some hotspots in some areas, which I would agree with. But if you look at the database that we have, it strongly argues that chromium VI is really from naturally occurring sources.

As a result of that work, we concluded there needed to be information on statewide occurrence of chromium VI in drinking water before we could adequately determine if the standard should be revised, and if so, what level that should be.

So in the spring of 2000 we announced that instead of revising the total chrome standard, we would adopt a regulation to require statewide monitoring of water systems for chrome VI. As is required by the Safe Drinking Water Act, we have to hold public hearings. We held two public hearings in September on that decision to require monitoring; one in Sacramento and one in Los Angeles. The Department has drafted and submitted for review the regulation for monitoring of chrome VI statewide, and we hope to have that regulation in place on an emergency basis by the end of this year.

We've also sent letters out to all water systems that are affected by this regulation, recommending they begin to monitor in anticipation of the rule. Once we have sufficient occurrence data on chrome VI, then we will be reevaluating the total chromium standard or possibly even regulating chrome VI individually.

And I would like to speak to the issue of taking five years that has been cited in the press on several occasions. That's a conservative estimate if you went the normal route of adopting a regulation. We've taken a different tact already with proposing -- or will be proposing a standard by emergency rule -- or we'll be adopting it by emergency rule by the end of this year, which will allow us to gather occurrence data much more quickly than otherwise.

I did want to mention what we're doing on SB 2127. I sent out letters to the affected water systems in the San Fernando Basin, recommending that we meet with those systems and determine how we can best implement the law as quickly as possible.

And finally, our advice to water systems is that they test for chromium VI, particularly those systems that have total chromium that they've measured previously from previous monitoring.

Secondly, we would also recommend those systems that are in proximity to sites that use chromium, such as electroplaters, the aerospace industry, to also monitor for chromium VI, particularly if they have some total chromium in their sources.

We'll also be looking at the water quality data that we have for chrome VI, of which we have quite a bit, and we'll be making recommendations for more frequent monitoring of public water systems as well.

However, at the present time, we do not believe that water systems should discontinue the use of water sources that contain chromium above the public health goal of 2½ parts per billion. We believe the Legislature has established a prudent process for the Department to review drinking water standards, and pending completion of the Department's review, the state drinking water standard for total chromium remains at 50 parts per billion.

Thank you, and be more than happy to answer any questions.

SENATOR ORTIZ: I think there's a question on your testimony from Senator Hayden.

SENATOR HAYDEN: Thank you, Madam Chair.

I have a number of questions that I'll hold until later, but either I misunderstood or there was a misstatement.

If I understood the words you chose, you said that you were going to set a standard, but I think you meant you were going to establish a regulation for a monitoring program by January 2001.

DR. SPATH: I did not say, I don't believe, that we were going to set a standard by 2001. I said that we were going to be adopting--

SENATOR HAYDEN: No, you did say that, and I just want to clarify that you didn't mean a standard. You're going to adopt a regulation to monitor. Is that correct?

DR. SPATH: If I did say that, it was in error. What I did mean to say was that we will be adopting a statewide monitoring requirement for all public water systems by January 2001 by an emergency rule.

SENATOR HAYDEN: And with respect to the standard, which is the enforceable standard, you haven't decided whether one needs to be set. Is that not correct?

DR. SPATH: That's correct at the present time. Well, with regard to total chromium, we have not decided whether we need to revise that standard.

SENATOR HAYDEN: Right.

DR. SPATH: With regard to chromium VI, we have not decided whether to set a standard because we want to look at the occurrence data, because the law requires us to determine what the impact will be, both from a cost and technical feasibility standpoint. And the only way we can do that is to understand what the occurrence of chrome VI is within the public water system.

SENATOR HAYDEN: So you haven't decided whether to set a standard to either revise the chromium standard or to set a standard for chromium VI.

DR. SPATH: We can't do that, Senator, without understanding the situation within the environment.

SENATOR HAYDEN: No, but the letter I have from your boss, Dr. Bontá, says, "if one is indicated." So at this point, you're saying -- and I think we're in agreement -- you don't have a basis, from your point of view, to adopt a standard based on what OEHHA has recommended as a goal, and you will not until you've done this statewide monitoring, which will be authorized by January 2001 and will take two years.

Is that a fair summary?

DR. SPATH: It doesn't necessarily have to take two years to begin with. But you're correct, we will not be either revising the total chromium standard or setting a separate chrome VI standard until we have sufficient data available to us, which will be generated by this monitoring, so that we can assess the costs and determine what level may be technologically feasible.

SENATOR HAYDEN: But you haven't decided whether to. Is that not correct?

DR. SPATH: Well, I suppose you could say we haven't decided whether to until we get a sense of how much chrome VI is out there in the environment. What it looks like is, yes, there's a preponderance of chrome chromium VI, which would certainly suggest that it would be appropriate to set a standard for chrome VI.

SENATOR ORTIZ: Senator Schiff had a question.

SENATOR SCHIFF: Mr. Spath, do you agree with the panel of experts that just testified that basically we know enough now to know there is a significant health risk associated with chromium VI in the water, we should not wait to act to do more studies? Do you agree with that assessment, and is all that's required now, as you view your responsibility to determine the other half of the question, is what's the cost? Or do you think that the data is still not there on the health risk such that you have to both examine the health risk and the cost?

DR. SPATH: Well, certainly we would defer to our sister agency who is responsible for doing the risk assessments. The only problem I think we see is the difference between both the federal side of the equation where USEPA has made a decision that chrome VI should not be regulated as a carcinogen and the position we have right now that it should be. We would hope that that difference of opinion could be resolved, and maybe it can't be. Maybe the way you look at the data is the way you look at the data.

But regardless of that, we are still proceeding ahead with generating as much data as quickly as we can so that we can decide how to regulate.

SENATOR SCHIFF: I'm not sure that answered the question.

Do you agree with the scientists who have testified that there is enough evidence of the carcinogenic impact when ingested through the water that that question, for the purposes of implementing a new standard, has been resolved to your satisfaction such that the only challenge you have remaining is determining what's the cost of the reduction?

DR. SPATH: We accept the recommendation from OEHHA that it should be considered a carcinogen through ingestion. So we will move forward with that in mind, and we would regulate on that basis at the present time.

SENATOR SCHIFF: So all you're going to wait to do then, the only time you need at this point to implement a new standard, is determine what the economic costs will be.

DR. SPATH: You're absolutely right. Exactly.

SENATOR ORTIZ: Assemblymember Kuehl.

ASSEMBLYMEMBER KUEHL: And you said the available technology. You're talking about cleanup technology?

DR. SPATH: Well, treatment technology. I think there's a confusion of terms here. Cleanup can also mean cleaning up the sources of chromium. I'm not talking about that. What I'm talking about is the cleanup technology to take the chromium out of the water. And again, what we seem to be seeing is that, for the most part, chrome VI is natural to the environment. I agree that there are some hotspots. But we've looked in places where there is no electroplating, there's no aerospace, there is no obvious source of chrome VI, and we see some significantly higher levels; higher than we've seen in the L.A. Basin.

SENATOR ORTIZ: I certainly would like to ask a couple of questions of Mr. Spath as well.

Can you tell me, do you monitor the water at the supply source or at the tap?

DR. SPATH: Monitoring is done by public water systems. In California it's a self-monitoring program. Most states around the country work off of that philosophy.

Most monitoring is done at the source, or, if there is some intervening action like treatment -- for example, if one chlorinates water that may have chromium in it -- we would look at the water after the chlorination occurs because there may be some oxidation taking place that would convert chrome III to chrome VI. But otherwise, we wouldn't require monitoring at the tap because, generally, what is coming out of the source is what one would see at the tap. Plus, it gets to be a very difficult operation, if you will, to monitor at the tap.

SENATOR ORTIZ: Now, are you concerned about chlorination's effect on--?

DR. SPATH: Yes. We will be advising water systems that do chlorinate their wells that they sample both before and after chlorination.

SENATOR ORTIZ: Because the chlorination process actually increases the conversion?

DR. SPATH: It has the potential of going from chrome III to chrome VI.

SENATOR ORTIZ: Which is the reverse that was--

DR. SPATH: Reverse of the stomach issue, yes.

SENATOR ORTIZ: I mean, we have focused on sort of the potentially less risky effects of chromium VI to chromium III. But now we have a reverse risk of C-III to C-VI through chlorination?

DR. SPATH: That's potentially the case where chlorination exists. Not all public water systems that use well water chlorinate. In fact, the majority of them don't here in California.

ASSEMBLYMEMBER KUEHL: Could I just ask you to clarify how the statements that you made go together in answer to Senator Hayden's questions?

In your testimony you said that the responsibility of your area is to make recommendations to the director on standards for chemicals in drinking water. That's in your written testimony.

DR. SPATH: That's correct.

ASSEMBLYMEMBER KUEHL: You answered that you were accepting, in terms of the health risk, the recommendation for standards made to you already, but that all you're planning to do is to issue regulations for monitoring, which is to find out how much there is in the water, and then to assess the cost and available technology.

DR. SPATH: Well, I think what's happened here is there's some confusion as to what a public health goal really means. It's not a standard. There's been a lot of indications certainly in the press that it's a standard that's been recommended by OEHHA. That is not the case. It's a goal, and the law requires us to strive to be as close to the goal as is feasible. Feasible means we have to take into account the economics, the cost to the water system, the cost to the customer, and whether there are technologies available that can treat down to certain levels.

ASSEMBLYMEMBER KUEHL: But will you set a standard without regard to the cost and the technology, or if you do not set a standard, is it only because of cost?

DR. SPATH: We would set a standard one way or the other, and we would strive to set it as close to the goal as possible. But we would take into account in setting that standard the cost of treatment, the cost to the customers, and the ability to treat to certain levels.

ASSEMBLYMEMBER KUEHL: But I thought you answered Senator Hayden in saying there was not an intention to set a standard.

DR. SPATH: Well, we're talking about two different things going on here. We're talking about a requirement to monitor. That's the first step. And then based on that requirement, we will be getting data from water systems on the occurrence of chrome VI in the water. Once we get that, then we can do an analysis as to what it would cost to remediate and reduce chrome VI to certain levels. We will look at what it would cost to bring the chrome VI in water down to the public health goal. We would look at it from maybe five times the public health goal, ten times the public health goal. And we will do an analysis, a cost-benefit analysis, and make a decision as to what the most appropriate standard is.

ASSEMBLYMEMBER KUEHL: Thank you very much.

DR. SPATH: Sorry that was confusing.

SENATOR ORTIZ: Senator Hayden has a question, and then I have a quick one.

SENATOR HAYDEN: Did you or anyone in your office ever tell the *Los Angeles Times* that they shouldn't be alarming people?

DR. SPATH: No, I certainly didn't. And I don't know of anyone -- or if anyone did.

SENATOR HAYDEN: In response to my letter about that, did you ask the people in your office whether anyone did?

DR. SPATH: I talked to our press office. There are only two people in my office, including myself, who will talk to the *LA Times*, and I have not advised them of that.

SENATOR HAYDEN: All right.

On this issue of local decisions, I want to understand this, and members, this could be a conflict of interest. It's a very interesting part of the law.

The city of Los Angeles does not have a person, a single person in charge of monitoring the condition of the water, much less enforcing it. I don't know about Burbank or other cities. It's left to the county or to the state. But, of course, the testimony shows that despite the fact that for eleven years OEHHA has said chrome VI is an oral carcinogen, nothing has happened, and there's no guarantee yet that a standard is going to be set.

You can opt out of this apparently, if this is the correct interpretation of the law, if the public water system -- that would be in Los Angeles the DWP -- holds a hearing to tell the customers of the cost of compliance with the public health goal. And then the customers can request a referendum to charge themselves for reaching the public health goal, which is used in this controversy to say, well, people have this option but haven't used it.

I want to know if there isn't a conflict of interest, if the agency that's trying to sell or transfer the water is in charge of telling the customer what it will cost, say, to close wells or take water from Northern California. Why shouldn't OEHHA be at the public hearing to tell people what the cancer risk is?

DR. SPATH: It doesn't preclude them from being at the public hearing.

SENATOR HAYDEN: But the hearings are sponsored by the water agency.

DR. SPATH: That's correct.

SENATOR HAYDEN: I should know this, but how do you request a referendum? Does somebody write a letter? Does the DWP have to vote? Maybe Leg Counsel can tell us.

DR. SPATH: I would assume it would be the public would request such. I mean, they are holding a public hearing, they are taking comments. If there is a preponderance of interest to do that, then I would assume that they would consider it.

SENATOR HAYDEN: Well, that's a local way out that could circumvent the need for the state study, but it seems to me, if the agency that sells you the water says it's going to cost you a lot of money, and that's the substance of the hearing and people don't hear from OEHHA, it's not much of an option.

My last question, or second -- there's two. Is it your belief that implementing the public health goal would close dozens of wells in this area?

DR. SPATH: From our assessment right now, it would -- in this area or statewide?

SENATOR HAYDEN: This area.

DR. SPATH: There are approximately 150, 155 sources that have total chromium above 10 parts per billion in the L.A. area. If you just assume that 50 percent of that is chrome VI, then all of those sources would have to be closed.

SENATOR HAYDEN: And is it your assumption that it would cost $47 million to import water to substitute for that water, to import water from Northern California or elsewhere?

DR. SPATH: I couldn't speak to that.

SENATOR HAYDEN: That's not your number.

DR. SPATH: That's not my number.

SENATOR HAYDEN: Okay.

And last, on schools -- I mean, there's some people that -- we have like a two-tiered system. I don't know about the north, but a third to half the people in L.A. County drink bottled water, and the rest can't. It's like many of our two-tiered systems. But school children and there's certain subpopulations that are dependent absolutely on the water being healthy for them developmentally.

Have you done any testing of public school water quality in Los Angeles County or elsewhere? And is there a way to segregate out the issue of school children and fast track that, since they don't have the option of bottled water or any other option?

DR. SPATH: If a school system is supplied by a public water system, then we would know the concentration certainly. The public water system would know the concentration of contaminants.

SENATOR HAYDEN: Have you done that with schools?

DR. SPATH: We haven't done that with schools that are served by public water systems. There are a large number of schools that have their own public water system, and we've done that, certainly.

Let me just mention, and Dr. Alexeef had also mentioned it, they take into account the effect on the young, the elderly, susceptible populations, when they do assessments on public health goals.

SENATOR HAYDEN: Well, I understand that. So they're saying, and I think you're corroborating them, that the public health goal should be set at a drastically more protective level, in particular taking into account vulnerable populations like children.

DR. SPATH: Right.

SENATOR HAYDEN: And speaking of feasibility, it's not feasible to give kids in a school an alternate water system, is it?

DR. SPATH: No. I mean, unless you give them bottled water.

SENATOR ORTIZ: Let me ask a question, just so that I'm clear.

The 2.5 parts per billion is the goal, the public health goal.

DR. SPATH: For total chromium.

SENATOR ORTIZ: For total chromium in all chromium found.

DR. SPATH: That's correct.

SENATOR ORTIZ: And the monitoring, or the data so far is suggesting that we have actually 50 percent plus total chromium -- chromium VI of all chromium?

DR. SPATH: It's a small database, and you have to recognize that first. But what we did, we went to several communities where they had higher levels of total chromium. That is, from about 15 to 30 or 40.

SENATOR ORTIZ: Which is significantly higher than the 2.5 already.

DR. SPATH: Right. And what we found in about, I'd say, 90 percent of the cases, that the chrome VI levels were more than 50 percent of the total chrome makeup.

SENATOR ORTIZ: And we have always relied on something like 7 percent rather than the 50 plus.

DR. SPATH: Actually, we had no database upon which to rely, and in fairness to OEHHA, they had to try to find some data, which they found looking at another state, to use that 7.2 percent.

SENATOR ORTIZ: I understand, and I just want to make a point, because there's a lot of question about why do we need monitoring. I think we need extensive monitoring, obviously. I don't think it's exclusive of, and I don't think it should occur only for some period of time and not have us move forward with trying to address what appears to be a problem. But we definitely need monitoring throughout California because I don't think it is something that is unique. My understanding is we're finding, certainly in my district, I think, some alarming numbers.

DR. SPATH: In Davis.

SENATOR ORTIZ: No, not Davis. Sacramento County.

DR. SPATH: I'm sorry.

Yeah, I can speak to the city of Davis where we found some fairly significant levels of chrome VI in the total chrome makeup.

SENATOR ORTIZ: Well, we can chat about Sacramento later on.

But I want to just comment on I think we need to monitor extensively. That's not exclusive of the other recommendations and direction we have heard. But I think we need to monitor simply because, in order to tackle the problem, we need to know how extensive, how widespread, what the nature is of the source. I think we need to spend a lot of time understanding various sources and the impact of chlorination.

SENATOR HAYDEN: Who does the monitoring?

SENATOR ORTIZ: Well, at this point, we know who does the monitoring. The question is: Who will do the monitoring? That's up to us.

DR. SPATH: Who does the monitoring, did you say?

SENATOR HAYDEN: The water agencies do the monitoring now.

DR. SPATH: That's correct.

SENATOR ORTIZ: But we can certainly possibly discuss, as we move forward, other options to that.

ASSEMBLYMEMBER JACKSON: I'd like to just follow up a little bit on this concept.

What I heard you say is that before we can do the necessary assessment to set drinking water standards, which have to include economic considerations and technological considerations, we have to monitor. And yet, at the same time, there have already been identified here, I think in testimony today, we know of at least 2,000 hotspots. There may be more. But we know where some of them are; certainly some of them are right here.

Why is it we have to wait until we do this whole extensive monitoring before we establish some standards from which we can then start taking action and removing this chromium VI from the water?

DR. SPATH: Well, we're charged with setting a statewide standard, and to do that we need to understand what the statewide occurrence is so that we can do this assessment.

Now, certainly, if a local water agency wants to take action to reduce its level of chrome VI, then they could take that initiative. But we had not taken it upon ourselves to go to certain individual systems and say, you know, *You should do this or you're required to remediate.*

ASSEMBLYMEMBER JACKSON: But this almost sounds like an enormous task to just try to come up with a monitoring program statewide that then allows you to set statewide standards. When we know that there are existing problems, why do we need to wait to see what some of the other different levels are statewide before we identify cost and technologies available to deal with the problem?

DR. SPATH: Are you suggesting that on an individual case basis we set a standard for a certain water system?

ASSEMBLYMEMBER JACKSON: I guess what I'm suggesting is how are you going to be able to do this? Are you going to generalize because in Davis it might be a higher level than, let's say, in San Diego, or in Sacramento it's a higher level than in some Central Valley community? I mean, how are you going to come up with statewide generalized standards that are going to effectively deal with specific local problems that may have to be dealt with on a very case-by-case basis?

DR. SPATH: Well, the way the law was written I think allows for that.

ASSEMBLYMEMBER JACKSON: Does it allow for it or does it require that? Because we're here to try to decide whether or not we need to make some adjustments in the law.

DR. SPATH: Well, it both requires a statewide standard, one statewide standard, and it allows, if there's a difference between the goal and the standard, for local action at the local level, which I think is a prudent way the Legislature decided to go.

ASSEMBLYMEMBER JACKSON: How long it is going to take to get a statewide standard? In other words, give us a sense of, if you go ahead and start aggressively monitoring, as Senator Schiff's bill now requires, how long is it going to take, and then how long would it take after that to set up statewide enforceable standards?

DR. SPATH: If we have an emergency rule in place by the beginning of this next year, and we can generate data, sufficient data, to make an assessment within a year or year-and-a-half, I would say between two and three years to have a formal enforceable standard in place.

ASSEMBLYMEMBER JACKSON: Thank you.

SENATOR ORTIZ: I know we have other speakers, but let me ask a real quick question.

I understand and respect that you're here to provide testimony within certain parameters, and you certainly can't speak for your department or the Administration. But to your knowledge, is there any statutory impediment that precludes you from establishing a standard?

DR. SPATH: Without going through the process that I have described?

SENATOR ORTIZ: You mean the public hearing notice process?

DR. SPATH: Doing an assessment of cost and benefits. I think that precludes us from adopting a regulation without going through that process. I think the statute is clear that we are obligated to go through that process. If it were a public health emergency, certainly we could take certain action.

But I think what needs to be recognized here is we're not talking about acute toxicity. What we're talking about is long-term toxicity over a 70-year lifetime. That's the way the assessment is done.

And so what has happened is that I think the public views this as being an acute problem. It is not an acute problem. There are, certainly, potentially some risks, and you've heard already from the speakers, but these are long-term risks, and they're very much theoretical risks as well.

SENATOR ORTIZ: I suspect we're going to hear from other witnesses who will offer a different opinion, but I appreciate that.

Now, can you cite the source of that provision? The statutory source?

DR. SPATH: The source for our--?

SENATOR ORTIZ: Is it the Administrative Law overview?

DR. SPATH: Health and Safety Code.

SENATOR ORTIZ: Yeah, Health and Safety Code.

DR. SPATH: Right.

SENATOR SCHIFF: May I ask one last quick question?

If I'm understanding you correctly, what you're saying is that even operating under an emergency timetable, it's going to be two to three years before the state adopts a new standard, if indeed you've even found a new standard was economically feasible.

Is that accurate?

DR. SPATH: Well, first of all, to go to the second part of our question, whether we find a standard to be economically feasible, there's a very strong likelihood, I think, that we will regulate chrome VI. The question becomes: At what level? And that's when you take into account the economics and the feasibility.

Now, it will probably take us two to three years to do that because we need the occurrence data and then we need to do the cost assessment based on the occurrence data.

SENATOR SCHIFF: So what local communities need to know then is that under the current process, there is going to be no new state standard for the next two or three years, and if local communities want a higher standard for the drinking water, they're going to have to impose it themselves.

DR. SPATH: I think that's correct. Certainly, they can come to us for advice, but they still would have to take the action.

SENATOR SCHIFF: Then the only way basically to get a quicker state standard were if the Legislature were to act and simply by virtue of state legislation impose a standard via legislation.

DR. SPATH: That's true.

SENATOR ORTIZ: I know we've spent a lot a time on your testimony. I suspect that we're going to have more questions for you. Thank you, but I do want to move forward.

The next speaker is Mr. Dickerson. Welcome.

MR. DENNIS DICKERSON: I do have a slide presentation here. Hopefully, that will come up. There it is. Great.

Members of the Assembly and Senate, good morning. My name is Dennis Dickerson. I'm the Executive Officer of the Los Angeles Regional Water Quality Control Board. This morning I would like to provide brief comments on the nature of chromium contamination in our region and our efforts to address it. And I would like to note that the L.A. region is specific to Los Angeles County and Ventura County. There are other regional boards throughout the state you may want to pursue to follow up on this issue in other areas.

Chromium contamination is present in the San Fernando Valley, especially along the industrial I-5 Corridor. It's predominantly the result of industrial practices that occurred from the '40s through the '70s and to a much more limited extent more recently. And as you've been hearing this morning, hexavalent chromium is, of course, the greatest concern.

Next are a couple of slides that talk about the fact that we have sources coming from various different industrial activities: metal plating, steel making, dyes and pigments. Probably the greatest source in this area, chrome plating is probably one of the largest.

This is a map that we do have a poster of, but it's showing up on your computer screen here. These are a selection of 200 sites that are along the I-5 Corridor that we are currently looking at as potential sources of chromium contamination.

Now, on the next slide you have another database that we're using from the Department of Toxic Substances Control. Here you have a slide which shows another 200 sites. Now, it could be that there's a total of 400. It could be that actually there's quite a bit of duplication. We're in the process of sorting them out right now.

But these are not confirmed sites for chromium contamination. These are all suspected sites with regard to a process that we're going to be going through, which I'll tell you more shortly.

We do have a number of sites that are actually under active investigation currently. These have been under Regional Board oversight for some time. These include Lockheed, ITT Industries, Menasco, Courtaulds Aerospace, Drilube Company. And this is a map that we have showing the locations of some of those facilities. You can take a look at that later. We'll have that up for you.

The sites that are located in blue are really sites that are related to the Superfund site -- potentially responsible parties. So we're really looking at a fairly small number of those sites which are suspected of the chromium contamination at the present time.

Now, in each of these, site assessment and/or cleanups are underway, and in some cases they're under orders that have been issued by the Regional Board -- cleanup and abatement orders. In some cases it's in a cooperative process that we have with many hundreds of sites throughout Southern California on chromium and other issues.

I'd like to briefly go through the historical context of where we've been on this. The San Fernando Valley, of course, has been the site of a Superfund designation with respect to groundwater contamination; that groundwater contamination identified in the early '80s as being related to the subject of volatile organic carbon compounds that have been used; degreasers, for example.

In 1986, the valley was placed on the Superfund site. That map that you have there up on the wall identifies the actual, what are called, Superfund Operable Units: the areas which are directly under Superfund oversight by USEPA.

The next slide just gives you, again, the same as identified on the map there, showing those operable units.

From '86 through '96, hexavalent chromium was discovered in the soil and groundwater during these Superfund investigations. In 1998, LA Department of Water and Power detected trace amounts of chrome VI in their groundwater monitoring, also in the San Fernando Valley. Then, in the current year, we're looking at substantial monitoring underway by USEPA at 87 of their monitoring wells within these operable units.

The San Fernando Valley Basin is a large unconfined aquifer composed of alluvial deposits that transfer pollutants very readily. That's why we have the Superfund problem that we do. Groundwater flows generally from west and north to the southeast, and it really is a major aquifer for Los Angeles, Burbank, and Glendale.

The next slide here shows you some of the pathways, the general groundwater flow from the northwest toward the southeast.

Chromium contamination can also be found in the San Gabriel Valley and other areas in the Los Angeles region. For example, through the excavation and development of the Alameda Corridor project, there was a site that was identified there; and indeed, a large amount of the soil contamination that was identified has been removed for disposal.

We did find at one facility -- and this particular facility, the Barkens Corporation -- a very high amount: 296,000 parts per billion in shallow groundwater. And I emphasize "shallow groundwater." That site is currently being assessed by us for the extent of contamination.

Now, in a related activity that occurred not long ago -- I think just within the last two or three weeks -- we had a drinking water well in the community of South Gate where they had to close their well because of levels of chromium contamination. So we are seeing a situation, at least with regard to this one well, and I believe there was one other well that was closed some time ago with regard to chromium contamination. And it adds, really, to the list of many dozens of wells that have been closed over time related to volatile organic carbon contamination.

So this is a concern and one that the Regional Board is taking very seriously.

Carbon contamination is initially found at high levels in soil and shallow groundwater near the source of the contamination, and that just makes sense. If you're going to have a spill, or you have a septic system that was taking this waste back in the '40s, '50s, and you have a source of contamination, then it spreads out from that point. Levels of contamination then typically will drop fairly rapidly away from that source.

But from the Regional Board's point of view, removing the source of contamination, and in particular the soils that are heavily contaminated, is one of our highest priorities.

Chromium contamination in deeper drinking water aquifers may result from contaminant spreading. It can happen through pathways such as an abandoned well which is not closed properly. That could serve as a pathway. Could be fractures in bedrock. It could be through just the alluvial dispersion that can occur in the groundwater. And contaminant migration to the lower aquifers is a concern over time.

Now, you're going to have dispersion dilution of the levels of contamination from, let's say, that hotspot that we talked about before. But as you go down, you have to get down some places to 800 feet to the drinking water supply. So there's a lot of room there, if you will, for that dispersion to occur. And drinking water aquifers generally now show comparatively low levels of contamination.

I believe it is imperative that existing sources of contamination be identified and the contamination be remediated as quickly as possible to protect the drinking water resource.

Now, chromium is found in many monitoring wells. Monitoring wells are generally much more shallow, and that's where we would expect to find higher levels of chromium contamination.

The next slide, I believe, shows you a map that shows a number of these drinking water wells, and it also shows you the concentrations of chromium that are associated with those. And they vary. Most of these monitoring wells are at relatively low levels in the 1 to 5 part per billion range. In a few instances, located near these hotspots, you can find these monitoring wells which are substantially higher.

And the map or slide that I just had was the EPA monitoring wells that are in place.

Now, Regional Board-directed oversight for cleanups are producing results. Two examples: the Anadite facility in South Gate. Shallow groundwater contamination has been reduced from 43,000 parts per billion down to 5,000 parts per billion currently, and remediation is still ongoing. At Lawry's in Los Angeles, groundwater contamination has been reduced from 34,000 parts per billion down to 110. So we are making progress. Progress can be made on this particular issue.

Now, the Regional Board has entered into a partnership with the United States Environmental Protection Agency to look at those sites. Those earliest maps that I showed you, which showed the 200 sites, we have a grant from EPA to conduct an investigation which is going to be looking at that. We're going to be sending out questionnaires very shortly to those sites, and we'll be doing follow-up inspections. The goal there is to identify where the sources of contamination are, to conduct site inspections, to issue orders or engage in cleanup activities as appropriate to address any contamination that might be found.

And the remaining two slides that I have just given you, the work plan for 1999 and the year 2000. I won't go into detail on that; you have that information in your slides.

And that concludes my presentation.

SENATOR ORTIZ: Thank you so much, Mr. Dickerson.

Unless there are questions for Mr. Dickerson now, we can certainly invite Mr. Lyou to come forward.

MR. JOSEPH LYOU: Unlike Professor Froines, I'm going to try to stick to my written comments, except for the very first two words, which were "good morning."

I will say good afternoon. I'd like to thank Senator Hayden, Senator Ortiz, and Assemblymember Jackson, as the chairs of the host legislative committees, for the opportunity to speak about this very important matter.

My name is Joe Lyou. I am Director of Programs at the California League of Conservation Voters Education Fund. The CLCV Education Fund is a nonprofit public interest organization dedicated to protecting and enhancing our environment where we live, work, play, and learn.

My interest in chromium VI comes from many years of working to protect our groundwater resources. I've spent countless hours pouring over reports on groundwater monitoring site remediation, site characterization, health risk assessment, and environmental impacts for post-permits, and I know it might not be the most exciting aspect of my life but I think it does serve as a pretty good basis for discussing groundwater protection.

It's truly an honor to be here today with such an esteemed group of scientists, administrators, and policymakers. Their expertise and experience will undoubtedly prove essential in dealing with the problem of chromium VI contaminated groundwater.

I come from a somewhat different perspective. I've made a profession of assisting communities and individuals dealing with environmental hazards. Today I have three simple messages:

1. Water that meets "acceptable standards" is not necessarily, "safe." And
2. If we are to err, we should err on the side of caution.
3. That polluters should pay for the costs associated with chromium contaminated groundwater.

We've been asked to discuss California's drinking water standards, or adequacy in enforcement, and the extent and distribution of chromium and chromium VI contamination in California.

Many people sum up the problem of chromium VI in our drinking water with one basic question: Is it safe? While the question is simple, rational, and perfectly legitimate, the answer is not so straightforward. The complexity begins with the acknowledgement that the current public policy is not to judge the quality of our air or our water in terms of safety but to base that judgment on the concept of acceptable risk.

Lately, I've been frustrated to read from reassurances that the chromium contaminated groundwater is safe. No one can tell us that with any degree of certainty, and it's misleading to make such a claim.

The Department of Health Services establishes regulatory limits for drinking water based on a judgment of "acceptable risk." In general, when it comes to the probability of getting cancer from environmental hazards, that risk is a level of one in a million. In essence, it's like playing Russian roulette with a really big gun: one with a million chambers and one bullet that could give you cancer. Using this analogy, it's but easier to visualize the difference between safety and acceptable risk. No matter how many chambers in your gun, it's not safe to play Russian roulette with a loaded weapon.

So, your basic question -- Is it safe? -- must be changed to: Does it pose an acceptable risk?

I think the answer to that depends on who makes the decision. My impression is there is a big difference between the opinion of polluters and the public opinion when it comes to this issue. The public has a hard time with the notion of being put at risk at the hands of polluters. There are many reasons for this: Drinking chromium VI contaminated water is not a voluntary risk, such as driving a car, but an imposed risk that the public has very little choice in accepting. The public has little control over this risk. We find only risks and no benefits in having our tap water contaminated with chromium VI. And the consequence of this risk, which could be cancer, is severe.

We have a right to demand air we can breathe and water we can drink without having to worry about the harm it may be doing us or our children.

Are the chromium drinking water standards adequate? What is the extent of the problem? No one knows for sure. There is an outstanding question about the toxicity of drinking water contaminated with chromium VI. The Office of Environmental Health Hazard Risk Assessment has decided that sufficient evidence exists to consider exposure to chromium VI drinking water may cause cancer. The Department of Health Services must now decide whether it agrees.

One disturbing sign from DHS is its misrepresentation of the US Environmental Protection Agency's position on this issue on its web site. DHS claims, and I quote -- it's a little different from what we heard today: "The US Environmental Protection Agency doesn't consider chromium VI to pose a cancer risk by ingestion." DHS cites two EPA publications in support of this claim.

When I checked those references, I found that EPA is undecided about the carcinogenic risk of chromium VI ingestion. EPA is explicit in its position, and I'll quote: "The potential carcinogenicity of chromium by the oral route of exposure cannot be determined at this time." So that's different from saying that they don't consider it a risk.

The contradiction between DHS's characterization of this position and what I found in the referenced EPA publications gives me cause to worry about how DHS will interpret the toxicological data in setting a new chromium drinking water standard.

In its public health goal, the Office of Environmental Health Hazard Assessment acknowledges the limitations of their conclusion that drinking chromium VI contaminated water could lead to cancer. We do need better studies.

Given the limited data that we have upon which to base a decision, OEHHA has developed a compelling argument that the standards should be strengthened, but OEHHA has made a prudent decision that if we are to err, we should err on the side of caution.

I would expand upon this a little bit to say that we must always remember to place the burden of proof on the pollutant and not upon the regulators who create the standards for public health.

In reviewing its chromium VI drinking water standard, DHS will consider the issue of cost. DHS will consider the cost of compliance, the cost of testing, treating, and replacing contaminated water. These costs could be significant, but I think the key to this analysis is really the question of who should bear the burden of those costs. The answer is clear: polluters should pay. They should pay for testing, they should pay for treatment, and they should pay for replacing groundwater that cannot be treated. In addition, DHS should base its analysis only on unrecoverable costs, those costs that we can't force the polluters to pay, and it must be added to our price of water.

If our legal and regulatory systems worked correctly, this wouldn't be such a radical idea. In theory, we all understand the polluters should pay for the mess that they've created. In practice, it really works out this way, and we have water providers coming across in our newspapers as being more concerned about the cost of water than they are with protecting public health. Water providers shouldn't be faced with a choice between cost and public health, and the public should not be faced with a choice between affordable and contaminated water.

While there've been many attempts to find legislative solutions to this problem, few have succeeded. I say the time has come for more effective enforcement and more protective laws; laws that work and laws that make polluters pay.

So in the interest of allowing the panel time to answer questions and discuss these issues, I'd just like to conclude by saying that the most acceptable solution to this dilemma, given the current approach towards risk management, would be to adopt emergency regulations for chromium VI drinking water standard of .2 parts per billion. This is a level that the scientists at OEHHA believe generally represents the excess lifetime cancer risk of one in a million. Water providers should begin taking the necessary steps to comply with this standard -- .2 parts per billion -- and that limit should be put in place until DHS has been able to determine whether a less stringent standard would adequately protect public health.

Thank you.

SENATOR ORTIZ: Thank you, Mr. Lyou. I know we probably have questions of you, but I would like, at this time, since I think it's helpful for members who want to ask questions of all the panelists in this section, to invite one other speaker forward who probably anticipated us requesting their comment on the record but we didn't have them listed.

I would like the USEPA representative, if possible, to come forward, and briefly sort of address your position on this debate -- standards, nonstandards -- and specifically, I would like you to sort of explain why the USEPA standard of 100 parts per billion is certainly at odds with California's 50, as well as some discussion as to whether the 2.5 should be the trigger.

But welcome, and please identify yourself.

MS. ALEXIS STRAUSS: My name is Alexis Strauss. I'm Director of the Water Division for USEPA. And I'm joined here, since both our Drinking Water program and our Superfund program are involved in supporting this, by my colleagues Bruce Mackler, who's on your list of experts, as well as by Lauren Henning, who is managing our Superfund program in concert with the Regional Board.

This is obviously an issue of great public concern to us, as well as it is to you and others, and we're focusing our attention on this and trying to find ways in which we could best assist the state. As you know, California has been delegated to running the Drinking Water program under the Safe Drinking Water Act. And we respect that although we may set national standards for a number of constituents, that California may and indeed has a more stringent standard in this situation than we have nationally.

The different standards that exist are, I believe, based on the same data sets that we are all using: CalEPA, Department of Health Services, USEPA, and other states around the country. Obviously, as more information may be published and peer reviewed, EPA is continually interested in revising its standards and updating them. In fact, we had not very long ago -- it was just a couple of years ago -- we had gone through a recent reassessment in '98 of chromium, during which, as we all agree, chrome VI was determined to be a human carcinogen by the inhalation route. I think for this there is no argument, and I won't even dwell on it.

EPA did conclude that carcinogenicity by the oral route could not be determined, and therefore, EPA has kept its standard at 100. The equivalent of what we call the maximum contaminant level goal, or the equivalent of what OEHHA has put forward as the PHG, is similarly 100.

So I recognize that there is a difference in our numbers. I would say that we are looking at the same data in terms of up through '98 what had been published and peer reviewed to date, but we are certainly very concerned and wish to continue to support both CalEPA and Department of Health Services as we can in what goes ahead.

SENATOR ORTIZ: Questions of any of the panelists at this point?

SENATOR SCHIFF: Senator, if I could. Before you leave, I just wanted to thank the EPA on behalf of the constituents I represent in Glendale. We had contacted you, along with the city, to request the 90-day extension before the groundwater was used to further examine the question. We appreciate your granting that request.

MS. STRAUSS: Well, we understand how important it is and how long we've all been involved with the Regional Board in addressing this problem. So thank you for that. And if there are Superfund specific questions, Lauren Henning would be well disposed to answer them.

SENATOR ORTIZ: Other questions of Ms. Strauss?

ASSEMBLYMEMBER SCOTT: This is really to the entire panel and it may be a little strange question, but my last chemistry that I took was a freshman year in college, so I have a certain ignorance of this.

Where is chromium mined? And is there not a possible study that could be taken? How do we get chromium? I mean, I assume it's mined somewhere. Does anybody know?

MR. DICKERSON: Chromium hasn't been mined in the United States for at least, I believe, twenty years. Most of it comes from overseas now.

ASSEMBLYMEMBER SCOTT: I see.

MR. DICKERSON: It's an oxide, or a--

ASSEMBLYMEMBER SCOTT: It's extracted from an oxide?

MR. DICKERSON: Yes.

ASSEMBLYMEMBER SCOTT: I was just thinking, that's a place where there must be quite a bit of chromium in the water. If somebody could study the impact of that on human beings, it might have some value.

MR. DICKERSON: I think OEHHA, in its report, has some studies on oral ingestion from China where that was the fact.

ASSEMBLYMEMBER SCOTT: Okay.

PROFESSOR COHEN: Also, if I may add, there are many studies that show that there are high levels of chromium in many agricultural soils. So it's another area that is important to look at chromium and to really see this idea, I think as was proposed to us, that there's some interconversion that occur, or I believe the statement I think was that some chromium VI is naturally occurring, to see if indeed that's the case.

ASSEMBLYMEMBER SCOTT: I'm assuming that chromium VI, as I gather from your testimony and others, it can either be a residual that comes from industrial processes such as at Hinkley, where it was in very high concentration, or it comes in natural form. I was assuming that wherever it's mined, it must be there that it comes in the greatest concentration.

But anyway, it was just a question.

SENATOR ORTIZ: Questions of any members of this panel?

SENATOR HAYDEN: Just a clarification.

The CLCV recommendation is that DHS adopt an emergency standard for chrome VI. DHS argued, I think, that first you have to monitor; and we haven't gone into the question of who does the monitoring. But I believe that Mr. Spath said, in response to a question, that, well, if it was an emergency we could set a standard.

So, is it correct that DHS could set a standard now but chooses not to because DHS believes it's not an emergency or not enough data is in? Is it not true that you could set an emergency standard?

DR. SPATH: I believe under the Health and Safety Code that we have sufficient power to establish an emergency standard.

I also said that I didn't believe this was a situation where there was an acute risk to public health.

SENATOR HAYDEN: Is that a legal term? Is that something in the statute that you have to make that finding in order to--

DR. SPATH: No, those are my own words, certainly.

Let me just draw a comparison. There are other contaminants that, if we raised chromium to the point where we're assuming it is necessary because of the threat to public health that we need a standard immediately, then that would argue for similar carcinogens which are even more potent, that we should also be acting in the same vein. Arsenic is a good example of that.

You can make the case for chromium, and then you can make the case certainly for arsenic.

SENATOR HAYDEN: And what would be wrong with doing that?

DR. SPATH: Because I don't believe, as I said before, that either of those represents a situation where there is such a threat to public health that an action would have to be taken immediately.

SENATOR HAYDEN: All right. Just to follow up, then it's confused on another question of whether or not the OEHHA public health goal explicitly took into account exposures to children. I thought that it did. I'm told it may not have. Does anybody know the answer to that question?

It's the issue of drinking water in schools.

MR. DICKERSON: Yeah, I think it's more explicit with regard to the reference of the nontoxicological effects that you have to take a look at -- OEHHA can explain it -- how it's done in determining a cancer slope factor.

SENATOR HAYDEN: A couple of people over here behind you nodded no, they don't, and I just want to know, is there a dispute about whether they take children's health explicitly into account?

MR. DICKERSON: With the noncarcinogenic effects, they assume a sensitivity factor of 10. They divide everything by a factor of 10 to give them some room for error. But I don't know about the carcinogenic effects.

DR. ALEXEEF: George Alexeef with OEHHA.

For our cancer risk assessment, there is no specific information on children that we were able to take into account. So we did not take into account any specific information on children.

SENATOR HAYDEN: All right, thank you.

Just one last thing. To federal EPA, how on earth, if you're using the same data, could you be a hundred miles apart from OEHHA?

MS. STRAUSS: We had commented on OEHHA's proposal in 1998. We had suggested then, and would still welcome, sort of a continuation of what you've had some of today, which is a sort of vigorous scientific exchange on our differing interpretations of the same studies. It's quite simply whether or not, absent what has yet to be published that was discussed earlier, it's just a differing interpretation of whether, for example, the German study from '68 in fact represents oral carcinogenicity, among other studies that were looked at. But EPA did not feel that that had been established. And taking the same studies and different assumptions, OEHHA respectfully came to a different conclusion than did EPA, and we can coexist in those worlds.

SENATOR HAYDEN: And you would call both conclusions scientific?

MS. STRAUSS: I think that reasonable and well-credentialed people came to different conclusions. More than just a few. Obviously, there's been a great deal of study, and I understand in a very recent toxicological journal of a couple of months ago, there's a British study that we're very interested in looking at that came to the same conclusion as did EPA, specifically focused on the oral route for cancer.

SENATOR HAYDEN: But your current position is that -- if I put it in lay terms -- is that this is much ado about nothing on the basis of the science that you've looked at. The California standard is already too low to be justified.

MS. STRAUSS: No. We are not saying that whatsoever.

SENATOR HAYDEN: Well, what are you saying? If it's at 100 ppb, and we're at 50, and debating 2.5--

MS. STRAUSS: I think that perhaps Dr. Froines gave an interesting illustration of that in the first panel when he said when you take into account various considerations. The range of what the actual public health goal could be could range from .2 to 20 or to 200. So I don't think that anybody could say with certainty that the public health goal should be any one number. I do think that EPA has a basis for both its defense of the 100 goal and the 100 maximum contaminant level, and it respects California's ability to set a more stringent level because it is willing to take a more conservative risk assessment approach.

SENATOR ORTIZ: I know we have a couple more questions, and I just want to remind members, our hope was to complete the testimony by 1:00. Unfortunately, I don't think we're going to meet that deadline. I think we really have some critical questions for the next panel that I suspect the members want to ask numerous questions of the representatives on the topic of San Fernando Valley's water supply in chromium VI.

UNIDENTIFIED: Could I make one comment as a rejoinder--

SENATOR ORTIZ: Wait a minute. Let me just provide some closure to this panel, then give you an opportunity.

I'm sorry?

UNIDENTIFIED: I'm sorry, but she misstated.

SENATOR ORTIZ: Well, we'll give you an opportunity to do that. I just really think it's very important that there are some witnesses here who've been waiting who need to get a sense of the timeline to provide their testimony, as well as others who are here, who expected us to be further along in the process. But I would invite you up to the mike to make the comments so that we can have it on the record. And I certainly have questions. I know Mr. Schiff has questions on this panel. But I just want to give us a sense of time.

If the members are fine, I'd like to continue until about 1:30 to allow the others to provide testimony, as well as our other guests here today. So my goal is to have the committee continue to 1:30. And with that, if you could quickly comment and then allow us to ask questions, and then Mr. Froines to come forward and clarify something that was said.

DR. ALEXEEF: Right. This is in response to Senator Hayden's comment.

We looked at the USEPA analysis versus our analysis in OEHHA and the USEPA did not consider the animal study on which we based our cancer slope. It's not in their report. We're not sure that if it was in their report, if they might have come to a different conclusion about whether or not cancer should be taken into account.

The other issue is, although we didn't have Dr. Froines' meta-analysis, we were aware of the inferences of additional cancers in other sites. That was something that we did rely on. And USEPA, their report, they suggest that there's only one possible study that might have this inference, and we knew there were several, although we weren't aware of the full amount that Dr. Froines mentioned.

SENATOR ORTIZ: I've just been informed that a couple of our witnesses are very short on time, and I want to remind members that if we could wrap up the questions of this panel very quickly and allow -- I think Ms. Brockovich is on a timeline, along with Mr. Masry, and I think rather than lose their testimony, we may want to take it out of order.

Anymore questions of the members on this panel?

SENATOR SCHIFF: One quick question to follow-up on Mr. Spath's testimony, and that is, what is the standard, in your view, that would require you to act in an emergency fashion? You mentioned, well, the risk from hexavalent chromium is not certainly greater than for arsenic, which is not necessarily acute. And I understand that the analyses is the likelihood of cancer after a lifetime of drinking the water, which for someone who just moves to the area and starts drinking it may not be as an immediate concern, but someone who's lived here 40 years, have been drinking it for 40 years, might be thinking, well, over the next two or three years, I might get that extra added increment of chromium that causes cancer.

In your view, what would the scientific evidence have to be for the Department of Health Services to act on a timeline faster than two or three years?

DR. SPATH: I would think, certainly, if there was some obvious disease prevalent statewide which could be shown connected to any contaminant. It doesn't have to be chromium. It could be any contaminant like that. Secondly, where we have new data that do suggest an acute toxicity associated with a chemical that we didn't know before.

But by and large, the policy has been that for those chemicals that cause cancer, or felt to cause cancer, that they are not considered an emergency, by and large, and should be addressed in a prudent way, given the fact that it is based on a lifetime exposure.

SENATOR ORTIZ: You know, I have a question, but I'm going to hold off but I do want to return specifically, if I could at least pose the question now, and Mr. Cohen can think about it.

I'm very concerned that there may be other sources of chromium VI or chromium in general that we have not even begun to look at. It goes to the question of monitoring and determining. You know, do we have a different problem in agricultural areas? Do we have a different problem in areas that are primarily in well water? I think the issue of monitoring has got to be far broader than we currently think of it, and the sources have to be pondered and looked at if we're going to look at any kind of increasing standards, revising standards, or going to the question of determining whether there's a public health emergency to bypass the two- to three-year standard.

So I think that's important. I'm going to ask you to address that.

The other issue is, I want to ask somebody from Department of Health Services whether we're at odds here between two different arms of the department, where we have a methodical process of monitoring and providing guidelines in a public input process versus the science and of suggesting that we've already exceeded our own standards.

Let's hold those questions. And I apologize to the next panel because I know you've been very patient. I know there are many members up here who want to ask questions of those whose job is to provide water supply and what the implications are for them. But I do know that we have a strict timeline; we're a little bit behind; and I want to provide the opportunity of, I think, what many people want to hear, testimony from Ms. Brockovich and Mr. Masry. I ask them to come forward now, if they would please.

Welcome, and thank you, and if you might give us your name and identify yourself for the record.

MR. EDWARD ALAN MASRY: Yes, I'm Edward Alan Masry. M-A-S-R-Y. I'm an attorney and I specialize in environmental problems.

MS. ERIN BROCKOVICH: Hi. My name is Erin Brockovich. What do I do? I'm here to share with you today some of what I saw firsthand in Hinkley, California. I work in environmental research with the law offices of Masry & Vittitoe, and I'm truly here as a consumer advocate and to just share with you firsthand what we've been through.

SENATOR ORTIZ: Members, if I might remind you, we're actually jumping to what should have been the recommendations on public policy, and that's the testimony that's going to be provided today by Mr. Masry and Ms. Brockovich.

MR. MASRY: You know, one thing I think that's important, we've listened to some of the testimony and we have a very impressive panel of scientists, but I don't think anyone here, other than Erin and I, have had the actual in-the-field training on chromium VI. I don't think anyone here has seen firsthand what chromium VI can do to a person. We have seen the cancers, the respiratory problem, the rashes, the bloody noses. We have seen terrible, terrible situations out in Hinkley. And we're coming from a perspective that, gee, I wish we could eliminate all this scientific jargon. Frankly, a lot of it Erin and I aren't quite sure we understand because there's so many conflicting statements in the scientific community about chromium VI.

There's one thing we know for sure: Chromium VI, in large enough doses being drunk, drinking, can kill you. There's no question of that because people commit suicide by drinking chromium VI.

Also, it's pretty well agreed to in the scientific community, pending further testings, that inhalation of chromium VI is much more dangerous than drinking chromium VI. So that means every time that we take a shower or we go swimming in a pool that has chlorine in it, which also affects chromium VI, we have a problem.

I frankly don't understand why it would take five years to come to some sort of conclusion what chromium VI, either ingestion or drinking, would do, for example, to a pregnant woman, or to a child, or to an older person, or someone with immune deficiencies. And I'm listening to all these timelines and I'm wondering, why the wait?

Chromium VI has been a known carcinogenic for a hundred years. There's page, after page, after page of study about chromium VI. Can't we find out a level that we can live with? Or, perhaps there's no level that we can live with. I don't know the answer.

But I think that the government has to get really going on this problem, and I don't think this talk about years, waiting for a result, is satisfactory.

Erin?

MS. BROCKOVICH: Well, I agree with Mr. Masry. I find it frustrating that we have sites such as Hinkley, Kettleman, California, and other chromium VI sites where there are populations and groups available to be studied by science, by Department of Health Services, who have, in fact, ingested hexavalent chromium.

We would like to propose that, one, there be a more stringent testing on water purveyors, agencies, and corporations. Quarterly is not enough.

I did hands-on testing in Hinkley, California, and I could take a test result on Monday and get a 12 -- a .12 part per billion hexavalent chromium, which was a totally different reading the following week. The level doesn't stay consistent. I don't know on any given day how much a person in Hinkley did or didn't ingest of hexavalent chromium. They did ingest hexavalent chromium. It's there. It made them sick. It made their animals sick. And I am concerned, in this area there is a known hexavalent chromium problem; yet, nobody can assure me on what days people do or don't get what dose of hexavalent chromium.

We set standards for a healthy adult, but we don't set them for children, pregnant mothers, people with weakened immune systems, just as Ed stated. So we want to see better protection, greater assurances for the public that they're receiving safe drinking water.

Society has zero tolerance for kids on drugs. We don't tolerate drunk drivers very well. There are actions for what they've done. Yet, corporations and entities pollute our water and polluters walk, and we would like to see some assurance that water is monitored and we all as consumers are getting safe drinking water.

And two, we understand the issue of other components besides hexavalent chromium. That's for you to discuss today. But our concern is the chromium VI. We want more testing. There should be more testing. We would like to see a state committee created to oversee water purveyors and these agencies so we can get a greater awareness out and assure the people that they're going to have safe water to drink.

I'm never comfortable with all the scientific debate. We've had these conversations with people who have been poisoned. They don't understand it either. You know, I have a child who can get stung by a bee. It doesn't bother them. I have another child who can get stung by a bee and they go into a coma. Who is to say, Department of Health Services or any of those other agencies, what level of chromium VI will or won't hurt you? It's a poison. I would not want it in my water. Ed and I would like to see nondetects across the board of hexavalent chromium in the water.

MR. MASRY: On that subject, for those of you who saw the movie *Erin Brockovich*, everything in that movie about Pacific Gas & Electric was true. There was not one misstatement in that movie. The documents you saw on the screen were actual documents. To this date, Pacific Gas & Electric, which has contaminated hundreds and hundreds of millions of aquifer, drinking water, in Hinkley, in Kettleman, Avenal, along the Arizona border in Needles, at the Topock Station, to our knowledge has never had one cent of fines levied on it, nor have they even had an administrative hearing.

Now, the *Los Angeles Times* reported last year that Pacific Gas & Electric gave ($)16 million to lobbyists in Sacramento, and that may be part of the reason. But I would certainly like to see some Senate committee, some state committee oversight on all drinking water in California, including bottled water -- I know Erin has said she would volunteer to be on that committee if there were citizens on it -- because bottled water isn't tested at all. We don't even know what's in it. We just kind of have to guess at that.

So, we really need to look at drinking water in California, and we need to look at it very, very sharply.

And both Erin and I would really like to express our thanks to you hard-working members of this committee. You are doing such a great service to the community. Unfortunately, it's been delayed in coming, but we're glad you're doing it. Any advice or any help that two laypersons can give, we'd be most happy to serve or do anything that you would like.

Any questions?

SENATOR ORTIZ: Thank you. I'm sure there are. Let me just sort of find out who wants to go first. I certainly have a couple of questions.

ASSEMBLYMEMBER JACKSON: We've been hearing how we need to do statewide monitoring at the direction of current law. The Department of Health Services insists they have to do a statewide monitoring because, under our drinking water standards requirements, we have to determine the economic as well as technological realities of cleaning up our water.

Mr. Masry, as an attorney, I assume that you have examined this area, and Ms. Brockovich, as an advocate, I assume you have as well. Do you have any suggestions on what we can say or what we should say to the Department of Health Services, either to try to help expedite that process, or do you have some thoughts on what some of the technologies may be so that we can get something on record right away or as soon as possible to try to do the necessary cleanup?

MR. MASRY: Well, I do believe there are methods to take the chromium VI out of the water so that you can get nondetects. I don't know what it would cost, for example, to put these purification plants on your influent piping system where you're distributing water. But whatever the cost is, it's cheap. Because, as we stand here, nobody can tell you what drinking .02 chromium VI water for 30 years is going to do to you. Nobody knows. I mean, it sounds okay. Erin and I are satisfied with it. But can anybody in this room guarantee it's not going to harm you? No. Nobody in this room can guarantee it won't harm you.

You know, we somehow come up with money for ballparks. We come up with money for this and that. Goodness, can't we come up with whatever money's required to clean our water? Only not just chromium, let's look at what this gentleman said, arsenic, lead, the other problems we have, and let's really address it.

But I believe the real start is you people and you appointing an oversight committee and that committee having the power to go to the water purveyors and say, *You're going to test every week. You're going to send the results to the public.* I think there's been too much good news and there's hasn't been any bad news given to the public, and you have to give the good news with the bad news.

So these are the things that we're definitely in favor of. We're in favor of an active state committee overseeing all the water purveyors, including bottled water, in this state and the people understanding what they're drinking when they're drinking it.

SENATOR ORTIZ: Other questions from committee members?

Go ahead.

SENATOR SCHIFF: In the case that you worked on, what were, if you can, if the levels of hexavalent chromium varied, what were the levels? What was the range and what was the length of exposure of the people that you worked with that you felt had contracted cancer as a result of the chromium?

MS. BROCKOVICH: Well, the results have varied. We have seen people at levels we're not sure what they were exposed to develop testicular cancer, stomach cancers and other diseases in a one-year time frame. We've seen people that have lived out there anywhere from one year to two years, to twenty years, to twenty-five years, in varying levels of hexavalent chromium. We've picked up levels as low as .06 part per billion. We've also seen levels historically as high as 24 parts per million. And it's been a range over 30 years of people who have ingested, swam, showered, and run this water that was contaminated through their swamp coolers, and that has been a concern for us. It's certainly a concern for the people. Because on any given day, you can't show scientifically what they did ingest and what they didn't.

So there's a range out there in Hinkley from, like I said, one to up to thirty years with varying levels of hexavalent chromium as low as .06 parts per billion up to, historically, 24 parts per million.

SENATOR HAYDEN: Just to follow up on that?

SENATOR ORTIZ: Go ahead.

SENATOR HAYDEN: There have been efforts to discredit you on the basis that there's no comparison between Hinkley and the San Fernando Valley or Los Angeles. I take it by your comment that you're not saying there's an automatic equation but that you do believe that, from your experience, the levels that have been reported in the Los Angeles area are cause for concern. You're not saying it's identical with Hinkley. You're not extrapolating from Hinkley. You've looked at the Los Angeles monitoring as well.

MS. BROCKOVICH: Yes, I have, and I'm concerned. I'm currently trying to work on two specific wells in the area that had in excess of 800 parts per billion of hexavalent chromium in those wells. I have picked up other reports with levels higher than that, and I've also heard the Regional Water Quality Control Board, where they know there's wells specifically with levels above 1,000 parts per billion. Those are levels that are of concern.

SENATOR HAYDEN: Yes, Mr. Dickerson, I think, testified the other night to the existence of those levels.

MS. BROCKOVICH: Mm hmm.

SENATOR HAYDEN: All right, thank you.

MS. BROCKOVICH: So we're not speculating. The hexavalent chromium, in fact, is there.

SENATOR ORTIZ: I have three quick questions. Thank you for being here.

Can you tell us on the record what your sources, your medical sources were, as you were putting together the various incidences? I mean, it'll help us work through the science that has been suggested as either solid or we need more, or at least will lead us in the right direction. So what studies did you rely heavily upon?

MR. MASRY: Well, at the time of the trial, which was tried by Walter Lack and Tom Girardi -- not my firm -- they spent approximately ($)10 million just in experts on medical and causation. They brought in experts from Italy, I believe France, all over the United States. There were five judges who tried the case. Two judges for 19, and then three judges for 20 persons, and at the end of that trial, which lasted approximately a year combined, those five judges came in with a verdict of ($)131 million for those 39 people.

And the point I'm making is, the evidence that our people showed, our scientists showed, was overwhelming. You know, you don't waive a jury trail on an emotional issue unless you know you've got the facts and the evidence with you. We waived a jury trial because we were confident that our experts would come in and say what they did, and they proved it to the satisfaction of five separate judges.

We'd be very happy to share that information with this panel, but some of the leading experts in the United States -- Dr. Titlebaum, Dr. Bick--

MS. BROCKOVICH: Dr. Max Costa is somebody from New York University who's one of our experts that I think could be very helpful to this panel.

SENATOR ORTIZ: Well, let me ask a question, because I think that was the testimony earlier that went to the non-GI respiratory aspects, but rather, the other associated cancers that Mr. Costa's study leads us to.

MS. BROCKOVICH: Max Costa has spent his entire career studying hexavalent chromium. He's just recently done another report, telling scientific persons, agencies, *You need to reconsider what oral ingestion of hexavalent chromium can do to you.*

It's a very good report. We'd be happy to give you his name, address, share those reports with you. He is an incredible world-renown expert on hexavalent chromium, both inhalation and ingestion.

SENATOR ORTIZ: Wonderful. That was my second question.

So the non-GI types of cancers are primarily focused, or found in the Costa study. Wonderful.

I certainly will withhold questions if there are other members.

MR. MASRY: I would like to make a point at this time.

SENATOR ORTIZ: Please.

MR. MASRY: About three weeks ago I went to Washington, D.C. for a press conference. The Center for Public Interest, the very large public law firm in Washington, D.C., in corroboration with Johns Hopkins University, did a new study on inhalation of chromium VI in the workplace. I don't know if you people have seen that. Have you people seen that study? Are you aware of it?

SENATOR ORTIZ: No.

MR. MASRY: The recommendation from Johns Hopkins was to lower the percentage of chromium, in effect, in the air, in these plants 200 times. In other words, it showed a tremendous amount of cancer. It's a very interesting study. I'll get some copies and I'll send it to you.

SENATOR ORTIZ: We appreciate that, and we'll distribute them, thank you.

MR. MASRY: I'm surprised none of these scientists have brought that study up, the Johns Hopkins study, and it's peer reviewed.

SENATOR ORTIZ: Wonderful. We appreciate that.

MS. BROCKOVICH: You know, anything that I might add, I really do, I have to share with Ed, where were you in Hinkley? I am very impressed and very honored that you're taking such steps to look at the groundwater problems, understand chromium VI, and do something on the behalf of the people, and I really mean that.

And something that was just, I think, confusing in Hinkley, California, it's not just that the people drank the water. When you have hexavalent chromium in your water, in your aquifer, these people swam in it, showered in it, ran it through their swamp coolers. So, I don't want inhalation factors to be dismissed when you have chromium VI in the groundwater. People are being exposed by oral, dermal, and inhalation, all three routes, when you have it in your groundwater. So I would hope that people consider that.

And again, I am truly honored to have been here today, and I appreciate everything that you're looking at on behalf of assuring us for safe drinking water. I really am.

SENATOR ORTIZ: Thank you so much for your testimony. We encourage you to stick around because I think the most interesting testimony is yet to come.

MR. MASRY: I second everything that Erin said. I really commend you for the job you're doing.

SENATOR ORTIZ: Thank you for what you've done.

Okay, members, I know that we had hoped to try to finish up by now, but I want to ask us to at least allow others who -- certainly whose job is to be the purveyors of water. I would encourage us to allow them to go through their testimony and then reserve our questions to the end, because I think many of our questions will be directed on their capacity and their ability to either mitigate or minimize any risk.

So I would welcome the participants of the "San Fernando Valley's Water Supply and Chromium VI" panel.

Mr. David Freeman. Welcome. Is Ron Davis here? And Dan Waters and Michael Drake to please come forward and provide your side of the story here.

MR. DAVID FREEMAN: Thank you, Madam Chairperson.

I'm testifying here today on behalf of the Department of Water and Power, but also on behalf of myself personally. I've spent most of my adult life as a fighter for cleaner air and clean water, and I want to start off by disabusing anyone of the idea that this water agency is on a different side than the members of this panel or any of the prior witnesses. We are seriously and deeply as concerned about this issue as anyone else. After all, it's our customers that are drinking the water.

We very much appreciate the time that this panel, which, if I might say so, consists of the best and the brightest of the Legislature, people that I've known personally and I certainly have great respect for. And I've listened this morning at the analytical and thoughtful manner in which you're approaching this issue, and I wanted to note that.

The LA Department of Water and Power, on its own initiative almost two years ago, began testing our water for chromium VI. We did find low levels -- maybe they're not low -- but we found levels with low numbers in the groundwater and reported our findings to the California Department of Health Services.

Now, I don't want to imply that these numbers are not matters of concern, but I think it important that we put this problem in perspective of some of the testimony we just heard. There is a difference between parts per million and parts per billion, and the prior witness was talking about parts per million, and we're talking about parts per billion.

I don't know that the levels that we have in our water today are safe at all, but I've heard a lot of testimony from the so-called doctors in this state where they are in great conflict. And I guess my plea to this panel is: What is a responsible water agency to do?

I'm perfectly ready, willing, and able to go to my commission to recommend that we shut down all the groundwater in the San Fernando Valley, but I have an obligation to tell you the consequences of doing that. Because I don't really know whether that's necessary or not. I hear the EPA saying one thing, the California EPA saying another thing, and then the doctor that you've designated by law, the Department of Health Services, are telling me that what we're doing is okay.

So, I have a right to be confused, and I have a right to congratulate the chairperson and everyone on this panel for taking the time in their so-called off season to go into this issue and hopefully go back to the Legislature in January and change the law. Because, if we are not concerned about cost, as everyone seems to say, then we need to get the issue of cost out of the criteria for setting the standards.

The state law today requires Dr. Spath to look into the cost, but I haven't heard anyone on this panel, or anyone in the city council, that said that we ought to consider cost seriously. In other words, a human life, you don't put a price on it. Well, if that's the public policy, let's implement it into the law and give me a 2.5 standard and we'll cheerfully obey it.

But right now, I feel like the Department of Water and Power, which is trying to do everything it can, is between a rock and a hard place. The state is speaking with at least two voices and the federal government with another voice.

Now, what we have done in these circumstances is we shut down the only two wells that were coming anywhere near any standards, but we have tested our tap water. The value of chromium VI has ranged from .06 parts per billion to .96 parts per billion, measuring the tap water. None of the well water has chromium VI above 10 parts per billion, but I don't know whether that's okay or not. It's well below the standard. But, you know, we can listen, and we hear the goal as being very, very different. I think the public has every right to be completely confused.

Now, can we get the chromium VI out of the water? I asked my people, and they tell me that there is no known technology that can take these small parts out. So we are working with Glendale and Burbank, and we've located a Dr. Singuptha(?), of the University of Lehigh, Pennsylvania, who's going to lead a research effort to try to get this ion exchange technology perfected to deal with these very small parts of chromium in the water.

Right now, if anybody knows about anything that will get it out of the water, I am ready, willing, and able to implement it. But as far as we know, there is no known technology to extract these parts per billion from the water. We are going to lead a research effort to try to find that out.

Also, I think the panel needs to know that there's no lab that's currently certified by the state to analyze chromium VI samples. I mean, you get all kind of different results from various different labs, and I think an urgent thing that needs to be done immediately is for them to certify labs so that when we all have a uniform, accepted basis of measuring -- and quite frankly, if the state wants to pay for other people to come and monitor our water to supplement what we're doing, they're welcome. I do think a system of spot-checking might be a cost-effective way of providing additional assurance.

And I recognize quite well that any water agency, no matter who heads it, is suspect in terms of the fox guarding the chicken coop, so that I am perfectly ready, willing, and able to accept standards set by whatever level of government you might empower to do so.

Now, one last point. Why not just shut down the well? At least until the studies are completed. It's a good question, and I think it's one that has to be thought through. Frankly, it's 15 percent of the city of Los Angeles' water supply and a growing percentage as we recycle more and more water. If you look at the water supply, it has to be substituted by MET Water, and you can do the math yourself. It does cost a bit more, but if that's what the doctor wants us to do, we will do it. But just recognize that the water that you substitute for that has got trihalomethanes, which is a cancer causing chemical, that is way above the zero goal for that contaminant. I don't think substituting surface water for the groundwater makes the water any cleaner and eliminates a major water supply.

As a matter of fact, and I think it's important that you know that, that if we eliminated all the water that has contaminants above the public health goals today, the state is without water. Now, that's not a threat. What we ought to do is to reduce every one of these contaminants down to as near zero as we possibly can. We have been negligent in not putting the money into the research for the technology to do that, and frankly, I don't think the environmental protection agencies have been very vigorous in trying to get the chromium out of the ground. It's the legacy of the defense efforts.

But let me just say this to you. We found chromium VI in the L.A. River between 1940 and 1970, checking through the data. It's gotten better; it's gone down now. This is a serious problem and we need your help.

Thank you.

SENATOR ORTIZ: Thank you, Mr. Freeman. I know that Senator Schiff has a question, and there are probably other members of the committee. But let me just thank you, and Senator Schiff, is your question for Mr. Freeman?

SENATOR SCHIFF: It is.

Much of the time the local agencies tell the state government and the federal government to stop mandating what they ought to do and give them local control. I hear you saying to some degree the state hasn't told us we have to change the situation, the federal government hasn't told us. They're not saying it's necessarily safe, they just haven't told us what to do.

Is there anything that you see that precludes you under state law or federal law from taking action in the city of Los Angeles to say, *Well, the state may have a higher* *standard, the federal government may have a higher standard than that, but we think it prudent to not draw from wells that have more than the public health goal, and we're going to implement that in Los Angeles*?

MR. FREEMAN: Well, I think that the City Council of Los Angeles and my commission has the power to do so. But quite frankly, we are not the doctor. I don't know what the safe level is. I don't have a basis, with all the conflicting testimony, to say that we ought to shut down the wells and substitute surface water which has a similar health hazard problem. I don't have a basis for doing that.

SENATOR SCHIFF: I don't think there's been conflicting testimony today about either the desirability of the public health goal or the imperative of acting now and not waiting for several years.

If Los Angeles decided to go to a 2.5 standard, what do your numbers tell you would be the effect on the cost for an average residential user?

MR. FREEMAN: It would raise the price about 10 or 15 percent, but it would eliminate our best and most lasting source of water, and it would have profound effects. It will not improve the quality of the water. We would be substituting water that has a different kind of cancer-causing ingredient that's above the goal for the one that we have.

SENATOR ORTIZ: Senator Hayden?

SENATOR HAYDEN: Well, I never like to get into arguments with men from Tennessee with a sense of humor, but I've been through this discussion several times. I believe what you're really saying is dismissive of these problems, and, that you don't believe there is an alternative.

The reason that I believe that you're dismissive rather than as objective as you say, when you say, *Well, listen to the doctors*, you have said that, *We're not going to do this just because it was in a popular movie. It's only a couple of eye drops in two swimming pools.* In a conversation with myself, you said that, *There's no cause for alarm. It's just one of those things like electromagnetic fields.* And then this other argument, which I find quite subtle, is that, *Well, I'll do anything you want, but I haven't heard anybody from the city council or the state proposing to raise the water bills for people.* And then the final argument is that, *There's lead and arsenic in the alternatives.*

If that's the argument, we have presided over a regulatory catastrophe or embarrassment, because it really means there aren't any sources of water that we can definitively say on the basis of scientific consensus are good for your kids.

This has disturbed me because as far as I can tell from your agency's testimony, there are 60 wells in the valley that are at 5 to 10 parts per billion, which is twice to ten times what OEHHA says is a safe public health goal.

I don't know how to move forward, but I would hope that you would take the lead in some kind of precautionary effort here rather than saying all choices are bad. I would start by saying that we've got to end the conflict of interest in which your agency doesn't have a check and balance. In other words, your agency is in the business of delivering the water but also certifying that it's safe, which is at least a perception problem. I think that there has to be an independent monitoring enforcement agency that your agency pays for, and there are many models of that kind.

But even then, all we'd be getting is some public certainty that really independent people who use the precautionary principle in their science are telling us what the water looks like. That would raise public confidence, but it still doesn't give us a solution.

SENATOR ORTIZ: Question?

SENATOR HAYDEN: What?

SENATOR ORTIZ: Maybe you can pose a question.

SENATOR HAYDEN: Well, I think that we're entitled to make comments, Madam Chair.

SENATOR ORTIZ: We're entitled but we do have three other witnesses.

SENATOR HAYDEN: The question is: Is it not the case that you're proposing that there is no good solution to the problem?

MR. FREEMAN: Senator Hayden, I have just complete(?) in almost all of your presentation of your own views, but I take great exception to your characterization of my views.

I sincerely have actions to support it. We are trying to reduce the pollutants down as low as practical. In all fairness, we've put a very large sum of money in a big effort into reducing arsenic. If there was some way that I could reduce this chromium VI -- we are putting the money into a research effort to try to figure out how.

Now, eliminating a big portion of our water supply is a major policy issue, and I think I have a duty to point out the ramifications of it, especially when I've got the federal EPA saying that I'm way down at 10 percent of their standard. And we have scientists that have testified that this is not a point, it's a wide range. I'm looking for some guidance.

If you all don't like the idea of cost being in the standards, change the law and eliminate cost. But right now, the laws of the state of California are telling me, in one breath, that I shouldn't do anything. Frankly, I do not claim to be the doctor. We are not regulating ourselves. I am looking for someone to lay down a standard that we can obey.

You're entirely correct: There is a conflict of interest between the water agency setting the standard. In my discussions with you, privately as well as publicly, I think that it would not be a bad idea to have the expertise at the county level, and I wrote you a letter saying that I think it's customary in environmental law for local agencies to have a more stringent standard. But somebody besides me needs to set them.

SENATOR ORTIZ: Mr. Freeman, I have a quick question. I think you sort of alluded to it. You mentioned that you're not aware that there is the technology available to extract chromium VI. I feel like that was the part of our panel today that maybe was a bit deficient. But I've heard that possibly a reverse osmosis or ionization might be the best available technology.

Maybe you can comment on the research you have underway.

MR. FREEMAN: The ionization process is not presently capable of reducing the levels down below the levels that exist. It functions at a much higher level. We are starting some research to perfect it so that it can reduce the 10 parts per billion down as close to zero as we can. And if anybody has any technology that we don't know about, one of the purposes of this hearing is to bring it to our attention.

SENATOR ORTIZ: Mr. Freeman, so reverse osmosis is not an option either?

MR. FREEMAN: Well, according to my staff, their information that they've given me is that we have no technology today that we could go out there, and my orders were: Let's get out there and reduce this stuff. They tell me that it requires a research program and that the federal and state agencies have not been working on that.

SENATOR ORTIZ: How long has your research been underway and when will it be completed, it will be public?

MR. FREEMAN: Well, we just started. We just started. And I congratulate the city council for holding hearings and for you for holding hearings to bring a sense of urgency to this. I'm not claiming that this effort isn't very, very useful; it is. But we're doing everything that anybody can suggest. Our concern is as deep and as active as anyone else's.

SENATOR ORTIZ: Okay. I appreciate that. I know that we have other witnesses here that probably can give us a little more technical direction, or maybe at least the topic of this is the extent and nature of chromium VI contamination, current efforts to manage or mitigate contamination, and potential cost and options for providing uncontaminated valley water. So if you could have your testimony address those points, that would be helpful.

So, I think Mr. Ron Davis is -- thank you.

MR. RON DAVIS: Good afternoon, Senator Ortiz, and other members of the panel. Ron Davis, General Manager, Burbank Water and Power.

I will try and limit my comments to the suggestions of Senator Ortiz, and with that, though, I would like to thank this panel and our regulatory agencies for their care in trying to provide the safe as possible drinking water to our public. We truly do appreciate it, and we do support the efforts. So we thank you for the consideration and the effort.

With that, I'd like to tell you a few specific things and skip a bunch of the other prepared stuff that we had, and tell you a few unique things that maybe haven't been said, and perhaps in a couple of instances complicate a little of what you've heard.

First, what we are showing here -- Paul, if you could focus on that slide that's on the board -- what we have here is a table of drinking water measurements in Burbank for the last year by water source, chrome VI and chromium. We've been doing this for years, as Mr. Freeman said. The local valley agencies have been doing this. It's part of the wonderful condition we have where we're a Superfund site, and we've been working on this. Even though it's under a temporary protocol to measure it, we do in fact have data.

The data shows us a few things. In our case, it shows us we have one well that is quite high, and, like Los Angeles, we turned that well off. That's something we've done. That will lower levels. But you continue that to the point of paying.

Here's the two points of paying. One is economic. You've heard something about that. It's a very, very secondary consideration. For the city of Burbank, for whatever it's worth, it would cost our customers on the order of 30 percent a year if we stopped taking groundwater.

But the more important point: The wells we're operating in Burbank are part of a cleanup of volatile organic compounds. The plume, of which you saw in testimony from Mr. Dickerson, flows down the valley and through the bottleneck in Burbank and Glendale. Should you stop pumping from these wells, the spread of that plume continues, and we don't clean up the groundwater from a known problem while we try and avoid a suspected problem and study it. We're trading one problem for another.

We are just in the start-up process, at least in Glendale's case, of cleaning up all the organic compounds we know are a problem. In Burbank and L.A., those cleanups have been going on for some time. Stopping that cleanup doesn't solve this problem.

So I don't know quite what you do, but it's a complication to just shut down the wells and pay high water bills. We have contaminated water; we're trying to clean it up. And we're not wanting the contamination to spread. Frankly, in the case of if one of us stops, it affects the other. Glendale's downstream of Burbank. If we stop cleaning it up, the plume spreads towards Glendale. If L.A. stops cleaning it up, the plume spreads towards Burbank.

Additionally, on the map that you have on the monitor now, you can see some granularity to the previous maps you saw in the valley, and these just show 1995 EPA data that was done on where is the chromium in the valley, and these sites show you the actual known chromium sites. That tells you what's been done in terms of what we've got to deal with and where we start.

The wells -- Fred, if you would show on the map -- the Burbank wells that we're operating are the eight dots that Mr. Lance has there indicated, and they are purposefully drilled where we can, frankly, suck up contaminants. Draw in volatile organic compounds as a result of the Superfund site, clean them up, and the stripping process that exists frankly does a very good job. It takes the volatile organics to nondetect. It does a good job. Stopping that is a concern to us.

So we don't know the answer, but we maybe complicate the problem.

A couple other things. One, we do test, and in the data that Mr. Lance had up, and other that we've sent you in the packets, we do test pre- and post-chlorination for chrome VI.

SENATOR ORTIZ: Oh, you do.

MR. DAVIS: We do. We test monthly. It's not quarterly. We've been doing this for years by well and blend it, and all that data's available, and there is no statistical difference we can see pre- and post-chlorination. Which doesn't make it not true. I'm just telling you from our data, pre- and post-chlorination, we don't see the difference.

SENATOR ORTIZ: It would be interesting, because I think there's data that a previous speaker said that's available that contradicts that statement.

MR. DAVIS: That very well may be the case. It also speaks to a second issue. We are measuring down to new levels we've never done before: parts per billion. And we are operating under temporary certification with our lab, and just this month -- in fact, I think this last week or so -- DHS has put out protocols to get everyone licensed to measure the chromium VI specifically down to one part per billion using a consistent methodology. But right now, we're all operating under temporary protocols, our labs are, to monitor down to one part per billion.

SENATOR ORTIZ: Would you repeat what -- DHS issued a notice to all?

MR. DAVIS: Well, there is a process underway now to certify the labs, all of them under one protocol, and I can't remember the number of the protocol off the top of my head, but I think there's several technical folks in the room who can tell you that protocol. But it's a single protocol to measure chromium VI for everyone and instructions with dates by where to apply to get all the labs certified under one protocol.

That has been done, and I think if you look on DHS's web site in chromium, you'll see the notice. It's out there.

SENATOR ORTIZ: I'm just curious whether they're not going through the regulatory process to certify that one method of measuring chromium VI or whether they have, you know -- maybe DHS can comment on that.

MR. DAVIS: You'd have to ask them.

SENATOR ORTIZ: Okay.

MR. DAVIS: But what you will note, when we go down to one part per billion, you will see some data consistency problems -- even in our own data -- that we will wind up with data showing you that chromium VI levels are higher than total chromium. It's laboratory sampling problems at that high level of granule area. So we are going to have problems with that.

And the variability in the sample results -- ignore who takes them -- could result in your exceeding the proposed health guidelines or not, just based on drawing the sample. That is, the granularity of the lab. That's an important thing maybe to understand.

SENATOR SCHIFF: Mr. Davis, I just wanted to ask you, because I wasn't sure that I was following it correctly, when you talked about the efforts that were being undertaken right now in terms of cleanup, were you referring to the water wells or were you referring to the land? in that you said, *Well, if we don't tap those wells, then we stop the cleanup process, and then it just becomes Glendale's problem or someone else's problem.*

What are you referring to? Are you talking about cleaning up the soil and removing contaminants in the soil? Are you talking about removing hexavalent chromium from the water?

MR. DAVIS: Today we don't know how to remove hexavalent chromium from the water.

SENATOR SCHIFF: Right. So what cleanup were you talking about that would be interrupted if we didn't use these wells?

MR. DAVIS: Volatile organic compounds from our EPA Superfund site here in the valley. There are three of those operable units. We call ours the Burbank Operable Unit. It's located out at the old Lockheed site, and it is drawn off for the eight wells that Mr. Lance had pointed to previously. It cleans up volatile organic compounds from the soil, specifically from the water.

SENATOR SCHIFF: Well, why is it necessary to use those wells for drinking water to continue the cleanup?

MR. DAVIS: It wouldn't be. You could flush that water down the river. Then we'd have some of issue with what you're putting in the river.

SENATOR SCHIFF: So we could continue to clean up the site without necessarily using that well for drinking water.

MR. DAVIS: If you decided to consciously discharge all the water into the Los Angeles River, you could do that. Public policy question.

So, all we wanted to say, in addition, is that because we are operating under a consent to clean up our land, not only do we have some data and we have some cleanup issues, we do have, should you choose to set a standard, probably a good opportunity to go back and pursue those people who had polluted the land and water and probably get additional plants built.

But in concert with Glendale and L.A., as Mr. Freeman mentioned, we are undertaking studies of which methods might most cost-effectively clean up the water. And there is a second project underway by McGuire & Associates to do some more of that work. So we do expect by as soon as mid-December to have some preliminary results on those cleanup methods.

SENATOR ORTIZ: Is that it for your testimony? Thank you. I know we have two others who are proposed to speak.

We've already extended the committee hearing a half hour beyond when we were supposed to. We agreed to go to 1:30, but there's been a request not only to finish this testimony -- I was hoping that the other panel could answer the questions that I raised earlier -- but in addition to that, there's been a request for public comment, which I think is an appropriate request.

So, if we could have the next two speakers. Try to be brief and maybe not repeat testimony that's been provided. Then we can have the last previous group come forward and maybe make some very brief comments on recommendations that they weren't able to make earlier, and then we will open up to public comment.

Thank you.

MR. DAN WATERS: Senator Ortiz, members of the panel, my name is Dan Waters, representing the city of Glendale, and I will be very brief. I will try not to repeat anything that Mr. Freeman or Ron Davis had to say.

The situation in Glendale is a little bit unique. We also have a treatment plant, a Superfund site, in Glendale, but the interesting thing, it was to begin operation, formal operation, in putting water into the Glendale system on September the 26th of this year. As a result of a lot of media attention and other things, we, for the first time, began monitoring chromium VI coming out of that treatment plant. And our treatment plant, just like the Burbank plant, is intended to remove TCE and PCE from the groundwater in the San Fernando Valley. And so, EPA is very anxious to get these plants operating to be cleaning up that aquifer.

So what happened is we presented data, and it's in the table attached to my testimony, to the city council on September the 19th which showed that we were measuring chromium VI at the treatment plant of approximately 10 parts per billion, which is obviously well in excess of the goal that's been set by the state. And in addition to that, we presented data to the city council that showed that throughout the Glendale system, we have less than one part per billion of chromium VI at the taps throughout the Glendale system. So, if we were to begin taking the water from the treated plant and putting it into our system, we would be fairly dramatically increasing the amount of chromium VI in the tap water in Glendale.

The Glendale City Council elected not to do that. They requested EPA that we delay taking water, at least 90 days, before we take water into the system. EPA, as Mr. Davis pointed out, wants us to begin the cleanup of this aquifer. So what we have agreed to do is to continue to run the plant, but we are discharging about 5,000 gallons per minute into the Los Angeles River and not taking it into our system. If we did that on an annual basis, it's a cost of roughly $2 million a year to the city of Glendale, because, basically, that treatment plant water is free, and we're paying a lot of money for Metropolitan Water District water which it would displace.

We have already hired McGuire Environmental Consultants, that Mr. Davis mentioned, and I think Los Angeles, city of San Fernando, and Burbank are going to participate with us in working with that consulting firm. One of their primary objectives is to find out if there are methods available today to remove chromium VI from the water. And as others have testified, we don't today know of any specific ability to do that in any reasonable manner, especially at these low levels.

One of the things that we would like to recommend -- we really have three recommendations to the committee. The first is that you continue to apply pressure to the state agencies, and what pressure you can apply to the federal agencies, to resolve this dilemma we face, because as Mr. Freeman said, we're kind of between a rock and a hard place.

Secondly, we think that the state Department of Health Services ought to consider implementing what they call an "action level." As I understand an action level, this is something between a goal and a standard, and it doesn't take the rigorous study and effort that setting a standard does to set an action. We believe that it might be possible to set such an action level within 30 days.

That would certainly relieve us in the water business and help us determine what we're going to do with this water that contains high levels of chromium VI. Because right now, we don't know. Within the 90-day period that EPA has allowed us to continue to discharge the water into the river and not take it into our system, when that period ends, we're not sure what position EPA's going to take. We could be imposing on the city of Glendale considerable fines and penalties under the agreements that we have both with the industrial group that paid to build this plant and with EPA.

So we really are between a rock and a hard place in this 90 days. I think that basically is where we're coming from.

Thank you.

SENATOR ORTIZ: Thank you. Questions?

SENATOR SCHIFF: I have a quick question. Thank you.

I understand the rock and hard place that you're talking about, and it's certainly not a desirable place to be. Assuming that the EPA was not a problem and that you would not be under fines because of the concern over chromium, you mentioned that there's a potential cost to Glendale of $2 million of not being able to make use of this water. Is that kind of an opportunity cost in that you're not using it now but if you could use it, you could reduce your cost by 2 million? Or, would the decision, if Glendale made the decision, not to use this water because of the concern over chromium, would that have an impact on the water rates of, for example, your residential users?

MR. WATERS: It wouldn't have any effect in raising them. Where we would really be looking at an opportunity to lower them, if we begin taking this water, it would offset about 10 percent of the water we now buy from the Metropolitan Water District, and basically, it would be free. So it's an opportunity to reduce costs.

But there is another dilemma here. We're not sure that the Regional Quality Control Board, who testified earlier this morning, would allow us to continue to discharge the water into the L.A. River. That's a big question. There is a court that's overseeing this whole adjudicated area in the San Fernando Valley that also might object to what some people would call "wasting water" in a time when we don't have a lot of excess water right now in the state.

So there are a lot of social and political issues involved in these decisions.

SENATOR SCHIFF: Is that the same calculus in Burbank? No. So if Burbank were going to reduce its level of hexavalent chromium, it's an added cost as opposed to the situation in Glendale where it's a foregone opportunity to lower costs. Is that correct?

MR. DAVIS: Four-and-a-half million annually.

SENATOR SCHIFF: And I understand that what we're talking about assumes a whole lot of decisions by EPA and others that may not come to pass. But I'm just trying to get a sense of what the impact on the consumers in this area is.

MR. WATERS: Theoretically, if our plant had gone into operation a year ago, we probably would have been taking this water into our system for the last year, and we would probably be seeing the same levels of chromium VI in the tap water that they are in other parts of the valley where they have been taking water from these treatment plants. We estimate we'd go to about 5 parts per billion in the system if we started taking the treated water into the system.

SENATOR ORTIZ: Thank you, Mr. Waters.

We have one last speaker on this panel. Mr. Drake?

MR. MICHAEL DRAKE: My name is Mike Drake. I'm Public Works Director for the city of San Fernando, and thank you for letting us speak here on behalf of the city.

Water quality has been a difficult situation for San Fernando. We haven't had to have any dealings with it. While we are a part of the San Fernando Valley, our water comes from the Sylmar Basin, which is a unique basin of its own in the North San Fernando Valley. It's a confined aquifer, and it's been fortunate for us that there has been no contamination. So, over the years, we haven't had to deal with water quality issues such as Burbank and Glendale have. San Fernando's been fortunate until now to have been fairly polluted free from our basin.

We also have tested over the years for chromium as required by the state Health Department. Most of the time it's nondetect, until the regulations have changed, and then we've reported the levels that we have.

Recently, we have been doing some initial testing to determine and report to our city council what the effects of chromium are in our wells. And we have four wells in the Sylmar Basin, and we've had results ranging from 5.8 to 7.3 parts total chromium, and we've also had ranging from 3.1 to 4.0 of chromium VI at the wellheads. We've also tested, or the county has tested at their county facilities within our city limits and they've reported chromium VI in the range between 5 and 5.4. That might have something to do with the effect of chlorine. Our water is treated with chlorine for disinfectant, and whether or not that is going to be determined that it affects chromium in an adverse way, we're waiting to see the results of that.

The last city council meeting we had an expert from the Water Master's Office, Mel Blevins. He came to present to the city council. He made a nice presentation to us about the confined aquifer in the Sylmar Basin, where the water is generated from, the runoff from the mountain ranges they come into, and has reassured us and determined that most of the chromium or chromium VI that we might find in the Sylmar Basin would come from the natural minerals of the soil. There's very little industry up there. We haven't had any aerospace industry such as in the San Fernando Basin around the I-5 Corridor, as you saw from the Regional Board's presentation. The flow of that water from the mountain ranges come into the Sylmar Basin. It's fairly contaminant free.

The city council, of course, is very concerned with the health effects of chromium VI, but they're also concerned with the economic factors of it. San Fernando is on a hundred percent well water. If we cannot meet the public health goals as proposed, then we would have to either find a treatment source, which we are working with McGuire & Associates and the other agencies -- Glendale, Burbank, and Los Angeles -- to try to determine what the impacts financially would be on that; or, our other option is we are a member of MWD. We would be able to purchase MWD water. If that happens, it would be around one to one-and-a-half million dollar impact annually.

So I tried to keep my comments brief.

SENATOR ORTIZ: I appreciate that. Thank you.

Questions of members for any of the last speakers? I understand Mr. Freeman would like to go back on the record on a point.

MR. FREEMAN: Yes ma'am. There was one item in my prepared testimony that I think should clearly be on the record.

We got an independent lab to test a bunch of bottled water, and we found in more than one brand that the bottled water contains chromium VI above the public health standard. So I think it's fair to say that this problem is pervasive. It is serious. But it cannot be cured by simply drinking bottled water.

SENATOR ORTIZ: Wonderful, I appreciate that. I think that's consistent with maybe Ms. Brockovich's presentation.

SENATOR SCHIFF: We're all going to go to orange juice now.

MR. FREEMAN: Well, I think it also suggests that this may be pervasive and not just a function of the defense industries.

SENATOR ORTIZ: I appreciate that. The last speaker indicated naturally occurring, which is consistent with Mr. Cohen's comments.

Okay. We do have a request for public testimony, but before we do that -- and my staff is very good to remind me what it was I needed to be reminded -- is to ask the panel that should have occurred, "Public Policy Options for Chromium VI." Much of that was introduced in their testimony earlier with the questions by the members.

But I'd like for those participants who weren't able to make recommendations on the record earlier, or who have been asked to respond to questions that I raised earlier, to please come forward and briefly either provide those recommendations, or public policy options, excuse me, to do so now, as well as, hopefully, briefly address the comments that any of the members raised earlier so that we can then move to public testimony.

DR. SPATH: Let me address one issue that was raised, and that is the certification of laboratories. You had a question with regard to that.

The Department certifies all commercial laboratories, and we sent out a letter, as was indicated, to laboratories who do total chromium analysis and asked if they would be interested in being certified for chrome VI. We also identified the method, which is an EPA method.

We don't need a regulation to go forward and certify in the laboratories. That's a part of the law and allows us to do that without regulation.

SENATOR ORTIZ: No, not without regulation, but there is a process that you have to go through rather than sole sourcing.

DR. SPATH: Yeah, there's a process of certification, yes. First of all, as I indicated, we seek out those who are interested in being certified. They apply, and then they have to analyze test samples to see if they're within the limits of the sample itself; and then we do an analysis of their laboratory practices as well.

SENATOR ORTIZ: Let me let you know, the reason I'm asking, Mr. Spath, is because, in the past, the Department of Health Services has decided in-house to, over a long period of time -- not in this instance of certification but in other instances of another test, a mandated test for fetal abnormalities -- that the Department spent years without opening it up to the public by using one source and declaring it was an emergency for a period of at least four or five years. So that's why I want it on the record, to know that there was an open process.

Thank you for responding to that.

Any other things that I had raised earlier?

DR. SPATH: No, I have no other comments, unless you have any questions.

SENATOR ORTIZ: I think that many of us are probably interested in hearing the Department's position regarding the recommendation of going to an action level rather than taking two to three years or two to five years for adopting a public reg.

DR. SPATH: An action level is simply a guidance level. It has no regulatory effect at all. We do not enforce action levels. It advises a water system that purely from a public health standpoint, it is a level that you may want to shoot for, similar to a public health goal.

If we were to take a stand by establishing an action level for a chrome VI, we would probably establish it at the public health goal right now. We would then recommend that water systems obviously test, and if they do find chrome VI above that action level, that they advise their customers of that. That's as far as that goes. It has no regulatory impact.

SENATOR ORTIZ: Well, I understand that from your perspective it doesn't have any force in effect of a mandate, but it certainly provides a little more direction in a more timely manner that suggests that there is a standard that is probably more beneficial to public health and takes less time to go through.

DR. SPATH: Right, it does provide guidance to the water utility industry so that they can shoot for something, and then also, they can advise their customers of how close it is to that goal.

SENATOR ORTIZ: I appreciate that.

Are there other questions?

Please.

DR. FROINES: I will be very brief.

I would urge you to seriously consider an action level or a guidance level. I think it's exactly what's needed at this particular point in time.

I think that I would also emphasize the need for exposure monitoring. We've seen chlorinated organics in water; we've seen MTBE in water; we've seen chromium. We know that arsenic is, in fact, worse than chromium. And now I would argue, if I had time, that we have polycyclic aromatic hydrocarbons in water as well.

So the more we look, the more we find, and the problem has been is that we haven't looked very well in some respects.

So I would urge you to take seriously the notion of doing more exposure monitoring.

The two other things I wanted to say was that our committee, the Scientific Review Panel, under AB 1807, was asked by OEHHA to review their public health guide for MTBE. We did so and we found the document was scientifically satisfactory, and we approved the document.

Since people have been throwing around numbers all day today, if you would like a scientific review panel that is highly regarded to review the PHG and give you a peer review, my Scientific Review Panel could do that in a very short period of time and give you a response from the state's Scientific Review Panel, which I think, as I say, is held in high regard. So that's worth considering.

The last thing I want to say is I put up a slide and I said the values could be from .02 to 20, and those numbers have been taken by others and used to make their own arguments.

I wanted to say that of course they can go over a range of 100 on either side. But I also think that the point I tried to make was that one should approach that from a public health perspective and not use it as a kind of license to go to 100 parts per billion.

That's all I really wanted to say about that because I think what we should do is take a number at this point, which is a reasonable number, like a .2, like 1, like .5 -- it doesn't really matter -- but take a number, get a number, and use it as a starting place to begin this process of getting these problems addressed.

So thanks very much.

SENATOR ORTIZ: Thank you. I think there was a question for you.

ASSEMBLYMEMBER SCOTT: I was very intrigued by your recommendation. You suggested that we take action now, not a comprehensive action but what we could do quickly, and then continue the study and do some residual work, as I understood your recommendation.

Do you want to be a little more specific about what action you think we ought to take now?

DR. FROINES: Well, the problem, for me, is I'm the biologist/chemist in the room and there's a lot of engineers who really know more about that than I do. So I would defer to people who have some better sense of what the remediation or cleaning up or control technology might be that would be appropriate. I think a great deal of effort has to be put into that, and I would rely on others' expertise beyond my own.

ASSEMBLYMEMBER SCOTT: But your idea was a two-phase kind of approach.

DR. FROINES: Yes.

ASSEMBLYMEMBER SCOTT: That there's some things we can do now and that there are some other things, that we ought to continue the study, and, say, in a few years we could then take those steps as well.

You don't want to conjecture as a citizen, not as a biologist, as to what you think those steps ought to be right now?

DR. FROINES: Well, I do think that the notion of an action level that gets us started, coupled with good exposure assessment, good looking at the numbers, looking at the magnitude of the problem, and then to begin to identify what is the best technology that we can implement quickly and immediately, and push people who say there is no technology to actually try and come up with some solutions -- again, I'm not an engineer -- but I think if we can take those kinds of steps and then begin to look at the long-term and more advanced technologies, more advanced science, the process will proceed better.

We want to make progress and then deal with the long-term problem in the long term. I think what we don't want to do is make it tradeoffs, and that's where we get into trouble. We don't want tradeoffs; we want a process which gets us going, makes improvements, and then continues in the long run.

SENATOR ORTIZ: Thank you.

Mr. Cohen.

DR. COHEN: Well, I'll start by saying I am an engineer.

ASSEMBLYMEMBER SCOTT: Good. You'll tell us then what to do.

DR. COHEN: I'd like to address two issues. First, monitoring. And I think that it was well stated that there is a need for monitoring, but I'd like to emphasize again, why is it that we need monitoring?

I don't think that we need monitoring as a way to avoid addressing the treatment issue, but we need monitoring in order to really understand what the sources are.

Today, I've heard a lot about, well, we think that there's a hotspot here, and we think that it's naturally occurring over there. The point is, that unless you have a source allocation, what you will be doing is treatment rather than a cure. And I think that if we want to have a cure to the problem, then we really need to know what those sources are, where are they, is there a continual source of chromium VI?

Those questions are very important. Because the question that is asked -- do we or do we not meet the standard? -- is very different from the perspective of monitoring if you ask: Am I looking for a source and am I looking for a cure? Because that will affect how often you monitor. That will affect where you monitor. And those are very important issues.

So I think that should be considered.

Now, with the issue of treatment, of course technology is very important, and whenever you deal with parts per billion removal, it's not an easy thing to do, because it always works against the laws of nature. And I won't get into thermodynamics, for those of you who may remember it from way back when.

But the issue is, technology that is being looked at today, aside from ion exchange which usually is for parts per million, not for the parts per billion range, is that of membranes. You heard Senator Ortiz mention reverse osmosis. If you use reverse osmosis for the sole purpose of removing chromium, then the cost is going to be astronomical. However, if you use reverse osmosis or membrane treatment in general as part of the overall process of water treatment, or enhancement of the quality of drinking water, then that can be an added benefit.

And for those of you who may not know, there is, in fact, a very intensive effort to develop and demonstrate membrane technology for water treatment. There is the so-called DRIP partnership program which involves many of the water agencies, MWD, DWR, not just agencies in Los Angeles but also in San Diego. This is a very significant effort. I know in my lab we're developing and working on various membrane technologies and there are a lot of problems. It's not something that we could say that you can implement tomorrow, but I think that there is a future for it.

So you ought to look into it, and if, indeed, legislation is going to be something that is going to push effort in this area and money to promote greater acceleration of development of such membrane technology, then that may work.

SENATOR ORTIZ: I appreciate that. I think that's the key on the best available control technology that we're seeking.

Mr. Lyou.

MR. LYOU: At long last we can come to the conclusion of this.

SENATOR ORTIZ: Thank you for being so patient, all of you.

MR. LYOU: I'm just going to make two real quick points. It's been discussed a little bit but I want to make it really clear that I think that there should be a separate standard for chromium VI. Given the variability and the data with regard to the ratio of chromium VI to total chromium, the only thing that we really can do is to come up with a separate chromium VI standard or assume that the total chromium is equal to 100 percent of the chromium VI.

So that aside, I think there's a public policy decision that's coming up on November 7th that we haven't discussed either. It's one that all of us as voters are going to have to make, and that has to do with Prop. 37. If it's passed, it will take away a very important means of recovering the type of money through fees from the polluters that could be used to remediate the problems that chromium VI has caused, and I think that it's one that should be in the forefront of all our minds to defeat Prop. 37.

So that's it. Thank you.

SENATOR ORTIZ: Thank you so much.

All right, members, I don't know if you would like to comment. There is some public testimony. We weren't going to take public testimony but we will go ahead and do so. Just because of the time -- we've gone an hour over -- but I would ask those who wish to comment and provide public testimony to please try to keep your comments to two minutes. The timer will be set at three, but if you can, I just think it's very important for you to try to keep to two minutes. Then members will have an opportunity to do closing comments, and that will be, hopefully, the end of our committee hearing.

Thank you. Welcome. And if you could please identify yourself on the record.

MR. R.C. "CHAPPY" CZAPIEWSKI: I'm R. C. "Chappy" Czapiewski. I live in North Hollywood but I spend most of my time in Burbank and especially on the B-6 property at the airport.

Congratulations to you, Senator Ortiz, and to all the members of the panel who came. I think the timing of this was very urgent, and I hope that you can carry some of that urgency on.

I was impressed especially by the comments of Mr. Froines, and that is that forget about the long term, and he was talking about the thing to do is to set something right now as a starting point.

Just one word of caution to you all: What you're doing is a record-breaking effort, I think, because of the kind of problems that you're going to face. And the biggest problem that you're going to face are all of the people who are right now part of the water establishment, and you're going to have to be careful about being bogged down by their lobbyists.

The second thing that you have to worry about, I think, is that if you're dealing with this area, then you've got to remember that Lockheed Martin was the polluter, that Lockheed Martin has the best lobbying team in the world; and therefore, anything that you do that's going to cause them to do more than just take care of the PCEs, etc., you're going to find that there's going to be an awful lot of resistance on their part to actually step forward again and to make sure that this is paid for.

Congratulations again to all of you, and Mr. Schiff, I hope you win.

SENATOR SCHIFF: Thanks.

SENATOR ORTIZ: So do we. Thank you. Thank you for adhering to the two-minute request. I appreciate that.

MR. TED McCONKEY: Good afternoon, folks. My name is Ted McConkey. I'm a resident and former Burbank Council member, and I also served on the Burbank City Environmental Oversight Committee, so I am somewhat familiar with the problem and with the issues.

I appreciate your coming here today, although it is a belated effort. I want to point out that over two years ago, when OEHHA first proposed the public health goals, that the issue was trivialized. Not only by the city of Burbank but by most of the jurisdictions. We were told that there wasn't a problem, and even if there was, we couldn't monitor; therefore, let it all go away. And that's what happened.

The real impetus for this, as you all well understand, was the movie *Erin Brockovich* and the *Los Angeles Times* articles. That's what brought this to the forefront. And don't let anyone kid you otherwise, because if those events had not occurred, we wouldn't be here today.

I also support the concept of an action that falls somewhere between a regulation, a standard, and the public health goal. That has to be taken into account, and you can put the pressure on the agencies and on the jurisdictions to do that. And I hope that you do do that.

I also want to point out that, although we're talking about ingestion and dermal contact, that there is another issue, and that is inhalation. For years Lockheed operated the spray booths, the coating booths out there, and Lockheed, in response to one of the lawsuits that they were engaged in, just did a study, commissioned a study, to see what the residual effects of the chrome VI was in many parts of the city. That information is available. Although the readings were low, this goes back decades, and many people in Burbank suffered the effects of inhalation of chrome VI. That information is available, and I urge you to read it and to understand it.

I wish you good luck. As a citizen of Burbank and a citizen of California, I hope that you do actively and vigorously pursue this. As Chappy pointed out, you're going to meet all sorts of resistance from the water professionals and from Lockheed and from the jurisdictions themselves who really don't want this to be an issue.

So good luck, and thanks very much for coming, and we'll look forward to the results.

SENATOR ORTIZ: Thank you for your testimony.

Welcome.

MR. HERMAN MELMAN: Hello. My name is Herman Melman. I'm President of Seniors for Political Action, and I've been involved in many environmental issues down the years. And I've been a very vigorous opponent of the DWP's project known as "toilet-to-tap."

What I would like to have on the record is I'd like to know how many homes, apartments, factories, and offices and business establishments have received notices that they will be drinking toilet-to-tap water if the DWP has its way.

The DWP has the obligation to offer evidence that this project is not contaminated by thousands of untested chemicals. The burden of proof rests with the DWP, not with the citizens of the city of Los Angeles. The burden must be on the DWP to prove their position, which they've done a very poor job of.

The people who will be the innocent victims of the project have every right to demand that the DWP prove that hospital waste, industrial waste, chemical waste, and toilet waste, after being treated by the DWP and claimed safe and pure, be proven before they turn on the taps.

Here is a full-page ad by a cigarette company in which it says, "Surgeon General's Warning: Smoking causes lung cancer, heart disease, emphysema, and may complicate pregnancy."

Here is another ad by the cigarette company in which it says, the old famous cowboy, "Surgeon General's Warning: Smoke contains carbon monoxide."

I would like to have the Department of Water and Power give us an equal warning printed on every letter and bill that they send out that they warn the recipients of that, that the equivalent of the Surgeon General's warnings be printed on the face of each letter telling them that the water from their tap contains hexavalent chromium number 6, and may be hazardous to their health. Plus thousands of other unnamed and untested chemicals. And that should be printed on every letter and every bill.

Let's get this secret(?) team, combined of the DWP, the ____________ office, to -- I mean, it's so harmed by all this criticism. My god, I mean, after all, the people--

SENATOR ORTIZ: Mr. Melman, could you wrap up? We're at three minutes.

MR. MELMAN: One more moment.

SENATOR ORTIZ: Thank you.

MR. MELMAN: The people of the city of San Diego were described as stupid by Mr. Freeman.

Thank you for your courtesy in allowing me to get my message across.

SENATOR ORTIZ: Thank you for your patience. I appreciate that. Thank you. Any other speakers, public comment? Please. Welcome.

DR. LANDOLPH: Hi. Joe Landolph, Associate Professor, USC -- Cancer Center, USC School of Medicine.

I just want to address two brief points. One was this public health goal, and there was some difficulty here in dealing with that between the USEPA and here, and Senator Hayden had addressed that question?

I think the reason is the database is fairly sparse, and CalEPA was more proactive in accepting that database; the USEPA didn't. This was the basis of my recommendation earlier, that I think the NTP should do a whole animal study and perhaps be nominated as a -- hexavalent chromium be nominated by this committee to the NTP program to add to that database, and I think that would take away some of the uncertainty and, hence, the confidence in the PHG goal.

And I think, certainly, it's very important to incorporate data like Dr. Froines has, the human data, and I would recommend that that PHG be updated periodically as an ongoing thing so we have most confidence in it.

These curves for carcinogenesis are presumed to be linear. So the question is: What's the slope of that curve? And that can affect how you set the regulations, the cost, and all the effort you're going to have to put into this. So I would recommend that effort be ongoing.

SENATOR ORTIZ: I think that's a doable recommendation. Thank you.

MR. ROBERT EDWARDS: Good afternoon, ladies and gentlemen.

SENATOR ORTIZ: Good afternoon.

MR. EDWARDS: If I might, the red envelopes -- can someone stand them up, please? -- for Ms. Ortiz and for you, Tom--

SENATOR ORTIZ: If you could speak into the microphone so that we might all be able to hear you? Thank you.

MR. EDWARDS: I'm sorry. The red envelopes are for yourself, Ms. Ortiz, and for you, Tom. They contain the color photographs. I was not able to reproduce; there are two other sets of the report there that you can share, please.

SENATOR ORTIZ: Thank you.

MR. EDWARDS: Part of what we're addressing here today--

SENATOR ORTIZ: Your name?

MR. EDWARDS: My name is Robert Edwards, and I am past-chairman for LEARN, for the LAUSD parents for the last six years. Brought you a few crazy ideas like standards, graduation standards, standards-based promotion, and career and prep tech, a few other things.

Got started into this with the problems over the aquifer, regarding DFI(?), and some problems with the dumps, and we have come to it regarding chromium VI because it has become a major focal point. But has been stated to you all day long, there are other problems.

The East Valley aquifer is a federal Superfund site, and what I'd like to show you here on this particular map, this at the top is Hansen Dam. It is the northern end of the valley. It is at the 118, almost the northern end. This is the southern end. This is, of course, down through the Elysian Pass.

Anything that you see on this map, according to the United States Environmental Protection Agency, is unfit for human consumption: all of the water in the East Valley aquifer. That is why we are only taking 15 percent of it out into the Los Angeles city supply. If we took any more than that out, it would all be unfit for human consumption.

What we're talking about right now with the toilet-to-tap issue is moving another biohazard even further upstream, and we have no idea what the relationship between these biocontaminants and what's going to happen when it hits the already VOCs: the trichloroethylenes, the perchloroethylenes, the beriliums, the arsenics, that are sitting down below.

So I would say that being as these pictures have been available for more than twenty years, that it is time to take an action movement on it.

Thank you very much.

SENATOR ORTIZ: I appreciate that. Thank you.

Any other testimony from the public?

MS. FRAN REICHENBACH: Hi. My name's Fran Reichenbach. I'm with the Hollywood Neighborhood Council and also Beachwood Canyon Neighborhood

Association. I've been involved in the whole, they call it, "toilet-to-tap," but I think that's been a little bit overused.

The East Valley Water Reclamation Project doesn't seem like it fits right into your chromium VI issue, but it really does. There are many different industries that gave us chromium VI in the first place. Those industries are not isolated to the valley. They are also down in Los Angeles, in the center and hearts of the flatlands, and all around downtown L.A., and all the way down to Long Beach.

This water, or the sewage that they plan to take out of industrial and hospital and homes, they've got their hand poised right on the button right now, the LADWP does. They were put on hold because they didn't do the right studies and they didn't do the right public outreach to let people know that this wasn't going just to agriculture and this wasn't going just to steam engines and plants. This was meant for our drinking water.

Now, one of the ways that they can use this at the Tillman Plant, one of the ways that they use this water, they plan to use it, is by double-chlorination. They chlorinate it after it gets out of the Tillman Plant as it goes into the spreading fields. Then they chlorinate it again as it's coming out of the underground aquifers. That chlorination process is not so good for chromium VI. It actually makes it propagate.

So we're concerned about that.

Now, as far as the drinking bottled water that Mr. Freeman was speaking of, many of our people that are involved in this whole toilet-to-tap issue have also decided that they would, after hearing Cindy Myzkowski(?) say that they were no regulations for bottled water -- the people started getting a little nervous. Is there water anywhere that we can drink and feel safe?

So we all took a different -- mine was Arrowhead. I contacted Arrowhead, who's run by Perrier. Their labs sent me a 20-page report, and the chromium level -- they test for total chromium -- it's .2 parts per billion. So there is no problem with that water. I sent those same tests to two different biologists. One is from CSUN. His name is Dr. Steven Oppenheimer. And the other is a retired biologist by the name of William M. Boden(?). They both give that the flying colors.

The other girls have other reports, but I just wanted you to know that Arrowhead's good anyway.

SENATOR ORTIZ: Okay, thank you for that. I appreciate it.

That ends the public testimony, and what I'd like to do now is allow each of the members to comment and close, and I'll close at the end.

I really want to certainly thank the city of Burbank for hosting us, and certainly the local members who've been so wonderful at this. Senator Hayden and Senator Schiff were out there and have been strong advocates on this issue. It certainly has been informative to me.

But I'd like others the opportunity to close, and then I'll end up and close the committee after they've spoken, because I've taken the lead on this.

Adam?

SENATOR SCHIFF: Senator Ortiz, I want to thank you again for all of your work, and Senator Hayden as well, in organizing the hearing today. And I appreciate all of the witnesses who've come and shared their expertise. I think it's been a very valuable hearing in shedding light on a very difficult subject on not only what the state of the scientific evidence is but what the regulatory process is and what steps can and need to be taken.

I think we've got some excellent suggestions today, and I certainly want to work after today's hearing to encourage the DHS to adopt an action level so that there is the requisite sense of urgency among the water agencies that this is something we ought to do now and not simply wait a multiyear period of time before we act on.

I think Dr. Landolph's suggestion also is a good one, that we work together to nominate hexavalent chromium for study by the National Toxicology Program so that that is proceeding concurrently.

I also want to work with Burbank and Glendale to make sure that we have the requisite cooperation from the USEPA to deal with the difficult box that they're in under a consent to agree to clean up the soil and water here from other volatile organics without adding to the hexavalent chromium problem in our water supply. So I think that's going to be an important challenge in the days ahead.

But I think that there is a strong level of consensus here that we ought to act now to reduce the level of hexavalent chromium while we study it, but not wait for the studies to be done and confirm or fail to confirm what we, I think, have a pretty strong sense of right now, and that is, it is a very real health risk and one that we ought not to run.

So I think what we need to embark on now is direct our attention to how do we prevent further accumulation of chromium, how do we treat the chromium that already exists, and what other mitigation steps that can be most effectively undertaken. I think that's the most important place for us to go from here.

And I want to thank my colleagues again for their participation today.

SENATOR ORTIZ: Tom?

SENATOR HAYDEN: Well, I want to thank my soon-to-be former colleagues for taking the time as well. And Mr. Schiff, I think, gave an excellent summary.

Last week in my Senate district we had a town meeting that a couple of hundred people went to, and there was an affirmation of several points that I just want to leave with you.

The feeling was very strong that this is a very big issue and that the Governor really ought to meet with some of the advocates and take a personal look. Because if it affects the San Fernando Valley with a million or two million people, it's obviously, from the evidence today, in other parts of the state as well.

And secondly, the unanimous feeling was that the DHS ought to set a standard or, I guess, an action level as close to the public health goal as possible on an emergency basis, and starting with the schools or identifying places where there are kids or vulnerable people who are pretty much locked into drinking from the drinking fountain or the tap. We weren't clear on who has jurisdiction over the school drinking water but thought there should be a start there.

And finally, that the city and the county or other jurisdictions ought to separate the monitoring and enforcement from the water agencies, which are now mixed together, so that you have checks and balances at the local level and don't just have to depend on occasional state intervention.

In closing, I wanted to add a response, though, to the earlier statement that "If it wasn't for *Erin Brockovich* and the *LA Times*, this wouldn't be an issue."

I think there is some truth to that, and water agencies might conclude that, therefore, they should just ride this out.

But we should remember and be thankful that it was also the Legislature passing a law in 1996 that moved OEHHA to set a public health goal that is a much more fundamental trigger than anything in the media or in entertainment. It's now before us and nobody has really today discredited the individuals at OEHHA who've said, *This is the goal. Anything beyond this you're risking unnecessary cancer.*

So, the Legislature has a basis for occasionally returning to the subject and saying, *What have we overlooked, what can we tighten up?*

There will be pressures from the water agencies. It's a bit of a nightmare, if you know the history of Southern and Northern California water, because what you're really talking about here is the fear that if the water is degraded, and that's admitted, then we'll have to take more Northern California water for Southern California subdivisions, and then it'll reignite this conflict.

So, it's absolutely critical that we not let clouded motives get in the way of what's going on, because anybody who's in the water agency business is going to have a vested interest of minimizing hazards or delaying the adoption of standards, because the implication is $47 million to import water from Northern California if we shut down these wells here.

So we're really in a bind, and there's been a regulatory lapse or failure or nonaction for a very long time except for OEHHA, and we should be thankful and protective of their independent position because they really have been the signal that has gotten our attention.

And I hope that the Legislature, when it resumes, will take the view that, regardless of whatever the pressure is from water agencies, the essential question is making sure that children have water that does not leave a residue that will impact their health long term. That issue, I think, will prevail over the alleged cost issue.

I would also urge you to independently evaluate the cost issue and the cleanup issues because those get thrown up as tough roadblocks: What if there's no cleanup technology? What if it costs too much? But no one is getting independent analysis the way the Legislature would expect of what it would really cost and are there other options.

Let's not let the water agencies determine our options.

Thank you very much.

SENATOR ORTIZ: Thank you, Senator Hayden.

Assemblymember Scott?

ASSEMBLYMEMBER SCOTT: Well, I think because both Senators Schiff and Hayden have said it so well, I'll certainly be brief.

I think all of us who are legislators recognize that our deepest obligation is to speak up for the constituents, and this is an issue that touches every constituent; every one of the 34 million citizens of California. It has to do with drinking water. It has to do with their personal health.

So I have heard a lot of information today; I think some superb testimony. It's heightened my concern over this issue. It's deepened my resolve to simply say that either to initiate or to support legislation that will improve the quality of our drinking water and guarantee its safety. Not only legislation but the resources that are necessary, and I certainly second what Senator Hayden said. Let's not be thrown off by cost, and let's look very carefully at that.

And I also want to say that I want to move on something now, and I want to continue this study in the future, and I hope that we can do that after this hearing.

I applaud Senator Ortiz and Senator Hayden and Assemblymember Jackson who are responsible for calling this hearing, and I appreciate a great deal Senator Schiff's action already in Senate Bill 2127.

SENATOR ORTIZ: Thank you.

Let me just, once again, thank the city of Burbank for accommodating us and allowing us to meet in the chambers. I used to be a member of a city council, so I greatly appreciate the timer and the two-minute rule. But truly, they've gone out of their way to accommodate us, and as someone who's not from Southern Cal but, rather, is from Northern Cal, I appreciate that.

I want to thank the staff. They really pulled together. It's difficult to bring a committee on the road and bring it down to another venue, so they did incredible work and I want to thank them for that.

I want to take a moment to acknowledge my colleagues. Senator Hayden is leaving, unfortunately, our Legislature because of this ridiculous thing called term limits, but he has been one of the most visionary and heartfelt, and often highly critical, which is the right thing to be when you're an advocate. We're going to miss you. Clearly, you've been out there informing people like me about this issue, and I appreciate that.

Senator Schiff also has been just incredible. Saw this as an issue, stepped in.

And it's just the beginning. We've got an obligation, the rest of us who are going to be around. Hopefully, I'll have Mr. Scott joining me in the Senate. And those of you who will be either going to local government or Congress, obviously you've been given your marching orders by this group.

For those of you, the witnesses, thank you so much for your testimony and your time. I know we went an hour-and-a-half over our allotted time, but that's pretty good considering. But we listened well to all of your recommendations, and I suspect that this will be the first of maybe at least a couple more hearings, information gathering. Certainly, I know my colleagues and I will be looking at many of the recommendations here.

But we fulfilled our objective, which was to gather the information and have persons on the record comment as to what their role is, or they perceive their role to be on this issue. And with that, now it's our job to get something done.

Thank you all for all of your time. You guys have been great.

This meeting's adjourned.

-oOo-

WRITTEN TESTIMONY

PROVIDED BY

PARTICIPANTS

Public Health Goal for Chromium In Drinking Water

PREPARED BY

Office of Environmental Health Hazard Assessment
California Environmental Protection Agency

Pesticide and Environmental Toxicology Section
Anna M. Fan, Ph.D., Chief

Deputy Director for Scientific Affairs
George V. Alexeeff, Ph.D.

February 1999

LIST OF CONTRIBUTORS

PHG PROJECT MANAGEMENT	REPORT PREPARATION	SUPPORT
Project Director Anna Fan, Ph.D. ***Workgroup Leaders*** Joseph Brown, Ph.D. Robert Howd, Ph.D. Lubow Jowa, Ph.D. David Morry, Ph.D. Rajpal Tomar, Ph.D. ***Public Workshop*** Rajpal Tomar, Ph.D. Coordinator Judy Polakoff, M.S. Juliet Rafol ***Report Template/Reference Guide*** Hanafi Russell Yi Wang, Ph.D. ***Revisions/Responses*** Joseph Brown, Ph.D. Michael DiBartolomeis, Ph.D.	***Author*** David Morry, Ph.D. ***Primary Reviewer*** David Chan, Ph.D. ***Secondary Reviewer*** Lubow Jowa, Ph.D. ***Final Reviewers*** George Alexeeff, Ph.D. Michael DiBartolomeis, Ph.D. Anna Fan, Ph.D. ***Education and Outreach/Summary Documents*** David Morry, Ph.D. Hanafi Russell Yi Wang, Ph.D. ***Fomat/Production*** Edna Hernandez Hanafi Russell	***Administrative Support*** Edna Hernandez Coordinator Juliet Rafol Genevieve Vivar ***Library Support*** Charleen Kubota, M.L.S. Mary Ann Mahoney, M.L.I.S. Valerie Walter ***Website Posting*** Edna Hernandez Laurie Monserrat

We thank the U.S. EPA (Office of Water; Office of Prevention, Pesticides and Toxic Substances; National Center for Environmental Assessment) and the faculty members of the University of California with whom OEHHA contracted through the UC Office of the President for their peer reviews of the PHG documents, and gratefully acknowledge the comments received from all interested parties.

PREFACE

Drinking Water Public Health Goals

Pesticide and Environmental Toxicology Section

Office of Environmental Health Hazard Assessment

California Environmental Protection Agency

This Public Health Goal (PHG) technical support document provides information on health effects from contaminants in drinking water. PHGs are developed for chemical contaminants based on the best available toxicological data in the scientific literature. These documents and the analyses contained in them provide estimates of the levels of contaminants in drinking water that would pose no significant health risk to individuals consuming the water on a daily basis over a lifetime.

The California Safe Drinking Water Act of 1996 (amended Health and Safety Code, Section 116365) requires the Office of Environmental Health Hazard Assessment (OEHHA) to perform risk assessments and adopt PHGs for contaminants in drinking water based exclusively on public health considerations. The Act requires that PHGs be set in accordance with the following criteria:

1. PHGs for acutely toxic substances shall be set at levels at which no known or anticipated adverse effects on health will occur, with an adequate margin of safety.
2. PHGs for carcinogens or other substances which can cause chronic disease shall be based solely on health effects without regard to cost impacts and shall be set at levels which OEHHA has determined do not pose any significant risk to health.
3. To the extent the information is available, OEHHA shall consider possible synergistic effects resulting from exposure to two or more contaminants.
4. OEHHA shall consider the existence of groups in the population that are more susceptible to adverse effects of the contaminants than a normal healthy adult.
5. OEHHA shall consider the contaminant exposure and body burden levels that alter physiological function or structure in a manner that may significantly increase the risk of illness.
6. In cases of insufficient data to determine a level of no anticipated risk, OEHHA shall set the PHG at a level that is protective of public health with an adequate margin of safety.
7. In cases where scientific evidence demonstrates that a safe dose-response threshold for a contaminant exists, then the PHG should be set at that threshold.
8. The PHG may be set at zero if necessary to satisfy the requirements listed above.
9. OEHHA shall consider exposure to contaminants in media other than drinking water, including food and air and the resulting body burden.
10. PHGs adopted by OEHHA shall be reviewed every five years and revised as necessary based on the availability of new scientific data.

PHGs adopted by OEHHA are for use by the California Department of Health Services (DHS) in establishing primary drinking water standards (State Maximum Contaminant Levels, or MCLs). Whereas PHGs are to be based solely on scientific and public health considerations without regard to economic cost considerations, drinking water standards adopted by DHS are to consider economic factors and technical feasibility. Each standard adopted shall be set at a level that is as close as feasible to the corresponding PHG, placing emphasis on the protection of public health. PHGs established by OEHHA are not regulatory in nature and represent only non-mandatory goals. By federal law, MCLs established by DHS must be at least as stringent as the federal MCL if one exists.

PHG documents are used to provide technical assistance to DHS, and they are also informative reference materials for federal, state and local public health officials and the public. While the PHGs are calculated for single chemicals only, they may, if the information is available, address hazards associated with the interactions of contaminants in mixtures. Further, PHGs are derived for drinking water only and are not to be utilized as target levels for the contamination of other environmental media.

Additional information on PHGs can be obtained at the OEHHA web site at www.oehha.ca.gov.

TABLE OF CONTENTS

PUBLIC HEALTH GOAL FOR CHROMIUM IN DRINKING WATER

SUMMARY

The Office of Environmental Health Hazard Assessment (OEHHA) has developed a Public Health Goal (PHG) of 2.5×10^{-3} mg/L (2.5 µg/L, 2.5 ppb) for total chromium. The California Maximum Contaminant Level (MCL) is currently 0.05 mg/L (50 ppb) for total chromium in drinking water. There are two forms of chromium, chromium VI and chromium III, that may be significant as drinking water contaminants. OEHHA believes that the health protective goals of the California Safe Drinking Water Act of 1996 are best served by assuming that chromium VI is carcinogenic when ingested. Based on this assumption, a health protective level of 0.2 µg/L, or 0.2 ppb is calculated for chromium VI, based on tumor development in female mice (Borneff et al., 1968). This study involved exposure of male and female mice to potassium chromate in drinking water at a level of 500 mg/L. The female mice exposed to potassium chromate had increased incidence of benign and malignant stomach tumors relative to controls. The cancer potency for chromium VI was calculated using ToxRisk, based on the increased incidence of these forestomach tumors in the female mice.

A non-cancer health protective level for chromium VI in drinking water of 70 ppb was determined based on a chronic drinking water study in rats (MacKenzie et al., 1958). This study showed no adverse effects at a level of 2.4 mg/kg-day. The health protective level was arrived at using an overall uncertainty factor of 500, and a relative source contribution (RSC) of 40%.

The health protective level for chromium III is 200 mg/L, or 200,000 ppb, based on a rat drinking water study (Ivankovic and Preussmann, 1975) which provided a NOAEL of 1,468 mg/kg-day, the only dose level tested in this study. This health protective level includes an uncertainty factor of 100 for extrapolation from animals to humans, and for intraspecies variability.

OEHHA estimates that total chromium would be made up of no more than 7.2% chromium VI. The PHG for total chromium was calculated from the health protective level for chromium VI (cancer endpoint) using 7.2% as the percentage of chromium VI in total chromium.

INTRODUCTION

Chromium is an industrially important metal, which has the potential to contaminate drinking water sources. Chromium VI is more water soluble, more easily enters living cells, and is much more toxic than chromium III. Chromium VI is a human carcinogen, as determined by the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC), the U.S. Environmental Protection Agency (U.S. EPA), and OEHHA (NTP, 1998; IARC, 1990; U.S. EPA, 1998b; Siegel, 1990). OEHHA has made a health protective assumption that chromium VI is a potential human carcinogen by the oral route (Siegel, 1990). Chromium III has not been shown to be carcinogenic to animals or humans by the oral route (IARC,1990; U.S. EPA, 1998a; ATSDR, 1993 and 1998).

The health protective level for chromium VI is based on carcinogenicity in a mouse drinking water study (Borneff et al., 1968). The health protective level for chromium III is based on a NOAEL derived from a rat drinking water study (Ivankovic and Preussmann, 1975). The values for the two chemical forms differ greatly, and they are based on different health effects. The PHG for total chromium is based on the health protective level for chromium VI, assuming that total chromium is made up of no more than 7.1% chromium VI.

CHEMICAL PROFILE

Chemical Identity

Chromium is a metallic element with an atomic number of 24. It is a member of group VIB on the periodic table, along with molybdenum and tungsten. Chromium possesses one electron in its outer electron shell. There are four naturally occurring isotopes of chromium. The most common ones are ^{52}Cr (83%) and ^{53}Cr (9.5%). None of the natural isotopes is radioactive (Weast et al., 1988).

Physical and Chemical Properties

Chromium generally occurs in small quantities associated with other metals, particularly iron. The atomic weight of chromium is 51.996. Chromium melts at 1,875° C, and boils at 2,680° C. The specific gravity of chromium is 7.19. The most common valences are +3 and +6. Chromium forms a number of salts, which are characterized by a variety of colors, solubilities and other properties. The name "chromium" is from the Greek word for color. The most important chromium salts are sodium and potassium chromates and dichromates, and the potassium and ammonium chrome alums (Hodgman, et al., 1961).

Production and Uses

The metal is usually produced by reducing the chromite ($FeCr_2O_4$) ore with aluminum (Weast et al, 1988). The combined production of chromium metal and chromium ferroalloys in the United States in 1988 was 120,000 metric tons (ATSDR, 1993). Most of this metal is used in the manufacture of automobiles, appliances and other consumer products.

Chromium is used to harden steel, in the manufacture of stainless steel, and in the production of a number of industrially important alloys (Weast et al., 1988). Chromium is used in making of pigments, in leather tanning and for welding. Chromium plating produces a hard mirror-like surface on metal parts that resists corrosion and enhances appearance.

Sources

The principal ore of chromium is chromite ($FeCr_2O_4$), found in Zimbabwe, Russia, Transvaal, Turkey, Iran, and other countries (Weast et al., 1988). The ore has not been mined in the United States since 1961 (ATSDR, 1993). Ore is imported into the U.S. from the above mentioned countries, and refined in the U.S. into chromium metal and alloys. In California there are over a hundred industrial facilities that process imported chromium (ATSDR, 1993).

ENVIRONMENTAL OCCURRENCE AND HUMAN EXPOSURE

Air

Chromium is present in the atmosphere in particulate form, usually as very small particles (approximately 1 μm in diameter). Chromium can enter the ambient air from anthropogenic point sources such as smelters, or from windblown soil, road dust or seawater. Cigarette smoke contributes chromium to indoor air. Chromium levels in the air in the U.S. are typically <0.01 $\mu g/m^3$ in rural areas, and in the range of 0.01 to 0.03 $\mu g/m^3$ in urban areas (ATSDR, 1993).

Soil

Chromium occurs naturally in crustal rocks, but the main source of chromium in soil is probably disposal of commercial products. Chromium is present in soil primarily in the form of the insoluble oxide, Cr_2O_3. Chromium is generally not mobile in soil (ATSDR, 1993).

Water

Chromium enters environmental waters from anthropogenic sources such as electroplating factories, leather tanneries and textile manufacturing facilities. Chromium also enters groundwater by leaching from soil. Chromium can exist in water as either Cr III or Cr VI. Cr VI in water will eventually be reduced to Cr III by organic matter. The rate at which this occurs depends on the amount of organic matter present in the water, and on the pH and redox potential of the water (Clifford and Man Chau, 1988). Rivers in the U.S. have been found to have from <1 to 30 μg/L of chromium. U.S. lakes usually have < 5 μg/L of chromium. When high levels are present, they can usually be related to sources of pollution. A survey of drinking water sources in the U.S. conducted for 1974 to 1975 found chromium levels ranging from 0.4 to 8.0 μg/L, with a mean of 1.8 μg/L (ATSDR, 1993).

California water monitoring data from 1984 to 1996 (California Department of Health Services, 1997) show that chromium (as total chromium) was detected in 822 of 9,604 drinking water sources, or approximately 9% of the sources surveyed. The practical detection limit was 10 μg/L. The range of total chromium levels in the samples where chromium was detected was from 10 μg/L up to a maximum of 1,100 μg/L, with a mean of

23 μg/L and a median of 17 μg/L. The chromium was not speciated, so we do not know how many of these sources would have had detectable amounts of chromium VI.

There are very few data available on which to base an estimate of the chromium VI fraction of total chromium in potential drinking water sources. Only one study was located in the literature which deals with speciation of chromium in potential drinking water supplies (Kacynski and Kieber, 1993). In order to determine the relative amounts of the two species, the investigators sampled a number of surface water sources, including both salt and fresh water sources. They analyzed the samples using iron hydroxide coprecipitation of chromium followed by graphite furnace atomic absorption spectroscopy. This method enables Cr III and Cr VI to be determined from the same samples, with a low detection limit (0.02 nM Cr III and total chromium). Two lakes in North Carolina were chosen for study because they were relatively free of tidal action and currents which would complicate the sampling. Samples were taken at different times of day and during different seasons. The research paper does not explain the sampling design in terms of the locations within the lakes where the samples were taken. The following table gives the mean chromium levels for these two lakes.

	Cr III (nM) nM=nanomolar	Cr VI (nM)	Total Cr (nM)	Percentage of Total Cr as Cr VI
Singletary Lake	0.168	0.003	0.171	1.8%
Greenfield Lake	0.032	0.013	0.045	29%
Geometric Mean				7.2%

These are very limited data from two potential drinking water sources in another state, but there were no data available on speciation of chromium in California drinking water sources.

Food

Virtually all foods contain some chromium, ranging from 20 to 590 μg/kg (U.S. EPA, 1985). The foods with the highest levels of chromium are meats, mollusks, crustaceans, vegetables, and unrefined sugar (U.S. EPA, 1985).

Chromium is only slightly bioconcentrated in fish. Trout exhibit a bioconcentration factor (BCF) for chromium of 1. Mollusks bioconcentrate chromium to a much greater extent, with BCFs ranging from 86 to 192 (ATSDR, 1993).

Dietary intake of chromium by humans has been estimated to range from 5 to 500 μg/day, with a typical value of approximately 100 μg/day (U.S. EPA, 1985).

Other Sources of exposure

Workers in chromium production, stainless steel production and welding, chromium plating, ferrochrome and chromium pigment industries may have occupational exposures to chromium III and chromium VI (ATSDR, 1993). Occupational exposure is mainly by inhalation. Ingestion exposures could occur in industry if industrial hygiene rules are not followed. See ATSDR (1993) for a complete list of industries that may contribute to sources of chromium exposure.

METABOLISM AND PHARMACOKINETICS

Absorption

Approximately 0.5% to 2% of chromium III is absorbed in the gastrointestinal tract of humans (ATSDR, 1993). Chromium VI appears to be better absorbed, however, chromium VI is readily converted to chromium III in the gastric environment (Kerger et al., 1997). The amount of chromium absorbed depends on the amount in the diet. More chromium (approximately 2%) is absorbed when dietary levels are low (approximately 10 µg per day). When dietary levels are higher (40 µg per day or higher) the degree of absorption declines to approximately 0.5% (Anderson, 1986).

Distribution

Studies of the distribution of chromium in human tissues indicate that chromium accumulates mainly in the liver and kidneys after acute exposure (in a 14-year-old boy who ingested 7.5 mg chromium VI/kg body weight) (Kaufman et al., 1970) or chronic exposure, as indicated by autopsy studies performed in the United States on individuals of various ages (Schroeder et al., 1962). The autopsy studies indicate that the levels in the liver and spleen increase up to approximately age 20 years, and decline thereafter. Recent studies in human volunteers (Kerger et al., 1997) show that when chromium VI is administered in drinking water, chromium is taken up and distributed to all parts of the body, and excreted. It cannot be determined from these experiments whether the chromium remains in the hexavalent state or is converted to chromium III.

Studies of mice exposed to chromium in drinking water indicate that whereas chromium III goes primarily to the liver, chromium VI is distributed to all organs, particularly the kidneys and spleen. Accumulation of chromium in the liver was 40 to 90 times higher in the chromium VI treated group, as compared to the chromium III treated group (Maruyama, 1982). After exposure to chromium III, chromium was found in liver, kidney, spleen, hair, heart and red blood cells in rats (Aguilar et al., 1997).

Metabolism

Chromium VI is unstable in the body and is reduced to chromium V, chromium IV, and ultimately to chromium III by many substances including ascorbate and glutathione. Chromium VI readily enters mammalian cells, where it becomes reduced to chromium III by NADPH (Petrilli et al., 1986). It is believed that the toxicity of chromium within the cell results from damage to cellular components during this process through generation of free radicals (ATSDR, 1998). Chromium III forms complexes with a variety of nucleic acids and proteins (ATSDR, 1998). Chromium III is eliminated from the body as a chromium III-glutathione complex (ATSDR, 1998).

A physiologically based model of chromium kinetics in the rat has been developed recently (O'Flaherty, 1996). The model involves parallel absorption and disposition schemes for chromium VI and chromium III, linked by reduction processes occurring throughout the body.

Excretion

Unabsorbed chromium (III and VI) is eliminated in the feces. Chromium VI that is absorbed into the circulation is reduced to chromium III, mainly in the liver. Chromium III forms a complex with glutathione and is then excreted in the urine (ATSDR, 1998).

Physiological/Nutritional Role

Chromium III is an essential nutrient. Chromium III complexes with other components (not completely characterized) to form glucose tolerance factor (GTF). GTF facilitates the binding of insulin to its cell membrane receptor, thereby playing a role in metabolism of glucose, proteins and lipids (ATSDR, 1993). Chromium deficiency can result in high blood glucose levels.

The Committee on Dietary Allowances, Food and Nutrition Board of the National Research Council has recommended a daily intake of 50 to 200 µg/day for adults based on the absence of chromium deficiency signs in the major part of the U.S. population consuming an average of 50 µg chromium/day (NRC, 1989).

TOXICOLOGY

Toxicological Effects in Animals and Plants

Acute Toxicity

Oral LD_{50}s (median lethal doses) have been determined for chromium III compounds in rats. Chromium acetate was reported to have an LD_{50} in rats of 2,365 mg Cr/kg (Smyth et al., 1969). Chromium nitrate had much lower LD_{50}s than chromium acetate, probably because of greater water solubility. The LD_{50}s for chromium nitrate were 183 mg Cr/kg in female rats, and 200 mg Cr/kg in male rats (Vernot et al., 1977). The signs of toxicity in the animals included hypoactivity, lacrimation, and diarrhea (Vernot et al., 1977).

Oral LD_{50}s for chromium VI compounds (sodium chromate, sodium dichromate, potassium dichromate, and ammonium dichromate) ranged from 13 to 19 mg Cr/kg in female rats, and 21 to 28 mg Cr/kg in male rats (Gad et al., 1986).

In general chromium VI salts had greater acute toxicity than Cr III salts, and female rats were slightly more sensitive to both chromium III and chromium VI salts (ATSDR, 1998).

Subchronic Toxicity

Ivankovic and Preussmann (1975) reported a 90-day feeding study in which chromium oxide green (Cr_2O_3) was administered to BD rats in their feed at doses of 2% and 5%. This experiment revealed no toxic effects of the chromium III by the oral route. The experiment was followed by a 2-year feeding study reported in the same paper and discussed below.

Genetic Toxicity

Genotoxicity studies of chromium compounds have been reviewed by Cohen et al. (1993). Chromium VI compounds were found to be mutagenic in both bacterial and mammalian cell assays. In E. coli, base substitution mutations were detected following treatment with potassium chromate, but only at near cytotoxic levels (Cohen et al., 1993). Chromium VI compounds were found to be mutagenic in several *Salmonella typhimurium* strains in the Ames test (Cohen et al., 1993). Chromate primarily caused base substitution mutations in this assay.

Chromium III compounds are not as active as chromium VI compounds in cellular genotoxicity assays because of their poor uptake (Cohen et al., 1993). However, trivalent chromium has been shown to interact with isolated nuclei, chromosomes or nucleic acid in vitro. Under these conditions, chromium III was shown to produce DNA-protein crosslinks, and to modify the fidelity and kinetics of DNA replication. In summary, both chromium VI and chromium III have genotoxic activity, but chromium VI is a more potent genotoxin in whole cells because of its greater ability to enter the cell (Cohen et al, 1993).

Developmental and Reproductive Toxicity

Chromium III was not reported to be fetotoxic or teratogenic in rats. Male and female rats fed 1,806 mg chromium III per kg of body weight for 60 days prior to mating and throughout the gestation period (for females) produced normal healthy offspring (Ivankovic and Preussman, 1975). Chromium III was also found not to cause reproductive effects in rats. Male and female rats fed chromium III as described above had normal fertility, gestational duration and litter size (Ivankovic and Preussmann, 1975).

Mice exposed for seven weeks to 9.1 mg chromium III/kg-day as chromium sulfate in the diet had reduced sperm count and degeneration of the outer cellular layer of the seminiferous tubules. Morphologically altered sperm were observed in mice given diets with 28 mg chromium III/kg-day as chromium sulfate (Zahid et al., 1990; ATSDR, 1998).

Chromium VI however caused severe developmental effects when tested in mice. Pregnant mice were exposed daily to 46 mg chromium VI per kg body weight in drinking water throughout gestation, resulting in increased fetal resorptions and post-implantation loss of fetuses as well as gross abnormalities such as subdermal hemorrhage, decreased cranial ossification and tail deformation. Crown to rump length and fetal weight were also significantly decreased. The incidence and severity of these abnormalities were increased at higher doses. Maternal toxicity, as evidenced by decreased body weight gain, was observed in animals exposed to 98 mg chromium VI per kg body weight or more (Trivedi et al., 1989; ATSDR, 1998). Under the same experimental conditions, chromium VI also caused severe reproductive effects in mice. Pregnant mice exposed as above showed increases in pre- and post-implantation fetal loss, and decreased litter size (Trivedi et al., 1989).

Zahid et al (1990) examined the effects of chromium VI and chromium III in the diet on mouse testes and spermatogenesis. Mice were fed 100, 200 or 400 ppm Cr VI or Cr III in the diet. Degenerated tubules were found at all three dosage levels for both forms of chromium, but not in the controls. Sperm counts were likewise depressed at all three dosage levels for both kinds of chromium, but the effect was greater for Cr VI.

Ingestion in drinking water of trivalent and hexavalent chromium compounds by adult male and female mice caused adverse effects on fertility and reproduction in experiments reported by Elbetieha and Al-Hamood (1996), however these experiments involved very high doses, 2000 to 5000 mg/L, so their relevance to human exposures is limited.

Kanojia et al (1996) found that pregestational exposure of female rats to chromium VI at doses of 250, 500 and 750 ppm as potassium dichromate via drinking water led to embryo- and fetotoxic effects in the form of a significant reduction in the number of implantations and fetuses. There was dose-dependent reduction in fertility in all three dosage groups relative to untreated controls. Skeletal abnormalities (reduced ossification) were also found in the fetuses of chromium VI treated mothers. Reduced parietal and inter-parietal ossification was observed only in the highest dosage group, whereas reduced caudal ossification was observed in all dosage groups.

Immunotoxicity

Daily exposure of rats to 16 mg chromium VI per kg body weight for three weeks led to sensitization of the animals as evidenced by increased proliferation of T and B lymphocytes in response to the mitogens concanavalin A and liposaccharide (Snyder and Valle, 1991; ATSDR, 1998).

Johansson et al. (1987) studied the effect of inhalation by rabbits of trivalent chromium (Cr $(NO_3)_3$) at a concentration in air of 0.6 or 2.3 mg/m^3. They found nodular intra-alveolar accumulation of enlarged macrophages with granular, eosinophilic cytoplasm in the lungs of rabbits exposed to both dosage levels. This study shows that administration to rabbits of trivalent chromium at levels close to the NIOSH occupational threshold limit value results in structural abnormalities in alveolar macrophages. No studies were located on the immunotoxic effects (if any) of orally administered trivalent chromium.

Neurotoxicity

No abnormalities of the brain or nervous system was found during histological examination of rats fed 2,040 mg chromium III/kg/day in the diet for two years (Ivankovic and Preussmann, 1975). Wistar albino rats exposed to 98 mg chromium VI/kg/day in drinking water for 28 days exhibited decreased motor activity and disturbed balance (Diaz-Mayans et al., 1986).

Chronic Toxicity

U.S. EPA based a reference dose (RfD) for chromium VI on a rat drinking water study with a duration of one year (MacKenzie et al., 1958). In this study, groups of eight female Sprague-Dawley rats were given drinking water containing 0-11 mg/L hexavalent chromium as K_2CrO_4 for one year. The control group (ten males and ten females) received distilled water. A second experiment involved three groups of twelve male and three female rats in each group. The first group was given 25 mg/L chromium VI as K_2CrO_4. The second group received 25 mg/L chromium III as chromic chloride. The controls received distilled water. No significant adverse effects were observed in appearance, weight gain, or food consumption. There were no pathologic changes in the blood or other tissues in any treatment group. The rats receiving 25 mg/L chromium VI as K_2CrO_4 exhibited a reduction in drinking water consumption of approximately 20%. This exposure level corresponds to a dose of 2.4 mg/kg-day based on actual body weight and water consumption data from the experiment. This study identified a NOAEL of 2.4 mg/kg-day for chromium VI in rats by ingestion. Overall, there was no effect reported at all dose levels, the highest being 25 mg/L, corresponding to 2.4 mg/kg-day.

Mortality was not increased in rats fed 1,468 mg Cr III/kg per day as chromium oxide in the diet (5% of diet by weight) for 600 days (Ivankovic and Preussmann, 1975; U.S. EPA, 1998). Thus the NOAEL for noncarcinogenic effects of chromium III in rats is 1,468 mg/kg/day determined in this study using a single treatment level.

Carcinogenicity

Chromium VI has been shown to be carcinogenic in animals by inhalation (Cohen et al., 1993; IARC, 1990; U.S. EPA, 1998b). Mice chronically exposed to chromium VI as $CaCrO_4$ dusts or chromic acid mists developed lung adenomas and carcinomas, although the incidences were not statistically significant (Cohen et al., 1993). Weekly intratracheal instillations of Cr VI compounds, in both mice and rats, produced numerous lung tumors (Cohen et al., 1993). In summarizing the available data from all the animal studies performed, the IARC Working Group on the Evaluation of Carcinogenic Risk of Chemicals to Humans concluded that there was sufficient evidence for the carcinogenicity of soluble calcium chromate and several relatively insoluble hexavalent chromium compounds in laboratory rodents (IARC, 1990).

The "preponderance of data" indicates that chromium III does not give rise to tumors by inhalation (Cohen, et al., 1993). With the exception of the Borneff study (discussed below) the animal bioassays for the carcinogenicity of chromium VI and chromium III by the oral route have yielded negative results (Cohen, 1993).

The potential of chromium VI to be carcinogenic by the oral route was studied in mice (Borneff et al, 1968). In this experiment, 2 of 66 female mice exposed to drinking water with 500 mg of potassium chromate (K_2CrO_4) per liter of drinking water were found to have malignant tumors of the forestomach, compared with none in the control mice. This was not a statistically significant result. Although it is not possible to determine from the report whether the two carcinoma-bearing mice also had papillomas, the assumption that they did not would give an incidence of papilloma or carcinoma of 11/66 treated female mice and 2/79 control female mice, which would give statistical significance of $p=0.003$ by the Fisher exact test.

Chromium VI has caused contact site tumors in laboratory animals (Hueper, 1955; Maltoni 1976).

No evidence of carcinogenicity was found in male or female rats fed diets containing chromium III at 1,468 mg/kg/day for 600 days, nor in the offspring of these rats (Ivankovic and Preussmann, 1975).

Toxicological Effects in Humans

Acute Toxicity

All reports of humans acutely poisoned by chromium compounds have involved compounds of chromium VI (ATSDR, 1993). A 14-year old boy died in the hospital eight days after ingesting 7.5 mg CrVI/kg as potassium dichromate. Death resulted from gastrointestinal ulceration and severe damage to the liver and kidneys (Kaufman et al., 1970). Other reports of humans dying from ingestion of chromium VI involved large amounts of the chemical (ATSDR, 1993 and 1998).

Effects on the cardiovascular, respiratory, gastrointestinal, hematological, hepatic and renal systems are observed in humans who die after ingestion of large amounts of chromium VI (ATSDR, 1998). A 22-month-old boy died of cardiopulmonary arrest after ingesting an unknown amount of sodium dichromate (Ellis et al., 1982). In another case report, a 17-year-old male died of cardiac arrest after ingesting potassium dichromate at 29 mg chromium VI/kg (Clochesy, 1984).

Chronic Toxicity

Ingestion by humans of chromium VI in drinking water or diet has been shown to have chronic effects as described below.

Hematological Effects

A village in the People's Republic of China had a drinking water well contaminated from a nearby alloy plant with 20 mg CrVI/L. A cross sectional study of people living in this village revealed that they suffered from leukocytosis and immature neutrophils (Zhang and Li, 1987). The alloy plant began operation in 1961, and the study was conducted in 1965. It was not clear whether the drinking water was free of chromium contamination before the plant began to operate. Similar results were reported by Zhang and Li (1987) from other villages in China.

Hepatic Effects

No reports were found of humans suffering hepatic effects as a result of chronic ingestion of chromium VI or chromium III.

Renal Effects

No reports were found of humans suffering renal effects as a result of chronic ingestion of chromium VI or chromium III.

Gastrointestinal Toxicity

Cross sectional epidemiological studies have been conducted on villagers in China who consumed water from wells contaminated with chromium VI (Zhang and Li, 1987). Drinking water from one of these wells contained 20 mg chromium VI/L. The villagers who drank this water experienced oral ulcer, diarrhea, abdominal pain, indigestion and vomiting. The dose was estimated to be 0.57 mg chromium VI/kg/day (Zhang and Li, 1987).

Developmental and Reproductive Toxicity

No studies in humans of developmental or reproductive effects caused by ingested chromium were found in reviews of past literature (ATSDR, 1993 and 1998) or in a computer search of current literature. Chromium is not listed under Proposition 65 (The California Safe Drinking Water and Toxic Enforcement Act of 1986) as a chemical known to the State to cause reproductive or developmental harm.

Immunotoxicity

Chronic dermal exposure to chromium VI in workers has led to contact dermatitis (ATSDR, 1998). This dermatitis is exacerbated by oral administration of 0.04 mg chromium VI/kg as potassium dichromate (Goitre et al., 1982).

Neurotoxicity

Autopsy of a 14-year old boy who had ingested 7.5 mg CrVI/kg revealed enlarged brain and cerebral edema. However, this effect may be secondary to kidney failure rather than a direct effect on the nervous system (Kaufman et al., 1970). No other reports of the effects of chromium on the nervous system in humans were located.

Carcinogenicity

Occupational exposures to chromium VI in the dichromate production industry over a period from the 1930s to the 1980s has been shown in numerous epidemiological studies to be correlated with increased risk of respiratory cancers (cancers of the lungs and respiratory tract)(ATSDR, 1998). Because of this positive evidence in humans, it has been concluded that chromium VI is a known human carcinogen by the inhalation route (IARC, 1990; ATSDR, 1998; U.S. EPA, 1998; NTP, 1998).

Although chromium VI is carcinogenic to humans by inhalation, some reviewers have concluded that it is unlikely to be carcinogenic to humans by the oral route (Cohen, 1993). A study of chrome workers, exposed to chromium VI by inhalation, found an elevated mortality due to stomach cancers and liver cancers, but no relationship was found between duration of employment in this industry and risk of death from these two cancers. There have been a number of other studies of gastrointestinal tumors in chrome industry workers. These have been reviewed by Cohen et al. (1993).

Zhang and Li (1997) reported a study of approximately 10,000 villagers exposed to drinking water with chromium VI levels as high as 20 mg/L. Cancer death rates for these villagers who lived along a chromium-contaminated river, were compared with villagers from two other provinces that had no detectable chromium VI in their drinking water. The authors did not report on exposures to other potential carcinogens in either the "exposed" or "control" areas. The period between the beginning of the exposures (1965) and the end of the period when cancer mortalities were studied (1970 to 1978) was only 13 years. This may not be long enough for cancers to develop. There was no statistical increase in cancer mortality in the three most-exposed villages, as compared to the control provinces (Zhang and Li, 1997).

Because of this epidemiological evidence, and because chromium VI is converted to chromium III in the gastric environment, some reviewers doubt that chromium VI would be carcinogenic by the oral route (Cohen et al., 1993). The reduction of chromium VI to chromium III in the gastric environment would not preclude the possibility that chromium VI could produce tumors in the stomach.

Others have argued strongly that chromium VI should be regarded as carcinogenic by the oral route. Costa (1997) reviewed evidence that supports the conclusion that hexavalent chromium is taken up by the GI tract and transported to all tissues of the body. He also reviewed epidemiological evidence that exposure to hexavalent chromium causes increased risk of cancer in bone, prostate, stomach and other organs.

OEHHA reviewed the evidence, and decided that chromium VI should be assumed to be carcinogenic by the oral route (OEHHA, 1991; Siegel, 1990; Siegel, 1991). The arguments supporting this position are as follows.

- Chromium is a known human carcinogen by the inhalation route.
- Non-respiratory cancers have been found in workers exposed to chromium VI by inhalation.
- Inhaled chromium VI causes respiratory tumors in rats.
- Chromium VI causes contact site tumors in laboratory animals.
- Ingested chromium VI has been associated with stomach tumors in mice.
- Chromium VI has been positive in a number of assays for genotoxicity.

For the protection of public health, it is safer to assume that a substance which is carcinogenic by one route may also be carcinogenic by other routes. This is the assumption OEHHA will make in evaluating chromium VI for a PHG determination.

There is no evidence that chromium III is a human carcinogen by the oral route (Cohen et al., 1993; ATSDR, 1998; IARC, 1998; U.S. EPA, 1998).

DOSE-RESPONSE ASSESSMENT

Noncarcinogenic Effects

The only study on which an assessment of the noncarcinogenic toxicity of chromium VI in drinking water may be based is the chronic drinking water study in rats reported by MacKenzie et al. (1958). This study was used by the U.S. EPA in calculating the RfD for chromium VI (U.S. EPA, 1996). It is the only chronic oral study in animals that was located. No other study was located in a computer search of the recent literature. This study yielded a NOAEL for chromium VI of 2.4 mg/kg-day.

For chromium III the best study is that of Ivankovic and Preussmann (1975). This is a two-year rat feeding study that yields a NOAEL of 1,468 mg/kg-day. No better study was located in a computer search of the literature.

Carcinogenic Effects

The cancer potency value for chromium VI by ingestion in humans will be calculated from the mouse drinking water study by Borneff et al. (1968). In this study there was only one exposure level, which was 500 mg potassium chromate/L. Stomach tumors were observed in both control and treated mice, but the frequency was increased in the female mice treated with potassium chromate. The tumor frequency increased from 2/79 in the female control group, to 11/66 in the female treated group. Of the 11 tumors in the female treated group, two were malignant carcinomas, and the remainder were benign papillomas with hyperkeratosis. All of the tumors in the control group were benign. These data from the female mice were used to calculate a cancer potency for chromium VI using ToxRisk. The q_1* calculated in this way was 0.21 (mg/kg-day)$^{-1}$. The cancer slope factor (based on the LED_{10}) calculated from the same data was 0.19 (mg/kg-day)$^{-1}$, almost the same. The cancer slope factor will be used to calculate a PHG for chromium VI in drinking water.

Chromium III has not been shown to be a carcinogen by the oral route (ATSDR, 1998).

CALCULATION OF PHG

Calculations of concentrations of chemical contaminants in drinking water associated with negligible risks for carcinogens or noncarcinogens must take into account the toxicity of the chemical itself, as well as the potential exposure of individuals using the water. Tap water is used directly as drinking water, for preparing foods and beverages. It is also used and for bathing or showering, and in washing, flushing toilets and other household uses resulting in potential dermal and inhalation exposures.

Noncarcinogenic Effects

Calculation of a public health-protective concentration (C, in mg/L) for ***chromium VI*** in drinking water for noncarcinogenic endpoints follows the general equation:

$$C = \frac{NOAEL \times BW \times RSC}{UF \times L/day}$$

where,

NOAEL	=	No-observed-adverse-effect-level
BW	=	Adult body weight (a default of 70 kg for male or 60 kg for female)
RSC	=	Relative source contribution (a default of 20% to 80%)
UF	=	Uncertainty factors (typical defaults of a 10 to account for inter-species extrapolation, a 10 for uncertainty from the subchronic nature of the principal study and a 10 for potentially sensitive human subpopulations)
L/day	=	Adult daily water consumption rate (a default of 2 L/day)

The NOAEL for chromium VI is 2.4 mg/kg/day from the MacKenzie et al. study (1958) discussed above. This was a chronic drinking water study in rats. No significant adverse effects were observed at all dosage levels up to 2.4 mg/kg-day, so a NOAEL but no LOAEL was derived from this study. The total uncertainty factors will be 500, based on a factor of 10 for extrapolating between species, and 10 to protect potentially sensitive human subpopulations, and 5 to compensate for the fact that the duration of the study was less than a full lifetime (one year rather than two years). An uncertainty factor of 10 is sometimes used to correct for the use of a short-term study. In this case the study lasted for half a lifetime, so a smaller factor of 5 was employed. U.S. EPA also used a factor of 5 for this purpose in calculating a RfD of for chromium VI (U.S. EPA, 1998).

Food is a significant source of human exposure to chromium (see above under "Environmental Occurrence and Human Exposure"). According to U.S. EPA (1985), a typical value for chromium exposure from food is approximately 100 μg/day. The mean and median levels of chromium in California drinking water sources are about 20 μg/L of total chromium (Storm, 1994). Neither source of chromium has been analyzed for hexavalent chromium, so we assume that the ratio of chromium VI to total chromium is the same in both sources. This would suggest a relative source contribution of 40%, based on two liters per day water consumption. OEHHA will use a relative source contribution of 40% based on the above considerations.

The calculation for chromium VI is as shown below:

$$C = \frac{2.4 \text{ mg/kg/day} \times 70 \text{ kg} \times 0.4}{500 \times 2 \text{ L/day}} = 0.067 \text{ mg/L}$$

The value of 0.067 mg/L is rounded off to 0.07 mg/L, or 70 ppb.

In the case of ***chromium III***, the NOAEL is 1,468 mg/kg-day, based on a rat chronic, two-year feeding study (Ivankovic and Preussmann, 1975) where no effect was observed following treatment at a single dose level. An uncertainty factor of 100 will be used for extrapolating from animals to humans, and the account for variability in sensitivity within the human species.

The calculation for chromium III is as follows:

$$C = \frac{1{,}468 \text{ mg/kg/day} \times 70 \text{ kg} \times 0.4}{100 \times 2 \text{ L/day}} = 205 \text{ mg/L}$$

The value of 205 mg/L is rounded off to 200 mg/L, or 200,000 ppb.

Carcinogenic Effects

The human cancer slope factor derived from the Borneff et al. (1968) study can be used to calculate a potential PHG for chromium VI, based on carcinogenicity. The cancer slope factor OEHHA will use is 0.19 $(\text{mg/kg-day})^{-1}$, based on total tumors (malignant and benign) in female mice. This is the cancer slope factor we calculated using ToxRisk.

$$C = \frac{\text{b.w.} \times R}{\text{CSF} \times 2 \text{ L/day}}$$

$$C = \frac{70 \text{ kg} \times 1\times10^{-6}}{[0.19 \text{ (mg/kg-day)}^{-1}]\times 2 \text{ L/day}} = 1.8\times10^{-4} \text{ mg/L} = 0.18 \text{ µg/L or } 0.18 \text{ ppb}$$

This can be rounded off to 0.2 ppb. This is much lower than the 70 ppb calculated for chromium VI based on noncarcinogenic effects.

PHG for Total Chromium

To calculate a PHG for total chromium, we must estimate the percentage of chromium VI in total chromium. The study by Kaczynski and Kieber (1993) described above in the section on "Environmental Occurrence and Human Exposure" provides the only available data on speciation of chromium in potential drinking water sources. Using the geometric mean from these two lakes, the percentage of total chromium that is present as chromium VI is 7.2%. We can use this estimate of chromium VI in total drinking water chromium to calculate a PHG for total chromium based on the C value for chromium VI calculated above in the "Carcinogenic Effects" section.

PHG Total Chromium = (C value for Cr VI) ÷ (percentage of total Cr as Cr VI)

= 0.18 µg/L ÷ 0.072 = 2.5 µg/L or 2.5 ppb.

OEHHA therefore has developed a Public Health Goal (PHG) for total chromium of 2.5 ppb.

RISK CHARACTERIZATION

The PHG for total chromium in drinking water is based on the assumed oral carcinogenicity of chromium VI. The percentage of chromium VI in total chromium in drinking water sources was estimated based on available data from the research literature. The available data are limited to two lakes in North Carolina (Kaczynski and Kieber, 1993). This is one source of uncertainty in this PHG calculation. In the future if better data are made available, particularly for California drinking water sources, this source of uncertainty can be lessened.

There is some controversy as to whether chromium VI should be considered a carcinogen by the oral route (ATSDR, 1993). In 1990, the Standards and Criteria Work Group (SCWG) of OEHHA reviewed the evidence, and determined it would be prudent to assume that chromium VI is a carcinogen by the oral route (Siegel, 1990). This decision was made based on the fact that chromium VI is carcinogenic by inhalation, and it is prudent policy to consider a carcinogen by one route to be a carcinogen by other routes as well. It was also based on the genotoxicity of chromium VI in bacterial and mammalian cell assays. However, no positive studies have been located linking chromium in drinking water with increased incidence of cancer in human populations (Cohen et al., 1993; ATSDR, 1993). The mouse study by Borneff et al. (1968) on which this PHG is based, found no statistically significant increase in malignant tumors in the treated mice. It was only when benign stomach tumors were included along with malignant tumors that the results became statistically significant (Borneff et al. 1968; Siegel, 1990). In developing a PHG based on carcinogenicity, OEHHA is continuing to assume that chromium VI is a carcinogen by the oral route, while acknowledging the uncertainty surrounding this issue.

The health protective level for chromium III is based on a rodent experiment, with extrapolation from animals to humans. There is always uncertainty in extrapolating from animals to humans, which is the reason for one of the uncertainty factors used in this calculation -- an uncertainty factor of 10. An additional factor of 10 (making a total UF of 100) was used to account for uncertainty about the variability in sensitivity of the human population.

Another source of uncertainty is the relative source contribution used in calculating the health protective level for chromium III. OEHHA has used a relative source contribution of 40%. OEHHA does not have exact data on which to base the relative source contribution for chromium III, so this is an estimate. In the future, if better data become available, a new relative source contribution can be calculated.

Chromium III is a nutritionally required element. The health protective level of 200 mg/L is much higher than the adult nutritional requirement of 50 to 200 µg/day (ATSDR, 1993). There is no concern that the health protective level for chromium III will interfere with the nutritional requirement. The PHG for total chromium would allow approximately 5 µg/day chromium intake. Most drinking water sources contain no detectable chromium, so nutritional requirements can be expected to be met by the food source of chromium.

OTHER REGULATORY STANDARDS

The U.S. EPA MCLG for total chromium is 0.1 mg/L. The U.S. EPA MCL is also 0.1 mg/L. There are no separate standards for chromium III and chromium VI. The U.S. EPA also has 1 day and 10 day health advisories of 1 mg/L for total chromium for children, and a "longer-term" health advisory for children of 0.2 mg/L. For adults the "longer-term" health advisory is 0.8 mg/L for total chromium. The reference dose (RfD) for adults is 0.005 mg/L (U.S. EPA, 1996).

The California MCL for total chromium is 0.05 mg/L (22 CCR, section 64431, Table 64431-A-Inorganic Chemicals).

REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR) (1993). *Toxicological profile for chromium.* U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR) (1998). *Toxicological profile for chromium (update).* U.S. Department of Health and Human Services. Public Health Service.

Aguilar, V, Martinez-Para, C, Gonzalez, J (1997). Effects of arsenic(V)-chromium(III) interaction on plasma glucose and chlolesterol levels in growing rats. *Ann. Nutr. Metab.* **41**, 189-195.

Anderson, RA (1986). Chromium metabolism and its role in disease processes in man. *Clin. Physiol. Biochem.* **4**, 31-41.

Borneff, I, Engelhardt, K, Griem, W, et al. (1968). [Carcinogenic substances in water and soil. XXII. Mouse drinking study with 3,4-benzpyrene and potassium chromate]. *Arch. Hyg.* **152**, 45-53. (German).

California Department of health Services (1997). Drinking Water Quality Monitoring Data 1984-1996. Annual Status Report. November 1997.

Cohen, MD, Kargacin, B, Klein, CB, Costa, M (1993). Mechanisms of chromium carcinogenicity and toxicity. *Critical Reviews in Toxicology* **23**, 255-281.

Costa, M (1997). Toxicity and carcinogenicity of Cr(VI) in animal models and humans. *Critical Reviews in Toxicology* **27**, 431-442.

Clifford, D, Man Chau, J (1988). The fate of chromium III in chlorinated water. U.S. EPA, EPA/600/S2-87/100.

Clochesy, JM (1984). Chromium ingestion: a case report. *J. Emerg. Nursing* **10**, 281-282.

Diaz-Mayans, J, Laborda, R, Nunez, A (1986). Hexavalent chromium effects on motor activity and some metabolic aspects of Wistar albino rats. *Comp. Biochem. Physiol.* **83C**, 191-195.

Elbetieha, A, Al-Hamood, MH (1997). Long-term exposure of male and female mice to trivalent and hexavalent chromium compounds: effect on fertility. *Toxicology* **116**, 39-47.

Ellis, EN, Brouhard, BH, Lynch, RE, Dawson, EB, Tisdell, R, Nichols, MM, Ramirez, F. (1982). Effect of haemodialsysis and dimercaprol in acute dichromate poisoning. *J. Toxicol. Clin. Toxicol.* **19**, 249-258.

Gad, SC, Powers, WJ, Dunn, BJ, et al. (1986). Acute toxicity of four chromate salts. In: Serrone, DM, ed. Chromium Symposium 1986: An Update. Pittsburgh, PA: Industrial Health Foundation Inc., pp. 43-58.

Goitre, M, Bedello, PG, Cane, D (1982). Chromium dermatitis and oral administration of the metal. *Contact Dermatitis* **8**, 208-209.

Hodgman, CD, Weast, RC, Shankland, RS, Selby, SM (1961). Handbook of Chemistry and Physics, 43rd Edition. Chemical Rubber Publishing Company, Cleveland.

Hueper, WC (1955). Experimental studies in metal carcinogenesis. VII. Tissue reactions to parenterally introduced powered metallic chromium and chromite ore. *J. National Cancer Institute* **16**, 447-462.

IARC (1990). *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans; Chromium, Nickel, and Welding,* Vol. 49, International Agency for Research on Cancer, World Health Organization, Lyon, France.

Ivankovic, S, Preussmann, R (1975). Absence of toxic and carcinogenic effects after administration of high doses of chromic oxide pigment in subacute and long-term feeding experiments in rats. *Food Cosmet. Toxicol.* **13**, 347-351.

Johansson, A, Robertson, B, Curstedt, T, Camner, P (1987). Alveolar macrophage abnormalities in rabbits exposed to low concentrations of trivalent chromium. *Environmental Research* **44**, 279-293.

Kaczynski, SE, Kieber, RJ (1993). Aqueous trivalent chromium photoproduction in natural waters. Environ. Sci. Technol. **27**, 1572-1576.

Kanojia, RK, Junaid, M, Murthy, RC (1996). Chromium induced teratogenicity in female rat. *Toxicology Letters* **89**, 207-213.

Kaufman, DB, DiNicola, W, McIntosh, R (1970). Acute potassium dichromate poisoning: treated by peritoneal dialysis. *Am. J. Dis. Child.* **119**, 374-376.

Kerger, BD, Finley, BL, Corbett, GE, Dodge, DG, Paustenbach, DJ (1997). Ingestion of chromium (VI) in drinking water by human volunteers: absorption, distribution, and excretion of single and repeated doses. *J. Toxicol. Environ. Health* **50**, 67-95.

MacKenzie, RD, Byerrum, RU, Decker, CF, Hoppert, CA, Langham, RF (1958). Chronic toxicity studies, II. Hexavalent and trivalent chromium administered in drinking water to rats. *Am. Med. Assoc. Arch. Ind. Health* **18**, 232-234.

Maltoni, C (1976). Predictive value of carcinogenesis bioassays. *Ann. Science* **271**, 431-443.

Maruyama, J (1982). The health effect of mice given oral administration of trivalent and hexavalent chromium over long-term. *Acta Scholae Medicinalis Universitatis in Gifu* **31**, 24-46.

NRC (1989). Recommended Dietary Allowances, 10th Ed. National Research Council, National Academy of Sciences, Washington, DC.

OEHHA (1991). Carcinogenicity of chromium VI via ingestion. Memo from Richard J. Jackson to Steven A. Book. June 11, 1991.

O'Flaherty, EJ (1996). A physiologically based model of chromium kinetics in the rat. *Toxicol. Appl. Pharmacol.* **138**, 54-64.

Petrilli, SL, Romano, M, Bennicelli, G, DeFlora, A, Serra , D, DeFlora, F (1986). Metabolic reduction and detoxification of hexavalent chromium. In: Serrone, DM (Ed.). *Chromium Symposium 1986: An Update*. Industrial Health Foundation, Pittsburgh, pp 112-130.

Schroeder, HA, Balassa, JJ, Tipton, IH (1962). Abnormal trace metals in man -- chromium. *J. Chron. Dis.* **15**, 941-964.

Siegel, DM (1990) Carcinogenicity of chromium via ingestion. Memo to Standards/Criteria Workgroup members, dated August 7, 1990.

Siegel, DM (1991) Carcinogenicity of chromium via ingestion. Memo to Standards/Criteria Workgroup members, dated May 30, 1991.

Smyth, HF, Carpenter, CP, Weil, CS, Pozzani, UC, Striegel, JA, Nycum, JS (1969). Range finding toxicity data: List VII. *Am. Ind. Hyg. Assoc. J.* **30**, 470-476.

Snyder, CA, Valle, CD (1991). Immune function assays as indicators of chromate exposure. *Environ. Health Perspect.* **92**, 83-86.

Storm, DL (1994). Chemical monitoring of California's public drinking water sources: public exposures and health impacts. In: Wang, RGM, ed. Water Contamination and Health. New York, NY: Marcel Dekker, Inc. pp 67-124.

Trivedi, B, Saxena, DK, Murthy, RC, Chandra, SV (1989). Embryotoxicity and fetotoxicity of orally administered hexavalent chromium in mice. *Reproductive Toxicology* **3**, 275-278.

U.S. EPA (1985). Proposed rules. Federal Register 50, No. 219, Wednesday, November 13, 1985, pp 46966-46967.

U.S. EPA (1996). Drinking water regulations and health advisories. EPA 822-R-96-001 (February, 1996). U.S EPA, Office of Water.

U.S. EPA (1998a). Chromium III. Integrated Risk Information System (IRIS). (http//www.epa.gov/iris).

U.S. EPA (1998b). Chromium VI. Integrated Risk Information System (IRIS). (http//www.epa.gov/iris).

Vernot, EH, MacEwen, JD, Haun, CC, Kincaid, ER (1977). Acute toxicity and skin corrosion data for some organic and inorganic compounds and aqueous solutions. *Toxicol. Appl. Pharmacol.* **42**, 417-423.

Weast, RC, Astle, MJ, Beyer, WH, eds. (1988). CRC Handbook of Chemistry and Physics, 69th Edition (1988-1989). Chemical Rubber Company, Boca Raton.

Zahid, ZR, Al-Hakkak, ZS, Kadhim, AH, Elias, EA, Al-Jumaily, IS (1990). Comparative effects of trivalent and hexavalent chromium on spermatogenesis of the mouse. *Toxicological and Environmental Chemistry* **25**, 131-136.

Zhang, J, Li, X (1987). Chromium pollution of soil and water in Jinzhou. *Journal of Chinese Preventive Medicine* **21**, 262-264.

Zhang, J, Li, X (1997). Cancer mortality in a Chinese population exposed to hexavalent chromium in water. *J. Occup. Environ. Med.* **39**, 315-319.

Joint Hearing of the Senate Committee on Health and Human Services, Senate Committee on Natural Resources and Wildlife, and Assembly Committee on Environmental Safety and Toxic Materials

Health Effects of Chromium VI Contamination of Drinking Water

John R. Froines, Ph.D.
Professor of Toxicology
UCLA School of Public Health

My name is John R. Froines. I am Professor of Toxicology in the UCLA School of Public Health. At UCLA I direct the Center for Occupational and Environmental Health; I also direct the Southern California Particle Center and Supersite, which is one of the largest research centers on air pollution in the U.S. I serve on the Board of Scientific Counselors of the National Toxicology Program and within the Board, the Subcommittee on Report on Carcinogens. I chair the Scientific Review Panel of the Air Resources Board under AB 1807 and serve on the Carcinogen Identification Committee under Proposition 65. My research focuses on three scientific areas: mechanisms of health effects derived from exposure to toxic air contaminants and particulate matter, the mechanism of the carcinogenicity and toxicity of arsenic, and other metals including chromium, lead and beryllium and exposure assessment to toxic substances including pesticides.

In my testimony today I want to focus on 5 issues:

1. **Is chromium VI (Cr VI) a carcinogen via inhalation?**
2. **What is the evidence for Cr VI being a carcinogen via the oral route?**
3. **What are some of the scientific issues associated with Cr VI carcinogenesis via the oral route?**
4. **What are the implications of the evidence of Cr VI carcinogenicity for risk assessment?**
5. **How should California address Cr VI contamination?**

<u>1. Is Cr VI a carcinogen via inhalation?</u>

It has been 80 years since it was first reported that workers in the German chrome ore industry developed lung cancer with greater frequency than the general population. Multiple studies since the 1920s have demonstrated that chromium workers have higher rates of lung and nasal cancer. Cr VI has been identified as a human carcinogen by the International Agency for Research on Cancer (IARC) based on sufficient evidence in humans and animals. Cr VI has been identified as a

human carcinogen by the National Toxicology Program, and the Department of Health and Human Services has determined Cr VI is a known carcinogen. The U.S. EPA lists Cr VI as a Group A carcinogen, and it has been identified as a toxic air contaminant under AB 1807 based on evidence of lung cancer in humans.

2. What is the evidence for Cr VI being a carcinogen via the oral route?

Dr. Alexeef has discussed some of the evidence for Cr VI carcinogenicity via the oral route including the animal study upon which the Public Health Goal (PHG) was based. In my testimony I want to report on the findings of one of a series of studies conducted in my laboratory over the past 6 years.

We have been interested in the potential adverse health problems associated with the use of Cr VI spray paints. Cr VI spray paints and primers have been used for a considerable period of time because of their strong corrosion resistance properties. They are widely used in the aerospace industry; every commercial and military aircraft is painted with Cr VI primer. We have conducted a lengthy study to determine the size distribution of Cr VI aerosol in spray paints to determine where the spray paint particles would deposit in the lung. Most of the Cr VI from spray painting deposits in the nasal region and upper airways and is therefore cleared from the lung via mucociliary clearance and swallowed. This raised the question of whether the swallowed Cr VI from spray painting could constitute a risk of gastrointestinal (GI) cancer or pass through the stomach to the systemic circulation and represent an internal organ cancer risk. In general, exposure to chromium in the form of mechanically generated dust results in substantial amounts being deposited in the head-airway region with subsequent mucociliary clearing and swallowing. This could lead to chromium deposition in the GI tract prior to absorption or reduction.

We have focused our attention on GI tract cancer. We have conducted a "meta analysis" based on studies in the literature to determine if there is excess risk of GI tract cancer as identified in previous studies.

A systematic search was performed from July to December 1998, to identify epidemiological studies published in peer review journals using the key words "cancer, carcinogenesis" and "Chromium exposure". This search resulted in a total 59 articles with information about gastric and or digestive, cancers for evaluation.

Of the 59 identified studies, 37 did not meet the requisite criteria for inclusion. Twenty-two studies fulfilled all the requirements and their study specific data were included in the meta-analysis.

Of the 22 studies, 15 showed an increased risk of GI tract cancer of which 7 were significant. The pooled Standard Mortality Ratio was 1.45 with a 95% confidence interval of 1.27 to 1.63. This suggests a 45% increase in risk of GI tract cancer at the concentrations of Cr VI found in the studies.

In conclusion, while we recognized there is significant heterogeneity in the results there is also evidence to indicate exposure to chromium may lead to an increase in the risk of gastric cancer.

Further toxicology and epidemiologic research is required to further clarify the potential risk associated with chromium and the GI track.

3. What are some of the issues associated with Cr VI carcinogenesis via the oral route?

It has been suggested there will be little to no risk of GI tract cancer or systemic uptake of Cr VI because in the acidic environment of the gut Cr VI will be reduced to chromium III which is less toxic than its counterpart. It is true that reduction does occur, and when Cr VI is taken in the prescence of ascorbic acid (vitamin C) the reduction appears relatively complete. However, there is evidence that under normal conditions the reduction of Cr VI to III is not complete and some material is available for cellular uptake and passage into the systemic circulation.

If two biological processes occur simultaneously with one another in the GI tract, such as the reduction of Cr VI to Cr III, a less toxic material and the absorption of Cr VI into GI tract cells or passage into the systemic circulation, then there will be a competition between the two processes. Unless the rate of one process is zero or the other is infinitely rapid then then both processes will occur and the degree of each will depend on their relative rate constants. That is, there will be both reduction and uptake of Cr VI and subsequent potential for damage. There will be a competition between reduction and absorption. As long as both of these processes are happening in the same compartment, absorption must get a share, and that share will tend to be constant at the limit of low dosage--below the region of concentration where there are appreciable saturation effects (as concentration gets very large, reduction systems could approach saturation and a relatively larger fraction of the input Cr(VI) would be available for longer times for systemic absorption).

The reduction of Cr VI to III in the gut may reduce the risk of GI cancer or systemic uptake and subsequent risk of internal cancers, but that is a quantitative issue; there is likely a risk of cancer.

Professor Costa of New York University has cited studies that as much as 10% of Cr VI is absorbed following oral exposure to humans and suggests this chromium may remain in the body for a considerable period of time. He also cites evidence for internal cancers associated with exposure to Cr VI. This evidence has been somewhat controversial and one must conclude that the risk of internal cancers has not be proved definitively, but one must also acknowledge the increased risk may exist and act accordingly.

Professor Costa has also demonstrated mutations in chromium crosslinks with glutathione and amino acids to the DNA phosphate backbone. This also has implications for a chromium III dependent pathway in Cr VI carcinogenicity.

<u>4. What are the implications of the evidence of Cr VI carcinogenicity for risk assessment?</u>

Based on animal evidence OEHHA calculated a PHG of 0.2 ppb for Cr VI. That value is based on a protective goal of 1 excess cancer in a million exposed persons. I want to comment on the risk assessment process.

Quantitative risk assessment is an integrative discipline which attempts to achieve a fair synthesis of all available information about the likely magnitude of a hazard.

But risk assessors are well accustomed to presence of imperfections in this information inputs.

Characterization of uncertainty often discloses uncertainties of at least an order of magnitude and frequently two orders of magnitude or more.

The goal of modern quantitative risk assessment is not to arrive at a single precise number, but to allow decision makers to face the possible consequences of a range of "not clearly incorrect" answers and decide on the protective policies that are warranted in the light of the range of possible future outcomes of alternative policies.

The uncertainty for Cr VI via the oral route can range from 0.002 to 20. This means that the standard setting process is less a scientific issue than a policy issue in which the Administration and the Legislature must decide on the level of protection to be afforded the public. The risk could be high or considerably lower and the selection of a standard depends on the level of protection policymakers choose to be acceptable. In evaluating the risk assessment public health protection should be given a high priority, but the ability to move quickly to achieve measureable goals should also be considered relevant.

It would be useful to request OEHHA develop risk numbers based on the human studies in the literature rather than relying on an outdated animal study.

<u>5. How should California address Cr VI contamination?</u>

The history of the Clean Air Act is instructive in the decision-making process for Cr VI in water. There were very few standards adopted for air pollutants from the seventies to the nineties because of the rancorous debates that occurred over the scientific evidence for health effects. I am concerned that if we debate the risk assessment values and a standard over a considerable period of time that we will not make much progress protecting the public health. It could take years before a

standard is finally adopted. I think a State guideline for cleanup and control purposes should be established which does not require going through lengthy standard setting procedures. This guideline would be used to address the problem of chromium contamination over the next few years, while an MCL is being established. This value should be public health protective. This guideline would not be used for enforcement purposes but would serve as a basis for all ameliorating efforts over a 3-5 year period.

In addition to the establishment of a guideline, which could be based on the PHG for Cr VI, the following approachs should be undertaken. I propose the following:

With the assistance of engineers, hydrogeologists and other qualified personnel we determine 1) what is the scope of the contamination throughout the State as soon as possible; 2) does the contamination derive from current uses of chromium or is the contamination the result of previous more poorly controlled uses, that is, we need to define as quickly as practicable what is the nature and scope of the problem (it is apparent that some Cr VI derives from oxidation of Cr III in chlorinated water and therefore it is important to differentiate differ sources of contamination); 3) identify the best technology for ameliorating the contamination as soon as feasible and implement that existing technology; 4) continue to assess the degree of Cr VI in the environment, particularly water sources; 5) develop residual risk assessments based on post implementation of the best existing technology; 6) implement improved technology over time to reduce Cr VI levels to maximize public health protection.

This approach would result in reduced exposure to Cr VI in a relatively short period of time and would provide important protection of the public health. Additional improvements could be developed over time as the technology develops to further limit exposure.

Finally, it is unlikely that major epidemiological (human) studies could be conducted in a timely manner to provide further insights on the oral intake issue. The levels of Cr VI in water are already relatively low thus making human studies difficult because of statistical limitations. Additional studies to examine the bioavailability of Cr VI via the systemic circulation would be relevant as well as further work on the relative rates of uptake versus reduction of Cr VI.

The key question is not standard setting; it is the determination of the level of protection to be afforded the public and to determine both the scope and origin of the current problem and followed by implementation of appropriate controls and cleanup that can be achieved on a short-term basis.

Materials Prepared for the Joint Hearing of the Senate Committee on Health and Human Services, Senate Committee on Natural Resources and Wildlife, and Assembly Committee on Environmental Safety and Toxic Materials - October 23, 2000.

Joseph R. Landolph, Ph. D., Associate Professor
Depts. of Microbiology and Immunology, Pathology,
and Molecular Pharmacology and Toxicology
USC/Norris Comprehensive Cancer Center
Keck School of Medicine and School of Pharmacy
University of Southern California

II. Chromium VI and Its Human Health Implications: Research Findings and Unanswered Questions

Summary: Hexavalent chromium, Cr(VI), is a toxic chemical that causes mutation, chromosome breakage, and cancer in animals. Industries manufacturing compounds containing Cr(VI) have increased incidences of nasal and respiratory cancer in workers exposed to Cr(VI)-containing compounds. Hence, compounds containing Cr(VI) are regarded as animal and human carcinogens when administered by the inhalation route. Cr(VI) enters cells on the non-specific anion transport carrier that transports phosphate and sulfate into cells, and all cells possess this transport carrier. All cells are thus potential targets for Cr(VI) carcinogenesis. Consistent with this, weaker data suggests that Cr(VI)-containing compounds may also cause cancer Hodgkins Disease, leukemias, stomach cancer, and renal cancer. Cr(VI) also causes conversion of normal mouse and hamster fibroblasts into tumorigenic cells and causes toxicity and mutation in laboratory cultures of normal human fibroblasts. Based on current data, OEHHA/California E. P. A. estimates that Cr(VI) is 1,000-fold more effective in causing cancer by the inhalation route compared to its far weaker activity in causing cancer by the ingestion (oral) route. New data is needed to carefully measure the cancer risk from ingestion or drinking Cr(VI)-containing compounds. Due to its potential for inducing toxicity and cancer at many sites when ingested or drunk, Cr(VI) levels in the drinking should be carefully regulated.

Background

Chromium is found in natural deposits as ferrous chromite, in the Cr(III) state (1). These deposits are mined, and the chromium becomes economically very useful in the manufacture of various chromate-containing compounds, including those used as paints to inhibit corrosion, in the manufacture of chromate-containing pigments, in electroplating, in tanneries, in the manufacture of steel alloys, in the welding of stainless steel, in the chemical industry, and in many other applications (reviewed in 1).

Many epidemiological studies have consistently shown that exposure of workers to hexavalent chromium, Cr(VI), in chromate production factories, in factories manufacturing chrommate-containing pigments and coatings, and in electroplating operations in many countries has led to increased incidences of respiratory cancer in the workers (1). Weaker evidence suggests cancer of the digestive tract (1). In the ferrochromium industry, it has been shown that workers have an increased incidence of kidney cancers.(1). Current evidence indicates that Cr(VI) is carcinogenic in humans and animals (reviewed in 1). Both insoluble compounds containing Cr(VI) and soluble compounds containing Cr(VI) appear to be carcinogenic (reviewed in 1). Chromium (III)-containing compounds have not been shown to be carcinogenic in animals to date. It is thought that the soluble Cr(III)-containing compounds are not carcinogenic. Further studies need to be conducted on insoluble Cr(III) compounds to determine whether or not they are carcinogenic. Zinc chromate and lead chromate are believed to be carcinogenic in humans exposed to these compounds by the respiratory route (1). In the chromium plating industry, exposure to chromic acid causes ulceration of the skin and nasal areas and allergic contact dermatitis(2).

Various compounds containing Cr(VI) have been found to be carcinogenic when administered to animals by various routes of administration, including intramuscular injection, intrapleural implant, intrabronchial implantation, inhalation, and ingestion (reviewed in 3). The most relevant study to drinking water was a study conducted by Borneff et al, who fed male and female NMRI mice 1 mg of potassium chromate per day in the diet and observed two carcinomas of the stomach in treated females but none in males or in control groups (4). Borneff et al also found benign stomach tumors in females and males above those in the control group, and they found that the incidence of benign plus malignant stomach was statistically significant in the treated females compared to the control group (4). OEHHA and the California Environmental Protection Agency have used this animal carcinogenesis data and extrapolated it to humans to estimate human risk caused by ingestion of Cr(VI). OEHHA/Cal E. P. A. calculated a slope for cancer causation by Cr(VI) by the inhalation route of 510/(mg/kg/day) and a slope for cancer causation by Cr(VI) by ingestion of 0.42/(mg/kg/day). Hence, the slope for cancer by inhalation of Cr(VI) is 510/0.42 or 1,214 times as high as the slope for cancer induction by ingestion of Cr(VI) (3). This may be due to a large ability of gastric tissues to reduce Cr(VI) to Cr(III) outside the cell, rendering it less toxic and carcinogenic in the gastric system compared to the lung and nasal sinuses (5).

Recent review articles indicate that Cr(VI) may pose a toxic and carcinogenic risk to many other tissues and organs in addtion to the lung and nasal sinuses. Cr(VI) enters red blood cells and is reduced to Cr(III), fixing it inside red blood cells (6). Chromate resembles sulfate and phosphate, and it is therefore taken into cells on the non-specific sulfate/phosphate anion transport carrier (7). Since all cells require sulfate and phosphate and hence have this transporter, chromium can potentially enter every cell at high enough concentrations and cause cytotoxicity and conversion of cells into tumor cells.

In mouse fibroblastic (connective tissue) cells in culture, our laboratory has shown that calcium chromate, potassium dichromate, and lead chromate kill the cells, and lead chromate induces conversion of the cells into a new state of altered morphology and converts them into tumor cells (8). In cultured human fibroblasts, we showed that various compounds containing Cr(VI), including lead chromate, potassium dichromate, calcium dichromate, calcium dichromate, kill human fibroblasts and induce mutagenesis in the cells. Compounds containing Cr(VI) were approximately 1,000-fold more cytotoxic to the cells than compounds containing Cr(III) based on the concentration at which the compounds kiled the cells. Soluble sodium chromate containing Cr(VI) was facilely taken up into the cells, but soluble chromium chloride containing Cr(III) was not appreciably taken up into human fibroblasts (9, 10).

There is developing an increasing concern that cancers at sites other than lung may also occur. Epidemiological studies have provided suggestive evidence that Cr(VI) may cause increased incidences of Hodgkins disease, leukemia, stomach cancer, and renal cancer (11). The recognition that Cr(VI) may penetrate to many cells in the body and be taken up into almost any cell on the relatively non-specific anion transport carrier for phosphate and sulfate suggests that may different organs may be targets for toxicity and carcinogenesis induced by Cr(VI) (reviewed in 11).

References

1. Langard, S. One Hundred Years of Chromium and Cancer: A Review of Epidemiological Evidence and Selected Case Reports. American Journal of Industrial Medicine, 17: 189-215, 1990.

2. Royle, H. Toxicity of Chromic Acid in the Chromium Plating Industry. Environmental Research, 10: 141-163, 1975.

3. Air Toxics Hot Spots Program Risk Assessment Guidelines. Part II. Technical Support Document for Describing Available Cancer Potency Factors. April, 1999. Secretary for Environmental Protection, California Environmental Protection Agency, Winston H. Hickox and Director of the Office for Environmental Health Hazard Assessment, Joan E. Denton, Ph. D.

4. Borneff, K., Engelhardt, W. Griem, H., Kunte, H., and Reichert, J. Kanzerogene Substanzen in Wasser und Boden. Arch. Hyg. 152 68, 45-53, 1968.

5. DeFlora, S., Camoirano, A., Bagnasco, M., Bennicelli, C., Corbett, G E., and Kerger, B. D. Estimates of the Chromium (VI) Reducing Capacity in Human Body Compartments as a Mechanism for Attenuating Its Potential Toxicity and Carcinogenicity. Carcinogenesis, Vol. 18, 531-537, 1997.

6. Miksche, L. W., Lewalter, J. Biological Monitoring of Exposure to Hexavalent Chromium in Isolated Erythrocytes. Biomarkers and Occupational Health: Progress and Perspectives, 313-323, 1995.

7. Markovich, D., and James, K. M. Heavy Metals Mercury, Cadmium, and Chromium Inhibit the Activity of the Mammalian Liver and Kidney Sulfate Transporter sat-1. Toxicology and Applied Pharmacology, 154: 181-187, 1999.

8. Patierno, S. R., Banh, D., and Landolph, J. R. Transformation of C3H/10T1/2 Mouse Embryo Cells to Focus Formation and Anchorage Independence by Insoluble Lead Chromate But Not Soluble Calcium Chromate: Relationship to Mutagenesis and Internalization of Lead Chromate Particles. Cancer Research, 48: 5280-5288, 1988.

9. Biedermann, K. A., and Landolph, J. R. Induction of Anchorage Independence in Human Diploid Foreskin Fibroblasts by Carcinogenic Metal Salts. Cancer Research, 47: 3815-3823, 1987

10. Biedermann, K. A. , and Landoph, J. R. Role of Valence State and Solubility of Chromium Compounds on Induction of Cyktotoxicity, Mutagenesis, and Anchorage Independence in Diploid Human Fibroblasts. Cancer Reseach, 50: 7835-7842, 1990.

11. Costa, M. Toxicity and Carcinogenicity of Cr(VI) in Animal Models and Humans. Critical Reviews in Toxicology, 27(5): 431-442, 1997.

V. Recommendations for Public Policy Options for Chromium VI: Related Contamination Sites and Public Policy Recommdenations for Chromium VI.

Summary: Efforts should be made along six lines to address problems associated with contamination of the drinking water with chromium (VI):

1. New data should be generated on the toxicity and carcinogenicity of chromium (VI) to animals when the Cr(VI) is administered in the drinking water in animal carcinogenicity assays. This data should then be used by OEHHA/Cal. E. P. A. to calculate a more reliable slope factor for cancer induction by the oral route. This slope factor should then be used to calculate a more reliable concentration of Cr(VI) in the water which would yield a cancer risk of one/one million, and this should become the new Public Health Goal.

2. Analysis should be conducted on the data on toxicity anbd cancer induction in humans on the populations that were exposed to Cr(VI) in the drinking water at the Hinckley and Kettleman sites. This analysis should be used if appropriate buy OEHHA/Ca. E. P. A. to derive an updated, accurate slope for cancer induction in humans to help reivse the Public Health Goal for Cr(VI) in water.

3. OEHHA/Califonria E. P. A. should continue their excellent efforts to utilize any new data on the toxicity and carciongenicity of Cr(VI) that arise in the scientific literature to further aid calculation of an updated, accurate cancer slope factor and Public Health Goal for Cr(VI) when administered in the drinking water.

4. Sites containing high levels of Cr(VI)-containing compounds in the air or drinking water should be remediated to prevent contamination of the residents of California with Cr(VI) to the greatest extent practical.

5. Modern technologies, including small home devices, should be utilized to remediate drikning water in areas where the levels of Cr(VI) substantially exceed the Public Health Goal value of 2.5 ppb for total chromium or 0.2 ppb for Cr(VI).

6. Standards for protection of public health should be based on measurements of Cr(VI), rather than measuring total chromium and assuming that 8% of total chromium is Cr(VI), as is currently done. Cr(VI) is the stronger toxic and carcinogenic agent by approximately 1,000-fold compared to Cr(III), and the ratios of Cr(VI) to Cr(III) vary.

Background

Exposures of humans to high concentrations of compounds containing chromium VI in the air in the occupational setting (chromate manufacture, electroplating, stainless steel welding) have been shown by epidemiological studies to correlate with elevated incidences of nasal and respiratory cancer (reviewed in 1, 11). Compounds containing chromium VI have been shown to induce tumors in animals (5, reviewed in 1, 11) and to induce cytotoxicity, mutagenicity, chromcosome breakage, morphological transformation(permanent change in cell shape), and neoplasttic cell transformation (conversion to the tumorigenic state) in mouse and hamster cells in laboratory cultures and to induce cytotoxicity and mutation in human cells cultured in the laboratory (8-10, reviewed in 11). Compounds containing chromium VI are now considerd to be animal and human carcinogens and are regulated as carcinogens by the Environmental Protection Agency of the State of California and the Environmental Protection Agency of the United States (1, 3, 4, reviewed in 11) . All efforts that are economically feasible should be made to minimize the concentrations of compounds containing chromium VI in the air in California.

Similarly, since compounds containing chromium VI are toxic and carcinogenic to animals and to humans in the respiratory tract when humans are exposed to chromium VI in the air in the occupational setting, and since compounds containing chromium VI are corrosive and hence toxic at high concentrations (reviewed in 1, 3, 4, 11), the concentration of these compounds should be kept to a minimum in the drinking water of the people of the State of Californ-ia. In a recent document, the Office of Environmental Health Hazard Assessment (OEHHA) of the California Environmental Protection Agency calculated that the amount of chromium VI that could be ingested or drunk in water that would be expected to caused a risk of cancer in one person in one million exposed people, which is widely considered an acceptable de minimis risk. The concentration calculated was 2.5 parts per billion (ppb) of total chromium, and 0.2 ppb of chromium VI (3). Hence, the Public Health Goal is to maintain concentrations of Cr(VI) in the water at or below 0.2 ppb to keep the risk of cancer at one/one million. There is a very small data base on which this calculation was based, consisting of one study conducted by the German workers Borneff et al in 1968 in which animals were fed potassium chromate, which contains Cr(VI) (4). OEHHA used the results of this study to derive a linear dose-repsone curve for induction of cancer when chromium VI compounds were administered by the oral route and then extrapolated or applied these risk calculations to humans. This data base is presently weak and should be expanded by having the National Toxicology Program conduct further modern animal toxicity and carcinogenicity studies to broaden this data base. Any new data resulting from these proposed studies should be used to update the slope of the dose-response curve for carcinogenicity for exposure of humans to chromium VI-containing compounds in the drinking water. Secondly, data from exposure of humans to drinking water contaminated with Cr(VI) in the cities of Hinckley, California, and Kettleman, California, should also be studied and also used to help calculate the slope of the dose-response curves for toxicity and cancer incurred by people drinking water contaminated with chromium VI-containing compounds. In this way, the slope of the dose-response curve for cancer induction following the drinking of water contaminated with chromium VI compounds can be updated, made more accurate, and used with more confidence to revise the concentration of Cr(VI) calculated in the Public Health Goal for chromium VI-containing compounds.

In addition, all efforts should be made to remediate sites whose air and ground water have been contaminated with high concentrations of compounds containing chromium VI. First priority should be given to those sites in or adjancent to, populated areas and additional sites that could contaminate drinking water used to supply populated areas. Among these sites, those that are local hot spots containing high concentrations of chromium VI with a high probability of contaminating public drinking water sites should be remediated first.

The current maximum contaminant level (MCL) for chromium VI in the drinking water is 100 ppb as set by the United States Environmental Protection Agency. The current MCL for chromium in the water is 50 ppb as set by the State of California. The U. D. and State of California MCL values are 40-fold and 20-fold greater than the Public Health Goal of 2.5 pbb calculated for the levels of total chromium (chromium VI plus chromium III) in the drinking water that would be allowed if a risk of one in one million for cancer, the widely accepted "de minimis risk", is accepted. Since chromium VI is a genotoxic carcinogen, it is currently regulated by the State of California using a model that assumes a linear risk of cancer induction without a threshold concentration to trigger carcinogenesis.

David P. Spath
California Department of Health Services
Testimony
Joint Informational Hearing
Health Effects of Chromium VI Contamination of Drinking Water
October 24, 2000

Respective Chairs and members, my name is David Spath. I am Chief of the Division of Drinking Water and Environmental Management at the State Department of Health Services. I am responsible for managing the State's Drinking Water Regulatory Program. That responsibility includes making recommendations to the Director of the Department of Health Services on appropriate standards for chemicals in drinking water. I appreciate the opportunity to come before you to discuss the issue of chromium 6 in drinking water particularly with the regard to the Department's activities in reviewing the appropriateness of the present drinking water standard for chromium and in assessing the need for a possible separate drinking water standard ~~setting~~ for chromium 6. Before I begin I would like to compliment the members on their interest concerning chromium 6. Hopefully, this hearing will provide the public with a better understanding of the complexities associated with setting drinking water standards and the efforts undertaken by the respective State agencies to ensure that high quality drinking water is provided to the citizens of California.

I would like to begin by discussing the drinking water standard setting process and the role of public health goals in that process as well as providing some background on the standard for chromium. Presently there is no state or federal drinking water standard for chromium 6. There is a drinking water standard for total chromium, which is a measure of both chromium 3 and chromium 6 in drinking water. The total chromium standard in

California is 50 parts per billion while the federal standard is 100 parts per billion. The federal standard was revised upward from 50 parts per billion in the early 1990's. The Department, however, chose not to revise the state standard at that time.

In February 1999, the State Office of Environmental Health Hazard Assessment adopted a public health goal for total chromium of 2.5 parts per billion. Judging from the articles in the media over the past couple of months, there is a great deal of confusion as to the meaning and intent of a public health goal and the relationship between drinking water standards and public health goals.

Standards are the levels that public water systems are required to meet in the drinking water that they provide their customers. California law mandates that the Department set drinking water standards as close to the corresponding public health goals as is technologically and economically feasible. Public health goals, which as I indicated are established by the State Office of Environmental Health Hazard Assessment, are levels that are set solely on health risk considerations and do not consider costs or technical feasibility. The law requires that public health goals be set at a level that, for acutely toxic substances, avoids any known or anticipated adverse effects on public health with an adequate margin of safety and, for carcinogens or substances that may cause chronic disease, at a level that does not pose any significant risk to health.

In crafting the law, the Legislature intended that the public health goal be the starting point for the Department when determining the most appropriate standard, while it acknowledged that in setting a drinking water standard there is a balance that must be reached between the cost to the public and the benefit the public receives in risk reduction. As a result there are cases where the public health goal and the drinking water standard are at different levels. The Legislature also intended that the public be allowed to make local decisions regarding compliance with the public health goal. The law requires public water systems to hold periodic hearings to inform their customers of the cost of complying with public health goals and respond to public comment. The customers, for example, could then request a referendum on paying for the additional cost of meeting the public health goal or staying with the drinking water standard. The Department is not aware of any instances in which customers have opted to pay additional costs to meet the public health goal.

I would also like to briefly describe what the Department has done since the public health goal for total chromium was adopted in February 1999. In March 1999, the Department gave notice that we would be evaluating the total chromium drinking water standard to determine if the standard should be revised. After an initial review we determined that there needed to be a better understanding of the distribution of chromium 3 and chromium 6 in drinking water in the State. The public health goal for total chromium was based on national data on the distribution of chromium 3 and chromium 6 and assumes that on average chromium 6 makes up about seven percent of the total chromium in drinking water. To test that assumption the Department collected recent information on chromium 6 from water systems that had been sampling for the chemical. In August 1999, the Department of Health Services began conducting its own chromium 6 sampling study at a number of water systems in various regions of the State. That study was completed in

January 2000. The Department's study and the information from a small number of water systems suggested that, on average, chromium 6 makes up a much larger percentage of the total chromium in drinking water, perhaps greater than 50 percent. As a result of that work the Department concluded that we needed information on the statewide occurrence of chromium 6 in drinking water before we could adequately determine if the standard should be revised and, if so, what level that should be. The Department announced that instead of revising the total chromium standard we would be adopting a regulation to require statewide monitoring by water systems for chromium 6. As required by law, the Department must hold public hearings on that decision. The first hearing was held on September 6^{th} in Sacramento and the second on September 14th in Los Angeles. The Department has drafted and submitted for review a proposed regulation to implement the statewide monitoring requirement. We hope to have the regulation in place on an emergency basis before the end of the year. The Department has also sent letters to all water systems that would be affected by the regulation recommending that they begin their monitoring in anticipation of the rule being in place. Once we have sufficient occurrence data on chromium 6, the Department will reevaluate the total chromium standard or consider regulating chromium 6 separately.

In addition, with the recent signing by the Governor of Senate Bill 2127, the Department has also begun working with water systems in the San Fernando Valley to develop information on the levels of chromium 6 in drinking water that are being served to the Valley residents. With those data we will be able to begin the assessment of exposure and risks to the public as required by the bill.

In closing, our advice to water systems is that they test for chromium 6 particularly those systems that have detected chromium in their drinking water sources through previous monitoring. We also recommend that those water systems that have detected chromium and have sources in close proximity to contamination sites or industries that used chromium such as electroplaters, increase the frequency of their monitoring. The Department will also be reviewing existing water quality data on chromium and may require more frequent monitoring for those affected water systems with sources vulnerable to contamination. The Department does not believe, however, that water systems should discontinue the use of water sources that contain chromium above the public health goal of 2.5 parts per billion. We believe that the Legislature has established a prudent process for the Department to review drinking water standards. Pending completion of the Department's review, the State's drinking water standard for total chromium remains at 50 parts per billion.

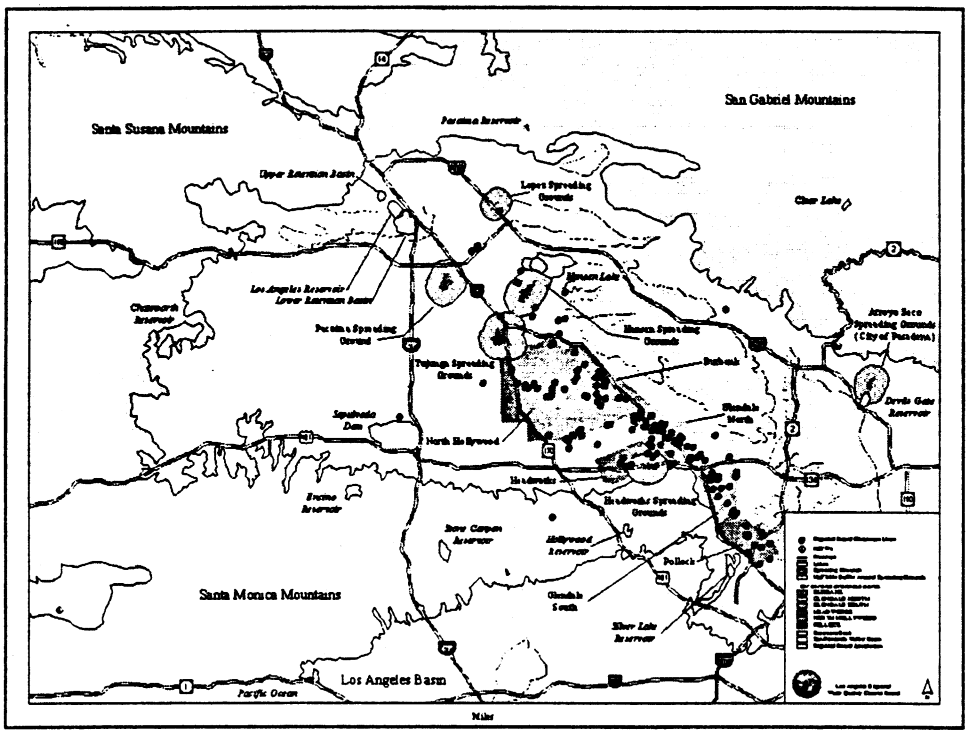
That concludes my remarks. If you have any questions, I will be happy to try to answer them.

Regional Water Quality Control Board - Los Angeles Region

Chromium Investigation

Chromium Contamination

- Chromium contamination
  - is present [redacted] in the San Fernando Valley especially along the industrial I-5 corridor
- Chromium contamination
  - is predominantly the result of industrial practices that occurred from the 1940s through 1970s and, to a much more limited extent, more recently
  - hexavalent chromium is of greatest concern



Sources of Hexavalent Chromium Contamination

- Metal plating
- Steel making
- Bricks in furnaces
- Dyes and pigments
- Chrome plating
- Leather tanning
- Wood preservation

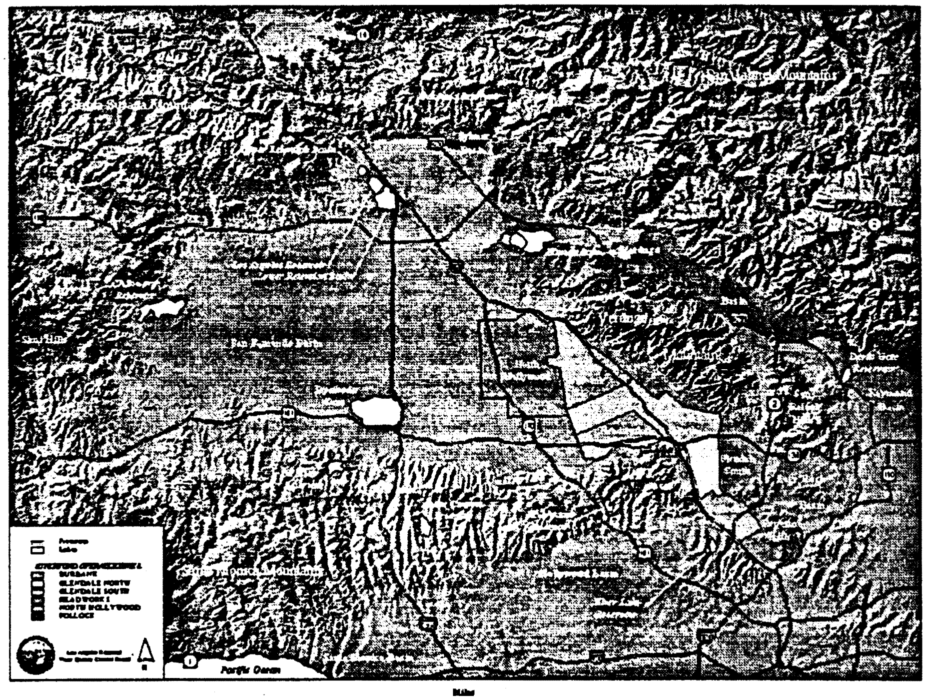
Chromium Contamination (cont'd)

- Several significant sites have been under Regional Board oversight for some time
  - Lockheed Aeronautics
  - ITT Industries
  - Menasco Division of Coltech Industries
  - Courtaulds Aerospace
  - Drilube Company
- Site Assessment and/or cleanups are underway

Historical Context

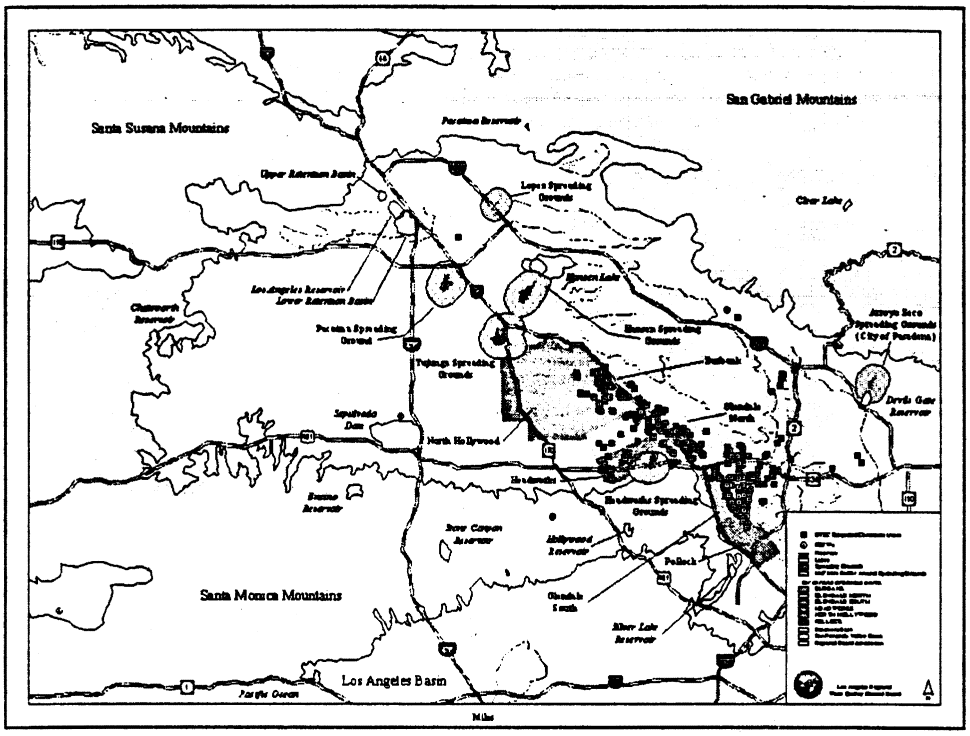
(20-year period in San Fernando Valley [SFV])

- 1980 - Discovery of volatile organic compounds (VOCs) in the groundwater.
- 1986 - Placed on National Priority List (Superfund)



Chromium Investigation
San Fernando Valley

- 1986 through 1996.
  - Hexavalent chromium (Cr^{6+}) discovered in soil and groundwater during Superfund investigations
- 1998
  - LADWP detected trace amounts of Cr^{6+} in their groundwater monitoring wells in San Fernando Valley.
- 2000
  - USEPA continues to monitor its 87 multi-depth groundwater cluster wells along the eastern SFV.

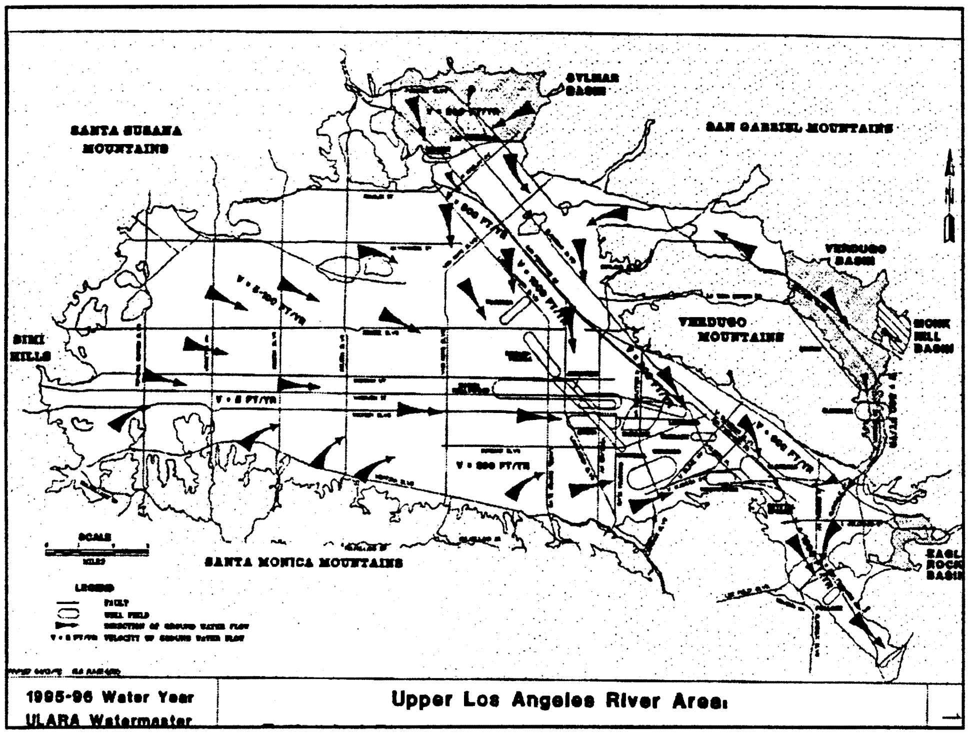


San Fernando Valley Basin

- Large unconfined aquifer composed of alluvial deposits.

- Groundwater flows from west and north to the SE.

- Major aquifer for Los Angeles, Burbank and Glendale.



Chromium Contamination (cont'd)

- Chromium contamination can also be found in the San Gabriel Valley and other areas in the Los Angeles Region
  - one recent site was discovered as a result of excavation of the Alameda transportation corridor
    - Barkens Corporation
      - 296,000 ppb in shallow groundwater
      - site currently being assessed for extent of contamination

Chromium Contamination (cont'd)

- Chromium contamination is initially found at high levels in the soil and shallow groundwater near the source of contamination
  - Usually in a limited area
  - Levels of contamination drop rapidly away with distance from a source
- Removing the source of contamination is a principal objective of Regional Board action

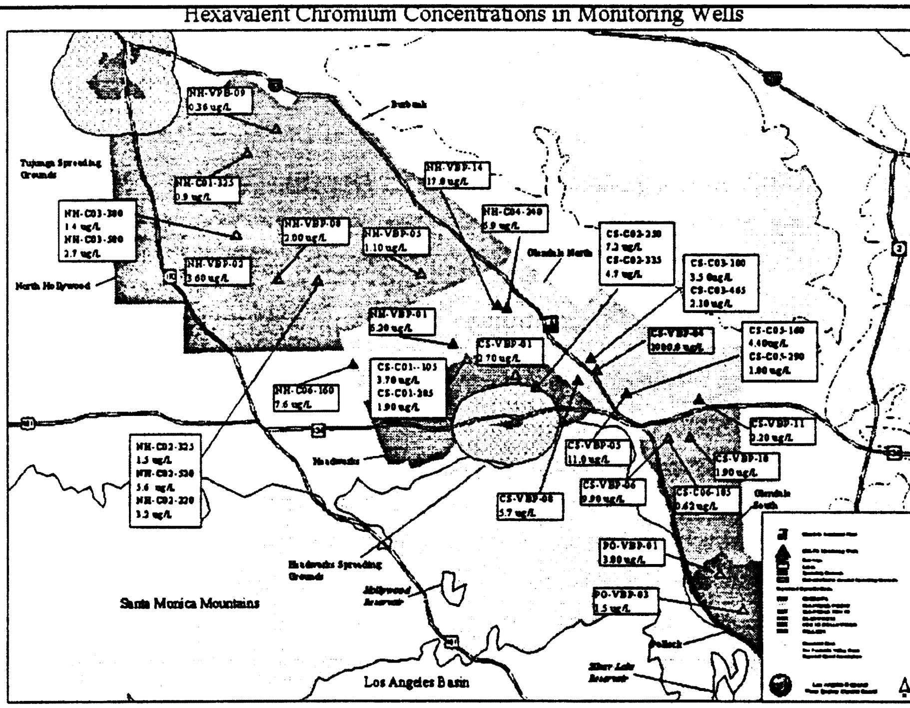
Chromium Contamination (cont'd)

- Chromium contamination in deeper drinking water aquifers may result from contaminant spreading
  - through pathways such as improperly abandoned wells
  - contaminant migration to lower aquifers over time
- While drinking water aquifers show comparatively low levels of contamination,
  - it is imperative that existing sources of contamination be identified and the contamination remediated as quickly as possible to protect the resource

Chromium Contamination

- Chromium is found in many monitoring wells
  - concentration varies widely
  - some uncertainty exists as to background concentrations
  - drinking water wells and tap water have been identified as containing chromium

Hexavalent Chromium Concentrations in Monitoring Wells



Miles

Chromium Contamination (cont'd)

- Regional Board directed/oversight cleanups are producing results
  - Anadite (Southgate)
    - shallow groundwater reduced from 43,000 ppb to 5,000 ppb
  - Lawry's (Los Angeles)
    - shallow groundwater reduced from 34,000 ppb to 110 ppb

USEPA/Regional Board San Fernando Valley Chromium Investigation

- Goal
  - Identify all sites that have used chromium - develop a multi-agency database.
    - ✓ Over 200 RB chromium sites identified
      - ✓ an additional database from DTSC is being reviewed
    - ✓ 6 active sites impacted with Cr^{+6}.
  - Inspections will identify all Cr^{+6} sites in phases.
    - ✓ Inspections will start beginning November 2000.
  - Regional Board will require soil assessment and groundwater assessment, where necessary.

USEPA/Regional Board 1999 Work Plan

- Identify sites that have used chromium - develop database
  - ✓ 6 active sites contaminated with chromium
- Develop chemical use database (for all chemicals)
- Write "findings of fact" for identified chromium site
- Develop geographical information system (GIS) maps
- Develop quality assurance project plan (QAPP)
- Develop database system to input chromium data
- Continue work on active solvent and chromium sites

USEPA Regional Board 2000 Work Plan

- Complete identification of potential chromium sites
  - ✓ Over 200 potential chromium sites identified
- Conduct site inspections on identified sites
  - ✓ Inspections will start beginning of November 2000
- Require soil and groundwater assessment, if needed
- Require soil and groundwater cleanup, if needed
- Complete Quality Assurance Project Plan (completed)
- Provide public outreach/workshops for dischargers and community

CLCV EDUCATION FUND

**Testimony of Joseph K. Lyou, Ph.D., Director of Programs,
California League of Conservation Voters Education Fund,
before the Joint Legislative Hearing on the
Health Effects of Chromium VI Contaminated Drinking Water**

**October 24, 2000
Burbank, California**

Introduction

Good morning. I would like to thank Senator Hayden, Senator Ortiz and Assemblymember Jackson, as the chairs of the host legislative committees, for the opportunity to speak about this very important matter. My name is Joe Lyou. I am the Director of Programs at the California League of Conservation Voters Education Fund. The CLCV Education Fund is a non-profit public interest organization dedicated to protecting and enhancing the environment where we live, work, play, and learn. My interest in chromium VI comes from many years working to protect our groundwater resources. I have spent countless hours pouring over reports on groundwater monitoring, site characterization, site remediation, health risk assessments, proposed permits, and environmental impacts of proposed agency decisions. Perhaps it's not the most exciting aspect of my life but it does serve as a good basis for discussing groundwater protection.

It's truly an honor to join such an esteemed group of scientists, administrators, and policymakers here today. Their expertise and experience will undoubtedly prove essential in dealing with the problem of chromium VI contamination in groundwater. I come from a somewhat different perspective. I have made a profession of assisting communities and concerned individuals confronting environmental hazards. Today, I have three simple messages:

10780 SANTA MONICA BOULEVARD, SUITE 210 LOS ANGELES, CA 90025
TEL: (310) 441-4162 FAX: (310) 441-1685

(1) Water that meets "acceptable" standards is not necessarily "safe;" (2) if we are to err, we should err on the side of caution; and (3) polluters should pay for the costs associated with chromium contaminated groundwater.

Panel III. Chromium and California's Drinking Water

We have been asked to discuss California's drinking water standards, their adequacy and enforcement, and the extent and distribution of chromium and chromium VI contamination in California. Many people sum up the problem of chromium VI in our drinking water with one basic question, "Is it safe?" While the question is simple, rational, and perfectly legitimate, the answer is not so straightforward. The complexity begins with the acknowledgement that the current public policy is not to judge the quality of our air or our water in terms of safety but to base that judgment on the concept of "acceptable risk." Lately, I've been frustrating to read about reassurances that chromium contaminated water is "safe." No one can tell us that with any degree of certainty and it's misleading to make such a claim.

The Department of Health Services establishes regulatory limits for drinking water based on a judgment of "acceptable risk." In general, when it comes to the probability of getting cancer from environmental hazards, that risk is set at a level of one-in-a-million. In essence, it's like playing Russian roulette with a really big gun, one with a million chambers and one bullet that can give you cancer. Using this analogy, it's easier to visualize the difference between "safe" and "acceptable risk." No matter how many chambers in your gun, it's not safe to play Russian roulette with a loaded weapon.

So, your basic question – "Is it safe?" – must be changed to, "Does it represent an acceptable risk?" The answer to that depends upon who makes the decision. My impression is that there is a big difference between the opinion of polluters and public opinion when it comes to this issue. The public has a hard time with the notion of being put at risk at the hands of polluters. There are many reasons for this. Drinking chromium VI contaminated water is not a voluntary risk, such as driving a car, but an imposed risk that the public has very little choice in accepting. The public has little control over this risk. We find only risks and no benefits in having our tap water contaminated with chromium VI. The consequence of taking this risk, which could be cancer, is severe. We have a right to demand air we can breathe and water we can drink without having to worry about the harm it may be doing us or our children.

Are the chromium drinking water standards adequate? What is the extent of the problem? No one knows for sure. There is an outstanding question about the toxicity of drinking water contaminated with chromium VI. The Office of Environmental Health Hazard Assessment has decided that sufficient evidence exists to consider exposure to chromium VI drinking water can cause cancer. The Department of Health Services must now decide whether it agrees. One disturbing sign from DHS is its misrepresentation of the position of the United States Environmental Protection Agency. On its web site, DHS claims, "[T]he US Environmental Protection Agency (US EPA) doesn't consider Cr+6 to pose a cancer risk by ingestion."[1] DHS cites two EPA publications in support of this claim. When I checked those references, I found that EPA is *undecided* about the carcinogenic risk of chromium VI ingestion. EPA is explicit in its position, "The potential carcinogenicity of chromium by the oral route of exposure cannot be determined at this time."[2] The contradiction between DHS's characterization of EPA's position and what I found in the referenced EPA publications gives me cause to worry about how DHS will interpret the toxicological data in setting a new chromium drinking water standard.

In its Public Health Goal, the Office of Environmental Health Hazard Assessment acknowledges the limitations of their conclusion that drinking chromium VI contaminated water could lead to cancer. We need better studies. Given the limited data we have upon which to base a decision, OEHHA has developed a compelling argument that the standards should be strengthened. OEHHA has made the prudent decision that, if we are to err, we should err on the side of caution. I would expand upon this a little further to say that we must always remember to place the burden of proof upon the pollutant and not upon the regulators who create the standards for protecting public health.

In reviewing its chromium drinking water standard, DHS will consider the issue of costs. DHS will consider the cost of compliance, including the cost of testing, treating, and replacing contaminated groundwater. These costs could be significant but the key to this analysis is really the question of who should bear the burden of those costs. The answer is clear. Polluters should pay. They should pay for testing. They should pay for treatment. They should pay for replacing water that cannot be treated. In addition, DHS should base its analysis only on unrecoverable costs – costs that we can't force polluters to pay and must be added to the price of water.

If our legal and regulatory systems functioned properly, this would not be such a radical idea. In theory, we all understand that polluters should pay for cleaning up the mess they've created. In practice, it rarely seems to work this way and we have water providers coming across in our newspapers as being more concerned with the cost of water than they are with protecting public health. Water providers shouldn't be faced with the choice between costs and public health. The public should not be faced with the choice between affordable and contaminated water. While there have been many attempts to find legislative solutions to this problem, few have succeeded. The time has come for more effective enforcement and more protective laws – laws that work, laws that make the polluters pay.

In the interest of allowing the panel time to answer questions and discuss these issues, I would like to conclude by saying that the most acceptable solution to this dilemma, given the current approach toward risk management, would be to adopt emergency regulations establishing a chromium VI drinking water standard of 0.2 parts per billion (µg/L). This is the level that the scientists at OEHHA believe represents the generally acceptable excess lifetime cancer risk of one-in-a-million. Water providers should begin taking the measures necessary to comply with this standard and the 0.2 ppb limit should stay in place until DHS has been able to determine whether a less stringent standard would adequately protect public health.

Panel V. Public Policy Options for Chromium VI

It is clear that we need a separate standard for chromium VI. Current standards based on total chromium exist only because of the added inconvenience of measuring for chromium VI specifically. OEHHA set a 2.5 ppb total chromium public health goal based on what has proven to be a false assumption about the ratio of chromium VI to total chromium. This ratio has been shown to vary dramatically among groundwater samples.[3] The percentage of chromium VI in total chromium has been found to range from 0 to 100%. Generally, it's closer to 100% than 0%. In this city, at the Burbank Health Clinic, the County of Los Angeles recently discovered that chromium VI made up 69% of the total chromium in tap water.[4] OEHHA assumed that chromium VI represents only 7.2% of total chromium. OEHHA should correct this mistake in its Public Health Goal and DHS should adopt a drinking water standard specifically for chromium VI.

A very important public policy decision will be made on November 7th when California voters decide the fate of Proposition 37. If this proposition passes, it will be much more difficult to add a fee to the use of chromium VI. Such fees could be used to provide the money needed to prevent further contamination of our groundwater supplies and to treat or replace the water that has already been contaminated. The environmental community is united in its opposition to this measure. We will have to wait and see whether California voters agree.

On the scientific front, we need policies that support the development of better toxicological data on the effect of drinking chromium VI contaminated water. I would also be interested in an analysis of possible inhalation pathways such as showers and boiling water. The physiological processes involved with the ingestion of chromium VI also do not appear to be well known and should be studied.

From a regulatory standpoint, several problems need to be addressed. We need to reassess our efforts at pollution prevention. Current users of chromium VI need to be carefully scrutinized. The regional water quality control boards need to coordinate activities with the Department of Toxic Substances Control to assure that contaminated sites have been properly characterized and cleaned up. In particular, from my personal experience, I would recommend that the regional water quality control boards make sure that the corrective action taken at DTSC sites included the protection of groundwater from chromium VI contamination. At the Tel-Air facility in Newbury Park, a troubling site that few people know about, DTSC adopted cleanup requirements protective of groundwater for chromium and other contaminants only after I submitted comments pointing out the their health risk assessment did nothing to enforce regional water quality control board regulations. I would imagine that this was not an isolated incident.

Soil and groundwater remediation technologies must be developed, tested, and approved. There are ways to enhance the reduction of chromium VI in soil and groundwater but I am not sure that any of them have been proven to be effective in large scale use or capable of reducing chromium VI to levels that would meet the OEHHA public health goal. These remediation technologies need to be investigated.

To assure that the chromium problem is handled properly, it will require an intensive and sustained political commitment. Legislators must pressure regulators to develop a chromium VI drinking water standard, to investigate contaminated sites, to monitor wells, and to enforce environmental laws. They must also provide regulators the resources necessary to do all of this in a timely manner. Regulators shouldn't have to complain about a lack of staff or funds to address this problem.

I would also recommend that a special effort be undertaken to maximize public participation in these decision-making processes. The public must be involved early on in the process and in a meaningful manner. This means taking seriously the concept of acting only with the consent of the governed.

On a more general level, we need to consider how to integrate the Precautionary Principle into our environmental policies. The Precautionary Principle holds that we should take measures to protect public health and the environment even in the absence of unambiguous scientific evidence of harm.[5] The burden of proof is on the polluter and care is taken to err on the side of caution. Given our history, the effectiveness of non-precautionary approaches toward the environment must be questioned. We have, it seems, a rather flat learning curve when it comes to groundwater protection. Chromium VI has joined benzene, MTBE (methyl-tert-butyl ether), TCE (trichloroethylene), and perchlorate on the infamous list of significant threats to California groundwater. I will conclude by saying that, viewed in this context, the chromium VI issue is not a novelty but rather a sobering reminder that we should better protect and clean up our environment. Thank you.

---

[1] California Department of Health Services, October 5, 2000 (update), "Hexavalent Chromium [Chromium +6] in Drinking Water," http://www.dhs.ca.gov/ddwen/chemicals/Chromium6/Cr+6index.htm

[2] United States Environmental Protection Agency, 1998a, *Toxicological Review of Hexavalent Chromium*, http://www.epa.gov/iris/toxreviews/cr6-toxf.pdf and also see, U.S. EPA, 1998b, *Chromium VI*, where EPA states, "Carcinogenicity by the oral route of exposure cannot be determined . . ." at http://www.epa.gov/iris/subst/0144.htm

[3] California Department of Health Services, October 5, 2000 (update); California Department of Health Services, September 9, 2000 (update), "Status of Reviews of MCLs for 13 Contaminants Atrazine, Cadmium, Chromium, Cyanide, DBCP, 1,2-Dichloropropane, DEHP, Ethylbenzene, Methoxychlor, Oxamyl, Thallium, 1,2,4-Trichlorobenzene, and TCE," http://www.dhs.ca.gov/ps/ddwen/chemicals/PHGs/reviewstatus.htm

[4] Blankstein, A. & Guccione, J., October 6, 2000, "Antonovich Urges State Standards on Chromium 6," *Los Angeles Times.*

[5] Geiser, K., 1999, "Preface: Establishing a General Duty of Precaution in Environmental Protection Policies in the United States, A Proposal," p. xxiii, in C. Raffensperger and J. A. Tickner, Eds., *Protecting Public Health and the Environment: Implementing the Precautionary Principle*, Washington, DC, Island Press.

CITY OF BURBANK
BURBANK WATER & POWER

CHROMIUM IN THE GROUNDWATER

(Statement by Ron Davis, General Manager, Burbank Water & Power at the Schiff Hearing, City of Burbank Council Chamber October 24, 2000.)

The City of Burbank supports the regulatory authorities in their action to set the appropriate Maximum Contaminate Level (MCL) for total chromium and chromium 6. The confusion over the safe levels of total chromium and chromium 6 and apparent limited ingestion health effect study data and regulatory differences between the California Department of Health Services (DHS) and Office of Environmental Health Hazard Assessment (OEHHA) do not help provide water consumers with confidence in their local water provider or the state regulatory authority. Any action to increase confidence in the public drinking water supply or its regulatory oversight is supported such as a possible joint DHS-OEHHA information letter on chromium 6. Any action taken to accelerate data collection such as chromium 6 ingestion studies is also appreciated.

In addition to distribution of the Annual Water Quality Report (Attached), Burbank has taken additional steps to share information with our customers. We are mailing a newsletter (Attached) to all of our customers. We have posted a listing of State approved home Reverse Osmosis systems on our web page www. Burbank-Utilities.com (Attached). We will continue to inform our customers at Council meetings (TV), newsletters, handouts, and on our web page. We have administratively removed one well with the highest chromium levels in an effort to lower the total chromium level reaching our customers.

We have measured the levels of total chromium and chromium 6 in our locally produced ground water for several years and have shared this data with regulators. Our annual level of total chromium varies from non detect to about half the state standard.

We believe that we have excellent working relationships with the DHS. Our Operating Permit for the EPA Treatment Plant has special provisions addressing chromium monitoring and operations of the production wells. We have participated in a Chromium Taskforce for two years working with Cal EPA, DTSC, DHS, RWQCB, and water purveyors in the area.

Over half of our water supply is provided from groundwater sources. All of the wells have demonstrated to varying degrees the presence of total chromium. (Attached) Our data also indicates that over 50 % of the total chromium is chromium 6. Our major groundwater source is operated under a Consent Decree with the U. S. Environmental Protection Agency. This Consent Decree requires that the City of Burbank will use the water if it meets the state MCLs. If the chromium regulations change, we have avenues to pursue in order to add additional treatment and seek cost recovery. Short of changed regulations or at least common regulatory positions, Burbank faces difficult alternatives that may include litigation and regulatory penalties.

By reference, the following attachments are included as part of this statement:

Annual Water Quality Report, 1999

Burbank Newsletter, Week of October 23, 2000

Reverse Osmosis web page (www.Burbank-Utilities.com)

Report to the City Council, September 26, 2000

Report to the City Council, October 10, 2000

Report to the City Council, October 17, 2000

Report to the City Council, October 24, 2000

CITY OF BURBANK

Burbank Water and Power

DATE: October 20, 2000

California Department of Health Services
Certified Water Treatment Device Directory of Reverse Osmosis Systems

Burbank water meets or exceeds all state and federal drinking water standards. Burbank reported in its 1999 Annual Water Quality Report that total Chromium varied from non detect to 26 parts per billion. The state maximum contaminant level for total Chromium is 50 parts per billion. Water quality data indicates that Chromium 6 would range from non-detect to 13 parts per billion. There is **not** a state standard for Chromium 6. Its value is included with total Chromium.

However, there has been a lot of concern recently about Chromium 6 in Burbank's groundwater.

Currently known ways to remove Chromium 6 in water is through Ion Exchange Treatment Systems and Reverse Osmosis. A filtration unit by itself will not remove Chromium 6.

A list of home water treatment devices certified by the California Department of Health Services can be found on their web site at www.dhs.ca.gov/ps/ddwem/technical/certification/device/sec6-6.pdf.

Burbank Water and Power does not specifically recommend any of these devices. The costs for these devices varies significantly, starting at $250. Some units will require further installation expenses and all units will have on-going operation costs. Devices on this list may not remove Chromium 6 to the suggested Office of Environmental Health Hazard Assessment recommendation of 0.2 parts per billion.

Home

Reverse Osmosis Systems

Certificate Number	Model Name	Type of System
91- 1013	Ultrefiner 9591N	under counter
92- 1016	EcoWater Systems - ERO 300E with monitor faucet	under counter
91- 1018	Culligan Good Water Machine AC-30	under counter
91- 1018	Culligan Good Water Machine AC-30 Premier	under counter
91- 1018	Culligan Good Water Machine AC-30L	under counter
91- 1018	Culligan Good Water Machine AC-30L Premier	under counter
91- 1018	Culligan Good Water Machine AC-30M	under counter
91- 1018	Culligan Good Water Machine AC-30M Premier	under counter
91- 1018	Culligan Good Water Machine H - 30PRV-C	under counter
91- 1018	Culligan Good Water Machine H - 30S-R	under counter
92- 1042	SQC Series - Model SQC2 HF	under counter
92- 1042	SQC Series - Model SQC3 HF	under counter
92- 1042	SQC Series - Model SQC4 HF	under counter
92- 1042-1	ICON 2000 DWS	under counter
92- 1056	WRI Super Deluxe - C	under counter
92- 1056	WRI UltraMicron Filtration System™ - C	under counter
92- 1070	Premier RO-TFM-4SV	under counter
92- 1070	Premier RO-TFM-5SV	under counter
92- 1073	Culligan Good Water Machine AC-30 Nitrate	under counter
92- 1073	Culligan Good Water Machine AC-30L Nitrate	under counter
92- 1073	Culligan Good Water Machine AC-30M Nitrate	under counter
93- 1169	Kinetico Drinking Water System - Plus VX with CTA Membrane	under counter
94- 1175	EcoElite - ERO392E with Monitor Faucet	under counter
94- 1175	EcoElite - ERO494E with Monitor Faucet	under counter
94- 1176	Sears Kenmore - 625.347050 (With Monitor Faucet)	under counter
97- 1194	Everpure ROM III	under counter
95- 1204	BestWater Reverse Osmosis System II, Model #52345	counter top
98- 1209	Good Water Machine AC-30 M Premier - VOC	under counter
98- 1209	Good Water Machine AC-30 M - VOC	under counter
98- 1209	Good Water Machine AC-30 Premier - VOC	under counter
98- 1209	Good Water Machine AC-30 - VOC	under counter
98- 1209	Good Water Machine AC-30L Premier - VOC	under counter
98- 1209	Good Water Machine AC-30L - VOC	under counter
98- 1209	Good Water Machine H - 30PRV-C - VOC	under counter
98- 1209	Good Water Machine H - 30S-R - VOC	under counter
95- 1213	GWC 251	
96- 1222	Essential Water & Air SQC4	under counter

Reverse Osmosis Systems

Certificate Number	Model Name	Type of System
96- 1223	Micromax 5500 TFC	under counter
97- 1263	Microline T.F.C.-4	under counter
97- 1263-1	Technetic Plus TRO-4	under counter
97- 1264	Microline T.F.C.-3	under counter
97- 1265	RaynePure	under counter
97- 1268	General Electric PNRV12ZBL01	under counter
97- 1269	General Electric PN RV18ZBB01	under counter
97- 1269	General Electric PN RV18ZBL01	under counter
97- 1269	General Electric PN RV18ZWH01	under counter
97- 1269	General Electric PN RV18ZWW01	under counter
97- 1273	Living Water	under counter
98- 1298	418B	under counter
98- 1298	520A	under counter
98- 1298	524L	under counter
98- 1298	K525	under counter
98- 1298	Q525	under counter
97- 1309	Everpure ROM II	under counter
97- 1323	Water Factory Systems SQC 2 HF (Nitrate)	under counter
97- 1323	Water Factory Systems SQC 3 HF (Nitrate)	under counter
97- 1323	Water Factory Systems SQC 4 HF (Nitrate)	under counter
97- 1328	NorthStar NSROWF	under counter
97- 1328	Tapworks TWROWF	under counter
98- 1334	Kinetico Drinking Water System - Plus GX with TF Membrane	under counter
98- 1335	Kinetico Drinking Water System - Base Model	under counter
98- 1354	Sierra NS-1N30	under counter
98- 1358	WaterSoft WSRO-35TA	under counter
98- 1360	GE GXRV10ABL01	under counter
98- 1362	WaterMaker Mini	faucet mount
99- 1370	Pure-Tel Premier Series	under counter
99- 1380	Kenmore 625.347051	under counter
99- 1384	Avian Drinking Water System RO-425	under counter
99- 1389	EcoWater ERO-R335	under counter
99- 1390	Culligan Water Tower Drinking Water Appliance CWT35ST3.0	under counter
99- 1391	Kinetico Drinking Water System - Plus GX	under counter
99- 1392	Kinetico Drinking Water System - Plus VX	under counter
99- 1396	TGI Pure TGI-525	under counter
99- 1397	Hydrotech 10103101	under counter

Reverse Osmosis Systems

Certificate Number	Model Name	Type of System
99- 1397	Hydrotech 10103102	under counter
99- 1397-1	U.S. Pure Water Corporation 10103101	under counter
99- 1397-1	U.S. Pure Water Corporation 10103102	under counter
99- 1397-2	Sierra Springs 10103101	under counter
99- 1397-2	Sierra Springs 10103102	under counter
99- 1398	Hydrotech 10304101	under counter
99- 1398	Hydrotech 10304102	under counter
99- 1399	Hydrotech 10303101	under counter
99- 1399	Hydrotech 10303102	under counter
99- 1400	Hydrotech 10107101	under counter
99- 1400	Hydrotech 10107102	under counter
99- 1401	Hydrotech 10106101	under counter
99- 1401	Hydrotech 10106102	under counter
99- 1402	Hydrotech 10105101	under counter
99- 1402	Hydrotech 10105102	under counter
99- 1403	Hydrotech 10104101	under counter
99- 1403	Hydrotech 10104102	under counter
99- 1403-1	Sierra Springs 10104101	under counter
99- 1403-1	Sierra Springs 10104102	under counter

City of Burbank Public Service Department Water-Light-Power

MEMORANDUM

DATE: September 26, 2000

TO: Robert R. Ovrom, City Manager

FROM: Ronald E. Davis, General Manager, PSD

SUBJECT: **Chromium and Hexavalent Chromium Contamination in the Groundwater Supplies Serving the City of Burbank**

BACKGROUND

The August 20, 2000 Los Angles Times article on chromium contamination written by Andrew Blankstein and Chip Jacobs brought attention to the physical presence of chromium and hexavalent chromium (chromium 6) in the San Fernando Groundwater Basin. The thrust of the initial article concerned state and federal regulations relating to total chromium and the lack of a standard for the maximum contaminant level (MCL) for chromium 6. The articles referenced levels of chromium found in area wells, but did not state that any regulations had been compromised in the water delivered to customers. Unfortunately, the articles did not note the difference between well data points and the water delivered to a customer. These articles coupled with the movie *Erin Brockovich*, which portrayed the plight of the people of Hinkley, California exposed to air born and water sources of chromium and the legal action against Pacific Gas and Electric (PG&E), raised reader concern about the quality of public drinking water. Numerous newspaper articles have followed. Various City and County of Los Angeles officials and State Senator Adam Schiff (D-Burbank) have voiced concern.

ANALYSIS

The Public Service Department has been sensitive to the presence of chromium in the groundwater supplies serving the City of Burbank. This sensitivity and awareness of chromium issues has been the result of our on going monitoring of state and federal regulations, the Burbank-Environmental Protection Agency Consent Decrees, California Department of Health Services (CDHS) water quality permit compliance monitoring and reporting activities, and our involvement with basin management and regulatory agencies. The areal extent of the chromium contamination is shown on Attachment A.

Chromium and Hexavalent Chromium Contamination in Groundwater

A special Chromium Task Force was formed as an outgrowth of the Upper Los Angeles River Area (ULARA) Watermaster's activity. The first meeting of this group was held on February 19, 1998. The Task Force is composed of ULARA groundwater producers and regulatory agencies (CDHS, Regional Board, EPA, and CDTSC) on a voluntary basis. The purpose of the Task Force has been to share information, increase our knowledge of the aerial extent of contamination in drinking water wells, and to track the progress of state and federal water standards relating to chromium.

The U.S. Environmental Protection Agency (USEPA) MCL for total chromium are 100 parts per billion (ppb). The California Department of Health Services (CDHS) and the World Health Organization MCL is 50 ppb. The water delivered to Burbank customers during calendar year 1999 was in the range from Non Detect to 26 ppb. This value was reported to all water customers in the June 2000 water bills in the Public Service Department "Annual Water Quality Report." PSD has provided customers an annual report for the last 10 years.

Current regulatory discussion has focused on whether a new drinking water standard for total chromium should be established, and if so, at what level and for which forms of chromium.

Two forms of chromium species may be present in drinking water supplies: chromium 3 and chromium 6. Chromium 3 is an essential nutrient at trace concentrations. Chromium 6 is a species of health concern, and its toxicity is the basis for setting the chromium drinking water standard. There are uncertainties in the balance of the two species in drinking water supplies, and there is evidence that chromium 6 may be reduced to chromium 3 in the human body, particularly in the reducing environment of saliva and gastric juices.

The U.S. Environmental Protection Agency (USEPA) classified chromium 6 as a human carcinogen by inhalation. In 1991, USEPA reviewed the existing chromium standard, and raised the maximum contaminant level (MCL) from 0.05 mg/L (1975 Interim Drinking Water Standard) to 0.1 mg/L as total chromium, based on its decision that chromium 6 was not carcinogenic by ingestion. 0.1 mg/L is 100 parts per billion.

The California EPA Office of Environmental Health Hazard Assessment (OEHHA) takes exception to USEPA's conclusion on chromium 6. The California Department of Health Services (CDHS) reviewed the chromium risk assessment data in 1994, and maintained the chromium MCL of 0.05 mg/L. In 1999, OEHHA determined that a health protective level against carcinogenicity for chromium 6 was 0.2 μg/L, and adopted a Public Health Goal (PHG) for total chromium at 2.5 μg/L. 2.5 μg/L is 2.5 ppb. The

PHG was calculated assuming that total chromium is made up of no more than 7.2 percent chromium 6.

The California chromium MCL is currently under review. CDHS has indicated that it must have more occurrence data before considering revising the total chromium MCL, or adopting an MCL for chromium 6. CDHS will likely add chromium 6 to the list of unregulated chemicals for which monitoring is required when the Department amends the existing unregulated chemicals regulation (2001).

The water supply for Burbank comes from the Metropolitan Water District of Southern California (MWD), the Groundwater Treatment Plant on Hollywood Way and the Lake Street GAC Treatment Plant. The Public Service Department (PSD) operates the treatment facilities under a permit from the CDHS. The permit specifies the type of test, frequency and the method to be performed. The PSD employs state certified laboratories to perform the required and voluntary analytical testing. The laboratories send the test results directly to the DHS and the PSD at the same time. This procedure eliminates concern about possible tampering with the test results. The water produced by the local wells and the city treatment plants is tested monthly for total chromium and chromium 6. Production from the Groundwater Treatment Plant is blended with additional MWD water before it is delivered to the distribution system.

Attachment B shows the total chromium and chromium 6 levels for the production wells in the Burbank Operable Unit Treatment Facility for the last twelve months. Examination of this data shows that the chromium levels are not uniform from well to well, or from month to month. We do not detect any trend of increasing levels. Water from these wells is blended by the selection of various wells' need to match a flow quantity needed on any given day. It is not correct to identify any single well value as representative of the water delivered to consumers.

Attachment C shows the total chromium and chromium 6 as it is received from the Burbank Operable Treatment Facility after it has been treated for volatile organic removals and after it has been blended with additional water from the MWD before it enters the water distribution system. The average total chromium and chromium 6 value to the distribution system has been 11 ppb and 6 ppb.

Attachment D shows the total chromium and chromium 6 levels for the production well and the water to the distribution system from the Lake Street Granulated Activated Carbon Treatment Facility. This facility is not used during the winter months. The average total chromium and chromium 6 value to the distribution system has been 8 ppb and 4 ppb.

Chromium and Hexavalent Chromium Contamination in Groundwater

The State Legislature passed SB 2127, sponsored by Senator Schiff, requiring an accelerated review of the San Fernando Valley's chromium-tainted water. This bill now sits on Governor Davis' desk. If this bill is approved, a report and recommendations on the chromium issues is due by January 2002. Senator Schiff has also called for a hearing on the chromium issues to be held in Burbank on October 26, 2000. The PSD will provide testimony at this hearing. Los Angeles County officials have begun testing for chromium 6 at various county facilities. The Board of Supervisors ordered this action last week. The PSD has been testing for Total Chromium and chromium 6 at individual production wells in addition to the introduction of water to the distribution system for almost two years and has been sharing the results with various governmental regulatory agencies. The annual summary is provided to our customers in the Annual Water Quality Report.

Chromium contamination in the San Fernando Valley water basin has been the result of industrial production over a long period of time. The Los Angeles Regional Water Quality Control Board reports have identified 205 industrial sites in Burbank, Glendale, and Los Angles that could have soil contaminated with chromium 6. From many sites, the soil contamination is connected with contamination of the ground water. The USEPA has been monitoring the groundwater contamination with monitoring wells located within the basin. The data from the Burbank Ground Water Treatment Plant production wells has been provided to the USEPA monthly. The Regional Board will be continuing with the site chromium investigations.

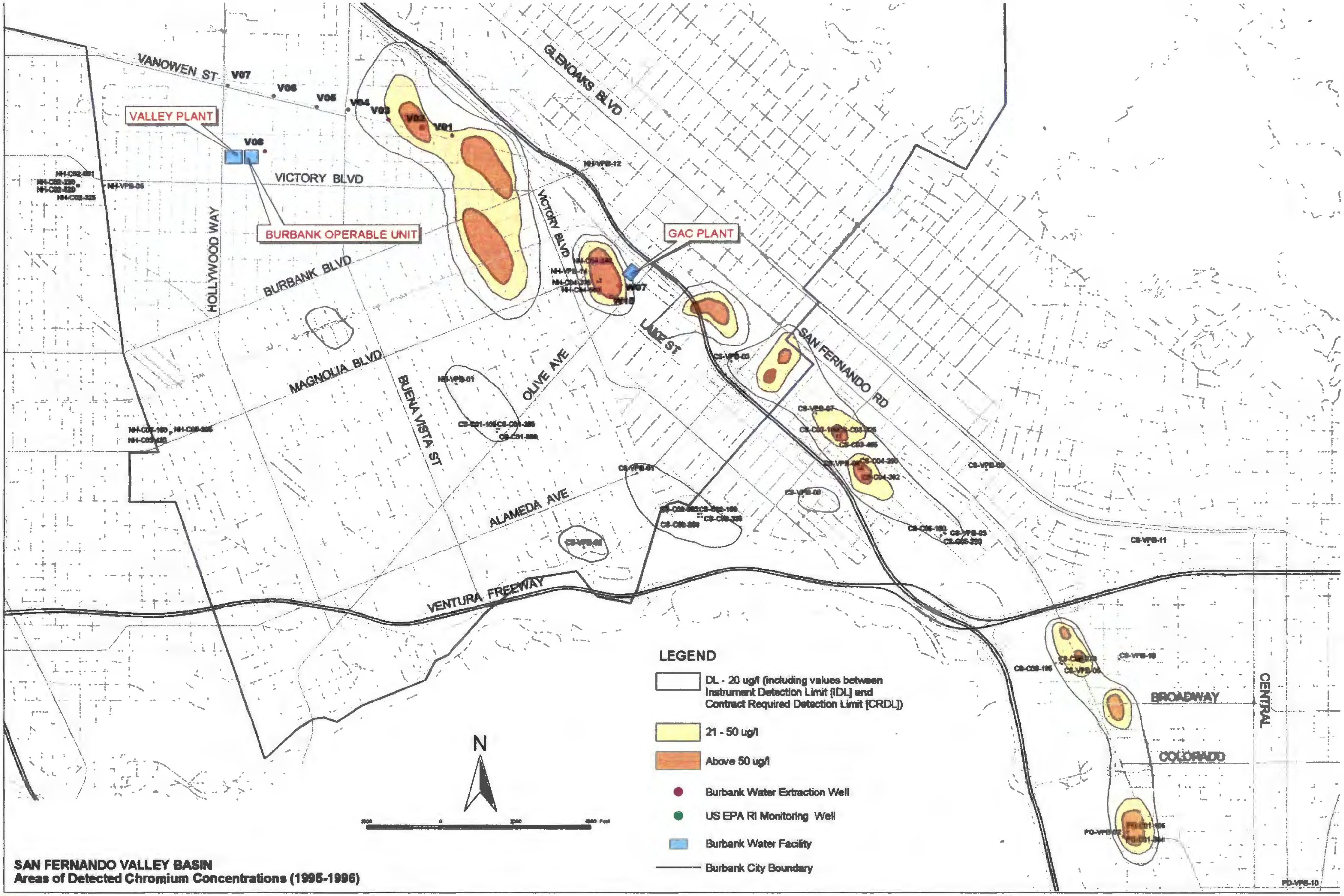
The PSD is supportive of SB 2127. We will continue to work with the Chromium Task Force and various regulatory agencies in establishing standards for chromium in the drinking water. We will share our data with these agencies and provide testimony at the Schiff hearings in October. We will be pleased to report to the City Council Environmental Oversight Committee and the Public Service Department Board on water test results and regulatory developments on a monthly basis. Additionally, PSD intends to develop a city-wide communication to all water users based on this report.

RECOMMENDATION

Note and file.

Attachments A-D

RED:JWL:rmd/ChromiumWaterStaffReport/lantz



235

BURBANK WATER WELLS

Attachment A

Burbank Operable Unit Treatment Facility

Well samples

	W110		W120		W130		W140		W150		W160		W170		W180	
DATE	**Cr**	**Cr6**	**Cr**	**Cr6**	**Cr**	**Cr6**	**Cr**	**Cr6**	**Cr**	**Cr6**	**Cr**	**Cr6**	**Cr**	**Cr6**	**Cr**	**Cr6**
Oct-99	30	16	20	6	20	11	ND	3	10	6	10	ND	ND	3	ND	ND
Nov-99	30	23	ND	6	20	9	10	5	20	9	20	9	10	2	10	4
Dec-99	40	21	10	5	20	11	10	4	10	9	10	6	ND	2	ND	5
Jan-00	20	ND	10	3	10	4	10	2	10	4	10	3	ND	4	10	3
Feb-00	20	16	ND	8	ND	3	10	9	10	5	ND	ND	ND	3	ND	ND
Mar-00	30	30	1	8	ND	4	ND	2	ND	5	ND	2	ND	ND	ND	2
Apr-00	20	9	ND	3	ND	ND	ND	6	ND	8	ND	6	ND	ND	ND	4
May-00	30	5	ND	2	10	8	10	9	ND	4	ND	8	ND	2	ND	ND
Jun-00	3	10	1	7	1	8	1	4	oos	oos	ND	8	ND	3	ND	4
Jul-00	ND	8	ND	7	ND	3	ND	4	oos	oos	ND	7	ND	ND	ND	4
Aug-00	20	16	10	6	ND	5	ND	5	ND	8	ND	2	ND	ND	ND	4
Sep-00	50	52	ND	7	8	8	ND	8	10	11	ND	8	oos	oos	ND	3
Sep-00	50	52	ND	7	8	8	ND	8	10	11	ND	8	oos	oos	ND	3
Average	24	17	4	6	7	6	4	5	7	7	4	5	1	2	2	3

Maximum Contaminant Level (MCL), parts per billion

	State	Federal	
Cr	*50*	*100*	Total Chromium
Cr6	Unregulated		Hexavalent Chromium

ND Non-Detect
OOS Out of Service
NA Not Analyzed

Note: EPA test method 200.7 has a DLR of 10ppb.
EPA prep-method 7195 was add to analysis method 200.7 to achieve a DLR 0f 2ppb for Cr6

ATTACHMENT B

Burbank Operable Unit Treatment Facility

PSD-Water Division sample results

DATE	BOU EFF*		BLEND EFF**	
	Cr	Cr6	Cr	Cr6
Oct-99	18	17	13.4	14
Nov-99	13	12	13	10
Dec-99	13	27	12.6	18
Jan-00	20	11	20.3	10
Feb-00	18	ND	14	ND
Mar-00	30	12	19.2	ND
Apr-00	25	ND	11.3	ND
May-00	22	ND	15.5	ND
Jun-00	18	ND	ND	ND
Jul-00	6.1	11	2.6	11
Aug-00	ND	ND	ND	ND
Sep-00	PD	PD	PD	PD
Average	17	8	11	6

Maximum Contaminant
Level (MCL), parts per billion

	State	Federal	
Cr	*50*	*100*	Total Chromium
Cr6	Unregulated		Hexavalent Chromium

ND	Non-Detect
OOS	Out of Service
NA	Not Analyzed
PD	Pending Analylical Result

Note: Chromium samples are collected monthly.
* BOU EFF sample is located at the point of delivery.
** BLEND EFF sample is located at point of entry into water distribution system.
EPA test method 200.8 with a DLR of 10ppb.

ATTACHMENT C

Lake St. GAC Treatment Facility

Date	WELL # 7		WELL # 15		PLANT EFFLUENT	
	Cr	Cr6	Cr	Cr6	Cr	Cr6
Oct-99	12.4	14	18.9	15	15.3	16
Nov-99						
Dec-99						
Jan-00			Plant Offline			
Feb-00						
Mar-00						
Apr-00	6.5	ND	6.8	ND	0.4	ND
May-00	ND	ND	16.2	10	10.5	ND
Jun-00	ND	ND	13.9	ND	10.4	ND
Jul-00	ND	ND	41	40	10.5	10
Aug-00	OOS	OOS	15.6	13	ND	ND
Sep-00	PD	PD	PD	PD	PD	PD
Average	4	3	19	13	8	4

Note: Chromium samples are collected monthly, Plant Effluent is located at point of entry into water distribution system.
EPA test method 200.8 with a DLR of 10ppb.

Maximum Contaminant
Level (MCL), parts per billion

	State	Federal	
Cr	***50***	***100***	Total Chromium
Cr6	Unregulated		Hexavalent Chromium

ND Non Detect
OOS Out of Service
NA Not Analyzed
PD Pending Analylical Result

ATTACHMENT D

City of Burbank Water and Power

MEMORANDUM

DATE: October 10, 2000

TO: Robert R. Ovrom, City Manager

FROM: Ronald E. Davis, General Manager, BWP

SUBJECT: **REPORT ON TAKING WELLS OUT OF PRODUCTION**

BACKGROUND

At the City Council meeting on October 3, 2000, the question was raised concerning Burbank Water and Power's (BWP) ability to remove Well 110 from operation to reduce the chromium levels (total chromium and chromium 6) of the Environmental Protection Agency (EPA) Treatment Plant. This report will summarize BWP's current production status.

DISCUSSION

BWP is investigating alternatives to reduce the chromium levels from the EPA Treatment Plant with both short-term and longer-term methods. In the short-term, all Metropolitan Water District (MWD) flow provided to the Burbank Water System will be added at the EPA Treatment Plant to maximize the blending of the well water. The focused addition of the MWD flow will reduce the chromium levels produced by the blended well production at the treatment plant. Additional water quality tests will be taken during the month to evaluate this alternative. We will also begin sampling MWD water for chromium so that all data is being performed by the same test protocol.

In the longer-term, two potential alternatives have been identified to reduce the chromium values of the well field. The first alternative is to use Well No. 110 only as maintenance or emergency back up. The EPA Treatment Plant is designed to operate at an annual average production of 9,000 gpm. Additional production capacity is required for normal maintenance events or the loss of a single well if 9,000 gpm is to be consistently produced and treated. When this level of production is provided, it would be reasonable to remove Well No. 110 for all but outages of relatively short duration. This is an operational decision that can be made by the operator of the plant and extraction facilities. This alternative is not available currently because of the reduced production capability of the well field.

A second alternative considers the provision of a substitute well(s) without high chromium values. We are evaluating the provision of a BWP well for this purpose. This alternative will need to be further evaluated and approved by the EPA because of the Consent Decree. All operation and maintenance issues are governed by the Consent Decree.

At the present time three constraints exist that affect our ability to remove Well 110 from production. First, BWP does not presently control the operation of the facilities. BWP is in a period of transition with Lockheed-Martin that began in July and will end on December 12, 2000. Although our operator is obtaining operating experience by training with Lockheed-Martin, we do not control the operating decisions in accord with the Consent Decree until December 12, 2000.

Second, we are bound by the Consent Decree to take the water, provided that it meets all state and federal water quality standards. Notwithstanding the current concern over the appropriate total chromium and chromium 6 maximum contaminate levels (MCL) for drinking water, the treatment plant currently produces water below the standard and is fully monitored under the state operating permit issued by the California Department of Health Services. If the standards change and we are unable to use the water because we can not meet the standard, production of individual or collective wells will be stopped. When this condition occurs, we will seek to reopen the Consent Decree for additional treatment procedures, construction and operation of the additional facilities, and cost recovery from potentially responsible parties.

Finally, the Consent Decree requires an annual average production from the plant. Due to operational problems since June, the plant has not been able to provide the required daily production. One well is out of production because of mechanical-electrical failure and has not been replaced, one well has been removed for operating considerations, and other wells have been throttled because of reported surging and air entrapment. We have not been satisfied with the Lockheed-Martin response to the production problems. We believe Lockheed-Martin can operate the existing wells deeper, i.e., pump water from lower in the aquifer, by removing the "packers" (shallow plugs in the casing) or, if necessary, by developing additional wells. In any event, Lockheed-Martin should perform at the decreed amount of 9,000 gpm before we provide any substitution production or wells and possibly cloud the financial responsibility defined in the Consent Decree.

BWP has voiced its concerns to the EPA about the loss of production at management meetings, through monthly reports, and by telephone conversations between EPA and Burbank project managers. Our attorney is in the process of formally noticing the EPA attorney about concerns of our contractual obligation to take over operation of the plant in December. We do not want the responsibility of operating the facility at less capability than the full design capacity.

BWP obtained a report from Lockheed-Martin this week about the reduced production. EPA and Burbank are not happy with its reported findings and solutions. We are conducting a full technical evaluation of the report and will respond to the EPA in the near future.

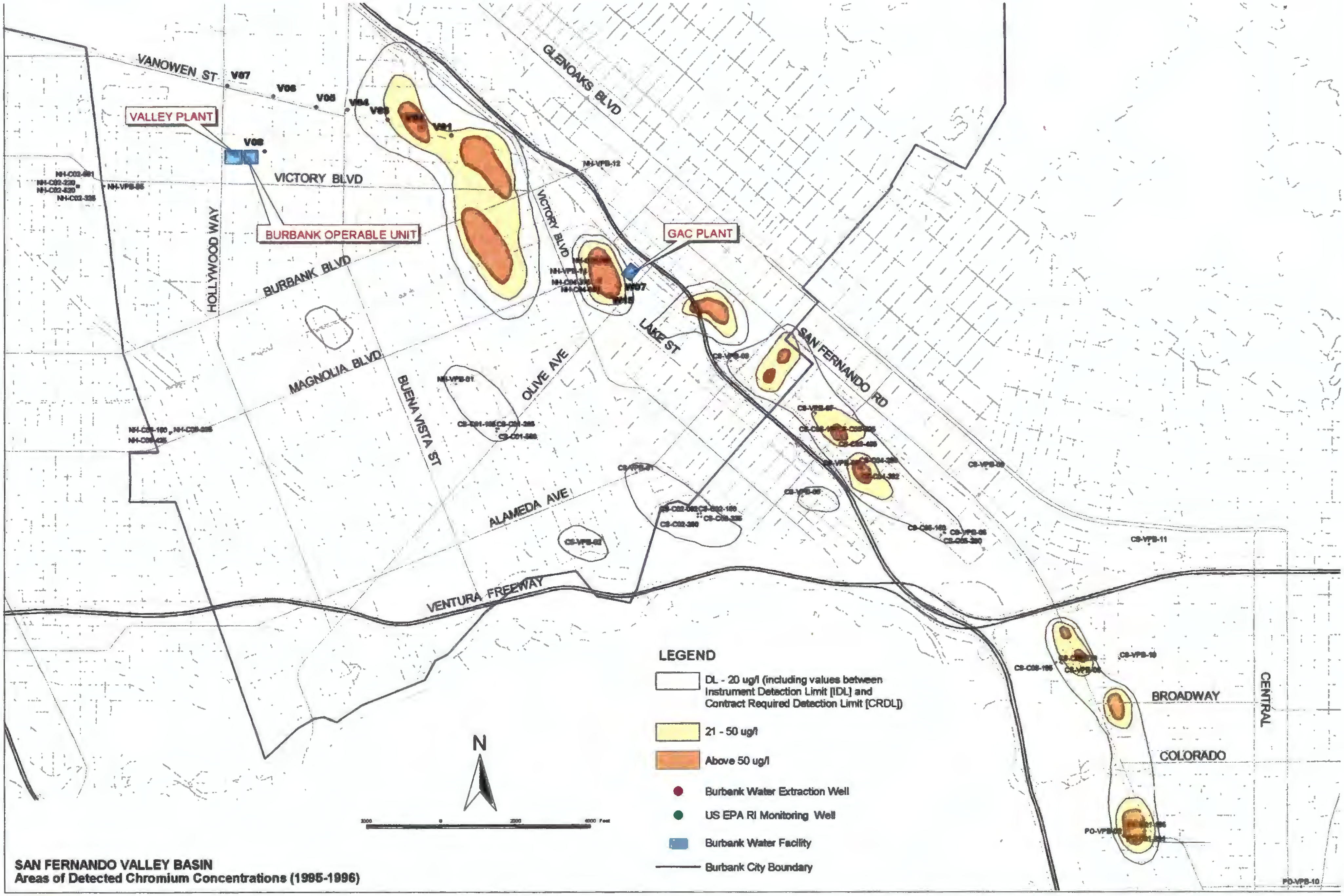
BWP will be attending a meeting that EPA has called on November 9th in San Francisco to discuss the report and its implications.

RECOMMENDATION

Note and file.

Attachments

RED:JWL:rmd/WaterReport2



242

BURBANK WATER WELLS

Attachment A

Burbank Operable Unit Treatment Facility

Well samples

DATE	W110		W120		W130		W140		W150		W160		W170		W180	
	Cr	Cr6	Cr	Cr6	Cr	Cr6	Cr	Cr6	Cr	Cr6	Cr	Cr6	Cr	Cr6	Cr	Cr6
Oct-99	30	16	20	6	20	11	ND	3	10	6	10	ND	ND	3	ND	ND
Nov-99	30	23	ND	6	20	9	10	5	20	9	20	9	10	2	10	4
Dec-99	40	21	10	5	20	11	10	4	10	9	10	6	ND	2	ND	5
Jan-00	20	ND	10	3	10	4	10	2	10	4	10	3	ND	4	10	3
Feb-00	20	16	ND	8	ND	3	10	9	10	5	ND	ND	ND	3	ND	ND
Mar-00	30	30	1	8	ND	4	ND	2	ND	5	ND	2	ND	ND	ND	2
Apr-00	20	9	ND	3	ND	ND	ND	6	ND	8	ND	6	ND	ND	ND	4
May-00	30	5	ND	2	10	8	10	9	ND	4	ND	8	ND	2	ND	ND
Jun-00	3	10	1	7	1	8	1	4	oos	oos	ND	8	ND	3	ND	4
Jul-00	ND	8	ND	7	ND	3	ND	4	oos	oos	ND	7	ND	ND	ND	4
Aug-00	20	16	10	6	ND	5	ND	5	ND	8	ND	2	ND	ND	ND	4
Sep-00	50	52	ND	7	8	8	ND	8	10	11	ND	8	oos	oos	ND	3
Average	24	17	4	6	7	6	4	5	7	7	4	5	1	2	2	3

Maximum Contaminant Level (MCL), parts per billion

	State	Federal	
Cr	*50*	*100*	Total Chromium
Cr6	Unregulated		Hexavalent Chromium

ND Non-Detect
OOS Out of Service
NA Not Analyzed

Note: EPA test method 200.7 has a DLR of 10ppb.
EPA prep-method 7195 was add to analysis method 200.7 to achieve a DLR 0f 2ppb for Cr6

ATTACHMENT B

Burbank Operable Unit Treatment Facility

PSD-Water Division sample results

DATE	BOU EFF*		BLEND EFF**	
	Cr	Cr6	Cr	Cr6
Oct-99	18	17	13.4	14
Nov-99	13	12	13	10
Dec-99	13	27	12.6	18
Jan-00	20	11	20.3	10
Feb-00	18	ND	14	ND
Mar-00	30	12	19.2	ND
Apr-00	25	ND	11.3	ND
May-00	22	ND	15.5	ND
Jun-00	18	ND	ND	ND
Jul-00	6.1	11	2.6	11
Aug-00	ND	ND	ND	ND
Sep-00	PD	PD	PD	PD
Average	17	8	11	6

Maximum Contaminant Level (MCL), parts per billion

	State	Federal	
Cr	*50*	*100*	Total Chromium
Cr6	Unregulated		Hexavalent Chromium

ND	Non-Detect
OOS	Out of Service
NA	Not Analyzed
PD	Pending Analytical Result

Note: Chromium samples are collected monthly.
* BOU EFF sample is located at the point of delivery.
** BLEND EFF sample is located at point of entry into water distribution system.
EPA test method 200.8 with a DLR of 10ppb.

ATTACHMENT C

City of Burbank Water and Power

MEMORANDUM

DATE: October 17, 2000

TO: Robert R. Ovrom, City Manager

FROM: Ronald E. Davis, General Manager, BWP

SUBJECT: **Weekly Council Update on Chromium**

The following activities have taken place since last Tuesday:

- On October 6, 2000, Well No. 110 was removed from production on its production cycle. It remains off at this date.

- The City sent two letters to the United States Environmental Protection Agency (EPA). One letter regarding the reduced operating levels achieved by Lockheed-Martin and our concern about taking over operation in December, and a second letter addressing the *force majeure* issue.

- A request to speed up the meeting date with the EPA between Project Managers was attempted. The EPA Project Manager is out of the country for the next three weeks. A second attempt between attorneys was made. BWP is awaiting a return telephone message.

- Staff made contact with a consulting engineer to perform water quality tests on Well Nos. 11 & 12. (These wells are the potential substitutes for Well No. 110.) We are awaiting the engineer's proposal.

BWP WATER REPORT OCTOBER 17, 2000

- Monthly total chromium and chromium 6 tests were conducted on all wells and MWD water on October 3, 2000. The results have not been received at this date.

- Staff continues to evaluate the Analysis of Groundwater Level Changes at the Burbank Operable Unit (BOU) Extraction and Treatment Facility report prepared by Earth Tech, Inc. for Lockheed-Martin.

- A second round of chromium tests of the BOU Well Blend and MWD Blend will be taken on October 17, 2000 to evaluate the absence of Well No. 110.

- Staff has agreed to share costs for a Chromium Treatment Process Study with the City of Glendale and Los Angeles.

- Staff continues to evaluate the mechanical-electrical installation for Well Nos. 11 & 12 costs and schedule.

- Staff has compiled a list of State approved Home Reverse Osmoses (RO) water treatment units.

- Staff has completed an information newsletter for direct mailing. We are working on the printing at this time.

Up-Coming Actions

- Mail the Chromium Newsletter to all customers.

- Issue a Professional Services Agreement for water quality testing of Well Nos. 11 & 12.

- Enter a cost sharing agreement with Glendale and Los Angeles for study of chromium treatment processes.

- EPA consultant to conduct an on-site inspection of the facilities.

- Schiff Hearing to be held at City Hall on October 24, 2000.

- Los Angeles Department of Water & Power's response on chromium issues is due to the Los Angeles City Council by November.

BWP WATER REPORT OCTOBER 17, 2000

- Burbank, Lockheed-Martin meeting in San Francisco is scheduled on November 9, 2000

RED:JWL:rmd/WaterReportOct17

City of Burbank Water and Power

164 West Magnolia Blvd.
P.O. Box 631
Burbank, California 91503-0631

Bulk Rate
U.S. Postage
PAID
Permit 121
Burbank, CA

Burbank Postal Patron

More on Chromium 6

And, for the past ten years, every Burbank household and business has received an annual water quality report from us, detailing the safety of our water. Here are some of the things we do to ensure Burbank receives quality drinking water:

- Each of our ten wells are sampled and tested monthly.
- All local water goes through treatment at one of Burbank's two water treatment facilities. Water from the Metropolitan Water District of Southern California is treated at its facilities.
- Final samples are taken from the fully treated and blended water and sent monthly for testing.
- An independent state certified laboratory conducts the tests and reports results simultaneously to the California Department of Health Services and to us.

Where Do We Go From Here?

Governor Gray Davis signed Senate Bill 2127 requiring an accelerated review of San Fernando water and Chromium levels in September. The City of Burbank supported this bill and will continue to work with the various regulatory agencies in establishing reasonable standards for Chromium in the drinking water. Additionally, California Senator Adam Schiff hosted a hearing on Chromium 6 on October 24. This was broadcast live from City Hall on Burbank TV channel 6.

How Can I Learn More?

You can visit us at www.Burbank-Utilities.com and read the entire report on Chromium presented to the City Council on September 26, 2000. You can also visit the California Department of Health Services at www.DHS.ca.gov to learn more about Chromium.

What Can Concerned Citizens Do?

Currently known ways to remove Chromium 6 in water is through Ion Exchange Treatment Systems and Reverse Osmosis. A filtration unit by itself will **not** remove Chromium 6.

A list of home water treatment devices certified by the California Department of Health Services can be found on their web site at www.dhs.ca.gov/ps/ddwem/technical/certification/device/sec6-6.pdf. This information is also on our website (www.Burbank-Utilities.com) We do not specifically recommend any of these devices. The costs for these devices varies significantly, starting at $250. Some units will require further installation expenses and all units will have on-going operation costs.

What About Bottled Drinking Water?

The bottled water industry often makes the claim that it is far better regulated than tap water suppliers are. However, according to the National Resources Defense Council, FDA rules for bottled water are generally *less* strict than tap water rules. As regards Chromium, bottled water standards are 100 parts per billion, as set by the U.S. Environmental Protection Agency. Burbank's water falls under California's Department of Health Services more stringent requirement of no more than 50 parts per billion. ✦

October 24, 2000

A Special Newsletter to Burbank Residents & Businesses

City of Burbank Water and Power

Chromium 6: Your Water and What You Need to Know

Burbank water meets or exceeds all state and federal drinking water standards. However, there has been a lot of concern recently about Chromium 6 in Burbank's groundwater. We hope you'll find these facts to be helpful.

What is Chromium 6?

Chromium 6 is just one part of total Chromium. If you take vitamins, you'll probably see Chromium included as one of the minerals. That's trivalent Chromium, or Chromium 3, a naturally occurring and necessary nutritional element. Hexavalent Chromium, or Chromium 6, does not occur naturally in significant amounts and has no nutritional value.

Chromium 6 is primarily a by-product of certain industrial processes and as you know, Burbank had long been home to a great deal of industrial production. The result has been the presence of small amounts of Chromium 6 in our groundwater.

How is Chromium 6 a Health Hazard?

Scientists have established that *breathing in* Chromium 6 is toxic. This is what happened to some of the citizens of Hinkley, California, as portrayed in the movie *Erin Brokovich*.

There currently is little if any scientific data or research that shows that *drinking* water with Chromium 6 is hazardous to one's health. At this point, it is most fair to say that the health risk needs to be determined through further study and review.

What are Current Government Standards?

Both the California Department of Health Services and the World Health Organization have set contaminant levels of 50 parts per billion for total Chromium. The U.S. Environmental Protection Agency has set a maximum contamination level that is twice that, at 100 parts per billion for total Chromium. There is no separate standard for Chromium 6. One organization, the Office of Environmental Health Hazard Assessment (OEHHA) is recommending that the goal for total Chromium be set at a level of no more than 2.5 parts per billion and 0.2 parts per billion for Chromium 6.

Burbank's Water Meets Current Chromium Standards

Burbank's water falls well below the maximum allowable for total Chromium. Here in Burbank, the average total Chromium incidence since October 1999 through August 2000 was 11 parts per billion for our largest water treatment facility and 8 parts per billions for our smaller treatment facility. Total Chromium incidence is well within current standards.

Because Chromium 6 is only a part of total Chromium, we know that Chromium 6 would be less than the 11 and 8 parts per billion. The City measured the amount of Chromium 6 directly, finding 6 parts per billion for our largest water treatment facility and 4 parts per billion for our smaller treatment facility.

But Is Water From Our Treatment Facilities Currently Safe to Drink?

We are very confident that it is. Otherwise, we would not be delivering water from these facilities to you. The California Department of Health Services sets standards at a level that it believes is protective of human health.

Burbank Water and Power has been monitoring and reporting the incidence of total Chromium and Chromium 6 for each of our wells since 1998.

DRAFT

City of Burbank **Burbank Water and Power** **Water-Light-Power**

California Department of Health Services
Certified Water Treatment Device Directory of Reverse Osmosis Systems
October 16, 2000

Burbank water meets or exceeds all state and federal drinking water standards. Burbank reported in its 1999 Annual Water Quality Report that total Chromium varied from non detect to 26 parts per billion. The state maximum contaminant level for total Chromium is 50 parts per billion. Water quality data indicates that Chromium 6 would range from non-detect to 13 parts per billion. There is not a state standard for Chromium 6. Its value is included with total Chromium.

However, there has been a lot of concern recently about Chromium 6 in Burbank's groundwater.

Currently known ways to remove Chromium 6 in water is through Ion Exchange Treatment Systems and Reverse Osmosis. A filtration unit by itself will **not** remove Chromium 6.

A list of home water treatment devices certified by the California Department of Health Services can be found on their web site at www.dhs.ca.gov/ps/ddwem/technical/certification/device/sec6-6.pdf. Burbank Water and Power will also post this information on its website (www.Burbank-Utilities.com).

Burbank Water and Power does not specifically recommend any of these devices. The costs for these devices vary significantly, starting at $250. Some units will require further installation expenses and all units will have on-going operation costs. Devices on this list may not remove Chromium 6 to the suggested Office of Environmental Health Hazard Assessment recommendation of 0.2 parts per billion.

Certified Devices:

Reverse Osmosis Systems

Certificate Number	Model Name	Type of System
91-1013	Ultrefiner 9591N	under counter
92-1016	EcoWater Systems - ERO 300E with monitor faucet	under counter
91-1018	Culligan Good Water Machine AC-30	under counter
91-1018	Culligan Good Water Machine AC-30 Premier	under counter
91-1018	Culligan Good Water Machine AC-30L	under counter
91-1018	Culligan Good Water Machine AC-30L Premier	under counter
91-1018	Culligan Good Water Machine AC-30M	under counter
91-1018	Culligan Good Water Machine AC-30M Premier	under counter
91-1018	Culligan Good Water Machine H - 30PRV-C	under counter
91-1018	Culligan Good Water Machine H - 30S-R	under counter
92-1042	SQC Series - Model SQC2 HF	under counter
92-1042	SQC Series - Model SQC3 HF	under counter
92-1042	SQC Series - Model SQC4 HF	under counter
92-1042-1	ICON 2000 DWS	under counter
92-1056	WRI Super Deluxe - C	under counter
92-1056	WRI UltraMicron Filtration System™ - C	under counter
92-1070	Premier RO-TFM-4SV	under counter
92-1070	Premier RO-TFM-5SV	under counter
92-1073	Culligan Good Water Machine AC-30 Nitrate	under counter
92-1073	Culligan Good Water Machine AC-30L Nitrate	under counter
92-1073	Culligan Good Water Machine AC-30M Nitrate	under counter
93-1169	Kinetico Drinking Water System - Plus VX with CTA Membrane	under counter
94-1175	EcoElite - ERO392E with Monitor Faucet	under counter
94-1175	EcoElite - ERO494E with Monitor Faucet	under counter
94-1176	Sears Kenmore - 625.347050 (With Monitor Faucet)	under counter
97-1194	Everpure ROM III	under counter
95-1204	BestWater Reverse Osmosis System II, Model #52345	counter top
98-1209	Good Water Machine AC-30 M Premier - VOC	under counter
98-1209	Good Water Machine AC-30 M - VOC	under counter
98-1209	Good Water Machine AC-30 Premier - VOC	under counter
98-1209	Good Water Machine AC-30 - VOC	under counter
98-1209	Good Water Machine AC-30L Premier - VOC	under counter
98-1209	Good Water Machine AC-30L - VOC	under counter
98-1209	Good Water Machine H - 30PRV-C - VOC	under counter
98-1209	Good Water Machine H - 30S-R - VOC	under counter
95-1213	GWC 251	
96-1222	Essential Water & Air SQC4	under counter

Reverse Osmosis Systems

Certificate Number	Model Name	Type of System
96- 1223	Micromax 5500 TFC	under counter
97- 1263	Microline T.F.C.-4	under counter
97- 1263-1	Technetic Plus TRO-4	under counter
97- 1264	Microline T.F.C.-3	under counter
97- 1265	RaynePure	under counter
97- 1268	General Electric PNRV12ZBL01	under counter
97- 1269	General Electric PN RV18ZBB01	under counter
97- 1269	General Electric PN RV18ZBL01	under counter
97- 1269	General Electric PN RV18ZWH01	under counter
97- 1269	General Electric PN RV18ZWW01	under counter
97- 1273	Living Water	under counter
98- 1298	418B	under counter
98- 1298	520A	under counter
98- 1298	524L	under counter
98- 1298	K525	under counter
98- 1298	Q525	under counter
97- 1309	Everpure ROM II	under counter
97- 1323	Water Factory Systems SQC 2 HF (Nitrate)	under counter
97- 1323	Water Factory Systems SQC 3 HF (Nitrate)	under counter
97- 1323	Water Factory Systems SQC 4 HF (Nitrate)	under counter
97- 1328	NorthStar NSROWF	under counter
97- 1328	Tapworks TWROWF	under counter
98- 1334	Kinetico Drinking Water System - Plus GX with TF Membrane	under counter
98- 1335	Kinetico Drinking Water System - Base Model	under counter
98- 1354	Sierra NS-1N30	under counter
98- 1358	WaterSoft WSRO-35TA	under counter
98- 1360	GE GXRV10ABL01	under counter
98- 1362	WaterMaker Mini	faucet mount
99- 1370	Pure-Tel Premier Series	under counter
99- 1380	Kenmore 625.347051	under counter
99- 1384	Avian Drinking Water System RO-425	under counter
99- 1389	EcoWater ERO-R335	under counter
99- 1390	Culligan Water Tower Drinking Water Appliance CWT35ST3.0	under counter
99- 1391	Kinetico Drinking Water System - Plus GX	under counter
99- 1392	Kinetico Drinking Water System - Plus VX	under counter
99- 1396	TGI Pure TGI-525	under counter
99- 1397	Hydrotech 10103101	under counter

Certificate Number	Model Name	Type of System
99- 1397	Hydrotech 10103102	under counter
99- 1397-1	U.S. Pure Water Corporation 10103101	under counter
99- 1397-1	U.S. Pure Water Corporation 10103102	under counter
99- 1397-2	Sierra Springs 10103101	under counter
99- 1397-2	Sierra Springs 10103102	under counter
99- 1398	Hydrotech 10304101	under counter
99- 1398	Hydrotech 10304102	under counter
99- 1399	Hydrotech 10303101	under counter
99- 1399	Hydrotech 10303102	under counter
99- 1400	Hydrotech 10107101	under counter
99- 1400	Hydrotech 10107102	under counter
99- 1401	Hydrotech 10106101	under counter
99- 1401	Hydrotech 10106102	under counter
99- 1402	Hydrotech 10105101	under counter
99- 1402	Hydrotech 10105102	under counter
99- 1403	Hydrotech 10104101	under counter
99- 1403	Hydrotech 10104102	under counter
99- 1403-1	Sierra Springs 10104101	under counter
99- 1403-1	Sierra Springs 10104102	under counter

City of Burbank Water and Power

MEMORANDUM

DATE: October 24, 2000

TO: Robert R. Ovrom, City Manager

FROM: Ronald E. Davis, General Manager, BWP Ron

SUBJECT: **Weekly Council Update on Chromium**

The following water activities have taken place since last Tuesday:

- Staff was directed to conduct chromium testing at various public buildings within the Burbank water system. Sites were selected and samples were collected on October 19, 2000. Test results will be available within 10 working days (Nov. 3, 2000). See Attached list.

- Staff has compiled a list of State approved Home Reverse Osmoses (RO) water treatment units. The list has been added to our web page. Copies are available on the council materials table.

- Staff has completed an information newsletter for direct mailing to Burbank customers. We are proceeding with the printing and mailing.

- Well No. 110 was removed from production on October 6, 2000. It remains off at this date.

- Staff completed the Professional Services Agreement for Water Quality Testing of Well Nos. 11 & 12 (alternative production wells for Well No. 110.) We are awaiting the consultant's signature of the documents. The consultant is Richard Slade & Associates.

WEEKLY COUNCIL UPDATE ON CHROMIUM
OCTOBER 24, 2000

- Staff continues to evaluate the mechanical-electrical installation for costs and schedule of Well Nos. 11 & 12.

- Monthly total chromium and chromium 6 tests were conducted on all wells, system blends, and Metropolitan Water District water. The results received are as follows:

EPA TREATMENT PLANT	**Total Cr**	**Cr. 6**
Oct. 2, 2000 Test	**DLR=10**	**DL=2**
• Well No. 110	26 ppb Cr.	18 ppb Cr.6
• Well No. 120	13 ppb Cr.	6 ppb Cr.6
• Well No. 130	11 ppb Cr.	4 ppb Cr.6
• Well No. 140	10 ppb Cr.	4 ppb Cr.6
• Well No. 150	13 ppb Cr.	7 ppb Cr.6
• Well No. 160	15 ppb Cr.	12 ppb Cr.6
• Well No. 170	N/S ppb Cr.	N/S ppb Cr.6
• Well No. 180	6 ppb Cr.	13 ppb Cr.6
Oct. 3, 2000 BOU	**DLR=1**	**DL=10**
• MWD @ B-5	ND ppb Cr.	ND ppb Cr.6
• Well Blend	5 ppb Cr.	11 ppb Cr.6
• System blend	5 ppb Cr.	ND ppb Cr.6
GAC Treatment Plant		
• Well No. 7	5 ppb Cr.	ND ppb Cr.6
• Well No. 15	11 ppb Cr.	13 ppb Cr.6
• System blend	6 ppb Cr.	ND ppb Cr.6
Oct. 17, 2000 BOU	**DLR=1**	**DL=1**
• MWD @ B-5	ND ppb Cr.	3 ppb Cr.6
• Well blend	9 ppb Cr.	10 ppb Cr.6
• System blend	4 ppb Cr.	8 ppb Cr.6

ND = Non Detection
DLR = Detection Limit
DL = Detection Limit
N/S = Not Sampled

The laboratory notes that instrument inconsistencies near the Detection Limit concentrations may indicate higher Cr. 6 levels than total Cr.

- Staff continues to evaluate the Analysis of Groundwater Level Changes at the Burbank Operable Unit Extraction and Treatment Facility report prepared by Earth Tech, Inc. for Lockheed-Martin.

- Staff has agreed to share costs for a Chromium Study (treatment options etc.) with the City of Glendale. The consultant is McGuire Environmental Consultants, Inc. The initial report is due on December 15, 2000.

Up-Coming Actions

- Schiff Hearing to be held at City Hall on October 24, 2000.

- Finalized Professional Services Agreement for Water Quality Testing of Well Nos. 11 & 12.

- Finalized Cost Sharing Agreement with Glendale for the Chromium Study.

- EPA consultant to conduct an on-site inspection of the facilities.

- Los Angeles Department of Water and Power response due to the Los Angeles City Council by November on chromium issues.

- Burbank, Lockheed-Martin meeting in San Francisco with the Environmental Protection Agency on November 9, 2000.

Attachment

RED:JWL:rmd/WaterReportOct24-2

CHROMIUM TESTING

PUBLIC BUILDINGS
OCTOBER 19, 2000

The City Council requested at its meeting of October 17, 2000, that total chromium and chromium 6 testing results be obtained for various public buildings in Burbank. Samples were collected on October 19, 2000. Truesdail Laboratories, Inc. is analyzing the samples and the results will be available within 10 working days.

The California Department of Health Services maximum contaminate level (MCL) for total chromium is 50 parts per billion (ppb). Total chromium is the sum of chromium 3 and chromium 6. There is no MCL for chromium 6 at this time.

SAMPLE LOCATIONS

Location	Address	Total Cr.	Cr. 6
City Hall	275 East Olive Ave.		
Main Library	110 North Glenoaks Blvd.		
Buena Vista Library	401 North Buena Vista St.		
Joslyn Center	1301 West Olive Ave.		
Fire Station No. 13	2713 Thornton Ave.		
Fire Station No. 12	664 North Hollywood Way		
Burbank High School	902 North Third St.		
John Burroughs High School	1920 Clark Ave.		
John Muir Middle School	1111 North Kenneth Rd.		
Robert Louis Stevenson Elem. School	3333 Oak Street		
William McKinley Elem. School	349 West Valencia Ave		
Valley Pumping Plant	2030 Hollywood Way		
Lake Street GAC	320 North Lake St.		

Edwards & Associates
Community Consultants

Preliminary Review

Los Angeles
Department of Water and Power

East Valley Water Reclamation Project

September 2000

Prepared by

Robert J. Edwards
Lead Consultant Project Analyst

The region covered in this report is in commonly known as the San Fernando Ground Water Basin (SFGWB) or East San Fernando Valley Aquifer (ESFVA) . The project reviewed is refereed to as the East Valley Water Reclamation Project (EVWRP). The questions addressed regard the feasibility of utilizing tertiary treated human and industrial effluence from the Tillman Water Reclamation Plant for ground water recharging of the East Valley Aquifer via: Hansen Dam flood control reservoir, the Hansen (106 acre), Pacoima (107 acre) and Tujunga (83 acre) spreading grounds... and the geological, environmental, biological and public health implications of the LADWP East Valley Water Reclamation Project.

The main data bases utilized for this report are : The original City of Los Angeles Department of Water and Power Final Environmental Impact Report on the East Valley Water Reclamation Project dated July 1991 and alternate configurations contained within, The Upper Los Angeles River Area Watermaster report on ground water pumping and spreading dated July 2000, the City of Los Angeles Community Redevelopment Agency Northeast San Fernando Valley Redevelopment Project Environmental Impact Report dated October 1999 The CRA EIR project areas northern and east - west boundaries are roughly identical to the ESFVA and include the DWP EVWRP area covering approximately 75% of the region addressed and the United States Environmental Agency. Additional reference materials are cited throughout.

Topography

see CRA EIR 5.9.3 figure 5.9-1 DWP EVWRP figure 16 - 4 pg. 3 summaries

The EVWRP project area is located in the urbanized , southeast sloping topography of the San Fernando Valley. Surface elevations range from approximately 1,150 ft above mean sea level at the northern end of the ESFVA area to 700 ft at the southwest and 600 ft msl at the southeast portion . The 1,150 elevations included are indicative of the hillside formations comprising the Lakeview Terrace portions of the region adjacent to the elevated earthworks comprising the Hansen Dam flood water retention structure some 250 & 150 ft. above normal grade respectively.

The Hansen flood retention basin is a natural depression situated at the juncture of 5 active earthquake faults ; the e/w Mission Hills Fault - the e/w Mission Hills Thrust - the e/w Wildwood Fault - the e/w Lakeview Thrust, all converging at the n/s Verdugo Fault at the northwest end of the basin .An unidentified connector fault running approximately 1 mile e/w from the Northridge Hills Fault through the Tujunga wash to the Vedugo Fault, form the southern and western ends of the basin.(1)

The Hansen spreading grounds are located within the 100 year flood plain approximately 750 to 1,500 ft immediately down grade from the Hansen Dam flood gates proper.(2) The Pacoima spreading grounds are similarly situated on the 100 year flood plains of the ne to sw Pacoima wash, approximately 1 mile ne of the Northridge Fault and 1/2 mi. sw of the juncture of the Lakeview Fault, Mission Hills Thrust and Verdugo Fault. (2) The Tujunga spreading grounds are located at the juncture of the I - 5 and SR 170, adjacent to a local high school and USEPA- NPL site.

Additional ground faults with potential for movement at the northern proximity to the EVWRP are ; The Whitney fault, Grapevine fault, Sombrero fault, Olive View fault and North Olive View fault. (see California Division of Mines and Geology. and City of L.A. general plan seismic safety plan Fault Zone Special Studies Zones identifying active or potentially active faults within 1/8 mile of known faults.)

1 see maps CRA EIR 5.9.3 figure 5.9.1
2 CRA EIR 5.8.16 fgr 5.8.4

Seismicity

The seismicity of So. Cal. is dominated by the intersection of the northwest San Andreas fault system and the east-west Transverse Ranges fault systems. These systems are respondent to strain which is relieved by right lateral strike slip faulting on the San Andreas and related faults; and by vertical, reverse slip or left lateral strike slip displacement on the transverse range systems. Hydraulic erosion has also been identified as a probable contributing factor in recent years.

Soils - Minerals

CRA EIR 5.9.1

"The EVWRP project area is located in the upper Los Angeles basin. Alluvial gravel, sand , and clay overlie the majority of the EVWRP project area. According to the Los Angeles General Plan Framework maps, a substantial portion of the project area contain significant mineral deposits ie: oil, gas, sand and gravel. The Pacoima Oil Field is also located within the (ESFVA) area near the mid western boundary."

1 see maps CRA EIR 5.14.2 fgr 5.14.1

Subsidence
CRA EIR 5.9.7

"Subsidence in So. Cal. is attributed to 4 major causes : tectonic activity, ground water extraction, hydro-compaction, and oil and gas withdrawal. Subsidence may occur regionally due to earthquake shaking, withdrawal of ground water, identification of soils, and / or withdrawal of hydrocarbons. Localized subsidence may occur in unconsolidated soils during earthquake shaking as a result of a more efficient arrangement and compaction of individual soil particles. Stream channel and valley alluvium are generally most susceptible to earthquake induced subsidence. Subsidence potential is a significant adverse impact within the proposed project area. Oil and gas withdrawal have resulted in significant subsidence in both Long Beach and Baldwin Hills. Subsidence may also occur as a result of consolidation of near surface soils and organic matter". The escalated use of the Pacoima and Hansen spreading grounds will significantly alter the consolidation of near surface soils and organic matter, which has the capacity of dramatically altering the project area subsidence potential.

see CRA EIR 5.13.2 / 5.9.3 fgr. 5.9.1 / 5.9.6 fgr. 5.9.2 / 5.8.16 fgr. 5.8.4 / 5.14.2 fgr. 5.14.1

Liquefaction
CRA EIR 5.9.4

"Liquefaction is the phenomenon in which saturated granular sediments (alluvial sands and gravel) temporarily lose their shear strength during periods of strong, earthquake induced ground shaking. The susceptibility of a site to liquefaction is a function of depth, density and water content of the granular sediments and the frequency and magnitude of earthquakes in the surrounding region. Saturated, non consolidated silts, sands and silt sands within 50 feet of the ground surface are most susceptible to liquefaction."

see maps CRA EIR 5.9.3 / 5.9.6 / 5.8.16 / 5.14.2

Liquefaction Potential
CRA EIR 5.9.7

"Liquefaction related phenomenon include : lateral spreading, ground oscillation, flow failures, loss of bearing strength, subsidence and buoyancy effects. In addition, densification of the soil resulting in vertical settlement of the ground can also occur. Lateral spreading and liquefaction were most responsible for the majority of pipeline failures in San Francisco in the 1989 Loma Prieta earthquake and in the San Fernando Valley during the 1994 Northridge earthquake (post DWP EVWRP EIR July 1991). Damage induced by lateral spreading and liquefaction occurs within 15 - 20 feet of the ground surface. Liquefaction potential in the center of the proposed project area is a significant factor."

"According to the L.A. General Plan Framework maps, there are potential liquefaction areas within the vicinity of the proposed project area. Areas susceptible to liquefaction include the northern portion of the ESFVA near Norman Lake, as well as the project area south of Hansen Dam (Hansen spreading grounds), and the junction of the I-5 and SR-170 freeways (Tujunga spreading grounds). Extended periods of heavy rainfall" (or spreading use for the EVWRP percolation) "significantly increase the areas susceptibility to liquefaction".

see maps CRA EIR 5.9.3 / 5.8.16 / 5.14.2 /

Natural water paths

The natural waterways that have historically recharged the East Valley Aquifer in general follow the geological depressions created by seismic activity along partitions of the transverse ranges, and continue following the general topography of the east valley floor starting from the north and east as delineated : (1) Norman Lakes area at the southern juncture of the Whitney, Grapevine and Sombrero faults leading into Bull Creek (now almost entirely concrete encased and below surface level) which forms the western most boundary of the ESFVA ; The Pacoima wash (entirely concrete encased) starting at the juncture of the Sombrero and North Olive View faults running n - sw into the Pacoima spreading grounds before turning due south with branches heading se across the historical flood plane to join the Tujunga wash ; Little Tujunga wash starting from the north via a due south depression at the Pacoima reservoir and from the east following the Wildwood fault feeding into the Hansen depression proper ; Big Tujunga wash following the Lake View thrust and feeding into the Hansen depression proper ; and from the La Tuna Canyon and La Tuna Canyon lateral creek beds following the   , and turning south as it meets the ns Verdugo fault.

1 CRA EIR 5.8.16 figure 5.8.4 (FEMAQ3 flood data)
2 CRA EIR 5.9.3 figure 5.9-1

Flooding
CRA EIR 5.8. 16 - 17 -18
" According to the City of Los Angeles Department of Public Works, there have been serious drainage problems associated with the project area. The City defines drainage problem areas, as " an area where waters overflow the local street curbs during a 10 year storm ". During the past and recent storms, runoff has exceeded the tops of curbs in the vicinity of Tuxford st. and San Fernando rd". (Additionally, curb height overflow has occurred annually from Bradley landfill, running south on Tujunga blvd. 1.25 mi. to Sherman way. Flood levels on Tujunga blvd. during 1996 - 7 rains exceeded curb heights by more than 15"). "As a result of this problem, Los Angeles County has proposed the development of a main trunk line system that would collect storm water runoff from the Sun Valley community and direct flows into the Los Angeles River". The Pacoima spreading grounds lie beside the Pacoima wash. Overflows and storm runoff are channeled directly into the wash and eventually into the Los Angeles river.
see maps CRA EIR 5.8.6 fgr 5.8.4
Inundated areas
CRA EIR 5.8.18
" Because of the extensive nature of potential inundation areas from Hansen Dam or other canyon storm water flows, impacts on the proposed project area are unavoidable."
" Development within the project Area creates a increased risk of exposure to residents and buildings to injury and damage ". (This should include the DWP-EVWRP development proposal to spread tertiary treated water on these spreading grounds within the flood plane. All spreading grounds designated for the EVWRP lie within the 100 year flood plane.)
see maps CRA EIR 5.8.6 fgr 5.8.4
Ground Water Tables - Hydraulics
CRA EIR figure 5.9.2 page 5.9.6 / CRA EIR 5.10.1 / ULARAW plate 1
"The proposed project area lies in the Upper Los Angeles River Area (ULARA). This entire groundwater basin is considered to be a Superfund Megasite, as refereed to by the Metropolitan Water Authority ". (The State of California Environmental Protection Agency and the United States Environmental Protection Agency { USEPA region 9 superfund site map}). " This classification is for the extensive groundwater contamination in the basin (three National Priority List {NPL} sites). In this case groundwater cleanup needs to address the entire basin through a coordinated management effort (1,6). The groundwater basin has deep alluvial basins, which do not have continuos effective layers above ground water levels (2)".

In general groundwater flows from the northeast to the southeast along the Verdugo foothill crescent of the Valley floor. The water table levels of the East San Fernando Valley follow the contours of the surface topography with vertical deviations for hilly or fault slip terrain's.(3)

According to the map created by the ULARA Watermaster (July 2000 ULARA plate 1) for groundwater contours in the ULARA, groundwater elevations in the northeastern portion of the proposed project area (Northeast of the Verdugo fault, a groundwater cascade) range from 650 amsl (above mean sea level) at normal grade central to Hansen Dam to 1025 feet amsl at the height of the Sunland Tujunga incline. The groundwater elevations in the southwestern portion of the proposed project area (southwest of the Verdugo fault) range from 500 to 650' amsl. Groundwater elevations in the Pacoima spreading grounds region average 600' to 650' amsl. the northern portions of the proposed project area (North of the Mission Hills thrust), an impediment to groundwater flow) range from 900 to 1150 feet amsl.

Average water table depths within the proposed EVWRP range from 10' to 50" on most median grade areas. This situation is reflected in the absence of basement, cellar and underground parking structures due to flooding during periods of heavy precipitation. Newly constructed (partial underground) parking facilities at the extreme southern limit of the ESFVA in the Crystal Springs area (Ventura Blvd. - Cahuenga Pass) resulted in considerable structural damage and emergency extraction with discharge directly into the Los Angeles river during recent heavy rainfall periods..

" A key element affecting the quantity and quality of groundwater in the San Fernando Valley area are spreading grounds. These undeveloped areas have been designated for the purpose of collecting surface water flows so that groundwater aquifers can be recharged by the percolation of surface water downward through various geological formations and strata. In addition, large undeveloped sites used for quarries and landfills also function as informal recharge areas for underground aquifers (5)". {{Hansen Dam (ground water table depth @ O+ feet), Hansen Dam spreading grounds (107 acres ground water table @ - 30 feet (4)) Pacoima spreading grounds (105 acres with water table @ 20' - 30') (4)) and Tujunga spreading grounds (90 acres water table @ 20' - 30') (4) are delineated within the EVWRP.}}
(1) Metropolitan Water District 5 - 1994 (2). California Regional Water Quality Board LAR 4 1994 (3) ULARA plate 5 (4) CRA EIR 5.9.6 /5.9.2 (5) CRA EIR 5.14.2 /5.14.1 (6) State Water Resources Control Board April 5, 2000. individual site acreage from DWP EVWRP EIR 7-91 table 4-1

Existing conditions
CRA EIR 5.11.1 -4 summaries

" Numerous underground storage tanks (UST), leaking underground storage tanks (LUSTS), solid waste landfills, and large quantity waste generators (LQG) have been identified within the boundaries of the ESFVA and EVWRP project areas. One National Priority List (NPL Superfund site) which has contaminated the ground water with volatile organic compounds (VOC) exists central to the proposed project site. Based on historical uses within the project area, a high potential for environmental impacts exists within all areas of the proposed project site ".

USEPA has designated the ESFVA site as a National Superfund Mega Site due to contaminant levels far in excess of existing contaminant standards. The lower 2/3 of the ESFVA or approximately 70% are contaminated with Perchloroethylene and Trichloroethylenes contents ranging from 5.01 micrograms per litre or above, 5% @ 20 mcg or above, 18% @ 100 mcg or above 5% @ 500 mcg or above and 2% @ 5,000 mcg or above. USEPA regulations delineate any PCE or TCE contaminant levels above 5.01 mcg per litre as unfit for human consumption (1). (estimated %).

USEPA maps demonstrate the nothern 1/3 of the ESFVA as spotted with large overlaying contaminant area plumes in the shallow and deeper zones, The extensive northern plumes are characterized by their proximity to the EVWRP spreading grounds, previous and currently existing landfills, and LAUSD school sites.

A September 1997 US Environmental Protection Agency report describes the status of the North Hollywood and Crystal Springs wellfield area.

"San Fernando Valley - North Hollywood wellfield area.

This wellfield is located in North Hollywood and Burbank. The LADWP has been operating a groundwater treatment system for Volatile Organic Compounds (VOC) in North Hollywood since 1989, while the Burbank groundwater treatment system for VOC's has been in operation since 1996. The treated groundwater is then distributed to the public through LADWP's North Hollywood pumping station or through a MWD blending process"

"San Fernando Valley - Crystal Springs wellfield area

This wellfield area is centrally located in the Glendale area. The USEPA discovered elevated levels of VOC's in the groundwater in 1989. Groundwater remediation systems are currently set up in the Glendale area, and after treatment, the groundwater will be blended with MWD water for distribution to the public ".

Significant data
Los Angeles Regional Water Quality Control Board 1997-98 annual report

"During the 1997-98 fiscal year, approximately 100,000 pounds of VOC's were removed from soils and ground water at facilities overseen by LARWQCB staff at Superfund sites in the San Fernando Valley.

During fiscal year 1997-98 77,000 pounds of VOC's were removed from soils at the former Lockheed facilities in Burbank. These clean up actions removed VOC's that would have otherwise migrated into groundwater systems ".

CRA EIR " Area oil ,gas wells, and hazardous / toxic materials records relating to the proposed project area were reviewed. A number of incomplete and/or abandoned oil wells are reported within the project area. Environmental Data Resources (EDR) and US Environmental Protection Agency (USEPA) materials were reviewed to research public data bases of facilities that generate, store, treat or dispose of hazardous materials. The LACRA contracted with EDR for facilities / sites for which a release or incident has occurred. There are approximately 3,100 listings in the EDR data base within a one mile radius of project area",(or northern 50% of the EVWRP area). " Review of government records indicates numerous underground and leaking storage tanks, small and large quantity hazardous waste generators, hazardous materials incidents (accidental releases or spills), three superfund sites, six potential superfund sites, and 35 landfill facilities exist within, or within a 1 mi. radius of the proposed project area.".

" Because of the identified historical and current land use, the majority of property within the project area has been determined to have either moderate or high potential for human health and safety impacts due to widespread historic and current use of hazardous materials ".

As part of the requirements under Superfund, USEPA must attempt to identify potential responsible parties. In addition, for any cleanup program to be effective, the existing source of contamination must be identified and mitigated.

1 see maps USEPA fgr 3-6,,7,9.10

" While a majority of the North Valley CRA project area is identified as having a high potential for the use or historic use of hazardous materials, the following area are of particular note :

* Commercial corridors along Lankershim Blvd.
* Residential and commercial corridors along Laurel Cnyn. Blvd.
* Commercial and Industrial corridors along Railway corridors.
* Commercial and Industrial corridors along Sherman Wy.
* Commercial and residential corridors along Paxton st.
* Commercial and industrial corridors along Foothill Blvd from McClay av. to Osborne st.
* Commercial and residential corridors along Rinaldi st.
* Commercial industrial and residential corridors along Laurel Cnyn. Blvd. from Paxton st. to Sheldon st.
* Commercial and residential corridors along Van Nuys Blvd. from Borden st. to Arleta av."

Ground water Basins Recharge and Extraction Rates ESFVA

LADWP City of L.A. Water Services

The San Fernando Ground Water basin consists of 112,000 acres and comprises 91.2 % of the total valley fill (1).Historical recharge data from natural storm precipitation and percolation is averaged at approximately 70,000 - 90,000 acre feet per year. Average withdrawal from this aquifer is delineated at 70,000 to 90,000 acre feet per year.(af/y). These figures represent annual data based on normal alternating seasonal periods of wet and dry

The projected long term groundwater extraction supplies available to the City are expected to increase from the current low precipitation rates of 110,000 af/y to 152,000 af/y by 2015. This increase is attributed to projects using recycled water for ground water recharge in the SFB (ESFVA). These figures demonstrate an intended extraction increase ranging from 50 to 80% annually, creating significant alteration in the saturation content of soils, groundwater flow, and underground erosion.

USEPA and LACo Department of Health set a maximum standard of 20% of ESFVA water may be blended into imported water supplies. These figures are based on the predication that higher percentages of ESFVA water would cause all Los Angeles "tap" water to exceed drinking water quality standards. The proposed project extraction and blending ratios would create a significant increase in the amount of total Volatile Organic Compounds (VOC's including PCE and TCE) to approximately 25 - 30% of City potable water usage.

As discussed previously, the southern 2/3 of the ESFVA are already 80% contaminated due to TCE, PCE and other VOC contaminants. The proposed EVWRP would result in the northern 1/3 of the ESFVA (already heavily spotted with VOC contamination) being exposed to the percolation and inundation of up to 72,000 acre feet of effluence containing an unknown content and diversity of regulated and unregulated biological and bacterial contaminants.

It is noted that the ULARA July 2000 report (pg. 10) delineates a significant decline in water extraction projections for wellheads of the southern and Heavily VOC contaminated EVWRP area (actual average 1979 - 1999 for North Hollywood at 32,548 acre feet per year. Projected extraction for N.H. 2003 - 04 is 18,850 af/y.

It is further noted that extraction projections for wellfields in the northern region, adjacent to or from spreading grounds containing as yet unknown biological contaminants, Rinaldi - Toluca / Tujunga, are expected to rise significantly, from 20,868 af/y 1979 -99 to 34,520 af/y by 2003 - 04, and 6,843 af/y to 25,870 af/y by 2003 - 04 respectively.

The DWP EVWRP EIR for the proposed project also includes references to utilizing " two or more " lakes within the Hansen Dam Recreation area for the discharge of EVWRP effluence. The volume of storm water and EVWRP projected to be percolated through the utilization of the spreading grounds can only be accomplished through three methods : (1) A much faster percolation to well depth and with drawal than purported. (2.) By the continuous "year round " utilization of spreading ground capacities and the influx of approximately 30,000 acre feet of effluence being incorporated into the Hansen Dam Recreation area. This would result in the loss of necessary dry periods to sustain shear strength of the alluvial soils at the spreading grounds and an enormous increase in the pressure against the earthwork structure. This could create a perilous geological structure at the foundation of Hansen Dam, or (3.) the discharge of approximately 60,000 + acre feet of effluence into Hansen Dam Recreation and Storm Water retention area directly, inundating a known environmental and ecologically fragile and protected area.

ULARA expected ground water elevation increases within the Hansen Dam Recreation area are projected at an increase of 100' suggesting that option 2 is one expected methodology. Percolation factors, transverse spreading and yearly flood control necessities suggest that combinations of all three remedial solutions will be employed on a regular basis.

Significant impacts
LADWP EIR EVWRP 4-7

"The Verdugo fault, which runs generally n-s along San Fernando rd. to the south of Hansen Dam spreading grounds , forms a natural barrier to groundwater flow and causes the water table to rise in this area after spreading. The fault forces spreading water to back up and flow in a westerly direction, towards the Bradley landfill. Water backed up behind the Verdugo fault eventually cascades over the underground barrier, and enters the main body of the ESFVA. However, the spreading of large quantities of water at Hansen Dam spreading grounds in the past has caused groundwater to rise within 10 feet of the base of the trash at the Bradley East landfill. Therefor, the amount of water spread at Hansen Dam spreading grounds must be limited, particularly in wet years, to prevent the water table from rising to the point where it encroaches into the Bradley East landfill. The rise in groundwater elevation near the Bradley East landfill which occurs when large amounts of water are spread is a well documented phenomena."

ULARA July 2000 pg. 19

"Above average recharge at the Hansen Dam spreading grounds is affected by the Bradley East landfill, located 3,000 feet downgradient. The RWQCB and the Watermaster's Office prohibit groundwater inundation of the landfill".

ULARA July 200 pg. 19

"The Tujunga spreading grounds are located immediately upgradient from the Sheldon - Arleta landfill. Methane gas has been produced by the landfill since the early 1990's, which has been a source of environmental concern."

" As is typical in the spreading of surface water, water moves through the soil column and displaces the air from voids contained in the soil matrix. A significant migration of air mass has the potential to displace methane gas out of the landfill. In years where above average volumes of water are spread, the methane has migrated and caused elevated gas levels at a nearby High School, and in at least one incidence, forced an evacuation of the school grounds".

The proposed EVWRP project area in the vicinity immediate between The Tujunga and Hansen Dam spreading grounds contains 8 abandoned or currently operating landfills in direct proximity to 9 LAUSD school sites.

Significant Criteria
CRA EIR 5.9.5 ** added criteria

The proposed project would have significant if :

- * The proposed project would entail development within or adjacent to known geological hazard areas, including areas of subsidence, liquefaction, active faults, Alquist-Priolo Special Studies Zones, landslides, mud flows, and expansive soils.
- * The proposed project would increase the potential for soil erosion
- * The proposed project would alter unique geological / geographical features.
- * The project would disrupt or significantly alter ground water flows.
- * The project would significantly reduce, increase or alter groundwater recharge flows
- * The project would substantially reduce or alter groundwater recharge areas for the purpose of gathering storm water accumulation.
- * The project would adversely effect the water quality at production wells
- * The project would significantly alter the flow, course, direction or quality of a surface water body such as a stream, river or lake.
- ** The project would significantly reduce, increase or alter the flow, course, direction or quality of a below surface water body such as a stream, river or aquifer.
- * The project would result in an increased erosion and siltation in existing surface water bodies such as streams, rivers or lakes.
- ** The project would result in an increased erosion and siltation in existing below surface water bodies such as streams, rivers or aquifers.

Visual and Aesthetics

According to the City of Los Angeles' Scenic Highways Plan, there are eight designated scenic highways within the proposed project area (CRA EIR 5.12.1-2) All are effected by the proposed project.

* 1. Stonehurst av. - Sunland bl. to Wentworth st. / 2. Wentworth st. - Glenoaks bl. to Foothill frwy (Views of horse ranches, hills, Hansen Dam and Tujunga wash) / 3. Foothill frwy - Golden State frwy (I-5) to City boundary / 4. Lopez Cnyn. rd. - G.S. frwy. to City boundary / 5. Simi Valley frwy. - City boundary to Balboa bl. / 6. Golden State frwy City boundary to Hollywood frwy (SR-70) / 7. San Diego G. S. frwy interchange to Simi Valley interchange / 8. Rinaldi st. - S.D. frwy. to Canoga to Canoga av Hillside st. (mountain, hillside and valley views.

1 see maps CRA EIR 5.12.2 fgr 5.12.1

Significant Impacts

The proposed project would have a significant detrimental impact if:

* The proposed project would block or adversely change the character of a scenic highway vista.
* The proposed project would produce odors or air born particulants, in surrounding residential, commercial or industrial neighborhoods.
* The proposed project would entail surface areas that are highly reflective.
* The proposed project would have an adverse effect on property values upon surrounding residential, commercial or industrial property values.
* The proposed project would present an increased danger to public health.

Biological Resources

CRA EIR 5.13.- "There are a number of Significant Ecological Areas (SEA) within the proposed project area. (see cra eir figure 5.13.1). These significant ecological areas are important natural resources in that they retain, in a relatively undisturbed state, habitat that is intrinsically unique to the area, or have become unique as a result of urban development. They offer habitat, especially for endangered species. Biological conditions within the proposed project area are characterized in six ecologically sensitive areas. These areas include:

* 1. Verdugo Mountains SEA / 2. Tujunga Valley / Hansen Dam Park / 3. Tujunga Spreading Grounds / 4. Pacoima Spreading Grounds / 5. Van Norman Reservoir Vicinity / 6. Jessup Park.

Tujunga Valley / Hansen Dam Park SEA ".

" The Tujunga Valley occupies the flood plain of Big Tujunga Canyon. Hansen Dam is a flood control basin receiving stream discharge from : Lopez, Kagel, Little Tujunga and Big Tujunga Canyons. The flood plain behind Hansen Dam supports one of the last examples of alluvial scrub vegetation in the fresh water marshes and willow forest. Alluvial scrub is habitat for the State listed Endangered Nevins Barberry and State and Federally listed Endangered slender horned spine flower(1). The Hansen Dam Park area reportedly supports a south coast minnow / sucker stream which supports native populations of arroyo chub (GILA orcutti) and Santa Ana sucker (Catastomus santaanae)(2). The arroyo chub remains common in Big Tujunga, whereas Pacific speckled dace (Rhinichthys osculus) and Santa Ana sucker have become scarce and perhaps extirpated(3). Areas to the southwest (below the dam) are used as spreading grounds for ground recharge water (storm waters) which has created several freshwater marsh areas used by marsh birds, migratory waterfowl and shorebirds ".

Tujunga Spreading Grounds SEA

" This SEA is located in the Tujunga wash downstream from Hansen Dam at the juncture of the Golden State frwy. (I-5) and the Hollywood frwy (SR-170). Although it currently contains little natural vegetation, it is an area of naturally occurring ponding and serves as an important nesting, feeding and resting ground for many migrating, resident and wintering bird species ".

Pacoima Spreading Grounds
" This area of storm water collection located southwest of the junction of the Golden State frwy. (I-5) and the Simi Valley frwy. (SR-170) It supports marsh like habitat when natural ponding occurs (3)., and offers opportunities for migrating waterfowl and shorebirds ".
1 - Englan & Nelson 1976, City of L.A. 1989. 2 - City of L.A. Sewer permit allocation eir 1989.
3 - Swift et al 1993

Significant criteria
cra eir 5.13.3
" The proposed project would have significant impact on biological resources if
* The proposed project has the potential to damage, destroy or harm a plant or animal species listed by the US Fish and Wildlife Services, California Dept. of Fish and Game, and / or listed on the California Natural Diversity Database.
* The proposed project would eliminate , reduce or incurs on an existing wetland
* The proposed project would eliminate, reduce or disturb an identified and designated natural habitat or wildlife migration corridor ".

Impacts
cra eir 5.13.3
" Significant impacts associated with the proposed project would involve loss or damage to sensitive biological habitats, especially when those developments occur in areas designated as significant ecological areas by the City of Los Angeles, and/or sensitive natural communities by the California Dept. of Fish and Game. Loss of these sensitive natural habitats could include loss or damage to Special Species Status.
The EVWRP is a specific project that should require a site specific environmental review ".

Litigation Concerns

The California Environmental Quality Act (CEQA) requires that the assessment of potentially environmental impacts specifically address the following topics.

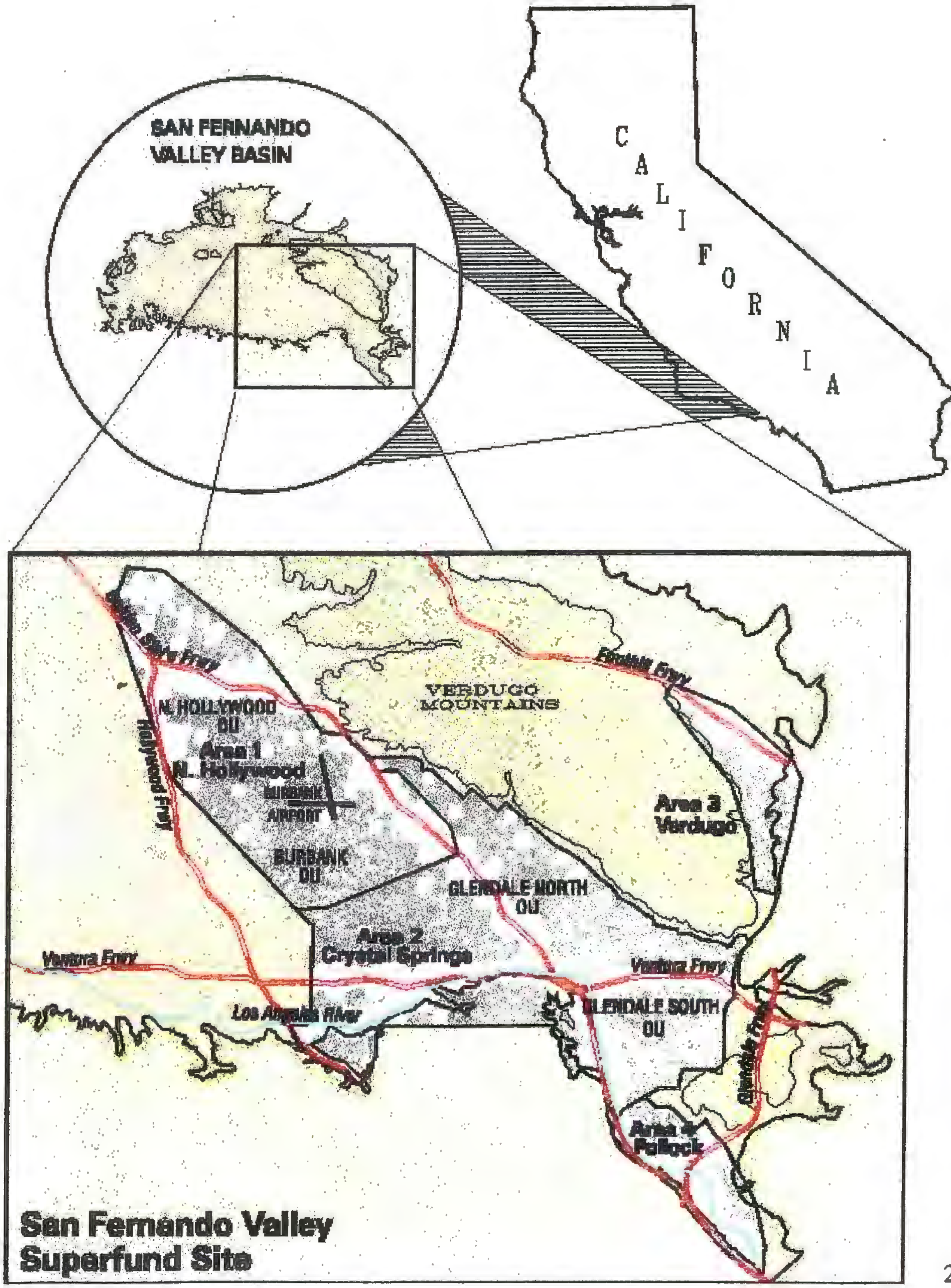
* **Irreversible environmental changes resulting from project implementation.**
* **Growth inducing impacts of the proposed action**
* **Cumulative impacts.**
* **No Project alternatives.**
* **Environmentally superior alternatives**

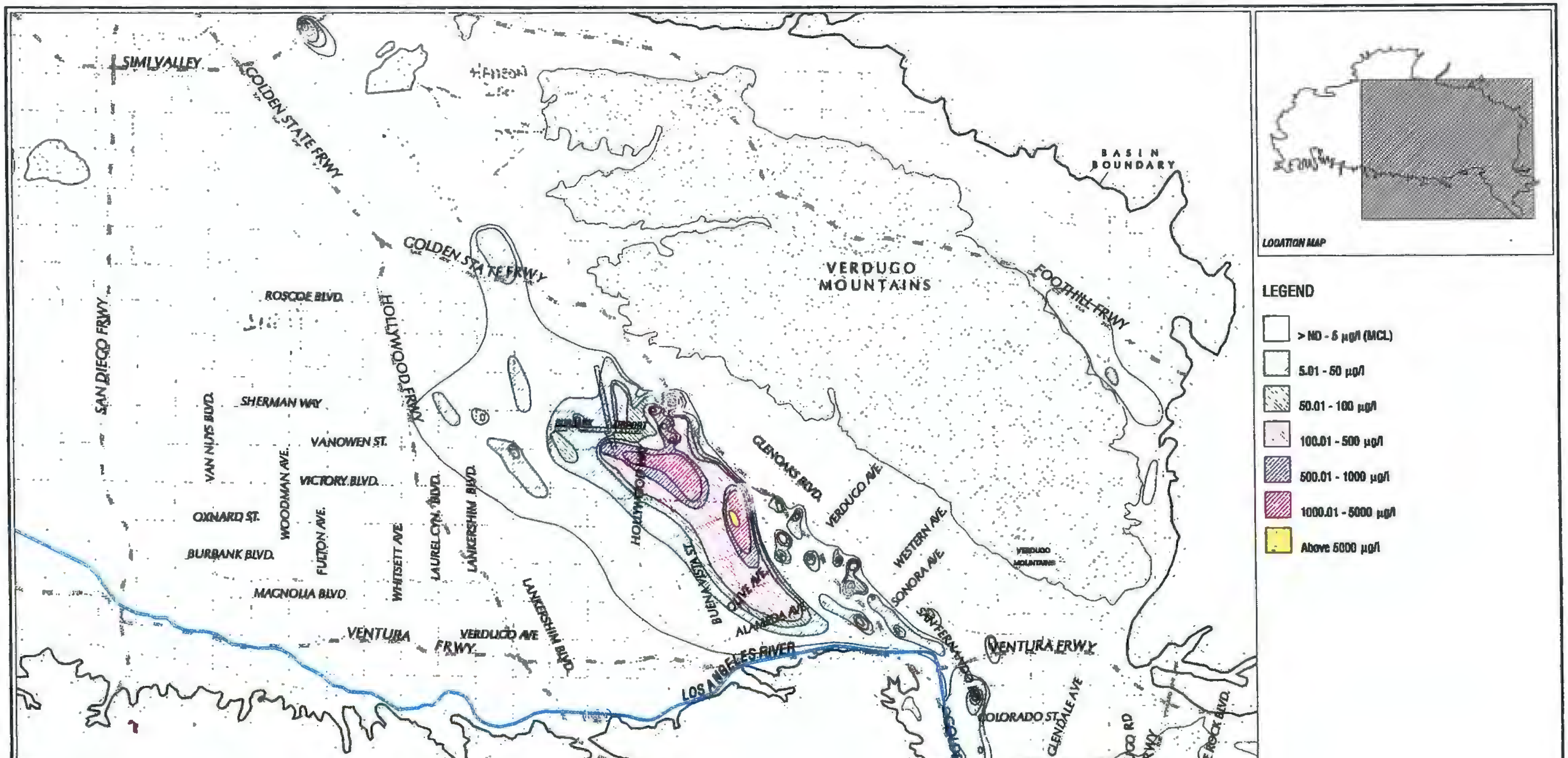
Respectfully submitted,

Robert J. Edwards

With great thanks to those who provided so much of their own time, effort and **data** to be assembled in such manner as the time frame as allowed!

Location Map





NOTES:

1. The areas of contamination shown on this map represent generalized two-dimensional approximations based on water quality analysis from RI Monitoring Wells, Facility Wells, and Production Wells where the top of screened interval is within 50 feet of the water table.

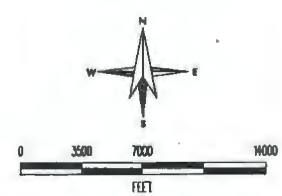
2. Due to the possible vertical zonation of contamination, a well within an identified area of contamination may produce water with contamination different than that indicated on this map.

3. Areas of contamination are based on: the highest concentration during 1998 sample events for RI wells sampled quarterly; the highest concentration during the previous two sample rounds (or 18 months) for wells sampled annually; and, the most recent record available for wells sampled more than 18 months prior to most recent sample event.

4. Areas outside the zones represented here may be contaminated. Data available in the areas outside the zones represented on this map are below the detection limit of 2 µg/l.

SAN FERNANDO VALLEY BASIN
PCE Contamination (µg/L) in Shallow Zone in 1998

Figure 3-7



20 Feb 99 13:34:57 Saturday

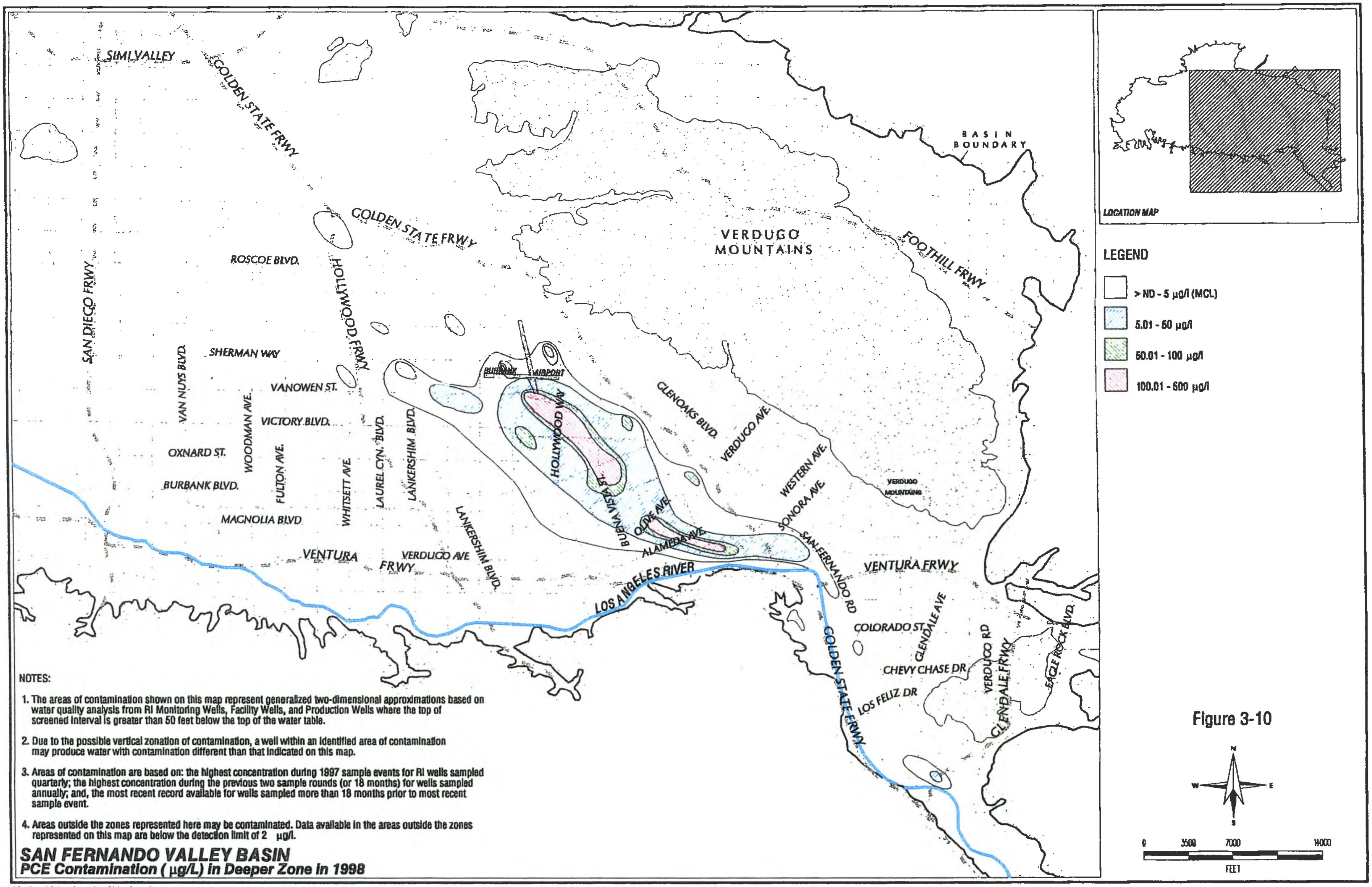


Figure 3-10

NOTES:

1. The areas of contamination shown on this map represent generalized two-dimensional approximations based on water quality analysis from RI Monitoring Wells, Facility Wells, and Production Wells where the top of screened interval is greater than 50 feet below the top of the water table.

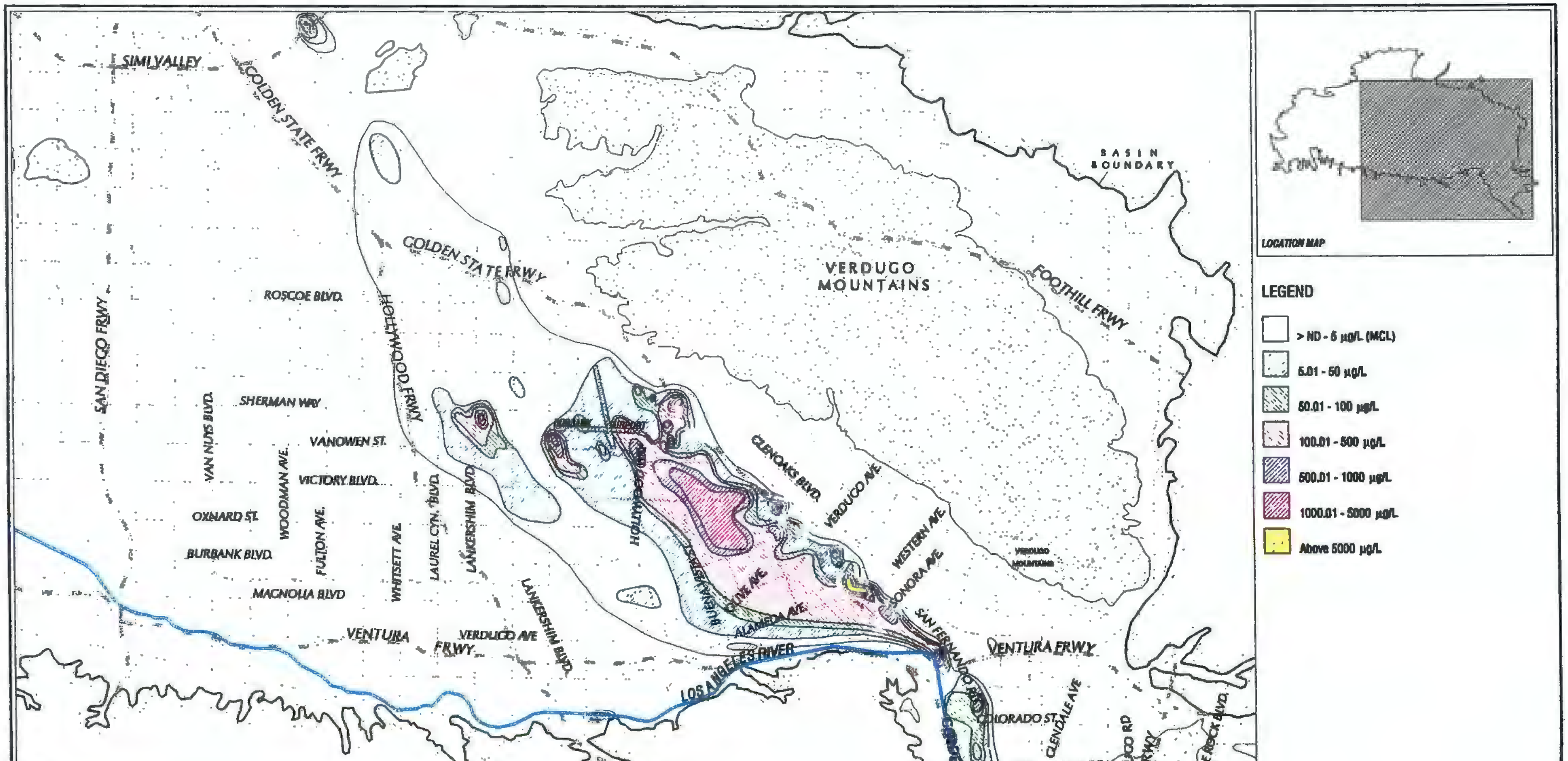
2. Due to the possible vertical zonation of contamination, a well within an identified area of contamination may produce water with contamination different than that indicated on this map.

3. Areas of contamination are based on: the highest concentration during 1997 sample events for RI wells sampled quarterly; the highest concentration during the previous two sample rounds (or 18 months) for wells sampled annually; and, the most recent record available for wells sampled more than 18 months prior to most recent sample event.

4. Areas outside the zones represented here may be contaminated. Data available in the areas outside the zones represented on this map are below the detection limit of 2 µg/l.

SAN FERNANDO VALLEY BASIN
PCE Contamination (µg/L) in Deeper Zone in 1998

d:/projects/sfplume/maps/small/plotplm.aml
20 Feb 99 13:35:26 Saturday



NOTES:

1. The areas of contamination shown on this map represent generalized two-dimensional approximations based on water quality analysis from RI Monitoring Wells, Facility Wells, and Production Wells where the top of screened interval is within 50 feet of the water table.

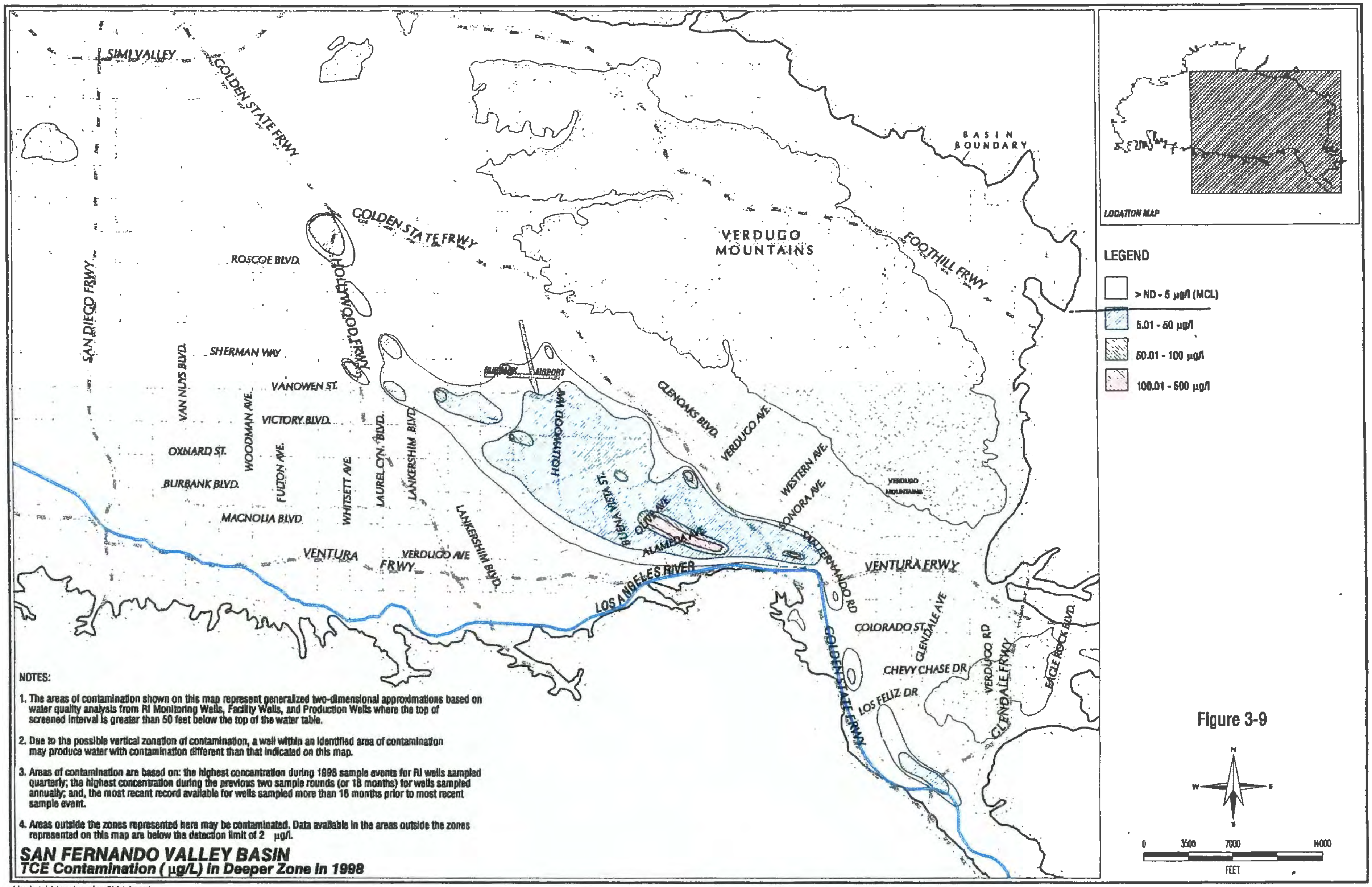
2. Due to the possible vertical zonation of contamination, a well within an identified area of contamination may produce water with contamination different than that indicated on this map.

3. Areas of contamination are based on: the highest concentration during 1998 sample events for RI wells sampled quarterly; the highest concentration during the previous two sample rounds (or 18 months) for wells sampled annually; and, the most recent record available for wells sampled more than 18 months prior to most recent sample event.

4. Areas outside the zones represented here may be contaminated. Data available in the areas outside the zones represented on this map are below the detection limit of 2 μg/l.

SAN FERNANDO VALLEY BASIN
TCE Contamination (μg/L) in Shallow Zone in 1998

20 Feb 99 13:33:03 Saturday



NOTES:

1. The areas of contamination shown on this map represent generalized two-dimensional approximations based on water quality analysis from RI Monitoring Wells, Facility Wells, and Production Wells where the top of screened interval is greater than 50 feet below the top of the water table.

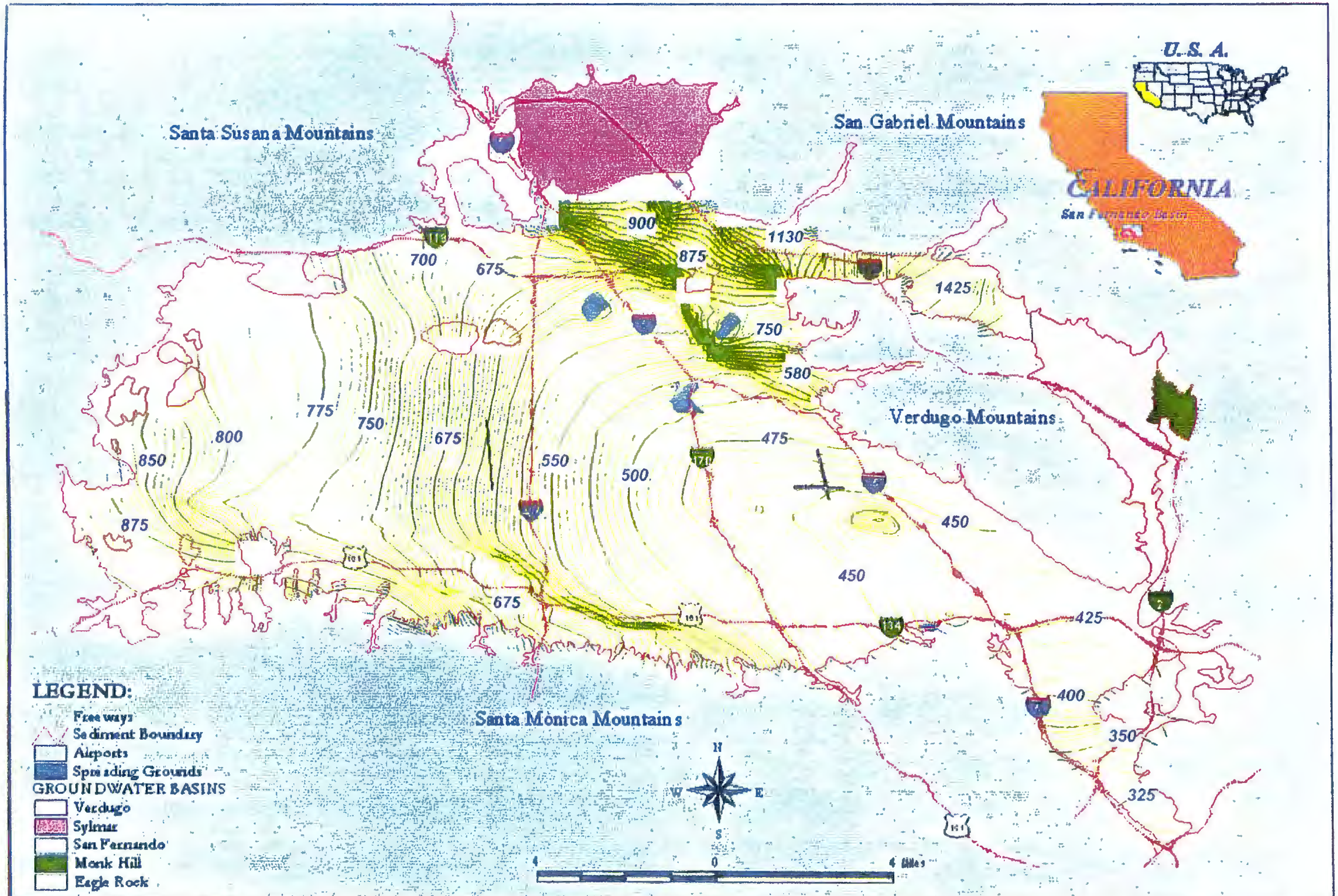
2. Due to the possible vertical zonation of contamination, a well within an identified area of contamination may produce water with contamination different than that indicated on this map.

3. Areas of contamination are based on: the highest concentration during 1998 sample events for RI wells sampled quarterly; the highest concentration during the previous two sample rounds (or 18 months) for wells sampled annually; and, the most recent record available for wells sampled more than 18 months prior to most recent sample event.

4. Areas outside the zones represented here may be contaminated. Data available in the areas outside the zones represented on this map are below the detection limit of 2 µg/l.

SAN FERNANDO VALLEY BASIN
TCE Contamination (µg/L) in Deeper Zone in 1998

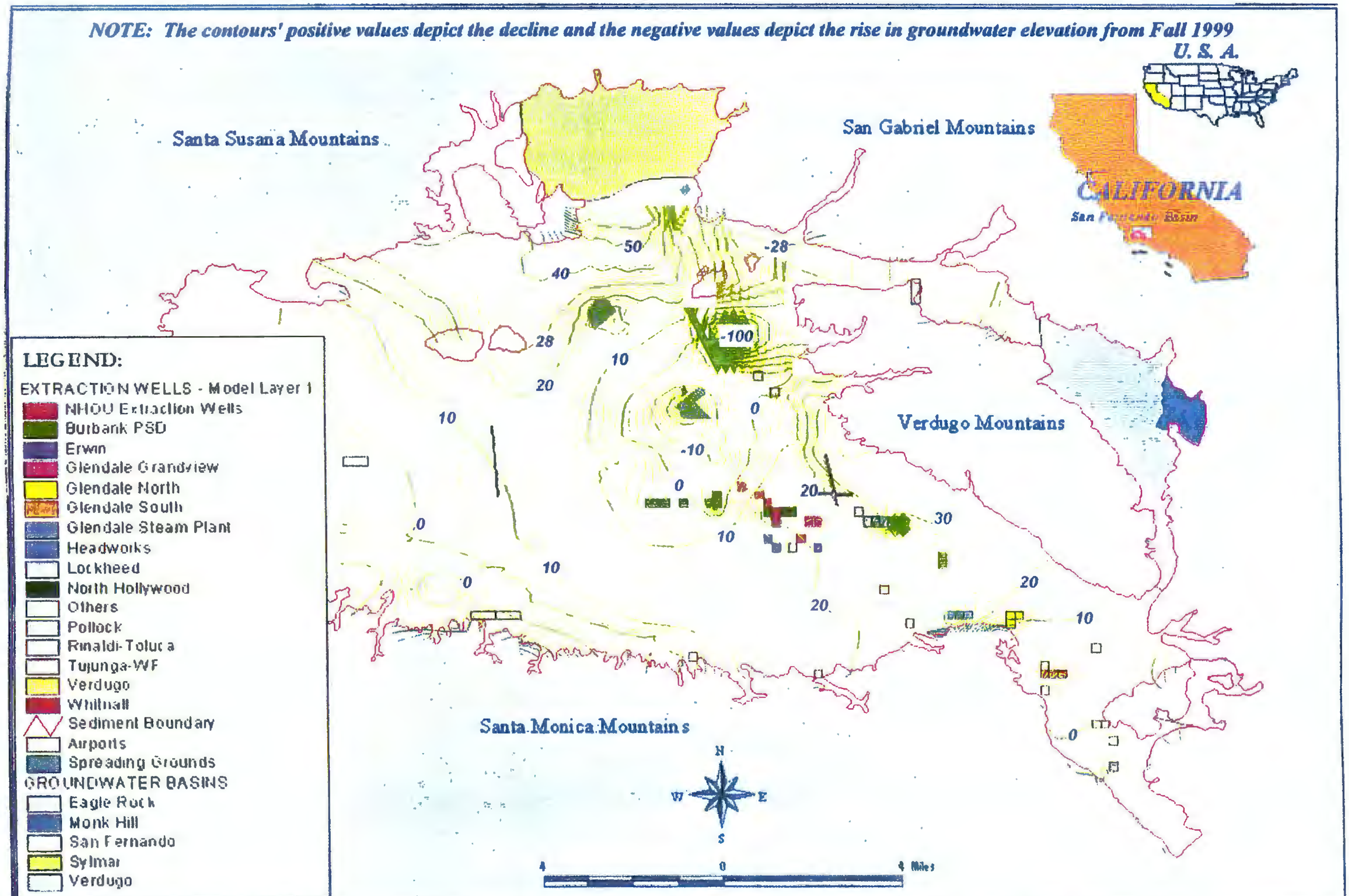
Figure 3-9



Upper Los Angeles River Area
WATERMASTER
Pumping and Spreading Report
1999-2004 WATER YEARS

Simulated Groundwater Contours - Model Layer 1
FALL 2004

PLATE
1

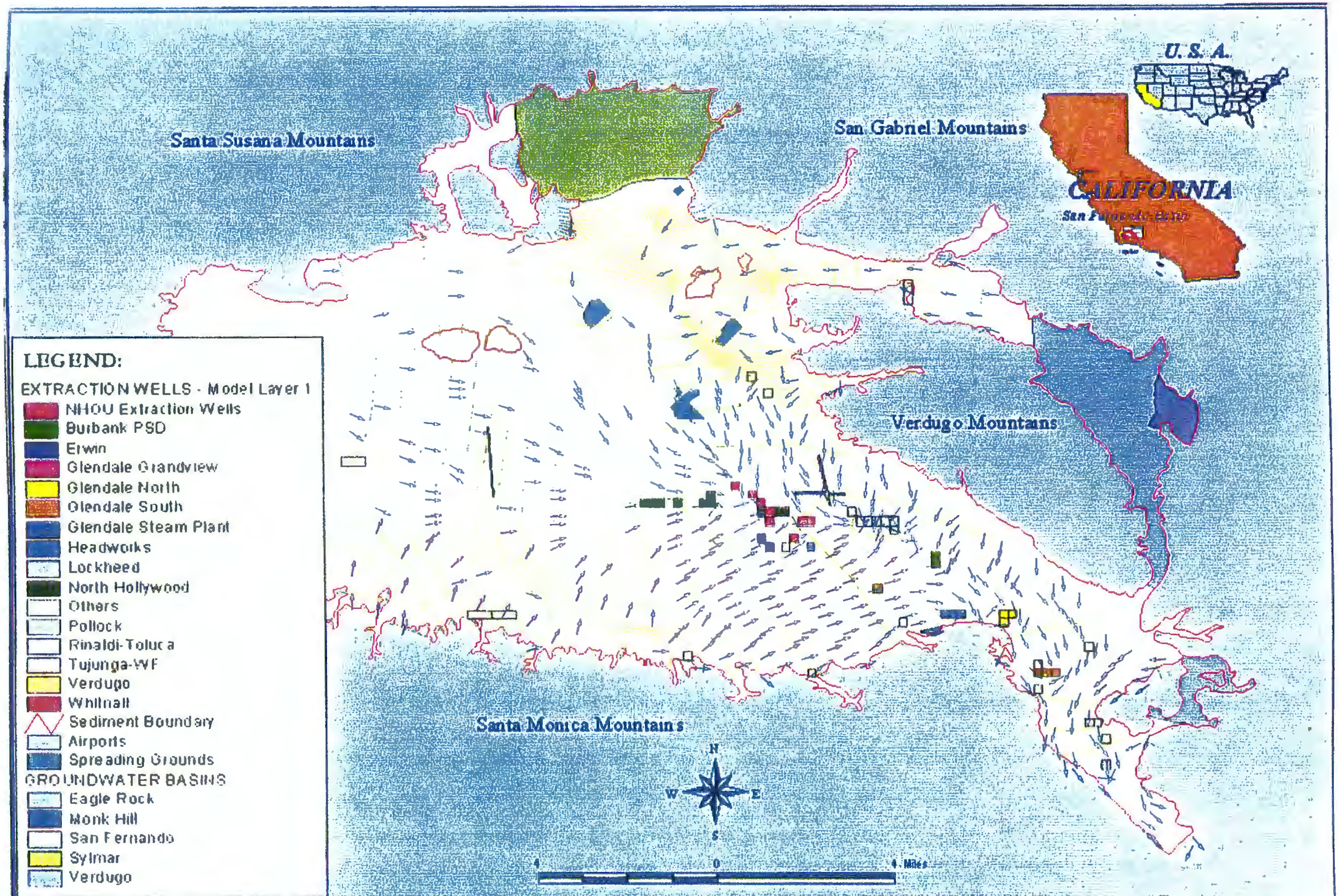


Upper Los Angeles River Area
WATERMASTER
Pumping and Spreading Report
1999-2004 WATER YEARS

Change in Groundwater Elevation - Model Layer 1

Fall 1999 - Fall 2004

PLATE
3



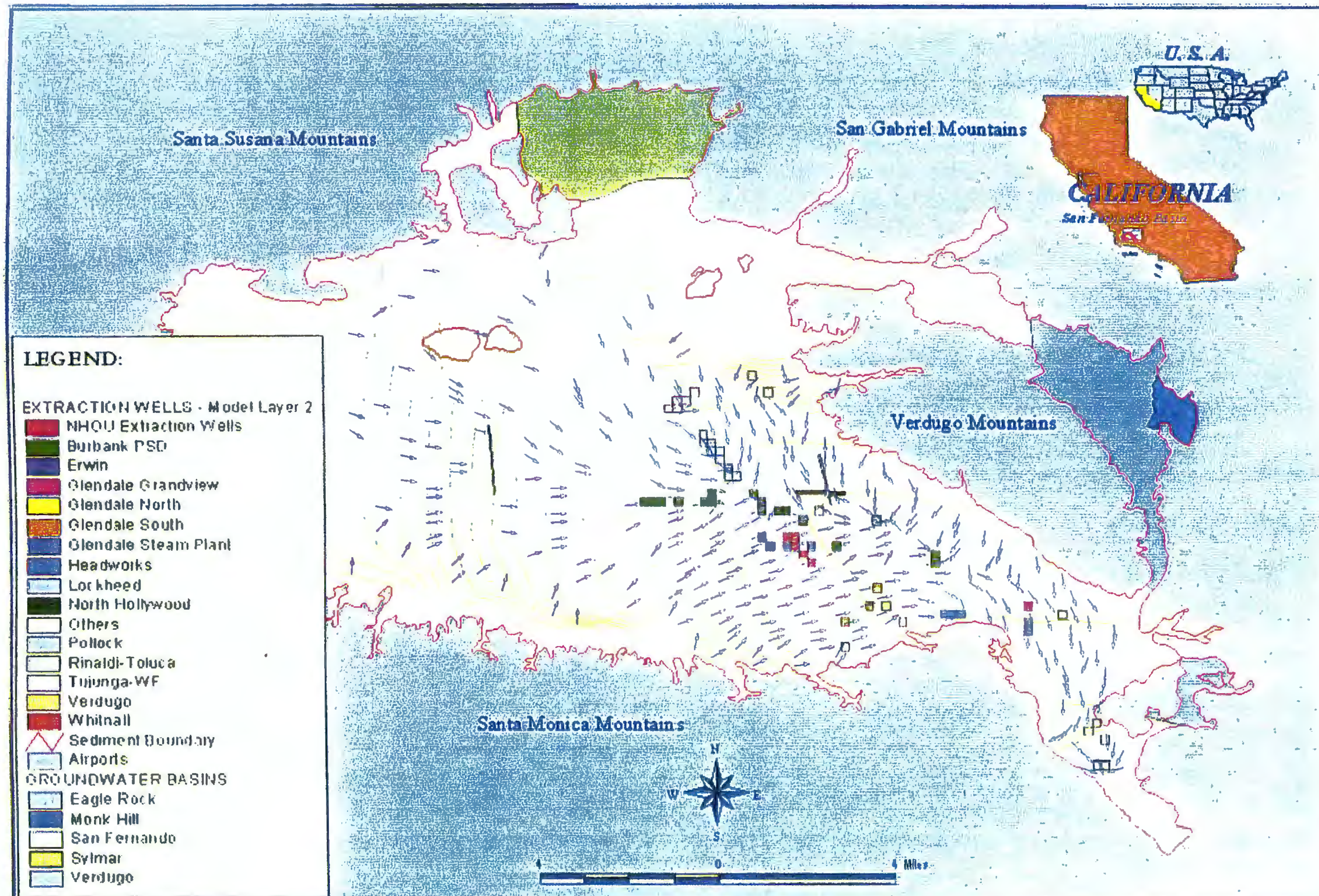
Upper Los Angeles River Area
WATERMASTER
Pumping and Spreading Report
1999-2004 WATER YEARS

Simulated Groundwater Flow Direction - Model Layer 1

FALL 2004

PLATE

5

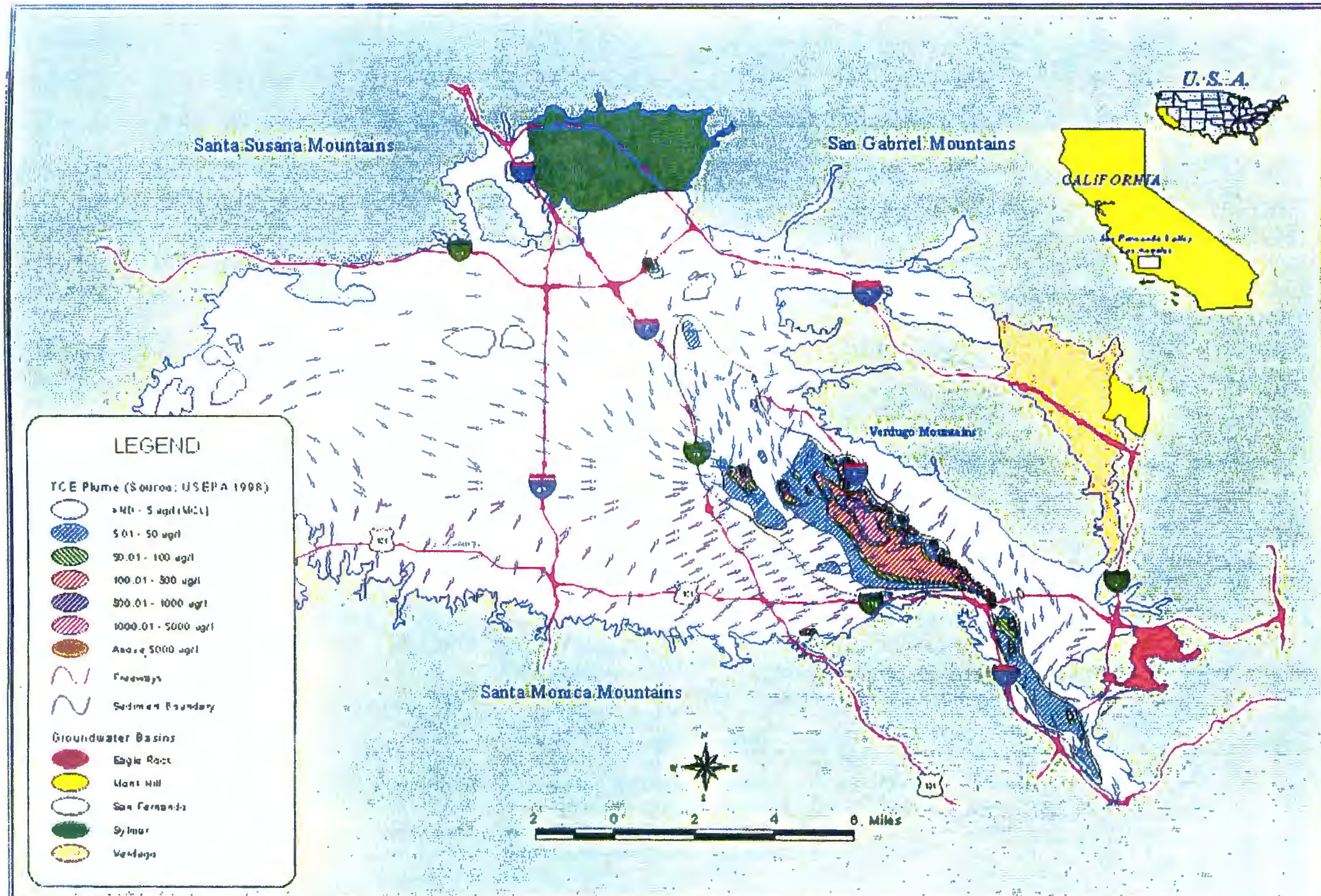


Upper Los Angeles River Area
WATERMASTER
Pumping and Spreading Report
1999-2004 WATER YEARS

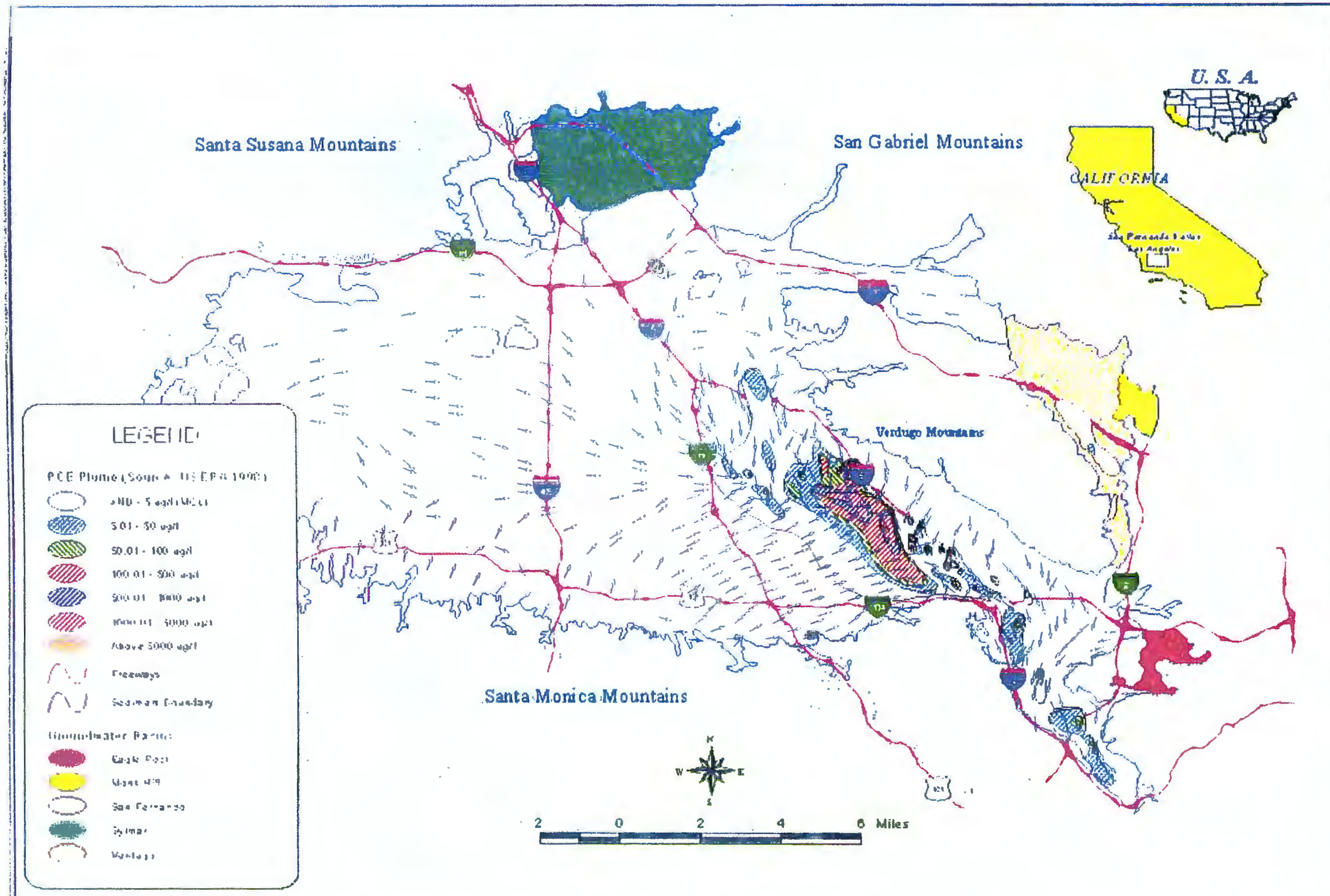
Simulated Groundwater Flow Direction- Model Layer 2

FALL 2004

PLATE
6



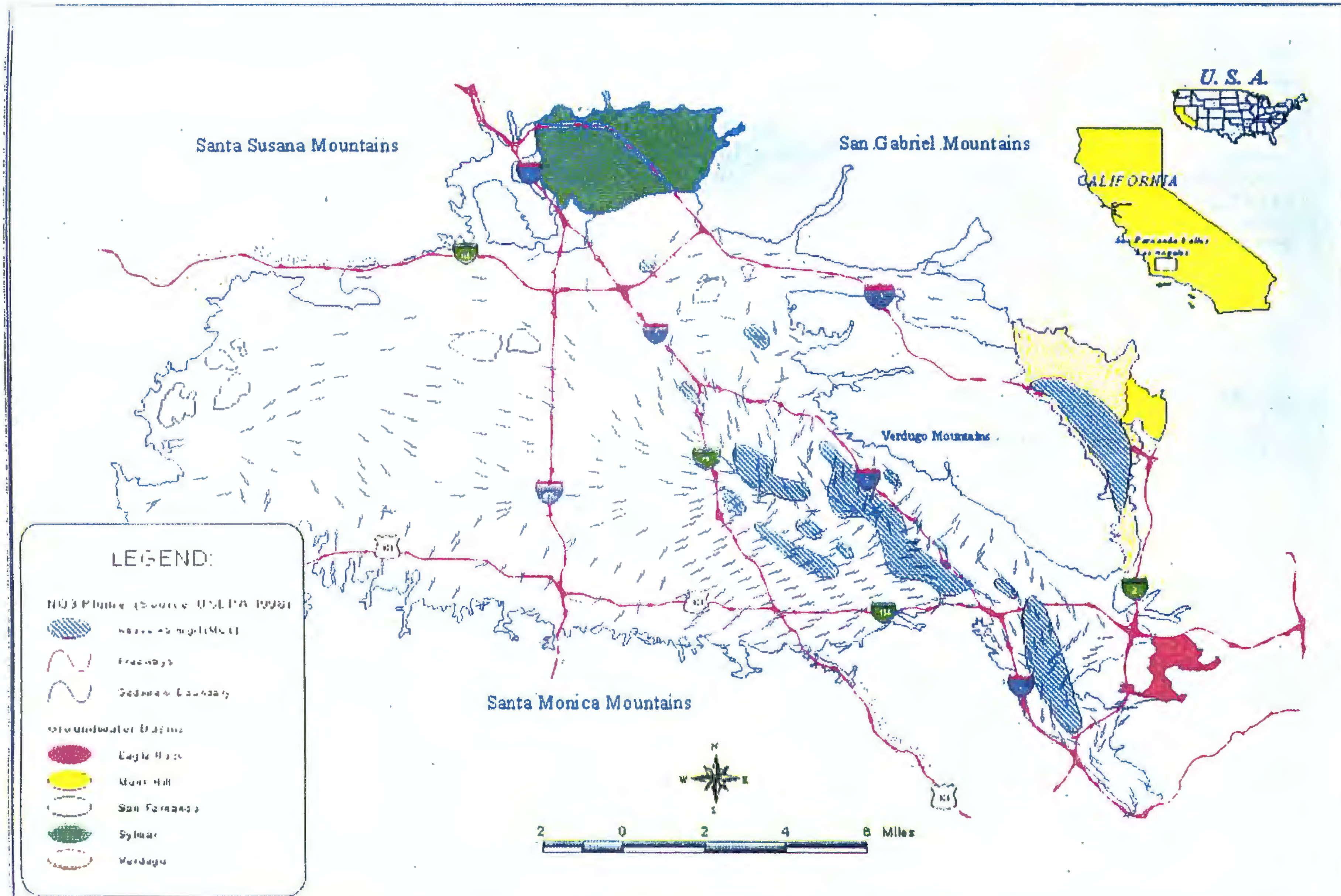
Upper Los Angeles River Area WATERMASTER **Pumping and Spreading Report** 1999-2004 WATER YEARS	**Simulated Groundwater Flow Direction and TCE Contamination** **Model Layer 1 - Fall 2004**	PLATE 7



Upper Los Angeles River Area
WATERMASTER
Pumping and Spreading Report
1999-2004 WATER YEARS

Simulated Groundwater Flow Direction and PCE Contamination
Model Layer 1 - Fall 2004

PLATE
8

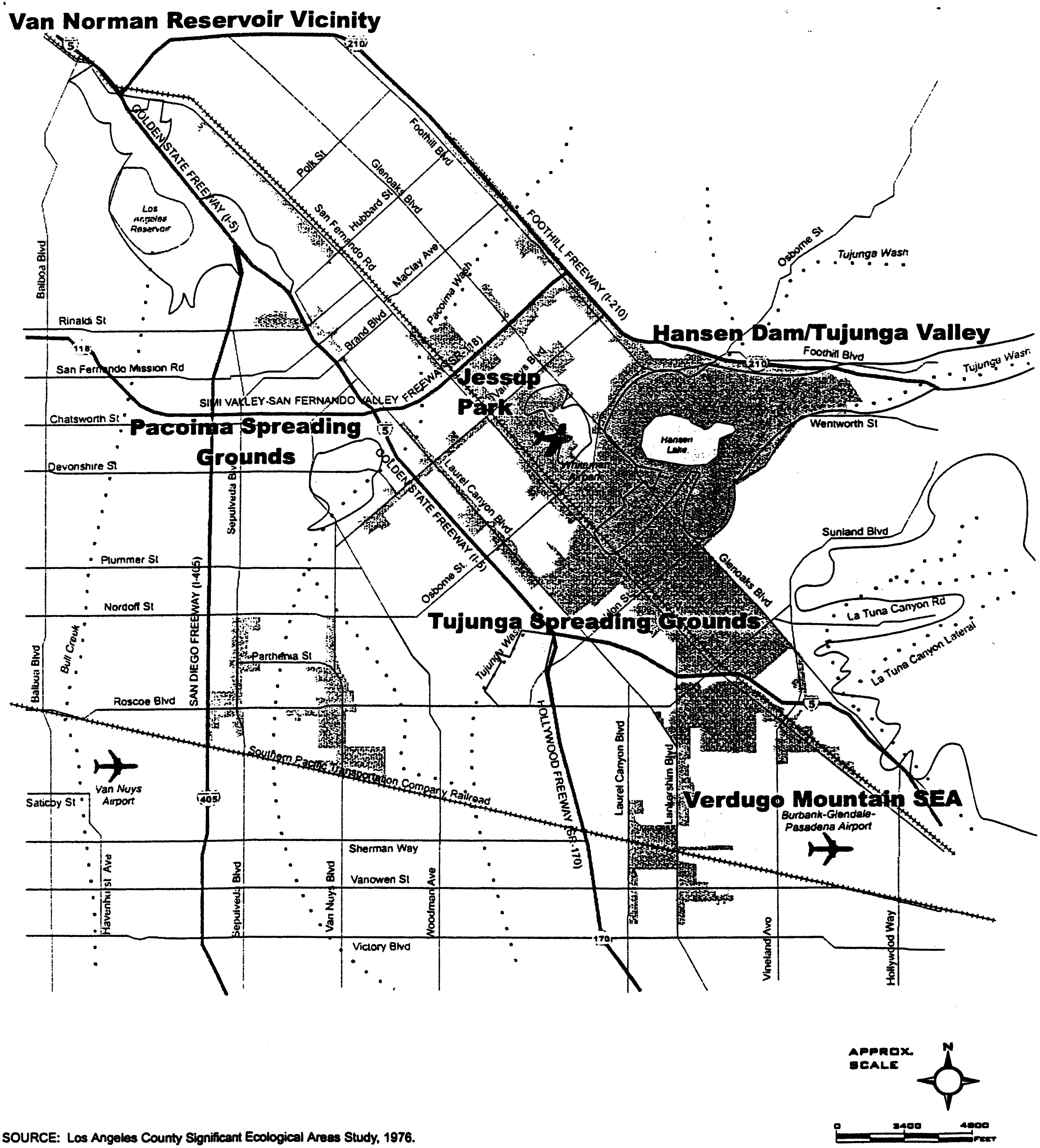


Upper Los Angeles River Area
WATERMASTER
Pumping and Spreading Report
1999-2004 WATER YEARS

Simulated Groundwater Flow Direction and NO3 Contamination

Model Layer 1 - Fall 2004

PLATE
9



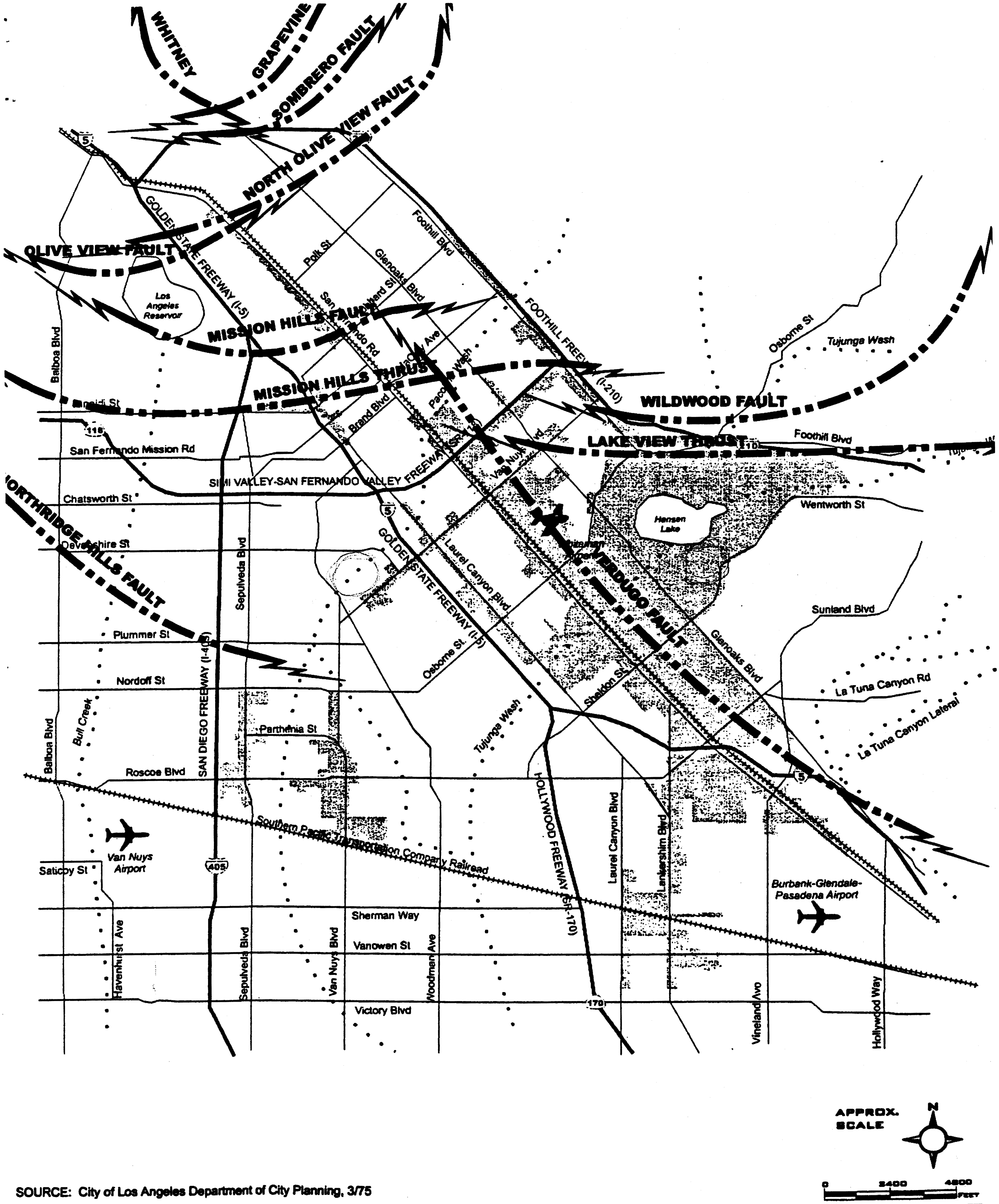
SOURCE: Los Angeles County Significant Ecological Areas Study, 1976.

NE San Fernando Valley Redevelopment Project Program EIR

COMMUNITY REDEVELOPMENT AGENCY OF THE CITY OF LOS ANGELES

FIGURE 5.13-1

SIGNIFICANT ECOLOGICAL AREAS



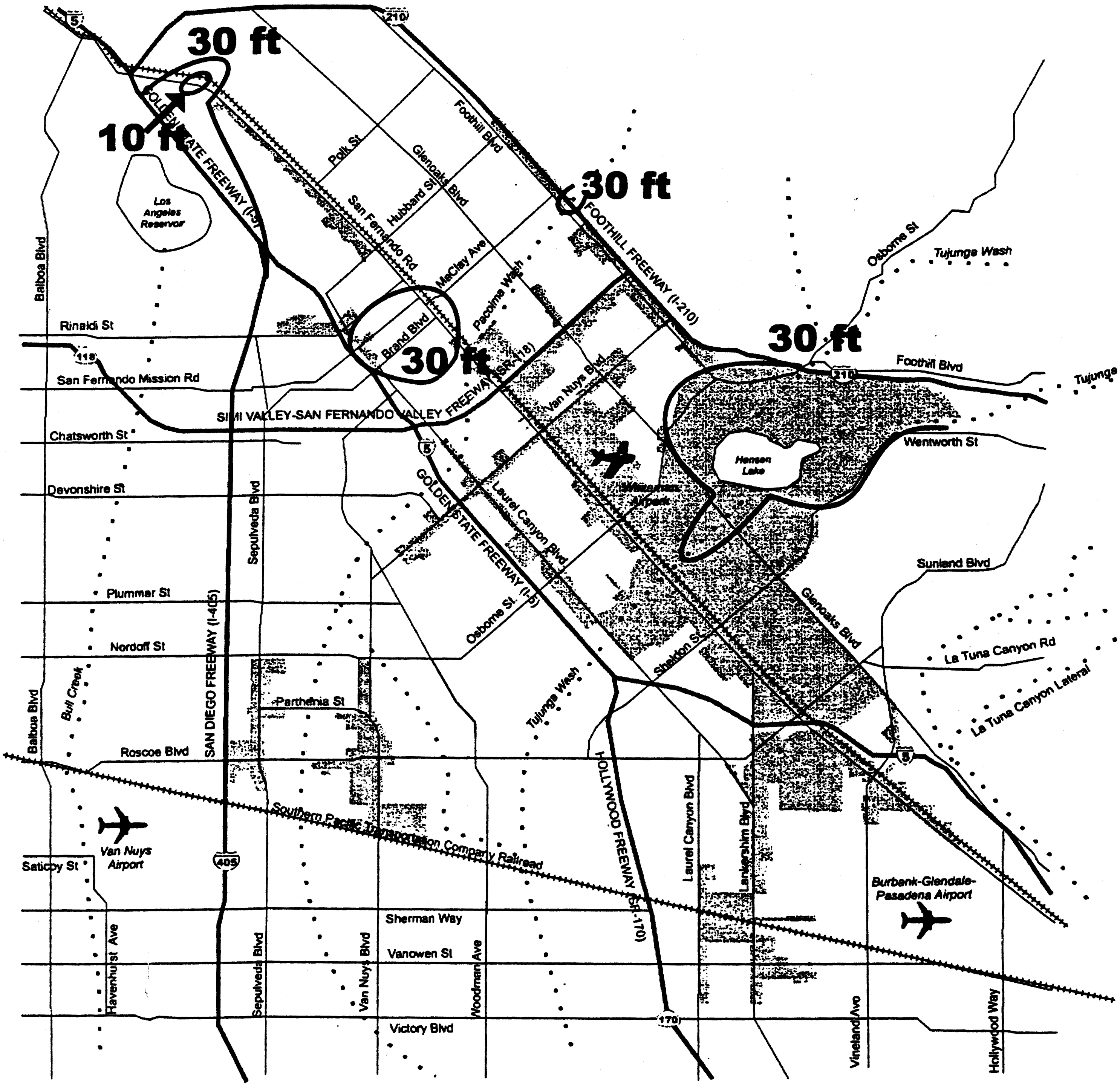
SOURCE: City of Los Angeles Department of City Planning, 3/75

NE San Fernando Valley Redevelopment Project Program EIR

COMMUNITY REDEVELOPMENT AGENCY OF THE CITY OF LOS ANGELES

FIGURE 5.9-1

FAULT LINES AND THRUSTS



APPROX. SCALE

0 2400 4800 FEET

N

LEGEND:

10ft/30ft = feet below surface of groundwater

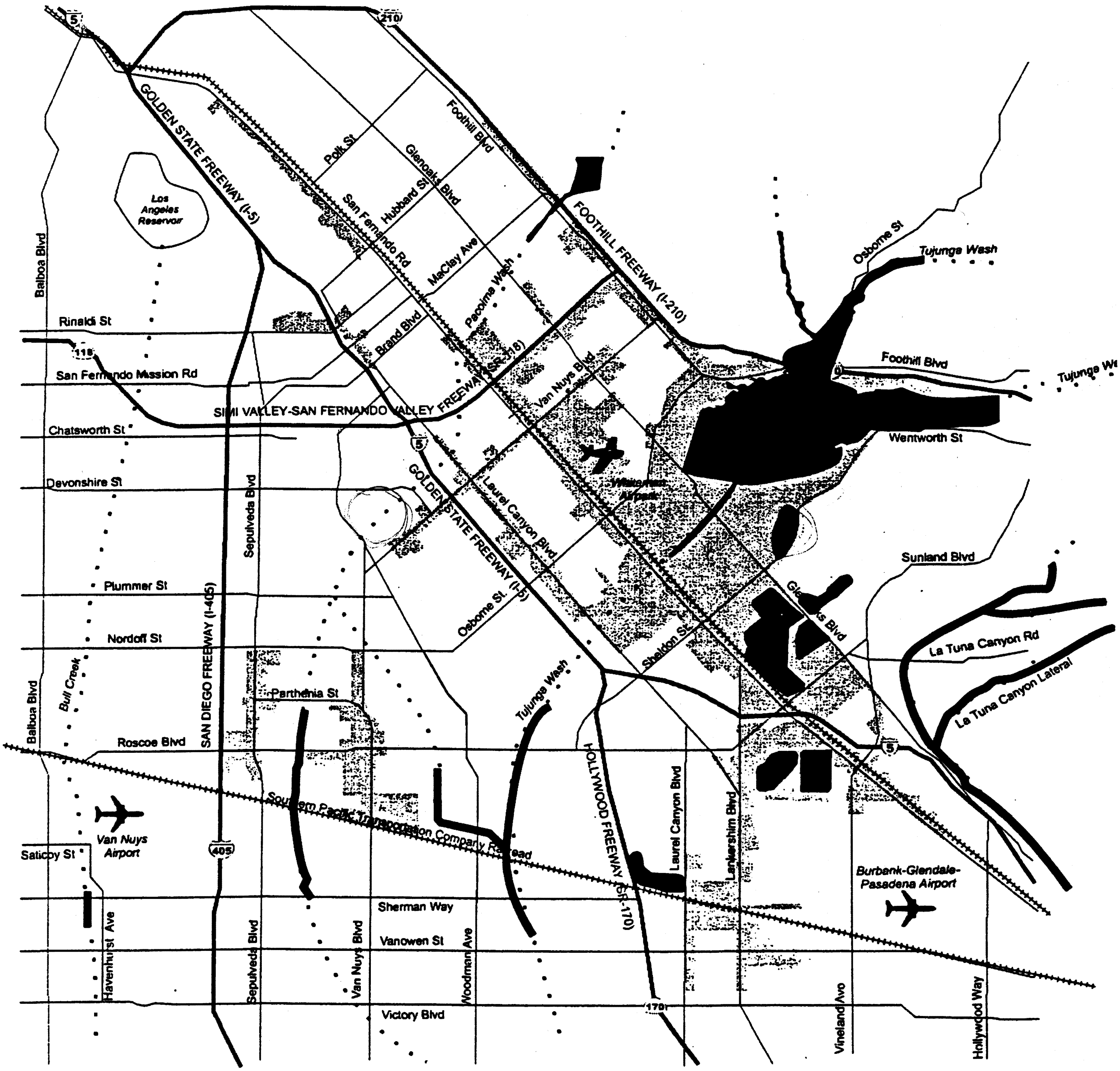
SOURCE: Los Angeles County Department of Public Works

NE San Fernando Valley Redevelopment Project Program EIR

COMMUNITY REDEVELOPMENT AGENCY OF THE CITY OF LOS ANGELES

FIGURE 5.9-2

GROUNDWATER DEPTH



LEGEND:

100-Year Flood Plain

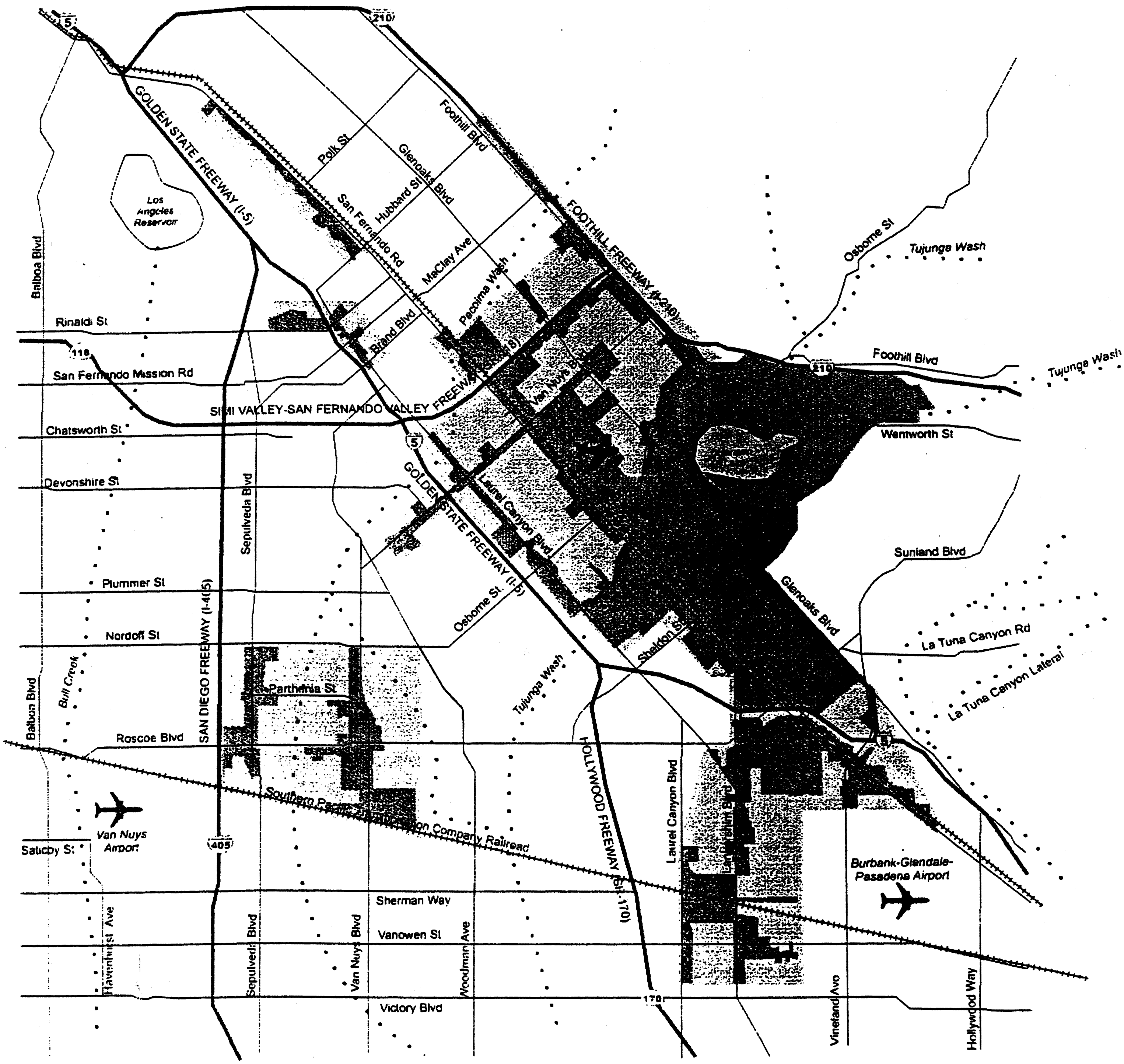
SOURCE: Federal Emergency Management Agency National Flood Insurance Program Map Numbers #0601370013C, #0601370014C, #0601300220C, #0601370030C ; Q3 Flood Data CD-Rom, Disc 1 California (Washington, D.C.: U.S. Federal Emergency Agency, May 1996).

NE San Fernando Valley Redevelopment Project Program EIR

COMMUNITY REDEVELOPMENT AGENCY OF THE CITY OF LOS ANGELES

FIGURE 5.8-4

100-YEAR FLOOD PLAINS



- Project Area
- HighPotential Impact Area
- Moderate Potential Impact Area
- Low Potential Impact Area

APPROX. SCALE

0 2400 4800 FEET

N

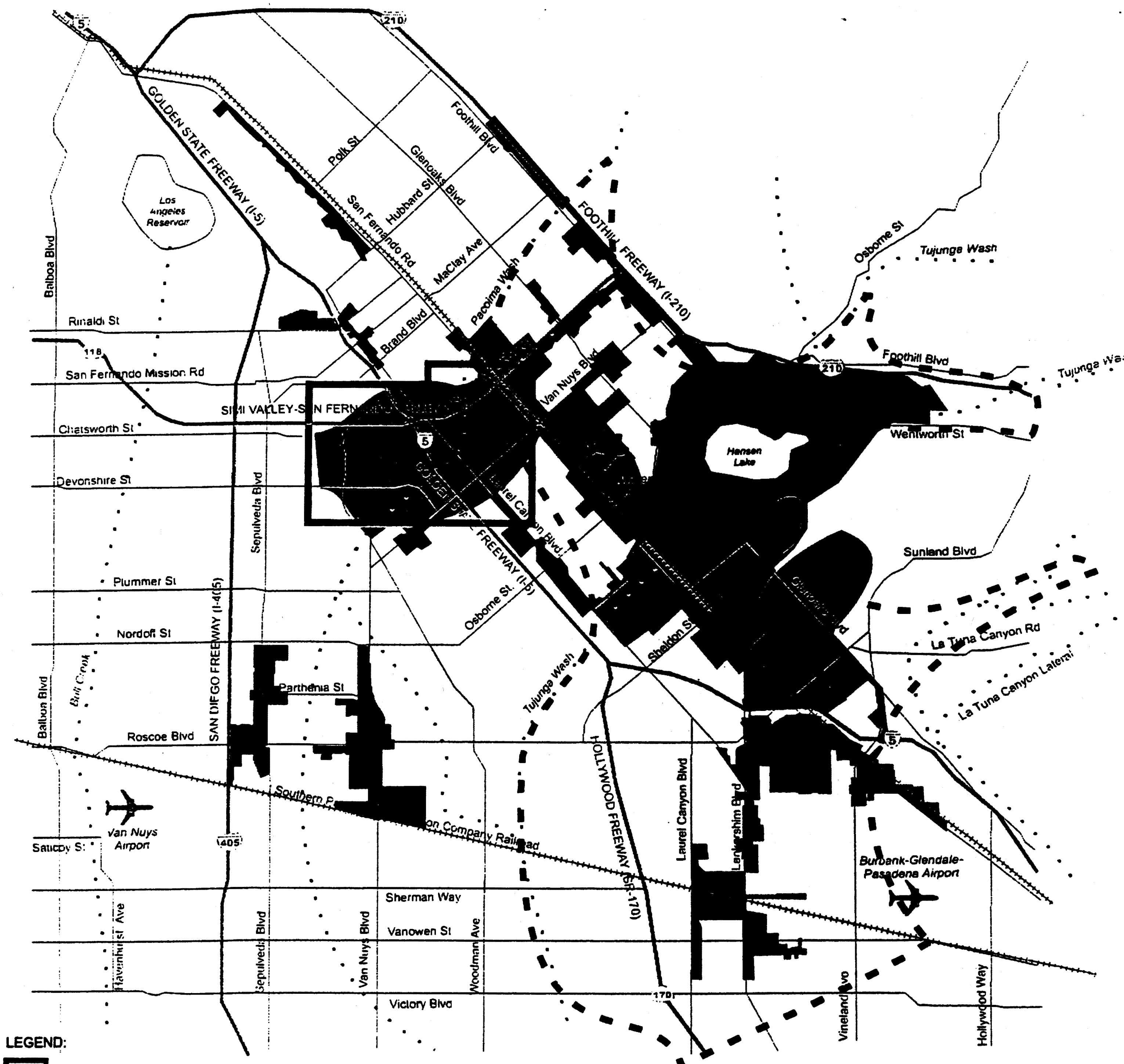
SOURCE: Rincon Consultants

NE San Fernando Valley Redevelopment Project Program EIR

COMMUNITY REDEVELOPMENT AGENCY OF THE CITY OF LOS ANGELES

FIGURE 5.11-1

GENERALIZED ZONES OF POTENTIAL ENVIRONMENTAL IMPACTS



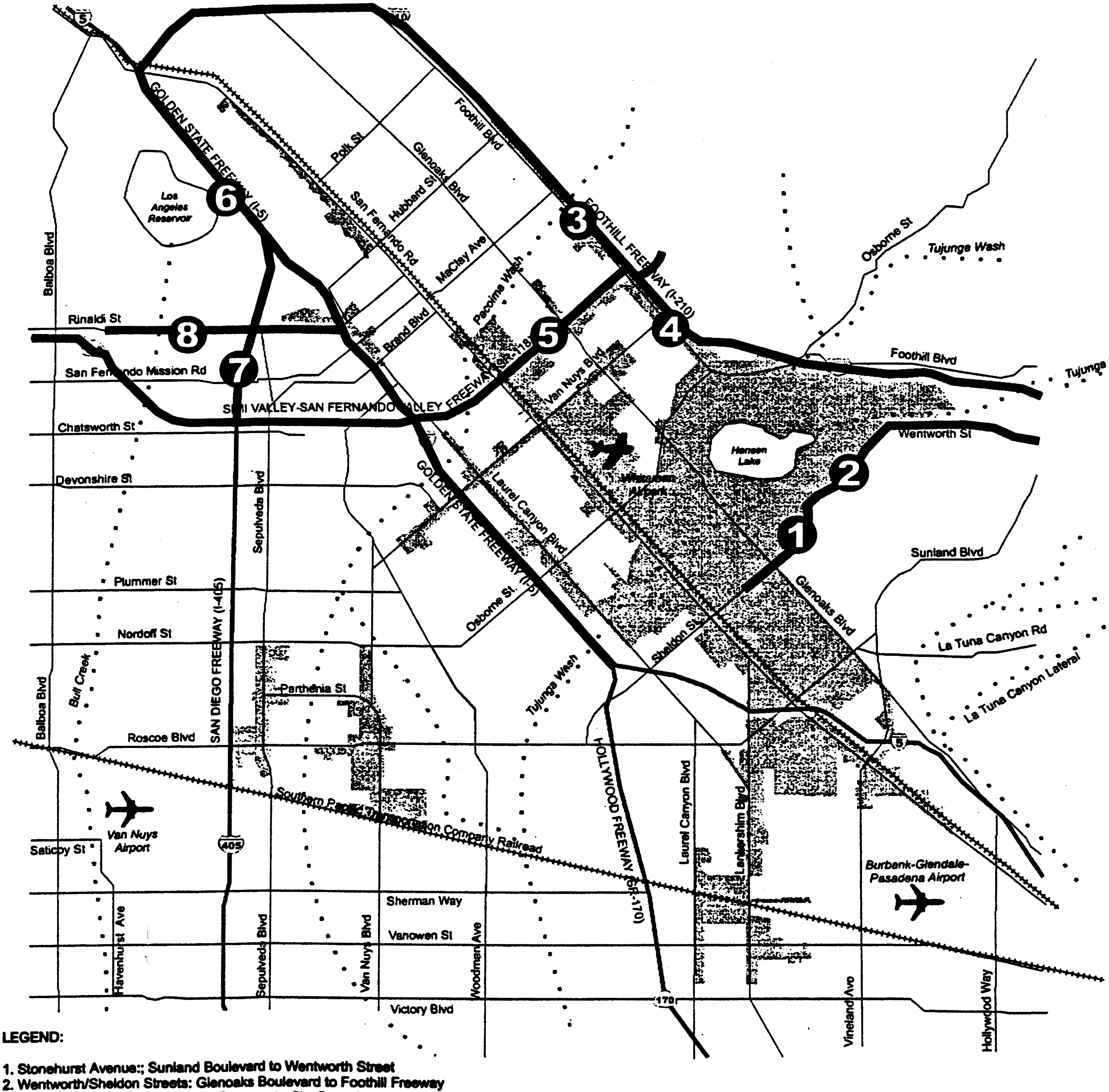
LEGEND:

- Designated Oil Field (Pacoima)
- Surface Mining District (Zone G)
- Oil Drilling District (Zone O)
- City of Los Angeles Mineral Resource Zone (MRZ-2)

SOURCE: City of Los Angeles, Environmental and Public Facilities Maps, September 1996.

FIGURE 5.14-1

GENERALIZED LOCATION OF MINERAL RESOURCES



LEGEND:

1. Stonehurst Avenue:; Sunland Boulevard to Wentworth Street
2. Wentworth/Sheldon Streets: Glenoaks Boulevard to Foothill Freeway
3. Foothill Freeway: Golden State Freeway to City Boundary
4. Lopez Canyon Road: Foothill Freeway to City Boundary
5. Simi Valley Freeway: City boundary to Balboa Boulevard
6. Golden Gate Freeway: City boundary to Hollywood Freeway Interchange
7. San Diego Freeway: Golden State Freeway interchange to Simi Valley interchange
8. Rinaldi Street: San Diego Freeway to Canoga Avenue

SOURCE: Scenic Highways Plan, Circulation Element of the General Plan of the City of Los Angeles

FIGURE 5.12-1

SCENIC HIGHWAYS

Project Profile

THE DONALD C. TILLMAN WATER RECYCLING PLANT IN VAN NUYS

The Safeguards

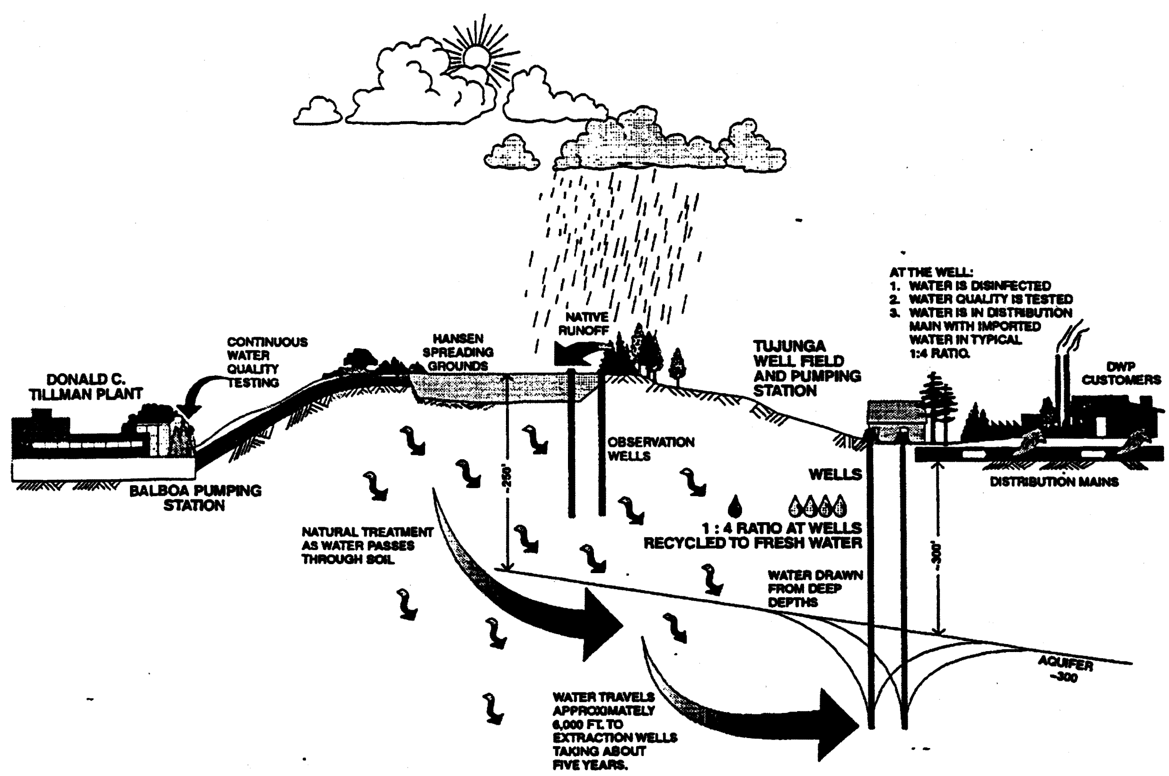
To receive regulatory approval for the East Valley Water Recycling Project, several quality safeguards and requirements were met. These included compliance with drinking water quality standards and several additional safety assurances.

There are many requirements designed to protect the public health. They are especially conservative for recharging groundwater basins with recycled water. The DWP is going beyond the already conservative requirements in many instances by adding protections beyond those imposed by the regulatory agencies. These protections include:

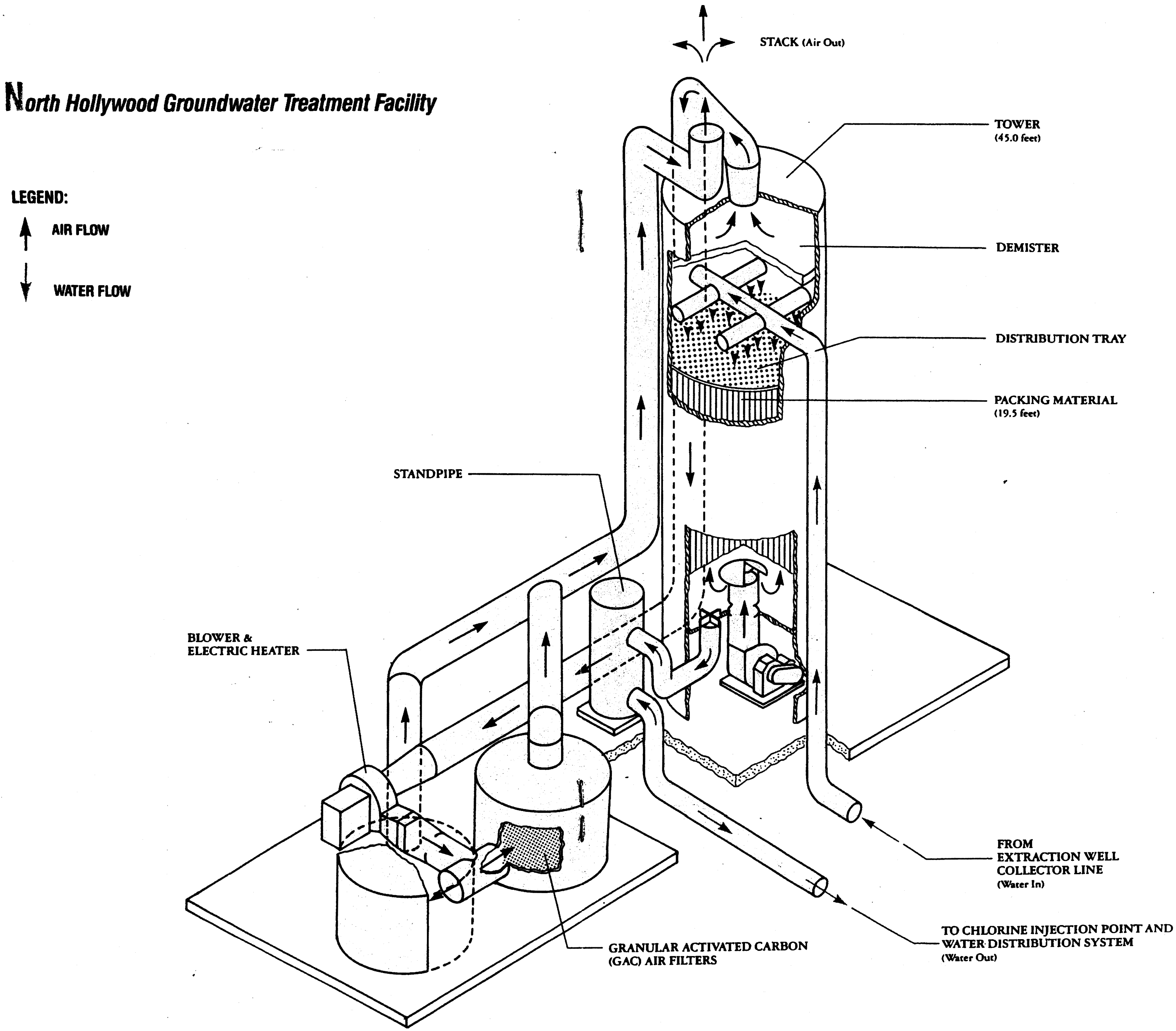
- This project's water will be filtered and cleansed through 100-300 feet of soil before it reaches the aquifer. This is 10 times the state requirements of a minimum soil thickness of 10 feet between the ground surface and the aquifer to allow for adequate filtration and cleansing by soil.
- This treated water will move underground for about five years after it is spread as part of the cleaning process. This is about 10 times longer than the required minimum time underground of six months. The water quality will be monitored as it moves.
- Adequate dilution of water provided to customers according to health department requirements. This means that water pumped from the wells must first be blended with native groundwater or other sources of imported water. The ratio at the well is four to one of fresh to recycled water. With additional mixing in the pipelines, at most 3 percent of the water that will reach DWP customers will come from the recycled water.
- Blended water must be chlorinated before being released to the distribution system for residential and business use.

The Final Step:

NATURAL TREATMENT AND TESTING



North Hollywood Groundwater Treatment Facility



From Waste Water to Tap Water

Water currently being dumped into the Pacific Ocean will have a new route to your faucets

Each day, 60 million gallons of recycled water is dumped into the Los Angeles River on its journey to the Pacific Ocean. Except for higher-than-allowed levels of nitrogen, the water meets drinking water standards.

However, work is well under way on the equipment that will get rid of the extra nitrogen so that this huge natural resource can be tapped.

Plans call for firing up a new pumping station in Van Nuys in December that will carry the recycled sewer water to basins near Hansen Dam where it will seep into the soil and collect in the aquifer. As it percolates 200 feet down through the ground, microbes will take care of the excess nitrogen. Five years later, the water will reach the city's Department of Water and Power pumping wells that will draw it to the surface for its eventual comeback through faucets citywide.

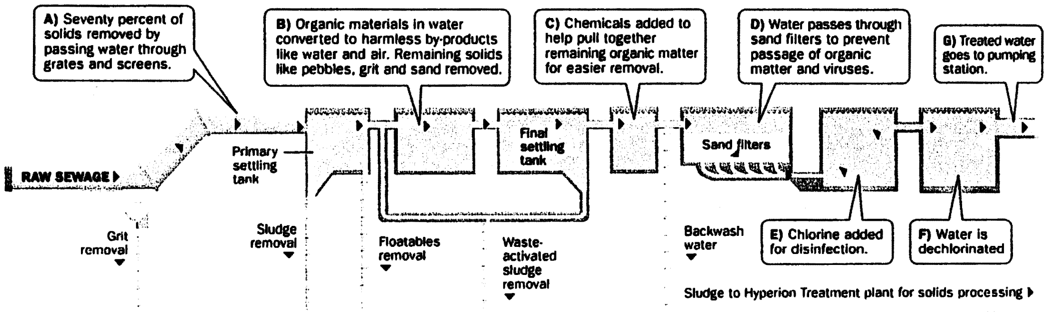
By replenishing the ground water beneath the San Fernando Valley, the East Valley Water Recycling Project will supply enough water for 200,000 city residents annually. Construction of the pumping station at the Donald C. Tillman Water Reclamation Plant began last August and pipes leading to Hansen Dam will soon be laid, followed by a two-mile stretch of pipe to basins in Pacoima.

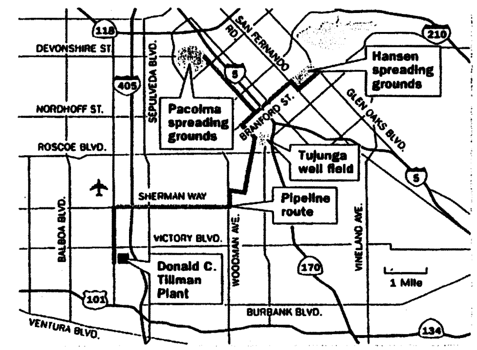
Eventually, a storage tank capable of holding up to 2 million gallons of water will be built near Hansen Dam.

Although this is the biggest such project for the DWP, water recycling is not an original idea. In eastern Los Angeles County, the Montebello Forebay ground-water recharge project has been using reclaimed water to replenish ground water since 1962.

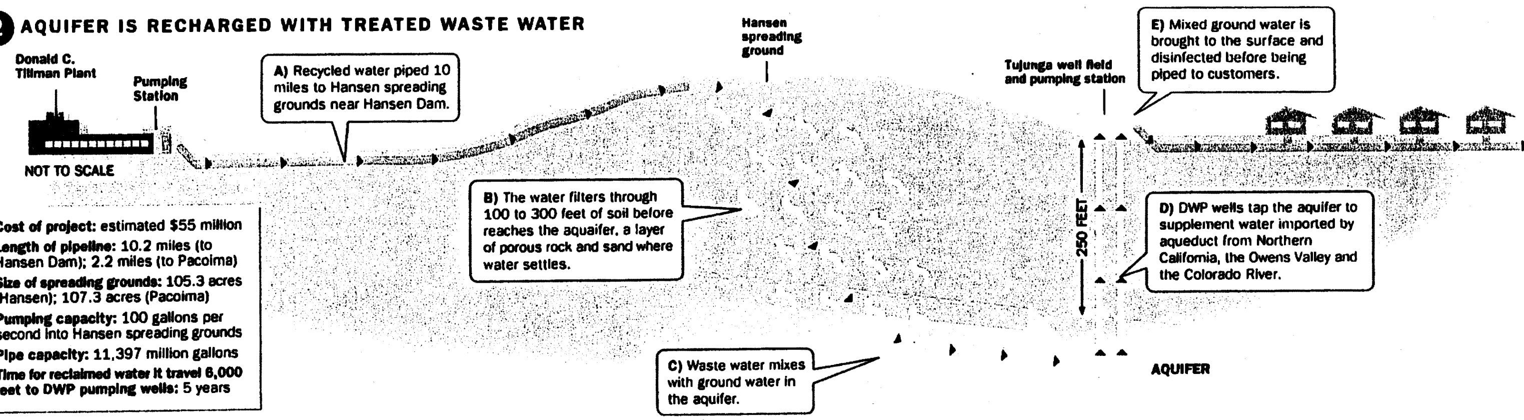
Here's a look at the way such water is recycled.

1 WASTE WATER IS TREATED AT DONALD C. TILLMAN PLANT





2 AQUIFER IS RECHARGED WITH TREATED WASTE WATER



Cost of project: estimated $55 million
Length of pipeline: 10.2 miles (to Hansen Dam); 2.2 miles (to Pacoima)
Size of spreading grounds: 105.3 acres (Hansen); 107.3 acres (Pacoima)
Pumping capacity: 100 gallons per second into Hansen spreading grounds
Pipe capacity: 11,397 million gallons
Time for reclaimed water it travel 6,000 feet to DWP pumping wells: 5 years

Source: City of Los Angeles Department of Water and Power; Researched by STEPHANIE STASSEL / Los Angeles Times

ROGER KUO / Los Angeles Times

CORRESPONDENCE

ACWA
90 Years
of Water Leadership

October 20, 2000

The Honorable Martha Escutia
California State Senate
State Capital, Room # 5064
Sacramento, CA 95814

Dear Senator Escutia,

ACWA's mission is to assist its members in promoting the development, management and reasonable beneficial use of good quality water at the lowest practical cost in an environmentally balanced manner.

The Association of California Water Agencies (ACWA) is pleased to submit the enclosed testimony for the October 24, 2000, joint Senate and Assembly field hearing on chromium in drinking water. ACWA consists of nearly 450 public water agencies in California. Our members serve 90% of the delivered water in California for residential, agricultural, and industrial uses.

As stated in our testimony, ACWA members are extremely concerned about the presence of chromium in drinking water and support the interest being shown by both the Assembly and Senate in this issue. We hope that our testimony will be of assistance to the committees.

Enclosed please find several copies of our testimony for distribution to the Senate Health and Human Services Committee members.

If you have any questions regarding the enclosed testimony, please feel free to contact Krista Clark, Regulatory Affairs Specialist, at 916-441-4545.

Sincerely,

Bob Reeb

Robert J. Reeb
State Legislative Director

Association of California Water Agencies
910 K Street, Suite 100
Sacramento, California
95814-3512

916/441-4545
FAX 916/325-4849
www.acwanet.com

Hall of the States
400 N. Capitol St., N.W.
Suite 357 South
Washington, D.C.
20001-1512

202/434-4760
FAX 202/434-4763

Statement to the Senate Committees on Health and Human Services and Natural Resources and Wildlife and the Assembly Committee on Environmental Safety and Toxic Materials

by

The Association of California Water Agencies

October 24, 2000

Mdms. Chairwomen, Mr. Chairman, and members of the committees, the Association of California Water Agencies (ACWA) appreciates the opportunity to submit this statement which shares the California water community's concerns with chromium in drinking water. ACWA represents nearly 450 urban and agricultural water utilities throughout the State of California, which deliver more than 90 percent of the water distributed in California.

ACWA fully appreciates the concerns expressed by local governments, the media, and most importantly the public about the risks posed by chromium VI in drinking water. We also are concerned about this contaminant and are working diligently to determine the true risks. ACWA member agencies concern themselves first and foremost with the protection of public health and pride themselves on delivering water that is truly safe.

We have also been active public health partners with the California Department of Health Services and are cooperating fully with its chromium VI investigation. We support the steps being taken by Department to determine the true occurrence of chromium VI in drinking water and many of our members are actively collecting data to expedite this investigation. We agree that the citizens of this state deserve to know as soon as possible if chromium VI is present in their water, at what levels, and the risks to human health these levels pose.

Because this information can be highly technical and often incomprehensible to the general public, we also believe that it is our responsibility to present this information with the proper perspective and accuracy. Simply generating technical data without appropriate quality control and thorough investigation could incite inappropriate public alarm and would be a disservice to consumers. For this reason, we support the drinking water standard investigation process enacted by the state legislature and employed by the Department of Health Services.

This process, which involves thorough sampling, analysis of exposure, assessment of health risks, and economic and technical feasibility, was the product of 1989's Assembly Bill 21, by then Assemblyman Byron Sher. This process is nearly identical to the process used by the federal government. It acknowledges that a standard truly protective of public health must be thoroughly understood and possible to achieve both technically and economically. Any rush to set a standard due to "perceived" threats could greatly strain public resources while providing little true benefit to public health.

The California Department of Health Services should expeditiously provide the public with all new and accurate information relating to the presence of chromium VI in drinking water. But as mentioned, this information must be presented responsibly which means careful consideration and analysis of the new data will take a bit longer than the public and political leaders may appreciate. Some of the issues that will need resolution during this time of analysis are as follows:

- Laboratory capabilities: Although a few laboratories are currently performing chromium VI analysis, the techniques used for this analysis are complex, expensive, and not yet accepted by the Department of Health Services as sufficiently accurate or precise. There are very few laboratories currently capable of performing the required analysis at the low levels of detection needed and there are NO labs currently accredited to perform it for state compliance purposes. The quality of the data and the capability of the labs to handle the volume of samples needing analysis will need to be resolved prior to the adoption of any drinking water standard. This is one reason there is very little occurrence data for chromium VI in California.

- Scientific Inconsistency: Although the California Office of Environmental Health Hazard Assessment (OEHHA) has declared chromium VI a carcinogen by ingestion, the World Health Organization (WHO), U.S. Environmental Protection Agency (EPA), and the Agency for Toxic Substances and Disease Registry have all determined that chromium VI is NOT a carcinogen when ingested. In fact, EPA felt so strongly about this determination that it raised the total chromium standard from 50 parts per billion (ppb) to 100 ppb, the first and only time the EPA has ever raised a drinking water standard. We are concerned about some of the health risk analysis that has been performed by OEHHA, especially in light of the findings by the EPA and WHO. Some consensus must be reached regarding the health risks of chromium VI in order to ensure the public is truly protected.

- Sources of Chromium VI in Drinking Water: If a widespread sampling effort shows that chromium VI is present in many drinking water sources, and if the health effects analysis shows that it is dangerous to human health, an analysis of the source of the chromium VI becomes critical. Most media reports have linked the presence of chromium VI in drinking water to industrial pollution. While this is sometimes true, it is also important to note that both chromium VI and chromium III are naturally-occurring elements. In fact, chromium is the 11th most common element in the earth's crust. It is possible that the costs to treat chromium VI-contaminated drinking water sources will be borne by consumers rather than an industrial polluter if the chromium is found to be naturally occurring. We have also located reports that suggest chromium can leach from certain plumbing parts or faucets. These factors must be considered when deciding what standard is appropriate, what meeting this standard will cost consumers, and what mitigation efforts are most sensible.

- Acute versus Chronic Exposure: Chromium toxicity is based on chronic long-term exposure, not on acute short-term exposure. We know that chromium VI is a human carcinogen by inhalation. However, there is currently insufficient evidence to show that ingested chromium VI is a health threat. This is similar to the case with asbestos; inhaled asbestos is a carcinogen, but ingested asbestos is not. There have been studies that suggest the human body detoxifies chromium VI in the digestive system by reducing it to non-toxic chromium III. And since chromium III is an essential nutrient for humans, this conversion does not produce any harmful health effects.

We stand ready to assist the Department of Health Services in collecting data as quickly as possible and making the necessary decisions listed above to assure the development of an appropriate drinking water standard if it is determined one is needed.

We are also greatly concerned about some of the reporting that has sought to sensationalize this issue. As mentioned previously, we feel it is our responsibility as drinking water suppliers to provide the public with the most accurate information available. Unfortunately, it does not appear that the media feel compelled to adhere to this tenet as well. Specifically, we would like to clarify for the committee members that a Public Health Goal is not a proposed drinking water standard. In nearly every press article on chromium VI, the media have referred to the Public Health Goal (PHG), adopted by OEHHA last year, as a proposed drinking water standard. Nothing could be farther from the truth. It is our understanding that this clarification has been made to the media by water suppliers and DHS but to no avail. A PHG is a health risk assessment that is "published" by OEHHA, not adopted. It serves as a very important basis for setting a drinking water standard but it was never intended to represent a "proposed drinking water standard". As listed earlier, DHS is required by law to incorporate many considerations such as occurrence, technology, cost, and feasibility into a proposed drinking water standard.

It is our understanding that the Department plans to list chromium VI as an Unregulated Contaminant, which would require most systems to begin sampling for the constituent. This process allows the Department to determine if the problem is isolated or widespread, how many agencies stand to be impacted, and what the potential treatment may be. In the absence of this requirement, many ACWA members have already begun collecting data on chromium VI in drinking water supplies. We fully support the Department's plan to list chromium VI as an Unregulated Contaminant.

Once the data have been collected and analyzed, ACWA will participate in the standard setting process followed by the Department regarding the need for a drinking water standard. This process can take time but is done with the utmost attention paid to health impacts, costs to consumers, environmental impacts, and technological capabilities. Water suppliers and the Health Department hold public health protection above all other responsibilities. This process for setting drinking water standards ensures that the standards are well designed and implemented for maximum public health protection, which is our primary concern.

1069-S
Additional copies of this publication may be purchased for $12.00 per copy (includes shipping and handling) **plus current California sales tax.**

Senate Publications
1020 N Street, Room B-53
Sacramento, CA 95814
(916) 327-2155

Make checks payable to SENATE RULES COMMITTEE.
Please include Senate Publication Number 1069-S when ordering.