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DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

April 28,1998

Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

Kevin Mayer
USEPA
Superfund SFD 7-2
75 Hawthorne Street
San Francisco, CA 94105

Dear Mr. Mayer:

Enclosed please find a copy of the March 18, 1998 health consultation on the following site prepared by the California Department of Health Services, under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

AEROJET GENERAL CORPORATION
RANCHO CORDOVA, SACRAMENTO COUNTY, CALIFORNIA
CERCLIS NO. CAD980358832

If you have any questions or comments, please feel free to call me (415) 744-2194.

Sincerely,

for William Q. Nelson, Senior Regional Representative
ATSDR, Region IX (HHS-1)
75 Hawthorne Street, Suite 100
San Francisco, CA 94105

cc: Max M. Howie, ATSDR/HAC/PERIS
Region IX File

Health Consultation

Perchlorate Contamination in the

Citizens Utilities' Suburban and Security Park

Water Service Areas

AEROJET GENERAL CORPORATION

RANCHO CORDOVA, SACRAMENTO COUNTY, CALIFORNIA

CERCLIS NO. CAD980358832

MARCH 18, 1998

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia

Health Consultation: A Note of Explanation

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

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

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HEALTH CONSULTATION

Perchlorate Contamination in the

Citizens Utilities' Suburban and Security Park

Water Service Areas

AEROJET GENERAL CORPORATION

RANCHO CORDOVA, SACRAMENTO COUNTY, CALIFORNIA

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Prepared by:

California Department of Health Services
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

BACKGROUND AND STATEMENT OF ISSUE

The California Department of Health Services (CDHS), under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), is conducting health assessment activities on the Aerojet-General Corporation (Aerojet) Superfund site in Sacramento County, California (See Figure 1). A Preliminary Health Assessment written in December 1988 recommended that when additional environmental information and data became available ATSDR would make another assessment (1). A Site Review and Update written in March 1993 also recommended a health assessment be conducted when more data became available (2).

This health consultation is one in a series that will be performed as part of the ATSDR health assessment process at this site. During this process, data and information on the release of hazardous substances and their impact on public health will be evaluated. Four health consultations have recently been written as part of this series (3-6). In this health consultation, we will focus on describing the Citizens Utilities service areas potentially affected by the perchlorate contamination (Figure 2). We are also in the process of writing several other health consultations that focus on perchlorate exposure to consumers of water from other water purveyors in the area and from private wells in the area. In addition, we have also written a health consultation that describes the perchlorate groundwater contamination west of the Aerojet Superfund site.

Aerojet began operation in 1951. Since that time, Aerojet has manufactured liquid and solid propellants for military and commercial rocket systems and has fabricated, assembled, tested and rehabilitated rocket engines (1). In addition, between 1974 and 1979, Cordova Chemical Company, a wholly-owned subsidiary of Aerojet, manufactured paint components, herbicides, and pharmaceutical products. Over the years, Aerojet and Cordova Chemical disposed of hazardous waste by burial, open burning, discharge into unlined ponds, and injection into deep underground wells (1). Some of these discharges, including perchlorate, contaminated the environment and have moved off-site of the Aerojet facility boundary (Figure 1). Perchlorate in the groundwater arises from ammonium perchlorate being a main component of solid rocket fuel. In addition to the natural migration of perchlorate-contaminated groundwater from the site, Aerojet is reinjecting treated groundwater, contaminated with perchlorate, at the site's western boundary. The Regional Water Quality Control Board (RWQCB), the California Department of Toxic Substances Control (DTSC) and the U.S. Environmental Protection Agency (USEPA), are the lead regulatory agencies overseeing groundwater investigation and cleanup at Aerojet, and are also investigating other sources of the perchlorate, such as the McDonnell Douglas (now Boeing) and Purity Oil Sales sites.

Citizens Utilities Water Service Description

The Citizens Utilities Company is a full-service telecommunications company with utility assets that provide natural gas distribution, electric distribution, and water and wastewater

treatment services. Citizens Utility stock is traded on the New York Stock Exchange. Citizens Utilities serves water to several geographical areas in Sacramento County, including two separate water systems near the Aerojet site, the Suburban and the Security Park systems (Figure 1).

The Suburban system is located to the west of the Arden Cordova Water Service and Mather Air Force Base. Citizens Utilities Company serves water to approximately 33,600 people via 10,192 connections (as of 1996), approximately 2000 are commercial and the rest residential in the Suburban System (7). Water is supplied to the Suburban system from 20 wells located within the service area (Figure 1)(7).

Due south of the Aerojet and McDonnell Douglas sites, the Citizens Utilities Company services the Security Business Park (8). There are two separate water systems located within Security Business Park; only one is being used. The system which is being used consists of two wells (only well #2 is being used), two storage tanks, and a booster pumping station. The second system, referred to as the Beta area has two pit wells, one storage tank, and a booster pumping station. A total of 16 service connections are in use and receive water from Security Business Park well #2. Approximately 600 people work at Security Business Park.

Citizens Utility was forced to shut down one its Suburban system wells (Citizens Utility Well #29, the Explorer well) because of tetrachloroethylene (PCE) contamination that originated from Mather was detected in the well water (8). Citizens Utilities requested compensation for the water production loss so the Air Force constructed an intertie between the Main Base system and Citizens Utilities' Suburban System which could provide 900 gallons per minute. The intertie was used to supply water from July to November 30, 1995 (9) and from July to October 1996 (10).

Another Suburban well (Citizens Utility well #37, the Moonbeam well) has also been contaminated by a plume coming from Mather Air Force Base (7). Carbon tetrachloride was found in the Moonbeam well (up to 0.5 parts per billion (ppb) and the Air Force placed a granular activated carbon treatment system on the well in early 1997.

Two of the 20 Suburban wells have had levels of nitrate above 22.5 parts per million (ppm) and one well (Whitewater well) has at least one reading above the Maximum Contaminant Level of 45 ppm (7).

DISCUSSION

In late January and early February 1997, Aerojet, as a part of their ongoing monitoring of certain off-site public drinking water wells, detected perchlorate in five off-site public drinking water wells west of Aerojet (none of these wells are Citizens Utility wells)(11). To analyze these water samples, Aerojet used a refined or improved analytical method such that instead of a reporting level of 400 ppb, they were able to obtain a detection limit of 35 ppb. The five

drinking water wells showed detectable levels of perchlorate ranging from 92 to 280 ppb with a detection limit of 35 ppb. Subsequent re-testing of the wells showed comparable levels. These detectable levels of perchlorate exceeded the concentration (4 to 18 ppb) suggested by the USEPA provisional reference dose (1 to 5E-4 mg/kg/day) based on a 70 kg individual consuming 2 liters of water a day (12).

In March 1997, the Sacramento District field staff of the CDHS Division of Drinking Water (DDW) sampled 41 public water supply wells in the area of the known perchlorate contaminated wells, including 14 Suburban system wells and the two Beta wells in the Security Park area (13). The well samples were processed by the CDHS's Radiation and Sanitation Laboratory with a detection limit of 4 ppb (Table 1). Perchlorate was detected but not quantifiable (<4 ppb) in one Suburban well (Citizens Utility well #32, the Malaga well). All other wells had no detectable levels (<4 ppb) of perchlorate in March 1997. Citizens Utilities has taken the Malaga well with detectable level of perchlorate off-line and it will only be used if needed for fire protection.

The DDW field staff have continued to monitor for perchlorate contamination in drinking water sources. In April, DDW staff sampled 22 wells, including the off-line Suburban well #29 and the Security Park well #2 (13). In May, DDW staff sampled 43 locations, including 15 Suburban system wells and the Security Park well #2. In June, DDW staff sampled 47 locations, including 14 Suburban wells and the Security Park well #2 (13). In July, DDW staff analyzed water from 40 locations, including 12 wells in the Suburban System and 2 wells in the Security Park System (14). In July, perchlorate was detected but not quantifiable in another Suburban System well (Citizens Utility well #27, the Rockingham well). In August, DDW staff analyzed water from 42 locations, including 15 wells in the Suburban System and the Security Park System well #2 (15). Perchlorate has not been detected in any well except wells #27 and #32, both of which have levels less than 4 ppb.

Community Concerns

The Citizens Utility staff have shared information about perchlorate contamination with their customers in the Suburban District and they report receiving only a few calls regarding this issue.

When the DDW sampling results became available, Citizens Utilities had their consultants prepare a notice notifying Suburban and Rosemont customers that 14 wells had no detectable levels and one well had a trace amount of perchlorate (see Attachment A). In this notice, Citizens Utilities notified their customers that they had taken the well with detectable level of perchlorate off line. Citizens Utilities, based on their customer demographics, translated the notice into five languages besides English (Vietnamese, Hmong, Cambodian, Russian, and Spanish). Citizens Utilities listed a phone number in the brochure that could be called if more information was needed. CDHS cooperative agreement staff prepared a fact sheet focusing on health issues related to perchlorate and made this available to water purveyors (16). Apparently, Citizens Utilities was making this

fact sheet available to those people who called the information line and wanted information about perchlorate toxicity.

Exposure Pathways

The sampling of Citizens Utility's Suburban and Security Park Systems wells has shown no quantifiable levels of perchlorate. However, exposure to certain Suburban System customers did occur as a result of the water that came through the intertie with the Mather Main Base water system. This exposure to the perchlorate contaminated water occurred at two discrete times (July to November 1995 and May to October 1996) in the past when water from Mather Air Force Base (now called Mather Field) was delivered through this intertie to the Suburban System customers (9, 10). No such exposure is currently occurring or has occurred since November 1996, the last time the intertie was open.

The Suburban System wells provide water to 10,192 connections, approximately 33,600 customers, mostly residents (7). The number of people potentially exposed to the larger amounts of perchlorate is likely much smaller because the intertie, when it was being used, only provided a fraction of the drinking water to the system. The commercial and residential users closest to the intertie connection are likely the highest exposed.

For a target population to be exposed to environmental contamination, there must be a mechanism by which that contamination comes into direct contact with the target population (17). An exposure pathway is the description of this mechanism. A completed exposure pathway consists of five parts: a source of contamination, an environmental medium and transport mechanism, a point of exposure, a route of exposure, and a receptor population. For a population to be exposed to an environmental contamination, a completed exposure pathway (all five elements) must be present. If any one of these is missing, then there is no exposure, though the presence of contamination may still be significant and require remediation. This is especially true if there is a possibility of an in complete exposure pathway becoming complete in the future.

In the next few paragraphs, CDHS will describe how we evaluated the completed exposure pathway related to the perchlorate contamination from the Main Base intertie for three receptor populations: adult resident, worker, and frequent adult customer/visitor (Table 2).

CDHS considers that no current exposure pathway exists with the Citizens Utility Water System because there is no quantifiable levels of perchlorate being delivered to the user. CDHS estimates there to be a potential future exposure pathway from perchlorate-contaminated water, since the perchlorate groundwater plume is moving toward the Citizens Utility Suburban System wells. Even if this exposure does reach these wells, Citizens Utility Company has already demonstrated a desire to prevent such exposure. For instance, they have taken well #32, the Malaga well off-line, as a result of perchlorate being detected but not

quantifiable (<4 ppb) in that well. Thus, it seems very unlikely a future exposure pathway exists for Suburban System users.

For the Security Park System, no past or current exposure pathway exists. Future exposure seems unlikely based on the movement of the perchlorate-contaminated groundwater (Figure 1). However, there is no redundancy in the system. Thus, if the only well that serves the Security System does become contaminated, a potential for exposure may exist.

When evaluating the potential health impact from exposure to contaminated potable water, CDHS considered all routes of exposure to perchlorate in the water. The most important route of exposure is through ingestion of the water. We did not evaluate exposure from eating homegrown fruits and vegetables that were irrigated with perchlorate-contaminated water, because we were not aware of bioconcentration parameters related to perchlorate (there are investigations into this issue, see Public Health Recommendations and Actions Section). We did not evaluate inhalation exposure to perchlorate in the potable water because perchlorate is not volatile (does not become a gas).

For certain chemicals, skin contact with contaminated water can be an important route of exposure. Generally speaking, skin absorption of a chemical is based on how much that chemical likes to be in fat-like surroundings. Inorganic ions like perchlorate do not like being in fat-like surroundings and thus their uptake by the skin, a fat-like environment, are typically less than 10% and frequently less than 1%. Since the permeability characteristic for perchlorate is not known, we used the permeability characteristic of another anion, chloride (1×10^{-10} cm/sec) to evaluate skin exposure to perchlorate (18). We found that skin contact would result in an exposure dose estimate that is less than 0.0005% of the dose estimate that would be received by ingesting the water. Therefore, CDHS focused on ingestion in calculating dose estimates.

The amount of Suburban System perchlorate-contaminated water that is ingested will be determined for each exposure pathway; however, when the route of exposure is ingestion, it will be assumed that there is 100% absorption of perchlorate into the body from the gut from the amount water that is ingested.

Toxicological Evaluation

This health consultation focuses on perchlorate exposure and thus the toxicological evaluation will focus on perchlorate. CDHS acknowledges that there low levels (below the drinking water standard) nitrates and nitrite, naturally-occurring and agriculturally-related, in the well water; however, the affect of nitrates/nitrites in combination with perchlorate will not be evaluated due to lack of toxicological information that would allow such an evaluation.

Most of the information about the toxicity of perchlorate comes from studies of potassium perchlorate as a treatment for hyperthyroidism, resulting from Graves' Disease. Perchlorate

inhibits the secretion of thyroid hormones (and can thus relieve the symptoms of Graves' Disease) by competitively inhibiting the accumulation of iodide in the thyroid (19). Discontinued administration of the ammonium perchlorate to Graves' Disease patients does result in a return to their hyperthyroid condition (20). People who have been treated with perchlorate have reported gastrointestinal irritation, skin rash, and hematological effects including agranulocytosis, aplastic anemia, and lymphadenopathy (19). The severe hematological effects seem to be more likely to occur when large doses of more than 1,000 mg/day (approximately 14 mg/kg/day for a 154 pound man) are used (21).

Potassium perchlorate was extensively used for treatment of Graves' Disease patients in the late 1950s and 1960s. After the reports of the severe hematological effects, potassium perchlorate was not used for many years (22). In the early 1980s, physicians in Europe began using it again for the treatment of Graves Disease, and reporting no serious side effects occurring as long as the dose was kept below 1,000 mg/day (approximately 14mg/kg/day for a 154 pound man)(21). In addition, potassium perchlorate has also been found helpful in treating thyrotoxicosis resulting as a side effect from other drug therapies (23-27).

There are only a few studies of the short-term exposure in persons without Graves Disease (28). The animal studies that have been conducted have also involved short-term exposures and the doses were too high to see a level where there was no effect on the thyroid. Both human and animal studies have primarily examined the effects of perchlorate on the thyroid, interference with the production of thyroid hormones resulting in a below normal level of thyroid hormone in circulation (hypothyroidism). The effect of perchlorate on systems other than the thyroid needs to be explored, especially, effects on the blood system (described above) and developmental effects (described below).

Children are not little adults, their bodies are not fully developed, and may not respond to a perchlorate in the same manner as an adult. For instance, thyroid hormone is critical to normal brain and physical development, and the critical period for this dependency on thyroid hormone begins in the uterus and extends up until three years of age. After the age of 3, thyroid hormone continues to play a primary role in physical development until puberty. Thus, a low level or absence of thyroid hormone in utero or in childhood may lead to irreversible mental retardation and retarded physical growth.

Perchlorate can cross the placenta and thus could affect the developing fetus, though these effects have not been studied in humans. It is known, however, that drugs currently being used to treat Graves' Disease such as propylthiouracil do cross the placenta and can produce neonatal hypothyroidism (29, 30) and fetal in utero goiter (enlargement of the thyroid)(31-33). In fact, because the developing fetus's thyroid is immature, propylthiouracil is a more potent suppressor of thyroid function in the fetus than in the mother (34).

In a study of the effects of potassium perchlorate (740mg/kg/day for the mother) fed to pregnant guinea pigs during pregnancy, a 15-fold enlargement of thyroid of the newborns was

noted, even though no increase in size of the mother's thyroids occurred (35). Thyroid hormone levels of the newborn guinea pig were not measured in this study. Another animal study in which the mother was given fairly high levels of perchlorate, also resulted in increased thyroid weight in the offspring and the mother (36). At this time, it is unclear whether lower doses of perchlorate would affect the thyroid of the developing fetus and young child and thus affect thyroid function at a time when normal thyroid hormone production is important to brain development.

There are animal studies underway which are exploring the toxicity of perchlorate, including effects on the immune system and developmental effects (see the Recommendations section at the end of the text for more information).

In 1992 and 1995, USEPA staff reviewed the perchlorate toxicology studies and derived a provisional reference dose (RfD)(12, 28). An RfD is a dose to which a person could be exposed over long-term period without having any appreciable risk of a noncancer health effect. The USEPA applied an uncertainty factor of 300 or 1000 to the No Observable Adverse Effect Level of 0.14 mg/kg/day (NOAEL)(28, 37) to derive an RfD of 1 to 5 x 10-4 mg/kg/day (12). (If one assumes that a person drinks 2 liters/day of water and weighs 70 kilograms, the reference dose range corresponds to an acceptable range of perchlorate in drinking water of 4 to 18 ppb).

The uncertainty factor of 300 or 1000 is derived from multiplying the following (12):

* An uncertainty factor of 10 to account for extrapolation from the acute exposure in the NOAEL study to chronic exposure of an RfD;

* An uncertainty factor for database deficiencies (3 or 10) to account for data limitations including limited data on subchronic and chronic exposure to low doses of perchlorate, limited data on other organ system effects, limited data on the effects on the hematopoietic system, and a lack of reproductive and multigenerational data;

* An uncertainty factor of 10 to protect sensitive subpopulations which would include groups such as hypothyroid patients and individuals with low iodine diets or with genetically impaired iodine accumulation.

The only information about the possible carcinogenicity of perchlorate has to do with cancers of the follicular thyroid cells (12). Interference with the normal thyroid-pituitary feedback mechanism, such as that caused by perchlorate, can theoretically lead to thyroid follicular cell neoplasia. Several animal studies found that thyroid tumors were induced in both rats and mice by long-term administration of high doses of perchlorate. However, humans are not supposed to be as sensitive as the rat to thyroid cancer (38, 39). Since perchlorate's possible carcinogenic effects on the thyroid are based on the same mechanism (interfering with the

thyroid-pituitary homeostasis) that determines its noncarcinogenic effects, it may be appropriate to consider the RfD as a dose which does not pose a significant risk of thyroid cancer (28).

It is even harder to determine whether or not perchlorate exposure can cause any other type of cancer. If a link is discovered, it will probably be based on perchlorate acting not as a mutagen (causing genetic changes) but rather as a growth promoter, an effect associated with a threshold. In other words, below a certain threshold, perchlorate would not have cancer-causing effects. More toxicological information is needed to ascertain whether perchlorate can cause cancer and if it can, at what dose this effect may start occurring.

Using USEPA's provisional reference dose (0.0001 to 0.0005 mg/kg/day) based on perchlorate's effect on the thyroid, CDHS evaluated the noncancer (thyroid) health impact of the completed exposure pathway from exposure to perchlorate-contaminated water through the intertie with the Mather Main Base System for several months in 1995 (35 weeks) and 1996 (22 weeks). We evaluated this completed exposure pathway for three different receptor populations: adult resident, worker and frequent adult customer/visitor (Table 2).

Though it is possible to estimate a dose for a child living near the Mather Main Base intertie, CDHS did not calculate this dose because we are not confident about how to interpret the dose estimate. To compare the estimate of a child's dose with toxicological information based on adult exposure ignores the fact that a child is not a small adult, especially when it comes to the importance of the thyroid in normal brain and physical development (see above). Thus, until there is more information about perchlorate's effect on children, CDHS is not able to evaluate past exposures to a young child living near the Mather intertie.

The water from the intertie came from the Mather Main Base Area. It is hard to estimate what concentration of perchlorate was delivered to the user from the Mather Main Base Water System in 1995 and 1996, because perchlorate was not analyzed in the water during those times using an analytical method that had a sensitive enough endpoint. It may be possible to recreate past exposures through a time intensive analysis of the historical documentation of the Main Base well logs and other water system documentation. However, for this health consultation, we will instead evaluate three well contribution scenarios: Main Base well #1 was delivering 100% of the water, Main Base well #2 was delivering 100% of the water, and all wells were equally contributing to the water being delivered to the user (so the concentration of perchlorate being delivered to the user in the third scenario is the average of the four well levels). By evaluating these three scenarios, we will be considering the worst case scenario, when well #2 was the lead well; the second worst situation, when well #1 was the lead well; and a rough approximation of the automated, rotational use of the wells with the storage tank being the place where the blending of the water occurs.

CDHS will use the concentrations of perchlorate measured in the Mather Main Base Water System wells when DDW sampled in March 1997 (Well #1= 67 ppb, Well #2=120 ppb, and

the average of all four wells= 51 ppb). Thus we will be evaluating past exposure based on recent perchlorate concentrations. Perchlorate levels in Mather wells and in other water purveyor wells (see other health consultations) have fluctuated a bit over the past several months of reliable perchlorate analysis, but on the whole seem to be relatively constant. This would mean that the dose estimates that we calculate may reflect exposures that have occurred in the near past, 1995 and 1996.

Adult residential exposure in the Suburban System: CDHS estimated the exposure for a adult resident who lives 24 hours per day, seven days a week, for 35 weeks in 1995 and 22 weeks in 1996 in a house located near the Suburban System intertie with the Mather Main Base Water System (Table 3 is a list of the exposure parameters used in the toxicological evaluation). CDHS estimated the dose if the adult resident was exposed to water as described in the three water contribution scenarios described above.

The estimated dose for a adult resident living in a house located near the Suburban System intertie with the Mather Main Base Water System for each of the three well contribution scenarios (0.0019, 0.0034, and 0.0015 mg/kg/day, respectively) exceeds the provisional reference dose range (0.0001 to 0.0005 mg/kg/day) which means that noncancer (thyroid depression) health effects may have occurred when adult residents of the Suburban Water System received water from the Mather through the intertie. However, because there is a very large uncertainty factor associated with the provisional reference dose and the estimated dose does not approach the NOAEL (0.14 mg/kg/day), it is unlikely that adult residential exposure to the Mather Main Base water through the intertie with the Suburban System caused any noncancer health effects.

Worker exposure in the Suburban System: CDHS estimated the exposure for a worker who worked eight hours a day, five days a week, for 35 weeks in 1995 and 21 weeks in 1996 at a business that is located near the Suburban System intertie with the Mather Main Base Water System (Table 3 is a list of the exposure parameters used in the toxicological evaluation). CDHS estimated the dose if the worker was exposed to water as described in the three water contribution scenarios described above.

The estimated dose for a worker at a business located near the Suburban System intertie with the Mather Main Base Water System for the second scenario, when Mather Main Base well #2 was the lead well (0.0008 mg/kg/day) exceeds the provisional reference dose range (0.0001 to 0.0005 mg/kg/day) which means that noncancer (thyroid depression) health effects may have occurred when the worker drank water delivered from Mather and well #2 was the lead well. However, because there is a very large uncertainty factor associated with the provisional reference dose and the estimated dose does not approach the NOAEL (0.14 mg/kg/day), it is unlikely that worker exposure to the Mather Main Base water through the intertie with the Suburban System caused any noncancer health effects.

The estimated dose for worker exposure to water from the Main Base water system through the intertie in each of the first and third well contribution scenarios (0.0004 and 0.0003 mg/kg/day,

respectively) does not exceed the provisional reference dose range (0.0001 to 0.0005 mg/kg/day). This means that noncancer (thyroid depression) health effects would not have occurred to the frequent adult customer/visitor drinking or washing with water from the Main Base water system through the intertie when well #1 was the lead well or when their was a rotation of four wells serving the water.

Frequent adult customer or visitor exposure at a Suburban business: CDHS estimated the exposure for a adult visitor or adult customer who went once a day, five days a week, for 50 weeks of the year to a business located near the Suburban System intertie with the Mather Main Base Water System (Table 3 is a list of the exposure parameters used in the toxicological evaluation). CDHS will assume that the adult customer/visitor drank one cup of water (0.24 liters) per trip to the business. CDHS estimated the dose if the frequent adult customer/visitor was exposed to water as described in the three water contribution scenarios described above.

The estimated dose for a frequent adult customer/visitor exposure to water from the Main Base water system through the intertie in each of the three well contribution scenarios (0.00016, 0.00028, and 0.00012 mg/kg/day, respectively) does not exceed the provisional reference dose range (0.0001 to 0.0005 mg/kg/day). This means that noncancer (thyroid depression) health effects would not have occurred to the frequent adult customer/visitor drinking or washing with water from the Main Base water system through the intertie.

CONCLUSION

Based upon the information reviewed, there was a completed exposure pathway to perchlorate-contaminated water in the Citizens Utility Suburban System. This completed exposure pathway occurred when water was delivered from the Mather Main Base Water System, which is known to be contaminated with perchlorate, to the Suburban System for several months in 1995 and 1996. Otherwise, the water that supplies the Suburban System customers comes from wells that have not had any quantifiable levels of perchlorate detected in them. Thus, most Suburban System customers have never been exposed to any perchlorate-contaminated water.

Residents who lived near and employees who worked at businesses near the Mather Main Base intertie may have been exposed on a regular basis to the perchlorate when they drank water and washed or showered with the water. Other exposures occurred over a short duration resulting in a very low dose to the customers and visitors who occasionally frequented the business establishments located near the Mather Main Base intertie.

It is difficult to predict when the perchlorate first contaminated the Mather Main Base wells but it may have been as early as 1987. In March 1997, the perchlorate concentration in two Mather Main Base drinking water wells (Main Base wells #1 and 2) exceeded a concentration (4 to 18 ppb) suggested by the USEPA provisional reference dose based on a 70 kg individual consuming two liters of water a day. There is currently a three hundred to thousand-fold

uncertainty factor incorporated into the provisional reference dose. Since the uncertainty factors are supposed to account for the somewhat limited toxicological information, it is conceivable that as more toxicological data becomes available, a change in the (provisional) reference dose may occur.

The estimated dose for a adult resident or worker (only when well #2 was the lead well) of the Suburban System who was exposed to water from the intertie with the Mather Main Base exceeds the provisional reference dose range which means that noncancer (thyroid depression) health effects may have occurred when the adult resident or worker was exposed to water from these wells. However, because there is a very large uncertainty factor associated with the provisional reference dose and the estimated doses do not approach the NOAEL, it is unlikely that these exposures did cause any noncancer health effects. This intertie is no longer being used, thus any noncancer health effects that may have occurred should no longer be occurring now that the exposure has ceased.

The estimated dose for a frequent adult customer/visitor or worker (when well #1 was the lead or there was a four well rotation) to a business served by the Suburban System and who was exposed to water the intertie with the Mather Main Base does not exceed the provisional reference dose range. This means that noncancer (thyroid depression) health effects would not have occurred to the frequent adult customer/visitor drinking or washing with water from the Mather intertie.

Based upon the information available at the time this health consultation was written, CDHS concludes that well water received through the intertie with the Main Base Water System for several months in 1995 and 1996 posed a health hazard when the water was delivered to the Suburban System. Since the water from this intertie is longer being used, there is no current health hazard from perchlorate to Suburban System users. Additionally, the well water in the Security Park System does not pose a health hazard due to perchlorate.

PUBLIC HEALTH RECOMMENDATIONS AND ACTIONS

The Public Health Recommendations and Actions Plan (PHRAP) for this site contains a description of actions taken, to be taken, or under consideration by ATSDR and CDHS at and near the site. The purpose of the PHRAP is to ensure that this health consultation not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The CDHS and ATSDR will follow-up on this plan to ensure that actions are carried out.

Actions Completed

1. Citizens Utility sent a notice to their Suburban System customers in March about the finding of no quantifiable levels of perchlorate in the Suburban wells.

2. CDHS prepared a fact sheet about perchlorate and health. CDHS made this fact sheet available to the affected water purveyors including Citizens Utility Company of California.

Actions Planned:

1. The Air Force and the Perchlorate Study Group (a number of manufacturers and users of perchlorate) are sponsoring an investigation into fate and transport question regarding perchlorate. For instance, they will investigate if is perchlorate taken up and bioconcentrated by vegetable crops and the skin permeability of perchlorate.

2. The Air Force and the Perchlorate Study Group are sponsoring a series of animal studies to address some of the information lacking in understanding perchlorate toxicology. CDHS cooperative agreement staff along with other state and federal scientists, were asked by the Air Force to recommend and oversee the planning of the animal studies. As of August 1997, the study protocols have been finalized and the process of choosing a laboratory to conduct the studies is underway. A report on the studies is expected in mid-summer 1998.

Recommendations for Further Action:

1. Continue communicating with the Citizens Utility Suburban Systems water customers about the perchlorate issue.

2. Continue monitoring drinking water wells for perchlorate, and discontinue using a well that has levels of 18 ppb or greater of perchlorate.

3. Consider conducting a dose reconstruction exposure investigation of perchlorate exposure in the Suburban System.

4. If indicated based on new toxicological information, review toxicological evaluation of past perchlorate exposures in the Suburban System.

5. Be prepared to address the possible contamination of the Security Park System.

REFERENCES

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CERTIFICATION

The Perchlorate Contamination in the Citizens Utilities' Suburban and Security Park Water Service Areas, Aerojet-General Corporation Health Consultation was prepared by the California Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was initiated.

Technical Project Officer, SPS, SSAB, DHAC

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

Chief, SPS, SSAB, DHAC, ATSDR

Table 1. Suburban System Wells and Perchlorate SamplingResults

Well ID	Status of Well	Perchlorate Analysis (ppb)					
		3/24/97	April	5/12/97	6/19/97	7/9/97	8/13/97
Well 23-Woodman		ns	ns	ns	ns	ns	ns
Well 24-Winchester		<4.0	ns	<4.0	<4.0	<4.0	<4.0
Well 26-Swansea		<4.0	ns	<4.0	<4.0	<4.0	<4.0
Well 27-Rockingham		<4.0	ns	<4.0	<4.0	<4.0[a]	<4.0
Well 29-Explorer	Off-line	<4.0	ns	ns	ns	ns	ns
Well 30-Gould		<4.0	ns	<4.0	<4.0	<4.0	<4.0
Well 31-Nut Plains		<4.0	ns	<4.0	<4.0	<4.0	<4.0
Well 32-Malaga		<4.0[a]	ns	<4.0[a]	<4.0[a]	<4.0[a]	<4.0[a]
Well 33-Mars Way		<4.0	ns	ns	ns	<4.0	<4.0
Well 35-Point Reyes		ns	ns	ns	ns	ns	ns
Well 37-Moonbeam		<4.0	ns	<4.0	<4.0	<4.0	<4.0
Well 38-West Loma Linda		<4.0	ns	<4.0	<4.0	<4.0	<4.0
Well 40-Chettenham		ns	ns	ns	ns	ns	ns
Well 41-Rogue River		ns	ns	ns	ns	ns	ns
Well 44-Salmon Falls		ns	ns	ns	ns	ns	ns
Well 45-Folsom/Bradshaw		<4.0	ns	<4.0	<4.0	<4.0	<4.0
Well 47-Folsom/Mayhew		<4.0	ns	<4.0	<4.0	<4.0	<4.0
Well 86-Butterfield		<4.0	ns	<4.0	<4.0	<4.0	<4.0
Well 97-Oaken Bucket	Threatened by VOC contamination	<4.0	ns	<4.0	<4.0	<4.0	<4.0
Well 114-Countryside	New well on-line 1996	<4.0	ns	<4.0	<4.0	<4.0	<4.0

ns= not sampled
<4.0[a]= perchlorate detected at a concentration <4.0 ppb, but not quantitated
Data taken from References (7, 13-15)

Table 2. Perchlorate Contamination in the Suburban System- Completed Exposure Pathway for Different Receptor Populations

Receptor Group Pathway Name	Source	Environmental medium	Point of Exposure	Route of Exposure	Exposed Population	Time
Residential Exposure in the Suburban System	Aerojet, McDonnell Douglas (?)	Intertie with Mather Main Base	House Tap	Ingestion	Adult Residents	Past
Worker exposure in the Suburban System	Aerojet, McDonnell Douglas (?)	Intertie with Mather Main Base	Business Tap	Ingestion	Workers	Past
Frequent customer or visitor to a business in the Suburban System	Aerojet, McDonnell Douglas (?)	Intertie with Mather Main Base	Business Tap	Ingestion	Frequent customer; Frequent visitor	Past

Table 3. Exposure Factors for Each Receptor Population of the Completed Exposure Pathway in the Suburban System

Receptor Group Pathway Name	Exposure Parameter	Value
Resident exposure in the Suburban System	Ingestion Rate	2 liters (8.6 cups)/day
	Body Weight	70 kilograms (154 pounds)
	Exposure Frequency	7 days/week 52 weeks/year
	Averaging factor	365 days/year
Worker exposed at a business served by the Suburban System	Ingestion Rate	2.0 liters (8.6 cups)/day
	Body Weight	70 kilograms (154 pounds)
	Exposure Frequency	8 hours/day 5 days/week 50 weeks/year
	Averaging Factor	365 days/year
Frequent customer or visitor to a business in the Suburban System	Ingestion Rate	0.24 liter (1 cups)/visit
	Body Weight	70 kilograms (154 pounds)
	Exposure Frequency	5 visits/week 50 weeks/year
	Averaging Factor	365 days/year

Figure 1
Perchlorate Groundwater Plume in Relation to Aerojet and the Citizens Utilities Suburban System

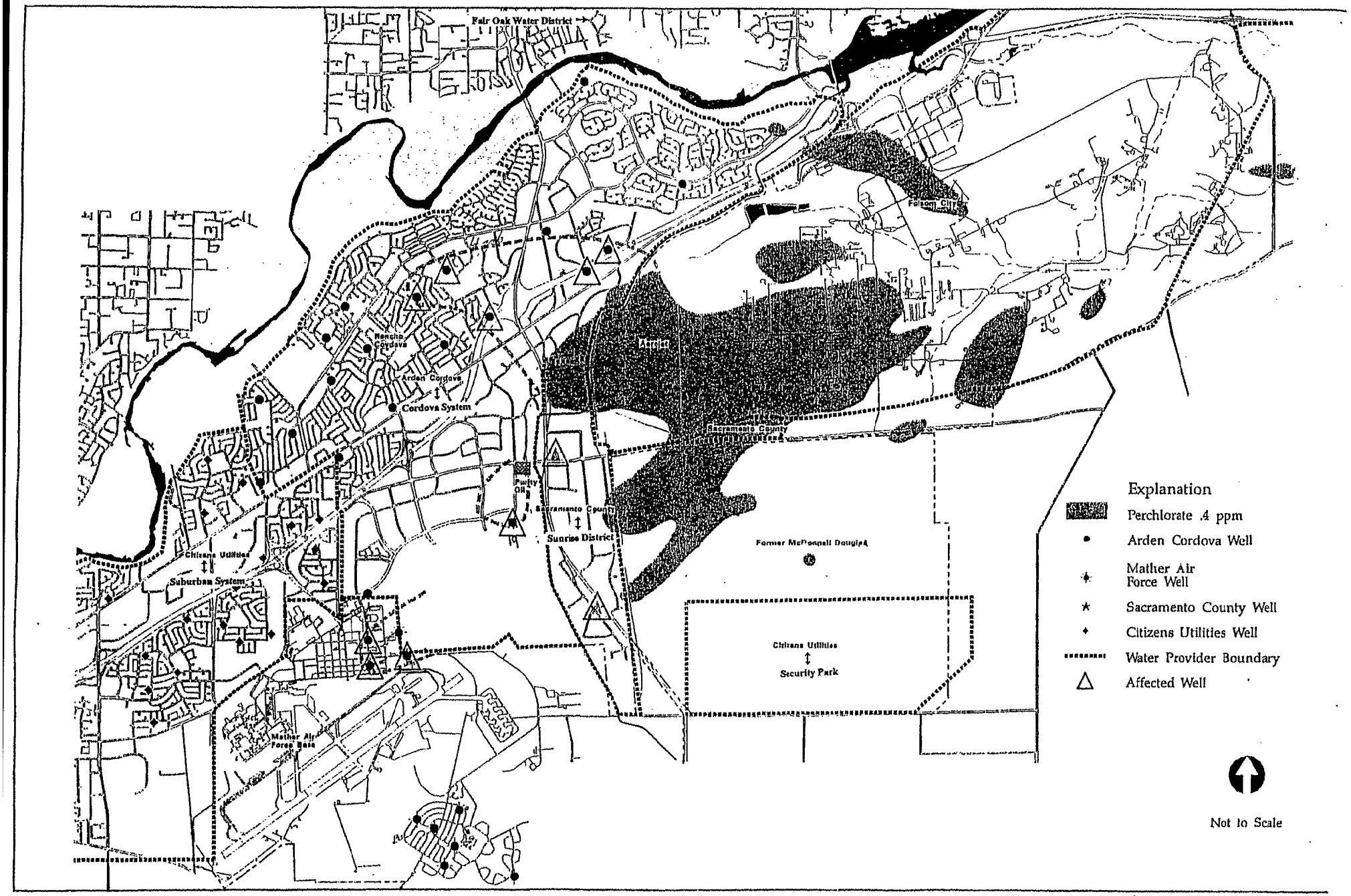
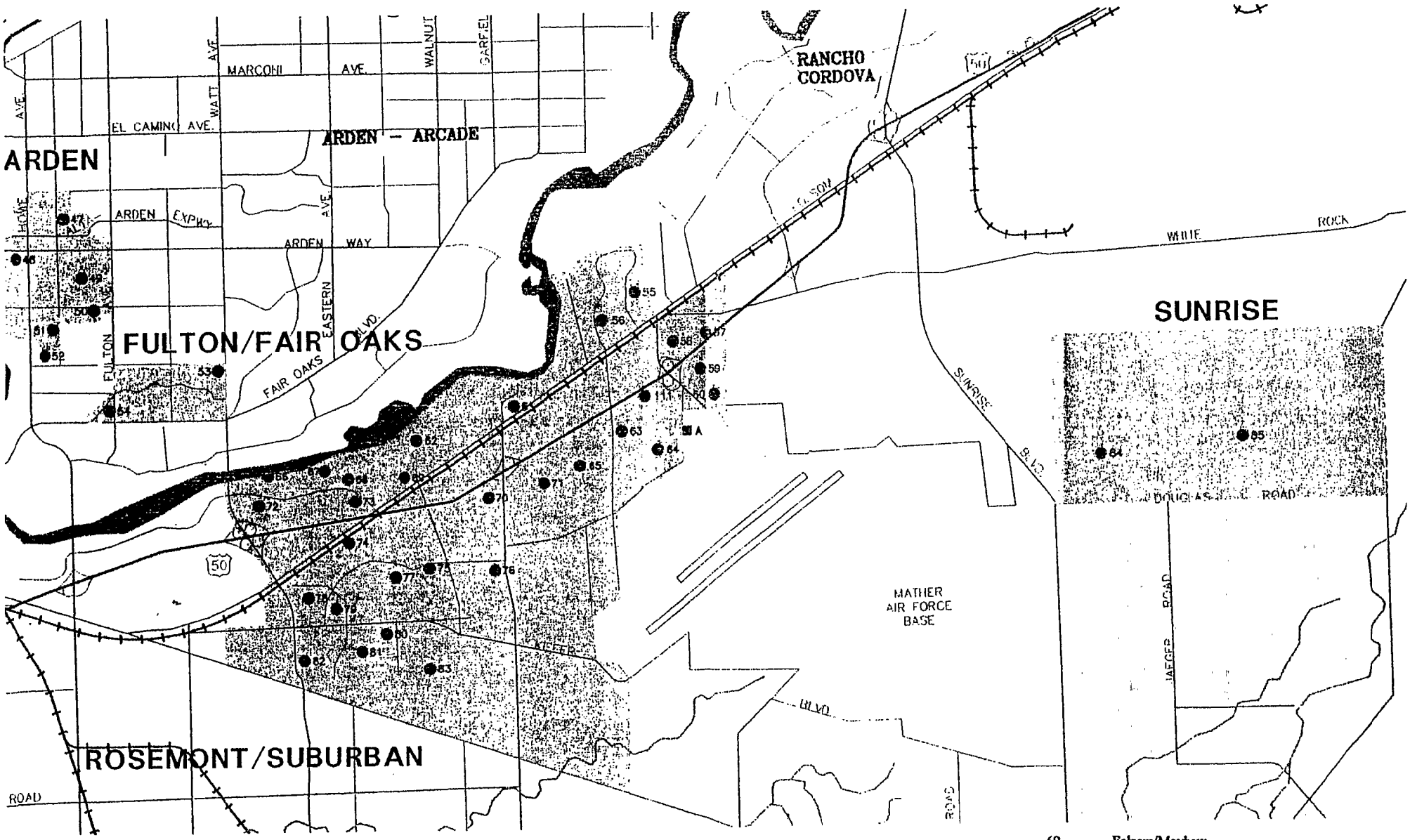


Figure 2
Suburban and Security Park Well Locations



WELL SITE LEGEND

		60	Rockingham	69	Folsom/Mayhew
		61	Folsom/Bradshaw	70	Oken Bucket
A	Mather AFB	62	Butterfield	71	Mars
		63	Gould	72	Salmon Falls
55	Malaga	64	Nut Plains	73	Point Reyes
56	West La Loma	65	Explorer	76	Moonbeam
57	Swansea	66	Woodman Way	84	Alpha Complex (3)
58	Winchester	67	Rogue River	85	Beta Complex (2)

Notice to our Rancho Cordova customers: Your water remains safe to drink.

Recently there have been news reports regarding the chemical perchlorate in some wells near Mather Air Force Base. Because the safety of your drinking water is our top concern, Citizens Utilities, in conjunction with the State Department of Health Services, tested 13 wells in the Rancho Cordova area.

Those tests indicated that water from these wells is perfectly safe to drink, although trace amounts of perchlorate were found in one well - amounts so low as to be unquantifiable and below the safety standard of four parts per billion (4pbb) set by the State Department of Health Services.

We are in the process of retesting that well. Although its water is safe to drink, we have taken it off line and will use it only for fire protection until we can determine whether the most recent test was accurate.

We will continue to monitor for perchlorate as part of our increased water quality monitoring program. If you would like more information, please call (888) 311-8840.

Citizens Utilities 1997 Water Conservation Program

Despite heavy rains in January, water sources throughout the region remain depleted and we must still conserve water. Our guidelines are as follows:

- Odd/even watering: odd-numbered street addresses may water on Tuesday, Thursday and Saturday. Even-numbered addresses may water on Wednesday, Friday and Sunday. No watering on Monday.
- Use shut-off nozzles on hoses.
- Set automatic sprinklers to operate between 9 p.m. and 5 a.m. – don't flood the gutters.
- Use brooms to clean driveways and sidewalks, not hoses.

Water wasters may be subject to installation of water meters and low flow restrictions on their water services. For more information, call (916) 568-4200. Thank you.

Tshaj tawm rau peb cov tub siv dej "customers" nyob Rancho Cordova Nej cov dej tseem huv thiab yeej zoo haus kawg.

Tau tsis ntev dhau los no muaj xov xwm tawm tias nej cov dej muaj cov tshuaj haus tsis tau "Chemical perchlorate" nyob rau ib co qhov dej haus nyob ze ntawm Mather tshav davhlau "Mather Air Force Base". Kev kho kom dej huv rau nej haus yog peb kev mob siab tshaj. Pejxeem txoj kev noj qab haus huv yog ib txog kev saib xyuas los ntawm "State Department of Health Services", peb kuaj txog li ntawm 13 lub qhov dej haus nyob ib thaj tsam ntawm Rancho Cordova, peb tsis pom muaj ib lub qho dej twg uas yuav tsis zoo haus nyob rau ntawm cov qhov dej no.

Tsis tas li no, peb tseem pheej yuav kuaj ntxiv mus lawm yav tomntej, kom cov dej no zoo haus tshaj ntxiv mus. Yog hais tias koj xav paub ntxiv hu rau (888) 311-8840.

Khooskas siv dej nyob rau xyoo 1997

Txawm los nag ntau npaum li cas nyob rau lub ib hlis no los txoj kev siv dej tseem nruj li qub nyob thoob plaws txhua qhov chaw thiab peb yuav tsum tau txuag dej cia. Peb txoj kev qhia nej siv dej raws li nram no.

- Ywg dej Khib/Khub: Chaw nyob zauv tab (leb khib) siv tau dej rau hnub peb "Tuesday", hnub Tsib "Thursday" thiab hnub Xya "Saturday". Chaw nyob zauv txooj (leb khub) siv tau dej rau hnub Plaub "Wednesday", hnub rau "Friday" thiab hnub Ib "Sunday". Tsis pub leej twg siv dej rau hnub Ob "Monday".
- Siv tus txau dej rau txoj yas tso dej.
- Caws cov kais tsuag dej "automatic sprinklers" ywg nyom tau rau lub caij thaum 9 teev tsaus ntuj mus txog rau 5 teev kaj ntug--tsis txhob cia dej nyab kwjdeg.
- Siv khaub ruab cheb txoj kev tsav tsheb tawm "driveway" thiab txoj kev taug ntawm ntug kev tsheb, tsis pub siv dej ntxuav.

Tus neeg nkim dej yuav raug txuas lub ntsuas dej "water meter" thiab yuav kaw dej kom los yau rau lawv siv. Xav paub xovxwm ntxiv hu rau (916) 568-4200. Ua nej tsaug.

Aviso a nuestros clientes de Rancho Cordova pueden continuar bebiendo su agua corriente con seguridad.

Recientemente han aparecido noticias que relacionan la substancia química perclorato con algunos pozos cercanos a la base Mather de la Fuerza Aerea. Puesto que la seguridad del agua para beber es nuestra preocupación principal, Citizens Utilities, conjuntamente con el Departamento de Servicios de Salud del estado, ha llevado a cabo controles en 13 pozos de la zona de Rancho Cordova. En ninguno de esos pozos se encontraron niveles detectables de perclorato.

Continuaremos investigando la presencia de perclorato como parte de la expansión del programa de control de calidad del agua. Si desea más información, sírvase llamar al (888) 311-8840.

Programa de Citizens Utilities de conservación del agua para 1997

A pesar de las lluvias fuertes de enero, los recursos de agua de toda la región siguen siendo reducidos y debemos continuar ahorrando agua. Nuestras pautas son las siguientes

- Riego por números impares y pares: Las direcciones con números impares pueden regar los martes, jueves y sábados; las direcciones con números pares lo pueden hacer los miércoles, viernes y domingos. Los lunes no hay riego.
- Utilice mangueras con boquillas que se cierran.
- Ajuste los rociadores automáticos para que funcionen entre las 9 p.m. y las 5 a.m., no inunde las canaletas.
- Limpie la entrada para el auto y la acera con escoba en vez de manguera.

Las personas que desperdicien agua pueden estar sujetas a que se les instale medidores de agua y a que se les restrinja el flujo de agua de sus servicios. Si desea más información, llame al (916) 568-4200. Gracias.

Ազդ՛ մեր Ռանչո Քորդովա յաճախորդներին.— Ձեր ջուրը խմելու համար ապահով է:

Վերջերս նոր լուրերի զեկուցումներ են եղել քիմիական փըրքլօրեյթի մասին, որը գտնվում է որոշ հորերի մեջ Մաթեր Օդային Ուժի Կայանի մօտ. Որովհետև ձեր խմելու ջրի ապահովութիւնը մեր մտահոգութեան պատճառն է, Սիթիզըն Իւթիլիթի-ին, Նահանգի Առողջապահութեան Ծառայութիւնների Բաժնի հետ միասին, քննարկման են ենթարկել 13 հոր Ռանչո Քորդովա շրջանում: Այդ հորերի մեջ, ոչ՛ մի մակարդակի փըրքլօրեյթի հետք չի յայտնաբերուել:

Մենք կշարունակենք հսկել փըրքլօրեյթի չափը, որպէս մեր ջրի որակի ծրագրին: Եթէ աւելի շատ տեղեկութիւն ցանկանաք, կխնդրենք հեռաձայնեք (888) 311-8840 համարին:

Սիթիզըն Իւթիլիթի 1997 Ջրի Խնայողութեան Ծրագիր

Չնայած, որ Յունվարին ծանր անձրևներ են տեղացին, ջրի պաշարները տարածաշրջանում մնում են սպառած և տակավին մենք պէտք է ջուր խնայենք: Մեր ուղղեցոյցները հետևեալն են.—

- Կենտ/զոյգ ջրել.— Փողոցների մեջ գտնվող կենտ համար ունեցող հասցեները կարելի է ջրեն Երեքշաբթի և Շաբաթ օրերը: Զոյգ համար ունեցող հասցեները կարելի է ջրեն Չորեքշաբթի և Ուրբաթ օրերը: Երկուշաբթի օրերը ջրելը արգելված է:
- Փակող-բանող փողծակոցից օգտուել ջրի խողովակների վրա:
- Ինքնաշխատող ջուր սփռող խողովակները աշխատելու համար հարմարացրեք երեկոյան ժամը 9և առաւօտեան ժամը 5 միջև ջրել– չհեղեղեք ջրանցքները:
- Ավելից օգտուեք անցուղին և մայթերը մաքրել ոչ թէ ջրի փողարկից:

Նրանք, որոնք ջուր կփչացնեն կարելի է ենթակա լինեն ջրի հաշվառքերի և ջրի ցածր հոսանքի սահմանափակումների իրենց ջրի ծառայութիւնների համար: Ավելի շատ տեղեկութիւնների համար, հեռաձայնեք (916) 568-4200 համարին, Շնորհակալութեամբ:

Сообщаем нашим потребителям в Ранчо Кордова: вода по-прежнему безопасна для питья

Недавно в программе новостей промелькнули сообщения о том, что в некоторых артезианских скважинах вблизи базы ВВС Матер замечены перхлораты (соли хлорной кислоты). Поскольку чистота питьевой воды – наша главная забота, компания Citizens Utilities совместно с Департаментом санитарных служб штата проверили 13 артезианских скважин в районе Ранчо Кордова. Ни в одной из них не было обнаружено сколь-нибудь заметных следов перхлоратов.

Мы будем продолжать следить за появлением перхлоратов – это часть нашей расширенной программы постоянного контроля качества воды. Если вам необходима более подробная информация, звоните, пожалуйста, по телефону (888) 311-8840.

Программа водосбережения на 1997 г. компании Citizens Utilities

Несмотря на обильные январские дожди, запасы воды в регионе продолжают оставаться скудными, и мы должны по-прежнему экономно расходовать воду. Руководствуйтесь следующими правилами:

- Полив по принципу "чёт-нечет": жители домов с нечётными номерами могут поливать по вторникам, четвергам и субботам, жители домов с чётными номерами – по средам, пятницам и воскресеньям. Полив в понедельник не разрешается.
- Просим пользоваться шлангами и поливалками с отсечкой воды.
- Настраивайте автоматические поливальные устройства на работу с 9 ч. вечера до 5 ч. утра. Не заливайте водосточные канавы.
- Убирайте въезды в гаражи и тротуары с помощью метлы – не пользуйтесь для этого шлангами.

В домах тех, кто не соблюдает режим экономии воды, будут установлены счётчики-расходомеры и наложены ограничения на водоснабжение. За дополнительной информацией обращайтесь по телефону (916) 568-4200. Благодарим вас.

Thông báo cho khách hàng tại Rancho Cordova: nguồn nước cung cấp cho quý vị vẫn an toàn để uống.

Gần đây, có những thông báo trên báo chí liên quan đến chất muối hóa học perchlorate trong các giếng nước gần Mather Air Force Base. Vì sự an toàn của nguồn nước cung cấp cho quý vị là mối quan tâm tối cao của chúng tôi, Citizens Utilities cùng với Bộ Dịch Vụ Y Tế của Tiểu Bang đã thử 13 giếng nước trong khu vực của Rancho Cordova. Không có mức độ của perchlorate nào được ghi nhận tại bất cứ các giếng nước nào.

Chúng tôi sẽ tiếp tục kiểm soát chất perchlorate là một phần của chương trình theo dõi gia tăng phẩm chất của nước. Nếu quý vị muốn biết thêm chi tiết, xin gọi số (888) 311-8840.

Chương trình bảo tồn nước năm 1997 của Citizens Utilities

Tuy có những cơn mưa lũ trong tháng Giêng, nguồn nước cung cấp trong cả khu vực vẫn bị giảm và chúng ta phải bảo tồn nước. Chúng ta phải theo những điều chỉ dẫn sau đây:

- Tưới nước theo phương thức chẵn/lẻ: Các gia hộ có số địa chỉ lẻ có thể tưới nước vào ngày thứ Ba, thứ Năm, và thứ Bảy. Các gia hộ có số địa chỉ chẵn có thể tưới nước vào ngày thứ Tư, thứ Sáu và Chủ Nhật, không được tưới nước vào ngày thứ Hai.
- Dùng vòi nước có thể tắt được.
- Cho đồng hồ tưới nước tự động hoạt động giữa 9:00 chiều và 5:00 sáng. Xin đừng tưới ngập nước.
- Dùng chổi quét nơi đậu xe và thềm đi bộ. Không dùng vòi để xịt.

Những người phun phí nước có thể bị bắt đặt đồng hồ đo nước hoặc hệ thống cho chảy chậm trong hệ thống dùng nước. Để biết thêm chi tiết, xin gọi số (916) 568-4200. Xin cám ơn quý vị.

APPENDIX A. RESPONSE TO COMMENTS FROM SITE TEAM REVIEW

In 1995, EHIB formed a site team to assist us in identifying public health concerns and to oversee what we do during the health assessment process for the Aerojet General site. The site team is composed of community residents, state and federal environmental and health agency staff, Aerojet staff, as well as EHIB staff. Health consultations that are produced as apart of the health assessment process are released for comment to site team prior to them becoming final. We received comments on this health consultation from the Drinking Water Branch of CDHS, U.S. EPA, DTSC, Aerojet, and RWQCB. In this appendix, we will respond to the submitted comments. (Some of the commenters used the Cordova Water System Health Consult as the basis for their comments and asked them to be applied to other health consultations when applicable. Thus, some of the comments make reference to the Cordova Water System and not the Citizens Utilities System, but we included the comment in this health consultation if it seemed applicable.)

COMMENTS RECEIVED FROM THE DRINKING WATER BRANCH OF CDHS

The Drinking Water Branch of CDHS regulates water purveyors in the state, and their comments were minor technical corrections to the numbers we cited in the text. These corrections were made to the original document.

COMMENTS RECEIVED FROM THE U.S ENVIRONMENTAL PROTECTION AGENCY

The EPA offers the following comments for your consideration:

USEPA comment: Page 7 - fourth sentence - the statement that "ammonium perchlorate has relevant physical and chemical characteristics similar to cadmium chloride does not appear to be justified. Although both of these compounds are salts, on dissolution (a necessary step in absorption) perchlorate would become an anion (negative charge) and cadmium would become a cation (positive charge). Therefore, one could conclude on this basis alone that cadmium would not be an appropriate surrogate for perchlorate. Comment applies to all reports but Fair Oaks Water District Report.

CDHS response: According to a highly regarded dermal absorption reference source, the permeability of charged ions is extremely low and membranes appear to be more permeable to cations than anions (40). *Thus, the comparison of perchlorate should not be made between the cation, cadmium, but the anion, chloride, that is found when cadmium chloride is in solution.*

USEPA comment: Page 8 - third paragraph - NOAEL term use - The NOAEL is an experimentally derived value that is often used as a basis for the RfD, however, the NOAEL is not regarded by EPA as a value that "would not be expected to be associated with any adverse effect". Rather, this definition better fits the RfD that is derived from a NOAEL after considering

uncertainties in the database. Comment applies to all reports but Fair Oaks Water District Report.

CDHS response: We have corrected the use of NOAEL and RfD in the text.

COMMENTS RECEIVED FROM THE CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

Below are DTSC's comments which may be considered as the documents are finalized.

DTSC comment: In the third paragraph of the consultations, it is stated that the Regional Water Quality Control Board is the lead regulatory agency. While this is correct for some aspects of the project, the lead regulatory agency controlling water district activities is the Department of Health Services, Office of Drinking Water. For matters concerning the Aerojet Superfund Site, the United States Environmental Protection Agency is the lead federal regulatory agency. A co-lead situation exists for certain matters covered under the Aerojet Superfund Site Partial consent Decree (United States District Court, Eastern District of California, Civil Action Nos. CIVS-86-0063-EJG and CIVS-86-0064-EJG).

CDHS response: Being a part of the complex government oversight at this site, we appreciate the clarification to the agency responsibilities. We have tried to rectify this in the text.

COMMENTS RECEIVED FROM AEROJET GENERAL CORPORATION:

Aerojet's comment about the attribution of source of the perchlorate in public water supply wells: Each draft Health Consultation assumes that perchlorate being found in public water supply wells came from the Aerojet Operating Plant, specifically from the reinjection wells associated with the GET facilities. There are numerous locations where such references appear. (See, for example, Arden Cordova Health Consultation at:

Page 6, paragraph 2 and page 22, Table 2.) This assumption is used to project length of exposure and concentrations in the wells over time. The conclusion is made for each well, for every water purveyor, regardless of the well's location, chemical concentrations or differing hydrogeological conditions.

We are aware of no detailed evaluation of sources, groundwater conditions and groundwater and contaminant movement undertaken by DHS or any other agency that would support statements in the DHS Consultations that attempt to link perchlorate in a well to an upgradient source, and it does not appear necessary for DHS to ascribe a source to reach its conclusions. The Health Consultations should identify that potential sources of perchlorate include the Aerojet Operating Plant, Purity Oil site, and the McDonnell Douglas (MDC) Site. DHS should not assert that the only source of the perchlorate is the GET facility recharge wells on the Aerojet Operating Plant. Neither should the period of operation of the GET wells form the basis for assumptions of

exposure of potential receptors. As the Health Consultations discuss potential sources, it should discuss the various uses of perchlorate, other than in rocket motor manufacturing, such as the use of perchlorate in pyrotechnics (fireworks), explosives and other industrial activities. It should also note that perchloric acid, which is used in various industrial activities, including metal-plating, in laboratories, and in other operations, when released can result in the formation of perchlorate and its movement into soils and groundwater.

Aerojet believes that there have been no health impacts associated with any exposure to perchlorate in the water supply. If the Health Consultations seek to discuss long term impact by assuming exposure for some period (e.g., 10 years), they can do so without assigning a source, but simply by positing the potential for such exposure (without reference to a source) and developing an exposure assessment.

CDHS response: These health consultations are written as a part of CDHS's public health review of the impact of the Aerojet General site. Thus, the documents are written in respect to Aerojet General and not to other sites or facilities. We do recognize that perchlorate may have also gotten into the groundwater from sources other than Aerojet and that is why in last sentence of the third paragraph on page 1, we refer to the RWQCB's investigation of "other sources of the perchlorate such as the McDonnell Douglas (now Boeing) and Purity Oil Sales sites."

Aerojet's comment about the toxicology: Aerojet recommends modifications to the discussion on toxicology. We are concerned that the draft consultations do not provide sufficient information about what is known about perchlorate toxicity (thyroid function) and end up, unintentionally, providing a less balanced presentation of the potential for impact and risk. For example, we believe there should be more discussion related to the past use of perchlorate in the treatment of Graves patients and its current use in Europe at very high doses without ill effects. Similarly, we recommend the inclusion of a statement that the mechanism of perchlorate on the thyroid as well as basic thyroid functions are well understood and we believe that the discussion as to exposure associated with children may lead to unnecessary concern and should be changed. Finally, we believe that there ought to be mention of the ongoing studies being conducted at the direction of the Air Force.

CDHS response: We did provide more information in the toxicology section. For instance, we have added more information about past and current uses of perchlorate and what is known and not known about toxicity to the developing fetus and young child. We did have a reference in the recommendations section about the on-going studies by the Air Force and the Perchlorate Study Group and we have added a sentence in the toxicology section referring the reader to the recommendations section for more information about these studies.

Aerojet's comment about the water system operations: The draft Health Consultations, especially in the background sections, contain statements of fact as to the manner of well and system operation of each water entity over time, including detail on well construction and operation in tables. Aerojet has not had an opportunity to complete an evaluation of the accuracy of such

statements. We further note that the factual statements generally do not seem to impact the exposure assessment, as the exposure assessment is based upon an assumed concentration that is not generally associated with the specifics of well interties or well operation. We would recommend the Health Consultations state that the water system information is based on current understanding unless DHS has had the opportunity to perform a detailed evaluation of the information.

CDHS response: In each health consultation, we cite the CDHS reports or other reports from which we gained this information. We refer Aerojet to those documents if Aerojet would like to evaluate the accuracy of such statements. We do think it is important to describe for the reader the basic structure of a particular water system; on the other hand, we don't want to add more information then is necessary. We hope that the amount of information we have provided will allow a Citizen Utility System customer to more easily understand that the limited extent of perchlorate contamination that has occurred in the system. By describing the water system information in this document, it also helps us to decide where we might consider follow-up activities, like an exposure dose reconstruction.

Aerojet's comment about the Exposure Conclusions: The draft Health Consultations are based upon a set of assumptions, including assumed receptors, exposure rates, and concentrations. From these assumptions, an assumed dose is calculated and then compared to the provisional RfD. We believe that the Health Consultations should carefully describe each assumption upon which the Health Consultations were based, and clarify that these assumptions have not been fully evaluated. For example, a preliminary assessment of proximity to a well is used to determine the type of "receptor" (e.g., resident, worker), but the exposure does not assume any dilution of water from that well with water from any other well.

CDHS response: All of the exposure parameters are listed in the table and a Citizen Utility System user can look at these exposure parameters and apply them to their own situation. Thus it does not seem necessary to explain distributions of exposure parameters or in any other way describe each assumption.

With these general comments identified, we now progress to the specifics. We use the Arden Cordova Health Consultation as the template for our comments, and emphasize that typically the same issue exists in the other draft Health Consultations.

Aerojet comment: Page 1, Paragraph 2 and Throughout: The term "perchlorate contamination" is subject to misinterpretation and references should be to "water containing perchlorate" or like phrase.

CDHS's response: In Webster's New Collegiate Dictionary, it says "contaminate" means "to make impure or unclean". Perchlorate is not typically found in groundwater, as would be the case with certain chemicals like arsenic or sulfates which are naturally occurring in groundwater. Thus it does seem appropriate to describe the "contamination" of groundwater by

a chemical such as perchlorate. Likewise, it may be appropriate to describe "water containing arsenic" if you are describing water which contains unusually high levels of arsenic due to natural reasons and arsenic-contaminated water if higher levels than normal may be due to non-natural reasons.

Aerojet comment: Page 1, Paragraph 3: The description of Aerojet operations and Cordova operations has been taken from earlier documents. Aerojet has historically pointed out the inaccuracies in the statements and rather than do so again we recommend, at a minimum, elimination of a reference to Cordova Chemical Company, because we do not believe it used perchlorate. We also recommend an elimination of the reference to the deep injection wells, because they are not relevant to the issue and can result in confusion when there is later discussion about recharge or reinjection wells associated with the GET facilities, which are different wells.

CDHS response: In the background paragraph, we are describing the lay of the land regarding the general site issues and thus we did not directly suggest that Cordova Chemical did use perchlorate, but rather this company was a part of the history of the site. Since perchlorate is reinjected at the site boundary as a part of the GET operations, we do not agree that reference to these should be eliminated.

Aerojet comment: Page 1, Paragraph 3: Delete "property" after "Aerojet's."

CDHS response: This incorrect grammar has been corrected in the text.

Aerojet comment: Page 1, Paragraph 3: Aerojet is not reinjecting treated water at the site's northern boundary.

CDHS response: This has been changed in the text.

Aerojet comment: Page 1, Paragraph 3: The Regional Water Quality Control Board (RB) is not the lead Agency; DTSC, USEPA and RB together provide oversight pursuant to the Partial Consent Decree.

CDHS response: The description of the lead agency/agencies was changed in the text.

Aerojet comment: Page 3, Paragraph 1: The discussion as to detection of perchlorate ought to be rewritten. Prior to the summer of 1996, Aerojet's laboratory used an ion specific electrode method. In 1997 Aerojet's laboratory did not use a different analytical method for perchlorate analysis to obtain the detection limit of 35 ppb but rather refined or improved the sensitivity of the existing ion chromatography method. In addition, it is accurate to say the "method" detection limit.

CDHS response: Based on this comment and a similar comment by other reviewers, the description of the analytical method was revised in the text.

Aerojet comment: Page 6, Paragraph 1: See the discussion above regarding the history of perchlorate sampling. It is not accurate to say that the analytical method Aerojet had been using was not sensitive to adequately assess the migration of perchlorate. It would be more accurate to state that Aerojet's historical analytical method's practical quantitation limit (PQL) for perchlorate was 400 ppb. As stated previously, there was no "alternative analytical method" used but the existing method was refined or improved and the PQL lowered.

CDHS response: According to the third sentence of the comment, the older method was indeed not sensitive enough to detect the perchlorate contamination. We did, however, revise the text to reflect the last two sentences of the comment.

Aerojet comment: Page 8, Second Full Paragraph and Page 9, Second Full Paragraph: The three well contribution scenarios identified in the paragraph on page 8 and the those identified on page 9 are not referenced the same. On page 8 scenario 1 is Well #1 delivering 100% of the water; on page 9 Well #1 is referenced as the second scenario. Page 8 references Well #2 in the lead as the worst case scenario but page 9, paragraph three states that noncancer health effects would not have occurred when Well #2 was the lead well. It is difficult to understand which exposure calculations relate to which well because of the inconsistent references.

CDHS response: The text on page 9 was incorrect and was corrected.

Aerojet comment: Page 10, Last Full Paragraph, First Line and Page 11, First Paragraph: As stated above, does the author mean Well #1 or #2?

CDHS response: The text should have read well #2, and this was corrected.
Aerojet comment: Page 8, Continuing Paragraph and following: We refer you to the general comments on toxicology above. The draft Health Consultations would be better balanced if there was more discussion related to the use of perchlorate in the treatment of Graves patients and its current use in Europe at very high doses without ill effects. A strong statement that stresses how unlikely it would be to suffer any of these side effects at the levels addressed in the health consultation would be appropriate. In particular, the draft Health Consultations ought to point out that perchlorate has been used successfully and without incident in a fairly large patient population and with a very small number of reports of aplastic anemia even at the very high therapeutic concentrations A statement that the mechanism of perchlorate on the thyroid as well as basic thyroid functions are well understood would help to clarify the presentation. While the provisional RfD is stated as a level in drinking water at 18 ppb, the remaining levels discussed in the document are stated in terms of mg/kg/day. A direct comparison of those doses with the LOAEL/NOAEL and the provisional RfD in the same unit of PPB's would be very useful to give perspective to the dose issue.

CDHS response: As noted on the response to a General Comment from Aerojet, we did provide more information in the toxicology section. For instance, we have added more information about past and current pharmacological uses of perchlorate and what is known and not known

about toxicity to the developing fetus and child. We also added a statement in the toxicological section that equates the dose to the drinking water concentrations.

Aerojet comment: Page 8, Continuing and Paragraph 1: The discussion of animal studies should be modified. There are animal studies where toxicologists have interpreted a NOAEL [(e.g. Mannisto (1970) and Caldwell (1996)]. As to the reference to children, in two places there is a discussion that suggests that nothing can be said about children. Aerojet is concerned that the reference might leave the reader with the impression that toxicologists do not consider impact to the thyroid as the focus of the evaluation or it might cause the reader to think that toxicologists view the child's thyroid as not understood. It would be more accurate to state that the mechanism of perchlorate intake on the thyroid is understood and that in evaluating the dose, one must evaluate the possibility that the child may have less iodine reserve which must be considered in evaluating how the child's thyroid compensates in comparison to an adult thyroid. However, any reference should also include the fact that all new-borns are routinely tested for thyroid hormone. levels. Aerojet believes that it would be inappropriate for the Health Consultations to be construed as indicating that children are at risk at the provisional RFD or that exposure to the higher concentrations before well shut down would be associated with any health impact.

While it appears in the text, we believe there should be a clear reference both in the toxicology discussion and in the exposure section, that perchlorate is discharged from the body very quickly and that one would not expect to see any continuing impact on the thyroid once the exposure ends.

CDHS response: See response to previous comment.

Aerojet comment: Page 8, Paragraph 3: Regarding the discussion of safety factors, various toxicologists believe that the hypothyroid individual would not be a sensitive subpopulation. Also, the Health Consultations should recognize that the sensitive subpopulation factor is already being accounted for with respect to DHS comments on exposure of children.

CDHS response: Comment noted.

Aerojet comment: Page 9, Paragraph 3: See discussion above on children. We believe that the two locations of discussion on children should be combined in one location.

CDHS response: Comment noted.

Aerojet comment: Page 9, Paragraph 4: Exposure discussion includes the volume of tap water consumed per day in liters and perhaps the inclusion of a unit like the number of 8 oz. glasses per day would benefit the average reader, or public citizen. This could be included in the text and in the Table.

CDHS response: We have added this information to the text and table.

Aerojet comment: Page 9, Paragraph 4 and Following: There is the repeated statement that the estimated doses for [identified type of exposure] from well # [identified well number] exceeded the provisional RfD range and a conclusion stating "health effects may have occurred." The phrase "may have occurred" could be misinterpreted as it may suggest a higher level of risk than existed, given the low levels of perchlorate found in relation to the provisional NOAEL described. Given the uncertainty factors associated with the provisional RfD, Aerojet believes that it would be more appropriate for the Consultations simply to conclude that the level was over the RFD and then follow with a conclusion as to the unlikely nature of any health impact. If DHS does continue to want to use "may have occurred" language, then the "may have occurred" language should be clarified when presented by referring to the key assumptions, the exposure assessment, etc., (e.g., the number of 8 ounce glasses of tap water needed to be consumed). The health consultations should also stress that there is a significant range between the provisional RfD of 18 ppb and the NOAEL level translated to 4900 ppb (assuming a NOAEL of .1 4 mg/kg/day and a 70 kilogram male drinking 2 liters per day). It would also be useful either to change the reference of "uncertainty" factors to "safety" factors or use the term uncertainty (safety) factors" for the benefit of the reader.

CDHS response: Comment noted.

Aerojet comment: Page 12, Paragraph 2: See the above comments regarding speculation as to source.

CDHS response: See previous response to similar comments.

Aerojet comment: Page 12, Paragraph 4: There are a number of paragraphs that repeat statements made in the exposure section. See discussion above (page 9) relative to language about dose above the RfD. Aerojet does not believe that it is appropriate to conclude that there "may" have been a "health hazard." If language as to hazard is described, it should not be separated from the DHS assumptions about exposure nor should it be stated without the conclusion as to the unlikeliness of any impact. Aerojet further notes that the various Consultations do not always use the same language on "health hazard," and the differences in language do not appear justified (e.g., see Mather page 12 paragraph 3).

CDHS response: Comment noted.

Aerojet comment: Page 13, Bullets #1 and 2 (Actions Planned): Aerojet believes that any dose reconstruction investigation should await completion of further investigations and should not assume sources. See general discussion above.

CDHS response: Comment noted.

Aerojet comment: Aerojet believes that any health statistics review of newborn thyroid testing raises significant issues regarding appropriate protocols for such study, timing of such study in

light of ongoing animal studies, appropriateness of such a study in Sacramento and presumes confidence in the "dose reconstruction" exposure assessments. Aerojet requests the opportunity to review draft DHS protocols for any such study.

CDHS response: We will try to include an outside review of the study protocol.

Aerojet comment: Page 13, Bullet #3 and Page 14, Bullet #4: The reference should be to the Perchlorate Study Group, not Perchlorate Work Group.

CDHS response: This has been corrected in the text.

Aerojet comment: Page 14, Bullet #2: The use of the word "safe" is inappropriate, Reference should be to the provisional RfD.

CDHS response: We have modified the text so as to remove the word "safe".

Aerojet comment: References, No. 17. The citation to the authors should be corrected.

CDHS response: This citation has been corrected.

Aerojet comment on Table 1: We have not had adequate opportunity to evaluate the descriptions of all of the wells and the well system. We note that the comments in the Table are based upon assumptions made as discussed in the text and our comments apply.

CDHS response: Comment noted.

Aerojet comment on Table 2: We believe a "source" category for this Table is inappropriate. Please see general comment above on sources.

CDHS response: Comment noted.

COMMENTS FROM THE CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD

Regional Board staffs comments on the documents are supplied below.

RWQCB General Comment: We recommend that the use of the term "contaminated" be selectively used. Contaminated should be used when the water represents a hazard to the public health. In the case of perchlorate, "contaminated" should not be used when discussing concentrations less than 18 ppb. It is even unclear whether the term should be applied to those concentrations that are currently found in some of the groundwater supply wells (up to 300 ppb). Instead of saying "perchlorate-contaminated water", we would recommend saying "water containing perchlorate".

CDHS response: As was stated under a similar comment raised by Aerojet, in Webster's New Collegiate Dictionary, it says "contaminate" means "to make impure or unclean". Perchlorate is not typically found in groundwater, as would be the case with certain chemicals like arsenic or sulfates which are naturally occurring in groundwater. Thus it does seem appropriate to describe the "contamination" of groundwater by a chemical such as perchlorate. Likewise, it may be appropriate to describe "water containing arsenic" if you are describing water which contains unusually high levels of arsenic due to natural reasons and arsenic-contaminated water if higher levels than normal may be due to non-natural reasons.

RWQCB General Comment: There is a paragraph in each of the health consultations which discusses the "reporting level to the RWQCB" of 400 ppb and a change in method which allowed for a detection level of 35 ppb. In the early 1990's, up until around 1995/96, Aerojet was using a ionspecific electrode to measure perchlorate concentrations in water with a detection level of 400-500 ppb. Aerojet then developed an alternate method using a GC which provided a detection level of 35 ppb and a reporting level of 400 ppb. This method was then used by Aerojet in all work required under the Partial-Consent Decree. In early 1996 RWQCB staff requested Aerojet to report all concentrations between the detection level (35 ppb) and reporting level (400 ppb) as trace. Aerojet was then able to lower their PQL to 100 ppb, while maintaining their detection level at 35 ppb. No method changes were made to get to the lower reporting level. It was in February 1996 that the concentrations in the off-site water supply wells were first reported.

CDHS response: Based on this comment and comments by others, the text was revised.

RWQCB General Comment: When discussing the nitrate levels, make sure that the values reported are designated as milligrams per liter as nitrate, or milligrams per liter as nitrogen. The MCL for nitrate should be expressed in the same units. There are two values for the MCL used in the five health consultations, 20 and 45 mg/l. A single value for the MCL should be used.

CDHS response: We have corrected this in the text.

RWQCB General Comment: We will not supply comments on the toxicological issues presented in the documents. We will rely on the experts at the Department of Health Services to make those evaluations.

CDHS response: Comment noted.

RWQCB comment: Page 2, paragraph 5. The value for the MCL for nitrate should be supplied to allow the reader to determine the significance of the values presented.

CDHS response: We have added the MCL as a reference in the text.

RWQCB comment: Page 13, second paragraph. Insert a "the" after "actions" in the second line.

CDHS response: There was a grammatical problem in the sentence, which we have corrected.