

GAO

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Before the Subcommittee on Environment
and Hazardous Materials, House
Committee on Energy and Commerce

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PERCHLORATE

**EPA Does Not
Systematically Track
Incidents of Contamination**

Statement of John B. Stephenson, Director
Natural Resources and Environment



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Highlights

Highlights of [GAO-07-797T](#), a testimony before the Subcommittee on Environment and Hazardous Materials, House Committee on Energy and Commerce

Why GAO Did This Study

Perchlorate has been used for decades by the Department of Defense, the National Aeronautics and Space Administration, and the defense industry in manufacturing, testing, and firing missiles and rockets. Other uses include fireworks, fertilizers, and explosives. Perchlorate is readily dissolved and transported in water and has been found in groundwater, surface water, and soil across the country. Perchlorate emerged as a contaminant of concern because health studies have shown that it can affect the thyroid gland, which helps regulate the body's metabolism, and may cause developmental impairment in fetuses of pregnant women. In 2005, EPA set a reference dose of 24.5 parts per billion (ppb)—the exposure level not expected to cause adverse effect in humans.

Today's testimony updates GAO's May 2005 report, *Perchlorate: A System to Track Sampling and Cleanup Results is Needed*, GAO-05-462. It summarizes GAO's (1) compilation of the extent of perchlorate contamination in the U.S. and (2) review of peer-reviewed studies about perchlorate's health risks. GAO's 2005 report recommended that EPA work to track and monitor perchlorate detections and cleanup efforts. In December 2006, EPA reiterated its disagreement with this recommendation. GAO continues to believe such a system would better inform the public and others about perchlorate's presence in their communities.

www.gao.gov/cgi-bin/getrpt?GAO-07-797T.

To view the full product, including the scope and methodology, click on the link above. For more information, contact John Stephenson at (202) 512-3841 or stephensonj@gao.gov.

PERCHLORATE

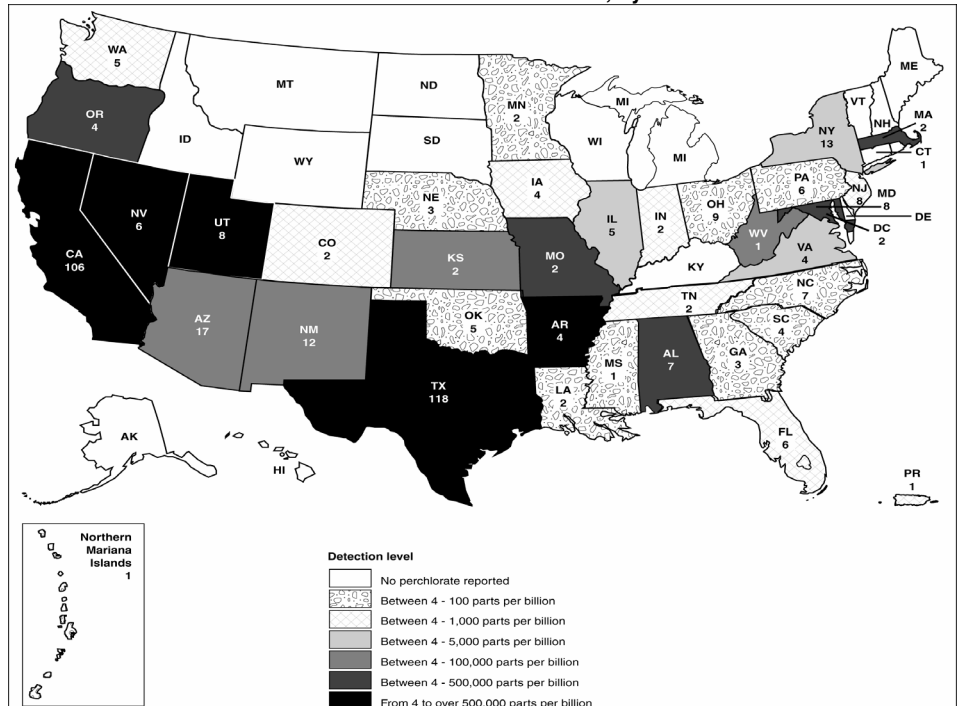
EPA Does Not Systematically Track Incidents of Contamination

What GAO Found

Perchlorate has been found at 395 sites in the U.S.—including 153 public drinking water systems—in concentrations ranging from 4 ppb to more than 3.7 million ppb. More than half the sites are in California and Texas, with the highest concentrations found in Arkansas, California, Texas, Nevada, and Utah. About 28 percent of sites were contaminated by defense and aerospace activities related to propellant manufacturing, rocket motor research and test firing, or explosives disposal. Federal and state agencies are not required to routinely report perchlorate findings to EPA, which does not track or monitor perchlorate detections or cleanup status. EPA recently decided not to regulate perchlorate in drinking water supplies pending further study.

GAO reviewed 90 studies of health risks from perchlorate published from 1998 to 2005, and one-quarter indicated that perchlorate had an adverse effect on human health, and thyroid function in particular. In January 2005, the National Academy of Sciences also reviewed several studies and concluded that they did not support a clear link between perchlorate exposure and changes in the thyroid function. The academy did not recommend a drinking water standard but recommended additional research into the effect of perchlorate exposure on children and pregnant women. More recently, a large study by CDC scientists has identified adverse thyroid effects from perchlorate in women with low iodine levels that are found in about 36 percent of U.S. women.

Number of Sites and Maximum Perchlorate Concentrations, by State



Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss our work on perchlorate, a chemical most commonly used in rocket fuel. A combination of human activity and natural sources has led to the widespread presence of perchlorate in the environment. Perchlorate has been used for decades by the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), and the defense industry in the manufacturing, testing, and firing of missiles and rockets. According to the Environmental Protection Agency's (EPA) estimates, 90 percent of the perchlorate produced in the United States is manufactured for use by the military and NASA, with total typical production quantities averaging several million pounds per year. Private industry also has used perchlorate to manufacture automobile airbags, fireworks, flares, and commercial explosives. Natural sources include certain atmospheric processes and Chilean nitrate salts (saltpeter) that have been mined and refined to produce commercial fertilizers for use in the U.S. Perchlorate forms salts that are readily dissolved and transported in water and that have been found in groundwater, surface water, and soil across the country. People are exposed to the perchlorate primarily by ingesting it in drinking water and food, or by working to manufacture products that contain the chemical. Health studies have shown that exposure to perchlorate can affect the thyroid gland, which helps regulate the body's metabolism, and may cause neurodevelopmental impairment in fetuses of pregnant women.

In 2003, EPA, DOD, NASA, and the Department of Energy asked the National Academy of Sciences to review the risks of exposure to perchlorate. In January 2005, the Academy recommended a reference dose of 0.0007 milligrams of perchlorate per kilogram of body weight per day, an estimated daily exposure level that is not expected to cause adverse effects in the children and pregnant women—the most sensitive human populations. This reference dose equates to a drinking water equivalent level of 24.5 parts per billion.¹ In February 2005, EPA adopted the Academy's reference dose for perchlorate, but it has not established a national federal standard for perchlorate in drinking water or other regulatory requirements to clean up perchlorate in groundwater, surface

¹The drinking water equivalent level is based on a reference adult weighing 70 kilograms (or 154 pounds) drinking 2 liters of water per day, assuming that all perchlorate exposure comes from drinking water.

water, or soil, citing the need for additional study about the health effects of perchlorate exposure.

My testimony today is based largely on our 2005 report for this Committee and summarizes (1) our analysis of the estimated extent of perchlorate found in the United States and (2) the results of our review of published studies on the health effects of perchlorate.² In the 2005 report, we recommended that EPA develop a tracking system for perchlorate releases and cleanup efforts across the federal government and state agencies. This statement also includes information from my February 2007 testimony about EPA's recent response to our recommendation.³

To provide an estimate of the extent of perchlorate found in the United States, we compiled and analyzed data on perchlorate detections from EPA, DOD, the U.S. Geological Survey, and state agencies. To identify studies of the potential health risks from perchlorate, who conducted them, and what methodologies were used, we conducted a literature search for studies of perchlorate health risks published since 1998, interviewed DOD and EPA officials on what studies they considered important in assessing perchlorate health risks, and examined the references of each study for other studies we had not obtained. We identified 125 studies on perchlorate and the thyroid, of which we reviewed 90 that were relevant to our review. A more detailed description of our scope and methodology is presented in appendix I of our 2005 report.

In summary, we found the following:

- As of our May 2005 review, perchlorate had been found by federal and state agencies in groundwater, surface water, soil, or public drinking water systems at almost 400 sites across the country in concentrations that ranged from 4 parts per billion (ppb) to more than 3.7 million ppb. However, there is not a standardized approach to reporting perchlorate data nationwide, therefore there may be more contaminated sites than we identified. These sites are located across 37 states and U.S. territories, but more than half were found in California and Texas. The sources of

²GAO, *Perchlorate: A System to Track Sampling and Cleanup Results is Needed*, [GAO-05-462](#) (Washington, D.C.: May 20, 2005).

³GAO, *Environmental Information: EPA Actions Could Reduce the Availability of Environmental Information to the Public*, [GAO-07-464T](#) (Washington, D.C.: February 6, 2007).

perchlorate at the sites vary, but the greatest known source is defense and aerospace activities such as propellant manufacturing, rocket motor research and test firing, or explosives disposal. More than one-third of the sites were public drinking water systems, where perchlorate concentrations ranged from 4 to 420 ppb. Fourteen of these 153 public water systems had concentration levels above 24.5 parts per billion, the drinking water equivalent of EPA's perchlorate reference dose. EPA and state officials told us they had not cleaned up contaminated public drinking water systems, principally because there was no federal drinking water standard or specific federal requirement to clean up perchlorate. Further, it is difficult to determine the extent of perchlorate in the United States or the status of any cleanup actions because EPA does not centrally track or monitor perchlorate detections, environmental releases, or cleanup activities.

- Recent research indicates that low-level perchlorate exposure may adversely affect the thyroid and increase the risk of neurodevelopmental impairment in fetuses of pregnant women. In our May 2005 review, we identified and summarized 90 peer-reviewed studies published from 1998 to 2005 on the health effects of perchlorate. The findings of 26 of these studies indicated that perchlorate had an adverse effect on thyroid function and human health. Most studies on adult populations were unable to determine whether the thyroid was adversely affected, because adverse effects of perchlorate on the adult thyroid, such as cancer, may happen over longer time periods than are generally observed in a research study. In contrast, the adverse effects of perchlorate on human development can be more easily studied and measured within study time frames, and 18 studies found adverse effects on development resulting from maternal exposure to perchlorate. We also found that some studies considered the same perchlorate dose but found different effects. The precise cause of the different results may be attributed to the studies' designs or to the physical conditions—such as sex, age, and blood iodine levels—of studies' subjects. Such unresolved questions were one of the bases for the differing conclusions among EPA, DOD, and other researchers on perchlorate doses and human health effects. In its January 2005 report, the National Academy of Sciences called for additional research on perchlorate exposure to help resolve questions about its effect on children and pregnant women. More recently, an October 2006 CDC study found that, for women with lower iodine levels, perchlorate reduced the thyroid hormone that helps regulate metabolism and that plays a part in central nervous system development in the fetus.

We concluded in our report that EPA needed more reliable information on the extent of sites contaminated with perchlorate and the status of

cleanup efforts, and recommended that EPA work with the Department of Defense and the states to establish a formal structure for tracking perchlorate information. In December 2006, EPA reiterated its disagreement with the recommendation stating that perchlorate information already exists from a variety of other sources. However, we continue to believe that the inconsistency and omissions in available data that we found during the course of our study underscore the need for a more structured and formal tracking system.

Background

According to EPA, perchlorate can interfere with the normal functioning of the thyroid gland by competitively inhibiting the transport of iodide into the thyroid, which can then affect production of thyroid hormones. The fetus depends on an adequate supply of maternal thyroid hormone for its central nervous system development during the first trimester of pregnancy. The National Academy of Sciences reported that inhibition of iodide uptake from low-level perchlorate exposure may increase the risk of neurodevelopmental impairment in fetuses of high-risk mothers—pregnant women who might have iodine deficiency or hypothyroidism (reduced thyroid functioning). The Academy recognized the differences in sensitivity to perchlorate exposure between the healthy adults used in some studies and the most sensitive population and the fetuses of these high-risk mothers. Consequently, the Academy included a 10-fold uncertainty factor in its recommended reference dose to protect these sensitive populations. The Academy also called for additional research to help determine what effects low-level perchlorate exposure may have on children and pregnant women.

EPA has issued drinking water regulations for more than 90 contaminants. The Safe Drinking Water Act, as amended in 1996, requires EPA to make regulatory determinations on at least five unregulated contaminants and decide whether to regulate these contaminants with a national primary drinking water regulation. The act requires that these determinations be made every five years. The unregulated contaminants are typically chosen from a list known as the Contaminant Candidate List (CCL), which the act also requires EPA to publish every five years. EPA published the second CCL on February 24, 2005. On April 11, 2007, EPA announced its preliminary determination not to regulate 11 of the contaminants on this list. The agency also announced that it was not making a regulatory determination for perchlorate because EPA believed that additional information may be needed to more fully characterize perchlorate exposure and determine whether regulating perchlorate in drinking water presents a meaningful opportunity for health risk reduction.

Several federal environmental laws provide EPA and states authorized by EPA with broad authorities to respond to actual or threatened releases of substances that may endanger public health or the environment. For example, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, authorizes EPA to investigate the release of any hazardous substance, pollutant, or contaminant. The Resource Conservation and Recovery Act of 1976 (RCRA) gives EPA authority to order a cleanup of hazardous waste when there is an imminent and substantial endangerment to public health or the environment, and one federal court has ruled that perchlorate is a hazardous waste under RCRA.⁴ The Clean Water Act's National Pollutant Discharge Elimination System (NPDES) provisions authorize EPA, which may, in turn, authorize states, to regulate the discharge of pollutants into waters of the United States. These pollutants may include contaminants such as perchlorate. The Safe Drinking Water Act authorizes EPA to respond to actual or threatened releases of contaminants into public water systems or underground sources of drinking water, regardless of whether the contaminant is regulated or unregulated, where there is an imminent and substantial endangerment to health and the appropriate state and local governments have not taken appropriate actions. Under certain environmental laws such as RCRA, EPA can authorize states to implement the requirements as long as the state programs are at least equivalent to the federal program and provide for adequate enforcement.

In addition, some states have their own environmental and water quality laws that provide state and local agencies with the authority to monitor, sample, and require cleanup of various regulated and unregulated hazardous substances that pose an imminent and substantial danger to public health. For example, the California Water Code authorizes Regional Water Control Boards to require sampling of waste discharges and to direct cleanup and abatement, if necessary, of any threat to water, including the release of an unregulated contaminant such as perchlorate. Finally, according to EPA and state officials, at least 9 states have established nonregulatory action levels or perchlorate advisories, ranging from under 1 part per billion to 18 parts per billion, under which responsible parties have been required to sample and clean up

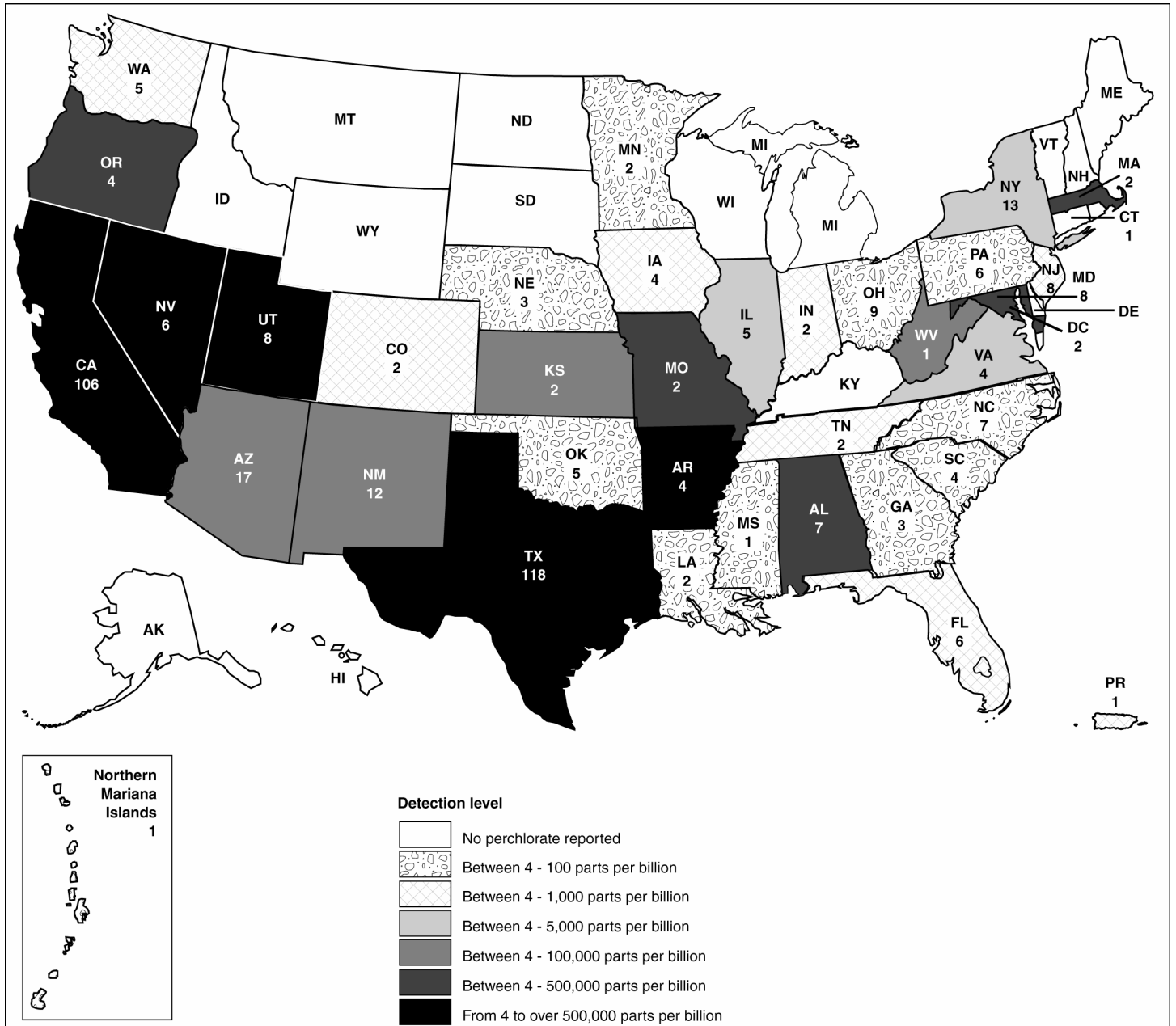
⁴*Castaic Lake Water Agency v. Whittaker Corp*, 272 F. Supp. 2d 1053 (C.D. Cal. 2003). The conclusion that perchlorate is a hazardous waste was the first step in the court's analysis of whether perchlorate is a hazardous substance under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). (The definition of hazardous substances under CERCLA includes hazardous waste under RCRA.)

perchlorate. For example, according to California officials, the state of California has a public health goal for perchlorate of 6 parts per billion and has used the goal to require cleanup at one site.

Perchlorate Has Been Found At 395 Sites Including 153 Public Drinking Water Systems

Because information on the extent of perchlorate contamination was not readily available, we thoroughly reviewed available perchlorate sampling reports and discussed them with federal and state environmental officials. We identified 395 sites in 35 states, the District of Columbia, and 2 commonwealths of the United States where perchlorate has been found in drinking water, groundwater, surface water, sediment, or soil. The perchlorate concentrations ranged from the minimum reporting level of 4 parts per billion to in more than 3.7 million parts per billion—a level found in groundwater at one of the sites. Roughly one-half of the contaminated sites were found in Texas (118) and California (106), where both states conducted broad investigations to determine the extent of perchlorate contamination. As shown in figure 1, the highest perchlorate concentrations were found in five states—Arkansas, California, Nevada, Texas, and Utah—where, collectively, 11 sites had concentrations exceeding 500,000 parts per billion. However, most of the 395 sites did not have such high levels of contamination. We found 271 sites where the concentration was less than 24.5 parts per billion, the drinking water concentration equivalent calculated on the basis of EPA’s reference dose.

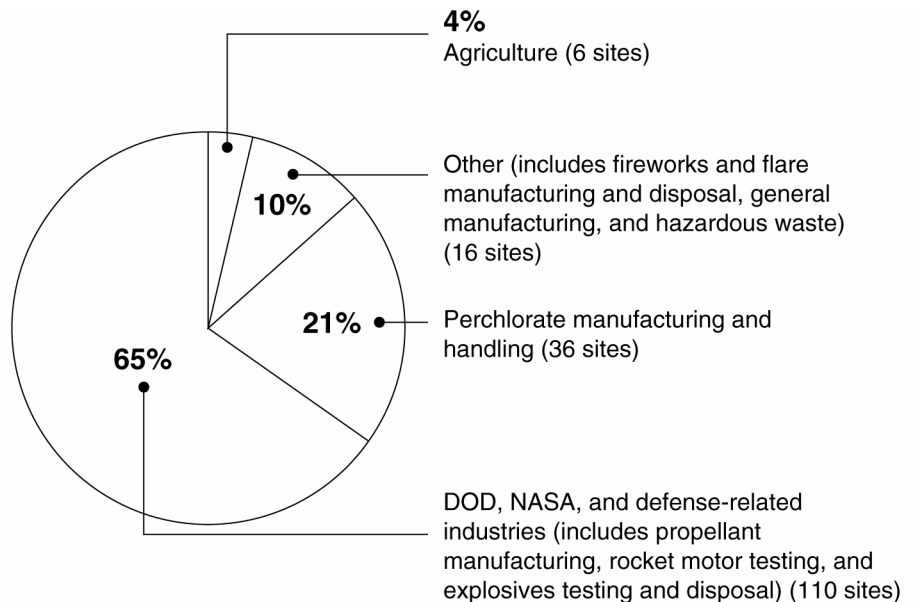
Figure 1: Number of Sites and Maximum Perchlorate Concentrations, by State



Sources: Environmental Protection Agency, Department of Defense, U.S. Geological Survey, and state environmental agencies.

According to EPA and state agency officials, the greatest known source of contamination was defense and aerospace activities. As shown in figure 2, our analysis found that, at 110 of the 395 sites, the perchlorate source was related to propellant manufacturing, rocket motor testing firing, and explosives testing and disposal at DOD, NASA, and defense-related industries. Officials said the source of the contamination at another 58 sites was agriculture, a variety of other commercial activities such as fireworks and flare manufacturing, and perchlorate manufacturing and handling. At the remaining sites, state agency officials said the source of the perchlorate was either undetermined (122 sites) or naturally occurring (105 sites). Further, all 105 sites with naturally occurring perchlorate are located in the Texas high plains region where perchlorate concentrations range from 4 to 59 parts per billion.

Figure 2: Activities Linked to Perchlorate, by Site



Sources: Environmental Protection Agency, Department of Defense, U.S. Geological Survey, and state environmental agencies.

Of the sites we identified, 153 were public drinking water systems. The Safe Drinking Water Act's Unregulated Contaminant Monitoring Regulation required sampling of public drinking water systems for a 12-month period between 2001 and 2003. As of January 2005, 153 (about 4 percent) of 3,722 systems that were sampled and reported finding perchlorate to EPA. Located across 26 states and 2 commonwealths, these 153 sites accounted for more than one-third of the sites we identified where perchlorate concentrations reported ranged from 4 parts per billion

to 420 parts per billion but averaged less than 10 parts per billion. Only 14 of the 153 public drinking water systems had concentration levels above 24.5 parts per billion, the drinking water equivalent calculated on the basis of EPA's revised perchlorate reference dose. California had the most public water systems with perchlorate, where 58 systems reported finding perchlorate in drinking water. The highest drinking water perchlorate concentration of 420 parts per billion was found in Puerto Rico in 2002. Subsequent sampling in Puerto Rico did not find any perchlorate, and officials said the source of the initial finding was undetermined.

These 153 public drinking water systems that found perchlorate serve populated areas, and an EPA official estimated that as many as 10 million people may have been exposed to the chemical. EPA officials told us they do not know the source of most of the contamination found in public drinking water systems, but that 32 systems in Arizona, California, and Nevada were likely due to previous perchlorate manufacturing at a Kerr McGee Chemical Company site in Henderson, Nevada. Regional EPA and state officials told us they did not plan to clean up perchlorate found at public drinking water sites until EPA establishes a drinking water standard for perchlorate. In some cases, officials did not plan to clean up because subsequent sampling was unable to confirm that perchlorate was present.

EPA officials said the agency does not centrally track or monitor perchlorate detections or the status of cleanup activities. As a result, it is difficult to determine the extent of perchlorate contamination in the U.S. EPA maintains a list of sites where cleanup or other response actions are underway but the list does not include sites not reported to EPA. As a result, EPA officials said they did not always know whether other federal and state agencies found perchlorate because, as is generally the case with unregulated contaminants, there is no requirement for states or other federal agencies to routinely report perchlorate findings to EPA.

For example, DOD is not required to report to EPA when perchlorate is found on active installations and facilities. Consequently, EPA region officials in California said they did not know the Navy found perchlorate at the Naval Air Weapons Station at China Lake because the Navy did not report the finding to EPA. Further, states are not required to routinely notify EPA about perchlorate contamination they discover. For example, EPA region officials in California said the Nevada state agency did not tell them perchlorate was found at Rocketdyne, an aerospace facility in Reno, or that it was being cleaned up. EPA only learned about the perchlorate contamination when the facility's RCRA permit was renewed.

Recent Research Indicates that Perchlorate Exposure May be a Concern for Pregnant Women

In our May 2005 review, we conducted a literature search for studies of perchlorate health risks published from 1998 to 2005 and identified 125 studies on perchlorate and the thyroid. After interviewing DOD and EPA officials about which studies they considered important in assessing perchlorate health risks, we reviewed 90 that were relevant to our work. The findings of 26 of these studies indicated that perchlorate had an adverse effect on thyroid function and human health. In January 2005, the National Academy of Sciences considered many of these same studies and concluded that the studies did not support a clear link between perchlorate exposure and changes in the thyroid function or thyroid cancer in adults. Consequently, the Academy recommended additional research into the effect of perchlorate exposure on children and pregnant women but did not recommend a drinking water standard.

DOD, EPA, and industry sponsored the majority of the 90 health studies we reviewed; the remaining studies were conducted by academic researchers and other federal agencies. Of these 90 studies, 49 were experiments that sought to determine the effects of perchlorate on humans, mammals, fish, and/or amphibians by exposing these groups to different doses of perchlorate over varied time periods and comparing the results with other groups that were not exposed. Twelve were field studies that compared humans, mammals, fish, and/or amphibians in areas known to be contaminated with the same groups in areas known to be uncontaminated. Both types of studies have limitations: the experimental studies were generally short in duration, and the field studies were generally limited by the researchers' inability to control whether, how much, or how long the population in the contaminated areas was exposed. For another 29 studies, researchers reviewed several publicly available human and animal studies and used data derived from these studies to determine the process by which perchlorate affects the human thyroid and the highest exposure levels that did not adversely affect humans. The 3 remaining studies used another methodology.⁵ Many of the studies we reviewed contained only research findings, rather than conclusions or observations on the health effects of perchlorate. Appendix III from our 2005 report provides data on these studies, including who sponsored them; what methodologies were used; and, where presented, the author's conclusions or findings on the effects of perchlorate.

⁵The number of study types is greater than the total number of studies because 3 studies used a combination of experimental design and data analysis methodologies.

Only 44 of the studies we reviewed had conclusions on whether perchlorate had an adverse effect. However, adverse effects of perchlorate on the adult thyroid are difficult to evaluate because they may happen over longer time periods than can be observed in a typical research study. Moreover, different studies used the same perchlorate dose amount but observed different effects, which were attributed to variables such as the study design type or age of the subjects. Such unresolved questions were one of the bases for the differing conclusions in EPA, DOD, and academic studies on perchlorate dose amounts and effects.

The adverse effects of perchlorate on development can be more easily studied and measured within typical study time frames. Of the studies we reviewed, 29 evaluated the effect of perchlorate on development, and 18 of these found adverse effects resulting from maternal exposure to perchlorate. According to EPA officials, the most sensitive population for perchlorate exposure is the fetus of a pregnant woman who is also nearly iodine-deficient. However, none of the 90 studies that we reviewed considered this population. Some studies reviewed the effect on the thyroid of pregnant rats, but we did not find any studies that considered perchlorate's effect on the thyroid of nearly iodine-deficient pregnant rats.

In January 2005, the National Academy of Sciences issued its report on EPA's draft health assessment and the potential health effects of perchlorate. The Academy reported that although perchlorate affects thyroid functioning, there was not enough evidence to show that perchlorate causes adverse effects at the levels found in most environmental samples. Most of the studies that the Academy reviewed were field studies, the report said, which are limited because they cannot control whether, how much, or how long a population in a contaminated area is exposed. The Academy concluded that the studies did not support a clear link between perchlorate exposure and changes in the thyroid function in newborns and hypothyroidism or thyroid cancer in adults. In its report, the Academy noted that only 1 study examined the relationship between perchlorate exposure and adverse effects on children, and that no studies investigated the relationship between perchlorate exposure and adverse effects on vulnerable groups, such as low-birth-weight infants. The Academy concluded that an exposure level higher than initially recommended by EPA may not adversely affect a healthy adult. The Academy recommended that additional research be conducted on perchlorate exposure and its effect on children and pregnant women but did not recommend that EPA establish a drinking water standard. To address these issues, in October 2006, CDC researchers published the results of the first large study to examine the relationship between low-

level perchlorate exposure and thyroid function in women with lower iodine levels. About 36 percent of U.S. women have these lower iodine levels. The study found decreases in a thyroid hormone that helps regulate the body's metabolism and is needed for proper fetal neural development in pregnant women.

Mr. Chairman, this concludes my testimony. I would be pleased to answer any questions that you or other Members of the Subcommittee may have at this time.

GAO Contacts and Staff Acknowledgments

For further information about this presentation, please contact me, John Stephenson, at (202) 512-3841 or stephensonj@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. Contributors to this testimony include Steven Elstein, Assistant Director, and Terrance Horner, Senior Analyst; Richard Johnson, Alison O'Neill, Kathleen Robertson, and Joe Thompson also made key contributions.

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