

# MERCURY POLLUTION PREVENTION PLAN

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## INTRODUCTION

The Palo Alto Regional Water Quality Control Plant (RWQCP) releases mercury (Hg) to the environment through its treated effluent, ash from sludge incineration, and incinerator air emissions. Although these releases comply with all regulatory requirements, they are of concern because of mercury's persistence in the environment and toxicity to humans and other environmental receptors. For this reason, the RWQCP seeks to reduce the quantity of mercury it releases by reducing the quantity of mercury in the plant's influent. To this end, the RWQCP conducted a study to identify the primary sources of mercury contributing to the influent loading at the plant (EIP, 1997). Table 1 lists each mercury source identified by this study and its estimated annual contribution to the influent load. The table divides the sources into categories to facilitate the development of the pollution prevention plan.

This document presents the pollution prevention plan that the RWQCP can implement to reduce the mercury it releases to the environment. The plan addresses sources of mercury for which the RWQCP currently has enough information to determine feasible control strategies. This document is intended to supplement the RWQCP's primary pollution prevention plan, the *Clean Bay Plan*. The RWQCP intends to include the control strategies identified in this report as "strategies for immediate implementation" in the *Clean Bay Plan 1998*. During the RWQCP's annual pollution prevention planning process, the RWQCP will also consider implementing actions identified in this report as "strategies for further consideration."

In the *Mercury Source Identification* report (EIP, 1997), a number of other mercury sources are identified for further study. Such studies may identify additional opportunities to reduce mercury discharges to the RWQCP. During the RWQCP's annual planning process, the RWQCP will evaluate any additional mercury pollution prevention opportunities identified through follow-up studies and other staff activities for inclusion in the *Clean Bay Plan*.

## EXISTING RWQCP MERCURY REDUCTION PROGRAMS

Over the past few years, the RWQCP has put in place several programs that reduce sources of mercury discharges. Among them are a program to reduce the use of mercury thermometers; best management practices for hospitals and other medical facilities, laboratories and pottery studios; and distribution of a guide to installing graywater systems.

### HOSPITAL AND MEDICAL FACILITIES

Mercury sources within hospitals include mercury-containing reagents used in laboratory processes, such as tissue-fixatives, and mercury-containing equipment, such as thermometers and blood pressure cuffs. They are estimated to account for 4% (approximately 0.95 pounds) of the annual influent loading to the RWQCP. The RWQCP has completed Best Management Practices (BMPs) for hospitals and medical facilities in cooperation with the five major medical facilities in the service area. The BMPs include pollution prevention guidance for all hospital operations that could involve the use of mercury or handling of mercury-containing wastes. During 1995, the RWQCP published a folder and packet of customized BMPs for each type of audience in the medical community. The packet includes guidance on proper management of

mercury-containing reagents, a description of a mercury spill prevention and cleanup plan, and recommendations for the elimination of mercury-containing equipment from hospital operations.

**Table 1. Mercury Sources and Estimated Annual Loads**

Mercury Discharge Source	Estimated Annual Hg Load (pounds)	Planning Category
Residents		
Human Waste	2.9	Human Waste
Laundry Graywater	2.5	Laundry
Thermometers	1.1	Household Products
Contact Lens Solutions	0.66	Household Products
Household Products	0.38	Household Products
Food Waste	0.17	Food Waste
Other Unidentified Residential Sources	2.9	Unknown Sources
Water Supply	5.1	Water Supply
Dentists	2.1	Dentists
Permitted Industries		
Hospitals	0.95	Permitted Industries
Biological and Pharmaceutical Labs	0.20	Permitted Industries
Electronics Industries	0.055	Permitted Industries
Miscellaneous Industries	0.14	Permitted Industries
Landfills	0.0087	Permitted Industries
Hazardous Waste Treatment, Storage, and Disposal Facilities	0.0015	Permitted Industries
Metal Finishing Industries	0.	Permitted Industries
Storm Water Inflow	0.73	Storm Water Inflow
Employee Related Human Waste	0.68	Human Waste
Stanford University	0.60	Permitted Industries (and residential categories)
Septage Haulers	0.24	Human Waste (and residential categories)
Commercial Laundries	0.028	Laundry
Portable Toilets	0.0024	Human Waste
Unknown Sources	1.6	Unknown Sources
<b>TOTAL</b>	<b>23.</b>	

*SOURCE: EIP Associates, 1997*

In 1995, and again in 1997, more than 1,000 copies of these educational materials were distributed through mailings to doctor's offices, nursing services, ophthalmologists, blood banks, veterinarians, nursing homes, medical clinics, chiropractors, podiatrists, dentists, and medical laboratories. Specialized mailings were sent to local pharmacies, highlighting products typically sold at the recommendation of pharmacists. Outreach conducted in coordination with hospitals has included an educational fair at one hospital and distribution of materials to hospital staff by hospital environmental health and safety coordinators.

### LABORATORIES

About 100 laboratories in the area conduct chemistry, biotechnology, medical, engineering, and semiconductor research and development. They are estimated to account for approximately 0.2 pounds of the influent load to the RWQCP. In 1993, the RWQCP developed and distributed a brochure of Best Management Practices (BMPs), a BMP checklist, and an informational poster. These documents address mercury-containing equipment and reagent handling activities at laboratories.

While the largest laboratories in the RWQCP service area were already permitted dischargers prior to the implementation of the laboratory educational program, the RWQCP Pretreatment program has stepped up efforts to identify and visit all laboratories in the service area. The RWQCP issues permits to mid-sized and large laboratories in the service area. Critical BMPs (like lips around sinks to keep spilled chemicals from reaching the sewer system) were included in ordinance requirements adopted in 1995.

In 1996, the RWQCP mailed all local laboratories an information packet that highlighted pollutants of concern for laboratories (mercury, chromium, and copper), provided information about new resources for laboratory pollution prevention, and included the laboratory BMP booklet and checklist. Since laboratory-related business is increasing in the RWQCP service area, the RWQCP plans to continue regular outreach to laboratories.

### POTTERY AND ART STUDIOS

In 1995, a booklet of Best Management Practices was published and distributed to some of the local pottery studios suspected of using and discharging metals (including mercury) from glaze pigments and clay impurities. During 1996, the RWQCP distributed the booklet to additional pottery facilities, particularly schools, and provided it to local art supply stores to share with home hobbyists.

### LAUNDRY GRAYWATER

Laundry graywater contains a significant fraction of residential mercury discharges, approximately 2.5 pounds annually. Under some conditions, laundry graywater may be able to be diverted for on-site irrigation use rather than sewer discharge. Recently developed building regulations allow use of laundry graywater for residential irrigation, although a number of restrictions apply. During 1995, the RWQCP monitored regulatory development in this area and conducted a brief evaluation of the general feasibility of local residential graywater system use, documented in "Feasibility of Promoting Laundry Graywater Systems in the Palo Alto Regional

Water Quality Control Plant Service Area” (Larry Walker Associates and Brosseau, 1996). That evaluation found that laundry graywater reuse in accordance with building regulations would be possible at many homes in the RWQCP service area. However, many other residences could have difficulty installing graywater systems due to the landscaped area requirements for such systems. Although the RWQCP has not vigorously pursued an outreach program on graywater systems, the RWQCP does provide residents with detailed information about setting up a laundry graywater re-use system at their homes.

## HOUSEHOLD MERCURY WASTE COLLECTION

The RWQCP has obtained a permit to allow service area residents to drop off mercury-containing products for disposal by the RWQCP. While the RWQCP plans to accept only mercury thermometers in the near-term, collection of other mercury-containing wastes is allowed by the permit.

## EVALUATION OF EXISTING PROGRAMS

Although the hospital and laboratory BMP programs have only been in place for two years, several indicators point to the success of the programs. Observed quantities of mercury discharged in wastewater from hospitals and laboratories in the RWQCP service area are relatively low compared to similar discharges in other areas of the country. These low levels are attributed to reductions achieved through the BMP programs. A majority of the hospitals in the RWQCP service area now contain all their mercury-containing reagents or have switched to other reagents. Many are in the process of removing their mercury-containing equipment and replacing it with mercury-free equipment (Torke, 1997). Stanford Hospital is in the process of trying to go mercury-free in its inpatient care operations (Moran, 1997). Although a program evaluation has not been conducted, the BMP packets have been well received and RWQCP staff have observed significant responses from hospitals and laboratories.

## MERCURY POLLUTION PREVENTION PLAN

Although the RWQCP has already addressed several sources of mercury discharges, other potentially controllable mercury sources exist within the service area, and additional measures can be taken to control discharges from the sources already addressed. The mercury pollution prevention plan lays out additional programs that the RWQCP plans to implement or is considering implementing in the future to reduce the amount of mercury in the influent to the plant. The source-specific control strategies are based on the categories outlined in Table 1. General control strategies and their application to specific sources in the RWQCP service area are described below.

## GENERAL CONTROL STRATEGIES

Source control strategies generally fall into four different categories:

- Technology-based Strategies

- Local Regulatory Strategies
- Public and Business Outreach
- Regional, National, or International Strategies

For each of these general categories, a short description of the elements of a general strategy and examples of program effectiveness are presented below.

### TECHNOLOGY-BASED STRATEGIES

Technology-based strategies involve a process modification or the use of equipment or chemicals to achieve reductions in mercury discharges. For example, installing household laundry graywater systems would effectively eliminate sewer discharge of mercury in laundry graywater. The effectiveness of these strategies depends on the ability of the technology to remove mercury from the source or the mercury discharge from the sewer as well as the amount of cooperation and participation that is necessary to implement the strategy. Although graywater systems would eliminate laundry graywater as a source of mercury to the sewer system, the installation of the systems would involve changes in the construction and design of houses, renovations of existing residences, and participation from planning and building officials, builders, developers, landscapers, and homeowners.

### LOCAL REGULATORY STRATEGIES

Local regulatory strategies include local ordinances and controls on specific industries or sources. These controls may include product bans or restrictions on a local level or enforced discharge limits and site visits for businesses. The feasibility of this strategy is limited by state and federal law (e.g. FIFRA prohibits many local restrictions on pesticides), and by the ability of dischargers to control the source of mercury in their discharges. The effectiveness of this type of strategy depends on the ability of the RWQCP to enforce the regulation.

### PUBLIC AND BUSINESS OUTREACH

In the RWQCP's service area, the largest source of mercury is residential activity. Regulatory strategies are generally not applicable in the residential sector and technology-based strategies are difficult to implement on a large, residential scale. Therefore, public education and outreach are often the most effective ways of implementing source reduction in the residential sector. Outreach and education to businesses can be a cost-effective way of raising awareness and changing business habits for source control without the difficulties and time involved in implementing legislative or technology-based controls.

Public and business outreach can be accomplished in many different ways. Brochures, point of purchase (POP) displays, event displays and media advertisements all can present clear, concise information to a broad audience. School programs can be used to create awareness in children which they can then pass on to their parents. Business outreach can take the form of education on alternative products and best management practices. Business incentive programs in which businesses are recognized for following pollution prevention guidelines or providing educational

materials to their customers are effective ways of educating both business owners and the public about environmental issues.

### REGIONAL, NATIONAL, OR INTERNATIONAL STRATEGIES

Some of the mercury sources are not easily controllable by the RWQCP, but the RWQCP can approach other entities to advocate the reduction of mercury from these sources. Strategies falling into this category may include working with regional or national groups to reduce mercury levels in air emissions or advocating the reduction of mercury levels in clothing and other products.

### SOURCE SPECIFIC CONTROL STRATEGIES

This plan presents a large menu of potential strategies for reducing mercury discharges to the RWQCP. The document divides these control strategies into two categories: strategies for immediate implementation and strategies for further consideration. The RWQCP plans to initiate implementation of the “strategies for immediate implementation” in the near term, because these strategies offer opportunities for relatively significant mercury reductions, have relatively low barriers to implementation, and are currently feasible. The RWQCP plans to evaluate the “strategies for further consideration” during its annual planning process and when conditions affecting these strategies change, with potential implementation in the future.

### STRATEGIES FOR IMMEDIATE IMPLEMENTATION

#### Mercury Reduction Policy

The RWQCP could develop and ask Palo Alto, Mountain View, Los Altos, Los Altos Hills, East Palo Alto Sanitary District and Stanford to adopt a Mercury Reduction Policy. That policy could set mercury reduction goals and establish general policies for guiding organizational directions to achieve the goals. While adoption of a mercury reduction policy would not directly reduce mercury discharges, it could provide a valuable framework for implementation of a mercury pollution prevention program. For this reason, a load reduction estimate was not developed for this control strategy.

#### Expanded General Public Outreach

Residential sources of mercury make up the largest percentage of the mercury load to the RWQCP (46%). A large part of the mercury pollution prevention plan involves educating the public about the hazards associated with mercury, sources of mercury in their homes, and ways they can help reduce the load of mercury from their households. Expanding general public outreach on mercury would serve to connect all the other aspects of the plan together and provide the general information necessary to complete other outreach activities. An expanded general public education program would serve as the background information for the rest of the control strategies presented below.

## Dentists

Dentists are the largest identified source for which the RWQCP has a high level of control and for which no specific mercury control strategies are currently in place. (Dentists were included in the hospital and medical facilities mailings, but these included only general information for their offices, rather than information specific to dentists). Dentist-specific outreach and education should be the first control strategy employed with dentists. However, local regulatory strategies are a possibility in the future if it is determined that there is a need for them.

An outreach program for dentists would involve the development of informational materials describing best management practices for dealing with amalgam, amalgam waste, and spills from amalgam preparation. The initial outreach material should:

- facilitate proper disposal and storage of mercury amalgam and management of amalgam wastes;
- promote the use of pre-encapsulated amalgam.

Important information for dentists includes:

- Proper ways to clean amalgam traps and vacuum filters to avoid releasing the trapped mercury to the sewer system.
- Proper storage of waste amalgam (used and unused) without the use of water.
- Waste amalgam disposal methods with an emphasis on recycling (and a list of mercury recyclers in the area).
- Mercury spill prevention and spill cleanup methods.

Dentists could be encouraged to reduce or eliminate the use of mercury amalgam and to use pre-encapsulated amalgam instead of mixing their own if amalgam is continued to be used. Pre-encapsulated amalgam eliminates the need for elemental mercury in the dentist's office, and the spills and dangers associated with elemental mercury.

When working with dentists, it is important to realize that if they already have chair-side amalgam traps and vacuum filters installed, the filters and traps capture up to 80% of the amalgam used by the dentist. Much of the mercury released comes from improper cleaning of traps and filters and the disposal of trapped amalgam down the sink. Initial educational measures should focus on proper cleaning of traps and disposal of the amalgam caught in the traps, as these relatively simple measures could prevent a significant amount of waste amalgam from reaching the sewer system. An outreach program to dentists in the Western Lake Superior Sanitary District's service area resulted in a reduction of 70% in mercury concentrations from the dentists sampled (WLSSD, 1997).

In addition to the best management practices described for working with dental amalgam, some treatment technologies exist that could be promoted to dentists as a way to reduce mercury

discharges. In many parts of Europe, amalgam separators are required as a treatment measure before the dentist discharges to the sewer system. Amalgam separators use a settling tank or centrifuge to separate amalgam from wastewater. The effectiveness of the systems range from 80-99% removal of the mercury associated with amalgam. However, the soluble mercury in wastewater is not removed by these systems, so that, even with the best practical technology installed, only about 90% of the mercury in the wastewater can be removed (WLSSD, 1997). Outreach activities to dentists should describe these technologies and recommend the use of separators.

To communicate this information to dentists, the RWQCP plans to adapt materials prepared by the San Francisco Water Pollution Prevention Program and distribute them to local dentists. These materials (which San Francisco has shared with other agencies, including Palo Alto) are especially valuable because they were developed in association with the San Francisco Dental Society and the California Dental Association.

A second phase of outreach could be conducted to address the use of alternatives to amalgam. Since this is a difficult issue, outreach plans, messages, and materials should be developed in conjunction with local dentists, preferably through the local dental society. In preparing an outreach program for dentists, the importance of the local dental societies in the success of the program should be recognized. Dental outreach programs in Maryland and Seattle have found that working with the local dental associations is very important to a successful program involving dentists. Additionally, dental societies may be willing to provide the outreach materials and serve as vehicles for outreach to dentists.

While discussing use of alternatives to amalgam fillings may be a difficult task for the RWQCP and local dentists, reducing amalgam use has the potential to offer significant reductions in mercury discharges to the RWQCP. Outreach to dentists that reduces the use of mercury-containing amalgam could reduce the mercury load from human waste as well as mercury discharges from dental offices. According to recent studies, mercury fillings could be a significant source of mercury in human waste (Bjorkman, 1997). These studies indicate that people with amalgam fillings excrete up to 10 times more mercury in their feces than people without amalgam fillings (Bjorkman, 1997). The study measured the concentration of mercury in feces from subjects before and after the removal of all of their mercury fillings. After an initial, large increase in mercury concentrations, the concentrations decreased to near the levels found in people without fillings after 60 days. Mercury loadings decreased from a median of 19 micrograms ( $\mu\text{g}$ ) per person per day to a median of 2.6  $\mu\text{g}$  per person per day. The amalgam-free group had a median loading of 1.6  $\mu\text{g}$  per person per day. These numbers indicate that between 80 and 90% (about 2.3-2.6 pounds) of the mercury loading from human waste could potentially be removed if no one in the RWQCP service area had mercury fillings. Therefore, outreach to dentists that recommends a reduction in the use of mercury amalgam could indirectly result in lowered mercury loads from human waste as well.

## Household Products

Household products, including thermometers and contact lens solutions, are responsible for approximately 9% of the mercury load to the RWQCP. Control strategies are presented below.

## Thermometers

Mercury thermometers constitute one of the largest sources of mercury from residents to the RWQCP, approximately 1.1 pounds per year. The RWQCP is currently initiating a Clean Bay Business Program with pharmacies in the service area to help reduce the number of mercury thermometers used by residents. Pharmacies can become Clean Bay Businesses by accepting thermometer rebate coupons and carrying RWQCP provided educational materials on the hazards of mercury thermometers. Currently, all pharmacies in the RWQCP service area have agreed to become part of the program (Moran, 1997). The Clean Bay Pharmacy Program is accompanied by outreach to the public to make them aware of the program. Residents who turn in a mercury thermometer to the RWQCP receive a coupon for \$2.50 discount on the purchase of a non-mercury thermometer or another product at a Clean Bay Pharmacy.

The Clean Bay Pharmacies program could be expanded in the future to provide more extensive outreach, to restrict sales of mercury thermometers, or to include other stores, like hardware stores, that sell thermometers, such as kitchen thermometers.

## Contact Lens Solutions

Several contact lens solutions available to consumers contain thimerisol, a mercury-containing preservative. Viable, cost-effective alternatives to these solutions are also readily available to consumers. The RWQCP could conduct outreach to optometrists, opticians, and other doctors that fit contact lenses to educate them on alternatives to thimerisol-containing solutions. The outreach would encourage doctors not to give out samples of thimerisol-containing solutions, while encouraging their patients to purchase mercury-free solutions.

When the Clean Bay Pharmacies program is renewed, the requirements for Clean Bay Pharmacies could be expanded to include placing educational materials provided by the RWQCP about thimerisol-containing solutions near the contact lens solutions. Such a program could be extended to other retailers as needed. The program would also need to include outreach to the public about thimerisol-containing solutions and alternatives to these solutions. At the time of the Clean Bay Pharmacy program renewal (anticipated in 1998), the RWQCP should check contact lens solution supplies at local pharmacies and assess the value of such a program expansion.

## Hospitals and Laboratories (Permitted Industries)

Hospitals are the largest source of mercury from a permitted industry in the RWQCP service area. Palo Alto has already instituted programs with hospitals and laboratories. Some possible expansions of those programs and additional control strategies are described in the following section.

## Mercury-Containing Equipment

Since hospitals and laboratories are permitted industries, additional pressure from RWQCP staff during inspections combined with information on alternatives could be used to reduce the use of mercury-containing equipment. Most of the hospitals and many laboratories have already

responded to RWQCP pressures to reduce mercury use. To facilitate further reductions in mercury use, the RWQCP could provide information to hospitals and laboratories that helps eliminate remaining barriers to the use of alternative equipment. While alternative equipment is often no more expensive than mercury-containing equipment, the capital expenditure needed to replace existing equipment can be a significant barrier. To help describe the real cost of using mercury-containing equipment, Stanford University is currently developing information about the frequencies and costs of mercury spill response. Another barrier to the use of alternatives to mercury thermometers involves concern about the accuracy of alternative thermometers. The RWQCP could gather information on this and other pros and cons of alternatives to mercury-containing equipment. The RWQCP could share information on these issues and the environmental impacts associated with mercury releases with the managers at hospitals and laboratories.

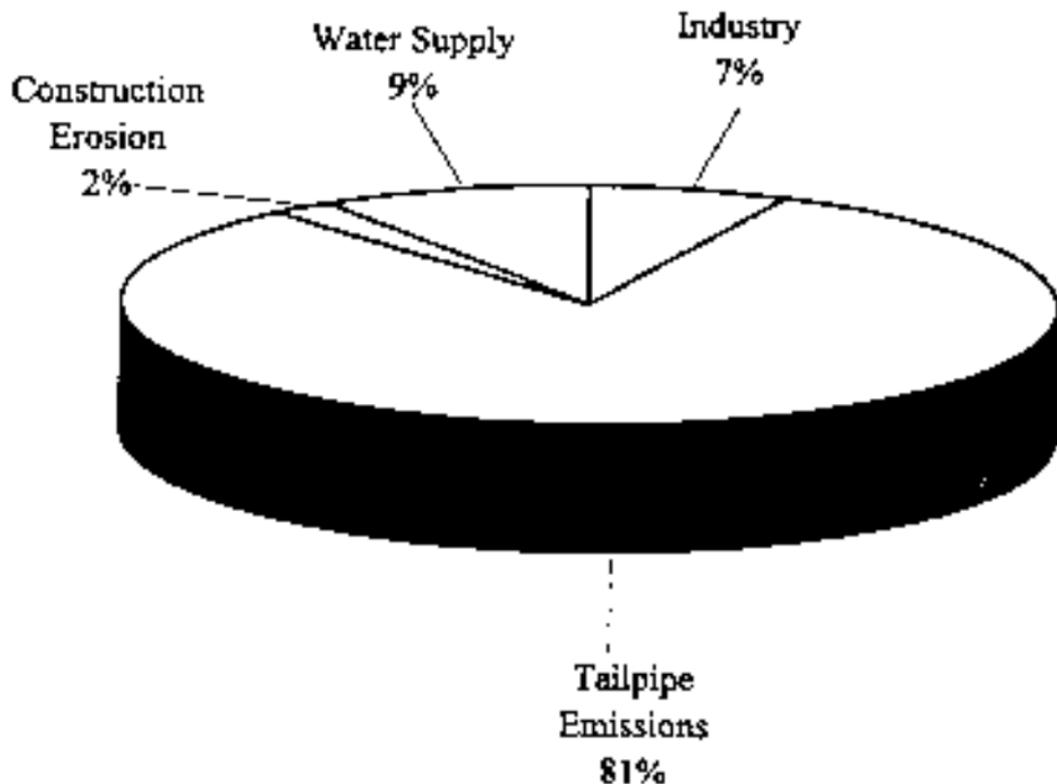
### Line Cleaning

Historical use of mercury may have caused a mercury build-up in sink traps and sewer lines in hospitals and laboratory buildings. However, the magnitude of this source is very uncertain. The RWQCP could support implementation of a demonstration project at a hospital or laboratory to determine the effectiveness of sewer line cleaning to remove mercury build-up. Mercury wastewater effluent concentrations should be measured before and after the cleaning to determine whether sewer line cleaning is an effective tool for reducing mercury loads to the sewer system.

### Storm Water Inflow

Sources of mercury in storm water are expected to be primarily from deposition of mercury on surfaces from airborne emissions. As shown in Figure 1, airborne mercury comes primarily from tailpipe emissions from motor vehicles (Santa Clara Valley Urban Runoff Pollution Prevention Program, 1997). Mercury sources in storm water are not directly controllable by RWQCP activities. The RWQCP could advocate the reduction of mercury levels in motor vehicle fuels to reduce mercury emissions from motor vehicles.

Figure 1. Sources of Mercury in Urban Storm Water Runoff



## STRATEGIES FOR FURTHER CONSIDERATION

### Household Mercury Waste Collection

Within its current permit, the RWQCP could expand its household mercury waste collection program to include mercury-containing switches, light-up tennis shoes, paint and paint additives, or other products. If such products are linked to possible sewer or storm drain disposal, the RWQCP would consider collecting such household wastes.

### Regulating Dentists

While working cooperatively with dentists is the recommended first step, it would be possible for the RWQCP to regulate dentists. Regulatory controls on dentists could be enforced by requiring permits for dental wastewater discharges. Dentists are currently included in the RWQCP's silver waste program, which involves compliance with waste management requirements for silver-containing fixer from x-ray developing. The permits could be modified to require the implementation of mercury amalgam handling and disposal practices, propose a reduction in the use of amalgam, or include effluent limitations on the amount of mercury contained in wastewater. The program could include reporting and monitoring requirements, site visits, and penalties for violating permit requirements.

### Conveyance Controls

The following strategies, involving management of laundry graywater and food waste, involve diversion of waste streams from the RWQCP to land in the RWQCP service area. Because these strategies do not reduce the use of mercury, they are less desirable than strategies that address the ultimate source of mercury release to the environment. While pollutant transfer to land is less desirable than source reduction, the two types of diversion discussed below have environmental merit in that they involve reuse of a resource (water or compost), rather than disposal of the material as a waste. Further, it should be noted that mercury concentrations in food (LWA, 1994) are similar to typical mercury concentrations in soil (Shacklette and Boerngen, 1984).

### Laundry

Graywater (water from washing machines, showers, and sinks) from residential and commercial laundries constitutes a significant load of mercury to the RWQCP, approximately 2.5 pounds annually. However, the sources of the mercury in the graywater have not been identified. Mercury may come from dirt, air deposition, or chemicals applied to cotton or finished clothing (LWA, 1994). The RWQCP has no direct control over any of these sources. While the RWQCP cannot control the sources of mercury in laundry graywater, it can encourage actions that prevent the mercury-containing graywater from entering the sewer system. Graywater can be used to irrigate lawns, trees, bushes and flowers. Graywater systems could be recommended and promoted to residents and contractors and builders for use in feasible locations.

Although graywater systems can divert significant loads of mercury from the sewer system, several problems interfere with the ability of the RWQCP to implement the use of these systems in the service area. To begin with, the Palo Alto area provides very little opportunity for new construction. This means that the program would primarily involve retrofits of existing houses. Graywater systems are estimated to cost between \$1500 and \$3000 to install (Sacramento Bee, 1994). The small yards in Palo Alto require small amounts of water to maintain and low water costs mean low cost savings unless drought or other costly restrictions are put in place.

To address the barriers to the use of graywater systems, the RWQCP could work with the local building departments to resolve issues surrounding graywater system use and develop a local supplement to the California Department of Water Resources *Graywater Guide*. Then, the RWQCP could select appropriate geographic areas and building types in the service area to target for an educational program on graywater systems.

Drought or other water conservation restrictions could make graywater systems more financially attractive to home-owners. The RWQCP could prepare to work with local water utilities to promote the use of graywater systems in retrofits and new construction should water restrictions occur in the future.

## Food Waste

Disposal of food waste down the sink results in mercury loads to the RWQCP. The RWQCP does not have direct control over the levels of mercury in food. However, the RWQCP could encourage residents not to use their garbage disposal to dispose of food waste and to compost food waste instead. The RWQCP could assemble and distribute outreach materials on household composting of food waste for the public and provide references for more information. Such an outreach program should be conducted in conjunction with local solid waste programs that encourage composting. The RWQCP should consider encouraging the use of kitchen storage containers or in-kitchen worm boxes as an element of this program. This would reduce the amount of mercury from food waste reaching the sewer system, by diverting that food waste and its associated mercury to individual gardens. Diverting food waste from the sewer system could affect wastewater treatment operations at the RWQCP. Investigation of potential operational consequences would need to be conducted prior to initiation of any large-scale program in this area.

## OTHER SOURCES

There are several sources of mercury to the RWQCP shown in Table 1 for which control strategies have not been identified. These sources were determined to either have a very low potential for controllability by the RWQCP or more information is needed before control strategies can be developed. The *Mercury Source Identification* report (EIP, 1997) recommends further investigation into most of these sources. At this time, the RWQCP believes it has very little ability to control three mercury sources: soil (which reaches the RWQCP via laundry, shower and wash water), food (which comes to the RWQCP through garbage disposals), and human waste. The plan identifies strategies to divert soil and food waste from sewer disposal. While use of composting toilets to divert human waste from sewer disposal is theoretically

feasible and is a subject for future RWQCP investigation, at this time, composting toilets do not comply with the plumbing code in Palo Alto (Herman, 1997). Substantial research would have to be conducted before installation of composting toilets in the RWQCP service area could be considered (Herman, 1997). For this reason, they are not considered to be a viable control strategy.

## ESTIMATED LOAD REDUCTIONS

Load reductions from each of the control strategies identified above can be estimated by determining the potential effectiveness of each control strategy. The effectiveness of the source control strategies described above can be estimated on the basis of the level of participation expected and the maximum load reduction achieved by the strategy. Development of participation and loading factors for each pollution prevention program is described below.

## PARTICIPATION FACTOR

Ideally, the implementation of a control strategy would result in the elimination of the source it was designed to address. In reality, only a certain percentage of the people and procedures addressed by the control strategy will be changed. The participation factor estimates the amount of participation that can be achieved for a given control strategy.

Participation factors used in this study are described below. Because limited data on participation levels is available, these participation factors should be considered to be rough estimates. Whenever possible, estimates from previous efforts in the Palo Alto area are used.

Public education and outreach programs can be expected to have an effectiveness between 5 and 20%. Outreach efforts in Seattle resulted in behavior changes in 6-13% of the people surveyed (King County Department of Metropolitan Services, 1996). In Palo Alto, the return rate for car wash coupons mailed to residents as an outreach measure was 10% in 1995 and 9% in 1996 (RWQCP, 1997). Since previous outreach efforts in Palo Alto resulted in approximately a 10% participation rate, 10% is used as the participation factor for most public education programs. In the cases where the program involves a more complicated message and/or clear alternative behaviors or products are not available, a 5% participation factor is used. A higher level of participation was assigned if the outreach effort was combined with a Clean Bay Business Program.

Business outreach programs are a function of how many businesses can be reached, the number of businesses reached that are willing to cooperate, and their share of the market. Most of the businesses addressed by business outreach programs are permitted industries in the RWQCP's service area. Historically, the RWQCP has been very successful at identifying non-permitted businesses for outreach in its service area. Therefore, it was assumed that the RWQCP could contact 100% of the businesses in its service area. The cooperation rate can range from 30-100% depending on the difficulty of the program and the presence of incentives. For example, Palo Alto has already contacted pharmacies to participate in a Clean Bay Pharmacy program for thermometers and all contacted pharmacies agreed to participate. A vehicle service facility

program was implemented that received participation from 49% of the businesses which increased to 88% during five years of the program.

For the purpose of these estimates, a participation rate of 50% was assumed for non-permitted industries based on the experience of the vehicle service facilities. Palo Alto only has 5 hospitals within its service area. According to a conversation with Ken Torke of the RWQCP, many of these hospitals have already implemented best management practices in association with the RWQCP's outreach effort. Only one hospital was reported to be less proactive in its pollution prevention efforts. Therefore, the business outreach participation factor for hospitals was assumed to be 80%.

Graywater management systems are expected to have a relatively low participation rate due to the cost of the systems and any retrofits that may have to be done to accommodate the technology.

The participation rate for a regional/national strategy to reduce mercury levels in vehicle emissions was very difficult to estimate because of a lack of information about who would be involved in implementing this strategy and its technical feasibility. Since a significant part of the program would probably involve educating regional and national entities on the connection between mercury in fuel and stormwater quality, the strategy was assumed to have the same participation rate as a difficult to implement public education campaign (5%).

## LOADING FACTOR

The loading factor is the amount of mercury load reduction from a source that could be expected if there was 100% participation. The loading factor varies depending on the sources of mercury that the strategy addresses. For example, all programs related to thermometers and contact lens solutions have a loading factor of 100% because control strategies aimed at these sources would effectively eliminate the source.

Loading factors were determined by estimating the amount of mercury coming from individual sources within a category. For example, sources of mercury from hospitals include mercury-containing equipment, mercury solutions and mercury present in the sewer lines. Each control strategy was then examined to determine the individual sources that it addressed. Business outreach and public education strategies were assumed to address all individual sources. In the case of dentists, it was determined, given current technologies, that a maximum of 90% of the mercury from dental amalgam could be removed if amalgam was being used at the dentist's office.

## RESULTS

Table 2 shows the estimated participation and loading factors and the resulting load reduction for each control strategy. This table represents the maximum loading reduction that can be expected from implementing all the control strategies listed above. As shown in the table, the maximum reduction that can be achieved is estimated to be 3.2 pounds or 14% of the total mercury influent

load. It should be noted that of the 23 pounds of mercury in the influent, only 9.1 pounds are thought to be readily controllable.

Figure 2 describes the controllability of the various sources by the RWQCP and lists some information needs.

**Table 2. Estimated Load Reductions-Implementation of all Strategies Identified in this Report**

Targeted Source	Load from Source (lbs/yr)	Percent of Total Load	Source Control Strategy	Participation Factor	Loading Factor	Effectiveness Rating <sup>(3)</sup>	Estimated Reduction <sup>(4)</sup>	Reduction in lbs/year	
<i>Strategies for Immediate Implementation</i>									
<b>Dentists</b> <sup>(1)</sup>	2.1	9%	Business Outreach	50%	90%	45%	4%	0.9	
<b>Household Products</b> <sup>(2)</sup>									
Thermometers	1.2	5%	Clean Bay Pharmacy	20%	100%	20%	1.0%	0.2	
Contact Lens Solutions	0.7	3%	Public Education	10%	100%	10%	0.3%	0.07	
		3%	Business Outreach	30%	100%	30%	0.9%	0.2	
<b>Permitted Industries</b>									
Hospitals	0.95	4%	Business Outreach	80%	100%	80%	3%	0.8	
		4%	Sewer Line Cleaning	40%	30%	12%	0.5%	0.1	
Laboratories <sup>(2)</sup>	0.22	1%	Business Outreach	70%	100%	70%	0.7%	0.2	
		1%	Sewer Line Cleaning	40%	20%	8%	0.08%	0.02	
<b>Storm Water Inflow</b>	0.73	3%	Regional Strategies	5%	60%	3%	0.1%	0.02	
<b>Estimated Load Reduction</b>								2.53	
<i>Strategies for Further Consideration</i>									
<b>Laundry</b>									
Residential <sup>(2)</sup>	2.6	11%	Graywater Systems	2%	100%	2%	0.2%	0.05	
Commercial Laundries	0.028	0.1%	Graywater Systems	40%	100%	40%	0.049%	0.011	
<b>Food Waste</b> <sup>(2)</sup>	0.18	0.8%	Public Education	5%	100%	5%	0.039%	0.009	
<b>Dentists</b> <sup>(5)</sup>	2.1	9%	Regulate Dentists	80%	90%	72%	7%	0.6 <sup>(5)</sup>	
<b>Estimated Load Reduction</b>								0.67	
<b>Load from sources listed above (lb/yr)</b>					<b>8.7</b>		<b>Total Estimated Load Reduction</b>		3.2
<b>Total Load (lb/yr) <sup>(6)</sup></b>					<b>23</b>		<b>Percent of Sources Listed</b>		37%
							<b>Percent of Total Load</b>		14%

(1) Includes estimated contribution to the source from Stanford University

(2) Dental control strategies that address the use of dental amalgam will also reduce mercury loads from human wastes. Removing mercury fillings and avoiding the use of amalgam for new fillings could result in a reduction in loads from human waste as high as 80% (2 lbs).

(3) Effectiveness equals the participation factor multiplied by the loading factor.

(4) Estimated reduction equals the effectiveness rating multiplied by the percent of total load.

(5) The calculated value for load reductions associated with regulating dentists equals 1.5 pounds. However, that includes reductions assumed to have already been achieved through outreach programs (0.9 pounds). The resulting additional reduction for regulating dentists is 0.6 pounds.

(6) Total load includes sources deemed to have low controllability by the RWQCP.

**Figure 2. Controllability of Mercury Sources**

Type of Source	Controllability (high-----low)	Information Needs
Dentists	--- <b>X</b> -----	
Household Products		
Thermometers	----- <b>X</b> -----	
Contact Lens Solutions	----- <b>X</b> -----	
Other Products	-----? <b>X</b> -----	What other household products contain mercury?
Permitted Industries		
Mercury-containing Reagents	- <b>X</b> -----	
Mercury-containing Equipment	- <b>X</b> -----	
Unidentified Sources	-----? <b>X</b> -----	What are the unidentified sources?
Laundry		
Soil	----- <b>X</b> -----	
Chemicals	-----? <b>X</b> -----	What chemicals or parts used in clothing manufacture contain mercury?
Graywater	----- <b>X</b> -----	
Food Waste		
Food	----- <b>X</b> -----	
Garbage Disposal	----- <b>X</b> -----	
Storm Water Inflow		
Motor Vehicles	----- <b>X</b> -----	
Other Sources	-----? <b>X</b> -----	How does mercury get into the water supply? Are there controllable sources of mercury in industrial storm water runoff?
Human Waste	----- <b>X</b> -----	
Water Supply	-----? <b>X</b> -----	How does mercury get into the water supply?
Unknown Sources	-----? <b>X</b> -----	What are the unidentified sources?

? indicates that more information is needed about the source to make an assessment of its controllability.

*SOURCE: EIP Associates and LWA, 1997*

## CONCLUSIONS

Implementation of all the strategies identified in this pollution prevention plan, including those planned for immediate implementation by the RWQCP and those for further consideration, has the potential to reduce mercury loads to the RWQCP by up to 14%. The “strategies for immediate implementation” have the potential to reduce mercury loads to the RWQCP by up to 11%, and the “strategies for further consideration” could add an additional reduction of up to 3% of the total mercury load to the RWQCP. The effectiveness of this plan depends on the receptiveness of businesses such as dentists and hospitals to actively reducing their use of mercury and the response of the public to using mercury-free household products. The plan is expected to result in measurable decreases in mercury loads to the RWQCP over time with a resulting decrease in mercury releases to the environment.

The *Mercury Source Identification* report recommends further studies be conducted to obtain additional information about several important mercury sources (notably, residential sources and the water supply). The lack of information about these sources precludes development of comprehensive control strategies for them.

## RECOMMENDATIONS FOR FURTHER STUDY

Other household products, such as laundry detergents and bleach, may contain significant levels of mercury. Several studies that quantify the amount of mercury in household and commercial cleaning products have been done. These studies should be obtained and reviewed to determine the accuracy of the results, the timeliness of the information, and the local relevancy of the products. The RWQCP could encourage state and federal agencies to explore the mercury content of consumer products.

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