DIOXINS POLLUTION PREVENTION PLAN

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INTRODUCTION

The Palo Alto Regional Water Quality Control Plant (RWQCP) releases dioxins to the environment through its treated effluent, ash from sludge incineration, and its incinerator air emissions. The RWQCP seeks to reduce the amount released by reducing the sources of dioxins in the plant's influent. The sources and conveyances of dioxins to the wastewater treatment plant were identified in *Dioxins Source Identification* (EIP, 1997). Using the sources identified and the recommended source reduction strategies in that report, a pollution prevention plan was developed for the large conveyances of dioxins to the RWQCP.

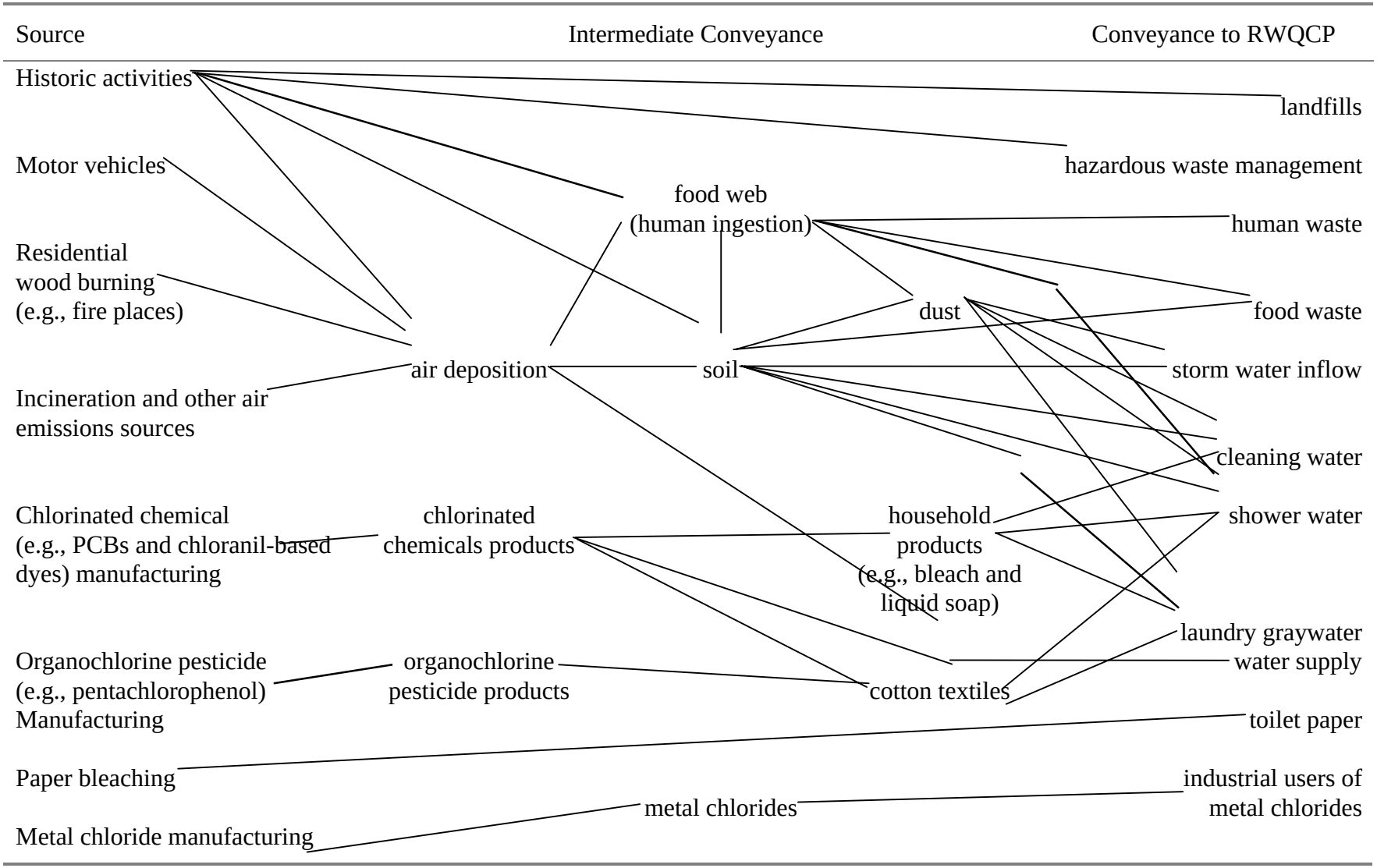
This document is intended to supplement the RWQCP's primary pollution prevention plan, the *Clean Bay Plan*. The RWQCP intends to include the control strategies identified in this report as "strategies for immediate implementation" in the *Clean Bay Plan 1998*. During the RWQCP's annual pollution prevention planning process, the RWQCP will also consider implementing actions identified in this report as "strategies for further consideration." During the RWQCP's annual planning process, the RWQCP will evaluate any additional dioxin pollution prevention opportunities identified through follow-up studies and other staff activities for inclusion in the *Clean Bay Plan.*

SOURCES OF DIOXINS

Dioxins are not intentionally produced: they are waste by-products of incineration, chemical manufacturing, and pulp and paper bleaching. Since no incinerators, chemical manufacturers, or pulp or paper bleaching operations discharge directly to the RWQCP, dioxins arrive at the plant through a variety of conveyances from potentially distant sources. In general, the RWQCP may have the ability to control the conveyance of dioxins to the plant, but will have little control over the actual source. Figure 1 shows the relationship between sources of dioxins and their probable conveyances to the RWQCP.

In *Dioxins Source Identification* (EIP, 1997), conveyances of dioxins were classified as either relatively large or relatively small contributors to the RWQCP's load. Table 1 lists the large conveyances to the RWQCP and the original sources of dioxins that each large conveyance carries to the RWQCP. Table 1 also shows the estimated loads from these sources. Because very limited data exist on dioxin discharges, these estimates have very high uncertainty. Source specific control strategies were developed for these large conveyances, and are presented in the following pollution prevention plan.

Figure 1. Major Sources of Dioxins and their Primary Routes to the RWQCP



SOURCE: *EIP Associates, 1997*

Table 1. Large Conveyances to the RWQCP

Large Conveyances to RWQCP	Most Important Sources	Estimated Load [(1)] (10^{-8} lb TEQ/day)
Laundry and Shower Graywater	Chlorinated Chemical Manufacturing and Organochlorine Pesticide Manufacturing	64
Storm Water Inflow	Motor Vehicles, Residential Wood Burning, Incineration, and Historic Activities	6
Human and Food Waste	Same as Storm Water Inflow	4.6
Toilet Paper	Paper Bleaching	2
Total Estimated Influent Load		6-200

SOURCE: EIP Associates, 1997

(1) Each estimate is subject to sufficient uncertainty that the estimates should *not* be added together to estimate the total contribution of the large dioxin conveyances. In fact, the estimated dioxin loads from the conveyances listed may sum to a value substantially greater than the actual dioxin load at the plant; alternatively, the individual conveyances could (in reality) fail to account for a substantial portion of the measured dioxin load.

DIOXINS POLLUTION PREVENTION PLAN

The pollution prevention plan for dioxins identifies strategies for controlling levels of dioxins from the large conveyances to the RWQCP, including graywater, stormwater inflow, human and food waste, and toilet paper. For each conveyance, a short description of the sources of dioxins to the conveyance is followed by the control strategies that the RWQCP plans to implement or is considering implementing in the future in an effort to reduce the influent dioxin load to the plant. The following section describes the general categories of control strategies that could be implemented. Due to the nature of dioxin sources, public outreach will be the primary strategy employed.

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 dioxin discharges. For example, installing household laundry graywater systems would effectively eliminate sewer discharge of dioxins in laundry graywater. The effectiveness of these strategies depends on the ability of the technology to remove dioxins from the source or the dioxin 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 dioxins 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 dioxins in their discharges. The effectiveness of this type of strategy depends on the ability of the RWQCP to enforce the regulations.

Public and Business Outreach

In the RWQCP's service area, the discharges from residences are important sources of dioxins. 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 at a young age 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

Many of the dioxin sources are not easily controllable by the RWQCP, but the RWQCP can approach other entities to advocate the reduction of dioxins from these sources. Strategies falling into this category may include working with regional or national groups to advocate pollution controls on diesel vehicles or reducing the use of pentachlorophenol internationally to treat raw cotton.

SOURCE SPECIFIC CONTROL STRATEGIES

This plan presents a menu of potential strategies for reducing dioxin 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 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, assess the potential for implementation in the future.

The following control strategies address known sources and conveyances of dioxins to the RWQCP.

Strategies for Immediate Implementation

Dioxins 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 Dioxins Reduction Policy. That policy could set dioxins reduction as a goal and establish general policies for guiding organizational directions to achieve that goal. While adoption of a dioxins reduction policy would not directly reduce dioxin discharges, it could provide a valuable framework for implementation of a dioxins pollution prevention program.

General Outreach

Many sources of dioxins are physically or operationally far removed from the conveyance that results in the discharge of dioxins to the RWQCP. Often, the connection between these sources and dioxins in wastewater is complicated and difficult to follow. A general outreach program could be developed that focuses on creating an awareness of the connection between activities that may create dioxins and water quality. Topics could include the connection between clothing dyes and pentachlorophenol treatments of raw cotton to dioxin contamination of water, the link between driving a diesel-fueled vehicle and water quality, and dioxin residues that remain on paper products after the bleaching process.

While educating the general public on these topics may be useful, alerting other public agencies and appropriate entities about indirect sources of dioxin releases to the sewer could be the most important portion of this program.

Storm Water Inflow

Storm water concentrations of dioxins primarily result from air deposition of dioxins on soil and water surfaces. Diesel-fueled vehicles are responsible for the majority of the dioxins released into the atmosphere in the Bay Area. The only other significant source is residential wood burning (Bateman, 1996). Potential strategies for reducing the amount of dioxins released by diesel-fueled vehicles and residential wood burning are presented below.

Diesel-Fueled Vehicles

The amount of dioxins released by vehicle emissions is directly related to the number of on-road and off-road diesel-fueled vehicles and the amount that they are driven. While the RWQCP has supported existing Air District public education programs that explain the impacts of driving on

the environment, encourage people to reduce the amount they drive, and provide residents with information on alternatives to driving including carpooling, bicycling, CalTrain and BART, and buses, these programs do not generally address diesel-fueled vehicles. Because diesel-fueled vehicles are the primary source of dioxins from motor vehicles, the RWQCP could also support outreach specifically targeting diesel-fueled vehicles that is conducted by the Bay Area Air Quality Management District or other entities. The RWQCP could support efforts to implement programs that would reduce emissions from both on and off-road diesel vehicles. For example, the RWQCP could support regulatory efforts to create emission control requirements for diesel vehicles.

Residential Wood Burning

Burning wood releases a wide variety of toxins into the environment. The Air District already has a public education campaign to encourage residents not to burn wood. The RWQCP could support the Air District in its efforts to educate residents about emissions from wood-burning fireplaces and low emission alternatives to burning wood.

Toilet Paper

Toilet paper has been shown to contain measurable levels of dioxins (LeBel, 1992). The amount of dioxins contributed to the RWQCP influent from this source in highly uncertain. Dioxin contamination of toilet paper most likely comes from the bleaching process used to make the paper white. Currently, the RWQCP has little information about dioxins in toilet paper. Prior to initiating action in this area, the RWQCP would need to conduct the following activities:

- Investigate bleaching. Three different bleaching processes can be used in the manufacture of toilet paper. Two of these processes involve the use of chlorine and one does not use any chlorine. It is unclear how these various bleaching processes affect the amount of dioxins in the toilet paper. The RWQCP could seek additional information about the levels and sources of dioxins in toilet paper and these bleaching processes to further assess this source.

- Identify low-dioxin toilet paper products. Determine what types of toilet paper contain the lowest amounts of dioxins and determine whether they are currently available in the service area.

- Investigate other factors. Determine if there are any factors associated with the production, distribution, and use of the alternative toilet paper that could make it environmentally undesirable or infeasible for use.

Once additional information has been collected, the RWQCP could evaluate that information and determine whether it is appropriate to initiate some actions to reduce the dioxin load coming from toilet paper. Depending on the information gathered, the RWQCP could consider initiating a public education campaign, a Clean Bay Business program, or involvement in regional or national efforts. If a public education campaign is selected, the connection between the use of dioxin-containing toilet paper and water quality would need to be explained. If it is found that the low dioxins toilet paper is generally not available in supermarkets and other mainstream stores (i.e. Target and WalMart), the RWQCP could initiate a Clean Bay Business Program that recognized stores that stock low dioxins toilet paper. Additionally, the RWQCP could support regional or national efforts to promote the production of low dioxins toilet paper.

Strategies for Future Consideration

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 production of dioxins, they are less desirable than strategies that address the dioxin release to the environment at the source. 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.

Laundry and Shower Graywater

Textiles made of cotton grown in certain parts of the world outside the U.S. have been shown to contain dioxins, apparently due to the treatment of raw cotton with pentachlorophenol (PCP) (EIP, 1997). These trace amounts of dioxins in clothing are believed to be a source of dioxins to laundry graywater. In addition, the upper levels of human skin are believed to accumulate dioxins from wearing PCP treated cotton clothing. During a shower, dioxins can wash off and contribute to dioxin levels in shower graywater (EIP, 1997). The RWQCP has very little control over these sources of dioxins to laundry and shower graywater, however some possibilities exist for controlling the conveyance of the water to the sewer system.

Under some conditions, laundry graywater may be able to be diverted for on-site irrigation use rather than sewer discharge. Graywater systems use water from washing machines, showers, sinks, etc. (graywater) to irrigate lawns, trees, bushes and flowers. The systems effectively prevent dioxin-containing laundry and shower water from reaching the RWQCP. 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. Currently, the RWQCP provides interested residents with detailed information about setting up a laundry graywater re-use system at their homes.

Although graywater systems can divert significant loads of dioxins 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. Since the RWQCP already provides information to interested residents, it could

expand the program to include outreach and promotion of graywater systems to other targeted residents and contractors and builders for use in feasible locations. Graywater systems, or the ability to install the systems, could be encouraged for new developments.

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.

Human Waste and Food Waste

Dioxins in human waste result primarily from dioxins in foods ingested by residents. Air deposition onto soil and water and bioaccumulation in the food web leads to contamination in foods. While the RWQCP has no control over dioxin levels in food, it does have some control over the pathways of food waste to the sewer system.

Food waste ends up at the RWQCP after residents put left over food down their disposals. Educating the public about alternative disposal methods, such as composting, would reduce the amount of food waste reaching the RWQCP by diverting the food waste and its associated dioxins to individual gardens. Palo Alto could institute an education campaign for residents on how to compost household food waste, sources of information on composting, and resources for disposing of any excess compost material. The RWQCP could support community composting workshops that teach the techniques of composting and hand out education materials. 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. 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.

Composting toilets have been proposed as a possibility for controlling contamination from human waste. However, composting toilets do not currently comply with the plumbing code in Palo Alto. Substantial research would have to be conducted before installation of composting toilets in the RWQCP service area could be considered (Herman, 1997).

ESTIMATED LOAD REDUCTIONS

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 public education programs with simple messages. However, since many of the outreach messages for controlling dioxin sources are more complex, a 5% participation factor is used for most of the public education programs. A higher level of participation was assigned if the outreach effort was combined with a Clean Bay Business Program.

A 2% participation factor was assumed for the installation of graywater systems due to the difficulty in installing the devices. However, since graywater systems have the ability to control graywater sources of many of the pollutants of concern, a more aggressive outreach program may be implemented to increase the participation rate.

LOADING FACTOR

The loading factor is the amount of dioxins load reduction from a source that could be expected if there was 100% participation. The loading factor varies depending on the dioxin sources that the strategy addresses. For example, all programs related to toilet paper have a loading factor of 100%. On the other hand, programs for storm water inflow may only address the sources from motor vehicles or residential wood burning and therefore have a lower loading factor.

Loading factors were determined by estimating the amount of dioxins coming from individual sources within a category. Storm water inflow is the only category in which loading factors are used. The loading factors were obtained from the *Dioxins Source Identification* (EIP, 1997). All other control strategies address 100% of the source they are designed to control.

RESULTS

The source reduction strategies were evaluated using the assumed participation and loading factors and the estimated load from each source presented in *Dioxins Source Identification* (EIP, 1997). As described in that report, the estimated loads are very uncertain as is the load to the RWQCP. Each of the source load estimates is subject to sufficient uncertainty that the estimates should *not* be added together to estimate the total contribution of the known dioxin conveyances. In order to evaluate the results that could potentially be achieved through implementing the identified control strategies, the report categorizes potential reductions as large (reduction potential equal to or greater than 10% or the RWQCP influent dioxin load), small (reduction potential between 1% and 10% or the RWQCP influent dioxin load), or very small (reduction potential less than 1% of the RWQCP influent dioxin load). By categorizing both sources and potential reductions as large or small, this report avoids inappropriately comparing the individual results with one another. The general outreach and dioxin reduction policy control strategies were not evaluated as these strategies are considered general vehicles rather than strategies that directly result in load reductions.

Table 2 shows participation and loading factors used to estimate reductions and the resulting load reductions for each strategy. As shown in the table, a small to very small portion of the total load might be reduced through the control strategies presented in this plan.

Figure 2 describes the ability of the RWQCP to control the various sources of dioxins identified. As shown in the figure, pesticides applied to cotton, human waste, and the toilet paper bleaching process are not easily controllable by the RWQCP. For this reason, control strategies were not developed for these sources. If additional information is found about these sources that changes their controllability, the RWQCP will address them in the future.

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

Targeted Source	Load from Source (10^{-8} lbs/yr TEQ)	Source Control Strategy	Participation Factor	Loading Factor	Effectiveness Rating (1)	Estimated Reduction(2)
Strategies for Immediate Implementation						
Storm Water Inflow	6.0	Public Education-Vehicles	5%	70%	4%	very small
		Public Education-Wood Burning	5%	15%	1%	very small
Toilet Paper	2.0	Public Education	10%	100%	10%	very small
		Clean Bay Business	15%	100%	15%	very small
Strategies for Further Consideration						
Laundry Graywater and Shower Water	64.0	Graywater Systems	2%	100%	2%	small
Human and Food Waste	4.6	Public Education	5%	100%	5%	very small

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

(2) A large reduction equals more than 10% of the influent load to the RWQCP, a small reduction equals 1% to 10%, and a very small reduction is less than 1% of the influent load.

Figure 2. Controllability of Sources of Dioxins by the RWQCP

Type of Source	Controllability (high----------low)	Information Needs
Laundry and Shower Graywater		
Pentachlorophenol and other pesticides applied to cotton	----------**X**-	
Chloranil-based dyes and other dioxin-contaminated pigments applied to textiles	----------**?**----------	What dyes contain dioxins and what textiles are they used on?
Graywater	----------**X**---------	
Storm Water Inflow		
Motor Vehicles (primarily diesel-fueled)	----------**X**-----	
Residential wood burning	----------**X**--	
Other Sources (not necessarily related to air deposition)	----------**?**----------	How much dioxin could be in pentachlorophenol-treated utility poles?
Human and Food Waste		
Food	----------**X**-	
Food disposal in kitchen sink	----------**X**----------	
Toilet Paper		
Bleaching process	----------**X**--	
Use of bleached paper	------**X**----------	

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

Source: *EIP Associates, 1997*

CONCLUSIONS

When discussing dioxins, a distinction must be made between the sources of dioxins and the pathways or conveyances by which they reach the RWQCP. The pollution prevention plan addresses the large conveyances of dioxins to the RWQCP. Implementation of all the control strategies identified in this report has the potential to reduce the dioxin load to the RWQCP by a relatively small percentage. The "strategies for immediate implementation" could slightly reduce the dioxin load to the RWQCP, and provide a framework and gather information for potential future control strategies. "Strategies for future consideration" have the potential to reduce dioxin loads to the RWQCP by a slightly greater, but still small, fraction. Additional information on sources of dioxins will be pursued during the implementation of the pollution prevention plan and may result in additional control strategies in the future.

As described in the *Dioxins Source Identification* report, dioxins are persistent in the environment and disperse widely throughout the world (EIP, 1997). As a result, many of the dioxins reaching the RWQCP come from this environmental dispersion of dioxins, and the magnitude of the concentrations in the plant's influent is related to these environmental dioxin levels. Recent studies have shown that these environmental levels of dioxins are gradually declining (Alcock, 1996). This trend is expected to contribute to reductions in dioxin levels in the RWQCP influent. Efforts made by the RWQCP to reduce dioxin levels in its releases could help further this trend.

The *Dioxins Source Identification* (EIP, 1997) report recommends further studies be conducted to obtain additional information about several dioxin sources (notably, the water supply and chlorinated chemical products). The lack of information about these sources precludes development of control strategies for them.

REFERENCES

Alcock, R.E. and Jones, K.C. *Dioxins in the Environment: A Review of Trend Data.* Environmental Science and Technology, 30(11) 3133-3142, 1996.

Bateman, B., and Deboisblanc, B., Toxic Evaluation Section, Bay Area Air Quality Management District, *Air Emissions of Dioxins in the Bay Area*, March 27, 1996.

EIP Associates. *Dioxins Source Identification.* Prepared for the Palo Alto Regional Water Quality Control Plant. Palo Alto, CA 1997.

Herman, Fred, Palo Alto Planning Department. Personal communication with Ashli Cooper. October 2, 1997.

King County Department of Metropolitan Services. *In-House Evaluation 1996 Education/Advertising Campaigns Pesticides and Paint.* Seattle, WA 1996.

Larry Walker Associates and Brosseau, G. Memorandum: *Feasibility of Promoting Laundry Graywater Systems in the Palo Alto Regional Water Quality Control Plan Service Area.* Palo Alto, CA 1996.

Larry Walker Associates. *Residential Metals Study.* Prepared for Contra Costa County Sanitary District. 1994.

LeBel, G.; Williams, D.; and Benoit, F. *Chlorinated Dibenzodioxins and Dibenzofurans in Consumer Paper Products.* Chemosphere, 25(11): 1683-1690.

Palo Alto Regional Water Quality Control Plant. *Clean Bay Plan.* Palo Alto, CA 1997.

Sacramento Bee. "Striking Gold in Graywater." April 3, 1994.