Review of Potential Measures to Reduce Urban Runoff Loads of PCBs to San Francisco Bay

Santa Clara Valley
Urban Runoff Pollution Prevention Program

Prepared for the
Santa Clara Valley Urban Runoff Pollution Prevention Program

by

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EXECUTIVE SUMMARY

Fish tissue monitoring in San Francisco Bay has revealed bioaccumulation of polychlorinated biphenyls (PCBs) and other pollutants. The levels found are thought to pose a health risk to people consuming fish caught in the Bay. The San Francisco Bay Regional Water Quality Control Board has concluded that municipal stormwater discharges may contribute to this water quality problem. As part of its efforts to address PCBs in urban runoff and comply with related NPDES permit requirements, the Santa Clara Valley Urban Runoff Pollution Prevention Program prepared this review of information related to controlling stormwater discharges of PCBs in the Bay Area. The objectives were to:

- Summarize and discuss past, current and planned efforts to identify PCBs sources in Bay Area urban runoff and control options, including the PCBs case studies performed to-date by Bay Area stormwater management agencies.
- Describe existing Bay Area urban runoff management practices that may help control discharges of PCBs.
- Identify potential additional management practices for controlling discharges of PCBs in urban runoff and qualitatively discuss advantages and limitations of each practice.

During FY 2000/01 and 2001/02, local stormwater management agencies collaborated to perform surveys of concentrations of PCBs congeners and other pollutants of concern in embedded sediments collected from stormwater conveyances throughout the Bay Area. Total PCBs concentrations were highly variable in urban locations, but generally much higher than in open space areas. Individual stormwater programs subsequently performed case studies in selected urban areas with relatively elevated total PCBs concentrations to begin identifying sources and controls. The techniques employed included further collection and analysis of embedded sediment samples and research on historical and current land use. During FY 2001/02 and 2002/03, a total of seventeen areas were investigated. Despite high spatial and temporal variability in the concentrations of total PCBs and other pollutants, the results of the sediment surveys and case studies suggested that embedded sediment sampling can identify at least some drainage lines with relatively elevated levels of total PCBs and potentially point to source areas within these drainages. There are likely many on-land areas with elevated PCBs remaining in the Bay Area that have not yet been identified by the surveys and case study work to-date. The case studies also revealed that the utility of land use research to identify PCBs sources within watersheds with elevated field samples may be limited.

Bay Area stormwater management agencies currently implement a variety of management practices that may reduce discharges of PCBs from urban runoff conveyances. Among these practices that reduce sediment discharges from stormwater conveyances probably have the greatest potential to reduce discharges of PCBs. Bay Area stormwater program components most closely associated with sediment control are related to 1) municipal maintenance activities and 2) new development and construction controls. Sediment controls may also reduce discharges of other particle-bound pollutants of concern, including mercury, chlorinated pesticides, polycyclic aromatic hydrocarbons and dioxins.

Potential additional PCBs stormwater control options are described and some of their advantages, limitations and cost factors are qualitatively discussed, without attempting to quantify costs or
benefits. Eight options were identified and placed in three categories, soil/sediment cleanup, pollution prevention/source control, and stormwater treatment:

**Soil/Sediment Cleanup**

- Cleanup of Sites with PCBs in Erodible Soils
- Increased Removal of Sediments During Routine Maintenance of Storm Drain Systems
- Non-routine Removal of Sediments Containing PCBs from Stormwater Conveyances
- Natural Attenuation

**Pollution Prevention/Source Control**

- Voluntary Replacement of PCBs-containing Equipment
- Outreach to Parties Performing Demolition

**Stormwater Treatment**

- Stormwater Runoff Treatment Retrofits
- Diversion of Stormwater Flows to Wastewater Treatment Plants

PCBs are primarily a legacy pollutant. Pollution prevention/source control measures may therefore have less potential to reduce loads than intercepting existing reservoirs of PCBs in erodible soils and stormwater conveyance sediments via soil/sediment cleanup and/or stormwater treatment. One way to prioritize implementation of urban runoff controls for PCBs and other particle-bound pollutants of concern would be to focus efforts on watersheds discharging relatively high loads of pollutants. Characterization techniques better suited to estimating loads than embedded sediment sampling would allow for a more refined prioritization of watersheds and assessment of the effectiveness of new control measures. Widely implementing such methods, however, may be cost-prohibitive to Bay Area stormwater programs at the present time.

Further analysis of the feasibility of potential urban runoff PCBs control measures is also needed, including quantitative evaluation of costs and benefits. The level of uncertainty in such an evaluation will be reduced when additional local data on PCBs controls become available, such as the results of a current Clean Estuary Partnership study and upcoming Proposition 13-funded studies by the San Francisco Estuary Institute and the City of Oakland. Factors other than strict cost-effectiveness may also be important in assessing feasibility, such as the likelihood of identifying responsible parties or obtaining state or federal funding for identification and cleanup of on-land PCBs sites. The benefit of implementing strategies that address multiple sediment-bound pollutants should also be taken into consideration. Bay Area stormwater management agencies plan to continue working with San Francisco Bay Regional Water Quality Control Board staff in coordination with the Bay Area Stormwater Management Agencies Association, the Clean Estuary Partnership and the San Francisco Estuary Regional Monitoring Program to address controllable sources of PCBs and develop the urban runoff implementation plan of the Bay PCBs TMDL.
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INTRODUCTION

Fish tissue monitoring in San Francisco Bay has revealed bioaccumulation of polychlorinated biphenyls (PCBs) and other pollutants. The levels found are thought to pose a health risk to people consuming fish caught in the Bay. As a result of these findings, the Office of Environmental Health Hazard Assessment has issued an interim advisory on the consumption of fish from the Bay (OEHHA 1997, 1999). The advisory led to the Bay being designated an impaired water body on the 2002 Clean Water Act 303(d) list due to PCBs and other pollutants. In response, the California Regional Water Quality Control Board, San Francisco Bay Region (Regional Board) is developing Total Maximum Daily Load (TMDL) programs addressing PCBs and other pollutants found in the Bay. The general goal of the PCBs TMDL is to identify and control sources of PCBs to the Bay and improve water quality.

Bay Area municipal stormwater NPDES permits generally include language such as “the Regional Board finds that there is a reasonable potential that municipal stormwater discharges may cause or contribute to an excursion above water quality standards” of PCBs and other pollutants in the Bay. The Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) prepared this review of information related to controlling discharges of PCBs from Bay Area urban runoff conveyances. The intent is to provide information that will assist Regional Board staff and Bay Area stormwater management agencies develop the urban runoff implementation plan of the Bay PCBs TMDL. This review also contributes to implementation of the PCBs control program required by the SCVURPPP’s NPDES permit (Provision C.9.e).

The objectives of this review were to:

- Summarize and discuss past, current and planned efforts to identify PCBs sources in Bay Area urban runoff and control options, including the PCBs case studies performed to-date by Bay Area stormwater management agencies.
- Describe existing Bay Area urban runoff management practices that may help control discharges of PCBs.
- Identify potential additional management practices for controlling discharges of PCBs in urban runoff and qualitatively discuss advantages and limitations of each practice.

EFFORTS TO IDENTIFY PCBs SOURCES AND CONTROLS IN THE BAY AREA

PCBs were manufactured in the United States from 1929 to 1977. They were widely used by many industries because of their low electrical conductivity, high boiling point, chemical stability and flame retardant properties. The largest use of PCBs was in electrical equipment, including transformers and capacitors, but they were also widely used in a variety of other applications, including hydraulic fluids, dust control, flame retardants, lubricants, paints, sealants, wood preservatives, inks, dyes and plasticizers (Abbot 1993, Binational Toxics Strategy 1998 and 1999, EIP Associates 1997). PCBs have also been found in a variety of non-liquid materials, including construction materials such as insulation, roofing and siding materials (64 CFR Part 761). In 1979, the U.S. EPA banned the manufacture of PCBs in the United States. Their import, export and
distribution in commerce were also banned and PCBs uses were restricted to totally enclosed applications. The U.S. EPA has authorized other minor uses since that time, but the unavailability of PCBs and health and safety concerns effectively ended their use in new applications (Binational Toxics Strategy 1998, EIP Associates 1997).

PCBs are often referred to as a “legacy” pollutant, meaning there are relatively few current uses, but past uses have left large amounts in the environment. Based on sediment chemical analysis data described later, the widespread historic use of PCBs apparently resulted in releases to soils and storm drains in the Bay Area. Since PCBs are highly persistent and associate with particulate matter, soils and accumulated storm drain sediments potentially contain PCBs released many years ago. Potential pathways for PCBs to have entered soils and storm drains include intentional or unintentional aboveground historic releases and illicit connections to storm drain lines. For example, the use of hydraulic fluids containing PCBs had significant potential to result in releases to the environment, since hydraulic systems were designed to leak slowly to provide lubrication (Binational Toxics Strategy 1998). Because the use of PCBs is currently limited and strictly regulated, the potential for new releases to the environment has probably greatly diminished.

The following sections summarize Bay Area efforts to characterize PCBs in urban runoff, develop a better understanding of their sources and identify management strategies.

BASMAAA Agency Sediment Surveys

Several agencies1 from the Bay Area Stormwater Management Agencies Association (BASMAA) recently collaborated to measure concentrations of PCBs and other pollutants of concern in embedded sediments collected from stormwater conveyances. The primary goal was to characterize the distribution of pollutants among land uses in watersheds draining to the Bay. This two-year field study was coordinated by the SCVURPPP and is referred to as the Joint Stormwater Agency Project (JSAP). The fieldwork was conducted during the fall of 2000 and 2001. An analysis of both years of data revealed that median PCBs concentrations normalized to fines (less than 62.5 microns) were over 100 times higher in samples from urban sites compared to open space sites. Concentrations of PCBs were highly variable in urban samples, with relatively elevated concentrations found in some samples. Statistically significant differences in normalized concentrations of PCBs were not found between industrial and residential/commercial sites. The study also developed order-of-magnitude estimates of urban runoff PCBs loads from the surrounding watersheds to the Bay (KLI 2001 and 2002).

The Alameda Countywide Clean Water Program (ACCWP) conducted a two-year watershed embedded sediment sampling survey in Alameda County in parallel with the JSAP regional survey (Gunther et al. 2001, Salop et al. 2002a). In contrast to the JSAP, most samples were collected at the bottom of watersheds and integrated a variety of upstream land uses. The study concluded that concentrations of pollutants such as PCBs in embedded sediments are useful for detecting order-of-magnitude differences among watersheds. Priority watersheds in Alameda County for further investigation were identified based on this approach.

Individual BASMAAA Agencies Activities

During FY 2001/02, Bay Area stormwater management agencies began performing case studies

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1 The participating agencies were: Santa Clara Valley Urban Runoff Pollution Prevention Program, Contra Costa Clean Water Program, San Mateo Countywide Stormwater Pollution Prevention Program, Marin County Stormwater Pollution Prevention Program, Vallejo Sanitation and Flood Control District, and Fairfield-Suisun Sewer District.
in some areas where relatively elevated PCBs were found during the above JSAP regional survey and the Alameda County survey.\textsuperscript{2} The primary goals were to develop methods to identify PCBs sources and begin to identify measures to address any controllable sources found. It was intended that the methodologies developed and lessons learned would assist development of the urban runoff implementation plan of the Bay PCBs TMDL. During FY 2001/02 and 2002/03, a total of seventeen areas were investigated. The techniques employed included collection and analysis of embedded stormwater conveyance sediment samples and research on historical and current land use.

Figures 1 through 5 show the general locations of each case study. Table 1 summarizes the study locations, primary land uses in the study areas, range of PCBs concentrations found, and any potential source areas identified. It should be emphasized that the potential source areas listed in Table 1 were identified based on preliminary findings and have not been confirmed. In addition, other source areas may exist in a drainage apart from those listed.

The PCBs case studies and other PCBs-related activities conducted by individual Bay Area stormwater management agencies are described in the following sections.

Alameda Countywide Clean Water Program

The Alameda Countywide Clean Water Program (ACCWP) completed source investigations in two areas during FY 2001/02 (Salop et al. 2002b). The study areas were the Glen Echo Creek and Ettie Street pump station watersheds, both located in the City of Oakland (Figure 1 and Table 1). Embedded sediment samples were collected and analyzed for PCBs and mercury. Since this review focuses on PCBs, the mercury results are not discussed here.

Land use in the Glen Echo Creek watershed is mainly residential and commercial. Total PCBs found in sediments collected from this watershed ranged from approximately 100 to 300 ug/Kg. The spatial distribution of PCBs concentrations suggested a source of PCBs to Glen Echo Creek in an area spanned by less than ten city blocks, but specific sources were not identified.

The Ettie Street watershed contains mixed land uses, including industrial, commercial and residential areas. PCBs were found at much higher concentrations in sediments collected from the detention basin of the pump station at the bottom of this watershed than in any other watershed in Alameda County (Gunther et al. 2001, Salop et al. 2002a). The ACCWP subsequently conducted two phases of sediment sampling and analysis in storm drain systems draining to the pump station, in an attempt to identify important source areas. Total PCBs found in sediments collected throughout the watershed ranged from approximately 25 to 3,300 ug/Kg. A linear regression model based on PCBs congener concentrations in the samples suggested one general area within the watershed (located adjacent to Peralta Avenue at Louise Street and 30th Avenue) might contribute the greatest loading to the pump station. The investigation results also suggested, however, that other source areas exist within the watershed. Specific sources of PCBs to storm drains were not identified. The City of Oakland has been awarded a Proposition 13 grant to attempt to identify specific sources of PCBs in the Ettie Street watershed and initiate cleanups. The project will include inspections of industrial facilities, additional targeted sampling and analysis, abatement activities and targeted public outreach (City of Oakland 2002). It is anticipated that the project will commence during 2004 (Feng 2003, personal communication).

\textsuperscript{2} The Marin County Stormwater Pollution Prevention Program and Fairfield-Suisun Sewer District have not performed PCBs case studies to-date because relatively elevated PCBs levels were not found in these jurisdictions during the JSAP regional sediment survey.
Figure 1. General Locations of PCBs Case Studies in Alameda County.
Figure 2. General Locations of PCBs Case Studies in Contra Costa County.
Figure 3. General Locations of PCBs Case Studies in City of San Jose.
Figure 5. General Locations of PCBs Case Studies in City of Vallejo.
Table 1. Summary of Bay Area Stormwater Program PCBs Case Studies

<table>
<thead>
<tr>
<th>Case Study Name</th>
<th>County</th>
<th>City</th>
<th>Primary Land Uses</th>
<th>Range of Total PCBs Concentrations in Embedded Sediments (ug/Kg)</th>
<th>Potential Source Areas Identified¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glen Echo Creek</td>
<td>Alameda</td>
<td>Oakland</td>
<td>COM, RES</td>
<td>~100 - 300</td>
<td>Unidentified location(s) within span &lt;10 city blocks.</td>
</tr>
<tr>
<td>Ettie St. Pump Station</td>
<td></td>
<td></td>
<td>IND, COM, RES</td>
<td>~25 - 3,300</td>
<td>Area adjacent to Peralta Ave. at Louise St. &amp; 30th Ave.</td>
</tr>
<tr>
<td>Lower Rheem Creek</td>
<td>Contra Costa</td>
<td>San Pablo</td>
<td>IND</td>
<td>41 - 196</td>
<td></td>
</tr>
<tr>
<td>Drainage Area 114</td>
<td></td>
<td></td>
<td>IND</td>
<td>30 - 165</td>
<td></td>
</tr>
<tr>
<td>Cutting Blvd.</td>
<td></td>
<td></td>
<td>IND</td>
<td>98 - 2,255</td>
<td></td>
</tr>
<tr>
<td>Wright Ave.</td>
<td></td>
<td></td>
<td>IND</td>
<td>151 - 1,153</td>
<td></td>
</tr>
<tr>
<td>Leo Ave.²</td>
<td>Santa Clara</td>
<td>San Jose</td>
<td>IND</td>
<td>1 - 19,836</td>
<td>Union Pacific railroad track right-of-way.</td>
</tr>
<tr>
<td>Burke St.²</td>
<td></td>
<td></td>
<td>IND</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>Sunol St./ Auzerais Ave.³</td>
<td>Solano</td>
<td>Vallejo</td>
<td>IND</td>
<td>10 - 46</td>
<td></td>
</tr>
<tr>
<td>W. Home St.³</td>
<td></td>
<td></td>
<td>IND</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Old Oakland Rd.</td>
<td></td>
<td></td>
<td>IND, COM, RES</td>
<td>2 - 328</td>
<td></td>
</tr>
<tr>
<td>Monterey Hwy.</td>
<td></td>
<td></td>
<td>IND</td>
<td>43 - 1,215</td>
<td></td>
</tr>
<tr>
<td>South Maple Pump Station</td>
<td>San Mateo</td>
<td>S. San Francisco</td>
<td>IND</td>
<td>70 - 2,719</td>
<td>245 Spruce Ave. property.</td>
</tr>
<tr>
<td>Bradford Pump Station</td>
<td></td>
<td>Redwood City</td>
<td>COM</td>
<td>2 - 339</td>
<td></td>
</tr>
<tr>
<td>Broadway Pump Station</td>
<td></td>
<td></td>
<td>IND, COM, RES</td>
<td>14 - 116</td>
<td></td>
</tr>
<tr>
<td>Pulgas Creek Pump Station</td>
<td>San Carlos</td>
<td></td>
<td>IND</td>
<td>30 - 11,521</td>
<td>1. PG&amp;E Substation 2. 977 Bransten Rd. property</td>
</tr>
<tr>
<td>Nebraska St.</td>
<td>Solano</td>
<td>Vallejo</td>
<td>RES</td>
<td>65 - 2,055</td>
<td></td>
</tr>
</tbody>
</table>

Notes:

IND - Industrial  
COM - Commercial  
RES - Residential  

1. The potential source areas listed in this table are based on preliminary findings and have not been confirmed. Other source areas may exist in the drainages where potential source areas are listed.
2. A composite sample from the Leo Ave. and Burke St. areas contained 26,746 ug/Kg total PCBs.
3. Duplicate composite samples from the Sunol St./ Auzerais Ave. and W. Home St. areas contained 133 and 654 ug/Kg total PCBs.
The ACCWP is also currently conducting a preliminary evaluation of some types of source control options for particle-bound pollutants of concern such as PCBs (Salop and Akashah, in preparation). The objective is to begin assessing some urban runoff-related implementation options for Bay Area TMDLs. The study does not include any fieldwork, but instead relies on existing information. It focuses on three general areas:

1. Investigating tools to identify and prioritize potential source areas of pollutants of concern. The focus is on evaluating regulatory agency contaminant site databases. The study is also developing criteria for prioritizing known sites and targeting watersheds for source identification and abatement.

2. Reviewing some remedial options at source areas to prevent or minimize discharges of pollutants to stormwater conveyances. The study is reviewing the source investigations in Alameda County described above (i.e., the Glen Echo Creek and Ettie Street watershed investigations) and associated costs. The study is also reviewing site cleanups in general, including cleanup standards, types of cleanups and example cleanups in the Bay Area, including available cost information.

3. Investigating some options to control pollutants that have already entered stormwater conveyances. The study is developing estimates of pollutant mass removed during current routine maintenance practices that remove sediment, such as inlet/catch basin cleaning, street sweeping and channel desilting. The study is also evaluating potential changes to maintenance practices that could increase sediment removal, and, when appropriate data are available, estimating associated costs and additional pollutant mass removed. Potential changes to maintenance practices include technological modifications (e.g., installing and maintaining structures such as filters, swales and detention ponds) and operational modifications (e.g., increased frequency of inlet/catch basin cleaning, street sweeping and channel desilting).

The ACCWP anticipates completing the study during the fall of 2003 (Salop 2003, personal communication).

Contra Costa Clean Water Program

The Contra Costa Clean Water Program (CCCWP) performed PCBs case study work in four primarily industrial areas in Contra Costa County during the past two years (Figure 2 and Table 1). During FY 2001/02, the CCCWP investigated an area designated Lower Rheem Creek in San Pablo and an area designated Drainage Area 114 in Richmond (CCCWP 2002). The CCCWP investigated two additional areas in the City of Richmond during FY 2002/03, one in the vicinity of Cutting Boulevard and the other in the vicinity of Wright Avenue (KLI 2003a). The investigations included sampling embedded storm drain sediments and analysis of PCBs congeners, land use analysis and identification of known and potential PCBs use and/or release sites.

Total PCBs found in sediments ranged from 41 to 196 ug/Kg in the Lower Rheem Creek area, 30 to 165 ug/Kg in Drainage Area 114, 98 to 2,255 ug/Kg in the Cutting Boulevard area, and 151 to 1,153 ug/Kg in the Wright Avenue area. The CCCWP has not identified specific sources of PCBs in the four areas investigated, but plans to work with City of Richmond staff to formulate next steps at the Cutting Boulevard and Wright Avenue sites.
During the past three years, the SCVURPPP prepared work plans that included scopes of work for each year of the JSAP sediment survey, guidance on performing FY 2001/02 PCBs case studies, a preliminary list of known sites where PCBs were used, stored and/or released in Santa Clara County, and preliminary tables summarizing PCBs control options (SCVURPPP 2000, 2001, 2002a and 2002b). The SCVURPPP also prepared an updated guidance document to assist Bay Area stormwater management agencies performing PCBs case studies during FY 2002/03 (SCVURPPP 2002c). In addition, during the past three years the SCVURPPP has coordinated a work group of representatives from BASMAA and Regional Board staff. This work group, which is designated the BASMAA PCBs work group, has met periodically to facilitate information sharing, coordinate field activities and plan regionally. A SCVURPPP staff also represents BASMAA on the Clean Estuary Partnership PCBs work group.

The SCVURPPP and the City of San Jose performed PCBs case study work during the past two years in six areas in San Jose (Figure 3 and Table 1) designated the Leo Avenue, Burke Street, West Home Street, Sunol Street/Auzerais Avenue, Monterey Avenue and Old Oakland Road areas (City of San Jose and EOA, Inc. 2002 and 2003). Land use was primarily industrial in the study areas, with the exception of the vicinity of Old Oakland Road, which had mixed land uses. Embedded storm drain sediment samples (and in some case surface sediments and soils) were tested for PCBs congeners.

Total PCBs found in sediments ranged from 10 to 90 ug/Kg in the Burke Street, West Home Street and Sunol Street/Auzerais Avenue areas. Total PCBs concentrations found in the initial samples collected from the Monterey Highway and Old Oakland Road areas during the JSAP regional survey were 1,215 and 328 ug/Kg, respectively. Samples collected during the subsequent case studies in these areas, which included resampling the initial sample locations, had lower total PCBs, ranging from 43 to 147 ug/Kg in the Monterey Highway area and 2 to 13 ug/Kg in the Old Oakland Road area.

Relatively elevated levels of PCBs (as high as 19,836 ug/Kg) have consistently been found in the Leo Avenue area. Additional research was therefore conducted on this area, including additional sediment sampling during the second year of case study work, and analysis of current and historical land uses, stormwater-related violations and hazardous materials use. The spatial distribution of PCBs concentrations coupled with an analysis of PCBs homolog distributions suggested that the Union Pacific railroad track right-of-way adjacent to Leo Avenue is the current major source of sediments with PCBs found in the storm drain line beneath Leo Avenue. Other potential sources of PCBs included historical activities at other properties adjacent to Leo Avenue, though specific evidence of PCBs use or release has not been found. During July 2003, the SCVURPPP and the City of San Jose requested that the Regional Board work with Union Pacific Railroad to investigate the possibility that PCBs from the right-of-way have entered storm drains (SCVURPPP 2003a). The City of San Jose also plans to perform the following additional actions during FY 2003/04:

- Investigate prevention of vehicular traffic between the railroad track right-of-way and Leo Avenue.

3 A composite sample collected from the Leo Avenue and Burke Street areas during the JSAP regional sediment survey contained 26,746 ug/Kg total PCBs. Duplicate composite samples from the Sunol St./Auzerais Avenue and W. Home Street areas, also collected during the JSAP survey, contained 133 and 654 ug/Kg total PCBs.
• Perform additional inspections of industrial facilities on Leo Avenue.

• Continue reviewing Santa Clara County Department of Health and San Jose Fire Department toxic material records and the last three years of facility inspection and Illegal Connections/Illlicit Discharges reports on Leo Avenue properties.

The SCVURPPP also tested sediment samples from Berryessa Creek, Lower Silver Creek, Lower Penitencia Creek and Upper Penitencia Creek for PCBs and other pollutants of concern during its FY 2002/03 surface water monitoring program (SCVURPPP 2003b). The concentrations detected in these samples were all relatively low (less than 20 ug/kg total PCBs).

San Mateo Countywide Stormwater Pollution Prevention Program

During the past two years, the San Mateo Countywide Stormwater Pollution Prevention Program (SMSTOPPP) has compiled a preliminary list of known PCBs use and/or release sites in San Mateo County (SMSTOPPP 2002a) and completed PCBs case study work in four areas (Figure 4 and Table 1). The case studies investigated the Bradford and Broadway pump station drainages in Redwood City, the South Maple pump station drainage in South San Francisco and the Pulgas Creek pump station drainage in San Carlos (SMSTOPPP 2002b and 2003a). Land use is industrial in the South Maple and Pulgas Creek drainages, commercial in the Bradford drainage and mixed in the Broadway drainage.

Total PCBs concentrations found in sediments collected from the Bradford and Broadway pump station sumps during the JSAP regional survey were 339 and 116 ug/Kg, respectively. Samples collected during the subsequent Bradford and Broadway case studies, which included resampling the pump station sumps, had somewhat lower total PCBs, ranging from 2 to 124 ug/Kg in the Bradford drainage and 14 to 93 ug/Kg in the Broadway drainage.

In the South Maple pump station drainage, total PCBs have been found at 70 to 2,719 ug/Kg. The sample with 2,719 ug/Kg PCBs was collected from a storm drain inlet on a private property located at 245 Spruce Avenue in South San Francisco. Due to this relatively elevated concentration, SMSTOPPP investigated current and historical land use of this property. The research revealed historical activities that could have included use of PCBs. However, the activities identified are common in industrial areas (e.g., use of hydraulic oils4) and direct evidence of PCBs use or release was not found.

PCBs were detected at 30 to 11,521 ug/Kg in embedded storm drain and creek sediment samples collected from the Pulgas Creek pump station drainage. SMSTOPPP contacted selected regulatory agencies in an attempt to identify any known PCBs use, storage and/or release sites in this drainage. Based on the results of the field sampling and the agency research, two potential sources of PCBs to storm drains in the study area were identified: a PG&E substation and a soil and groundwater investigation and remediation site with PCBs and other pollutants at 977 Bransten Road in San Carlos. However, even if the substation and the 977 Bransten Road property were confirmed as source areas, the investigation results suggested that there are other sources of PCBs in the study area, given the widespread spatial distribution of PCBs found in storm drain sediments.

During June 2003, SMSTOPPP requested that Regional Board staff work with the appropriate parties to investigate the possibility that PCBs from the 245 Spruce Avenue property in South San

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4 One historic use of PCBs was in hydraulic oils.
Francisco and the PG&E substation and the 977 Bransten Road property in San Carlos have entered storm drains. A similar request was also made with regard to another property, commonly referred to as the Delta Star property, which is located in San Carlos outside of the Pulgas Creek pump station drainage (SMSTOPPP 2003b). Relatively elevated levels of PCBs were found in storm drain sediments collected downstream of this site during the JSAP regional sediment survey. PCBs transformers were formerly manufactured at this site and PCBs had been found in soil and groundwater there before the JSAP survey. The Regional Board is overseeing a site cleanup.

During FY 2003/04, SMSTOPPP plans to perform additional case study work in the vicinity of Colma Creek, another location where elevated levels of PCBs were found during the JSAP survey.

Vallejo Sanitation and Flood Control District

The Vallejo Sanitation and Flood Control District (VSFCD) performed a PCBs case study in the City of Vallejo during FY 2002/03 (Figure 5 and Table 1) (KLI 2003b). The case study was performed as a follow-up to relatively elevated concentrations of total PCBs found in sample VFC-006 (1,259 ug/Kg) collected in the vicinity of Nebraska Street in Vallejo during October 2001 as part of the JSAP regional survey.

During October 2002, VFC-006 was re-sampled and total PCBs were found at 2,055 ug/Kg. Sediment appeared to have accumulated over time in the storm drain line in the vicinity of the manhole where VFC-006 was collected; approximately 1 to 1.5 feet of sediment were noted at the VCF-006 location at the time of sampling. Additional embedded sediment samples were collected upstream of VFC-006 from two branches of the storm drain system. Total PCBs concentrations ranged from 65 to 1,729 ug/Kg in the four samples collected from the first branch. One sample and a field duplicate were collected from the second branch. PCBs concentrations were 78 and 183 ug/Kg.

The source of the PCBs found in the storm drain sediments in the Nebraska Street area is currently unknown. Land use in the area is mainly residential. Based on the spatial distribution of PCBs in the sediment samples, the first storm drain branch described above appeared to be associated with a more significant source area. An assessment of the distribution of PCBs homologs in the case study samples did not provide any information useful for tracking sources.

Railroad Track Right-of-Ways

McMurtry 2001 reported “PCBs in the railroad industry were reportedly used only for transformers. However, a local transportation agency staff person said that a study of local railroad corridors in the mid-1990s found PCBs all along the track right-of-way.” This information, coupled with evidence discussed above that sediment from the Union Pacific right-of-way adjacent to Leo Avenue in San Jose contain PCBs, led some Bay Area stormwater management agencies to incorporate sampling of areas draining railroad track right-of-ways into their case studies during FY 2002/03.

The data gathered since that time generally do not implicate railroad track right-of-ways as major source areas of PCBs. With the exception of the Leo Avenue area, PCBs concentrations were not particularly elevated (less than 200 ug/Kg) in samples collected in the vicinity of railroad tracks during case studies in San Carlos, San Jose, Richmond and Vallejo (SMSTOPPP 2003, City of San Jose and EOA, Inc. 2003 and KLI 2003a and b). Furthermore, the author of the above report later stated that subsequent research revealed that polycyclic aromatic hydrocarbons (PAHs),
rather than PCBs, were found in the investigation of the railroad corridor (McMurtry 2002, personal communication).

Silicon Valley Toxics Coalition Study

The Silicon Valley Toxics Coalition (SVTC) teamed with Pioneer High School in San Jose and the City of San Jose’s Environmental Services Department to monitor PCBs in resident and transplanted clams during an 11-week period beginning in May 2000 (McMurtry 2001). Goals of the study included evaluating whether transplanted clams could be useful in identifying stream segments with elevated PCBs and focusing efforts to identify PCBs sources in local watersheds. Five locations in Santa Clara County were monitored: three in the Guadalupe River watershed, one in Coyote Creek and one in the Sunnyvale East Channel. Lipid-normalized PCBs concentrations in clams varied by as much as an order-of-magnitude. PCBs congener patterns were generally similar among the samples, with the exception of the most upstream sampling location in the Guadalupe River watershed. The study report discusses potential source areas, but concludes that additional sampling would be needed to draw any conclusions about sources.

A map was also prepared during the study that shows the location of potential industrial users of PCBs in the study area and where stormwater runoff from these sites is discharged to Guadalupe River or Coyote Creek. General categories of industries that potentially used PCBs were compiled during development of the map. Potential PCBs user locations were then mapped by geocoding addresses found in 1955 and 1964 local city directories of specific companies that appeared to fall under these categories.

Clean Estuary Partnership

The Clean Estuary Partnership is currently conducting a study that will evaluate methods to reduce urban mercury stormwater loads. The results of the study will assist efforts to control other pollutants such as PCBs, since many of the control strategies evaluated would address multiple sediment-bound pollutants. The study tasks are:

- Performing a literature review on strategies available to urban runoff programs to reduce loads, their effectiveness, and associated costs.
- Preparing an inventory of control strategies currently implemented in the Bay Area.
- Developing a methodology to estimate potential mercury load reductions (and reductions of other particle-bound pollutants such as PCBs where feasible) through implementation of control strategies.
- Developing order-of-magnitude estimates of potential load reductions through implementation of existing control strategies and forecasting how expanding the use of existing strategies or implementing new strategies may increase potential load reductions.

Grant Program Applications

The San Francisco Estuary Institute (SFEI) recently received notification of success on a Proposition 13 Coastal Non-point Source Pollution Grant proposal submitted to the consolidated grant program last October (SFEI 2003). The project will help develop methods to quantify and control stormwater loads of PCBs, mercury and other pollutants to surface waters in California.
The project was funded for the full amount proposed ($1.32 million) and will be implemented over the period from mid 2004 to early 2007.

The technical approach of the project includes four general tasks aimed at gathering data useful to the Bay TMDL efforts:

- Developing GIS coverages of urban storm conveyances in selected areas draining to San Francisco Bay.
- Developing modeling methods to extrapolate estimates of pollutant loadings from spatially and temporally limited existing data, including local suspended sediment concentrations, pollutant concentrations in sediment, rainfall, geology, geomorphology and land use.
- Reviewing current methods used to reduce stormwater pollutant loadings in the Bay Area, and, when data are available, the effectiveness and implementation costs of the methods.
- Quantitatively evaluating the efficiency of stormwater pollutant controls through modeling and field monitoring.

BASMAA is currently working with SFEI to develop an appropriate project oversight committee.

EXISTING URBAN RUNOFF MANAGEMENT PRACTICES THAT MAY HELP CONTROL PCBs

Bay Area stormwater management agencies currently implement a variety of management practices that may reduce discharges of PCBs from urban runoff conveyances. Among these, practices that reduce sediment discharges from stormwater conveyances probably have the greatest potential to reduce discharges of PCBs. Sediment controls may also reduce discharges of other particle-bound pollutants of concern, including mercury, chlorinated pesticides, PAHs and dioxins. Bay Area stormwater program components most closely associated with sediment control are related to 1) municipal maintenance activities and 2) new development and construction controls.

Municipal Maintenance Activities

The municipal maintenance component of stormwater programs is designed to maximize removal of pollutants and minimize discharge of pollutants to storm drains during municipal operations. Bay Area stormwater programs educate municipal staff on pollution prevention, including best management practices for corporation yards. Maintenance activities typically must meet performance standards designed to maximize pollutant removal during the following activities:

- Street sweeping.
- Storm drain facility inspections and maintenance (e.g., removal of solids from storm drain system inlets, piping and detention basins).
- Channel desilting operations.

Some mass of sediment and associated particle-bound pollutants, including PCBs, are removed during these activities. As discussed previously, the ACCWP is developing estimates of pollutant
mass removed during some routine maintenance practices. The estimates will be based on ranges of pollutant concentrations derived from recent sediment studies by BASMAA agencies.

**New Development and Construction Controls**

This stormwater program component is designed to reduce or eliminate pollutant discharges and minimize increases in runoff flows and volumes associated with development. During construction, municipalities typically require developers to prepare a Stormwater Pollution Prevention Plan (SWPPP). The SWPPP includes actions to eliminate non-stormwater discharges from construction sites and minimize or eliminate discharges of pollutants in stormwater runoff. Municipalities typically perform construction site inspections to verify SWPPP implementation and educate developers and municipal staff, including construction site inspectors, on proper management practices. A principal goal of construction controls is to minimize erosion and discharges of sediment to storm drains and creeks.

Bay Area municipal stormwater NPDES permits have recently been or are being amended to expand requirements related to new and redevelopment (“C.3 Provisions”). The new requirements emphasize site planning and design to minimize increases in stormwater runoff flows and volumes and incorporation of standards for stormwater treatment measures to reduce pollutants. Typical measures include minimization of impervious surfaces and some combination of filtration, detention and/or infiltration of runoff. Such stormwater treatment measures may remove sediment and associated pollutants. However, new sites in previously undeveloped areas would have low potential to discharge significant loads of PCBs, since PCBs uses are currently very limited. PCBs discharges are more likely in older urban areas, which are generally built-out. C.3 Provisions are only implemented in these areas when redevelopment occurs.

**Other Activities**

Other typical Bay Area stormwater program components include illicit discharge controls, industrial/commercial facility inspections and public outreach. Typical facets of these components that have some potential to reduce PCBs discharges include:

- Responding to reports of illicit discharges, conducting illicit discharge field investigations and performing enforcement activities.
- Inspecting industrial and commercial facilities and performing enforcement activities as needed.
- Sponsoring and/or coordinating with household hazardous waste collection programs.
- Educating the public and businesses about stormwater pollution prevention and control and encouraging participation in related efforts.

The potential for these activities to control PCBs may be limited, since the current use of PCBs is limited and strictly regulated by the U.S. EPA.
POTENTIAL ADDITIONAL URBAN RUNOFF CONTROLS FOR PCBs

Criteria typically used to evaluate the effectiveness of stormwater pollution prevention and control measures include:

- Effectiveness at preventing a pollutant from entering stormwater runoff (i.e., pollution prevention or source control).
- Effectiveness at removing a pollutant from or changing the characteristic of a stormwater discharge (i.e., stormwater treatment).
- The effect that reducing the input or changing a characteristic of a pollutant has on the beneficial uses of receiving waters.
- Practicability (e.g., capital and operational costs, institutional and siting constraints).

Because relevant site-specific data are sparse, it would likely be difficult to quantitatively apply such evaluation criteria to current or potential new urban runoff PCBs controls in the Bay Area. This review instead describes selected potential PCBs stormwater control options and qualitatively discusses some of their advantages, limitations and cost factors, without attempting to quantify costs or benefits. Eight options were identified and placed in three categories: soil/sediment cleanup, pollution prevention/source control, and stormwater treatment.

Soil/Sediment Cleanup

- Cleanup of Sites with PCBs in Erodible Soils
- Increased Removal of Sediments During Routine Maintenance of Storm Drain Systems
- Non-routine Removal of Sediments Containing PCBs from Stormwater Conveyances
- Natural Attenuation

Pollution Prevention/Source Control

- Voluntary Replacement of PCBs-containing Equipment
- Outreach to Parties Performing Demolition

Stormwater Treatment

- Stormwater Runoff Treatment Retrofits
- Diversion of Stormwater Flows to Wastewater Treatment Plants

The following sections describe each option; Table 2 summarizes this information.

Cleanup of Sites with PCBs in Erodible Soils

The erosion of soils containing PCBs from historic releases is potentially a significant ongoing source of PCBs to stormwater conveyances. PCBs were used widely in the past in urban areas.

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5 Strategies to remediate sediments that have already entered the Bay, such as in-Bay capping and dredging and disposal, are not considered here.

6 The sediment cleanup and stormwater treatment options would also potentially help control other particle-bound pollutants of concern such as mercury, chlorinated pesticides, PAHs and dioxins.
and are highly persistent in the environment. PCBs released many years ago are therefore potentially present in urban soils today. This strategy would employ land use research and field investigations to identify on-land reservoirs of PCBs in erodible soils. These sites would then be prioritized and selected sites remediated. A typical site cleanup methodology for PCBs is excavation of soil followed by offsite disposal at a Class I or II landfill, depending on the concentrations of PCBs present.

This approach would have the advantage of reducing new inputs of PCBs to storm water conveyances. Such measures are generally preferable to attempting to treat or remove pollutants that have already entered the storm drain system. A limitation is that identifying all areas with PCBs in erodible soils would likely be difficult, since PCBs use was formerly unregulated and widespread. As discussed previously, preliminary methods to identify known or potential PCBs use and/or release sites have been developed by the SCVURPPP, SMSTORP and the SVTC. The ACCWP is also currently investigating such techniques for PCBs and other pollutants of concern.

Known release sites often are in the process of investigation and cleanup or may have already been remediated to a standard deemed acceptable by the regulatory agency providing oversight. Cleanups are generally intended to be protective of criteria such as human health, wildlife and water quality in the vicinity of a site. Unfortunately, such cleanups may not be protective of beneficial uses in the Bay, especially uses impaired by bioaccumulation of pollutants in the food web.

Costs associated with this approach would include identifying sites with PCBs in erodible soils and cleanup of selected sites. Cleanup costs would depend on many factors, including the extent and concentrations of PCBs (and possibly other pollutants) at each site, the number of cleanups performed, and the cleanup standard chosen. Cleanups would be prioritized based on criteria such as mass of PCBs present, mobilization potential, proximity to storm drains, anticipated costs and whether a responsible party could be identified. Responsible parties would ideally perform remediations, but their identification would likely be difficult in many cases. In general, cleanups would be facilitated by regulatory programs or funding mechanisms separate from urban runoff programs (e.g., CERCLA, Proposition 13, State Cleanup and Abatement Account).

Immobilizing erodible soils with PCBs is potentially a lower cost alternative to excavation and disposal. This strategy is often referred to as capping, and involves creating a physical barrier (e.g., paving) that would prevent pollutant mobilization and exposure of humans and wildlife to pollutants. A limitation that this approach shares with treatment or removal is that identifying all areas with PCBs in erodible soils would likely be difficult. Another limitation is that leaving PCBs in place might require placing deed restrictions on future uses of a property. In addition, capping surfaces may conflict with new and redevelopment site design goals that emphasize minimization of imperviousness. As with treatment or removal of soils, responsible parties would ideally perform the work, but their identification would likely be difficult in many cases.
Table 2. Preliminary Comparison of Potential Options to Reduce Discharges of PCBs from Urban Runoff Conveyances

<table>
<thead>
<tr>
<th>Control Option</th>
<th>General Description</th>
<th>Advantages</th>
<th>Limitations</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soil/Sediment Cleanup</strong></td>
<td>Identify urban areas where erodible soils contain PCBs and request cleanup under regulatory programs or funding mechanisms separate from municipal stormwater programs (e.g., CERCLA, Proposition 13, State Cleanup and Abatement Account). Typical remedial strategies would include excavation and proper disposal and immobilization of erodible soils (capping).</td>
<td>Would reduce new inputs of PCBs to storm drain conveyances.</td>
<td>Identifying all areas with PCBs in erodible soils would likely be difficult, since PCBs use was formerly unregulated and widespread. Capping may restrict future property uses and conflict with new and redevelopment site design goals that emphasize minimization of imperviousness.</td>
<td>Cleanup costs would depend on factors such as the extent and concentrations of PCBs (and possibly other pollutants) at each site and the cleanup standard chosen. Responsible parties would ideally perform cleanups, but their identification would likely be difficult in many cases. Cleanups would be prioritized based on criteria such as mass of PCBs present, mobilization potential, proximity to storm drains, anticipated costs and whether a responsible party could be identified.</td>
</tr>
<tr>
<td>Cleanup of sites with PCBs in erodible soils.</td>
<td></td>
<td>Build on established practices already implemented in the Bay Area. Would potentially reduce loadings of other pollutants of concern.</td>
<td>Most potential modifications would not reduce new inputs of PCBs to stormwater conveyances.</td>
<td></td>
</tr>
<tr>
<td>Increased removal of sediments during routine municipal maintenance activities.</td>
<td>Modify routine maintenance practices to increase removal of sediment and associated particle-bound pollutants. Potential modifications would include increasing the frequency of inlet/catch basin cleaning, street sweeping and channel desilting.</td>
<td>Would directly remove PCBs and potentially other pollutants of concern from stormwater conveyances.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-routine removal of sediments containing PCBs from stormwater conveyances.</td>
<td>Identify stormwater conveyances with accumulated sediments containing PCBs. Perform targeted dry season sediment removals with proper disposal. In general, the fieldwork would not be associated with routine municipal maintenance practices and would require extra mobilization of labor and equipment.</td>
<td></td>
<td>Periodic removal actions might be needed if there are ongoing inputs of PCBs to a storm drain conveyance. In some creeks and flood control channels removal of sediment would conflict with regulations designed to protect in-channel habitat.</td>
<td>Identification and abatement of any ongoing inputs would be desirable before performing removal actions. On the other hand, removing sediments and then testing new sediments that accumulate might help determine whether there are continuing inputs to the system.</td>
</tr>
</tbody>
</table>
### Table 2. Preliminary Comparison of Potential Options to Reduce Discharges of PCBs from Urban Runoff Conveyances (cont.)

<table>
<thead>
<tr>
<th><strong>Control Option</strong></th>
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<th><strong>Limitations</strong></th>
<th><strong>Comments</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural attenuation.</td>
<td>Allow PCBs in soils and accumulated stormwater conveyance sediments to naturally degrade or be flushed through the system.</td>
<td>The only costs incurred would be for periodic monitoring to evaluate whether concentrations were declining in urban runoff.</td>
<td>Since PCBs degrade very slowly in the environment, a prohibitively long time period might be required for concentrations to attenuate to acceptable levels. Would not address any new inputs to soils or stormwater conveyances, and would not reduce loadings to the Bay on the short term.</td>
<td>No actions would be taken except periodic monitoring.</td>
</tr>
</tbody>
</table>

**Pollution Prevention/Source Control**

| **Voluntary replacement of PCBs-containing equipment.** | Perform targeted outreach on identifying equipment with PCBs, obtaining suitable replacements and proper decommissioning methods. Potentially develop regulatory incentives to make equipment replacement more attractive to facility owners. | Would potentially reduce new inputs of PCBs to the environment and storm drain conveyances. Would reduce potential liability to equipment owners associated with accidental PCBs releases and health and safety concerns. New equipment would also potentially reduce facility operation and maintenance costs (e.g., modernizing electrical equipment could result in energy savings). | Since the use of PCBs is currently limited and strictly regulated, the mass of PCBs that could potentially be released to the environment from PCBs-containing equipment may be relatively small. Replacement of such equipment may therefore have only a limited potential benefit. There is also a risk of releases to the environment and human exposure during equipment replacement. | Potential costs would include developing and distributing outreach materials and developing and implementing regulatory incentives to replace PCB-containing equipment. Equipment owners would incur labor and capital costs for decommissioning old equipment and purchasing and installing replacement equipment. Decommissioning costs would likely include testing and disposing of PCBs-containing materials. Further evaluation of this control option should include additional documentation of the current status of PG&E’s efforts to remove PCBs from their equipment. |
| **Outreach to parties performing demolition.** | Perform targeted outreach to help contractors identify construction materials potentially containing PCBs and implement proper testing, removal and disposal techniques. | Would potentially reduce new inputs of PCBs to the environment and storm drains. Could potentially be coordinated with related programs such as asbestos and lead abatement. | Potential benefits would be limited to reducing loads by the mass of PCBs in existing structures. Estimating this mass and the potential for its release to storm drains would likely be difficult. | Costs to implement this option would include developing and distributing outreach materials. Property owners would potentially incur costs to test materials for PCBs before demolition, implement special removal procedures, and dispose of PCBs-containing materials. Further research on which specific construction materials contained PCBs and the general time period of their use would potentially help target outreach efforts. |
### Table 2. Preliminary Comparison of Potential Options to Reduce Discharges of PCBs from Urban Runoff Conveyances (cont.)

<table>
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</thead>
<tbody>
<tr>
<td><strong>Stormwater Treatment</strong></td>
<td>Stormwater runoff treatment retrofits</td>
<td>Stormwater treatment retrofit technologies are readily available and can effectively remove sediment and associated pollutants when designed, installed, operated and maintained properly. Would potentially reduce loadings of other pollutants of concern.</td>
<td>Would not reduce new inputs of PCBs to storm drain conveyances. Siting of some treatment technologies may be limited by factors such as soil types, groundwater elevation, slopes, insect breeding and space constraints.</td>
<td>Costs associated with stormwater treatment retrofits include facilitating public involvement, planning and siting, design, permitting, installation/construction and operation and maintenance. In general, costs and benefits would be site specific. Retrofit planning should consider objectives other than removing PCBs, such as removing other pollutants, stabilizing stream channels and improving aquatic habitat within urban streams. Treatment structures such as wet ponds and constructed wetlands would need to be designed to minimize mercury methylation.</td>
</tr>
<tr>
<td>Diversion of stormwater flows to wastewater treatment plants.</td>
<td>Identify wastewater treatment plants with excess wet weather treatment capacity that serve areas discharging urban runoff containing relatively elevated levels of PCBs and other pollutants and divert urban runoff for treatment.</td>
<td>Would use excess treatment capacity of existing treatment works, rather than requiring construction of new treatment facilities. Would reduce loadings of other pollutants of concern.</td>
<td>Would not reduce new inputs of PCBs to storm drain conveyances. Treatment plants may not have sufficient excess capacity to accept large additional flows or sediment-laden flows during wet weather. Excess capacity in existing facilities was generally not designed and constructed with consideration to accepting stormwater flows. Treatment plants accepting urban runoff might not have the ability to meet certain requirements of their current NPDES permits. Such requirements include 85% removal of suspended solids and biological oxygen demand, toxic pollutant effluent limits and bypass prohibitions. Sanitary sewer ordinances typically contain prohibitions against the intentional introduction of flows other than wastewater into sewerage systems.</td>
<td>Costs associated with connecting storm drain systems to wastewater treatment plants would include facilitating public involvement, planning and siting, design, permitting, and constructing potentially significant new infrastructure such as diversion/capture structures, conveyance piping, pumps, storage structures and controls. In addition, the treatment plant would potentially incur additional operational costs associated with purchase of extra power and chemicals, increased biosolids management, increased sediment/grit removal and disposal, and additional wear on physical facilities associated with increased sediment concentrations. Wastewater treatment plants and stormwater management agencies would need to work together to devise equitable means of addressing all of these costs. Overall cost-effectiveness would depend on factors such as the capacity of the existing sanitary sewer collection system and wastewater treatment plant to accept water from the targeted stormwater conveyance, distance of the treatment plant from the targeted conveyance, the number of pollutants for which treatment would be valuable, and the magnitude of the pollutant loads diverted.</td>
</tr>
</tbody>
</table>
Increased Removal of Sediments during Routine Municipal Maintenance Activities

As discussed earlier, some mass of sediment and associated particle-bound pollutants, including PCBs, are removed during routine municipal maintenance practices such as inlet/catch basin cleaning, street sweeping and channel desilting. This control option would necessitate modifying maintenance practices to increase removal of sediment and associated particle-bound pollutants. Potential modifications would include increasing the frequency of storm drain inlet/catch basin and pump station sump cleaning, street sweeping and channel desilting.

This approach would have the advantage of building on established practices already implemented in the Bay Area. In addition, it would potentially reduce loadings of other pollutants of concern. One limitation is that most potential modifications would not reduce new inputs of PCBs to storm drains.

Potential costs to implement this control option would include additional labor, maintenance and depreciation of equipment (e.g., street sweepers), and testing and disposal of sediments. As discussed previously, the ACCWP is currently performing a preliminary evaluation of some modifications to maintenance practices to increase pollutant removal. When appropriate data are available, the ACCWP is estimating some associated costs and additional pollutant mass removed.

Non-routine Removal of Sediments Containing PCBs from Stormwater Conveyances.

Storm drain systems are generally designed to efficiently convey stormwater and associated sediments away from urban areas to surface waters. Sediments typically accumulate, however, at depositional areas within a system, including flood control channels in low lying areas and low areas in storm drain system pipes caused by settlement. Sediments also accumulate by design in some structures such as pump station wet wells and detention basins. Sediments are removed from storm drain conveyances to some extent during routine maintenance practices.

The JSAP and ACCWP regional sediment surveys revealed that some urban stormwater conveyances contain reservoirs of sediments with PCBs and other pollutants of concern. Little is known about the spatial extent and residence time of such sediments in the system. This approach would initially use field investigations to identify conveyances with accumulated sediments containing PCBs (and potentially other pollutants of concern). These sites would then be prioritized and targeted dry season sediment removals with proper disposal implemented. In general, the fieldwork would not be associated with routine municipal maintenance practices and would require extra mobilization of labor and equipment.

An advantage to this approach is that it would directly remove PCBs and potentially other pollutants of concern from stormwater conveyances. A potential limitation is that periodic removal actions might be needed if there are ongoing inputs of PCBs to a storm drain conveyance. Thus identification and abatement of any ongoing inputs would be desirable before performing removal actions. On the other hand, removing sediments and then testing new sediments that accumulate would help determine whether there are continuing inputs to the system. Another potential limitation to this approach is that in some creeks and flood control channels removal of sediment would conflict with regulations designed to protect in-channel habitat. Parties performing projects that include substantial sediment removal are required to obtain Clean Water Act Section 401

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7 Two of the case study sites described previously, Leo Avenue in San Jose and Nebraska Street in Vallejo, may be examples of such areas.
water quality certifications from the Regional Board before work commences.

Costs associated with this control option would include identifying stormwater conveyances containing accumulated sediments with PCBs and sediment removal actions in selected areas. Sediment removal costs would depend on factors such as the type of conveyance, the extent and concentrations of PCBs (and other pollutants), and the cleanup standard chosen. The number of areas that would be cleaned out in association with the Bay PCBs TMDL is difficult to predict. More data would be needed on the extent of stormwater conveyances that drain to the Bay with significant accumulations of sediments containing PCBs. Removal actions would be prioritized based on criteria such as costs, mass of PCBs present and whether a responsible party could be identified. Responsible parties would ideally perform sediment removal and disposal, but their identification would likely be infeasible in many cases.

Natural Attenuation

This approach would allow PCBs in soils and accumulated stormwater conveyance sediments to naturally degrade or be flushed through the system. No actions would be taken except periodic monitoring. The principal advantage of this approach is that the only costs incurred would be for periodic monitoring to evaluate whether concentrations were declining in urban runoff. However, since PCBs degrade very slowly in the environment, a prohibitively long time period might be required for concentrations to attenuate to acceptable levels. In addition, this strategy would not address any new inputs to soils or stormwater conveyances, and would not reduce loadings to the Bay on the short term.

Voluntary Replacement of PCBs-containing Equipment

The U.S. EPA still allows the use of PCBs in limited applications. As discussed previously, a lack of availability and health and safety concerns have effectively ended the use of PCBs in new applications (EIP Associates 1997). However, PCBs may remain in some older equipment, including enclosed electrical applications such as transformers and capacitors.

This control option would encourage identification and voluntary replacement of PCBs-containing equipment. Implementation actions would include targeted outreach on identifying equipment with PCBs, obtaining suitable replacements and proper decommissioning methods. In addition, regulatory incentives could potentially be developed to make equipment replacement more attractive to facility owners. An advantage to this approach is that removing PCBs-containing equipment from service would potentially reduce new inputs of PCBs to the environment and storm drain conveyances. Another advantage would be reducing potential liability to equipment owners associated with accidental PCBs releases and health and safety concerns. New equipment would also potentially reduce facility operation and maintenance costs (e.g., modernizing electrical equipment could result in energy savings). On the other hand, given that the use of PCBs is currently limited and strictly regulated, the mass of PCBs that could potentially be released to the environment from PCBs-containing equipment may be relatively small. Replacement of such equipment may therefore have only a limited potential benefit. There is also a risk of releases to the environment and human exposure during equipment replacement.

Potential costs would include developing and distributing outreach materials and developing and implementing regulatory incentives to replace PCB-containing equipment. Equipment owners would incur labor and capital costs for decommissioning old equipment and purchasing and installing replacement equipment. Decommissioning costs would likely include testing and disposing of PCBs-containing materials.
Equipment in the Bay Area that potentially contains PCBs includes PG&E electrical equipment with dielectric fluids, such as substation transformers. A letter from PG&E to Regional Board staff (Doss 2000a) indicates that the “vast majority of PCB-filled electrical equipment” was removed from its system during the mid-1980s. The letter also states: “Distribution line equipment and all other fluid-filled substation electric equipment contains mineral oil dielectric fluid. …The over 900,000 mineral oil-filled distribution line pieces of equipment in service are generally not tested for PCBs until fluid is removed at the time of servicing, or in the event of a spill or release of such fluid. PG&E’s experience has been that, in general, approximately ten percent of such units contain PCBs at concentrations of 50 parts per million (ppm) or greater, and less than one percent of these units contain PCBs at concentrations of 500 ppm or greater.” A follow-up letter (Doss 2000b) states: “The declining percentage of oil-filled units which contain PCBs reflects our efforts to remove such units during servicing, as well as the replacement programs PG&E conducted in the mid-1980s.” Further evaluation of this control option should include additional documentation of the current status of PG&E’s efforts to remove PCBs from their equipment.

**Outreach to Parties Performing Demolition**

PCBs were formerly used in paints, sealants, and wood preservatives (EIP Associates 1997) and have been found in construction materials such as insulation, roofing and siding materials (64 CFR Part 761). This strategy would entail developing an outreach program to reduce potential releases of PCBs during demolition. Targeted outreach would help contractors identify construction materials potentially containing PCBs and implement proper testing, removal and disposal techniques.

This approach would have the advantage of potentially reducing new inputs of PCBs to the environment and storm drains. In addition, this strategy could potentially be coordinated with other programs such as asbestos and lead abatement. Potential benefits, however, would be limited to reducing loads by the mass of PCBs in existing structures. Estimating this mass and the potential for its release to storm drains would likely be difficult. Further research on which specific construction materials contained PCBs and the general time period of their use would potentially help target outreach efforts.

Costs to implement this option would include developing and distributing outreach materials. Property owners would potentially incur costs to test materials for PCBs before demolition, implement special removal procedures, and dispose of PCBs-containing materials.

**Stormwater Runoff Treatment Retrofits**

Solids removal is generally the most feasible option to treat PCBs and other sediment-bound pollutants in stormwater runoff. Stormwater treatment structures that remove solids commonly rely on filtration, sedimentation, flow through separation or some combination of these processes. Structures may be built in-place or proprietary manufactured devices may be installed. Examples include storm drain inlet inserts, manufactured flow through separation devices (e.g., vortex separator), vegetated filtration systems (e.g., grassy swale), infiltration trenches/basins, media filtration (e.g., sand filter), detention basins, wet ponds and constructed wetlands (CASQA 2003).

This approach would require retrofitting stormwater treatment structures such as the above into the urban landscape. Retrofits are potentially applicable at widely varying scales, ranging from, for example, a storm drain inlet filter in a small parking lot to a constructed wetland at the base of a watershed. An advantage to this approach is that stormwater treatment retrofit technologies are
readily available and can effectively remove sediment and associated pollutants when designed, installed, operated and maintained properly. One limitation of this approach is that it would not reduce new inputs of PCBs to storm drain conveyances. In addition, siting of some technologies may be limited by factors such as soil types, groundwater elevation, slopes, insect breeding and space constraints. Treatment structures such as wet ponds and constructed wetlands would need to be designed to minimize mercury methylation.

Costs associated with stormwater treatment retrofits include facilitating public involvement, planning and siting (including field reconnaissance), design, permitting, installation/construction and operation and maintenance. For a variety of reasons, available data typically indicate variable treatment performance for a given type of treatment and pollutant, often making comparisons of cost-effectiveness among treatment technologies problematic (CASQA 2003). Total Suspended Solids is often used as a surrogate for particle-bound pollutants of concern when evaluating treatment performance. In general, costs and benefits would be site specific. Current efforts in California to test the cost-effectiveness of stormwater treatment methods include 121 pilot studies by the California Department of Transportation (Caltrans 2003).

The planning of stormwater treatment retrofitting is potentially complex, since it should be carried out in a watershed context. The specific objective related to the PCBs TMDL would be to help protect beneficial uses of San Francisco Bay by reducing PCBs loadings to the Bay. To meet this goal retrofits would likely target urban areas with high potential for discharges of PCBs in urban runoff. However, retrofit planning should also consider other objectives such as removing other pollutants, stabilizing stream channels and improving aquatic habitat within urban streams.

**Diversion of Stormwater Flows to Wastewater Treatment Plants**

Sanitary sewer collection systems and wastewater treatment plants are often designed with capacity exceeding that needed to accommodate dry weather flows. The extra capacity typically is used to treat increased wet weather flows caused by inflow and infiltration into the collection system and to accommodate population growth in a community.

This strategy would divert urban runoff to wastewater treatment plants for removal of PCBs and other pollutants (LWA 2002, Abu-Saba 2002). This practice has been used in Southern California during dry weather flows to reduce microorganism levels associated with beach closures. However, urban runoff typically only has significant concentrations of suspended solids and associated pollutants during wet weather, with the highest levels found during first flush storm events. Applying this strategy to reduce loads of particle-bound pollutants such as PCBs would therefore require diversion and treatment of wet weather flows.

This approach would include identifying wastewater treatment plants with excess wet weather treatment capacity that serve areas discharging urban runoff containing relatively elevated levels of PCBs and other pollutants. It has the advantage of potentially using excess treatment capacity of existing treatment works, rather than requiring construction of new treatment facilities. A principal limitation is that wastewater treatment plants may not have sufficient excess capacity to accept large additional flows or sediment-laden flows during wet weather. Excess capacity in existing facilities was generally not designed and constructed with consideration to accepting stormwater flows. Storage of urban runoff and subsequent treatment during lower sanitary system flows could potentially help address this issue. Another potential limitation would be the ability of wastewater treatment plants accepting urban runoff to meet certain requirements of their current NPDES permits. Such requirements include 85 percent removal of suspended solids and biological oxygen demand, toxic pollutant effluent limits (sometimes including mass limits), limits
related to biosolids quality, and bypass prohibitions. Also, sanitary sewer ordinances typically contain prohibitions against the intentional introduction of flows other than wastewater into sewerage systems. In addition, managers should consider the potential negative impacts of reducing flows and changing sediment deliveries to receiving waters before diverting stormwater flows.

Costs associated with connecting storm drain systems to wastewater treatment plants would include facilitating public involvement, planning and siting, design, permitting, and constructing potentially significant new infrastructure such as diversion/capture structures, conveyance piping, pumps, storage structures and controls. In addition, the treatment plant would potentially incur additional operational costs associated with purchase of extra power and chemicals, increased biosolids management, increased sediment/grit removal and disposal, and additional wear on physical facilities associated with increased sediment concentrations. Wastewater treatment plants and stormwater management agencies would need to work together to devise equitable means of addressing all of these costs. Overall cost-effectiveness would depend on factors such as the capacity of the existing sanitary sewer collection system and wastewater treatment plant to accept water from the targeted stormwater conveyance, the number of pollutants for which treatment would be valuable, and the magnitude of the pollutant loads diverted.

DISCUSSION

The regional sediment surveys and PCBs case studies performed to-date by Bay Area stormwater management agencies have relied on analysis of embedded sediment samples collected from stormwater conveyances. Pollutant loadings estimated using this data are highly uncertain, since a variety of chemical and geomorphic processes lead to high spatial and temporal variability in the concentrations of PCBs and other pollutants found in embedded sediments. Thus this method may only be useful for detecting order-of-magnitude or greater differences among watersheds (Salop et al. 2002a, McKee et al. 2003). Another issue with this monitoring technique has been the limited number of samples typically collected due to budget constraints. This problem has sometimes been exacerbated by difficulties often experienced in designing sampling strategies due to the limited number of accessible locations within stormwater conveyances where sufficient sediments accumulate to collect samples. Nevertheless, the results of the sediment surveys and case studies suggest that embedded sediment sampling may identify at least some drainages with relatively elevated levels of PCBs and can potentially point to source areas within these drainages. There are likely many on-land areas with elevated PCBs remaining in the Bay Area that have not yet been identified by the surveys and case study work to-date.

In addition to analyzing the spatial distribution of PCBs concentrations in embedded sediment samples, the case studies often evaluated sample PCBs congener distributions. One goal was to use such PCBs “fingerprints” to help link different samples to a common source area. Most case studies employed simple qualitative comparisons of homolog distributions among samples. This appeared to yield useful results in some cases. For example, most samples collected in the Leo Avenue area had similar homolog distributions, suggesting a single dominant source of PCBs in this area (City of San Jose and EOA, Inc. 2003). During the Ettie Street source investigation, the ACCWP took the additional step of applying a regression modeling technique based on congener concentrations. The goal was to estimate relative contributions from various areas within the drainage to the pump station at the bottom of the watershed. The results helped the ACCWP recommend areas within the Ettie Street drainage to focus on during future source investigation efforts (Salop et al. 2002b). In general, evaluation of PCBs congener concentrations and homolog distributions may sometimes be a useful tool to help focus source identification and management efforts. There are, however, a number of potential confounding factors. PCBs found in a single
sample potentially originate from multiple sources, which may confound comparisons of distributions among samples. Other considerations include the expected high variability of PCBs congener concentrations in embedded sediment samples, and, more specifically, different patterns and rates of weathering among PCBs congeners in the environment. Weathering mechanisms in storm drain environments potentially include volatilization, aerobic biodegradation and reductive dechlorination under anaerobic conditions. Understanding the effects of weathering is particularly problematic in the relatively unstable storm drain environment, since sediments may be exposed to a variety of conditions as they are transported through the system (KLI 2002).

The case study field sampling efforts were often supplemented by current and historical land use research. This has included reviewing records of past and current property occupants and their activities, reviewing regulatory agency databases, interviewing agency staff (e.g., hazardous material and sanitary sewer pretreatment inspectors) and reviewing agency files. The research typically revealed many properties where historical activities may have included the use of PCBs, such as sites that used electrical equipment and hydraulic oils. However, direct evidence of PCBs use or release within the case study areas was not found, apart from one release site in San Carlos (977 Bransten Road). The lack of historical evidence of PCBs use or release in areas with relatively elevated PCBs in field samples was not particularly surprising, given the formerly ubiquitous and unregulated use of PCBs in urban areas. Thus the utility of land use research to identify PCBs sources within watersheds with elevated field samples may be limited.

There are a variety of potential management measures that may reduce loads of PCBs associated with urban runoff. In the late 1970s, uses of PCBs were restricted and new uses effectively eliminated. It is therefore likely that new releases of PCBs to the environment have greatly diminished during the past few decades. As a result, pollution prevention/source control measures, such as replacing equipment that contains PCBs, may have less potential to reduce loads than intercepting existing reservoirs of PCBs in erodible soils and stormwater conveyance sediments before they reach the Bay.

One way to prioritize implementation of urban runoff controls for PCBs and other particle-bound pollutants of concern would be to focus efforts on watersheds discharging relatively high loads of pollutants. Characterization techniques better suited to estimating loads than embedded sediment sampling would allow for a more refined prioritization of watersheds and assessment of the effectiveness of new control measures. However, widely implementing such methods may be cost-prohibitive to Bay Area stormwater programs at the present time. SFEI has proposed investigating a modeling approach to estimate watershed pollutant loadings in the previously described Proposition 13 grant application.

Further analysis of the feasibility of potential urban runoff PCBs control measures is also needed, including quantitative evaluation of costs and benefits. The level of uncertainty in such an evaluation will be reduced when additional local data on PCBs controls becomes available, such as the results of a current Clean Estuary Partnership study and upcoming Proposition 13-funded studies by the San Francisco Estuary Institute and the City of Oakland (these studies were discussed previously). Factors other than strict cost-effectiveness may also be important in assessing feasibility, such as the likelihood of identifying responsible parties or obtaining state or federal funding for identification and cleanup of on-land PCBs sites. The benefit of implementing strategies that address multiple sediment-bound pollutants should also be taken into

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8 SFEI is currently developing more accurate techniques to estimate pollutant loadings from the Guadalupe River watershed in Santa Clara County. This work is funded by the Clean Estuary Partnership and the San Francisco Estuary Regional Monitoring Program.
consideration. Bay Area stormwater management agencies plan to continue working with Regional Board staff in coordination with BASMAA, the Clean Estuary Partnership and the San Francisco Estuary Regional Monitoring Program to address controllable sources of PCBs and develop the urban runoff implementation plan of the Bay PCBs TMDL.

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