Approach, Feasibility, and Expected Benefits of Implementation Actions for Urban Runoff in the San Francisco Bay Mercury TMDL

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Background

Urban runoff programs have two types of tools available for reducing pollutant loads from the urban environment: programmatic and infrastructure. Programmatic approaches focus on establishing and reinforcing behavior that prevents release of pollutants. This usually takes the form of both municipal ordinances and codes combined with public outreach and education. Infrastructure tools typically focus on diversion of stormwater through facilities that increase detention time and sediment loads (and therefore loads of particle-associated pollutants). Both of these approaches are combined with monitoring to evaluate the benefits of pollution control measures on receiving waters. This report summarizes programmatic, infrastructural, and monitoring approaches for mercury available to urban runoff programs from the Bay Area, including the expected costs and benefits.

Programmatic Approaches

Maximum Extent Practicable

The Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) reissued on February 21, 2001, required development and implementation of a pollution prevention plan for mercury (Provision C.9.c, Appendix A). That plan includes the following elements:

i. Development and adoption of policies, procedures, and/or ordinances calling for:

· The virtual elimination of mercury from controllable sources in urban runoff, including the identification of mercury-containing products used by the Dischargers and a schedule for their timely phase out; and

· Coordination with solid waste management agencies to ensure maximum recycling of fluorescent lights and/or establishment of "take back" programs for the public collection of mercury-containing household products (potentially including thermometers and other gauges, batteries, fluorescent and other lamps, switches, relays, sensors and thermostats);

ii. A schedule for assisting the Regional Board staff in conducting an assessment of the contribution of air pollution sources to mercury in the Dischargers' urban runoff

iii. Assessment of the sediment mercury concentrations and percentage of fine material at the base of key watersheds, above the tide line;

iv. A public education, outreach and participation program designed to reach residential, commercial and industrial users or sources of mercury-containing products or emissions; and

v. Participation with other organizations to encourage the electric light bulb manufacturing industry to reduce mercury associated with the disposal of fluorescent lights through product reformulation.

The above five elements can be considered definitions of maximum extent practicable as currently implemented through the San Francisco Bay Regional Water Quality Control Board's NPDES program for urban runoff. The staff of SCVURPPP were interviewed to determine costs of building and implementing a mercury pollution prevention program with their copermittees.

Costs to Develop and Implement a Mercury Pollution Prevention Program

Implementing a mercury pollution prevention program proceeds in three steps:

1) **Set up the program**. After developing a pollution prevention plan (Appendix A), this step primarily involves educating the copermittees by getting individual stormwater managers to understand the need for the pollution prevention program and agree to participate. Direct costs to the SCVURPPP to set up the mercury pollution prevention program and perform the initial outreach was $25,000.

2) **Implement the program**. This step involves development of policies, guidelines, and model ordinances, and training copermittee staff, as well as tracking and reporting the success of program implementation. The SCVURPPP has allotted $60,000 as the direct cost for program implementation.

In addition to direct costs to an urban runoff program, indirect costs are incurred by municipal copermitees through the use of their staff time. The SCVURPPP estimates that program development and implementation required 1/12 of a person year (160 hours) from each copermittee as a one-time cost, and will require an additional 160 hours per copermittee as an annual ongoing cost. Valuating staff time at $100 an hour, this suggests that development and implementation of the pollution prevention program cost the fifteen SCVURPPP copermittees $240,000 initially and will cost an additional $240,000 annually.

3) **Monitor responses**. A monitoring approach for mercury in Bay Area watersheds has been established by the Bay Area Stormwater Management Agencies Association (BASMAAA) to characterize mercury concentrations in sediments of urban and non-urban watersheds. This approach helps estimate mercury loads based on estimates of sediment discharged from urban and non-urban drainages. The total cost of the monitoring included costs for other pollutants of concern (e.g., PCBs, chlorinated

pesticides). The SCVURPPP estimates that mercury monitoring costs amounted to $50,000 for one year, including the cost of collecting samples, analyzing them for total mercury and grain size, and reporting the data. The response time of urban watersheds to implementation of pollution prevention measures is on the order of years to decades, so this type of monitoring should take place once every permit cycle (five years). Therefore, as an ongoing commitment, monitoring costs for a mercury pollution prevention plan are expected to amount to $10,000 per year for a program the size of SCVURPPP.

The total costs to develop and implement a mercury pollution prevention program consistent with the fulfillment of provision C.9.c in the SCVURPPP permit are summarized in Table 1, along with costs extrapolated to a population of 6.5 million. Although current NPDES stormwater programs do not currently cover that many people, 6.5 million is a reasonable upper estimate for the number of people affected once phase-II stormwater permits are issued to smaller municipalities. Based on these projections, the fiscal impact of mercury TMDL implementation in urban runoff programs is expected to be approximately $1.2 million as a one-time cost and an additional $1 million annually. Most of this cost is in the form of staff time for municipal workers (indirect costs).

Start-up costs	Direct Costs	Indirect Costs
Plan Development (start-up)	$ 25,000	$ 120,000
Plan Implementation (start-up)	$ 60,000	$ 120,000
Plan Implementation (ongoing)		$ 240,000
Monitoring	$ 10,000	
Population of Santa Clara County	1,700,000	
Per capita startup costs	$ 0.19	
Per capita ongoing costs	$ 0.15	
Startup costs for entire Bay Area	$ 1,242,647	
Ongoing costs for entire Bay Area	$ 955,882	

Table 1: Estimated cost to develop and implement mercury pollution prevention plans for 6.5 million people, based on costs to the SCVURPPP. Direct costs refer to contracts, whereas indirect costs refer to city staff time valuated at $100 / hour.

Economies of scale and SCVURPPP's experience with the NPDES program may underestimate the true cost to newer and / or smaller programs. On the other hand, statewide and regional approaches, such as the Department of Toxics Control's proposed mercury waste classification and management regulations, may improve cost efficiency.

In addition to costs to urban runoff programs, county household hazardous waste programs will need to expand services to achieve meaningful programmatic goals for mercury reduction. For example, a recent analysis states that city and county Household Hazardous Waste programs in Santa Clara County, which are fee-funded at $2.3 million per year, aren't enough to support collection on a scale projected by full implementation of the DTSC regulations, the SCVURPPP mercury reduction program, and implementation actions in the Bay mercury TMDL (Appendix B). Grant programs have been proposed to pilot retailer take-back and collection programs for retailers of fluorescent lights and other mercury-containing products. As pilot programs, these types of grant-funded programs are intended to initiate participation from the business sector. Ultimately, expanded costs of mercury collection programs may be passed on to the consumer, unless they are covered by fees or other mechanisms.

In its CEQA analysis of its proposed regulations, DTSC summarizes cost estimates for implementing its waste classification and management regulations on a statewide basis. Extrapolating this to the Bay Area suggests that collection costs for mercury will increase by millions, rather than hundreds of thousands or tens of millions of dollars. It is important to note that these increased collection costs are likely outcomes of DTSC's proposed mercury regulations, regardless of the outcome of the San Francisco Bay mercury TMDL.

Expected Benefits of Mercury Pollution Prevention Programs

One way of estimating the potential mercury load reduction from pollution prevention progrreams is to hypothesize that that reducing the release of mercury from improper disposal (Figure 1) will, over time, cause sediments discharged from urban areas to have mercury concentrations more comparable to sediments from open spaces (Figure 2). This simple adaptive management hypothesis helps make estimates of the load reductions over time and propose alternative strategies if the hypothesis is found to be wrong.

The mercury source assessment assumes that sediments discharged from the urban environment have, on average, 0.5 ppm mercury, with a likely range of 0.2 - 1 ppm for this estimate. The source assessment also assumes discharge of 191 M kg sediment per year from urban watersheds (range 119 – 262 M kg / yr). If, over time, sediments from the urban environment attain concentrations of 0.1 ppm, comparable to non-urban sediments, this would correspond to a load reduction of 76 kg, with a likely range of 12 – 236 kg.

The above projection based on reduction of mercury concentration in urban sediments can be checked against source control estimates. It is estimated that in Santa Clara County 863,000 lamps, 3 million batteries and 18,000 thermostats will be generated in 2006 by households. Assuming 10 milligrams mercury per lamp, 100 per battery, and 1 gram per thermostat, that implies 326 kg of mercury in household waste streams for Santa Clara County alone. Thus, the scale of mercury collections projected supports the feasibility of attaining load reductions on the order of 100 kg from urban discharges.

Figure 1: Preventing improper disposal of mercury-containing devices (e.g. 200 fluorescent tubes) reduces discharges of mercury to the urban environment. Photo courtesy of City of Hayward Stormwater Pollution Prevention Program.

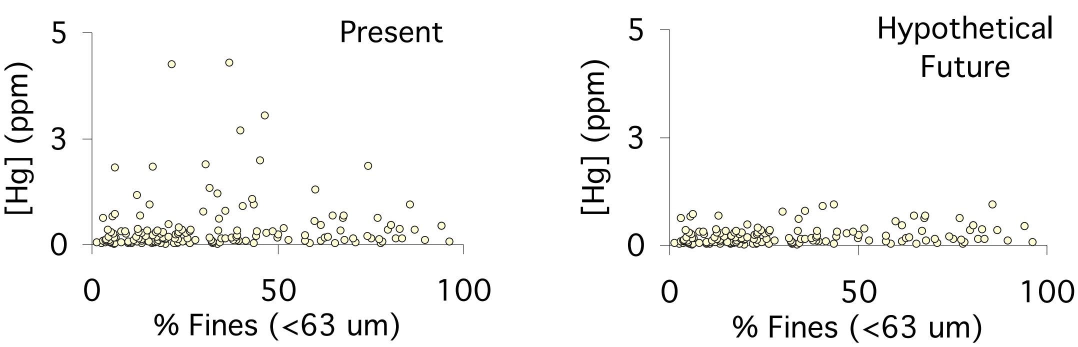

Figure 2: Possible response of monitoring to reductions of mercury discharges to the urban environment over a 10 – 30 year time period. The left-hand graph shows the concentration of mercury in sediments vs. percent fines measured by BASMAA agencies in urban and non-urban conveyances, 2000 – 2001. The right-hand plot illustrates the urban runoff adaptive management hypothesis by removing the upper 10'th percentile of mercury concentrations from the 2000 – 2001 data set.

Additional Benefits

In addition to reducing direct discharges of mercury from urban watersheds to controllable background levels, pollution prevention programs will reduce transport of mercury into landfills. Over time, this is important to reduce both the concentration of mercury in landfill leachate, which is discharge to municipal treatment plants or treated onsite. More importantly, landfills are extremely reducing environments, which can produce reactive gaseous forms of mercury, including dimethylmercury. Thus, over time, programs that effectively collect and recycle mercury can help reduce the production of a pontentially significant source of bioavailable mercury to the atmosphere, which can help reduce local deposition rates.

Adaptive Management Strategy

The simple conceptual model proposed in Figure 1 and Figure 2 is a working hypothesis. Adaptive management attempts to forecast reasons the working hypothesis might be revised based on new information, and then make reasonable predictions of how management actions would be affected.

For example, despite the full implementation of pollution prevention programs, there could be discreet conveyances with elevated mercury concentrations because of discharges from historic mining activity. In such an instance, it would be incumbant on the Regional Board to implement the steps outlined in the mines program of the Basin Plan. Other conveyances may have elevated mercury concentrations in sediments due to weathering of naturally occurring minerals, absent mining disturbances. In such a case, the appropriate management strategy would be erosion control measures consistent with the Basin Plan's stream protection policy. This may be implemented through urban runoff programs, resource conservation districts, or watershed associations, as appropriate.

Atmospheric deposition may be a significant limiting factor on the controllability of mercury discharges from urban watersheds. The monitoring approach for this is described elsewhere . This is the basis for including support of state and federal programs to reduce air emissions as a management action for urban runoff programs.

After mercury pollution prevention programs have attained MEP, the next alternative to reduce any residual "ubiquitous" urban background is capture, detention, and possibly treatment of urban stormwater. Substantial stormwater capture infrastructure is expected to result from the latest construction and new development requirements of the urban runoff programs (the" C-3" provisions). In fact, implementation of "C-3" and the general approach of including vegetative buffering around impervious surfaces may be the best approach to controlling residual urban background mercury loads.

Infrastructural Approaches

Another implementation alternative is the reduction of mercury loads by treating stormwater discharges to reduce particle loads. This could be accomplished using specifically designed treatment systems, or by routing stormwater through sanitary sewage treatment plants to use excess wastewater treatment capacity. This section describes general approaches to assessing the feasibility of such infrastructural approaches to load reductions. Actual costs, benefits and considerations will be very site specific.

General Considerations

The feasibility of routing urban runoff through conventional pollution control plants is affected by several factors. The primary consideration is matching areas with existing capacity to the nearest significant sources. The evaluation of existing capacity should scrutinize actual existing capacity after inflow and infiltration. Furthermore, technological requirements for secondary treament plants include the requirement to reduce influent loads of total suspended solids (TSS) by 85%. Capturing large volumes of urban runoff with low TSS loads can jeopardize the ability to comply with this technology-based requirement, so a mechanism for waiving the 85% removal requirement may be a prerequisit to deliberate introduction of stormwater to a sanitary sewer. There are also potential public finance barriers for using municipal wastewater fees to implement municipal stormwater controls.

Finally, while blending urban stormwater with municipal sewage has the potential to reduce multiple pollutant loads (e.g., PCBs and chlorinated pesticides), this could also have the unintended consequence of increasing the pollutant concentrations of biosolids. This is potentially a concern for proper biosolids management (Committee on Toxicants and Pathogens in Biosolids Applied to Land, 2002). While it is worthwhile evaluating the multipollutant benefits of treating urban stormwater discharged from moderately to highly polluted areas, it is likely that the most feasible approaches will be development of discreet infrastructure, rather reversing the past thirty years of Clean Water act Implementation by merging urban runoff with sewage. As a first step, urban runoff programs should evaluate the pollutant load reductions that will be attained through implementation of New and Redevelopment Performance Standards for urban stormwater (the “C-3 provisions”).

Sample Calculations

As an example, the hypothetical scenario of an industrialized catchment can be considered. Sediments collected from a catch basin at the Ettie Street puming station in West Oakland have approximately 1 ppm mercury and 3 ppm PCBs (Gunther et al., 2002). The catchment is estimate to produce between 0.04 and 0.1 million kilograms of sediment per year. Therefore, effectively capturing this sediment could potentially reduce mercury loads to the Bay by 0.04 – 0.1 kg per year, and PCB loads by 0.1 to 0.3 kg per year. If the stormwater carrying this sediment has an average TSS of 10 mg/L, this would mean that approximately 10^{10} liters of water would have to be treated – approximately 2200 million gallons. 2200 million gallons is a lot of water to treat – the nearest facility (EBMUD) has a capacity of 75 million gallons per day. However, treatment of an extra 2200 million gallons over a period of a year would use an extra 6 million gallons per day of capacity, so the feasibility of such an approach would be enhanced by construction of storage facilities. A detailed feasibility assessment for this example should examine the cost of designing and constructing sufficient storage capacity (i.e., up to 2,000,000 gallons), pumps and pipes to transport the water approximately three miles, the cost of permitting and public review, and any changes to the biosolids management plan that might result.

The lessons learned from this exercise are:

1) feasibility of treating urban stormwater increases with increasing pollutant concentrations in sediments;
2) feasibility also increases with increasing TSS levels in stormwater;
3) feasibility decreases with increasing distance to the nearest facility;
4) feasibility increases with increasing wet-weather capacity;
5) the most feasible approaches may be implementation of New and Redevelopment Performance Standards for stormwater.

References

Committee on Toxicants and Pathogens in Biosolids Applied to Land, 2002. Biosolids Applied to Land: Advancing Standards and Practices, National Research Coucil, Washington, D.C.

Gunther, A.J., Salop, P., Abu-Saba, K.E. and Feng, A., 2002. Characterization of PCB, Mercury, PAH, and Chlorinated Pesticide Concentrations in Drainages of Western Alameda County, CA, Livermore, CA.

Appendix A: SCVURPPP Mercury Pollution Prevention Plan

Appendix B: Santa Clara County Memorandum on Household Hazardous Waste Recycling Capacity