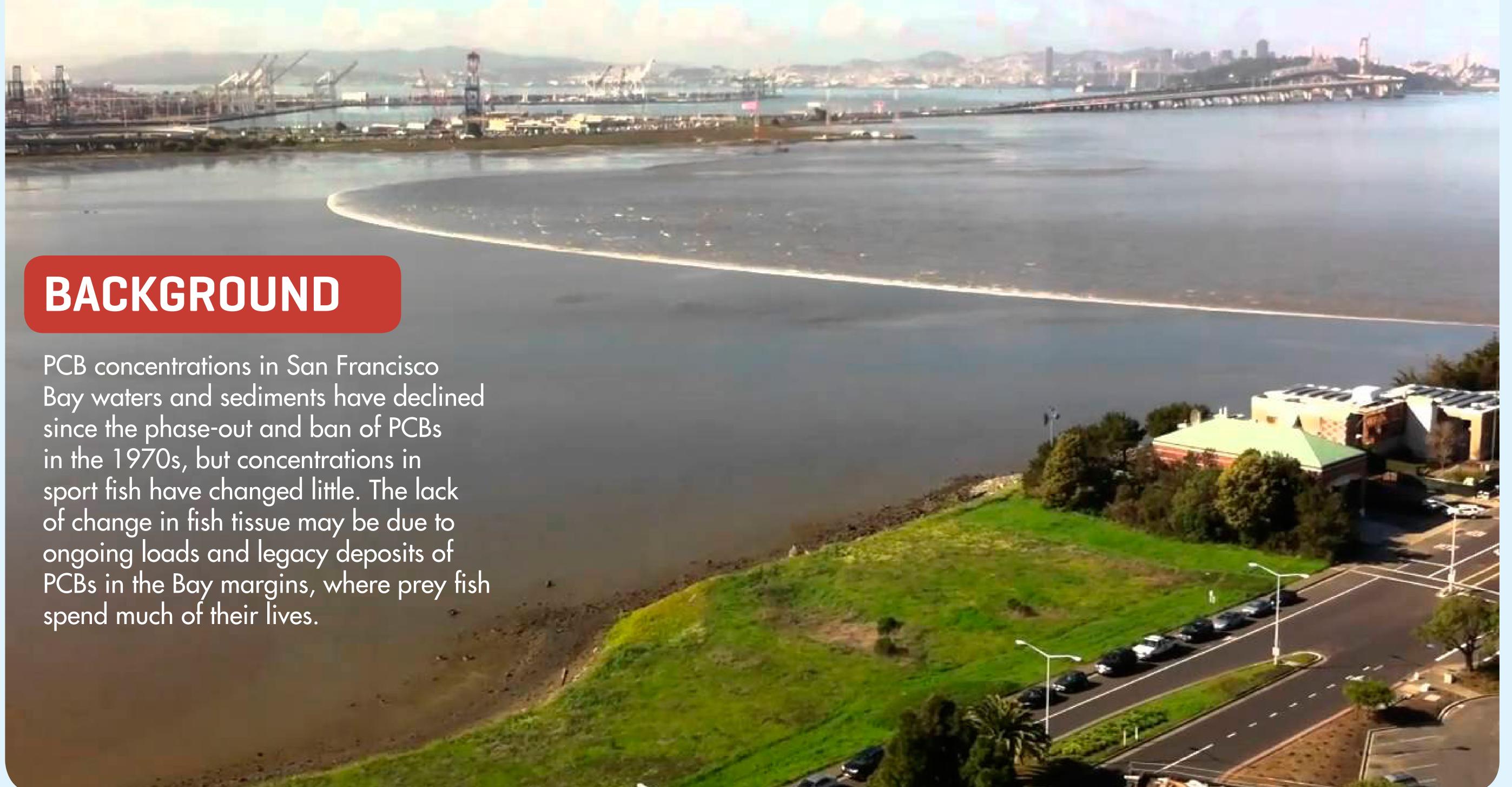
SIMPLE MASS BUDGET MODEL TO EVALUATE LONG TERM PCB FATE IN THE EMERYVILLE CRESCENT SUB-EMBAYMENT

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METHODS

To examine the potential for recovery in margin areas, we applied a simple (one sediment and one water phase) box mass budget model for Emeryville Crescent (Figure 1), a small semi-enclosed sub-embayment with known past PCB source areas.

About one-third of the area of Emeryville Crescent is interidal (elevation between MLLW and MHHW). Much of the remaining subtidal area is shallow, averaging about 0.5m depth at MLLW (0.7m at MLW). On average, about two-thirds of the volume is exchanged (between MLW and MHW) on each tidal cycle, so there is potentially substantial export of any contaminants dissolved or suspended in the water column.

PCB loads for Emeryville Crescent were estimated using the Regional Watershed Spreadsheet Model (RWSM), applying model generated average annual flows with PCB concentrations extrapolated from empirical data in one sub-watershed area (Ettie Street Pump Station), and model estimated yields (based on land use) for the remaining areas (**Table 1**). Estimated annual loads ranged from 140 to 370g, with a best estimate of around 210g per year.

90% or more of loads are estimated to be delivered in storms smaller than events with a 1 year average recurrence interval (ARI). Although a 10 year ARI storm individually will deliver about twice the load of a 1 year ARI event, collectively the much higher frequency smaller events contribute more to cumulative loads across years.

Within a given storm, a large portion of the load likely deposits within Emeryville Crescent, given its shallow slope and depth. In a settling experiment conducted on urban stormwater from other sites, about 50% to 70% of PCBs settled out in a laboratory column at a rate of 1m per hour or faster, with about half that mass dropping out around 10m per hour.

We therefore estimated the travel distance for simplified jets of water entering Emeryville Crescent at an initial linear flow rate of 1.7m per second, which corresponds to a 1 year ARI storm discharging within 3 hours, or a 10 year ARI over a 6 hours (Figure 2). Travel distances for longer storms of lower intensity would be smaller, as the incoming flood tide would retard net flow. At least within a storm, a majority of PCBs discharged likely settles in the near-field of its entry

Using a simple box model (Figure 3) and data from open water SSC and sediment PCBs from nearby sites, we projected the long term change in PCBs in Emeryville Crescent under different loading rate assumptions, using PCB 118 to represent an "average" PCB. We have no current measurements of PCB concentrations in Emeryville Crescent sediment, but assumed a mean concentration from adjacent sites to start (~20ng/g dw).

RESULTS & DISCUSSION

The simple box model suggests a potential for Emeryville Crescent to recover moderately quickly in response to load reductions (**Figure 4**). With continued loading at current rates, PCBs would be projected to remain approximately constant at around the initial concentration. At the opposite extreme, totally eliminating watershed loads of PCBs to Emeryville Crescent, concentrations drop to those seen in the adjacent ambient bay sediment sites.

There are large uncertainties and gaps in much of the available data, but our initial assessment suggests the ambient PCB concentrations of the area would reach within 10% of a new steady state in 10 to 15 years with changes in PCB loading. Sediment and biota surveys are planned to test some of these expectations. Despite numerous uncertainties, this simple mass budget has been a valuable tool for prioritizing future data collection and identifying critical areas for future, more detailed, mechanistic or empirical model development. Similar applications of simple models in other areas of the Bay and Delta may be useful for synthesizing available information and prioritizing future pollutant management and monitoring plans.

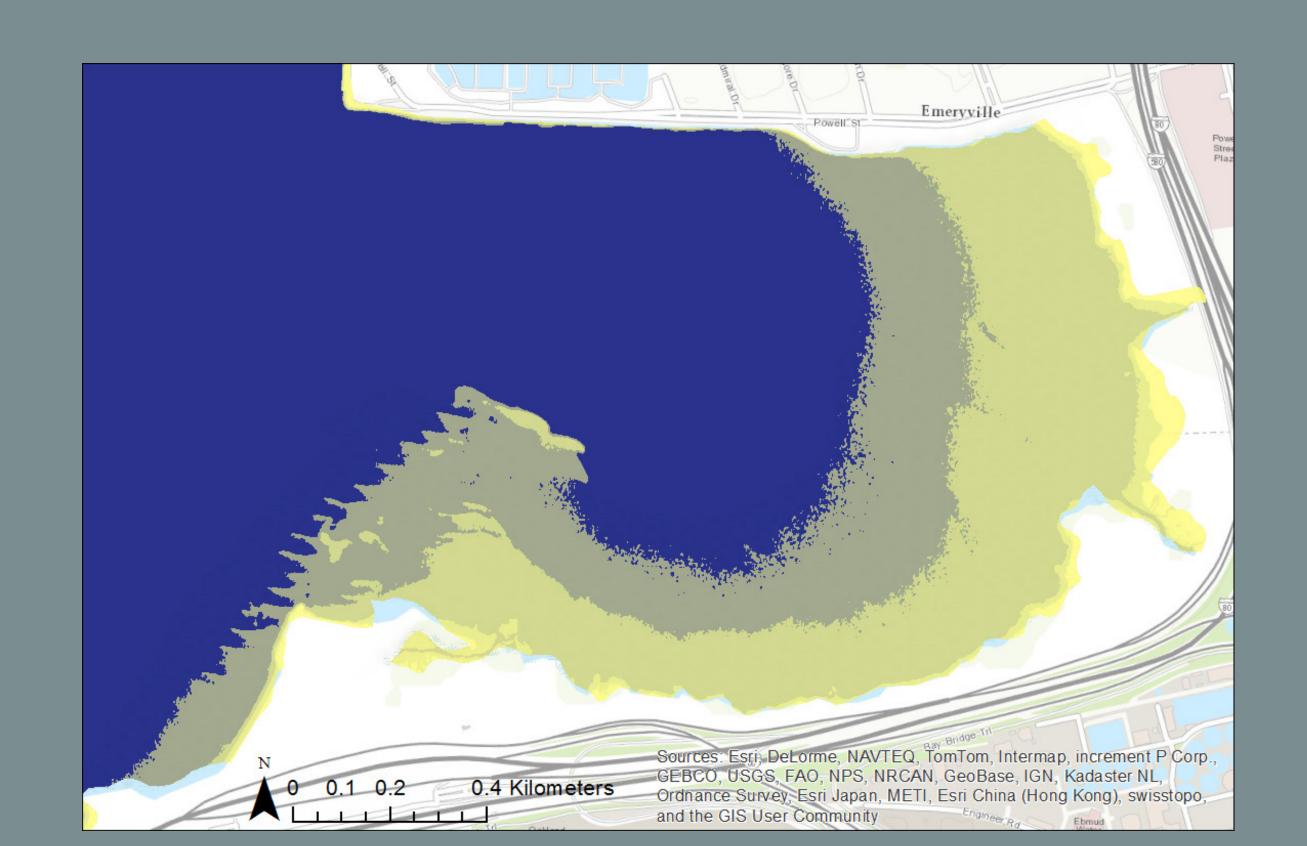


FIGURE 1.
Tidal datums in the Crescent. MLLW, MLW, MSL, MHW, and MHHW indicated by colored contours, from darkest (blue) to lightest (yellow), respectively.

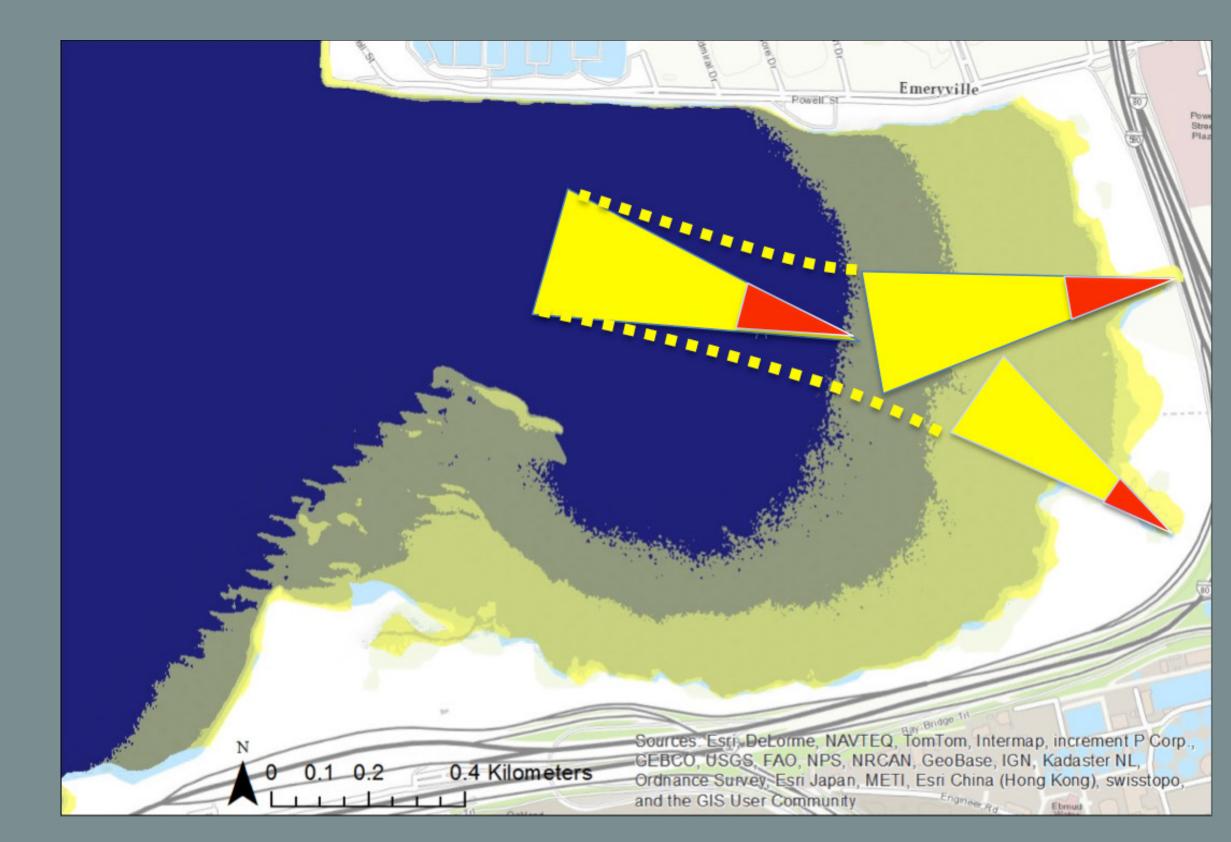


FIGURE 2.

Travel distances over 0.1 (red cone) and 1 hour (yellow) for idealized jets of discharge from Emeryville Crescent watersheds. Transport zones are shown for Temescal and Emeryville North/Ettie St Pump Station watersheds discharging separately at MHHW, or combined at MLLW. In quiescent conditions, up to 2/3 of discharged PCBs may settle out of the shallow water column (much of it <1m depth near the point of entry) within 1 hour.

Watershed	Total Area (km²)	Total Run-off Volume (Mm³)	PCBs Load - Low Estimate (g)	PCBs Load - High Estimate (g)	PCBs Load - Best Estimate (g)	PCBs Yield - Best Estimate (µg/m²)	Method
Emeryville Crescent North	3.7	1.2	24	81	39	10.5	RWSM flows and RWSM estimated PCB concentrations
Ettie St Pump Station	4.6	1.5	61	113	87	18.9	RWSM flows and empirical PCB concentrations
Temescal Creek	10.6	3.3	56	175	88	8.3	RWSM flows and RWSM estimated PCB concentrations
Total for Margin Unit	18.9	6.0	141	369	214	37.7	

TABLE 1.

Average annual load estimates for the Emeryville Margin Unit watersheds.

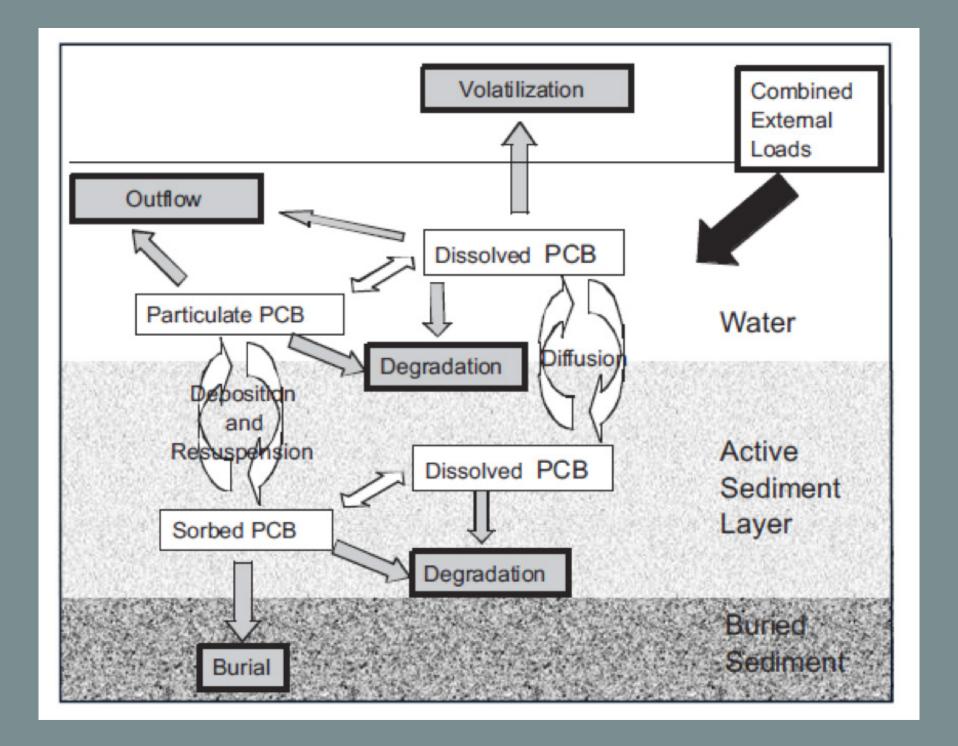


FIGURE 3.
Simple conceptual model of PCB fate.

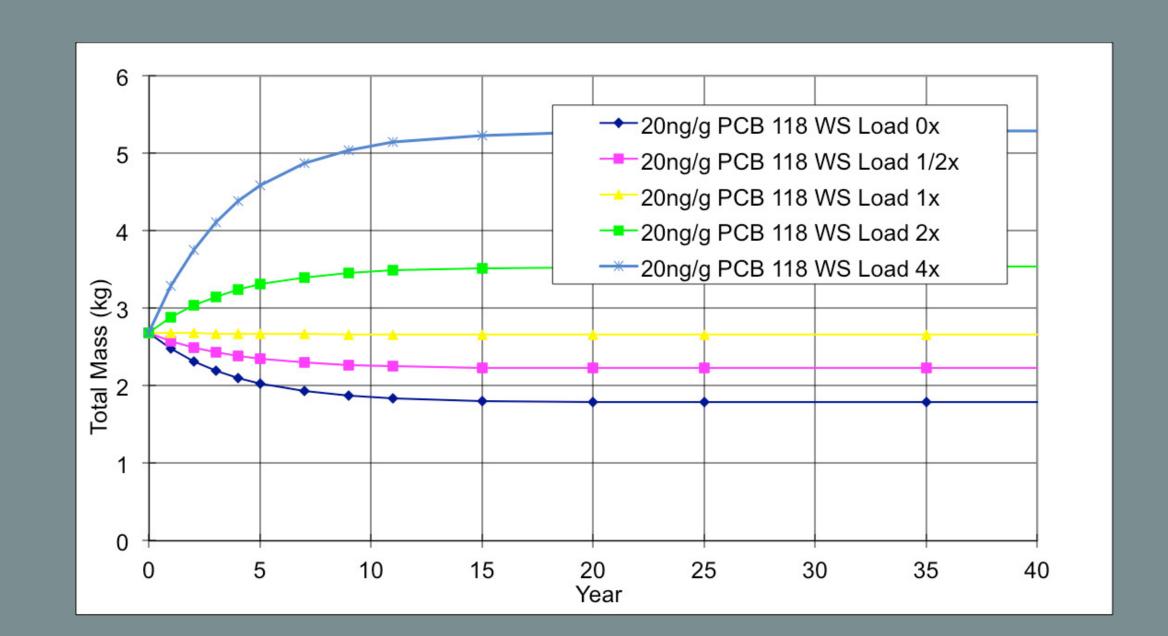


FIGURE 4.
Projected PCB mass in Emeryville Crescent with 20 ng/g starting concentrations, under differing watershed (WS) load assumptions.
In the base (1x) load case, WS load is half the tidal load from the bay.





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