Watershed Characterization Field Study

Appendix E to Small Tributaries Loading Strategy Multi-Year Plan

Version 2011

The RMP budgeted $300,000 in 2011 funds for small tributaries monitoring with the assumption that Water Year 2010-11 would be the start-up year for POC Loads Monitoring to comply with the MRP. However at the June 14, 2010 Small Tributaries Loadings Strategy (STLS) Team meeting, it was concluded that there was insufficient evidence to confidently select a group watersheds to monitor beginning October 2010. Instead, the Team supported a wet season reconnaissance sampling study as an alternative use of the budgeted funds[1]. Details of the sampling design were developed during July-September 2010, starting from the following general outline:

- **Watershed selection:** The STLS Team screened sites within a framework based on the Greenfield et al. (2010) classification in particular the more frequent watershed clusters #1, #2, #3, and #6). Within strata factors were considered such as %old industrial, %imperviousness, soil and sediment concentrations, known watersheds where greater management effort is likely, existing flow data, logistics, statistical validity, and other factors such as local knowledge of hot spots.
- **Number of stations:** Within budget limits try for an average of 4 stations per strata but perhaps 3 stations in several strata and 5-6 stations in the other two strata.
- **Sampling method:** Manual depth-integrated grabs similar to previous sampling at Guadalupe River and Zone 4 Line A.
- **Sampling Frequency:** Minimum of 5 samples per station (better 6 or 7) during storm flow (ideally 1 storm) resulting from (predicted) 0.25 inches of rain in the urbanized (usually lower elevation) portion of the watershed. Focus would be on storms prior to January 31st from prior evidence that these are the "dirtiest" and to get early results.
- **Analyte list:** Default is MRP category 1 analytes only; Logistically the analytical list would ideally be smaller for small watersheds and could be more inclusive (for example include dioxins) in larger or selected watersheds.
- **Ancillary data:** Turbidity (grab), stage (manually read staff plate installed before wet season), velocity if possible (in larger watersheds where logistics allow)
- **Data interpretation:** Primary method is envisioned to be graphical as from the Z4LA first-year report, but the collection of stage data might also allow rudimentary flow-weighting of samples (knowing that at a minimum flow increases by a factor of stage

[1] This redirection is allowed by MRP Provision C.8.a, which indicates that initiation of the required POC loads monitoring can be deferred to October 2011 if the stormwater Permittees are participating in a regional collaborative process to plan and conduct the monitoring.

squared). Watersheds would be assigned preliminary rankings based on this storm data from most contaminated to least contaminated for each analyte. The STLS Team expected to be statistically able to group the watersheds in to high, medium and low categories.

A total of 16 tributaries were sampled during one or two storms that occurred in FY 2010-11 and water samples were analyzed for a number of POCs, including PCBs, total mercury, PBDEs, polycyclic aromatic hydrocarbons (PAHs) and selenium. Preliminary results were presented to the STLS Team and the Sources, Pathways and Loadings Workgroup (SPLWG) in spring 2011.

Table E-1 shows the watersheds selected for the characterization study, along with a summary of some of their key attributes. Criteria for the composition of the sampling list included the following:

- Multiple representatives of the most common small to medium sized watershed classes 1-3, distributed throughout the four counties (Contra Costa, Alameda, Santa Clara, and San Mateo) where loads monitoring is required by the MRP.
- A few representatives of the medium to large watershed classes.
- Smaller catchments, generally heavily urban with industrial land uses, where stormwater programs are planning enhanced management actions to reduce PCB and mercury discharges.
- Other watersheds with distinctive histories of mercury or PCB occurrence, or related management concerns.

Figure E-1 shows the general locations of the study watersheds and the drainage areas above the initially selected monitoring locations. Some of the monitoring station locations were adjusted after field reconnaissance. Table 4 lists watersheds considered but not selected for the study, and also watersheds excluded from the study because of the availability of significant amounts of previously collected PCB and mercury data.

In June 2011 the STLS Team reviewed the results of the WY2011-12 sampling. Analytes measured at each sampling site varied depending on budget and Water Board management questions (Table E-2). Between 4 and 7 PCB, total mercury, SSC and organic carbon samples were collected at each site. PBDE and PAHs were collected at a subset of sites chosen based on logistics (essentially randomly from a water quality perspective). Selenium data were only measured at Contra Costa sampling locations.

Table E-1. Watersheds sampled during reconnaissance characterization study of Water Year 2011.

Watershed/ station	Area (km^2)	Prelim, Cluster No.	Percent Impervious	Percent Old Industrial	Reconnaissance Feasibility/ Safety	PCB-Hg attributes
Ettie Street Pump Station	4.0	1*	73.4**	28.60**	Good/Good	PCB P13 Cluster, CW4CB pilot watershed
Pulgas Creek	7.1	2	28.2		Good/Good	CW4CB pilot watershed
Sunnyvale East Channel	18.0	2	59.7	3.47	Good/Good	PCB P13 Cluster
Santa Fe Channel	2.64	2	70.3	3.6	Poor-Medium/ Good	Confirm proposed station vs. locations of CW4CB pilot watersheds
Lower San Leandro Creek	8.9	2	37.5	2.96	Good/Good	PCB spill into creek in 1995
Stevens Creek	73.7	6	15.8	0.24	Good/Good	Within airshed of Lehigh-Hanson Cement Manufacturer
Zone 5 Line M	8.1	*	33.5	3.15	Good/Good	Hg P13 Cluster
Lower Marsh Creek	97.5	?	14.7		Good/Good	Drains historic Hg mine
San Lorenzo Creek	124.8	6	13.2	0.50	Medium/Good	
Walnut Creek	318.7	7	16.6	0.72	Good/Good	
Lower Penitencia Creek	12.0	*	67.1	7.14	Good/Good	
Belmont Creek	7.2	2	27.4	0.00	Medium/Good	
Borel Creek	3.2	2	31.4	1.57	Medium/Good	
Calabazas Creek	52.9	1	45.6	0.44	Good/Good	
Glen Echo Creek	5.4	3	39.3	0.80	Good/Good	Hg P13 Cluster
San Tomas Creek	114.1	1	34.4	0.35	Good/Good	

***** Catchment does not correspond to a polygon used in cluster analyses
****** Estimated for larger polygon used in cluster analyses

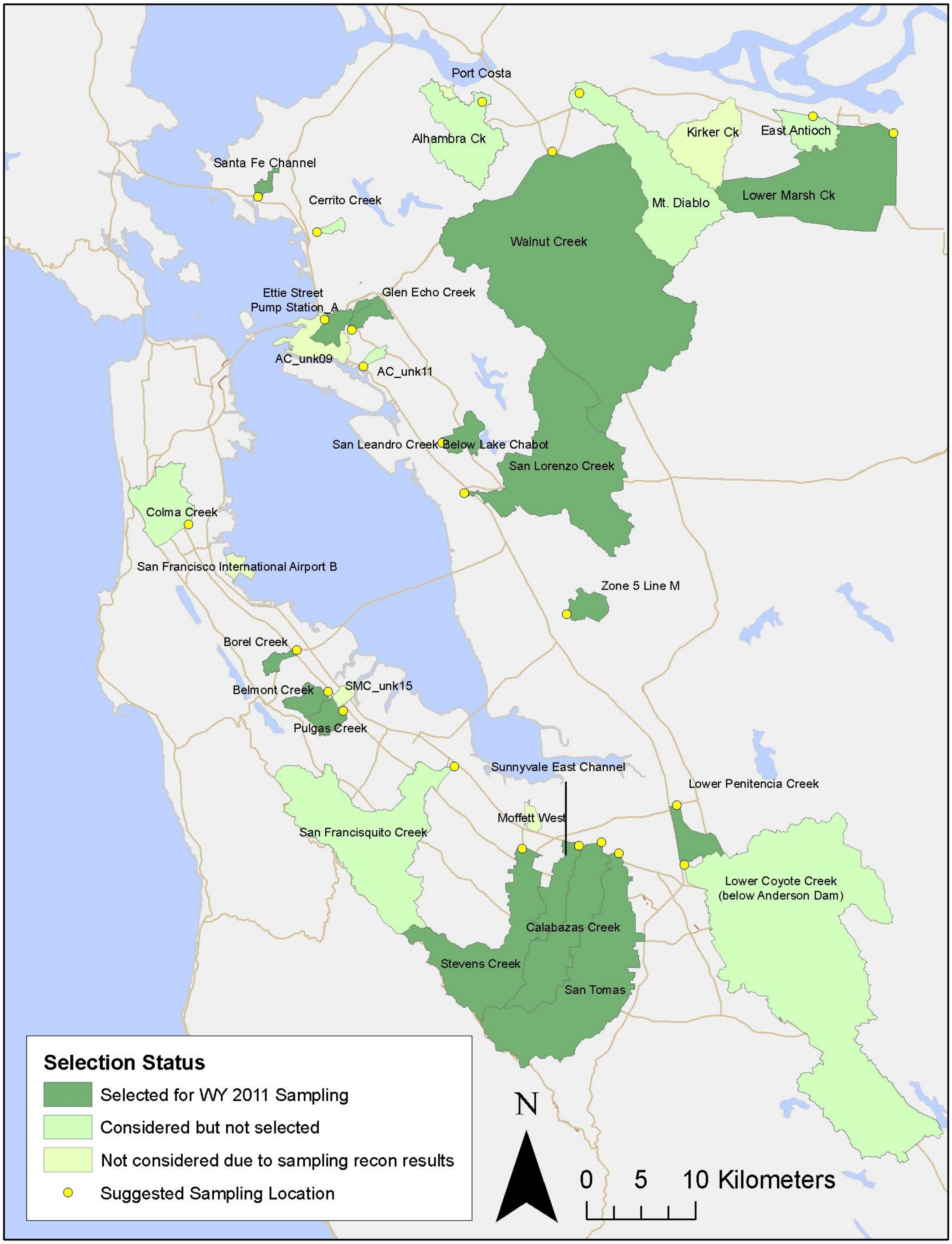

Figure E-1. Watersheds sampled in Water Year 2010-11 reconnaissance characterization study.

Table E-2. Summary of analytes collected during the water year 2010-11 reconnaissance characterization study.

Analytes	MRP Category	Number of Samples
PCB	Category 1	91
Total Mercury	Category 1	91
SSC	Category 1	91
Total Organic Carbon	Category 1	91
PBDE	Category 2	22
PAH	Category 2	22
Total Selenium	Category 2	30
Dissolved Selenium	Category 2	30

Maximum total mercury concentrations varied from 19-1740 ng/L (about 100x) between sites in relation to suspended sediment concentration and watershed characteristics. Given that SSC was a strong driver on the magnitude of concentrations, concentrations relative to particles (normalizing for SSC) was recommended as a better way of reviewing the data set in support of management questions and sampling decisions (Table E-3). Methylmercury did not relate directly to either maximum total mercury or median normalized (HgT/SSC) observed at each site and more likely is influenced by factors other than urban land use or Hg sources and uses in these watersheds.

Maximum PCB concentrations varied from 1,851 - 467,696 pg/L (Table E-4) a variation of about 250x. In the case of PCBs, data on SSC were not collected instantaneously with the PCB data; instead turbidity was used to normalize the data to remove the effects of sediment on preliminary interpretations. Organizing the data in this manner reveals a different pattern; the Santa Fe channel still appears to be the most contaminated of the sites sampled but the Ettie Street Pump Station watershed comes in second on the list and Glen Echo which was second comes in fifth. Also notable is that the patterns for PCBs and Hg are different; consistent with our conceptual model of differing use patterns and sources. Data for the other analytes have not yet passed through final quality assurance. Final results will be provided in a 2012 version of this Appendix.

Table E-3. The ratio of total mercury to suspended sediment concentration for the water year 2010-11 reconnaissance characterization study.

Watershed	Median HgT/SSC (ng/mg)	Max HgT (ng/L)	Median MeHgT/SSC (ug/kg)
Walnut Creek	0.077	181	0.066
Calabazas Creek	0.15	89	-
Lower Penetencia Creek	0.16	19	1.96
Borel Creek	0.18	74	0.91
San Lorenzo Creek	0.18	77	2.36
Stevens Creek	0.25	121	1.62
Belmont Creek	0.25	59	0.78
San Tomas Creek	0.26	129	0.38
Zone 5 Line M	0.31	1740	1.95
Sunnyvale East Channel	0.35	151	0.96
Glen Echo Creek	0.36	179	4.70
Pulgas Creek Pump Station - North	0.45	27	4.23
San Pedro Storm Drain	0.63	499	4.10
Santa Fe Channel	0.70	217	2.06
Ettie Street Pump Station	0.78	73	3.86
Pulgas Creek Pump Station - South	0.80	28	0.47
San Leandro Creek	0.82	477	5.63

Table E-4. Maximum concentrations of PCBs for the reconnaissance characterization.

Watershed	Maximum PCB concentration (pg/L)
Lower Penetencia Creek	1,851
Lower Marsh Creek	4,136
San Tomas Creek	4,372
Belmont Creek	4,909
Borel Creek	8,671
San Lorenzo Creek	20,421
Stevens Creek	22,554
Walnut Creek	24,396
Calabazas Creek	24,765
Zone 5 Line M	25,091
San Leandro Creek	31,336
Pulgas Creek Pump Station - South	53,894
Sunnyvale East Channel	67,462
Ettie Street Pump Station	68,996
Pulgas Creek Pump Station - North	84,490
Glen Echo Creek	85,815
Santa Fe Channel	467,696

Table E-5. Summary of PCB and Hg results organized by PCB/turbidity ratio.

Site	PCB/Turb Avg Ratio (pg/NTU)	HgT/SSC Avg Ratio (ng/mg)	PCB Rank	Hg Rank	Rank Sum	Feasibility Constraint?
Santa Fe	2882	0.68	1	4	5	Tidal
Ettie St	1097	0.78	2	3	5	Access time restricted
Pulgas North	822	0.47	3	5	8	Extremely flashy
Pulgas South	639	0.83	4	1	5	Extremely flashy
Glen Echo	443	0.38	5	7	12	Underground downstream
Sunnyvale Channel	369	0.34	6	8	14	Bridge narrow
San Leandro	98	0.8	7	2	9	
Z5LM	84	0.41	8	6	14	SSC > 1800 mg/L
San Lorenzo	74	0.28	9	9	18	
Stevens	33	0.26	10	11	21	
Calabazas	29	0.16	11	16	27	
Walnut	21	0.1	12	17	29	SSC > 1800 mg/L, 12-24 hour hydrograph – sample preservation
San Tomas	21	0.27	13	10	23	
Lower Penetencia	20	0.16	14	15	29	
Borel	17	0.17	15	14	29	
Belmont	15	0.24	16	12	28	
Lower Marsh	4	0.2	17	13	30	SSC > 1800 mg/L, Remote, access by Hwy 4, sample preservation

For the most part, sampling logistics at these sites were taken into account is part of the decisions made prior to the reconnaissance study. However, there were some additional lessons learned during the reconnaissance study about feasibility and potential sampling constraints that are worth noting (TableE-5). The tidal nature of Santa Fe channel, although it was sampled during low tide, will challenge the measurement of discharge if loads at this site are desired in the future; acoustic Doppler technology at a greater cost would be needed. Three locations (Zone 5 Line M, Walnut and Lower Marsh) had observed turbidities that exceed the use of the DTS12 turbidity sensors employed previously at Guadalupe and Zone 4 Line A; sensor technology that ranges to 4000 NTU is available but with some loss of sensitivity at lower the ranges (<50 NTU). The narrow sampling platform at Sunnyvale East Channel adds challenges for sampling equipment and safety due to lack of space. Sampling locations such as Walnut and Guadalupe with hydrographs that span a day or more may add sample preservation challenges if ice melts before samples can be retrieved following storm events. Lower Marsh Creek is a challenging location due to travel time to the site and the same kinds of preservation challenges.