Item 5 Prioritization of Status and Trends

MEMORANDUM

September 13, 2005

To: Technical Review Committee

From: Meg Sedlak and Jay Davis

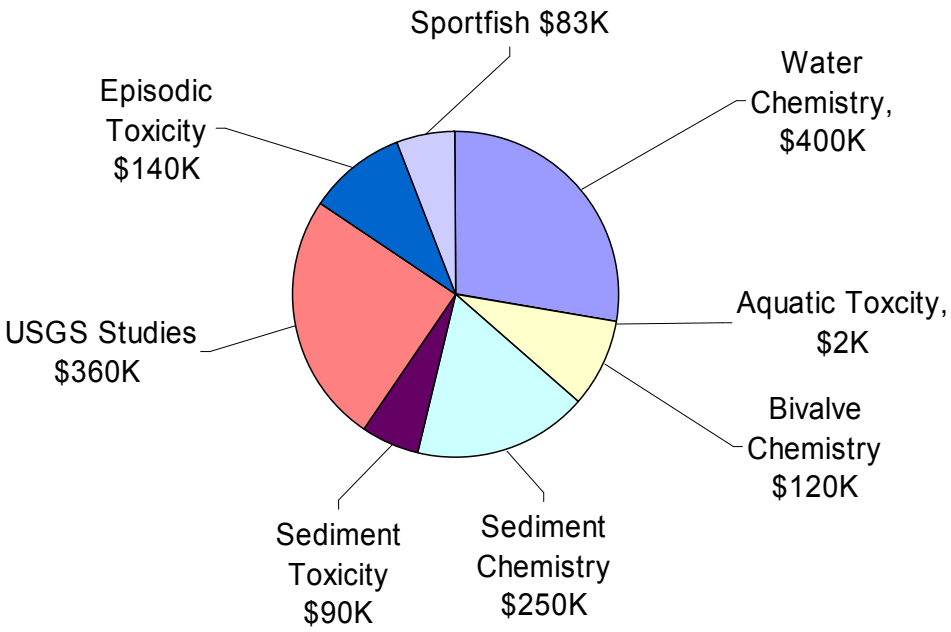
Re: Prioritization of Status and Trends Program Elements

I. INTRODUCTION

The purpose of this memorandum is to evaluate and prioritize the individual elements of the Status and Trends Program and to make recommendations for modification of the Status and Trends Program. The approved budget for the 2005 Status and Trends Program is approximately $1,370,000. Program costs for 2006 are approximately $240,000 higher due to the 2006 triennial fish study ($210,000 for 2006, $40,000 is carried over into 2007) and increased costs associated with the sediment toxicity analyses ($20,000).

The program consists of four major elements: water and sediment chemistry; toxicity (sediment toxicity, aquatic toxicity and episodic toxicity); biological exposure (sportfish survey and bivalve studies); and USGS studies (suspended sediment and hydrography and phytoplankton in the Estuary). The latter program element, which totals $360,000, is conducted and managed by USGS. The RMP only funds a small portion of the total cost. Figure 1 represents the relative annual costs of each of the program elements. The sport fish bioaccumulation monitoring occurs once every three years; however, each year $83,300 is set aside to fund this study to mitigate the impact on any one year. Aquatic toxicity monitoring is conducted approximately once every five years at a cost of $12,000. Table 1 presents a summary matrix of the program elements, priority for inclusion into Status and Trends and recommendations.

Figure 1 Average Annual Program Costs



Insert Table 1 - Program elements, priorities, and recommendations

II. WATER CHEMISTRY

A. DESCRIPTION

Each year water samples are collected from 31 sites within the Estuary and analyzed for select metals and organics. Five of these sites are historical sites and are included in the revised sampling plan to provide continuity between the historic sampling conducted along the spine of the Estuary from 1993 to 2001 and the new random sampling design that was implemented in 2002. The five historic sites are BA30 Dumbarton Bridge, BC10 Yerba Buena Island, BG20 Sacramento River and BG30 San Joaquin River. Three sites, BA30 Dumbarton Bridge, BC10 Yerba Buena Island, and BG20 Sacramento River, are used by the San Francisco Bay Regional Water Quality Control Board for the development of National Pollution Discharge Elimination System (NPDES) permits.

Water samples are analyzed for metals, water quality parameters, and organics including polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and polybrominated diphenyl ethers (PBDEs). A complete list of analytes is presented on Table 2.

Table 2. RMP 2005 Parameter List, Contracting Laboratories, and Target Method Detection Limits (MDLs)

Conventional Water Quality Parameters	Lab(s)
Conductivity	AMS/UCSCDET
Dissolved Ammonia	UCSCDET
Dissolved Nitrate	UCSCDET
Dissolved Nitrite	UCSCDET
Dissolved Organic Carbon	UCSCDET
Particulate Organic Carbon	UCSCDET
Dissolved Oxygen	UCSCDET
Dissolved Phosphates	UCSCDET
Dissolved Silicates	UCSCDET
Hardness (when salinity is < 5 o/oo)	EBMUD
PH	AMS/UCSCDET
Phaeophytin	UCSCDET
Salinity (by salinometer)	UCSCDET
Salinity (by SCT)	AMS/UCSCDET
Temperature	AMS/UCSCDET
Total Chlorophyll-*a*	UCSCDET
Total Suspended Solids	UCSCDET
Sediment Quality Parameters	**Lab(s)**
% clay (< 4 µm)	UCSCDET
% silt (4 µm–62 µm)	UCSCDET
% sand (2 mm > 62 µm)	UCSCDET
% gravel (> 2 mm)	UCSCDET
% solids	BRL/CCSF/EBMUD
Depth	AMS
Hydrogen Sulfide *(QAQC measurements)*	MPSL
pH (porewater, interstitial sediment)	AMS
Total Ammonia *(QAQC measurements)*	MPSL
Total Organic Carbon	UCSCDET
Total Sulfide *(QAQC measurements)*	MPSL
Total Nitrogen	UCSCDET
Bivalve Tissue Parameters	**Lab(s)**
% Lipid	CDFG
% Moisture	CDFG
Bivalve Percent Survival	AMS
Growth - Change in Internal Shell Volume (mean, std. dev)	AMS
Dry Flesh Weight (mean and std error)	AMS
Toxicity Tests—Water and Sediment	**Lab(s)**
Episodic Aquatic Toxicity – (*Ceriodaphnia, Menidia,* Mysid) % Survival	PERL
Sediment Toxicity – (Amphipod) % Survival	MPSL
Sediment Toxicity – (Bivalve) % Normal Development	MPSL

TABLE 2 (CONTINUED). RMP 2005 PARAMETER LIST, CONTRACTING LABORATORIES, AND TARGET METHOD DETECTION LIMITS (MDLS)

Trace elements analyzed in water, sediment, and tissue samples:
Target Method Detection Limits (MDLs) are in parentheses following the reporting units.

	Water (Dissolved and Total)	**Sediment** (dry weight)
Lab(s)	BRL/UCSCDET	BRL/CCSF/ UCSCDET
Aluminum (Al)*	-	mg/kg (200)
Arsenic (As)	µg/L (0.1)	mg/kg (0.2)
Cadmium (Cd)*	µg/L(0.001)	mg/kg (0.001)
Cobalt (Co)*	µg/L(0.001)	
Copper (Cu)*	µg/L (0.01)	Mg/kg (2)
Iron (Fe)*	µg/L(10)	mg/kg (200)
Lead (Pb)*	µg/L (0.001)	mg/kg (0.5)
Manganese (Mn)*	µg/L (0.01)	Mg/kg (20)
Mercury (Hg)	µg/L (.0001)	mg/kg (0.00001)
Methylmercury (MeHg)	Ng/L (0.005)	µg/kg (0.005)
Nickel (Ni)*	µg/L (0.01)	Mg/kg (5)
Selenium (Se)	µg/L (0.02)	mg/kg (0.01)
Silver (Ag)*	µg/L (0.0001)	mg/kg (0.001)
Zinc (Zn)*	µg/L (0.005)	Mg/kg (5)

- Parameter is not sampled for the matrix.

* Near-total instead of total concentrations are reported for water. Near-total metals are extracted with a weak acid (pH < 2) for a minimum of one month, resulting in measurements that approximate bioavailability of these metals to Estuary organisms.

TABLE 2 (CONTINUED). RMP 2005 PARAMETER LIST, CONTRACTING LABORATORIES, AND TARGET MDLS

Trace organic parameters (lab; reporting units) – in water (AXYS & CDFG; pg/L), sediment (EBMUD; µg/kg), and bivalve tissue (CDFG-WPCL; µg/kg) samples:
Organochlorines analyzed by GC-ECD will be determined using two columns of differing polarity.

PAHS
(Target MDLs: water – 200 pg/L, sediment and tissue – 5 µg/kg; water PAHs reported in ng/L)

1-Methylnaphthalene
2,3,5-Trimethylnaphthalene
2,6-Dimethylnaphthalene
2-Methylnaphthalene
Biphenyl
Naphthalene
1-Methylphenanthrene
Acenaphthene
Acenaphthylene
Anthracene
Fluorene
Phenanthrene
Benz(a)anthracene
Chrysene
Fluoranthene
Pyrene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(e)pyrene
Benzo(k)fluoranthene
Dibenz(a,h)anthracene
Perylene
Benzo(ghi)perylene
Indeno(1,2,3-cd)pyrene
Dibenzothiophene

Alkylated PAHs
C1-Chrysenes
C2-Chrysenes
C3-Chrysenes
C4-Chrysenes
C1-Dibenzothiophenes
C2-Dibenzothiophenes
C3-Dibenzothiophenes
C1-Fluoranthene/Pyrenes
C1-Fluorenes
C2-Fluorenes
C3-Fluorenes
C1-Naphthalenes
C2-Naphthalenes
C3-Naphthalenes
C4-Naphthalenes
C1-Phenanthrene/Anthracenes
C2-Phenanthrene/Anthracenes
C3-Phenanthrene/Anthracenes
C4-Phenanthrene/Anthracenes

SYNTHETIC BIOCIDES
(Target MDLs: water – 2 pg/L, sediment and tissue – 1 µg/kg)

Cyclopentadienes
Aldrin
Dieldrin
Endrin

Chlordanes
alpha-Chlordane
cis-Nonachlor
gamma-Chlordane
Heptachlor
Heptachlor Epoxide
Oxychlordane
trans-Nonachlor

DDTs
o,p'-DDD
o,p'-DDE
o,p'-DDT
p,p'-DDD
p,p'-DDE
p,p'-DDT

HCH
alpha-HCH
beta-HCH
delta-HCH
gamma-HCH

Other Synthetic Biocides
Chlorpyrifos (water only; CDFG-WPCL)
Dacthal (water only)
Diazinon (water only; CDFG-WPCL)
Endosulfan I (water only)
Endosulfan II (water only)
Endosulfan Sulfate (water only)
Hexachlorobenzene
Mirex
Oxadiazon (water only)

OTHER SYNTHETIC COMPOUNDS
[1]New analytes added in 2002.
[2]Not required by RMP but are expected to be analyze in the 2002 RMP samples.

PCB congeners (IUPAC numbers)
(Target MDLs: water – 2 pg/L, sediment and tissue – 1 µg/kg)
8, 18, 28, 31, 33, 44, 49, 52, 56, 60, 66, 70, 74, 87, 95, 97, 99, 101, 105, 110, 118, 128, 132, 138, 141, 149, 151, 153, 156, 158, 170, 174, 177, 180, 183, 187, 194, 195, 201, 203

Polybrominated Diphenyl Ethers[1]
(BDE-IUPAC No., Compound Name)
(Target MDLs: water – 1 pg/L, sediment and tissue – 1 µg/kg).

BDE 7	[2,4-DiBDE]
BDE 8	[2,4'-DiBDE]
BDE 10	[2,6-DiBDE]
BDE 11	[3,3'-DiBDE]
BDE 12	[3,4-DiBDE]
BDE 13	[3,4'-DiBDE]
BDE 15	[4,4'-DiBDE]
BDE 17	[2,2',4-triBDE]
BDE 25	[2,3',4-triBDE]
BDE 28	[2,4,4'-triBDE]
BDE 30	[2,4,6-triBDE]
BDE 32	[2,4',6-triBDE]
BDE 33	[2',3,4-triBDE]
BDE 35	[3,3',4-triBDE]
BDE 37	[3,4,4'-triBDE]
BDE 47	[2,2',4,4'-tetraBDE]
BDE 49	[2,2',4,5'-tetraBDE]
BDE 51	[2,2',4,6'-tetraBDE]
BDE 66	[2,3',4,4'-tetraBDE]
BDE 71	[2,3',4',6-tetraBDE]
BDE 75	[2,4,4',6-tetraBDE]
BDE 77	[3,3',4,4',-tetraBDE]
BDE 82	[2,2',3,3',4-pentaBDE]
BDE 85	[2,2',3,4,4'-pentaBDE]
BDE 99	[2,2',4,4'5-pentaBDE]
BDE 100	[2,2',4,4',6-pentaBDE]
BDE 105	[2,3,3',4,4',-pentaBDE]
BDE 116	[2,3,4,5,6-pentaBDE]
BDE 119	[2,3',4,4',6-pentaBDE]
BDE 120	[2,3',4,5,5'-PeBDE
BDE 126	[3,3',4,4',5-PeBDE]
BDE 128	[2,2',3,3',4,4'-hexaBDE]
BDE 138	[2,2',3,4,4',5'-hexaBDE]
BDE 140	[2,2', 3,4,4',6'-hexaBDE]
BDE 153	[2,2',4,4',5,5'-hexaBDE]
BDE 154	[2,2',4,4',5,6'-hexaBDE]

Trace organic parameters (lab; reporting units) – in water (AXYS & CDFG; pg/L), sediment (EBMUD; µg/kg), and bivalve tissue (CDFG-WPCL; µg/kg) samples:

Organochlorines analyzed by GC-ECD will be determined using two columns of differing polarity.

PAHS	SYNTHETIC BIOCIDES	OTHER SYNTHETIC COMPOUNDS
(Target MDLs: water – 200 pg/L, sediment and tissue – 5 µg/kg; water PAHs reported in ng/L)	(Target MDLs: water – 2 pg/L, sediment and tissue – 1 µg/kg)	[1]New analytes added in 2002. [2]Not required by RMP but are expected to be analyze in the 2002 RMP samples.
		BDE 155 [2,2',4,4',6,6'-hexaBDE]
		BDE 166 [2,3,4,4',5,6'-hexaBDE]
		BDE 181 [2,2',3,4,4',5,6'-heptaBDE]
		BDE 183 [2,2',3,4,4',5',6-heptaBDE]
		BDE 190 [2,3,3',4,4',5,6-heptaBDE]
		BDE 203 [2,2',3,4,4',5,5',6]
		BDE 206 [2,2',3,3'4,4',5,5',6]
		BDE 209 [2,2',3,3',4,4',5,5',6,6'-decaBDE]

B. PURPOSE

The collection and analyses of water samples is primarily driven by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB or Water Board). The RMP water data is used to evaluate wastewater permitting requirements (i.e., NPDES permits), to determine Total Maximum Daily Loads (TMDLs), and to determine whether 303 (d) listings under the Clean Water Act are needed. The San Francisco Bay has 303 (d) listings for the following chemicals: chlordane, copper chlorpyrifos, diazinon, dieldrin, DDT, lead, mercury, mirex, nickel PAHs, PCBs, selenium, tributyltin, and zinc. The Water Board has developed a TMDL for mercury and is in the process of preparing a TMDL for PCBs. PBDEs are also of interest to the Water Board because they are viewed as an emerging contaminant with the potential for significant biological effects.

Beyond the regulatory need, information on trace metals, organics, and pesticides is of interest to the RMP to understand food web dynamics. Contaminant information is also of interest scientists that conducted research on the Estuary and consultants involved in the remediation of contaminated sites in the Estuary.

C. USE OF THE DATA/ASSESSMENT OF RMP OBJECTIVES

RMP water data to date has been used in the development of the following regulatory documents, standards, permits and listings:

- TMDLs for Mercury and PCBs (all sites)
- Revised Copper/Nickel Objective for the South Bay
- NPDES permits (three sites only)
- 303 (d) Listings (all sites)

Based on a review of the 2003 Annual Monitoring Results, regulatory standards were exceeded for the following chemicals: copper (one site above California Toxic Rule (CTR)); mercury (three sites were above the total mercury objective); and PCBs (54 sites were above the CTR human health criterion).

In addition, the data are somewhat relevant in answering RMP Objectives 1 (Describe the distribution and trends of pollutant concentrations in the Estuary) and 5 (Compare monitoring information to relevant benchmarks such as TMDL targets, tissue screening levels, water quality objectives, and sediment quality objectives). In general, the water data does not provide good trend or distribution data; however, it is relevant to the evaluation of water quality objectives.

D. COST

The cost of the water chemistry element of the status and trends program in 2005 is presented on Figure 1 and is approximately $400,000. This cost includes both analytical costs and the cost for logistical support (e.g., labor associated with collection of samples, ship costs, etc.). The analytical costs are presented in Table 3.

Table 3 Water Chemistry Costs by Analyte

Trace Metals and Water Quality Parameters		Lab	Cost/Sample	No. of Samples	Cost
	TEs and Water Quality Parameters	UCSC			**103,443**
	WQ (cond, DOC, Do, pH, Phaeo., Sal, Temp, Chlorophyll,etc.)		490	31	15,190
	WQ (POC (new in 2004))		150	31	4,650
	TEs (sample prep.)		60	62	3,720
	TEs (Ag)		105	62	6,510
	TEs (Cu, Ni, Zn, Co)		210	62	13,020
	TEs (Fe, Mn)		130	62	8,060
	TEs (Cd)		105	62	6,510
	TEs (Pb)		105	62	6,510
	TEs (Hg)		135	62	8,370
	TEs (mHg)		220	62	13,640
	Data Reporting		17263		17,263
	TEs (As, Se)	BRL	220	62	**13,640**
	WQ (Hardness)	BACWA-EBMUD	30	20	**600**
Organics		AXYS			**129,470**
	PAHs		450	64	28,800
	PAHs (3 CTR sites -- 3 dissolved and 3 total)		450	6	2,700
	PCBs (dis/part.)		500	64	32,000
	PCBs (tot.) 4L based on cruise schedule		500	2	1,000
	PESTs (original RMP analyte list)		600	64	38,400
	PBDEs (total)		750	29	21,750
	PBDEs (part. and dis.)		750	6	4,500
	Data package & Reporting		70		70
	Shipping costs (extracts to CDFG)		250		250
Select Pesticides		CDFG-MPSL			**9,496**
	Diazinon and Chlorpyrifos in water		118	72	8,496
	Direct Costs & Reporting				1,000
Total					**256,649**

E. POTENTIAL ALTERNATIVES

Potential alternatives to the existing sampling plan include:

- Water sampling is based on a power analysis of copper concentrations because at that time of the design of sampling sites, copper was listed as impairing the Estuary. This is no longer the case; however, the sampling design has not changed. Approximately ten stations are sampled in South Bay, six in Lower South Bay. In the remaining three hydrographic regions, Central Bay, Suisun Bay, and San Pablo Bay, four sites are sampled. It is possible that if the power analysis were developed for a different chemical that the number of samples collected in the South and Lower South Bay would be reduced. If the total cost of the program is divided by site, each site represents a cost of approximately $13,000.
- Reducing the total number of sites by half. This would represent a savings on the order of approximately $150,000 due to the relatively fixed costs of mobilization/demobilization.
- Reduce the frequency of water sampling to every other year (a savings of approximately $200,000).
- The ambient water quality criteria for organics have been established for total concentration of organics present. In the Status & Trends program, PCBs, pesticides, and PAHs are typically analyzed for both total and dissolved fractions. It is not clear that information on the dissolved fraction is being used. If the RMP analyzed only total PCBs, pesticides, and PAHs in water, this would represent a savings of $16,000, $19,000 and $24,000, respectively.
- Re-evaluate analyte list to determine those chemicals are of most importance and reduce the frequency of the analytes that are of less interest (e.g., PAHs).

III. SEDIMENT CHEMISTRY

A. DESCRIPTION

Sediment contaminant monitoring is undertaken at 40 random stations and seven fixed stations (Sacramento River (BG20), San Joaquin River (BG30), Grizzly Bay (BF21), Pinole Point (BD31), Yerba Buena Island (BC11), Redwood Creek (BA41), and Coyote Creek (BA10). At least one historical station was maintained per region to allow for analysis of long-term temporal trends.

Sediment samples are analyzed for metals, sediment quality parameters, and organics including PAHs, PCBs, pesticides, and PBDEs. A complete list of analytes is presented on Table 2.

B. PURPOSE

Sediments represent both a source and a sink for contaminants. Contaminants may be resuspended into the water column as a result of wave action, bioturbation, seismic activity, or other disturbances. Depending on the area of the Estuary, contaminants may be buried as material settles out of the water column. Sediment samples are analyzed to better understand the fate and transport of contaminants in the Estuary and the introduction of contaminants into the food web. Sediment data are used corroborate modeling efforts.

C. USE OF DATA/ASSESSMENT OF RMP OBJECTIVES

RMP sediment data has been used to develop the following regulatory policies and documents:

- Development of TMDLs for Mercury and PCBs
- Development of California Sediment Quality Objectives
- 303 (d) Listings
- Development of Ambient Sediment Concentration (ASC) by the Water Board which are used to distinguish “ambient” from “contaminated” sediments.

In addition, the data are somewhat relevant in answering RMP Objectives 1 (Describe the distribution and trends of pollutant concentrations in the Estuary), Objective 2 (Project future contaminant status and trends using current understanding of ecosystem processes and human activities), and 5 (Compare monitoring information to relevant benchmarks such as TMDL targets, tissue screening levels, water quality objectives, and sediment quality objectives). With regard to Objective 1, the spatial trends are easily discerned from the sediment data and correlate well with our understanding of sediment contamination, hot spots and sources. Strong temporal trends in the sediment data are not evident. Under Objective 2, sediment data has been useful for the calibration of the multi-box model which will be used to predict future

contaminant concentrations. Lastly, it is anticipated that the RMP data will be useful for evaluating Objective 5, particularly after the Sediment Quality Objectives are promulgated in 2007.

D. COST

The cost of the sediment chemistry element of the Status and Trends program is presented on Figure 1 and is approximately $180,000, which includes logistical support. Table 4 presents the sediment chemistry costs by analyte.

Table 4 Sediment Chemistry Costs by Analyte

Parameter	Lab	Cost/Sample	No. of Samples	Costs
TEs & Sediment Quality	UCSC			**34,659**
SedQuality (% solids, TOC, TN)		120	47	5,640
SedQuality (Grain size)		140	47	6,580
TEs (Hg)		135	47	6,345
TEs (mHg)		220	47	10,340
Data Reporting		5754		5,754
TEs (Al, Ag, Cd, Cu, Fe, Pb, Mn, Ni, Zn)	BACWA-CCSF	160	47	**7,520**
TEs (As, Se, %solids)	BRL	217	47	**10,199**
ORGs	BACWA-EBMUD			**99,200**
PAHs		350	47	16,450
PCBs (original RMP analyte list)		550	47	25,850
PEST (original RMP analyte list)		550	47	25,850
PBDEs		550	47	25,850
Proj. Management & Reporting		5200	na	5,200
Total				**151,578**

E. POTENTIAL ALTERNATIVES

Potential alternatives include the following:

- Reducing the number of shallow surface samples and using this funding to collect sediment cores. Very few coring studies have been conducted in the Estuary. A limited study was conducted in 1990s by the USGS in which two cores were advanced. Buried sediments are in many instances more contaminated than surface sediments. Recent work by the USGS indicates that many areas of the Bay that were once depositional are now eroding. As such, these buried

contaminated sediment may represent a potentially significant future input to the Estuary. In 2005, as part of a special study with the Clean Estuary Partnership (CEP), the RMP will advance approximately 17 cores to a depth of two meters in the Estuary to enhance our understanding of sediment chemistry and dynamics. Because of the dearth of coring information, it may be appropriate for the RMP to collect cores on annual basis. The estimated aggregated cost per core for the 2005 study is approximately $20,000. Cores will be segmented and analyzed for radioisotopes, PCBs, PBDEs, and mercury on a limited basis.

- An argument can also be made for expanding the collection of surface sediments. At present, very little data is available regarding the near-shore sediments. The redesign program initiated in 2003 has begun to address this issue; however, a targeted effort at near shore samples may be warranted.

- Conduct power analysis to determine the number of sites. Similar to water chemistry, the sampling design for sediment was largely driven by copper, which is no longer a significant concern. A new power analysis may indicate that fewer sites are needed in the South Bay or Lower South Bay.

- Evaluate the analyte list. It may be that fewer analyses are required on an annual basis.

IV. BIVALVE BIOACCUMULATION MONITORING

A. DESCRIPTION

The RMP deploys mussels (*M. californianus*) at nine fixed-mooring stations within the Estuary for a period of 90 to 100 days. The number of sites was calculated in part on a power analyses to detect change within the five segments for PCBs and dieldrin. Bivalve monitoring is conducted during the dry season months (June through August). In addition, resident clams (*Corbicula fluminea*) are collected from the Sacramento and San Joaquin River stations. Bivalves are analyzed for organics annually and approximately every five years are analyzed for trace metals. Bivalves were most recently analyzed for trace metals in 2001.

B. PURPOSE

Bivalves are an excellent organism for understanding the uptake of contaminants into the food web and the potential bioavailability of contaminants of concern. Bivalves are a good organism to monitor because they tend to assimilate contaminants from the water column and sediment, have limited mobility, and are fairly resistant to contaminant effects.

C. USE OF DATA/ACHIEVEMENT OF RMP OBJECTIVES

RMP tissue data to date has been used in the following programs:

- State Mussel Watch (SWM) Program

The bivalve data is one of the best indicators of long term temporal trends of organics in the Estuary. These data are used to address RMP Objective 1 (Describe the distribution and trends of pollutant concentrations in the Estuary) and Objective 2 (Project future contaminant status and trends using best understanding of ecosystem processes and human activities) through the use of this data to verify models.

D. COST

The cost of the tissue chemistry element of the 2005 status and trends program is presented on Figure 1 and is approximately $125,000 including both analytical costs and sampling logistics (e.g. labor associated with deployment and collection of mussels, ship costs, etc.). Detailed analytical costs are presented on Table 5.

Table 5 Bivalve Costs by Analyte

Lab/Analyte	Sample Cost	No. of Samples	Cost
CDFG-MPSL			
Organics			
Wet chemistry (prep)	110	13	1,430
%Moisture, % Lipid	19	13	247
PAHs	700	13	9,100
PCBs	474	13	6,162
PESTs (original RMP analyte list)	515	13	6,695
New analyte – PBDE	474	13	6,162
Direct costs & Reporting	2,145		2,145
Total			**31,941**

E. POTENTIAL ALTERNATIVES

Potential alternatives include:

- Elimination of maintenance cruise. At present, maintenance cruises are conducted to assure that the cages that contain the bivalves are in good condition. Applied Marine Sciences, the subcontractor that conducts this work, has determined that maintenance cruises are no longer necessary. If the cruises are eliminated, the program will save approximately $10,000.

- Re-instate Horshoe Bay as a sampling site. Horseshoe Bay was eliminated as a sampling site in 2003. As this site represents one of seven sites in which long-term data is available from the Mussel Watch Program, it is recommended to re-instate this site. The approximate cost to re-instate this site is $13,000.
- Long-term trends are more consistently observed in dry season data than in wet season data. However, significant correlations between delta outflow and pesticide concentrations have been observed during the wet season. To evaluate the influence of delta outflow on the contaminant load, it is recommended that wet season sampling be conducted at BC10 (Yerba Buena Island).
- Institute a biennial program.
- Reduce the number sites to seven for which there is long-term data from the State Mussel Watch Program.

V. SPORT FISH BIOACCUMULATION MONITORING

A. DESCRIPTION

Sport fish sampling occurs on a three-year cycle and will occur next in 2006. The following sport fish species are collected and analyzed for mercury, PCBs, and organochlorine pesticides, and PBDEs: striped bass, California halibut, leopard shark, white croaker, white sturgeon, jacksmelt,and shiner surfperch.

B. PURPOSE

Sport fish data is used to evaluate the necessity for fish consumption advisories. It also gives an indication of the potential bioaccumulation of contaminants in the food web.

C. USE OF DATA/ACHEIVEMENT OF RMP OBJECTIVES

RMP fish data to date has been used in the following regulatory documents:

- Development of Mercury and PCB TMDLs;
- 303 (d) Listings; and
- OEHHA Fish Consumption Advisories.

This task fulfills RMP Objective 1 (i.e., describe patterns and trends in contaminant concentration and distribution) by evaluating the temporal trends in impairment of the fishability of Bay waters; however, the sport fish data is not the best indicator of temporal trends. The fish data is compared to screening values for protection of human health, representing a key impairment indicator for the Estuary and therefore, fulfills Objective 5 (i.e., compare monitoring information to relevant benchmarks such as

TMDL targets, tissue screening levels, water quality objectives and sediment quality objects). In addition, information about concentrations of contaminants in fish is key for determining exposure to humans (Objective 4 Measure pollution exposure and effects on select parts of the Estuary ecosystem including humans).

D. COST

The cost of the sport fish bioaccumulation element of the Status and Trends program is presented on Figure 1 and is approximately $83,300 per year. The sport fish sampling is conducted every three years and costs $250,000. Approximately $83,300 is set aside each year for this program in an effort to lessen the financial burden of this program on any one year.

E. POTENTIAL ALTERNATIVES

Potential alternatives include:

- Conduct the program less frequently (e.g., every four or five years).
- Analyze fewer species (e.g., two major species such as striped bass and croaker and small fish).

VI. SEDIMENT TOXICITY

A. DESCRIPTION

Sediment bioassays are conducted on sediment collected from 27 stations. Two types of sediment bioassays are conducted to determine the toxicity of the sediment and the pore water within the sediment. Amphipods (*Eohaustorius estuaries*) are exposed to whole sediment for ten days with percent survival as the endpoint. Larval mussels (*Mytilus galloprovincialis*) are exposed to sediment elutriates (water-soluble fraction) for 48 hours with percent normal development as the endpoint. When a sample is observed to be toxic, it is interpreted as an indication of the potential for biological effects to estuarine organisms. In addition to the bioassays, in some cases, further work is conducted to determine the potential cause of toxicity by using Toxicity Identification Evaluations (TIE).

B. PURPOSE

Purpose of sediment toxicity analyses is to attempt to understand the biological effect of the contaminants in the sediment. The analyses are somewhat limited in that they focus on one species looking for acute effects.

C. USE OF DATA/ACHIEVEMENT OF RMP OBJECTIVES

RMP sediment toxicity data to date has been used to:

- Restrict the use of diazinon and chlorpyrifos

- Development 303 (d) Listings

The sediment toxicity data is one of the primary means for evaluating Objective 4 - Measure pollution exposure and effects on selected parts of the Estuary ecosystem (including humans). This data will also be useful in evaluating the Sediment Quality Objectives when they are promulgated in 2007 and will address Objective 5, Compare monitoring information to relevant benchmarks, such as TMDL targets, tissue screening levels, water quality objectives and sediment quality objectives.

D. COST

The cost of the sediment toxicity element of the Status and Trends program is presented on Figure 1 and is approximately $90,000, which includes both the cost of conducting the tests and logistical support necessary to collect bivalves. The analytical costs are presented in detail below.

Laboratory	Analysis	Cost of Sample	Number of Samples	Cost
UCD-GCML	Toxicity Test	$1,400	27	$37,800
	TIE	$23,250	2	$23,250

E. POTENTIAL ALTERNATIVES

Potential alternatives include:

- Sediment toxicity is more pronounced in the winter. At present, sediment toxicity is only measured in the summer. It would be easier to determine the potential cause of the toxicity of the sediments if samples were collected when there is a higher toxicity signal, which occurs in the winter. One alternative is to collect half the number of samples in the summer and then collect the remaining half in the winter.
- Focusing the TIE testing on sites that have high signals of toxicity to understand what is causing the toxicity in the Estuary. This effort would likely be focused on the winter sampling event when toxicity is greater.
- The number of sites could be reduced.
- Alternate between wet and dry season sampling events.

VII. AQUATICTOXICITY

A. DESCRIPTION

Aquatic toxicity is conducted at nine shallow stations. The seven-day toxicity tests are conducted using Americamysis bahia (a brine shrimp). Little aquatic toxicity has been observed over the last several years, which in part may be due to the declining use of the organophosphate pesticides (e.g., diazinon and chlorpyrifos). As a result of the diminished aquatic toxicity, this program element is scheduled every four or five years. The last event was conducted in 2002. The next event is scheduled to occur in 2006.

B. PURPOSE

Aquatic toxicity measurements are a method to evaluate the overall health of the Bay. Chemical analyses do not always provide complete information (e.g., the effects of multiple contaminants on an organism may not be readily identified from chemical analyses alone).

C. USE OF DATA/ACHIEVEMENT OF RMP OBJECTIVES

RMP data has been used:

- To evaluate whether water or sediment samples are impacting aquatic life.

Aquatic toxicity data provides information to answer management Objectives 4 (Measure pollution exposure and effects on selected parts of the Estuary ecosystem (including humans) and 5 (Compare monitoring information to relevant benchmarks such as TMDL targets, tissue screening levels, water quality objectives and sediment quality objectives).

D. COST

The cost of the aquatic toxicity element of the status and trends program is presented on Figure 1 and is approximately $12,000. This cost does not include the cost for logistical support (e.g., ship costs, labor associated with collection of samples, etc.)

E. POTENTIAL ALTERNATIVES

This element is considered a relatively inexpensive method to measure the overall health of the Estuary. The program is conducted infrequently, approximately once every five years.

- It is recommended that in additional to mortality, other endpoints such as fecundity and growth be measured.

VIII. EPISODIC TOXICITY

A. DESCRIPTION

Episodic toxicity studies are conducted annually. In 2005, the program evaluated the potential effects of sediment and aquatic toxicity. The study investigated the potential toxicity to both freshwater and estuarine amphipods in sediments from six tributaries around the Estuary whose land uses include varying combinations of urban and agricultural practices. Aquatic toxicity was evaluated in five tributaries in the Spring of 2005 using ceriodaphnia (invertebrate) and menidia (larval fish) tests. The results from these investigations are still pending.

The toxicity workgroup recently met in September 2005 to discuss sediment, aquatic, and episodic toxicity and how these program elements can be designed to work collaboratively. The toxicity workgroup also considered ways in which benthos can be incorporated into the toxicity studies. A draft work plan has been circulated to the workgroup and a recommendation will be made to the Technical Review Committee in the near future. One important discussion point at the meeting was the seasonal aspect of toxicity. Greater toxicity is observed in the wet season; however, the bulk of the Status and Trends program is conducted during the dry season.

B. PURPOSE

The episodic toxicity program provides information on the impact of increased contaminant loads during storm events. Understanding the causes and duration of toxicity will assist in the design of appropriate management actions.

C. USE OF DATA/ACHIEVEMENT OF RMP OBJECTIVES

RMP data has been used:

- To evaluate whether water or sediment samples are impacting aquatic life.

Episodic toxicity data provides information to answer management objectives 4 (Measure pollution exposure and effects on selected parts of the Estuary ecosystem (including humans) and 5 (Compare monitoring information to relevant benchmarks such as TMDL targets, tissue screening levels, water quality objectives and sediment quality objectives).

D. COST

The cost of the episodic toxicity of the Status and Trends program is presented on Figure 1 and is approximately $140,000 annually

E. POTENTIAL ALTERNATIVES

Potential alternatives include:

- Conducting this program on a biennial or triennial basis.

- Designing a program that will include sediment toxicity, aquatic toxicity and a benthos element to evaluate causes of toxicity. It is anticipated that the sampling program would evaluate conditions before and after episodic events to identify the impacts of the events and the duration of toxicity. This program element might include TIE to identify the causes of toxicity.

VIII. USGS STUDIES

A. DESCRIPTION

The USGS investigates suspended sediment dynamics at ten stations in the Estuary. This work has yielded many insights into sediment and contaminant dynamics in the Estuary. The RMP funds a portion of the overall work conducted by the USGS in the Estuary. In light of USGS funding shortfalls in 2005, the number of stations monitored for the 2005/2006 year will likely be reduced from ten to six.

The RMP also funds work conducted by the USGS on hydrography and phytoplankton. Water samples are collected monthly at 38 stations and analyzed for basic water quality parameters such as salinity, temperature, dissolved oxygen, chlorophyll, suspended sediments, and phytoplankton mass.

B. PURPOSE

The purpose of collecting the suspended sediment data is to better understand sediment transport and by analogy contaminant transport within the Estuary. The purpose of the collection of hydrography and phytoplankton information is to provide basic water quality information on the Estuary.

C. USE OF DATA/ACHEIVEMENT OF RMP OBJECTIVES

USGS data to date has been used in the following regulatory documents:

- Development of Mercury and PCB TMDLs;
- 303 (d) Listings; and
- Development of the multi-box models.

Information on suspended sediments is important for describing the distribution and trends of pollutant concentrations in the Estuary (Objective 1). Contaminants are frequently associated with particulate matter so an understanding of suspended sediment loads is imperative. Information on suspended sediments is also used to answer questions associated with management Objectives 2 (Project future contaminant status and trends using current understanding of ecosystem processes and human activities) and Objective 3 (Describe sources, pathways, and loadings of pollutants entering the Estuary). Suspended sediment loads are an integral part of the development of the multi-box model which is being developed to predict future trends and impacts of management actions. Suspended sediment measurements are also key in the calculation of loads entering the Estuary (Objective 3).

Water quality information provided by the hydrography and phytoplankton work is used to evaluate Objective 1 with regard to trends in dissolved oxygen, primary production, and turbidity as well as address Objective 5 with regard to the water quality objective for oxygen.

D. COST

The cost of the USGS element of the Status and Trends program is presented on Figure 1 and is approximately $360,000 per year. The USGS suspended sediment study costs $250,000; the hydrography and phytoplankton study is $110,000.

E. POTENTIAL ALTERNATIVES

The USGS is currently re-evaluating its station locations in the Estuary. Preliminary meetings with the USGS, RMP, and the US Army Corps of Engineers suggest that six stations will be funded in the Estuary for the 2005/2006 year. These stations proposed include: Mallard, Benecia, Point San Pablo, and Dumbarton Bridge. Two temporary movable sites were proposed. One temporary site was proposed at the aquatic transfer station near Hamilton Air Force Base. The location of the second site was not discussed. Instead it was proposed that the funding for the second temporary site be used to develop sediment flux calculations at the Dumbarton Bridge station.

It is possible that the hydrography and phytoplankton studies could be reduced in frequency to biennial studies.

IX. NEW STUDIES: CORMORANTS

A. DESCRIPTION

The Exposure and Effect Pilot Study of the RMP (EEPS) began studying cormorant eggs in 2002 to determine if they were suitable as a long-term trend and spatial indicator of contamination in the Estuary. To date, EEPS has collected two years of cormorant data (2002 and 2004). Three colonies were sampled: Don Edwards (South Bay), Richmond Bridge (Central Bay), and Wheeler Island (Suisun Bay). At each colony, 20 randomly selected freshly laid eggs were collected by US Fish and Wildlife Service and composited into two samples consisting of ten eggs each. The samples were analyzed for PCBs, Hg, Se, pesticides, PBDEs, and dioxins as well as the emerging contaminants (musks, nonylphenol, triphenylphosphate).

B. PURPOSE

The purpose of the collection and analyses of cormorant eggs is to determine its suitability as a spatial and temporal indicator, to evaluate contaminant impacts to piscivorous birds, and to gain an understanding of the potential for bioaccumulation in the food web. Double-crested cormorants are recommended as an indicator for the following reasons: they are year-round residents, they eat Bay fish almost exclusively; they have been the subject of organochlorine studies in the Bay; their eggs are easy to

collect; the colonies and eggs are reliably present; and they are known to accumulate Hg and organochlorines. To date, they have been a valuable indicator of trends.

C. USE OF DATA/ACHIEVEMENT OF RMP OBJECTIVES

Cormorant data will be useful in answering Objectives 1 (Describe the distribution and trends of pollutant concentrations in the Estuary) and 4 (Measure pollution exposure and effects on selected parts of the Estuary ecosystem (including humans)).

D. COST

The cost of the cormorant element of the status and trends program is expected to be approximately $40,000 for the chemical analyses. In the past, US Fish and Wildlife Service has collected egg samples pro bono. It is anticipated that this program will be undertaken on a biennial basis.

X. NEW STUDIES: BENTHOS

A. DESCRIPTION

SFEI has assisted in the development of Sediment Quality Objectives (SQOs) for the State Water Resources Control Board. SQOs are based on multiple lines of evidence (e.g., sediment chemistry, toxicity and benthic community assessments) that in aggregate suggest an adverse impact. This is a new regulatory approach that includes measurements of exposure and biological effects. SQOs are scheduled to be promulgated in 2007.

In preparation for the promulgation of the SQOs, an RMP work group consisting of the Regional Water Quality Control Board, SFEI, Department of Water Resources, and interested RMP participants would be convened in 2006. The work group would develop a benthos sampling plan for the 2007 field season. This planning effort is estimated to cost approximately $10,000.

B. PURPOSE

The purpose of the benthos study is to provide the Regional Water Quality Control Board with benthic data that can be used in the assessment of the SQOs.

C. USE OF DATA/ACHIEVEMENT OF RMP OBJECTIVES

SWQCB will use benthic data and the SQOs for NPDES, 303(d), dredging, and remediation decisions. In addition, the benthic data will be useful in evaluating Objective 4, measure pollution exposure and effects on selected parts of the Estuary ecosystem (including humans). As part of a five-year review of the RMP by outside experts, a recommendation was made that the RMP conduct more monitoring of biological exposure and effects in an effort to understand the impact of the contaminants observed in the Estuary. This program element is a direct response to this recommendation.

D. COST

At this time, it is envisioned that three samples would be collected in each of five Estuary benthic assemblages, for a total of 15 samples annually. DWR currently samples benthos in San Pablo, and Suisun Bays, and the Delta, and may be willing to provide their data from those samples, leaving the RMP to increase the number of samples collected in Central and South bays. Sample collection would be undertaken concurrently with the annual RMP sediment sampling cruise, thereby adding minimally to sampling costs. Sorting and taxonomy of the benthic samples could be accomplished for approximately $3,000 per sample. Data management will require about 50 hours and data analysis, interpretation, and reporting would become part of the Pulse of the Estuary production and may require approximately 60 hours of staff time annually. A sampling program of this magnitude would have an estimated annual cost on the order of $60,000.