Sarah Holingren

organic and inorganic toxicants, bacteria, and viruses.

From an agricultural perspective, the effects of turbidity on plants and soils include the formation of crusts at the soil surface (which inhibits water infiltration and aeration, impedes seedling emergence, and hinders leaching of saline soils), and the formation of films on plant leaves (which blocks sunlight and reduces photosynthesis and marketability). High colloidal content in water used for sprinkler irrigation can result in deposition of films on leafy vegetable crops such as lettuce, which affects marketability and management. Settleable matter in the water can prematurely decrease reservoir capacity, and increase maintenance requirements on delivery canals due to siltation. Turbidity also increases wear on pumping facilities. As agricultural lands in the Sacramento and San Joaquin valleys continue to be irrigated with low-volume irrigation systems like drip and micro-sprinkle, clogging, maintenance, and on-farm water management (e.g., filtration) requirements will need to be considered when selecting a new system or evaluating water supply. Filtration and maintenance requirements for turbid water for low-volume irrigation can be costly and may make the water unusable.

### 3.2.2 Loadings of Parameters (or Constituents) of Concern

~~[This section is currently being rewritten. It remains unchanged from its September 2, 1997, version.]~~

Sources of water quality parameters of concern in the Delta and its tributaries include:

- drainage from inactive and abandoned mines that introduce metals such as cadmium, copper, zinc, and mercury;
- stormwater inflows and urban runoff that may contribute metals, selenium, turbidity, pathogens, organic carbon, nutrients, pesticides, petroleum, and other chemical residues;
- municipal and industrial discharges that may contribute salts, metals, trace elements, nutrients, pathogens, chemical residues, oil and grease, and turbidity;
- agricultural tail-water, or return flows, that may contribute salts, nutrients, pesticide residues, pathogens, and turbidity; ~~and,~~
- subsurface agricultural drainage that may contribute salts, selenium and other trace elements, nutrients, and pesticides (including some fungicides); and,
- atmospheric deposition that may contribute metals, pesticides, and some organics.

Where information was available, estimated loadings for parameters of concern were developed. These estimates are shown in Tables 3.6 to 3.154. Source loadings ~~are~~ originate primarily ~~due to either~~ from agricultural drainage, ~~or~~ mine drainage, wastewater discharges, and urban runoff. ~~or~~ They may be modified by flow regulation. These tables ~~illustrate~~ provide the quantitative results of the analysis of the relative loadings of ~~parameters~~ consituents from four of the five CALFED study regions (~~e.g~~ i.e., the Bay, Delta, San Joaquin, and



Rec'd 12/2/97 from Peter Standish-Lee

Sacramento regions). ~~Note, in the graphs accompanying each table, zero values do not indicate zero loads, but rather a lack of information (as depicted in the tables).~~ Additional information that was used in compiling these tables can be found in ~~Attachment B~~ Attachment C.

Load estimates were made for four regions;; the Sacramento River Basin, the San Joaquin River Basin, the Delta, and the Bay Region. The Sacramento River Basin estimates were further subdivided into loads generated above and below the three major dams, Shasta, Oroville, and ~~Nimbus~~ Folsom.

Load estimates ~~will be~~ were used to help evaluate ~~determine~~ the relative importance of different ~~parameter of concern~~ sources and the potential effectiveness of CALFED water quality actions. For example, it may be determined that municipal and industrial wastewater treatment plants contribute less than 5 percent of the copper discharges to the Delta. It is apparent from the copper loading estimates that additional measures to reduce copper from this source are unlikely to ~~greatly~~ significantly affect copper concentrations in the Delta.

**Analytical Approach and Organization of Information**

Considerable information on pollutants discharged to the Sacramento River Basin, the San Joaquin River Basin, the Delta, and the Bay Region, as well as ~~and~~ pollutant concentrations found in various water bodies, is available, but it is not found in a single drepository. Developing ~~a comprehensive picture~~ estimates of pollutant loadings involvesd compilation of potentially relevant data from published and unpublished sources, review of the data by the CALFED water quality team and, in many cases, further ~~manipulation~~adjustment of the data ~~into the form of~~ to provide the most realistic load estimates possible.

Pollutant load estimates are difficult to make for large geographical areas because data are always limited and many assumptions ~~have to~~ must be made. The approach used here was to try to make fairly complete load estimates for the various ~~parameters~~ constituents, even if fairly gross assumptions ~~have to be made. The load estimates will then be progressively refined as additional data are acquired and analyses completed~~ are required.

The ~~following analytical report includes a number of~~ results of the analysis are summarized in nine separate sections which addressing each key ~~parameter~~ constituent of concern. Each section ~~consists of~~ contains a tabular ~~and graphical~~ summary of loading data and a series of notes. ~~The~~ Additional notes (see Attachment C) describe the data sources and any analyses undertaken to produce the load estimates.

Two approaches to load estimation were used, and where possible, their results were compared in the tabular~~and graphical~~ summaries. The first approach was to estimate the loads attributable to each of the major sources and then to sum the loads ~~up~~ to provide a total basin load. Major contaminant source categories include agricultural ~~stormwater~~ tailwater (surface) runoff and subsurface drainage, mine drainage, municipal and industrial wastewater discharges, and urban stormwater runoff. Loadings from these sources are typically associated with discharges from outfalls and/or agricultural drains.

The second approach was to estimate the total pollutant emission from ~~a~~each basin ~~by calculating the load contained in water exiting the basin at its downstream end~~based on in-stream flows and water quality data. The loads calculated using the two approaches are not directly comparable because some of the pollutants discharged to waterways in a basin may be stored in sediments, reservoirs and biota, or transformed into other substances as a consequence of chemical reactions and biological activity. However, they do provide a means to check for order-of-magnitude reasonableness.

**Limitations**

Because of the many assumptions and simplifications involved in the load estimates, the results ~~need to~~ are only order-of-magnitudes estimates and they should be used with caution. Moreover, informational gaps precluded making estimates for all sources, including many that are considered to be major. The more important assumptions and simplifications are noted below.

Year-to-year variations

Most contaminant sources are affected by meteorological conditions. For example, ~~T~~ the total annual contaminant loads from agricultural and urban runoff depend on the volume of runoff, which can vary widely from year-to-year. Similarly, annual ~~M~~ mine drainage loads are ~~similarly~~ weather-dependent. Waste loads associated with municipal and industrial wastewater discharges are less affected by weather. The same may be true for waste loads in agricultural subsurface drainage, which probably depend more on irrigation rates than precipitation.

Because the data available to characterize contaminant loads ~~is~~are limited, ~~it was~~ they were not separately compiled for different meteorological conditions. Ideally, loads should be separately estimated for wet, normal, dry, and very dry years. Instead, data from different years, representing different meteorological conditions, were compiled to produce a single annual load estimate. ~~that may approximate "typical" conditions~~ Thus, they are not truly reprsentative of actual conditions.

Seasonality of loadings

Most contaminant emissions vary seasonally. The initial load estimates contained in this report were made on an annual basis. ~~If the available data allows, later refinements may be made to the load estimates to account for seasonality~~ In cases where pollutant effects are seasonal, seasonal loads may be a more appropriate indicator than annual loads.

Background loads

The load estimates do not attempt to account for background loads. Many substances regarded as contaminants occur at low concentrations in waters not ~~un~~influenced by human activities. This is the case for metals and trace elements, salts, naturally-occurring organic substances and ~~plant~~ nutrients. ~~This~~ It does not apply to synthetic organics, including pesticides.

Theis lack of allowance for background loads probably does not greatly affect load estimates for relatively concentrated waste streams. If, for example, a city draws water from a river, uses it for municipal supply and discharges it back to the river afterfollowing wastewater treatment, then the phosphorus load attributable to the municipal wastewater discharge is the load contained in the effluent less the background load contained in the source water. In this case, the background phosphorus concentration might be 0.05 mg/l while the concentration of phosphorus in the wastewater effluent would berange from 5 orto 10 mg/l. Thus Tthe phosphorus load attributable to the municipal source would be similar, whether or not the background concentration is allowed forwas considered.

However, the Llack of an adjustment for background loads can have a greater effects on loads attributable to dilute, but high-volume, waste streams. For example, copper concentrations in agricultural runoff may be estimated to beat 0.01 mg/l, while copper concentrations in runoff from non-agricultural lands with similar soil chemistry characteristics may be 0.005 mg/l. Not

**Table 3.6 Bromide Loading**

## Table 3.6 ESTIMATED MEAN ANNUAL BROMIDE LOADINGS

( thousands of pounds/year)

| Source | Upper Sacramento Basin above Dams | Note | Lower Sacramento Basin below dams | Note | San Joaquin Basin | Note | Delta | Note | Bay Region | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| Agricultural | | | 380 | *a* | | | | | | |
| Mine Drainage | | | | | | | | | | |
| M&I Wastewater (POTW) | | | | | | | | | | |
| Urban Runoff | | | | | | | | | | |
| Flow Regulation | | | | | | | | | | |
| Total Load | | | | | | | | | | |
| Basin Emission | | | <450 | *e* | 1300 | *e* | | | | |

General Notes:

Note 1: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Note 2: Loads include background and/or upland sources

Note 3: A source of bromide to the Delta is seawater intrusion from San Francisco Bay but no quantitative estimate of this source is currently available

Note 4: San Joaquin loads reflect bromide that comes from the Bay and is recirculated (See Attachment C).

Note 5: Loads may vary significantly from mean annual values depending on water year type

Note 6: See Attachment C for further notes and an explanation of how the loading estimates were derived.

Key: [vertical-hatched box] - Further literature review required.
[stippled box] - Source does not contribute significant load of constituent in this watershed.

x:\calfed\LOADTBLS.XLS\Bromide

## Table 3.7 ESTIMATED MEAN ANNUAL CADMIUM LOADINGS

(pounds/year)

| Source | Upper Sacramento Basin above Dams | Note | Lower Sacramento Basin below dams | Note | San Joaquin Basin | Note | Bay Region | Note | Delta | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| Agricultural | | | 600 | *a* | | | | | | |
| Mine Drainage | 2600 | *b* | 16,600 | *b* | 10 | *b* | | | | |
| M&I Wastewater (POTW) | | | 100 | *c* | Not available | | 6600 | *c* | 80 | c |
| Urban Runoff | | | 600 | *d* | 200 | *d* | 3000 | *d* | 150 | d |
| Flow Regulation | | | | | | | | | | |
| Total Load | | | | | | | | | | |
| Basin Emission | | | | | <160 | *e* | | | | |

General Notes:

Note 1: Letters listed in italics under the Note column provide the background and references associated with the accompanying load (see App. C)
Note 2: Loads include background and/or upland inputs
Note 3: Basin emissions for cadmium are unreliable as most data are below detection levels
Note 4: Loads may vary significantly from mean annual values depending on water year type
Note 4: See Attachment C for further notes and an explanation of how the loading estimates were derived.

Key: (hatched) - Further literature review required.
(stippled) - Source does not contribute significant load of constituent in this watershed.

x:\calfed\LOADTBLS.XLS\cadmium

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## Table 3.8 ESTIMATED MEAN ANNUAL COPPER LOADINGS

(thousands of pounds/year)

| Source | Upper Sacramento Basin above Dams | Note | Lower Sacramento Basin below dams | Note | San Joaquin Basin | Note | Delta | Note | Bay Region | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| Agricultural | | | 41 | *a* | | | | | | |
| Mine Drainage | 220 | *b* | 330 | *b* | 0.20 | *b* | 4 | *b* | | |
| M&I Wastewater (POTW) | | | 6 | *c* | | | 2 | *c* | 55 | c |
| Urban Runoff | | | 21 | *d* | 7 | *d* | 5 | *d* | 70 | d |
| Flow Regulation | | | | | | | | | | |
| Total Load | | | | | | | | | | |
| Basin Emission | | | 700 | *e* | 91 | *e* | | | | |

General Notes:

Note 1: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Note 2: Loads include background and/or upland inputs

Note 3: Loads may vary significantly from mean annual values depending on water year type

Note 4: See Attachment C for further notes and an explanation of how the loading estimates were derived.

Key: [hatched] - Further literature review required.

[shaded] - Source does not contribute significant load of constituent in this watershed.



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| Table 3.9 ESTIMATED MEAN ANNUAL MERCURY LOADINGS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (pounds/year) | | | | | | | | | |
| **Source** | **Upper Sacramento Basin above Dams** | **Note** | **Lower Sacramento Basin below Dams** | **Note** | **San Joaquin Basin** | **Note** | **Delta** | **Note** | **Bay Region** | **Note** |
| Agricultural | | | | | | | | | | |
| Mine Drainage | | | | | 2 | *b* | | | | |
| M&I Wastewater (POTW) | | | 22 | *c* | | | | | 900 | *c* |
| Urban Runoff | | | | | | | | | 70 | *d* |
| Flow Regulation | | | | | | | | | | |
| Total Load | | | | | | | | | | |
| Basin Emission | | | 460 | *e* | | | | | | |

General Notes:

Note 1: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Note 2: Loads include background and/or upland inputs

Note 3: Loads may vary significantly from mean annual values depending on water year type.

Note 4: See Attachment C for further notes and an explanation of how the loading estimates were derived.

Key: [hatched] - Further literature review required.

[grey] - Source does not contribute significant load of constituent in this watershed.



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| Table 3.10 ESTIMATED MEAN ANNUAL NITRATE LOADINGS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (thousands of pounds/year) | | | | | | | |
| **Source** | **Lower Sacramento Basin** | **Note** | **San Joaquin Basin** | **Note** | **Delta** | **Note** | **Bay Region** | **Note** |
| Agricultural | | | | | | | | |
| Mine Drainage | | | | | | | | |
| M&I Wastewater | | | | | | | | |
| Urban Runoff | 1,700 | *d* | 85 | *d* | | | | |
| Flow Regulation | | | | | | | | |
| Total Load | | | 85 | | | | | |
| Basin Emission | | | | | | | | |

General Notes:

Note 1: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Note 2: Loads include background and/or upland sources

Note 3: Loads may vary significantly from mean annual values depending on water year type

Note 4: See Attachment C for further notes and an explanation of how the loading estimates were derived.

Key: (vertical hatching) - Further literature review required.
(stippled shading) - Source does not contribute significant load of constituent in this watershed.



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## Table 3.11 ESTIMATED MEAN ANNUAL SELENIUM LOADINGS

| | (pounds/year) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source** | **Upper Sacramento Basin above Dams** | **Note** | **Lower Sacramento Basin below dams** | **Note** | **San Joaquin Basin** | **Note** | **Delta** | **Note** | **Bay Region** | **Note** |
| Agricultural | | | | | 7,000 | *a* | | | | |
| Mine Drainage | | | | | | | | | | |
| M&I Wastewater (POTW) | | | | | | | | | 4,500 | c |
| Urban Runoff | | | | | | | | | | |
| Flow Regulation | | | | | | | | | | |
| Total Load | | | | | | | | | | |
| Basin Emission | | | | | 9,200 | *e* | | | | |

General Notes:

Note 1: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Note 2: Loads include background and/or upland sources

Note 3: Loads may vary significantly from mean annual values depending on water year type

Note 4: See Attachment C for further notes and an explanation of how the loading estimates were derived.

Key: (hatched) - Further literature review required.

(shaded) - Source does not contribute significant load of constituent in this watershed.

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| Table 3.12 ESTIMATED MEAN ANNUAL TOTAL DISSOLVED SOLIDS (TDS) LOADINGS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (thousands of pounds/year) | | | | | | | | | |
| **Source** | **Upper Sacramento Basin above Dams** | **Note** | **Lower Sacramento Basin below dams** | **Note** | **San Joaquin Basin** | **Note** | **Delta** | **Note** | **Bay Region** | **Note** |
| Agricultural | | | 1,600,000 | *a* | 830,000 | *a* | | | | |
| Mine Drainage | | | | | | | | | | |
| M&I Wastewater (POTW) | | | | | | | | | | |
| Urban Runoff | | | 43,000 | *d* | 680 | *d* | | | | |
| Flow Regulation | | | | | | | | | | |
| Total Load | | | | | | | | | | |
| Basin Emission | | | 8,600,000 | *e* | 2,900,000 | *e* | | | | |

General Notes:

Note 1: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Note 2: Loads include background and upland sources

Note 3: Loads may vary significantly from mean annual values depending on water year type

Note 4: See Attachment C for further notes and an explanation of how the loading estimates were derived.

Key: [vertical-line shading] - Further literature review required.

[stippled shading] - Source does not contribute significant load of constituent in this watershed.

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| Table 3.13 ESTIMATED MEAN ANNUAL TOTAL ORGANIC CARBON (TOC) LOADINGS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (thousands of pounds/year) | | | | | | | | | |
| **Source** | **Upper Sacramento Basin above Dams** | **Note** | **Lower Sacramento Basin below dams** | **Note** | **San Joaquin Basin** | **Note** | **Delta** | **Note** | **Bay Region** | **Note** |
| Agricultural | | | 17,000 | *a* | 7,500 | *a* | | | | |
| Mine Drainage | | | | | | | | | | |
| M&I Wastewater (POTW) | | | 7,800 | *c* | | | | | | |
| Urban Runoff | | | | | | | | | | |
| Flow Regulation | | | | | | | | | | |
| Total Load | | | | | | | | | | |
| Basin Emission | | | 230,000 | *e* | 70,000 | *e* | | | | |

General Notes:

Note 1: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Note 2: Loads include background and/or upland sources

Note 3: Loads may vary significantly from mean annual values depending on water year type

Note 4: See Attachment C for further notes and an explanation of how the loading estimates were derived.

Key: (vertical-line shading) - Further literature review required.

(stippled shading) - Source does not contribute significant load of constituent in this watershed.

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# Table 3.14 ESTIMATED MEAN ANNUAL ZINC LOADINGS

(thousands of pounds/year)

| Source | Upper Sacramento Basin above Dams | Note | Lower Sacramento Basin below dams | Note | San Joaquin Basin | Note | Delta | Note | Bay Region | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| Agricultural | | | 110 | *a* | | | | | | |
| Mine Drainage | 990 | *b* | 4,500 | *b* | | | | | | |
| M&I Wastewater (POTW) | | | 34 | *c* | | | 2 | *c* | 175 | c |
| Urban Runoff | | | 161 | *d* | 53 | *d* | 38 | *d* | 220 | d |
| Flow Regulation | | | | | | | | | | |
| Total Load | | | | | | | | | | |
| Basin Emission | | | 1,300 | *e* | 250 | *e* | | | | |

General Notes:

Note 1: Letters listed in italics under the Note column provide the background and references associated with the accompanying load

Note 2: Loads include background and/or upland sources

Note 3: Loads may vary significantly from mean annual values depending on water year type

Note 4: See Attachment C for further notes and an explanation of how the loading estimates were derived.

Key:
- (hatched) - Further literature review required.
- (shaded) - Source does not contribute significant load of constituent in this watershed.

accounting for the background concentration in the load calculations would result in an overestimation of loads attributable to agricultural runoff by a factor of 2.

### 3.2.3 Existing or Planned Programs to Reduce Loadings of Parameters

#### Mine Drainage

Cadmium Copper and Zinc

Remediation efforts are being conducted on ~~over~~ more than 8 inactive mine sites in the Sacramento River Basin. The most well-known work is being conducted at the Iron Mountain Mine complex. This work effort includes, but is not limited to, construction of dams, installation of treatment facilities, and the construction of bulkheads in the mine portals. The main focus of attention at Iron Mountain has been on the acute effects of uncontrolled spills. Additional work is being performed on other Shasta Lake Area Mines. The majority of the work to date has focused on portal closures or treatment of mine drainage.

Regional Board staff continue to address the discharge of copper and zinc from the Walker Mine and Walker Mine Tailing sites in Plumas County. This work includes tunnel rehabilitation, infiltration control and diversion structures, and relocation of mine wastes. Long-term monitoring programs have been conducted for these projects by the Regional Board and the U.S. Forest Service.

Penn Mine, an abandoned copper mine adjacent to the Mokelumne River, is scheduled for remediation by 2000. The EIS has been approved and contracts are being let to begin remediation. The mine was historically one of California's largest copper and zinc producers (Peterson, 1985). Acid mine drainage from the site has caused significant negative water quality impacts in the Mokelumne River and Comanche Reservoir. Concentrations of copper, cadmium and zinc in on-site ponds (whose capacity is periodically exceeded) exceed water quality criteria for aquatic life. The remediation will include complete removal and disposal of waste material to an on-site landfill and complete restoration of drainage channels. Penn Mine site remediation should result in a 60 to 80 percent reduction in copper, cadmium and zinc loadings to the Mokelumne River.

Mercury

Various technical meetings are being held to discuss mercury monitoring, assessment, and cleanup issues. One very important issue is how to compare total mercury loads to bioavailable mercury (loads) from all sources upstream of the Delta and San Francisco Bay.

The draft final report for the Sacramento River Mercury Control Project has been completed and was discussed at a recent public advisory committee meeting. This report addresses mercury ~~impacts~~ effects in the lower Feather River, Yuba River, Bear River, and the Sacramento River near the City of Sacramento. The report also discusses various control strategies and recommends implementation of the mercury recycling program.

U.S. EPA has an ongoing SuperFund cleanup project at the Sulfur Bank Mine adjacent to Clear Lake. Lake County is also