Improved Forecasting for PCBs in San Francisco Bay

John J Oram, Jay A Davis
“A Legacy of PCB Contamination”

- Spread across watershed
- Deep in Bay sediments
- Associated with urban and industrial zones
- Levels pose health risks to humans and wildlife
PCB Sources, Pathways, and Loadings

Total External Loads ~ 33 kg/yr
(RMP’s Latest Best Estimate for WY 2000-2005)

- Local Watersheds (20 kg/yr)
  - Diffuse sources
- Delta Outflow (11 kg/yr)
  - Low conc., large flows
  - Episodic flow-thru
- Wastewater (2 kg/yr)
- Atmospheric Dep. (0.5 kg/yr)
  - Volatilization > Deposition
Conceptual Model*

* Based on 2002-2006 RMP data
A Multibox Model of SF Bay

[Map and diagram of the San Francisco Bay area with different layers and sediment.]
A Day in the Life of the Multibox Model
Model Applications

• Hindcast
  – 1940-2002
  – Model calibration and validation
  – Historic sediment and PCB budget
  – Assess model uncertainty

• Forecast
  – 2000-2099
  – Estimate future trajectory of Bay
  – Assess management options
Hindcast Results
1940-2002
Hindcast : Model Uncertainty

Model Uncertainty is: +/- 100% at 95% CI
Hindcast Results: Comparison to Observations

* Uncertainty expressed at 70% CI
Hindcast Summary

• Model compares well to observations
  – Model captures key processes
• Model uncertainty is known & quantified

→ OK to extrapolate into future …
Forecast Assumptions

- **Sedimentation**
  - Lower South Bay depositional; Others erosional

- **Watershed PCBs attenuate**

- **Climate conditions similar to last 30 years**
  - Climate change captured by sea level rise and hydrograph modification

* Assessing probable future conditions of Bay given best current understanding
What About Vertical Profile?
Vertical PCB Profiles in Sediment

Scenario 1: Decreasing

Scenario 2: Increasing

Scenario 3: Triangular

Scenario 4: Uniform
Forecast Results
2000-2099
Tributary Loading Scenarios

Vertical Profiles
Wastewater Loading Scenarios

Vertical Profiles
What Management Options Affect Recovery?

Suisun Bay

Lower South Bay

PCBs in Surface Sediment (ng/g)

Depth

PCBs

Elapsed Time (years)

No Load

40 kg/yr

40 kg/yr

20 kg/yr

0 kg/yr
Confidence in Model Estimates Bolstered by:

• Peer review
• Comparison to observations
  – Ability to reproduce spatial patterns and depth of maximum concentration
• Scenario testing
  – Pulse loads and extreme Delta loads
• Uncertainty and Sensitivity Analyses
• Independent testing by Tetra Tech
• Multiple iterations / Collaborative development
Summary of Forecast Findings

• Anticipate slow recovery of Bay
  – Northern reach faster than southern

• Effectiveness of management actions depends on PCB profile in sediments, degradation, and attenuation
Conceptual Model*

Total Export = ?

~400 kg

Total Load ~ 33kg/yr

Erosion / Deposition
Poorly Known

Depth

PCBs

* Based on 2002-2006 RMP data

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Next Steps

• Reporting / Publishing
• Sediment coring pilot study
  – Incorporate results of sediment cores and re-calibrate model as needed
  – Analyze wetland cores to estimate loading history and attenuation
• CFWG Guidance
  – Consider multiple contaminants
  – Look towards future models
Barrel Spills

Graphs showing the concentration in bay surface sediments (ng/g) over elapsed time (years) for different barrel spills. The graphs include:

- Suisun Bay
- San Pablo Bay
- Central Bay
- South Bay
- Lower South Bay

The curves represent different scenarios:
- Base Forecast
- Barrel Spill: Alameda Creek 100 kg
- Barrel Spill: Alameda Creek 200 kg
- Barrel Spill: Napa River 100 kg
- Barrel Spill: Napa River 200 kg
Sedimentation