

MODELING USING THE REGIONAL WATERSHED SPREADSHEET MODEL (RWSM)

SUPPORT FOR MQ2: IMPROVED ESTIMATES OF REGIONAL AND SUB-REGIONAL SCALE LOADS

SOURCES PATHWAYS AND LOADINGS
WORKGROUP MEETING
SPRING 2014

Item #4



May 29, 2014

J. Wu

L. McKee



QUESTIONS FOR THE WORKGROUP

- Q1. Are the proposed immediate uses of the uncalibrated model reasonable?**
- Are there other possible uses that could be considered?
- Q2. Are the proposed model improvements for 2014 & 2015 the best use of available funds or are there alternative improvements that should be prioritized?**
- Are there alternative improvements that could be considered?
- Q3. Is the rationale for prioritizing watersheds with certain characteristics suitable to improve the calibration data to support use of the model for confident estimates of regional scale PCB & mercury loads in relation to possible TMDL revisions?**
- Are there other possible rationale that could be considered?



BACKGROUND

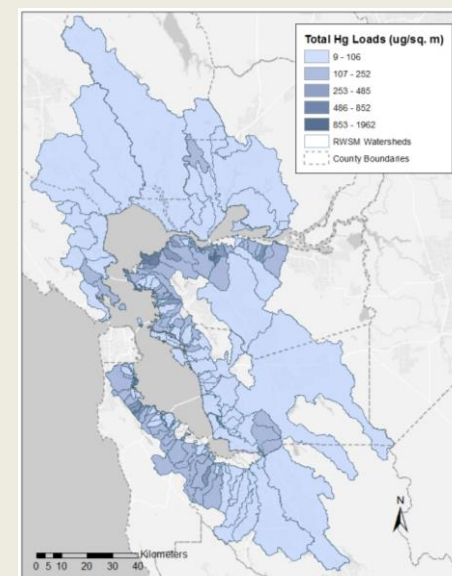
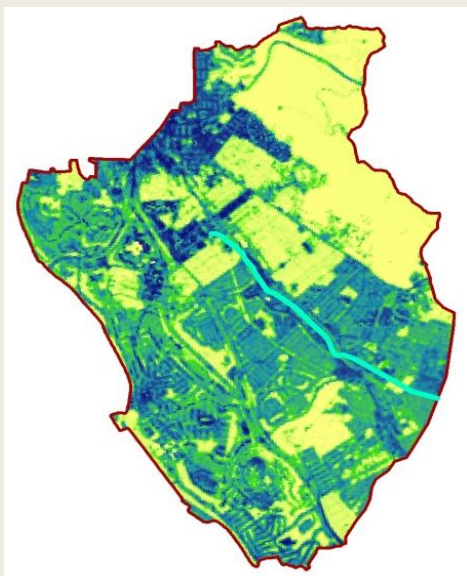
- **2008:** Identified need to improve PCB & Hg loads used for the TMDLs
- **2009:** Spreadsheet recommended (after much deliberation)
- **2010:** V1 hydrology model; “POC profiles” for PCBs, Hg, Se, dioxins, & Cu
 - Proposed model parameters (GIS layers & available coefficients)
- **2011:** V2 hydrology model, V1 PCB & Hg models (test cases to support recommendations)
- **2012:** Cu test case model; Improved GIS layers to support source area basis
- **2013:** Sediment model → PCB & mercury models.



PCB/MERCURY MODEL DEVELOPMENT

- PCB & mercury models built upon sediment model
- Model development focused on quantifying land use/source area specific particle ratios

$$\text{Particle ratios} \quad \times \quad \text{Sediment loads} \quad = \quad \text{PCB/Hg loads}$$





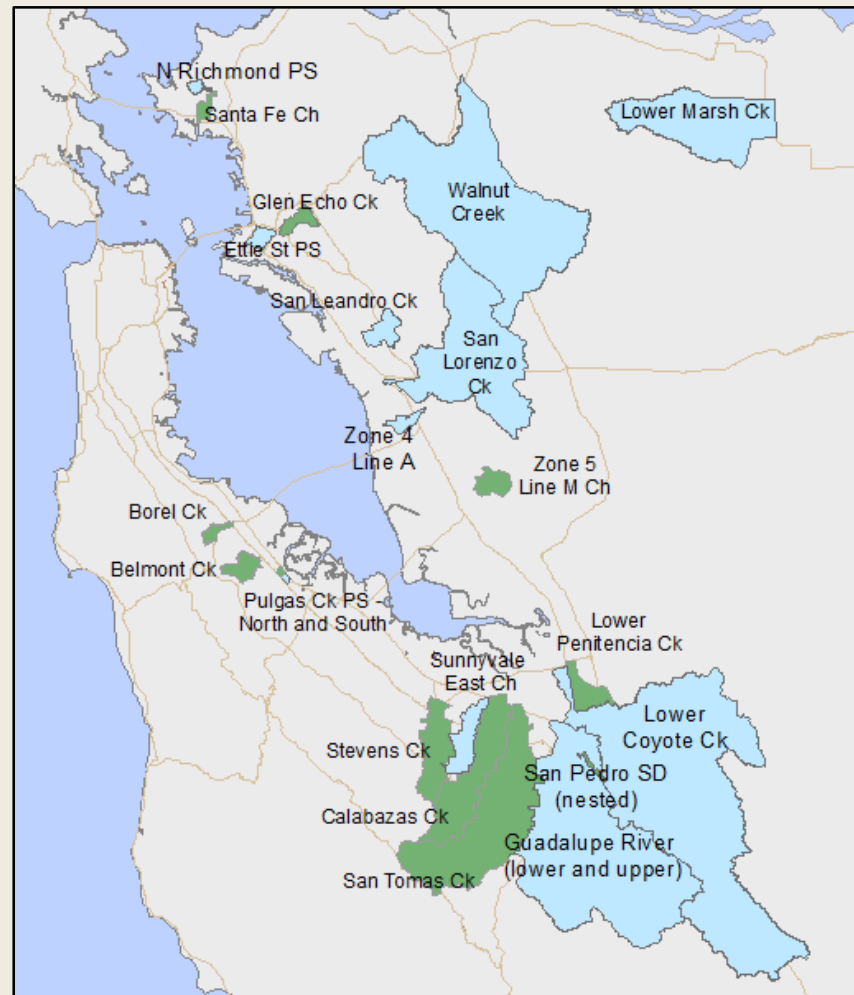
AVAILABLE CALIBRATION & COMPARISON DATA

■ Calibration particle ratio data

- PCBs = 22 watersheds
- Hg = 21 watersheds
- Variable quality (accuracy & bias questionable) (Note: Alicia will comment on this later)

■ Loads data

- PCBs & Hg = 12 watersheds
- Variable quality (low bias likely)
- Management priority areas not well represented except:
 - Guadalupe R (Both)
 - Sunnyvale (PCBs)
 - Ettie (PCBs)
 - North Richmond (Both)
 - Pulgas (PCBs)





LAND USE & SOURCE AREAS IN RELATION TO AVAILABLE CALIBRATION DATA

- Land use well represented
- Some key source areas absent
 - Inclusive acceptance criteria - 10% or just 2 watersheds
 - Low or absent
 - autoRecyc
 - recycMetals
 - electricTransf
 - electricPower
 - oilRefineries
 - recycDrum
 - transpShip
 - More discussion on Item#5

Land use or Source Area		Percentage of calibration watersheds with at least 0.5% of the area represented	
		PCB	Hg
Land Use	Open % WS Area	100	100
	Residential % WS Area	100	100
	Commercial % WS Area	100	100
	Transportation % WS Area	100	100
	Industrial % WS Area	68	67
	Agriculture % WS Area	23	14
Source Area	streets % WS Area	100	100
	oldUrbanAndIndustrial % WS Area	95	95
	highways % WS Area	91	90
	transpRail % WS Area	68	71
	crematoria % WS Area	41	33
	manufMetals % WS Area	27	29
	recycWaste % WS Area	27	29
	recycAuto % WS Area	14	14
	recycMetals % WS Area	9	10
	transpAir % WS Area	9	5
	cement % WS Area	5	5
	electricTransf % WS Area	5	5
	electricPower % WS Area	0	0
	military % WS Area	0	0
	oilRefineries % WS Area	0	0
	recycDrums % WS Area	0	0
transpShip % WS Area	0	0	



MODEL CALIBRATION

- Model calibrated through a constrained optimization
 - 17 optimization experiments performed
 - Differing parameter combinations
 - Differing coefficient constraints
- Logical progression based on previous test results

Final draft model for PCBs

<u>Land uses</u>	<u>Source areas</u>
All urban	All recycle
Ag/Open	Transp Rail
	Electric Transf
	Old industrial

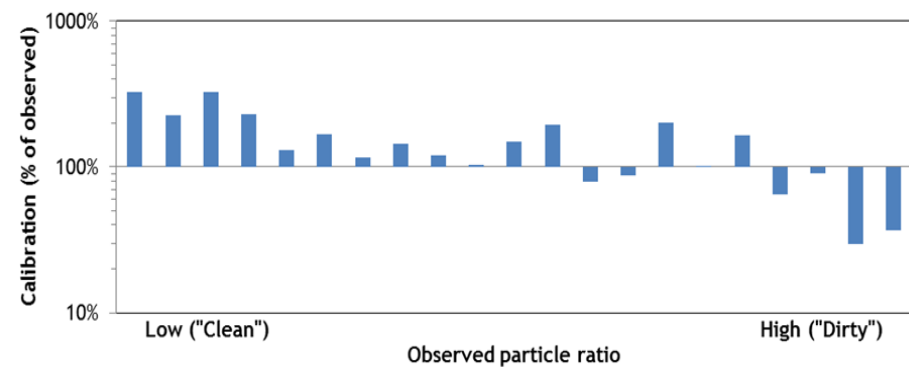
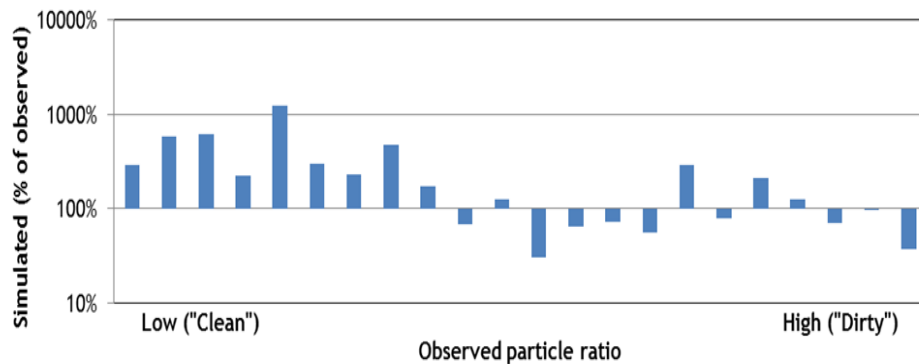
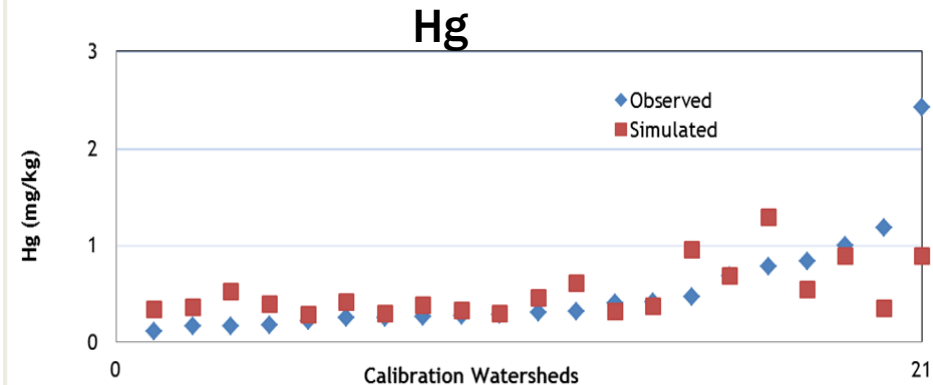
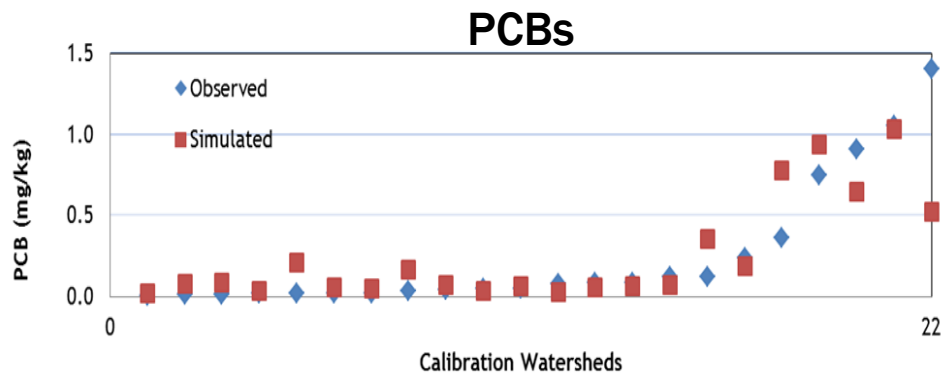
Final draft model for mercury

<u>Land uses</u>	<u>Source areas</u>
Other urban	All recycle
Ag/Open	Transp Rail
	Manuf Metal



MODEL CALIBRATION RESULTS

- Models over-simulate particle ratios (& loads) in cleaner watersheds & under-simulate highly polluted watersheds

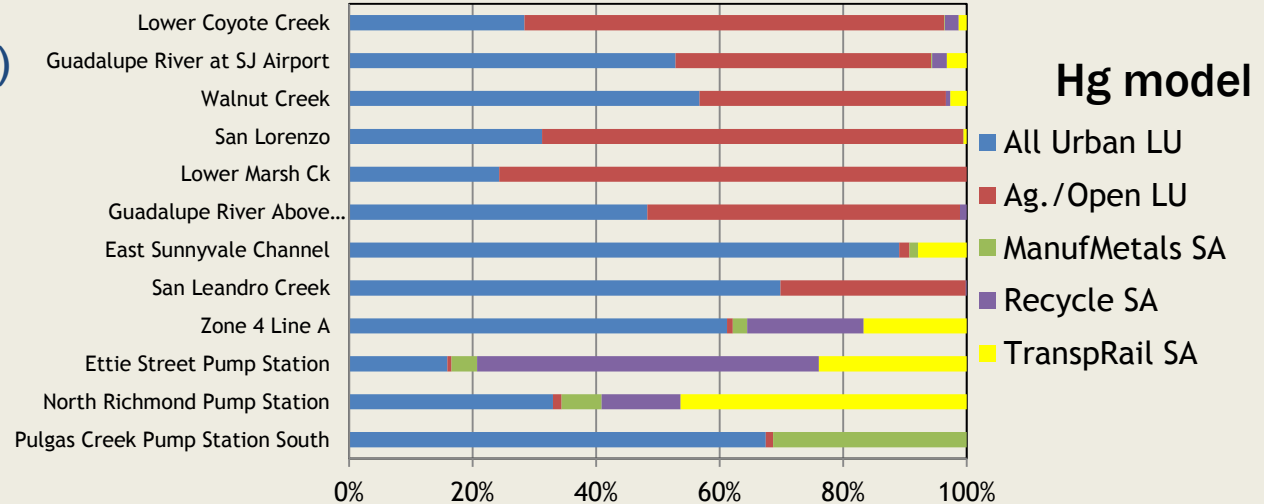
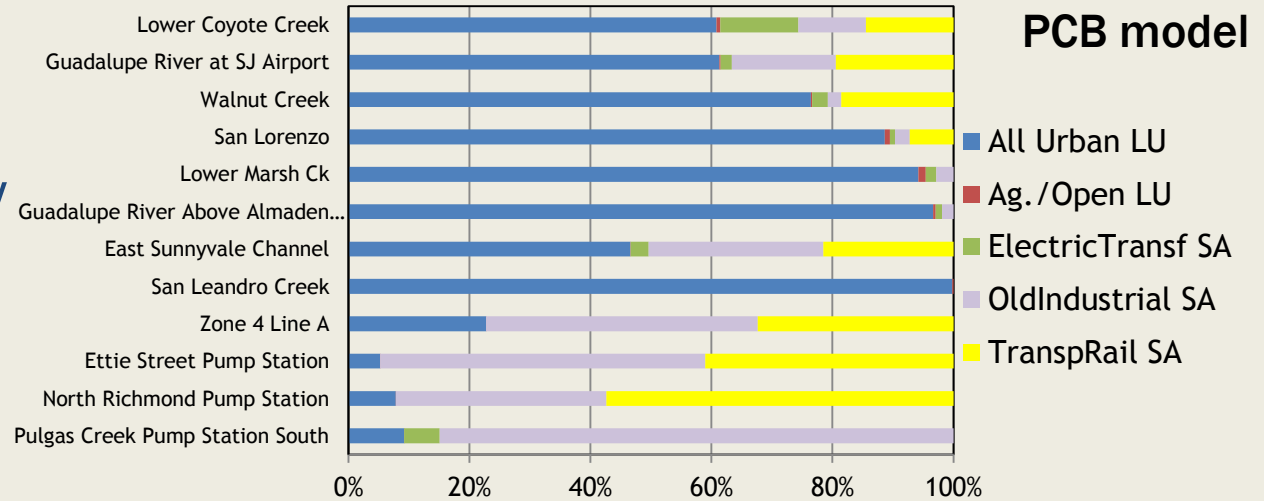




% LOAD CONTRIBUTION BY PARAMETER

■ Loads controlled by a few parameters:

- All Urban (Both)
- Old Industrial (PCBs)
- Transport rail (Both)
- Ag/Open (Hg)



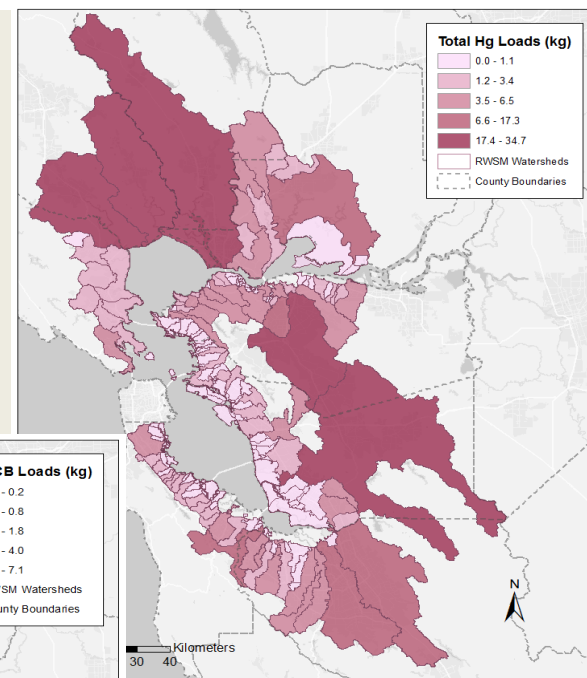
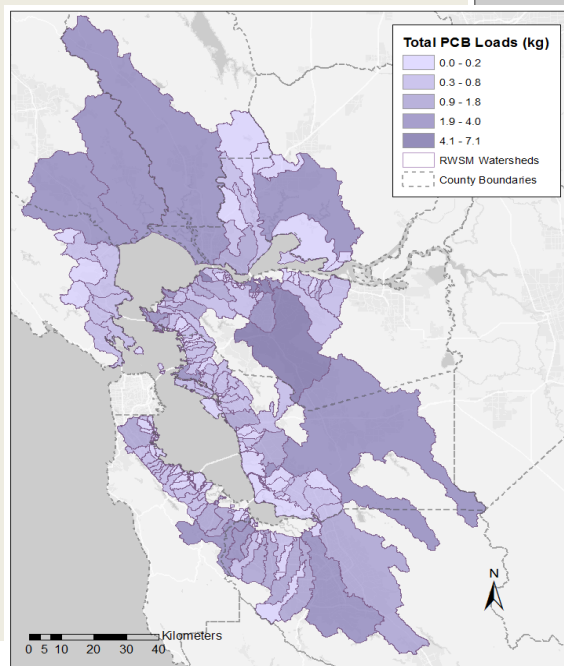


RWSM LOAD ESTIMATES

- Larger than past estimates & measurements
 - e.g. reported in TMDLs
 - Field measured concentrations

- Loads are larger in:
 - Medium size urban & industrial land uses
 - Larger watersheds

- RWSM regional estimate:
 - PCB = 117 kg
 - Hg = 487 kg





SUMMARY OF MODEL STRENGTHS

- Coefficients have been calibrated for all parameters (land uses & source areas) in relation to sediment
- Simple 5 or 6 parameter models appear to calibrate logically
- Model parameters & outputs generally obey conceptual models
 - Less variability between the coefficients of Hg parameters relative to PCBs
 - Production normalized by unit area, 28% (PCBs) v 7% (Hg) coming from 1% of the watershed area
- Model overall over-and under-simulated cleaner & dirtier watersheds respectively, but general trends likely hold



SUMMARY OF MODEL WEAKNESSES

- **Weak structural basis for model**
 - Sediment model is not calibrated
 - Some important source areas not represented well (low or absent)
- **Uncertain parameter coefficients**
 - Calibration data for any given watershed are not accurate or precise
 - Lack of constraints on the relative order in the auto calibration process
- **Calibration unstable & bias towards moderate pollution watersheds**
 - Larger, less polluted over-simulated
 - Smaller, more polluted under-simulated
 - More polluted watersheds are only represented by a few load coefficients
 - Calibration watersheds do not correspond to management priority watersheds
- **Regional watershed loads are biased high**
 - Cleaner watersheds cover a large area: Over predictions of these areas lead to over-predicted regional loads



PROPOSED WORK PLAN 2014

Task	Potential improvement options	Estimated Budget \$k
#1	Use all or a subset of the uncalibrated parameters to rank watersheds, sub-watersheds, or patches	<2
#2	Coalesce some of the small near homogeneous “watersheds” on the Bay margin into nearby areas	<2
#3	Use the latest GIS databases incorporating recent BASMAA improvements	<3? Uncertain
#4	Use a data quality weighting factor on PCB & Hg calibration data	<2
#5	Redevelop PCBs/Hg model based on hydrology	>20



PROPOSAL TO TRC 2015

- If hydrology based PCB/ Hg model calibrates poorly (2014 work plan)
 - Either complete further development based on water (TBD)
 - Or complete further improvement of the sediment based PCB & Hg models

Task	Potential improvement options	Est. budget \$k
#6	Add constraints on the relative order of loading coefficients in auto PCB/Hg calibration process	<2
#7	Add a climatic parameter to the sediment model or base on hydrology & then recalibrate the PCB & Hg models based on the revised sediment model outputs	>30



QUESTIONS FOR THE WORKGROUP

- Q1. Are the proposed immediate uses of the uncalibrated model reasonable?**
- Are there other possible uses that could be considered?
- Q2. Are the proposed model improvements for 2014 & 2015 the best use of available funds or are there alternative improvements that should be prioritized?**
- Are there alternative improvements that could be considered?
- Q3. Is the rationale for prioritizing watersheds with certain characteristics suitable to improve the calibration data to support use of the model for confident estimates of regional scale PCB & mercury loads in relation to possible TMDL revisions?**
- Are there other possible rationale that could be considered?