Willamette Mercury TMDL

Model Updates and Response to Questions

Willamette Mercury TMDL Advisory Committee Meeting
March 7, 2019

DEQ

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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RECAP OF MODEL COMPONENTS AND LINKAGES

Purpose of Modeling

- Provide a Linkage Analysis that connects the revised fish tissue concentration criteria to THg loads appropriate to calculate the assimilative capacity for the TMDL
- Identify relative magnitude of THg loads from different sources to support implementation, including development of allocations to individual permitted discharges and types of nonpoint load sources
- Support revision of the TMDL consistent with court order on contents and schedule

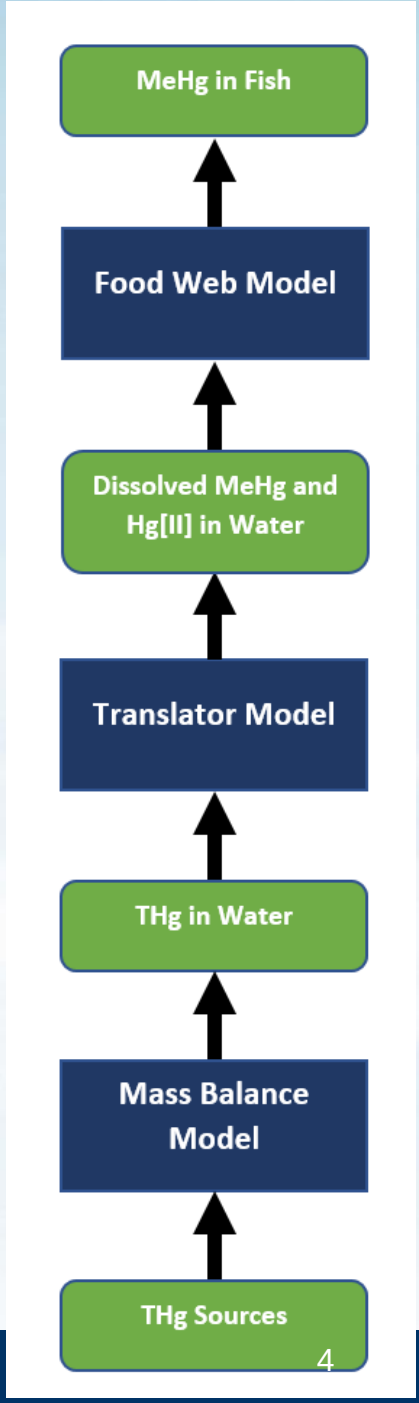
TMDL Linkage Analysis

- Link sources of total mercury (THg) to methylmercury (MeHg) in fish
- Three components:

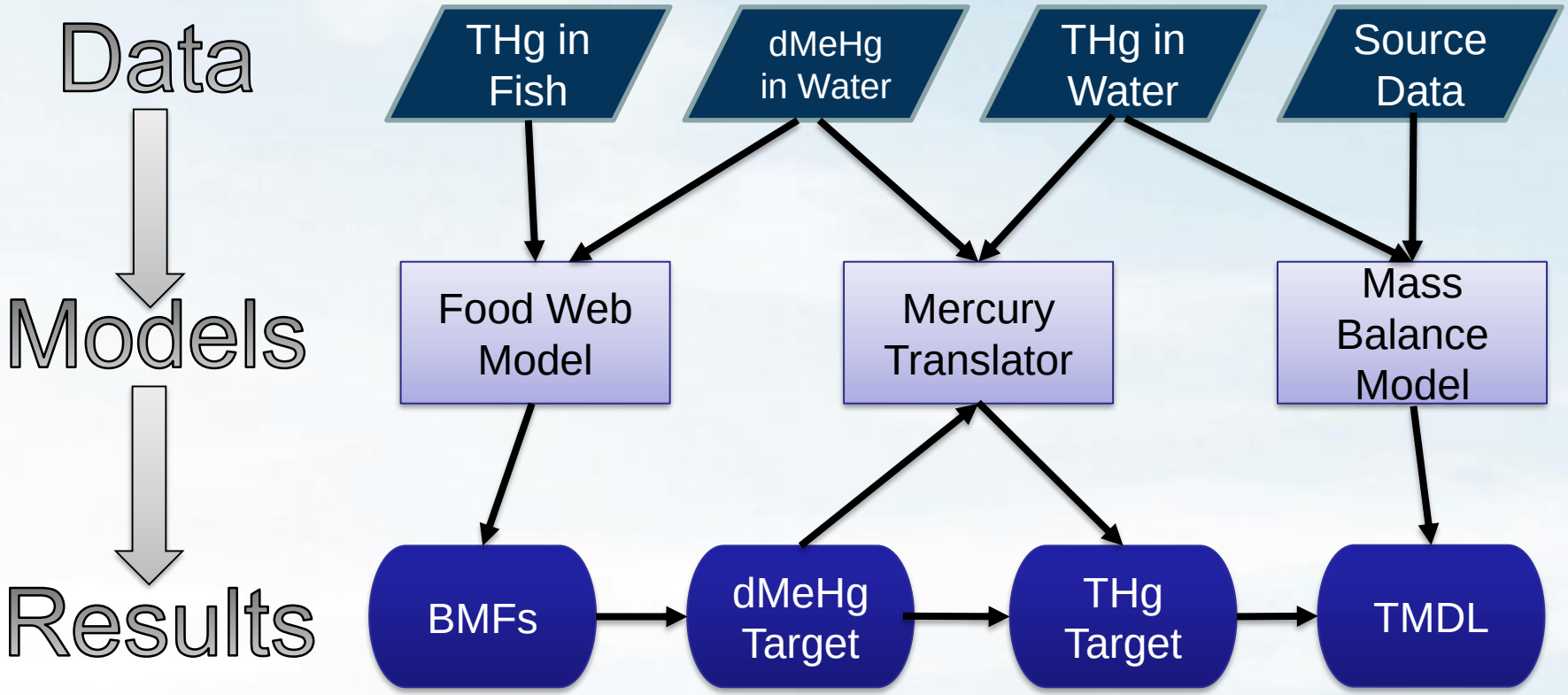
  1. Mass Balance Model: Link THg sources in the watershed to instream concentrations

  2. Mercury Translator: Link THg concentrations to MeHg and Hg[II] exposure concentrations

  3. Food Web Model: Link exposure concentrations of MeHg to fish tissue concentrations



Information Flow



Update Process

- Advisory Committee review draft of Technical Support Document (TSD), 8/31/18
- Presentation to AC, 9/19/18
- Solicitation of written comments from AC
- Updated internal draft based on AC, EPA, and DEQ comments, 12/21/18
- [Government shutdown, 12/22/18 – 1/25/19]
- EPA and DEQ review
- Revised TSD, 2/23/19

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MAJOR CHANGES AND ENHANCEMENTS SINCE 8/31/18 DRAFT

Food Web Model

- QA analysis revealed errors in one fish tissue database as supplied to Tetra Tech
  - Length, weight, THg incorrectly associated when unique sample identifiers not present in data
  - Created false “non-duplicates”
  - Contents of this database removed from analysis; results not present in other supplied datasets re-retrieved from original sources
- This issue required recalibration of the FWM
  - Does not affect Translator or Mass Balance Model
  - Does not change resulting THg water column target rounded to 2 significant digits (0.14 ng/L)

Mercury Translator

- No changes to Translator itself
- THg target levels by species (Table 4-4) change because of the corrections to the FWM

Mass Balance Model

- - Updated the stationary air emissions of THg within WRB
- - Updated major POTW loads with additional data
- - Incorporated minor domestic WWTPs
- - Updated industrial discharger loads with additional data
- - Developed separate loads for individual permitted MS4s (including ODOT) and urban DMAs; incorporated additional data provided by these entities (the MS4 loads include developed land only, pervious and impervious surfaces; sources: runoff, sediment erosion, and interflow)

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SUMMARY OF MODEL RESULTS

Food Web Model

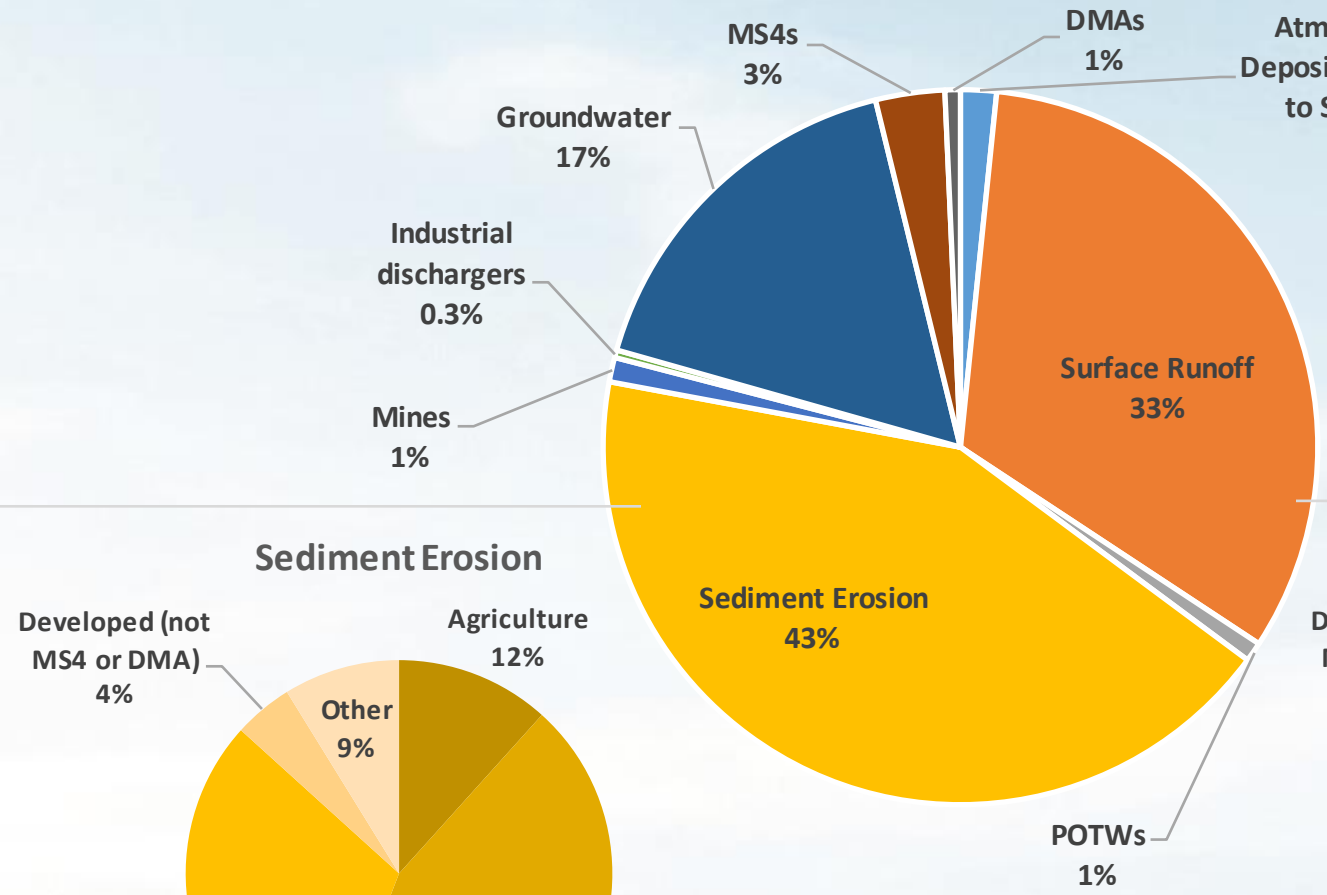
- Slight changes in BMFs
- Northern Pikeminnow is still the most sensitive species
  - BMF increases from 2.96E7 to 3.40E7
  - Target THg concentration depends on inverse of BMF

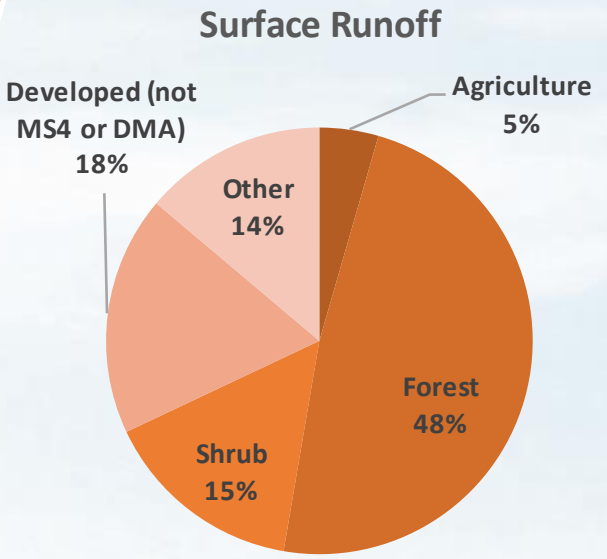
Mercury Translator

- THg:MeHg calculations are unchanged
- Median THg target to meet fish tissue concentration of 0.040 mg/kg is practically unchanged at 0.14 ng/L
  - Went from 0.141 to 0.136 ng/L; both round to 0.14

Mass Balance Model: THg Source Loads

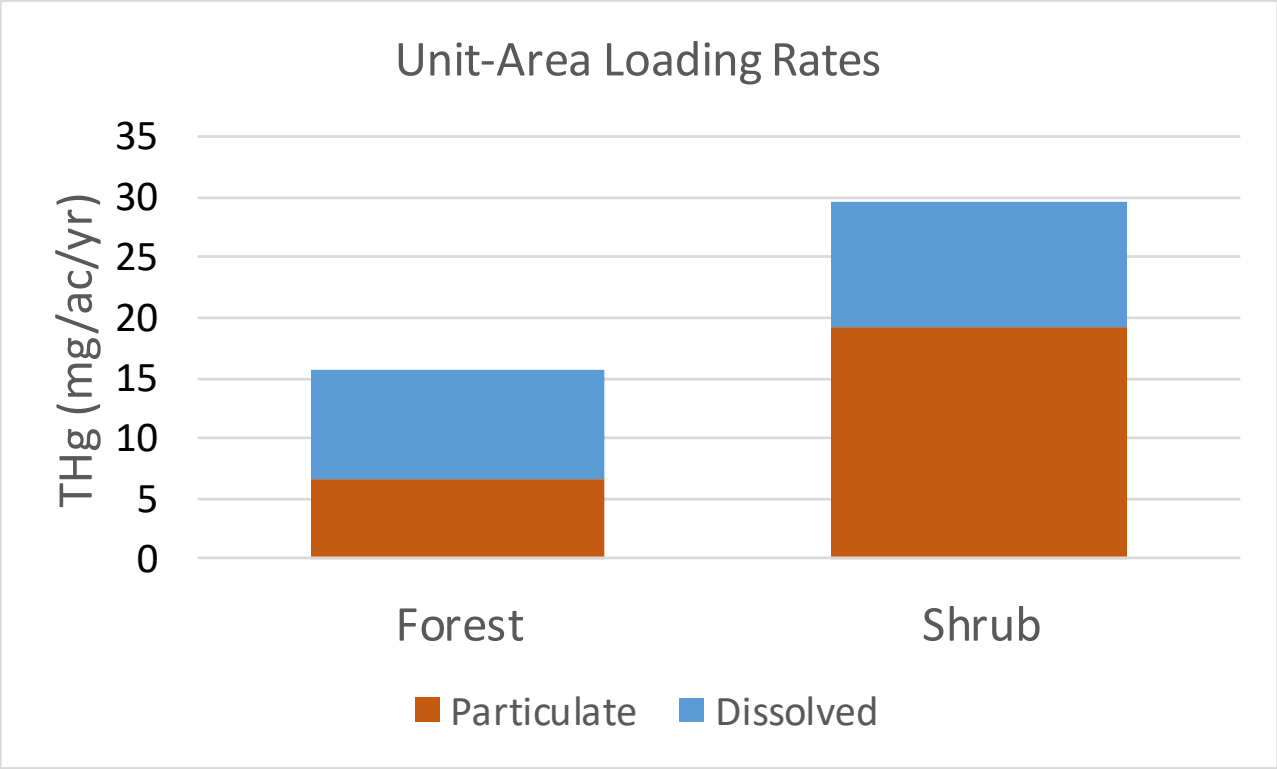
- Refined, but little change in big picture:





Example: Forest vs. Shrub

- "Shrub" mostly disturbed forest (harvest, landslide, burn, etc.)
- Similar soil THg concentrations
- Forest has lower erosion -> lower particulate THg
- Lower surface runoff -> lower dissolved THg
- Greater acreage -> greater total watershed load



Questions on model update?

Willamette River near Portland (Image credit: Stuart Seeger, Flickr)

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ADVISORY COMMITTEE WRITTEN QUESTIONS

Two Sets of Written Questions

- Submitted January 16 from the ACWA members of the advisory committee including Krista Reininga (Brown and Caldwell), Raj Kapur (Clean Water Services), Matt Stouder (City of Springfield) and Kristin Preston (City of Albany)
- Questions submitted January 16 from Geosyntec on behalf of advisory committee members Mary Anne Cooper (Oregon Farm Bureau), Taylor Lucey (Oregon Forest & Industries Council) and Jeff Stone (Oregon Association of Nurseries)
- Answers will be provided by topic area

General Questions

Have sensitivity analyses been conducted for individual parameters in any of the models?

Extensive sensitivity analyses have been conducted during development of the FWM and Translator. The watershed model was completed under a QAPP and was not recalibrated; however, sensitivity of the Mass Balance to assumptions such as groundwater THg concentration was tested. Tetra Tech's scope does not cover development and reporting of comprehensive sensitivity analyses; however, key points are discussed in the revised document.

Food Web Model

Has there been any consideration of replacing the northern pikeminnow with a theoretical average fish in the river?

No.

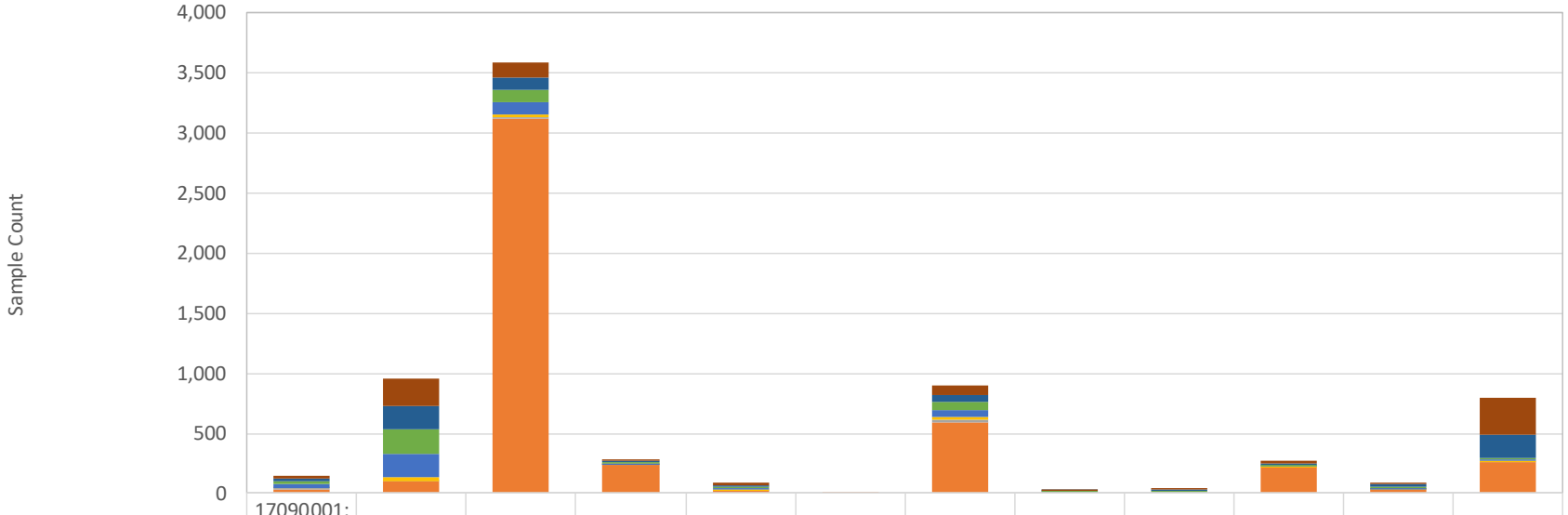
Direction from the court was to update the 2006 TMDL taking into account new data and the revised tissue criterion. Consistent with that approach the water column target is based on the most sensitive fish species, which remains the NPM.

Food Web Model

In Figure 2-1 it shows about 10,760 samples have been collected. Yet in Figure 3-5, if you add the n values you get 1,066 samples. That represents 10% of total samples. Why was only 10% of the data included?

Figure 3-5 included only wet-weight fish data from the 8 target species. Figure 2-1 included all fish species as well as some false “non-duplicates” and non-fish (such as clams) that had been coded as fish. “10,760” includes 3,447 dry weight samples, which are not relevant to the FWM. The revised count is now 4,633 wet weight fish samples.

Food Web Model, Revised Figure 2-1



	17090001: Middle Fork Willamette	17090002: Coast Fork Willamette	17090003: Upper Willamette	17090004: Mckenzie	17090005: North Santiam	17090006: South Santiam	17090007: Middle Willamette	17090008: Yamhill	17090009: Molalla-Pudding	17090010: Tualatin	17090011: Clackamas	17090012: Lower Willamette
Water, total THg	27	224	130	13	25	0	78	10	14	18	15	309
Water, dissolved THg	25	197	103	9	13	0	63	5	10	9	13	185
Water, total MeHg	25	201	103	9	13	0	63	5	10	9	12	13
Water, dissolved MeHg	25	197	103	9	13	0	63	5	10	9	12	13
Sediment, THg	10	33	14	4	5	0	22	0	0	4	5	10
Sediment, MeHg	8	4	12	4	4	0	20	0	0	4	4	4
Fish (wet), THg	32	99	3124	235	20	3	592	7	0	214	28	259

Food Web Model

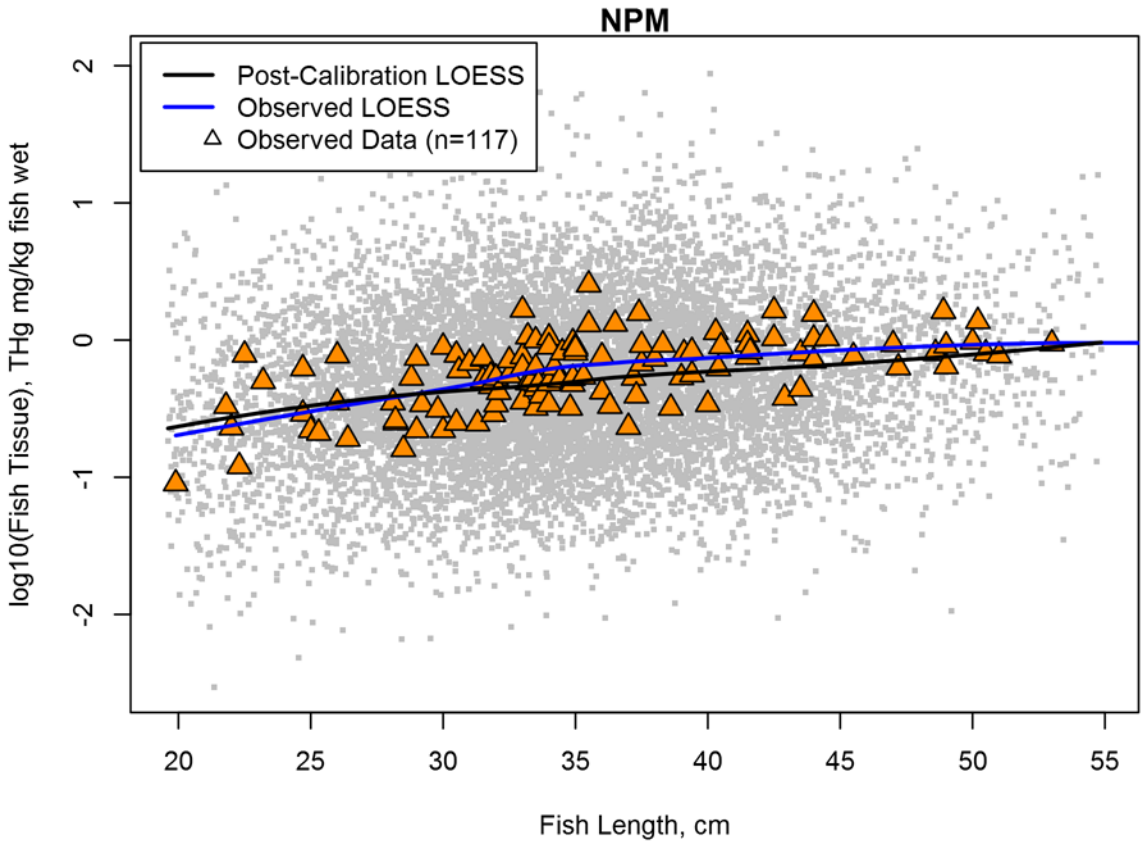
If the northern pikeminnow is the only fish whose Food Web Model parameterization is used in the determination of the target mercury concentration, then why is its calibration in the Food Web Model poor? Why not calibrate to fit the cumulative distribution function for its fish tissue mercury concentration to the available data and allow other fish to have a poor calibration?

We do not characterize the fit for NPM as poor. There are deviations at the tails of the distribution, which may reflect variability and uncertainty in the food web structure, but the fit is matched at the median – which is the basis for BMF calculation. It would not be appropriate to force a better fit for NPM by degrading fit for lower trophic levels, even if feasible, as concentration in NPM depends on bioaccumulation from those lower trophic levels.

Food Web Model

- Post-calibration plot for Northern Pikeminnow

Gray dots represent 10,000 Monte Carlo simulation runs



Food Web Model

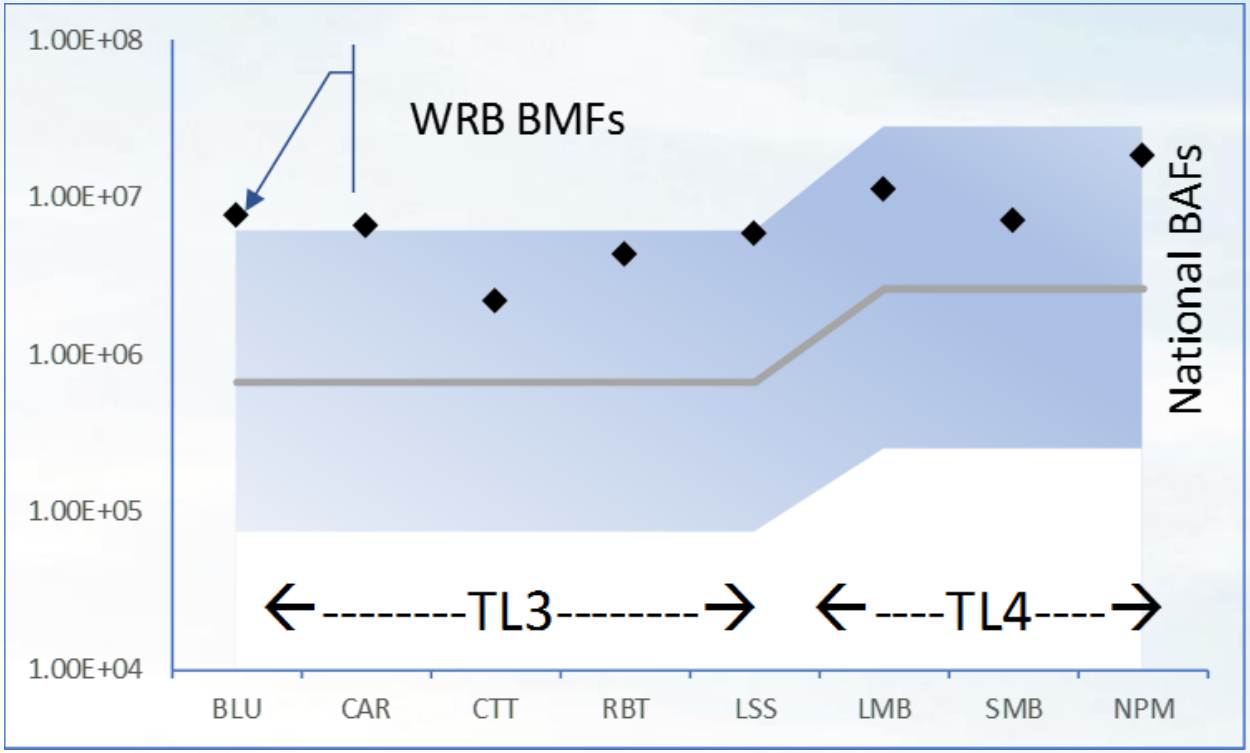
In the Food Web Model, what are the ranges of parameter values for fish ingestion rate of mercury, fish assimilation rate of mercury, and fish elimination rate of mercury that were explored? Did other combinations of these parameter values lead to similar calibrations? If so, what was the effect of these alternative parameter sets on the biomagnification factor?

Ingestion, assimilation, and elimination rates were all tested and updated during FWM calibration. The latter two are treated as stochastic parameters in the Monte Carlo simulation so the range of calculated BMFs reflects the range of effects of different reasonable combinations of these parameters.

Food Web Model

Has the biomagnification factor been compared to available literature?

A section has been added on this topic. The WRB cumulative BMFs are generally near the upper 95%le bound of national BAFs in USEPA (2001)



Questions on food web model?

Dorena Reservoir (NOAA copyright-free picture)

Mass Balance Model: General

What were the calibration adjustments made for flow and sediment as reference on page 52?

The existing HSPF model is used “as is” for the Willamette Mercury TMDL. The statements regarding calibration refer to calibration to observed flow and sediment concentrations conducted for the earlier project. No calibration adjustments were made for the Mercury TMDL analysis.

Mass Balance Model: General

Can you quantify what portion of Hg is from natural sources, global anthropogenic sources that are outside of the states' control, local sources? What are the likely Hg levels without local source contributions? What are the Hg levels in the environment based on natural sources?

There is not an easy answer to this question due to the long half-life of mercury in the ocean and soils. Human activities have increased the amount of Hg in circulation since ancient times. As of 2004, Seigneur et al. estimated that about 1/3 of Hg deposition came from human activities within North America, 1/3 from other continents, and 1/3 from "natural" sources, including re-emission of past human-derived Hg stored in the oceans. Most ultimate sources are not subject to local control, but local efforts can reduce the transport of deposited and stored mercury from land to water.

Mass Balance Model: HSPF

What is the basis of the infiltration rates in the HSPF model?

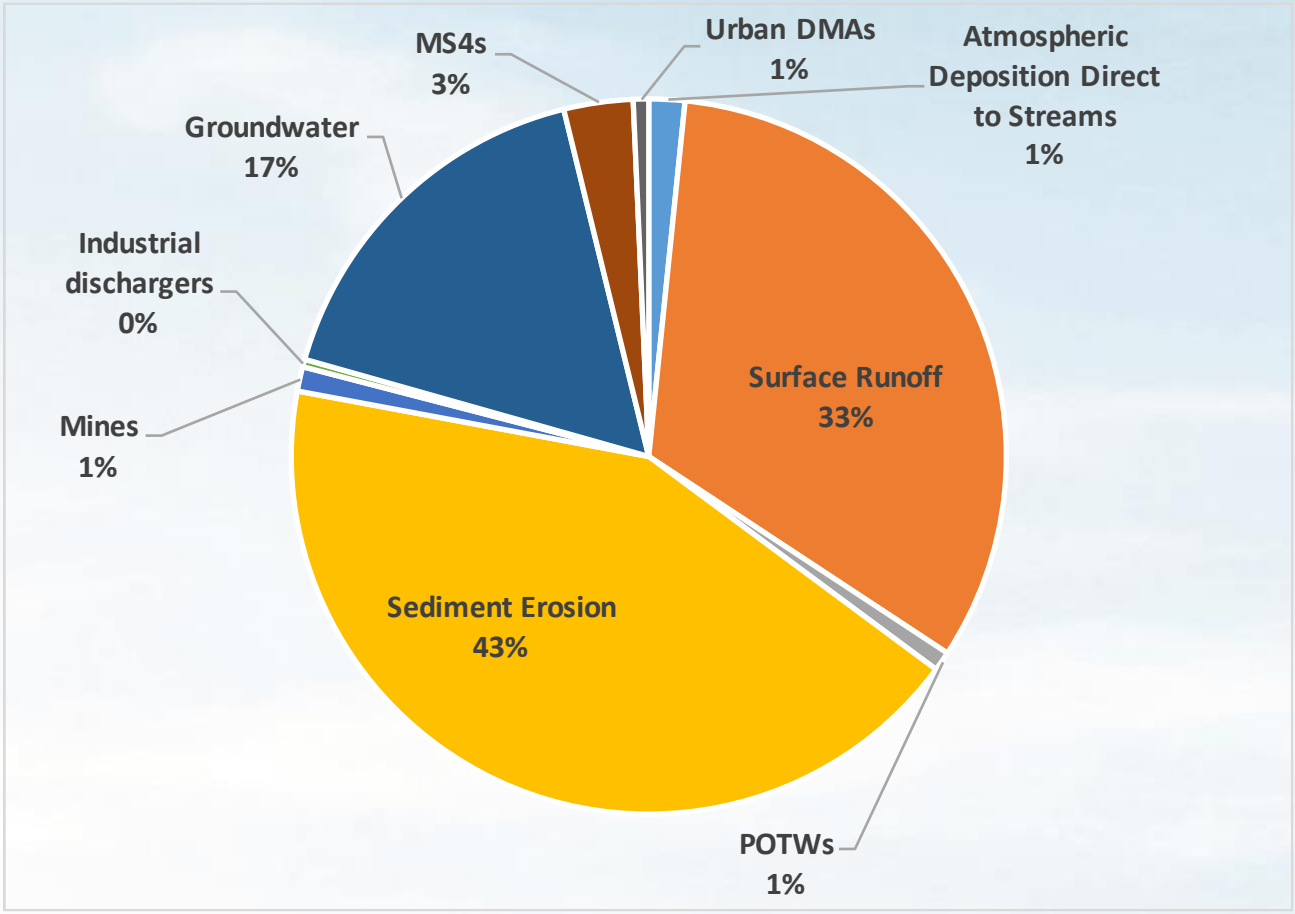
Infiltration capacity was assigned according to soil survey Hydrologic Soil Group, consistent with EPA guidance in BASINS Technical Note 6, *Estimating Hydrology and Hydraulic Parameters for HSPF*. Actual infiltration rate varies continuously as a function of simulated soil moisture.

Mass Balance Model: Atmospheric Deposition

Why does page 9 say the mean annual loading rate at the mouth of the WR is 126.8 kg/yr and on page 63 it says it is 43.1 kg/yr? Then on page 64 it says 44.5 kg/yr compared to the 2006 value of 53.7 kg/yr? Can you provide a table that shows an accounting of all these numbers (wet deposition from different areas plus dry deposition from different areas, etc.) and how they add up?

126.8 kg/yr (p. 9) is the estimate from the 2006 TMDL of total Hg load from all sources. Page 64 referred only to loads attributed to atmospheric deposition, both directly and indirectly. We have modified the terminology to refer to direct atmospheric deposition to water and loads associated with surface runoff and erosion, with extensive source tables.

Mass Balance Model: Atmospheric Deposition



A majority of the surface runoff and sediment erosion loads are ultimately derived from atmospheric deposition

Mass Balance Model: Soil Concentrations

What is the distribution of soil mercury data by HUC8? How, and in what land use types, were soil mercury concentrations measured?

Data and analysis for soil mercury concentrations are described in detail in Section 5.3.2.

Land Cover	HUC8	THg Potency (µg/kg)
Forest and Shrub	17090001	49.7
Forest and Shrub	17090002	48.2
Forest and Shrub	17090003	85.4
Forest and Shrub	17090004	60.7
Forest and Shrub	17090005	80
Forest and Shrub	17090006	79.7
Forest and Shrub	17090007	96.8
Forest and Shrub	17090008	105.1
Forest and Shrub	17090009	90.2
Forest and Shrub	17090010	115.9
Forest and Shrub	17090011	77.3
Forest and Shrub	17090012	111
Cultivated Land	All	36.7
Herbaceous Upland	All	23.3
Other	All	30.1

Data are sufficient to distinguish THg potency by HUC8 only for forest land cover.

Mass Balance Model: POTWs

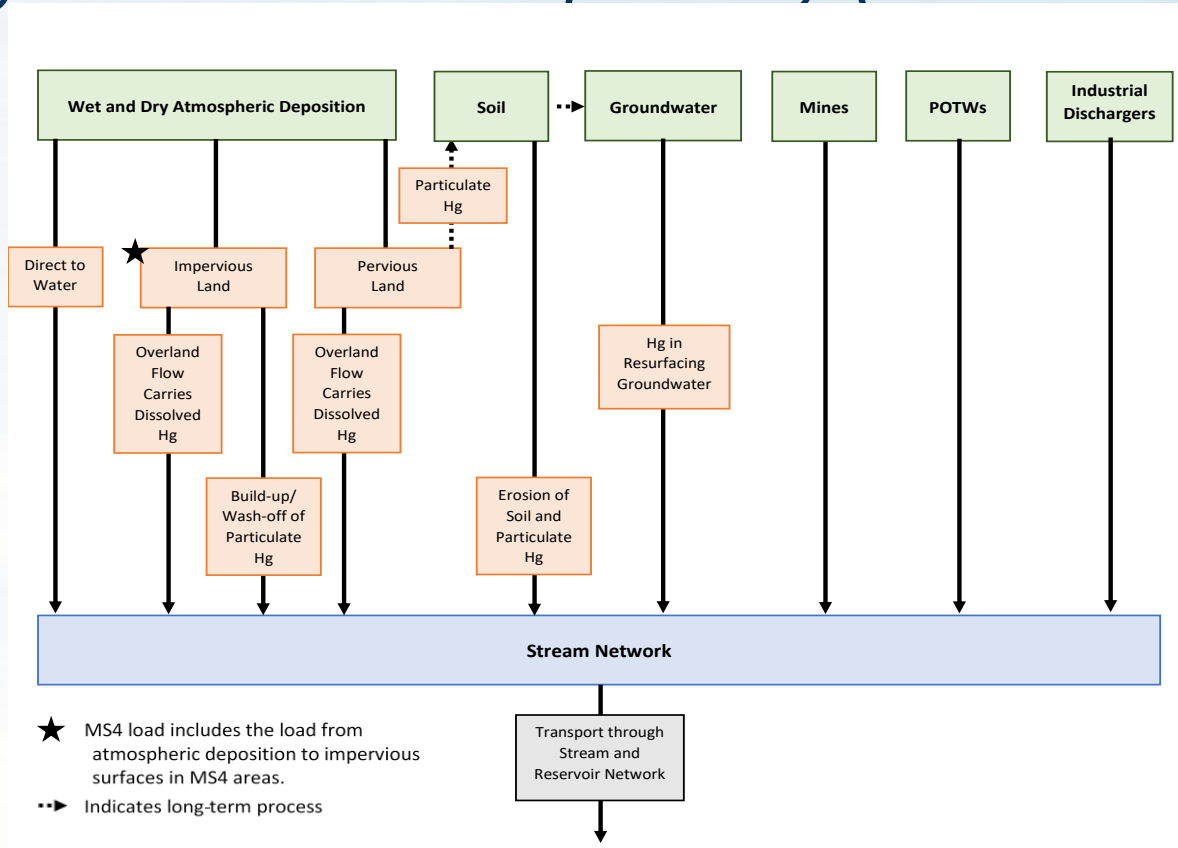
What data are being used to characterize discharges from small municipalities (bottom of page 77)? Can you let us know which facilities this applied to? What is the allocation strategy going to be for these smaller facilities? Has the model been updated to reflect more recent POTW data?

The POTW loads have been extensively updated based on stakeholder and DEQ input

- Removed POTWs in basin that discharge to Columbia River
- Tabulated all permitted minor facilities
- Updated concentration estimates based on new data
- Minor POTWs without Hg monitoring assigned median of results from majors (2.6 ng/L)

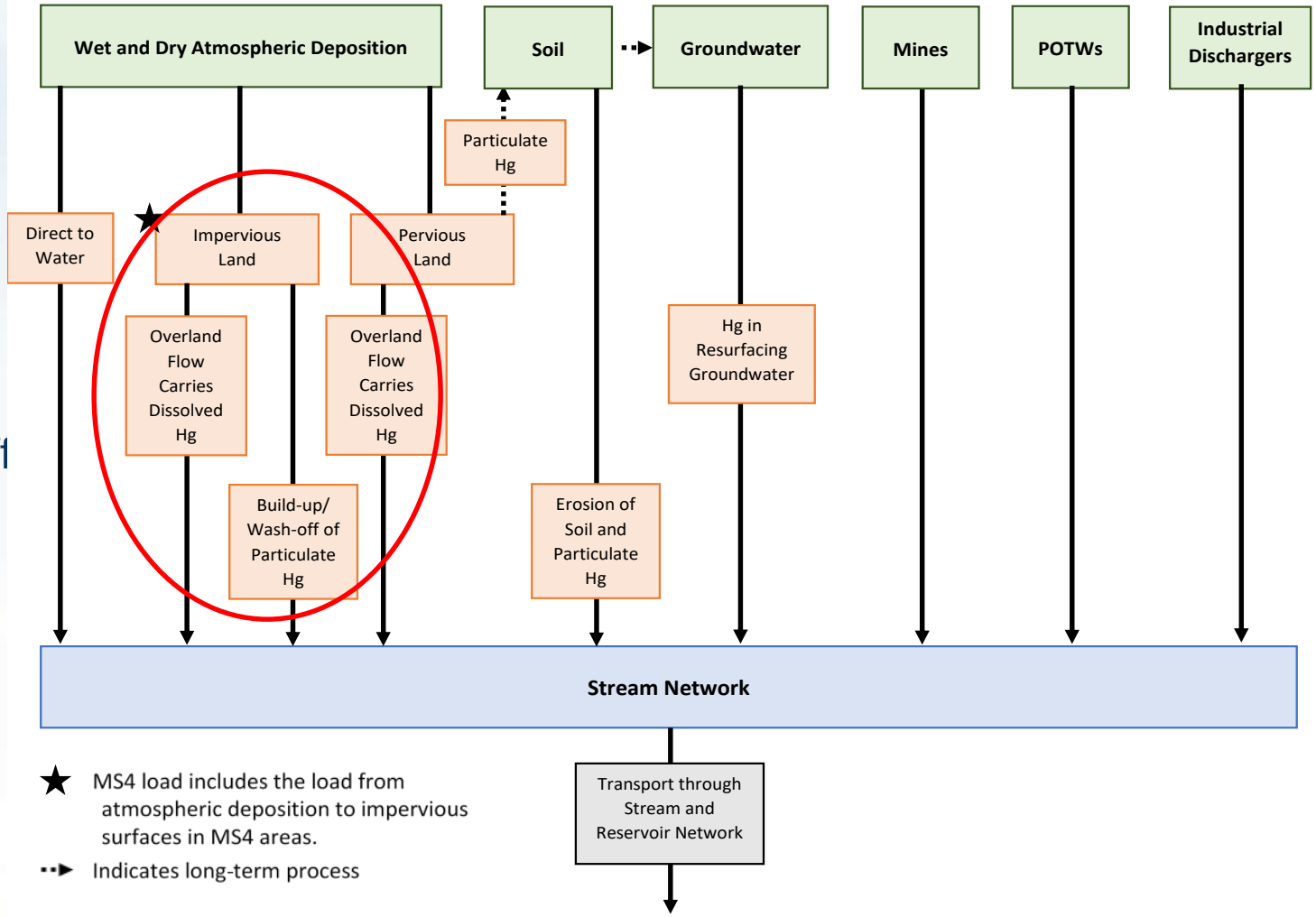
Mass Balance Model: Urban Stormwater

In Figure 5-2, can you explain how the overland flow and build up wash off boxes are different from each other and how they are modeled separately (under impervious area)?



Mass Balance Model: Urban Stormwater

In this conceptual representation, the overland flow box represents runoff of dissolved Hg from wet deposition, the buildup/washoff box represents particulate Hg from dry deposition



Mass Balance Model: Urban Stormwater

Can you please explain how you tabulated impervious areas for MS4s and which cities were included? Can you also explain when you did and did not use NLCD values to estimate impervious areas for MS4s and how you used them? And, how are non MS4 areas that discharge stormwater captured in the model?

Impervious area was estimated by landuse from the 2011 NLCD, which was intersected with updated MS4 boundaries, urban DMAs, and ODOT areas. Only impervious area associated with developed land was attributed to MS4s. Areas identified as draining to combined sewer, to infiltration BMPs, or out of the basin are excluded. THg loads from other land uses within MS4 boundaries are attributed to their respective non-MS4 categories.

Mass Balance Model: Urban Stormwater

The calibration included a 55% reduction in the atmospheric wet deposition concentration and a change in the design storm causing washoff of 90% of the THg from 0.5”/hour to 0.08”/hour. Can you provide more background on the rationale for those changes and explain why that reduction in wet deposition concentration doesn’t present inconsistencies with other components of the model?

If a 55% reduction in atmospheric mercury reduction is necessary to calibrate the urban stormwater mercury load in the Mass Balance Model, then why is it appropriate to use the atmospheric deposition data in the remainder of the watershed without modification?

Reductions in effective loading rate of dry deposited Hg from impervious surfaces are expected due to re-emission. The cited numbers are calibrated to the CDF of MS4 monitoring data and do not apply to wet deposition. The net effect of dry deposition on pervious surfaces is represented by soil concentration data, so no correction is needed.

Mass Balance Model: Urban Stormwater

Can you explain the first paragraph on page 91?

We agree that this paragraph, explaining the calibration to the observed CDF of THg in MS4 monitoring, was obscure and confusing. It has been replaced with a discussion that emphasizes that this was a fitting exercise to approximate the distribution of observed data.

Mass Balance Model: Urban Stormwater

Table 5-12 – Gresham shows 317 data points. However, only approximately 16 of those data points were collected from outfalls (on the upstream end of water quality facilities) using clean sampling techniques. Did you filter out data that was not collected using these techniques?

We filtered the Gresham data to include only "stormwater" samples identified as from outfalls (upstream of BMPs). This left 39 data points, all analyzed by EPA Method 200.8 (Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry,) with a detection limit of 0.002 µg/L. Only one sample was below the detection limit. The database does not contain information on sampling technique.

Mass Balance Model: Urban Stormwater

Page 92 – Is there some analysis that supports equating CSO's to typical stormwater runoff concentrations? (Also, it should be noted that CSO loads should be covered under their applicable Waste Discharge permits and not the MS4 permit. So, this load needs to be removed from the MS4 load).

The text was misinterpreted and has now been clarified. Areas served by CSs in Portland are omitted from the MS4 analysis. Several smaller municipalities did not provide CS service boundaries, so those areas could not be omitted. Hg in any overflows from those areas is likely to be primarily from wet deposition in storm events. Adjustments for such loads could be made during implementation if information is provided.

Mass Balance Model - LOADEST

What is the hydrologic spacing of the total mercury observations in the river that were used in the LOADEST program?

Five of the LOADEST stations are in-line along the Willamette River and Coast Fork

Gage	River Mile
14211720 (Portland)	12.8
14197900 (Newberg)	50
14191000 (Salem)	84.2
14166000 (Harrisburg)	161
14153500 (Cottage Grove)	216

Model Results – Margin of Safety

Have you had a chance to quantify the margin of safety (i.e., based on use of NPM, etc.) and can you explain what it is in terms of magnitude?

Has the implicit Margin of Safety that is included in the determination of the target concentration of mercury in the river been quantified?

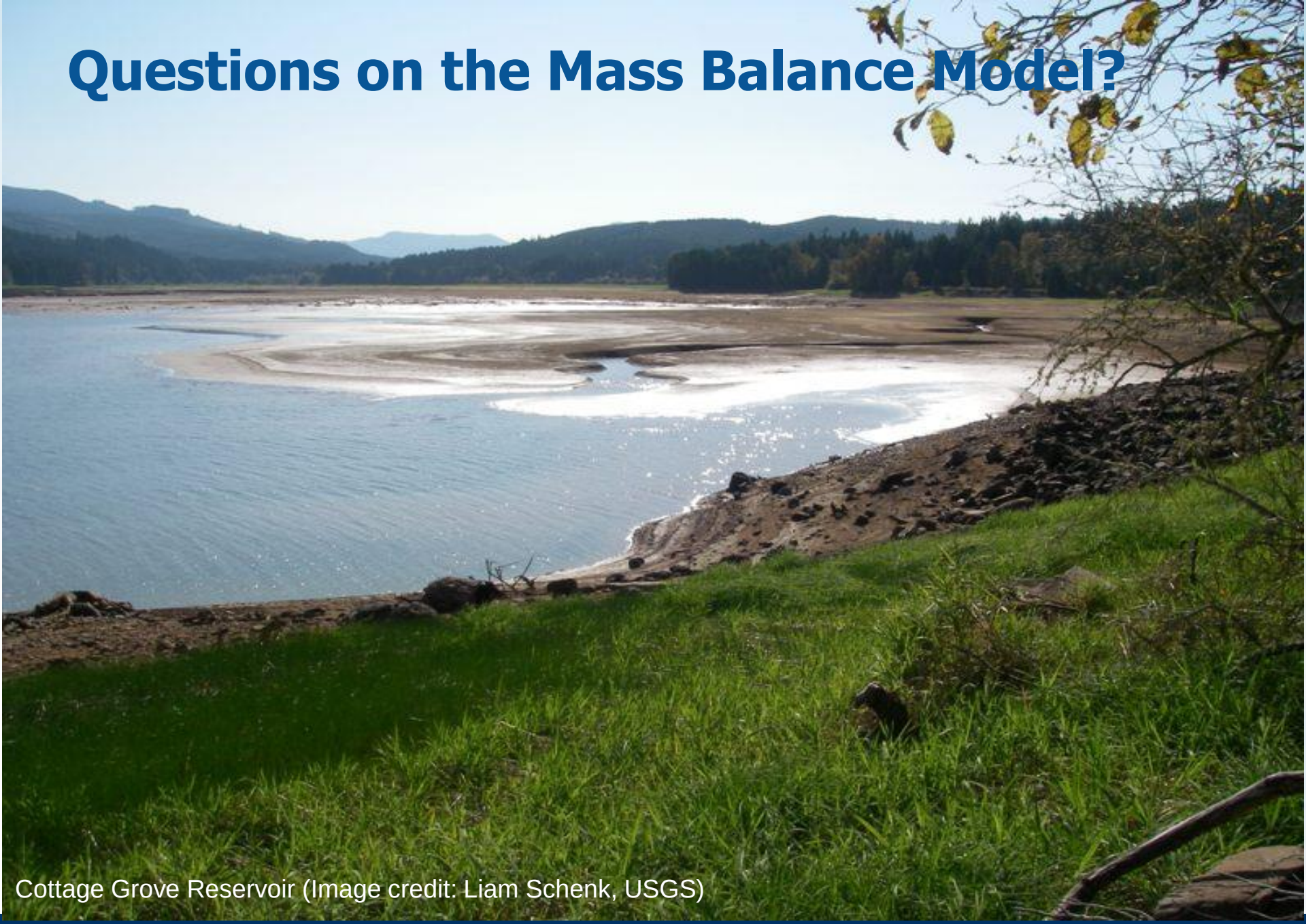
A TMDL MOS can be either implicit or explicit. The MOS is ultimately a policy decision and will not be included in Tetra Tech's Technical Support Document. We leave this matter for DEQ and EPA discussion.

Model Results

Can you explain the difference between Figures 5-16 and 5-17 on page 127? Why is the total load delivered to the Columbia smaller than the load delivered to the stream network?

THg load is lost during transit due to volatilization or burial. Figure 5-16 showed the at-source loads, prior to transit losses. Figure 5-17 showed the loads delivered to the Columbia, after transit losses.

Questions on the Mass Balance Model?



Cottage Grove Reservoir (Image credit: Liam Schenk, USGS)