South River TMDL Project

Linking Mercury Loadings to Water Column Concentrations

Jack Eggleston

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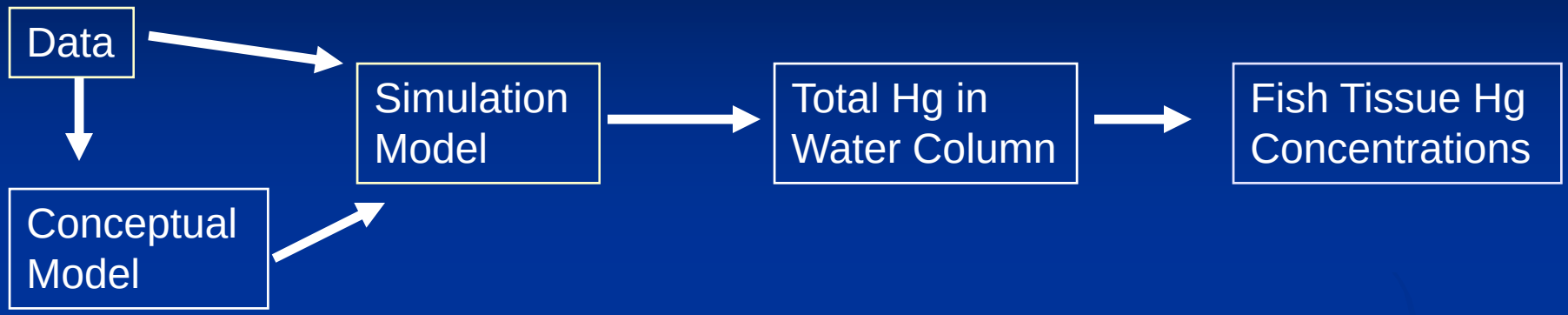
Cooperating Agencies

DEQ Virginia Department of Environmental Quality

United States Environmental Protection Agency

TMDL Modeling Approach



- Total mercury loading leads to fish tissue mercury concentrations. Mercury methylation and bioaccumulation are intermediate steps.
- Mercury loading reductions that will bring fish below the target Hg concentration of 0.5 ppm (0.3 more likely) will be calculated using the simulation model plus the site-specific BAF approach.

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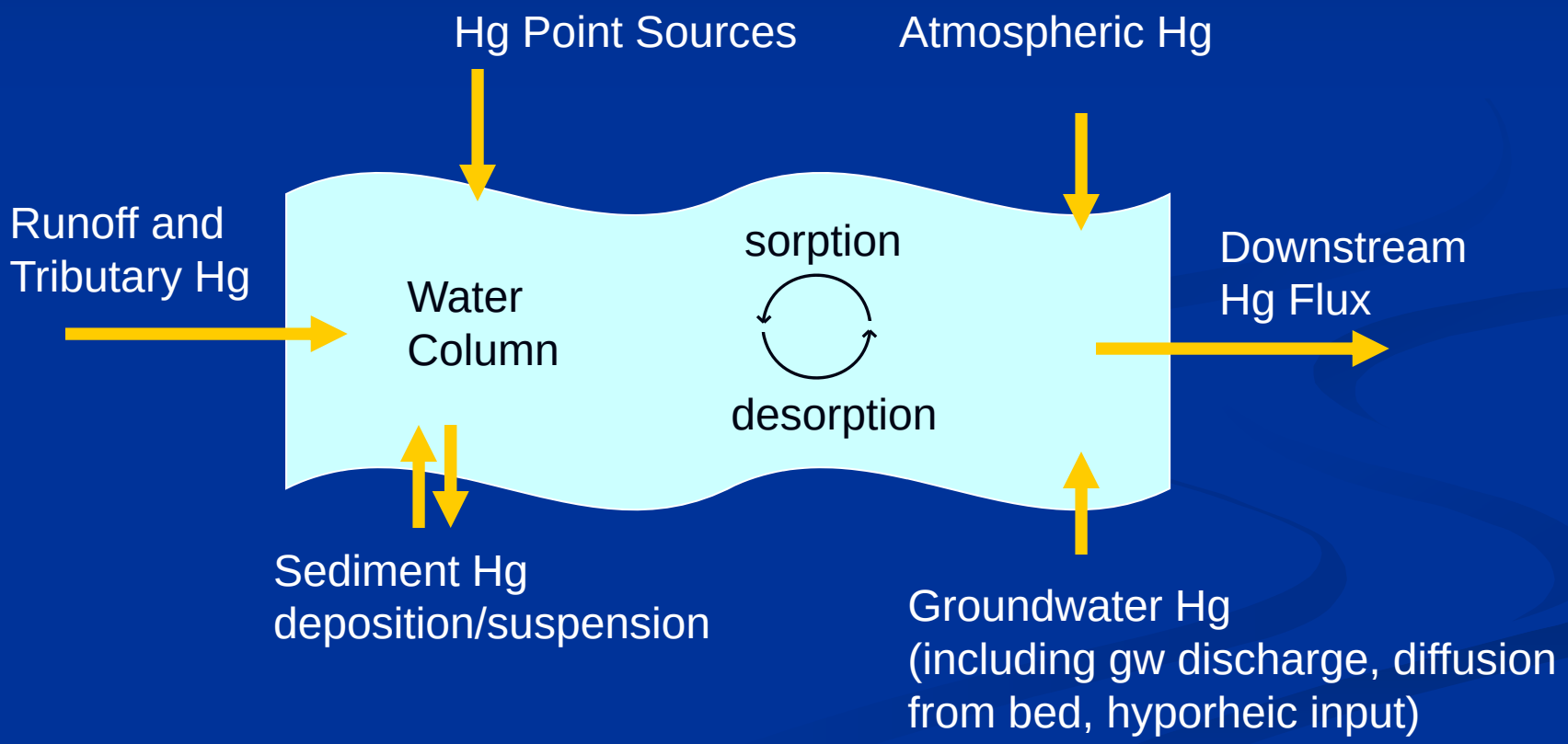
Conceptual Model of Total Mercury in the South River



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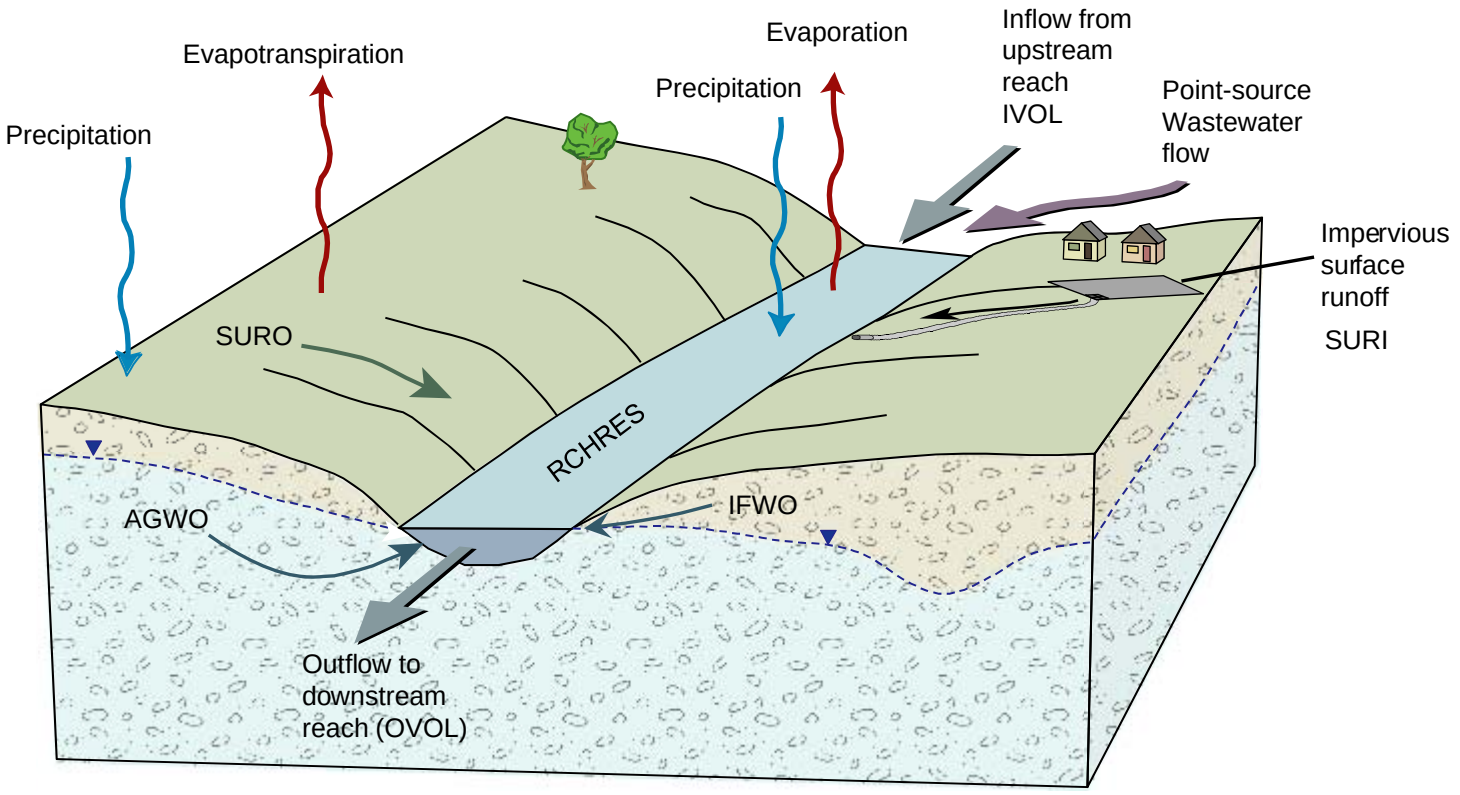
Modeling Framework - HSPF



EXPLANATION

SURI–Surface runoff from impervious areas

SURO–Surface runoff from pervious areas

IFWO–Interflow

AGWO–Active groundwater flow (base flow)

RCHRES–Stream reach or reservoir segment

IVOL–Inflow volume

OVO-Outflow volume

SURI–Surface runoff from impervious areas

SURO–Surface runoff from pervious areas

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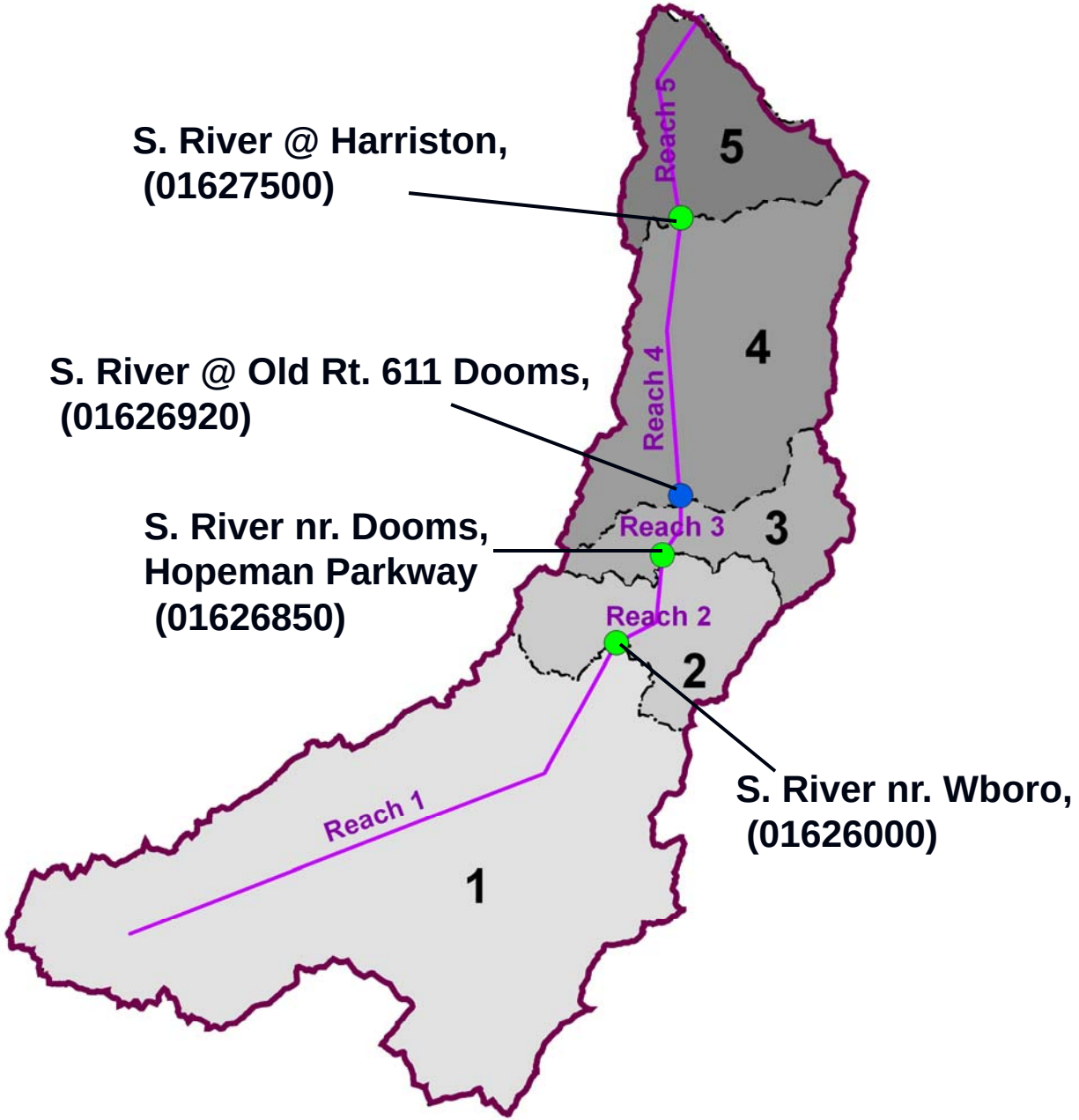
Sub-Basin Delineation

Within each subbasin, transport is handled by ~50 different hydrologic response units (HRU) that allow for differences in land use, climatic stresses, hydrologic parameters such as slope, and Hg concentrations



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Model Development

1) Develop Hydrologic Model

Calibration Goal : Simulated and observed daily flows match at Waynesboro (01626000) and Harriston (01627500)

2) Develop Sediment Transport Model

Calibration Goal : Simulated loads and concentrations match distribution (cdf comparison) of observed at Waynesboro and Harriston

3) Develop Mercury Transport Model

Calibration Goal : Simulated loads and concentrations match distribution (cdf comparison) of observed at Waynesboro and Harriston

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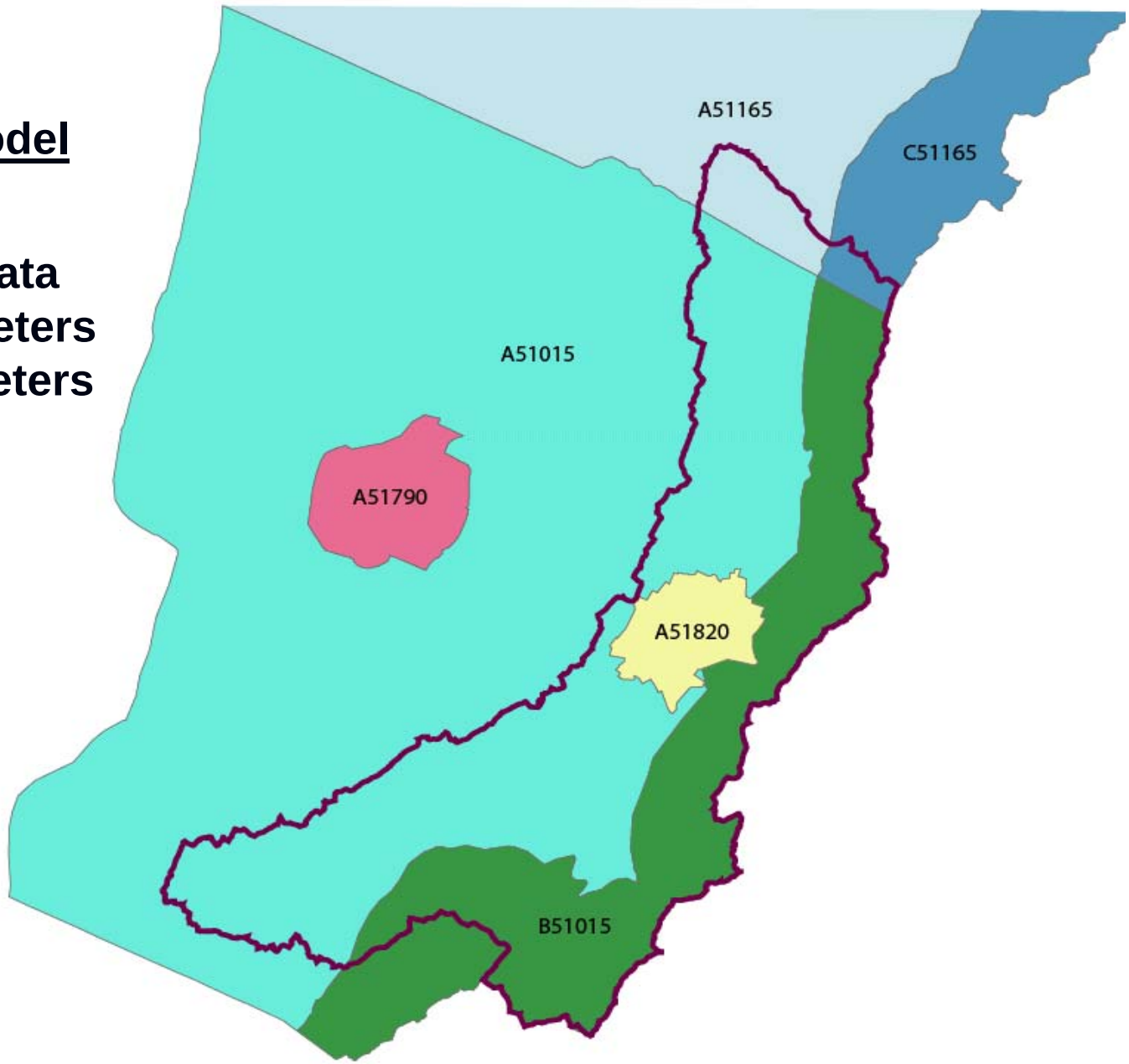
Land Use, Precipitation, Meteorology

Phase V
Chesapeake Bay Model

- **Land uses**
- **Meteorological data**
- **Hydraulic parameters**
- **Sediment parameters**



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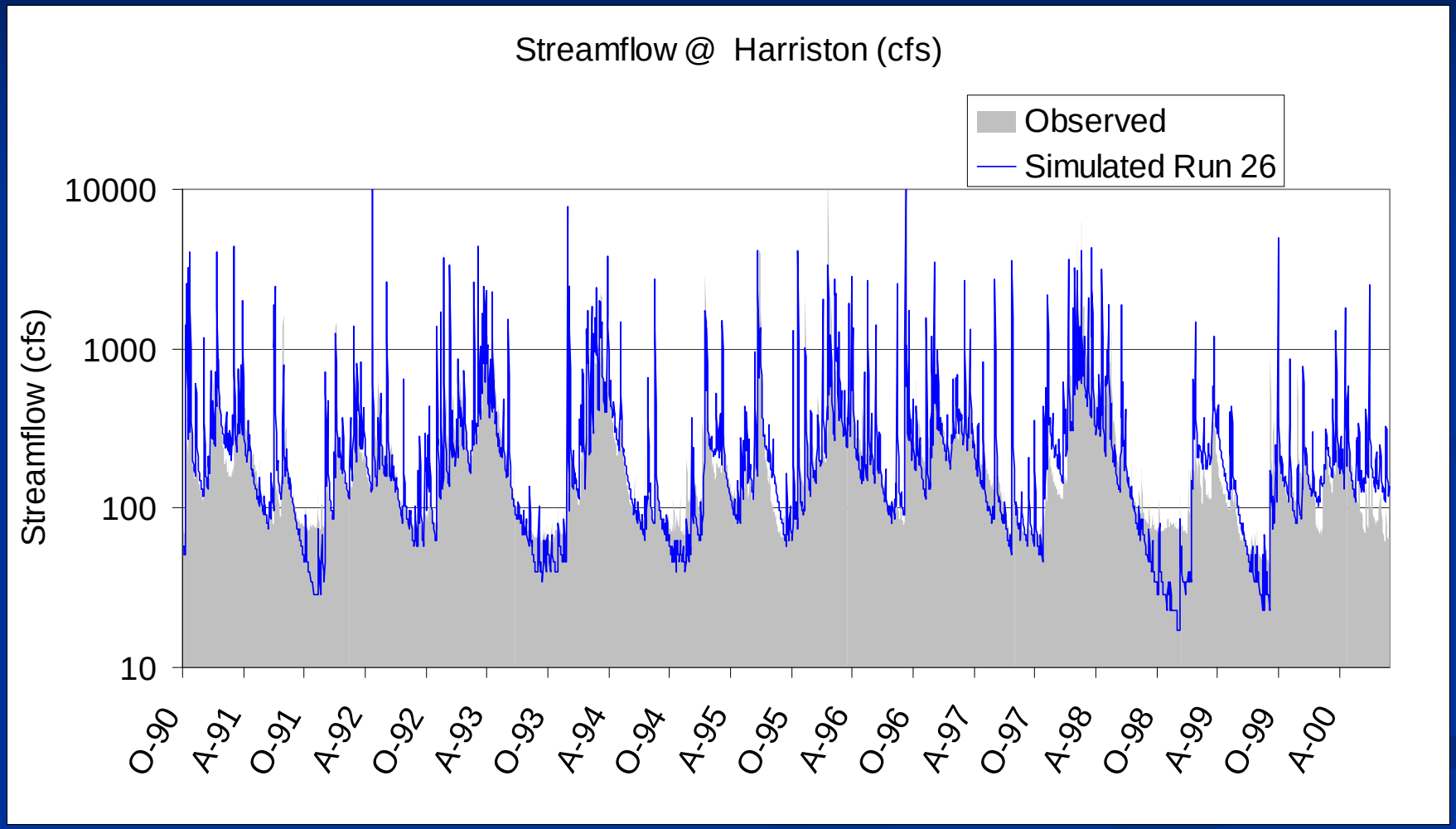
Daily Streamflow (cfs) – Harriston



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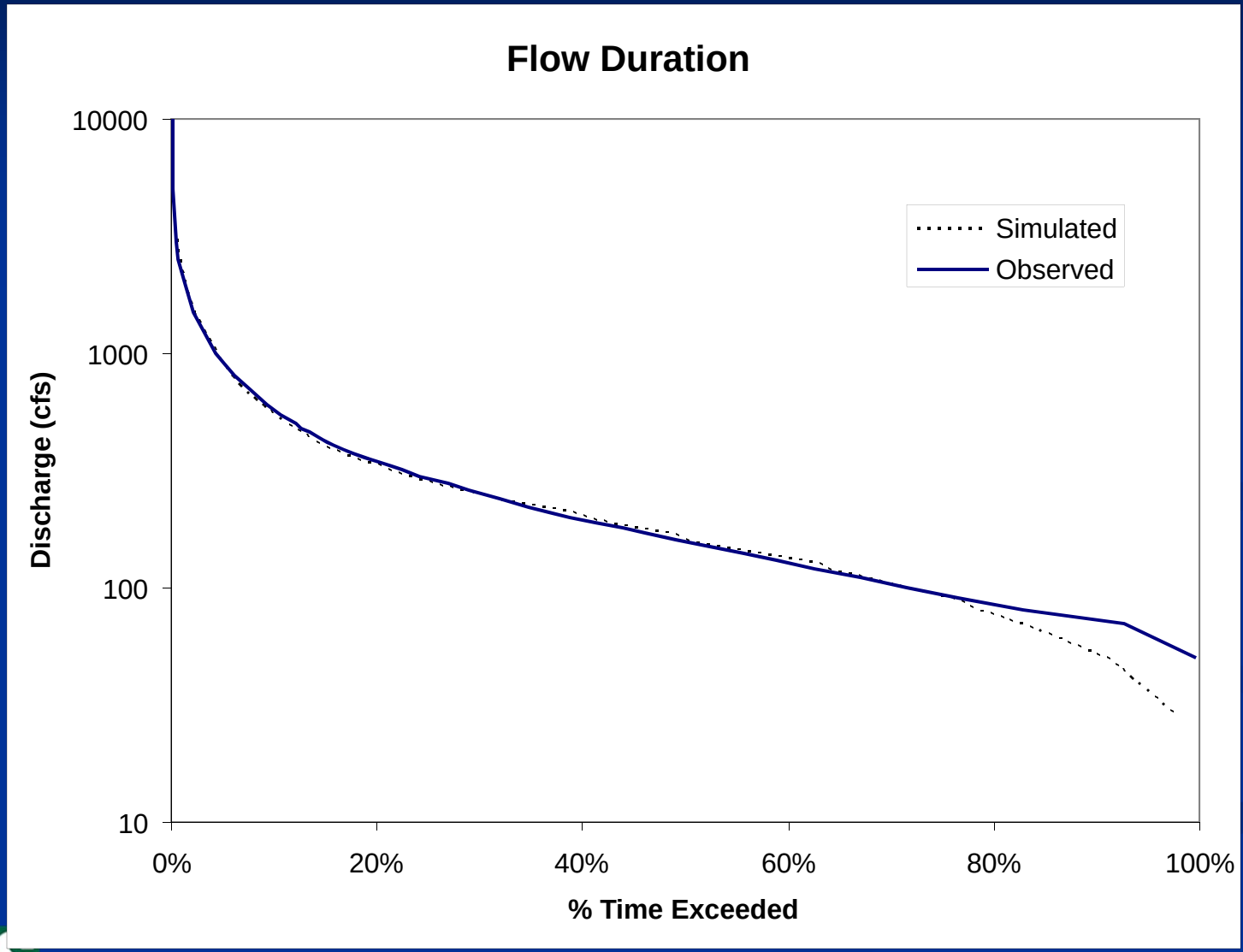
Preliminary data subject to revision, Oct. 2007

Flow Duration Curve – Harriston (01627500)



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Surface Sediment to River

Hourly time steps

Model simulates SSC (mg/L) and sediment fluxes

Purpose:
- **Improve subsequent simulation of mercury transport**

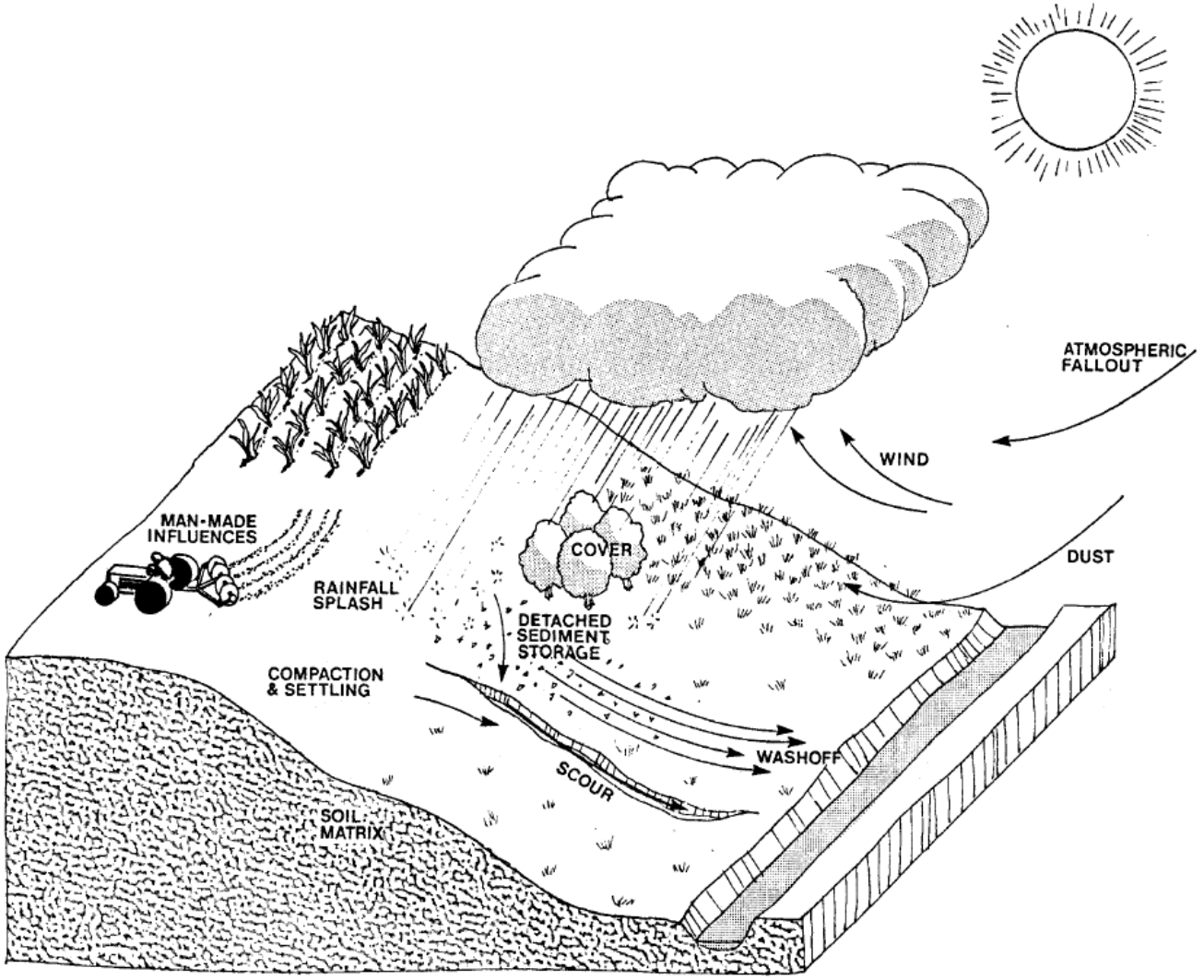

Figure 22: Erosion processes

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Sediment Budgeting in River Reaches

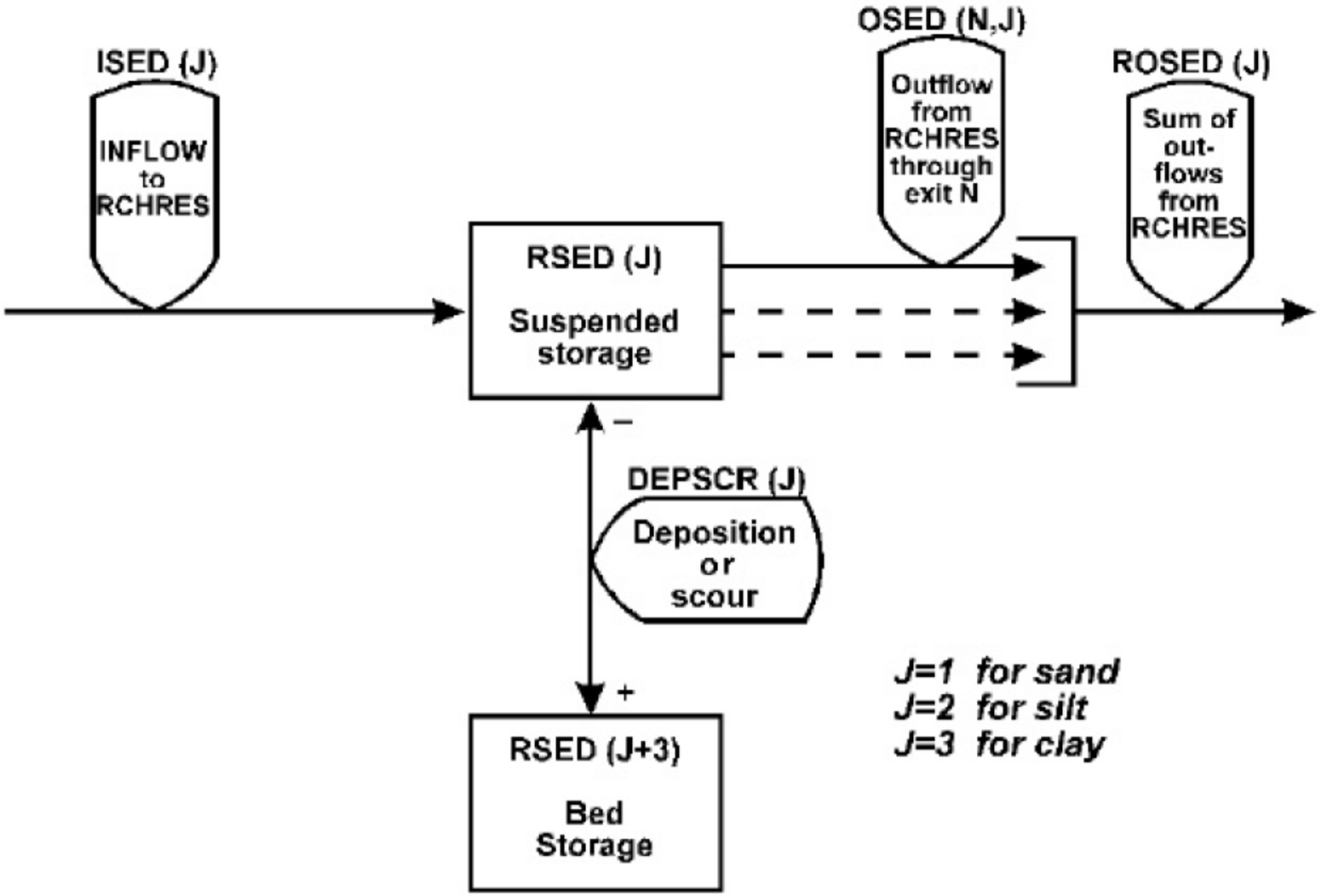

Figure 47: Flow diagram of inorganic sediment fractions in the SEDTRN section of the RCHRES Application Module

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Hg Transport Modeling

HSPF Modules to be used for Hg Input/Transport

Ground Water :	PERLND > AOQUAL
Interflow :	PERLND > IOQUAL
Sediment Associated Hg :	PERLND > WASHQS & IMPLND > WASHSD
Precipitation Hg to Stream :	RCHRES > CONS
Point Sources of Hg :	RCHRES > GQUAL
Sorption/Desorption :	RCHRES > GQUAL > ADSDES
Downstream Advection :	RCHRES > ADVECT (Dissolved Hg)
	RCHRES > ADVQAL (Sediment associated Hg)

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Hg Sorption to Suspended Sediment

- Transfer between dissolved mercury in the water column and mercury sorbed to suspended sediment will be modeled
- HSPF can simulate either equilibrium or non-equilibrium sorption
- Equilibrium sorption will be assumed for Total Hg following the ‘shake and bake’ batch test results
- Non-equilibrium (rate dependent) sorption might used for Methyl-Hg

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Hg Loads

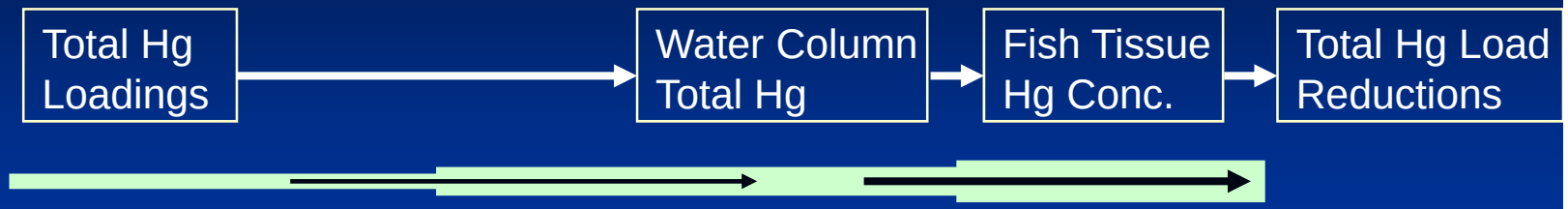
Sept. 2007

Hg Source	Current Hg Load Estimate (kg/yr)	Data Sources	Model Input
Atmospheric deposition	11 (only 1.1 to river)	EPA Data NADP Program	Assigned Conc for GW and Interflow inputs
Plant outfalls	1 - 5	Dupont data	Point Sources
Plant ground-water discharge	<1	2004-06 GW monitoring reports	GW Inflow – Assigned Hg concentrations
Other point sources	<1 from upper river sources	Flow data + water samples	Point Sources to RCHRES 1-3, 5
Groundwater and diffusion from bed sediments	5 - 20	Water and sediment analyses + loading rates at base flow	GW Inflow – Assigned conc.
Sediment associated Hg to river	10-100	Water analyses Sediment Hg data Loading calculations	Fixed Sed Hg Conc by Reach + Sed Transport
Total	13 - 111		

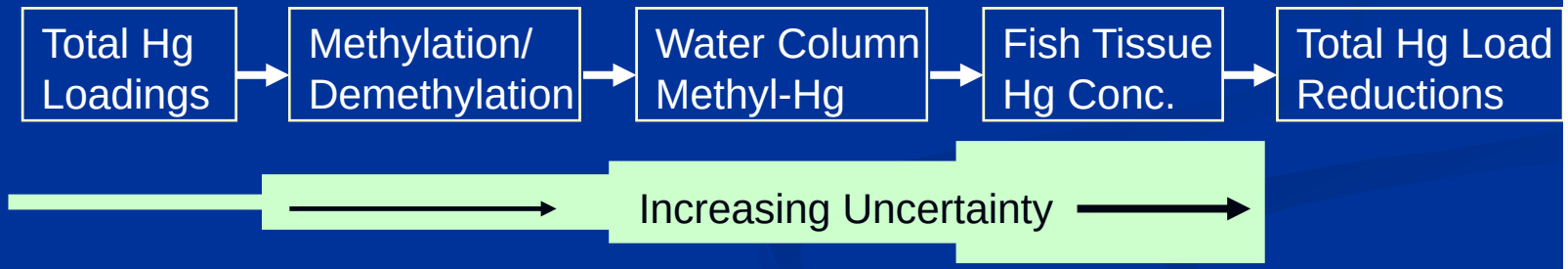
Preliminary data subject to revision, Oct. 2007

Alternate TMDL Modeling Approaches

Total Hg based TMDL



Methyl-Hg based TMDL



- Adding methylation to the model will probably increase uncertainty in predicted fish tissue Hg concentrations due to poorly constrained parameters and additional steps.
- Greater uncertainty may require greater Hg loading reductions to stay within the margin of safety

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End of Presentation

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