Load Sensitivity to Inputs: Soliciting Input
+
Sanitary Sewer Exfiltration: Background and Update

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Agenda

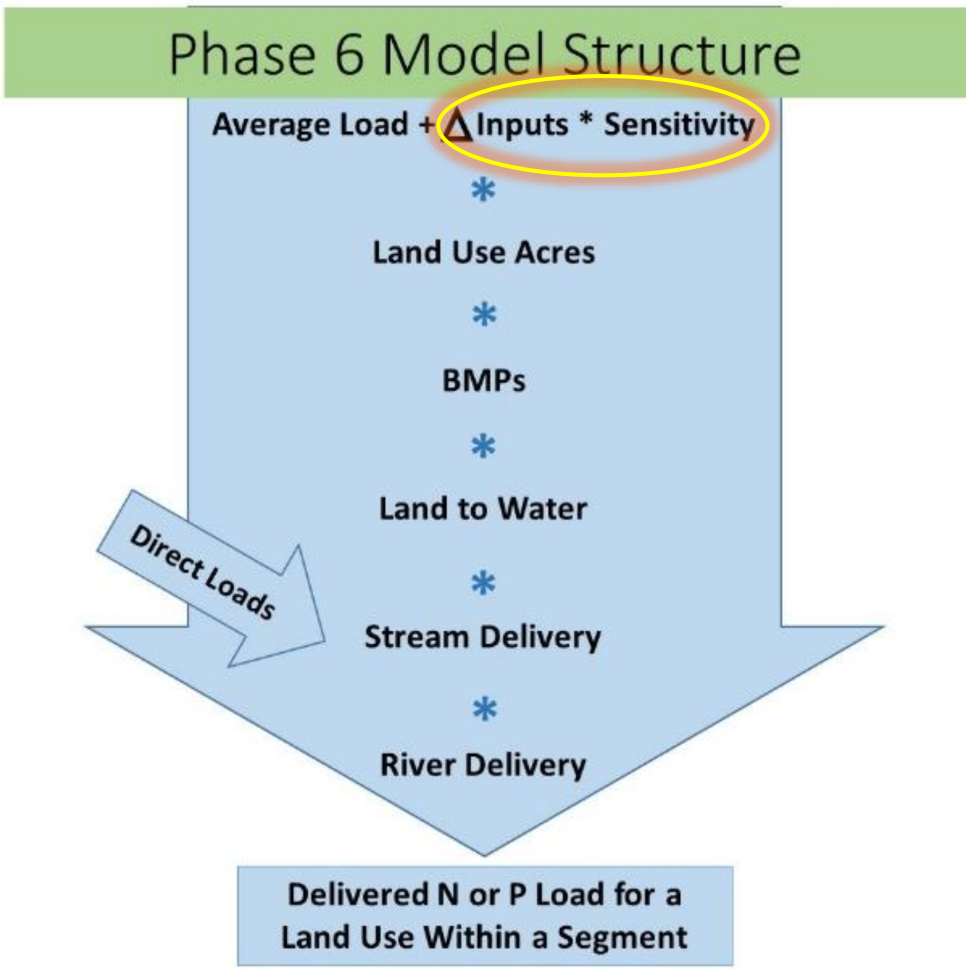
- Input on load sensitivities to inputs
- Background on sanitary sewer exfiltration and update on WWTWG consideration

Load Sensitivity to Inputs

Sensitivity (S) is defined as the change in export load per change in input load. If inputs change by Δ, the export will change by S*Δ (S=Δ Export/Δ Input).

What is load, by source, available for export?

We are updating these values for Phase 7.



In Phase 6….

Load Source

- Non-Regulated Roads
- Non-Regulated Buildings and Other
- Non-Regulated Turf Grass
- MS4 Tree Canopy over Turfgrass
- MS4 Turf Grass
- MS4 Tree Canopy over Impervious
- MS4 Buildings and Other
- MS4 Roads
- MS4 Construction
- Non-Regulated Tree Canopy over Turfgrass
- Non-Regulated Tree Canopy over Impervious
- CSS Tree Canopy over Turfgrass
- CSS Tree Canopy over Impervious
- CSS Construction
- CSS Roads
- CSS Buildings and Other
- CSS Turf Grass

Nutrient Species

- NH3
- OrgN
- NO3
- TP

Input Type

- AtmDep
- Fert
- Uptake
- CropCov

Focus efforts updating sensitivities

- Which load sources and inputs should be revisited?
- How might we determine new sensitivity values?
  - Literature review
  - Available data
  - Existing models
  - Parameterization within CalCAST

Phosphorus

What are we missing?

- P loading appears to be increasing despite management efforts and model predictions
- In P6 fertilizer is the only input of P to developed load sources

Load Sensitivity to Inputs Discussion

- Joseph Delesantro, jdelesantro@chesapeakebay.net

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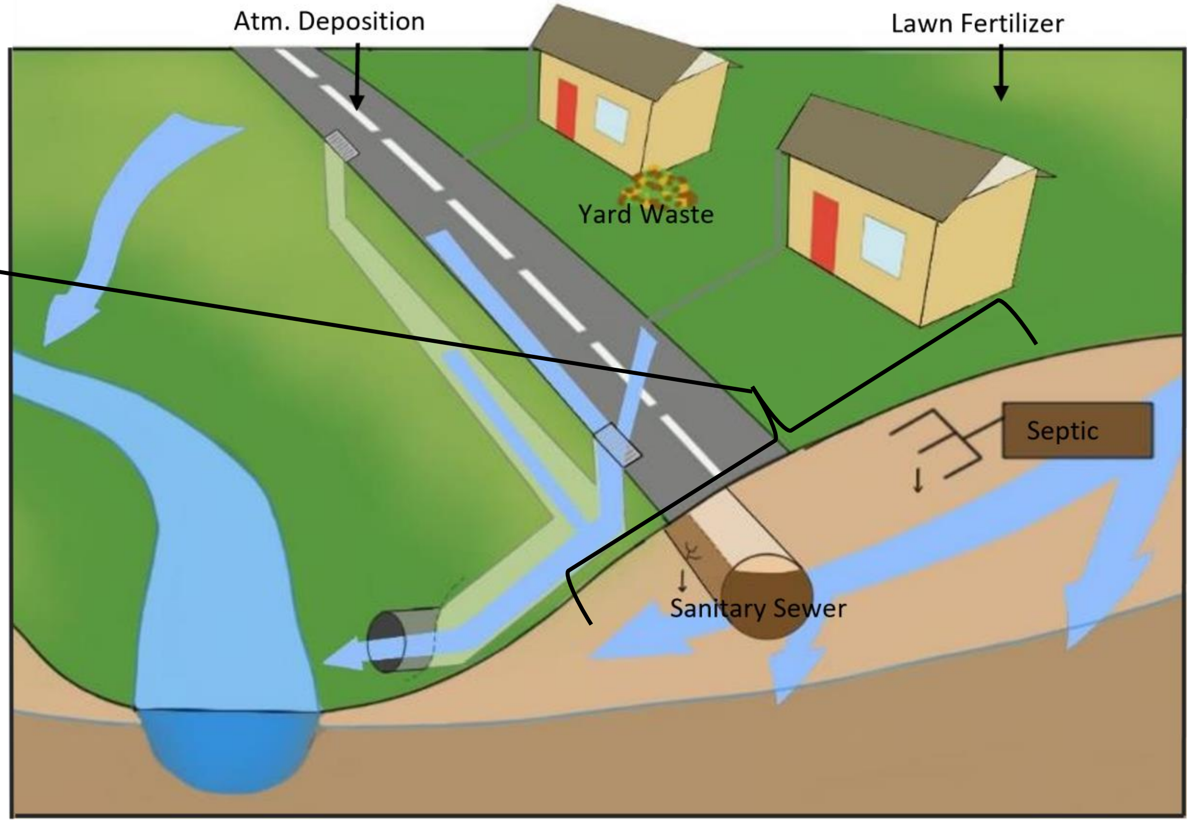
Sanitary Sewer Exfiltration: Background and Update

- Humans convert food to wastewater

- And we depend on sanitary infrastructure to contain and treat this nitrogen source



Bernhardt et al.: *Urban Impacts on Surface Water Nitrogen Loading*

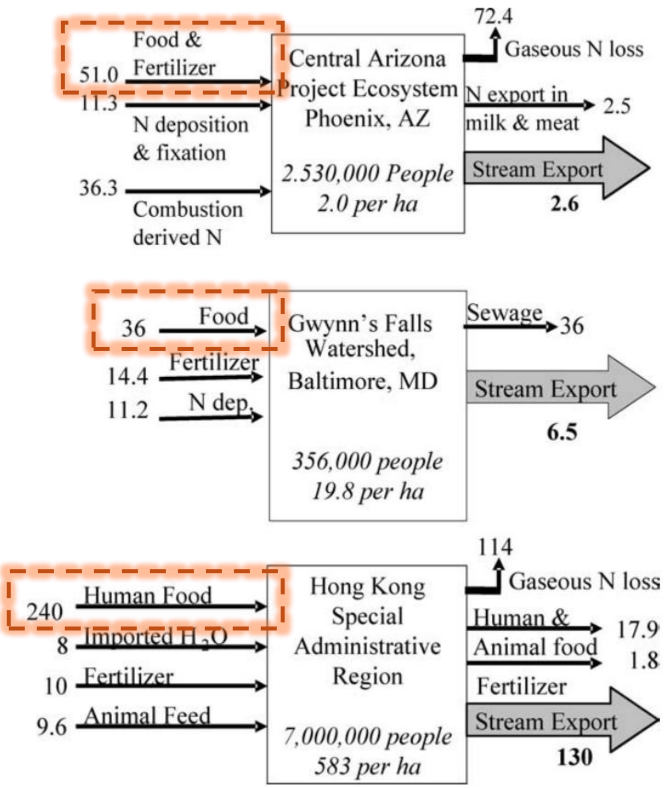


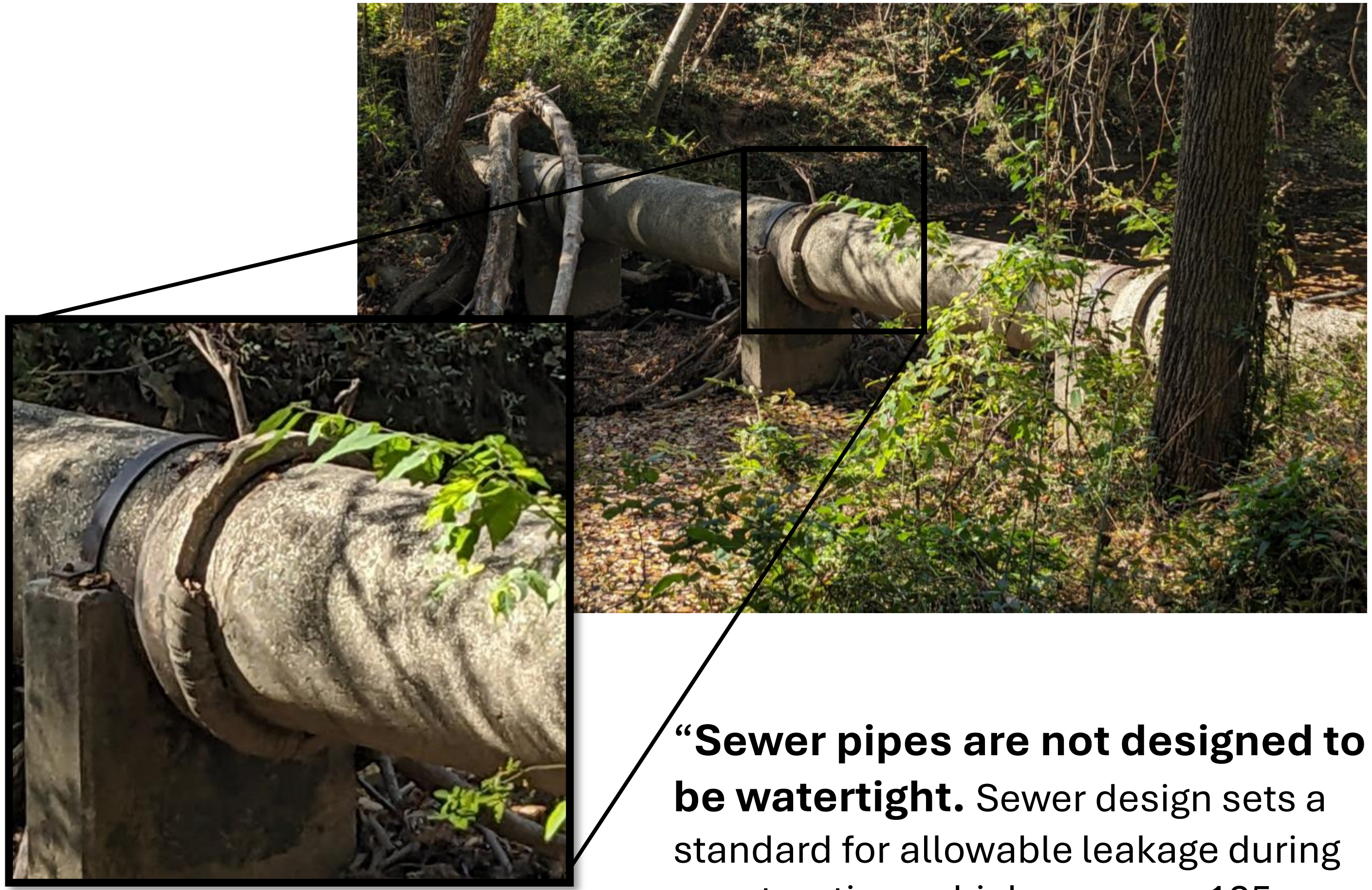
Figure 2. Compiled mass balance estimates for three cities (data in kg N ha^{-1} y^{-1}) arranged in order of increasing population density. Data for Phoenix from Baker *et al.* 2001, for Baltimore from Groffman *et al.* 2004, and for Hong-Kong from Warren-Rhodes and Koenig 2001. Note the discrepancies between the types of fluxes measured in each study.

Bernhardt, E. S., Band, L. E., Walsh, C. J., & Berke, P. E. (2008). Understanding, managing, and minimizing urban impacts on surface water nitrogen loading. *Annals of the New York Academy of Sciences*, *1134*, 61–96.

Baker, L. A., Hope, D., Xu, Y., Edmonds, J., & Lauver, L. (2001). Nitrogen balance for the Central Arizona-Phoenix (CAP) ecosystem. *Ecosystems*, *4*(6), 582–602.

Groffman, P. M., Law, N. L., Belt, K. T., Band, L. E., & Fisher, G. T. (2004). Nitrogen Fluxes and Retention in Urban Watershed Ecosystems. *Ecosystems*, *7*(4), 393–403.

Warren-Rhodes, K. & A. Koenig. (2001). Ecosystem appropriation by Hong Kong and its implications for sustainable development. Ecol. Econ. 39: 347–359.

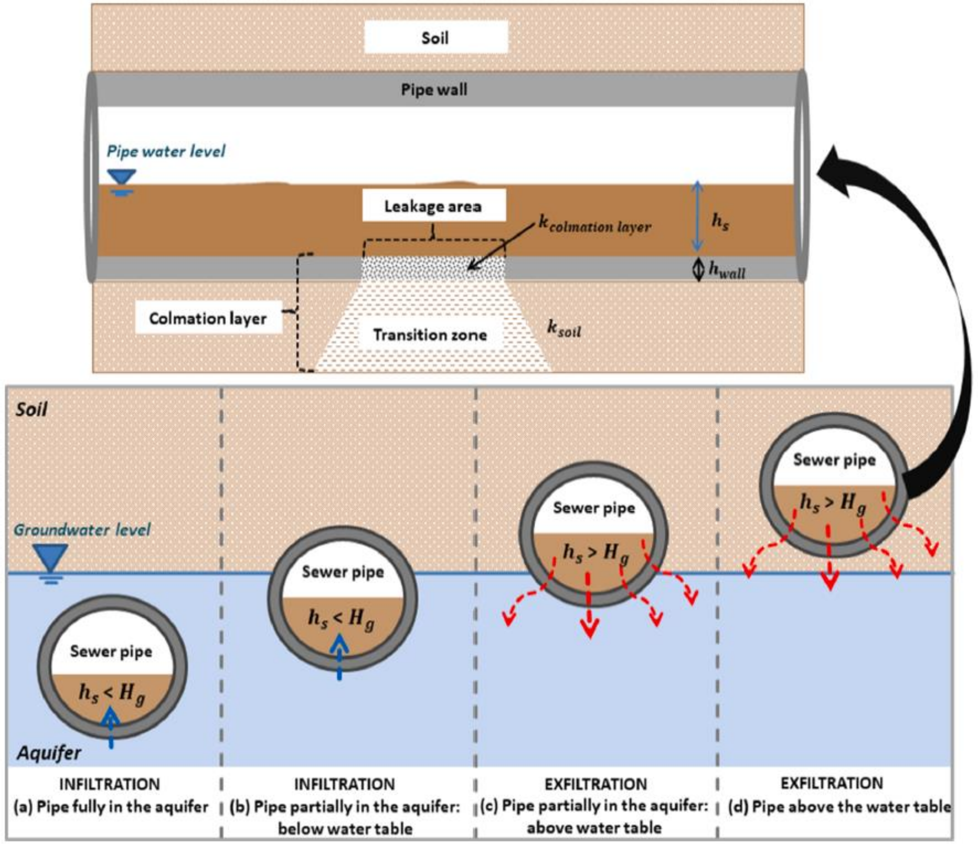


“**Sewer pipes are not designed to be watertight.** Sewer design sets a standard for allowable leakage during construction, which averages 125 gallons per 400 feet of pipe, which is the standard distance between sewer manholes (ASTM, 2009), or about 1,650 gallons per mile of standard sewer pipe.”

Chesapeake Bay Program, (2014). “Final Expert Panel Report on Removal Rates for the Elimination of Discovered Nutrient Discharges from Grey Infrastructure”

If it can infiltrate, it can exfiltrate.

- Net system infiltration does not exclude areas of exfiltration
- Segments may infiltrate in wet periods and exfiltrate in dry periods
- Because WW nutrient concentrations are 2 orders or magnitude greater than background, small amounts of exfiltration can represent large loads



Nguyen, Hong Hanh, Aaron Peche, and Markus Venohr. "Modelling of sewer exfiltration to groundwater in urban wastewater systems: A critical review." *Journal of Hydrology* 596 (2021): 126130.

Why does this matter for the model?

- Proper appropriation of loads
- Improved targeting and crediting of management actions
- Scenario analysis (E.g., remediation, pipe ageing, etc.)

This load is in the bay, the load is in the model, but it is currently misappropriated.

Potential impacts of SS Exfiltration in the CBW

Conservative estimated contribution to the CBW from literature:

- 665,392 – 2,217,974 lb N/year
- 0.23 - 0.76% of the total N load to the CB
- 1.51 - 6.04% of the WW load to the CB
- 3.28 - 10.93% of the urban load to the CB
- 0.60% – 48.9% of the load from individual urbanized catchments to CBW**
- 13 - 47.5% of the measured load from individual urbanized residential catchments in the NC Piedmont*

Note: Values derived from the mean of studies or study regions (Delesantro et al., 2022; Nguyen and Venohr, 2021)
Assuming 30mg/l N in raw WW
Delesantro et al., 2022: Assuming NO_3^- proportion from WW ~ TN proportion from WW
*Assuming stormflow WW exfiltration loading from mean of Delesantro et al., (in review) urban catchments and baseflow WW exfiltration from Delesantro et al., 2022
** using full range in exfiltration values reported from Nguyen and Venohr, 2021