



Omni Environmental

Export of Phosphorus from
Great Swamp to Passaic River

Thomas Amidon

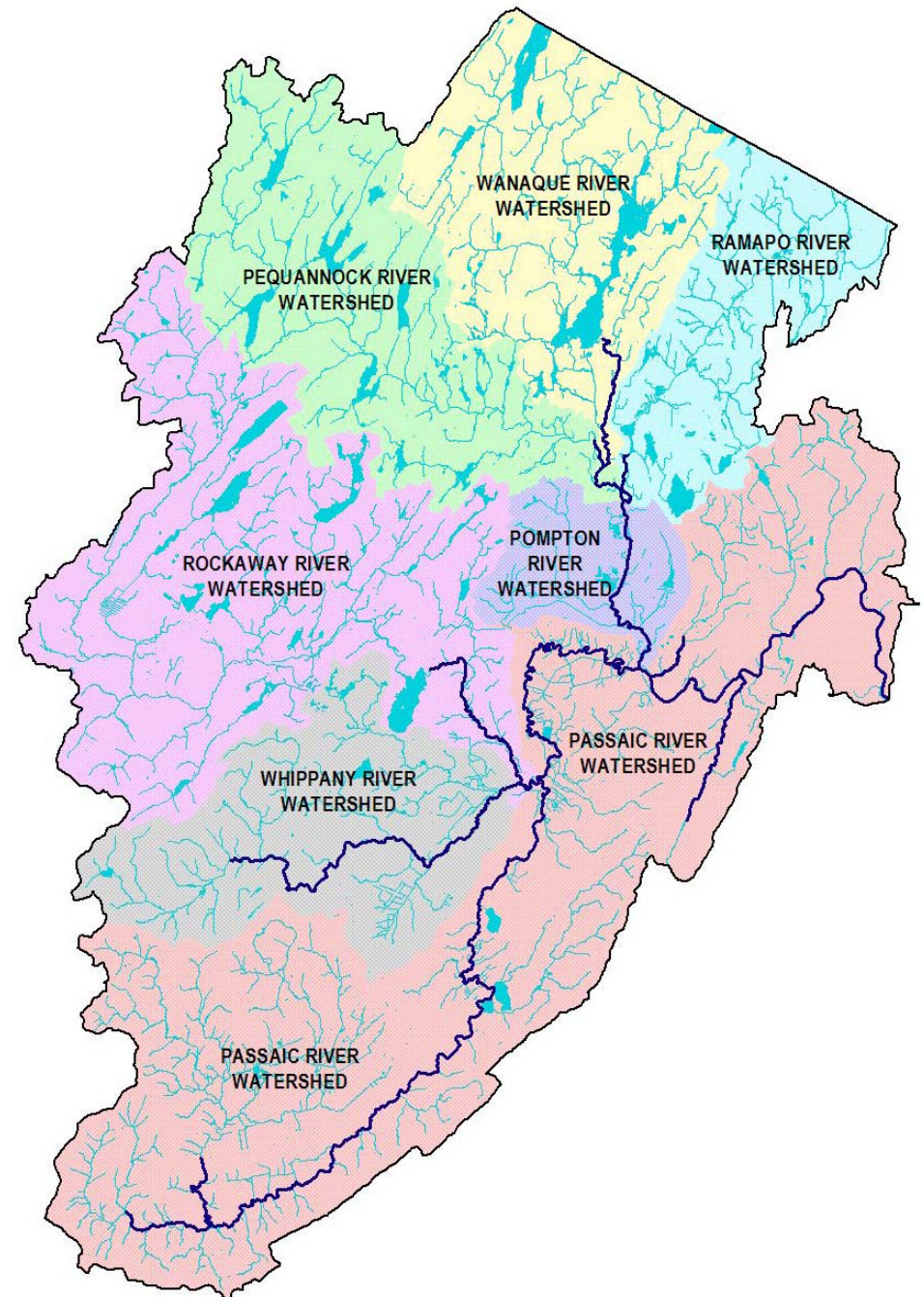
American Water Resources Association
2007 Annual Conference
Albuquerque, NM
November 15, 2007

Acknowledgements

- Funding, Project Management, and Technical Review
 - New Jersey Department of Environmental Protection
 - Rutgers University – New Jersey EcoComplex
- Data Sources
 - Great Swamp Watershed Association and Ten Towns Great Swamp Watershed Management Committee
 - <http://www.greatswamp.org/StreamMon.htm>
 - New Jersey Department of Environmental Protection
 - Omni Environmental sampling data
 - TMDL Monitoring locations (Black Brook and Great Brook)
 - Quarterly sampling in Black Brook for Chatham Township
 - Monthly Discharge Monitoring Reports
 - Morris-Woodland STP and Chatham-Main STP
 - United States Geologic Survey – flow data
 - Passaic River near Millington (01379000)
 - http://waterdata.usgs.gov/nj/nwis/nwismap/?site_no=01379000&agency_cd=USGS

Background

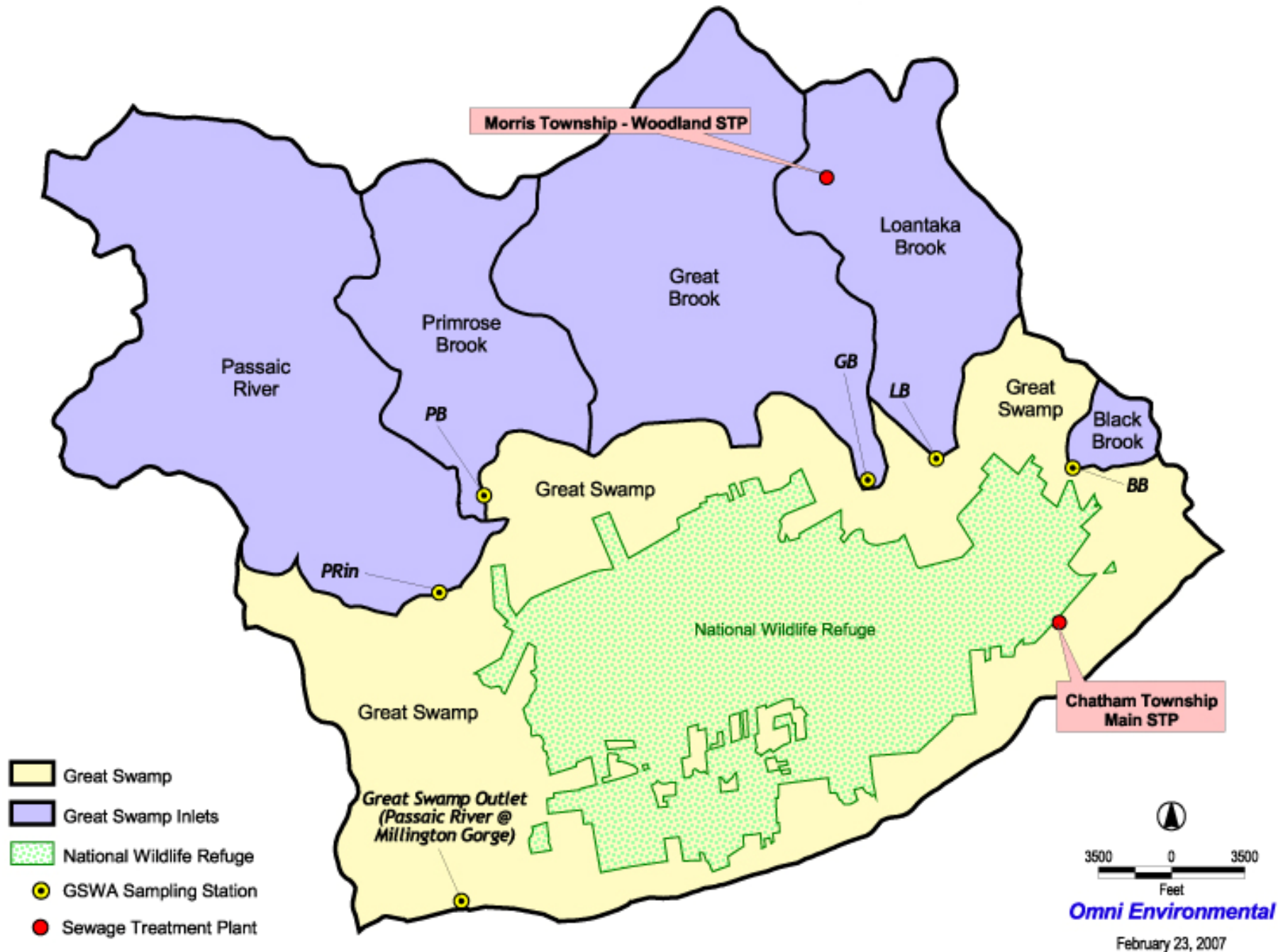
- Passaic River at Millington Gorge
 - Headwater boundary for Passaic River Basin TMDL model
 - Outlet of Great Swamp watershed
 - Exhibits relatively high phosphorus concentration (~ 0.1 mg/l)



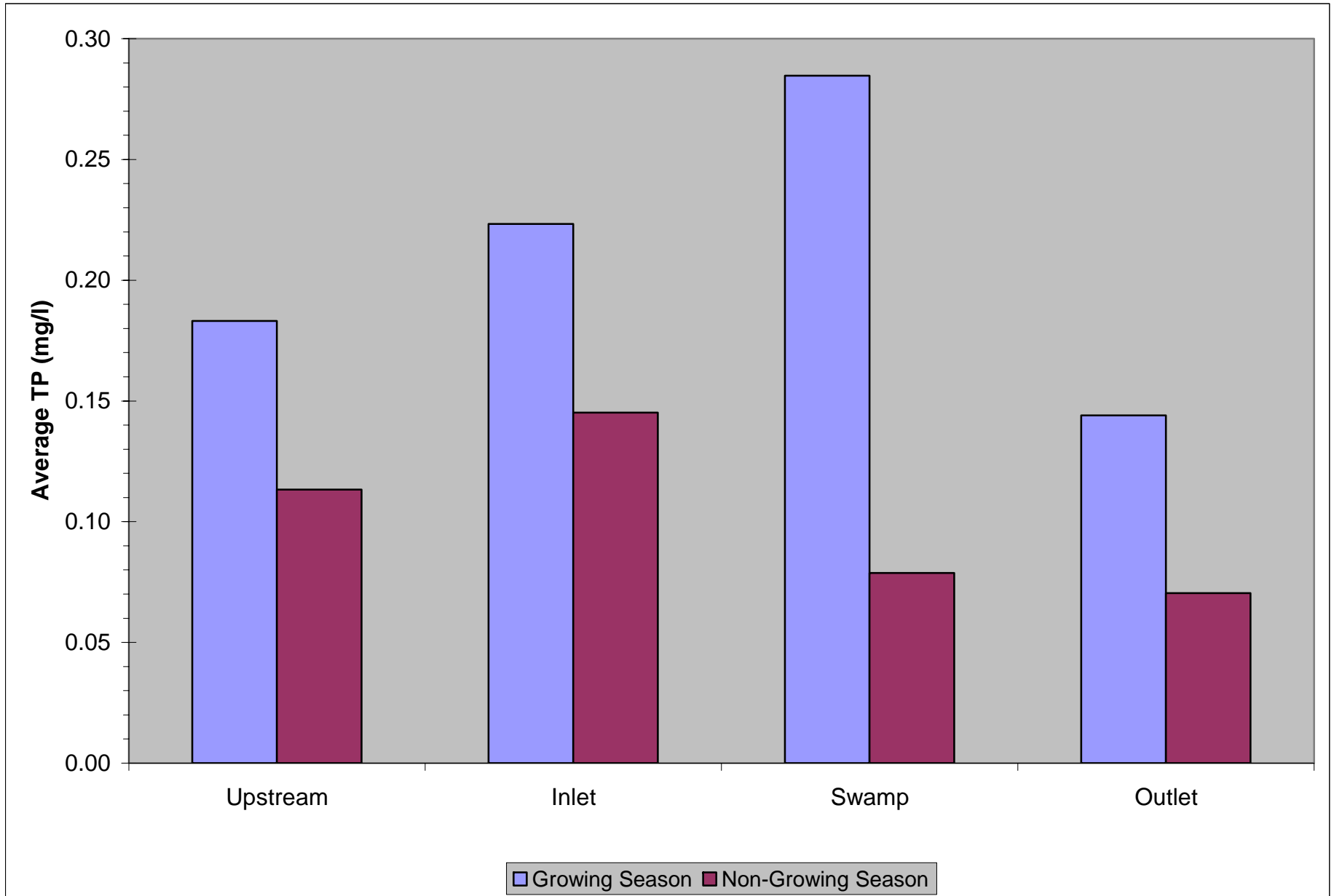
Purpose

- Characterize Passaic River headwater boundary at outlet of Great Swamp
 - Refine phosphorus boundary condition
- Compare tributary and point source inputs to Great Swamp with the export of phosphorus to the Passaic River
 - Provide basis for effluent limitations
- Limited study based on making the best use of existing data
 - Not designed to quantify processes within the Great Swamp itself

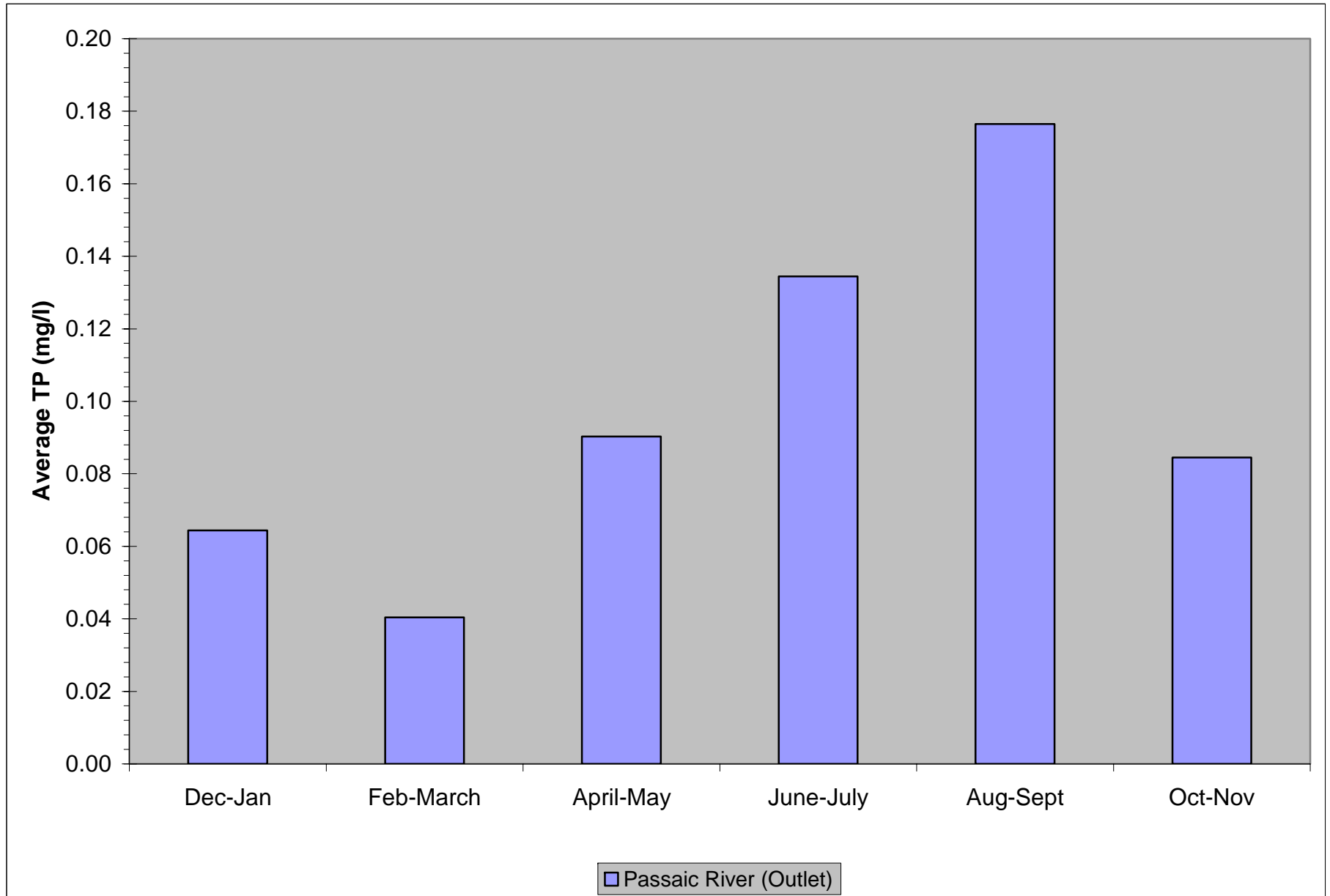
Great Swamp - Inlets, Point Sources, and Outlet



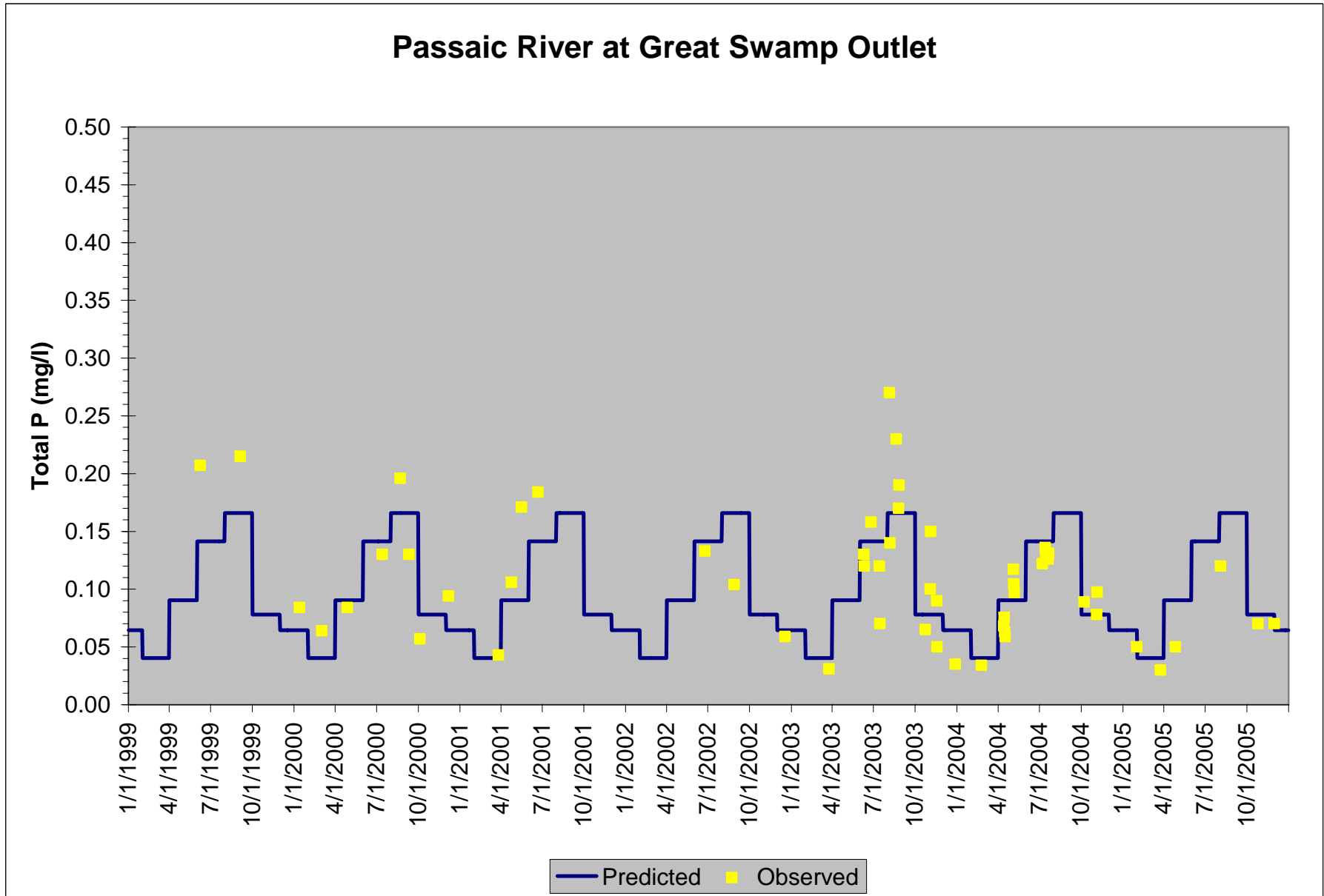
Average Phosphorus Concentrations in Great Swamp Watershed



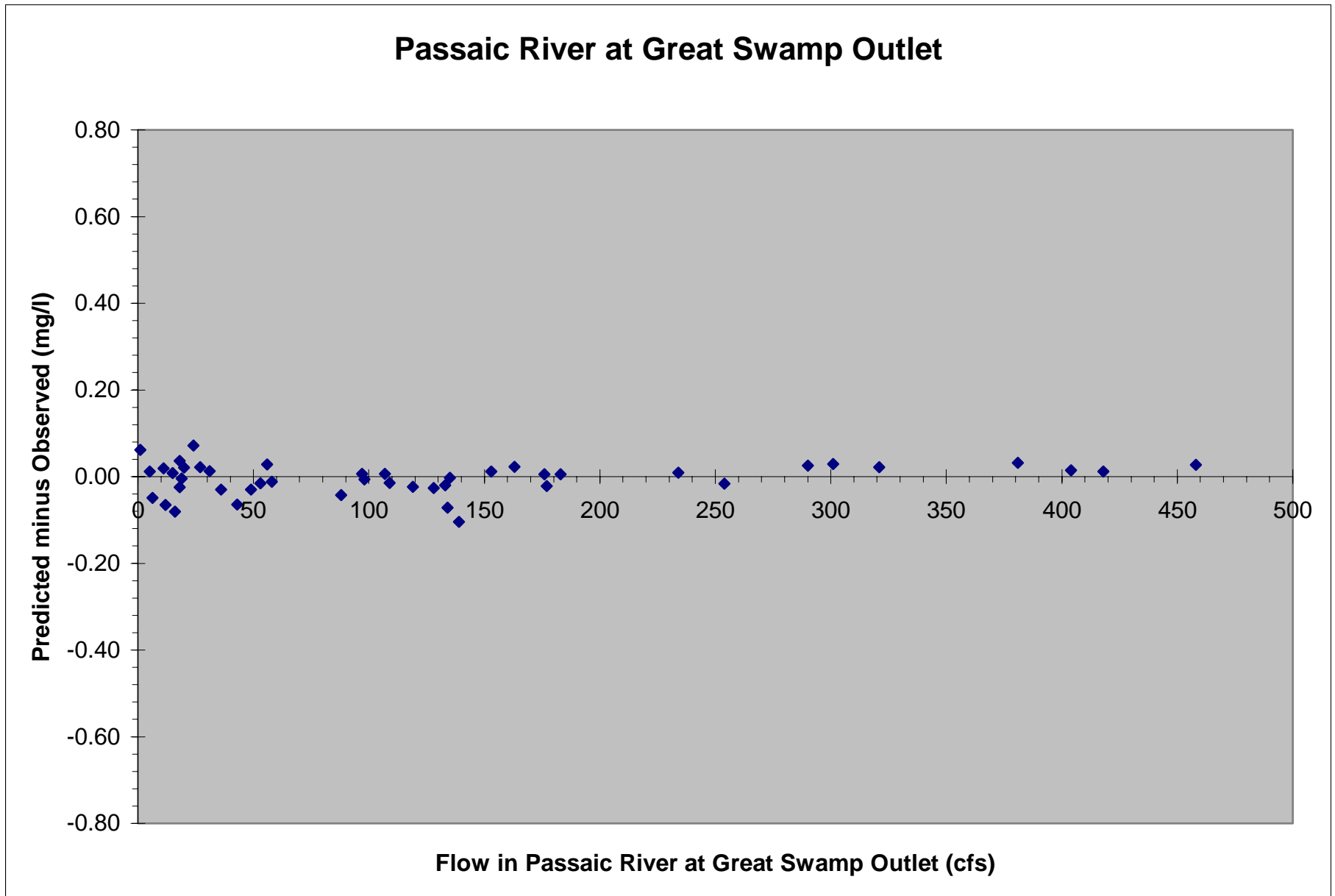
Average Phosphorus Concentrations at Outlet of Great Swamp



Basis for Passaic Headwater Boundary Condition for TMDL Model



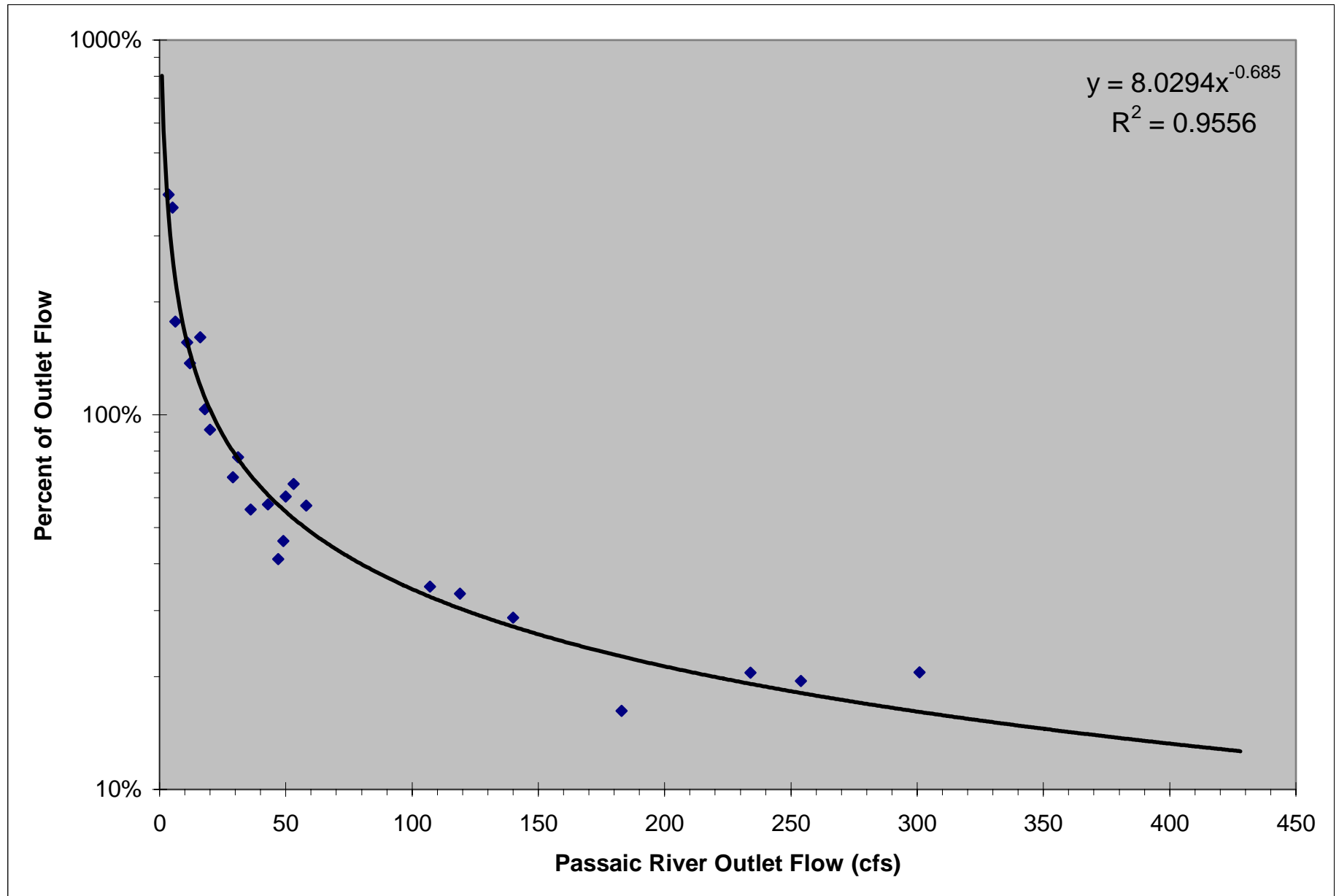
Residual TP Error at Passaic River Outlet versus Outlet Flow



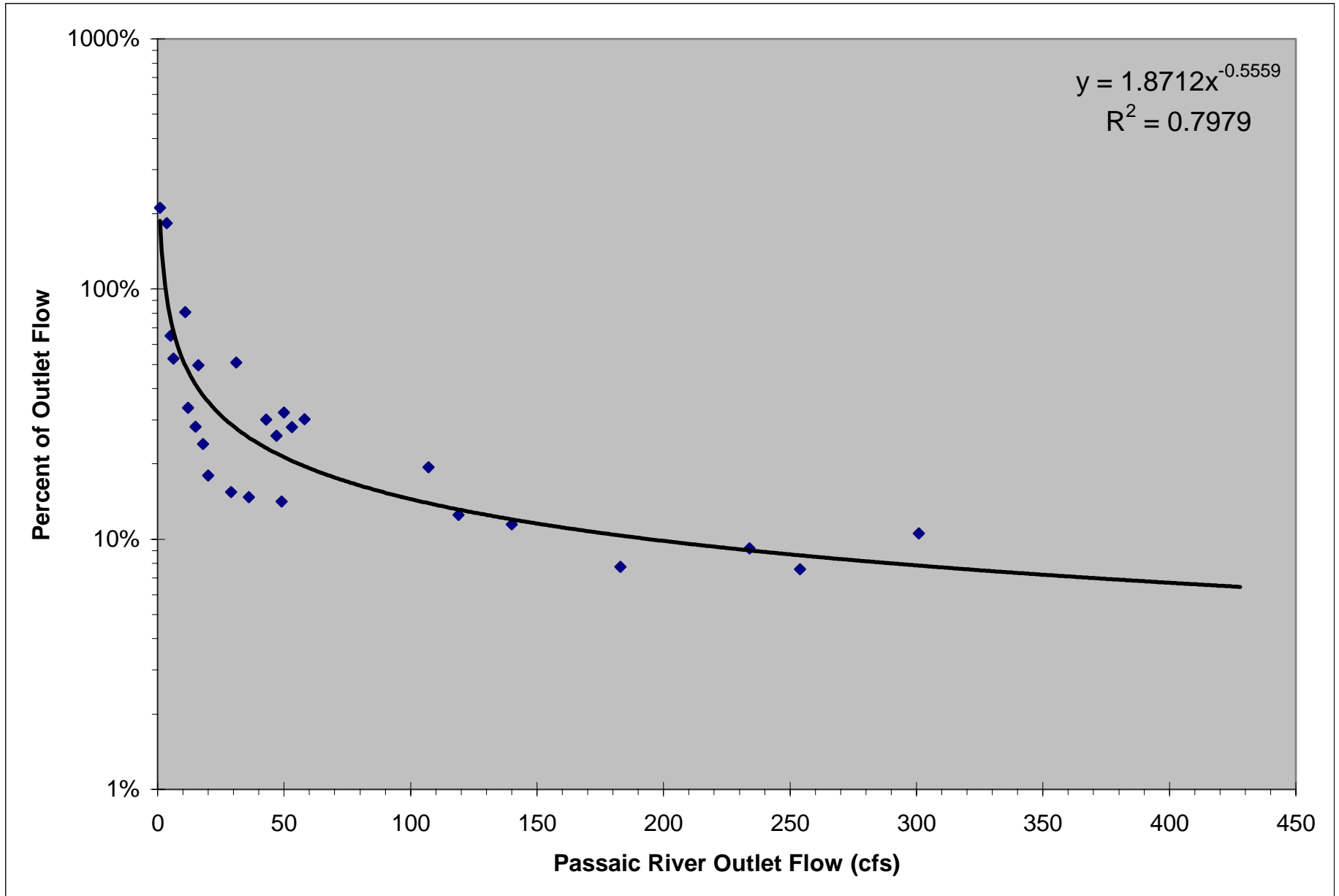
Hydrology of Great Swamp Inlets and Outlet

- Flow at outlet available from USGS gage at Millington (01379000)
- Flows at inlets are often measured by GSWA/TTC
- Relationship defined between inlet flows and outlet flow
 - Traditional drainage area methods do not work
 - Inlet flows as a percentage of outlet flow varies with the outlet flow
 - The lower the outlet flow, the higher the inlet flow as a percentage of the outlet flow
 - Individual inlet flows were frequently larger than the outlet flow during low-flow conditions
 - Relationships very strong when described using power functions

Flow at Passaic River Inlet as a Percentage of Outlet Flow



Flow at Great Brook Inlet as a Percentage of Outlet Flow



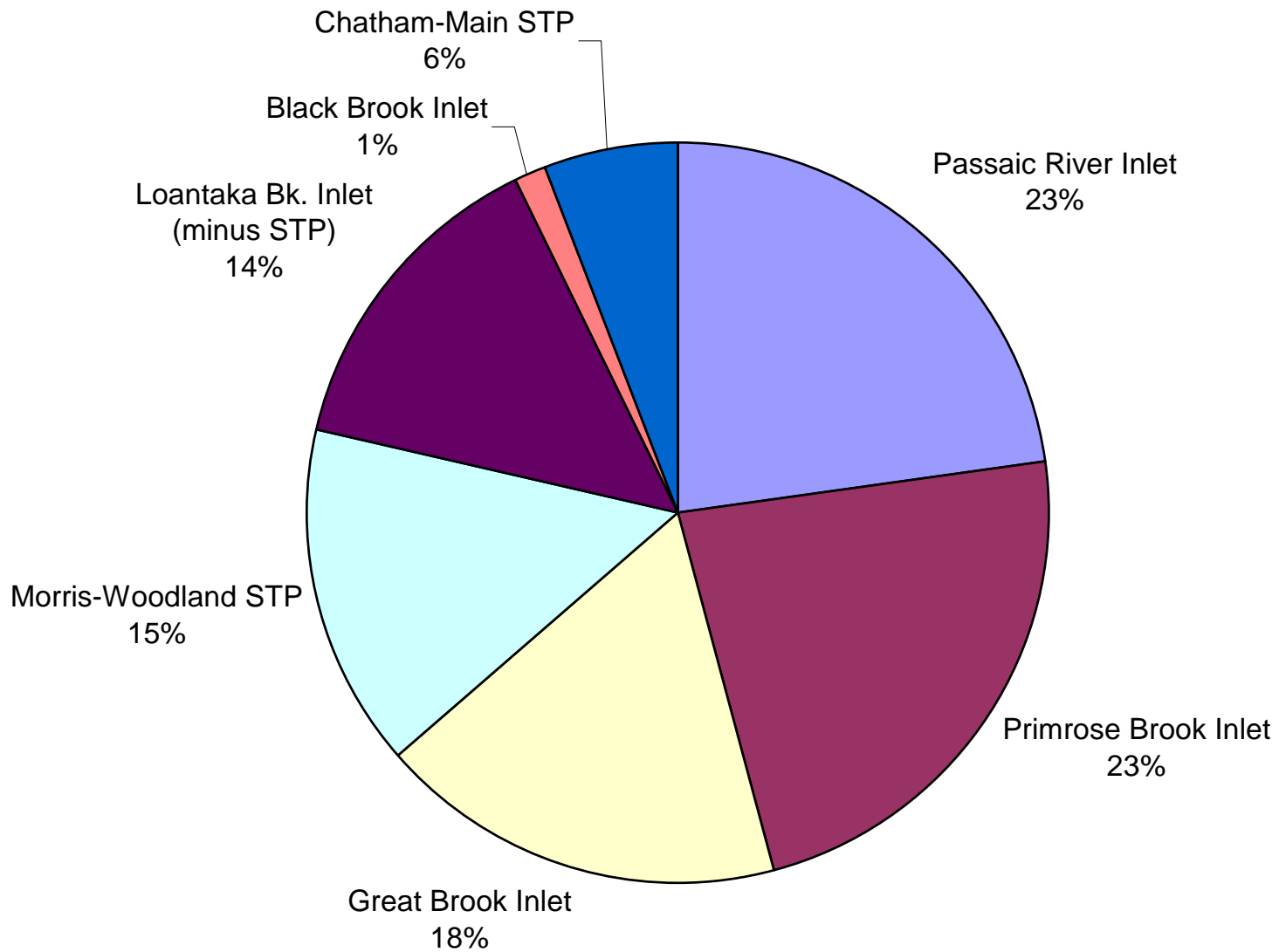
Hydrology Notes and Implications

- These are remarkably strong flow correlations
- During low-flow conditions, much more water is flowing into the Great Swamp than flowing out
 - In fact, several of the inlet flows alone are greater than the outlet flow during low-flow conditions
 - The Great Swamp during low-flow conditions is storing and/or losing (e.g., through evapotranspiration) vast quantities of water
- Under high-flow conditions, there is much more water flowing out of the Great Swamp than is flowing in at that time
- This evaluation is not a water balance for the Great Swamp
 - The objective of the loading analysis is to quantify loads entering the Great Swamp at the inlets and exiting via the Passaic River at Millington
 - Flows at the inlets were calculated directly from the USGS flow at the outlet based on power functions, providing a basis for load calculations

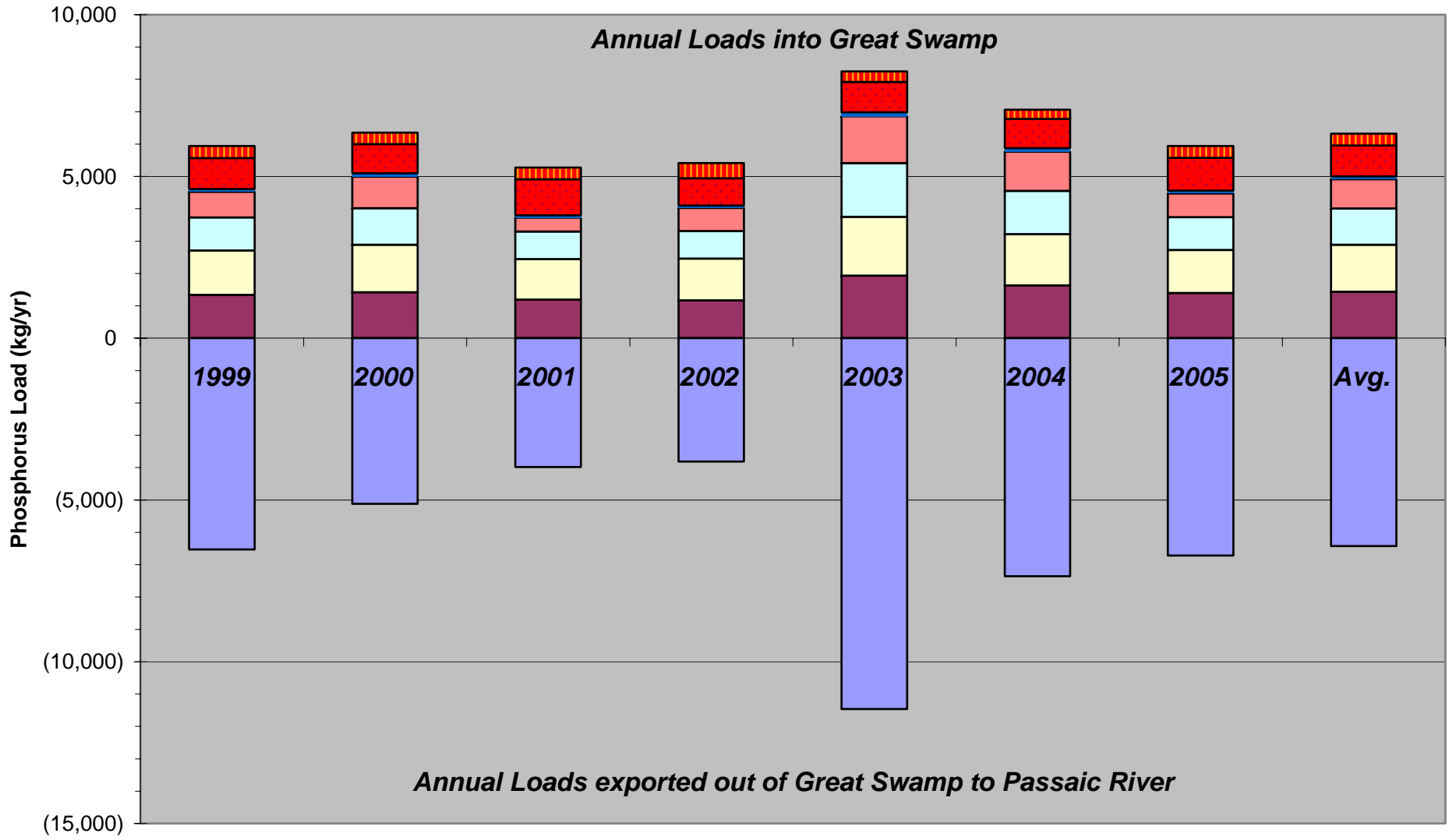
Summary of Phosphorus Loading Model

- Powerful empirical tools were developed to calculate both stream flow rates and total phosphorus concentrations at the inlets and outlet of the Great Swamp
 - Empirical flow model
 - Daily flows for each subwatershed inlet were calculated based on power functions described previously
 - DMRs used to characterize STP flows
 - Empirical phosphorus concentration model
 - Subwatershed inlets were assumed to vary by growing season and general flow condition
 - DMRs used to characterize STP concentrations
 - Great Swamp outlet was assumed to vary on a bi-monthly basis
- The only inputs required include gaged flow rate at the outlet (Passaic River at Millington) and the month of the year.
- Daily Loads estimated from 1999 – 2005

Phosphorus Loads to Great Swamp



Annual Loads into Great Swamp



Annual Loads exported out of Great Swamp to Passaic River

- Passaic River Inlet
- Primrose Brook Inlet
- Great Brook Inlet
- Loantaka Bk. Inlet (minus STP)
- Black Brook Inlet
- Morris-Woodland STP
- Chatham-Main STP
- Passaic River Outlet

Observations Based on Loading Model

- During dry years like 2001 and 2002, Great Swamp functions like a sink
 - More phosphorus enters Great Swamp than leaves it
- During wet years like 2003, Great Swamp acts like a source
 - Much more phosphorus leaves the Great Swamp than enters it
- This analysis is not a water or phosphorus balance
 - There are important processes within the Swamp that very likely affect the balance of both water and phosphorus, such as groundwater discharge

Conclusions

- Hydrology and phosphorus concentrations at the inlets and outlet of the Great Swamp are remarkably predictable
- Over the seven-year period analyzed, the total load leaving Great Swamp was almost the same as the load entering Great Swamp
- Great Swamp experiences substantial year-to-year variation in the degree to which it functions as a phosphorus source or a phosphorus sink
 - Affected by hydrologic and seasonal patterns
- It appears that the sediment dynamics in the wetlands are driving the phosphorus conditions rather than plant uptake
- Application of Great Swamp study to Passaic TMDL
 - Realistic Passaic River headwater boundary condition for phosphorus
 - Technical basis to impose stricter STP effluent limits for TP

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Questions?

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