Fall Line Input Monitoring on the Potomac River at Chain Bridge 1983 - 2007

Metropolitan Washington Council of Governments

and

Occoquan Watershed Monitoring Laboratory

Regional Monitoring Subcommittee Meeting

15 August 2007

Virginia Tech

History of the Station - I

- Originally operated by USGS
  - Difficulty in maintaining automatic sampler operations
  - Manual sampling (USGS cross-section integrated method) very difficult to use during high flow events
- MWCOG/OWML assumed operation in 1983
  - Storm sampling conducted under assumption of a well-mixed flow regime at Chain Bridge due to narrowing of Potomac River at that point
  - Storm sampling originally was by collection of discrete samples triggered remotely (*via* phone from OWML)
    - Flows obtained *via* telephone access to Little Falls gage

History of the Station - II

- In January 1986, OWML converted to computer-controlled automated station
  - Storm samples were flow-composited *in situ* using OWML-developed system
    - "Monitoring of Stream Hydrology and Quality using Microcomputers," Proceedings, Symposium on Monitoring, Modeling, and Mediating Water Quality, AWRA, 1987.
  - Apart from equipment upgrades, this is basically the same system used today

Objectives

- Locate, instrument, and operate a stream gaging and water quality sampling station for the Potomac River at the fall line
  - Measurement of constituent loads delivered to the Potomac Estuary
  - Enable comparison of point and nonpoint source loads in watershed
- Two candidate sites
  - Potomac River at Little Falls Dam
  - Potomac River at Chain Bridge

Little Falls

- Long-term gaging record available
  - March 1930 - Present
  - Good hydraulic control (Little Falls Dam)
  - Rating table maintained by USGS

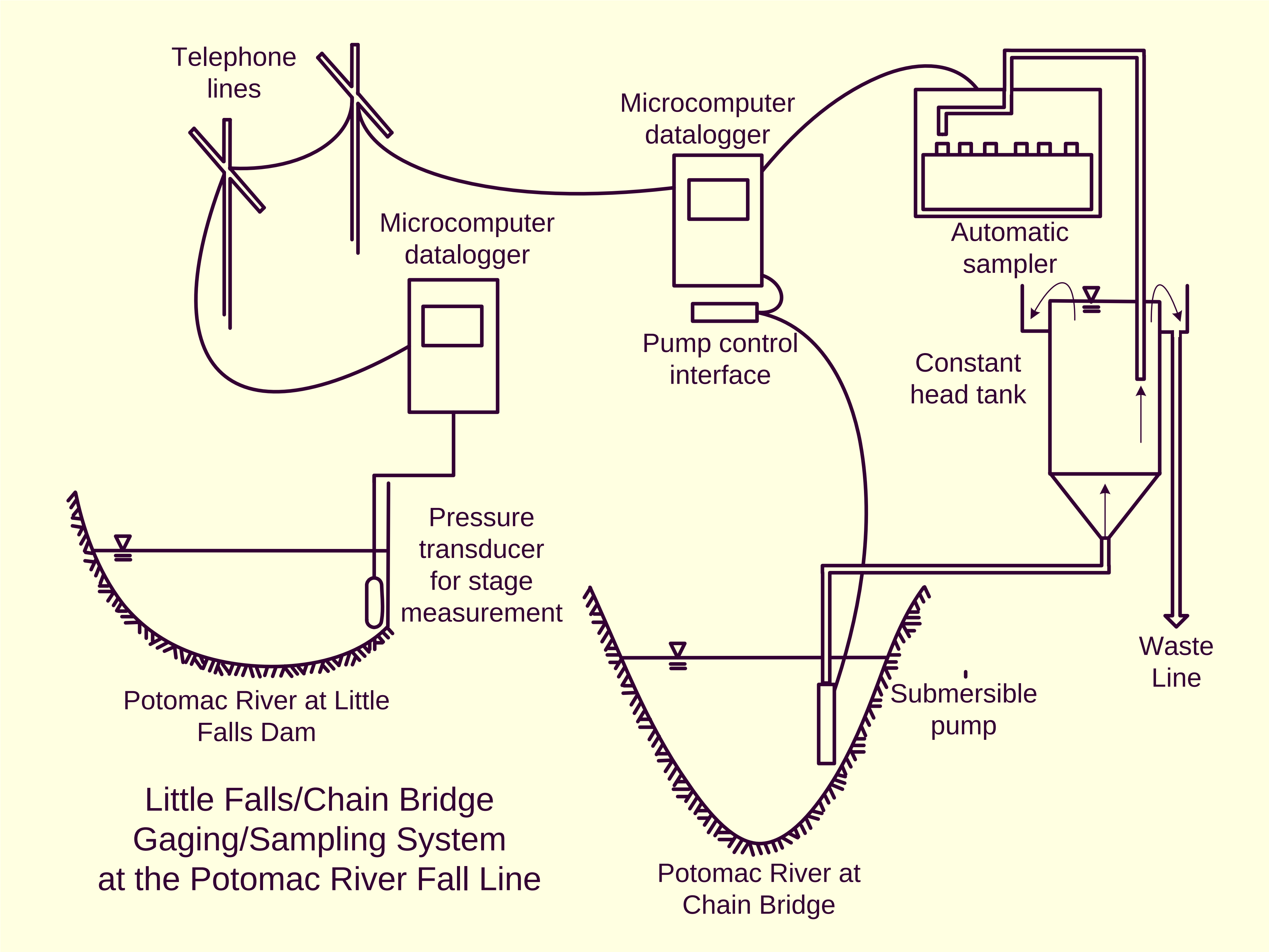
- Poor sampling location
  - River is wide
  - Point sampling to characterize loads not practical
    - Flow patterns and mid-stream islands require cross-section sampling approach
    - Access and safety issues

Chain Bridge

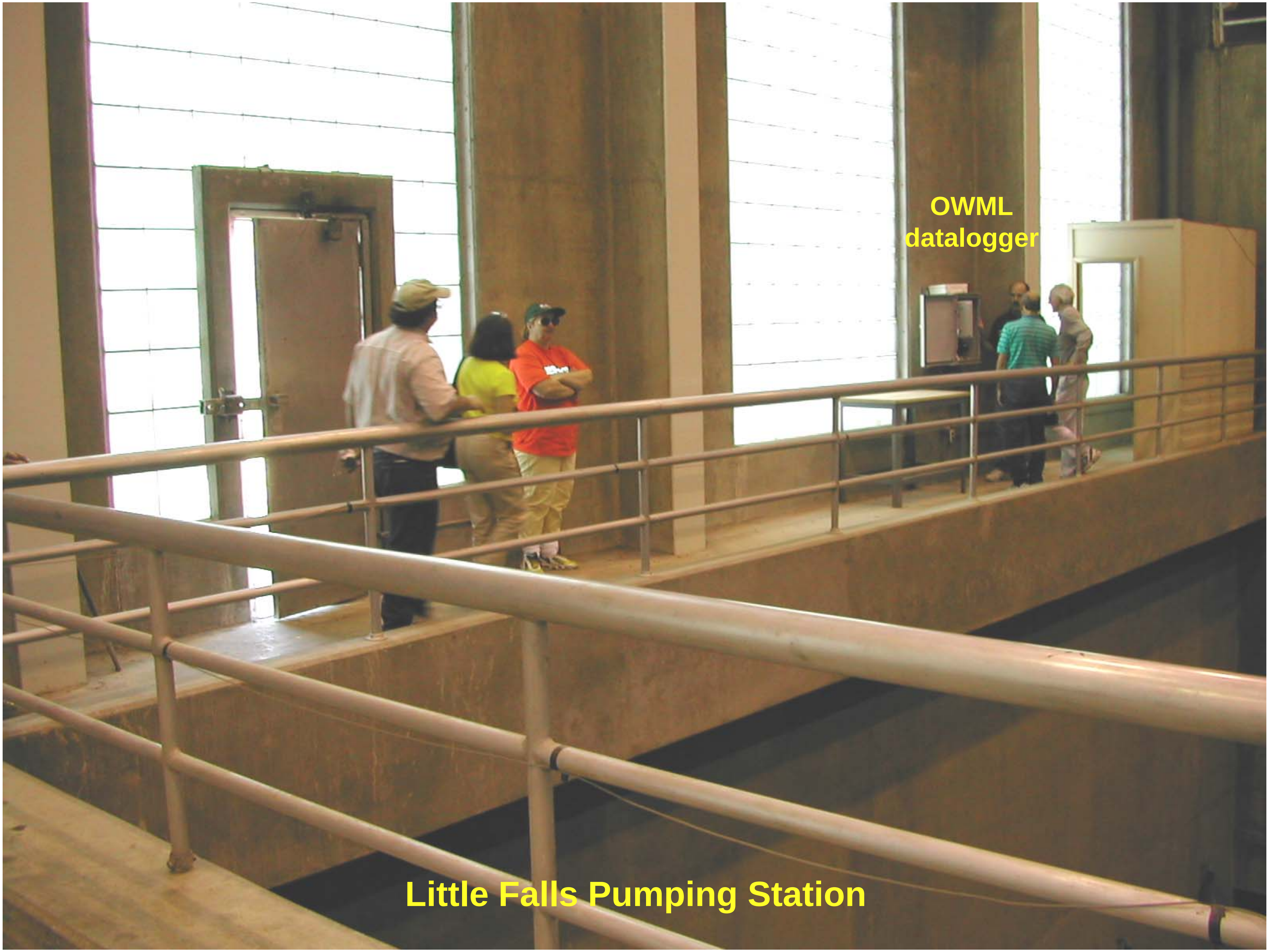
- Unsuitable site for stream gaging
  - Variable backwater effects from tidal fresh portion of estuary
  - Complications in developing low and moderate flow rating table
- Excellent site for sampling
  - Narrow, well-mixed cross section
  - Suitable for using point samples to characterize river flow
  - Method validated against cross-section integration approach

The Solution

Use Little Falls for flow measurements and Chain Bridge for sampling

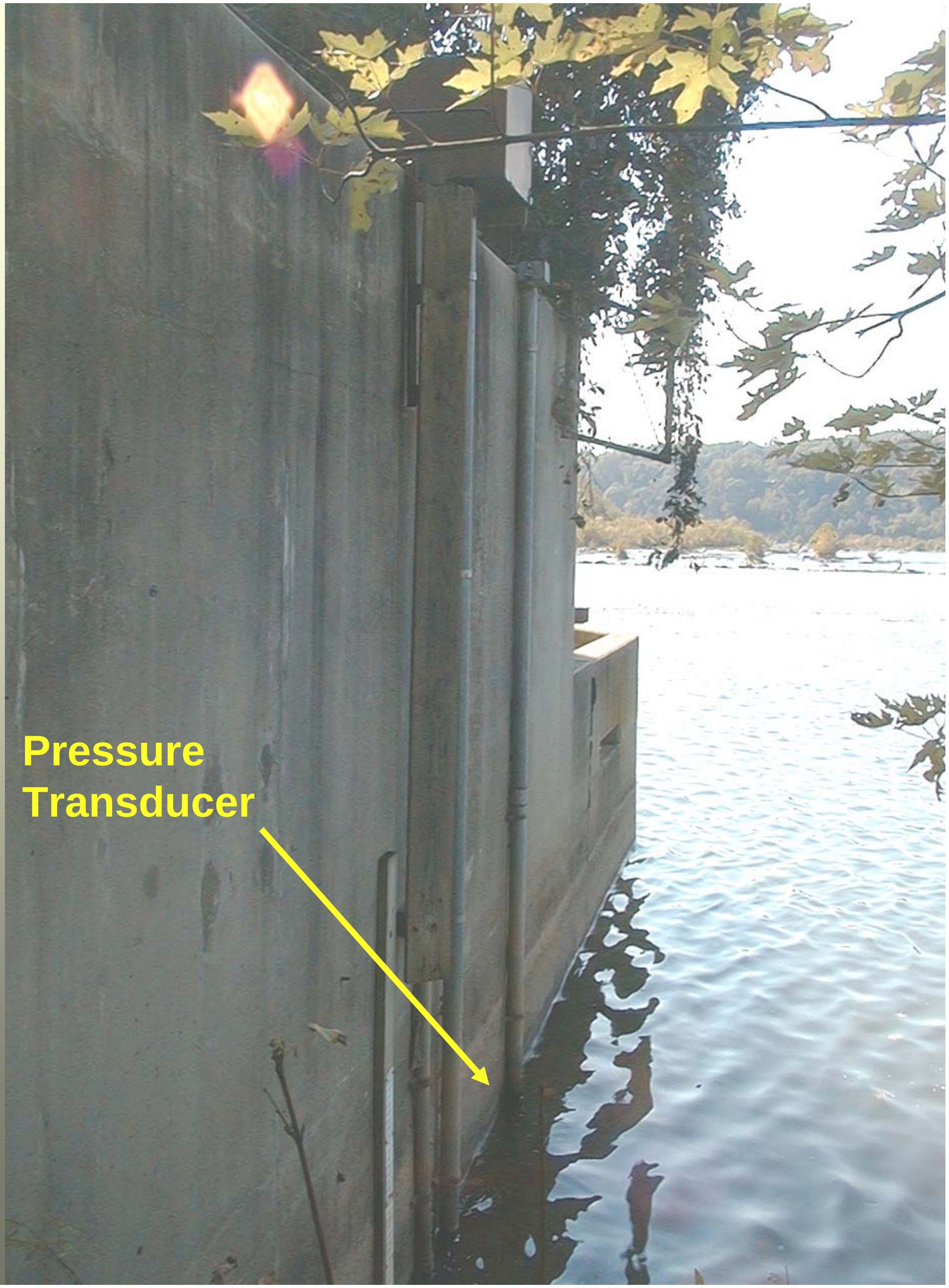

Telephone lines
Microcomputer datalogger
Automatic sampler
Microcomputer datalogger
Pump control interface
Constant head tank
Pressure transducer for stage measurement
Waste Line
Submersible pump
Potomac River at Little Falls Dam
Potomac River at Chain Bridge
Little Falls/Chain Bridge Gaging/Sampling System at the Potomac River Fall Line


Little Falls Dam Looking South
from WAD Pump Station


OWML
datalogger
Little Falls Pumping Station


SUTRON 8210
DATA RECORDER / TRANSMITTER
SET
ON
OFF
PCMCIA MEMORY CARD
SUTRON
MADE IN THE USA
10
OWML Datalogger
Phone Jack

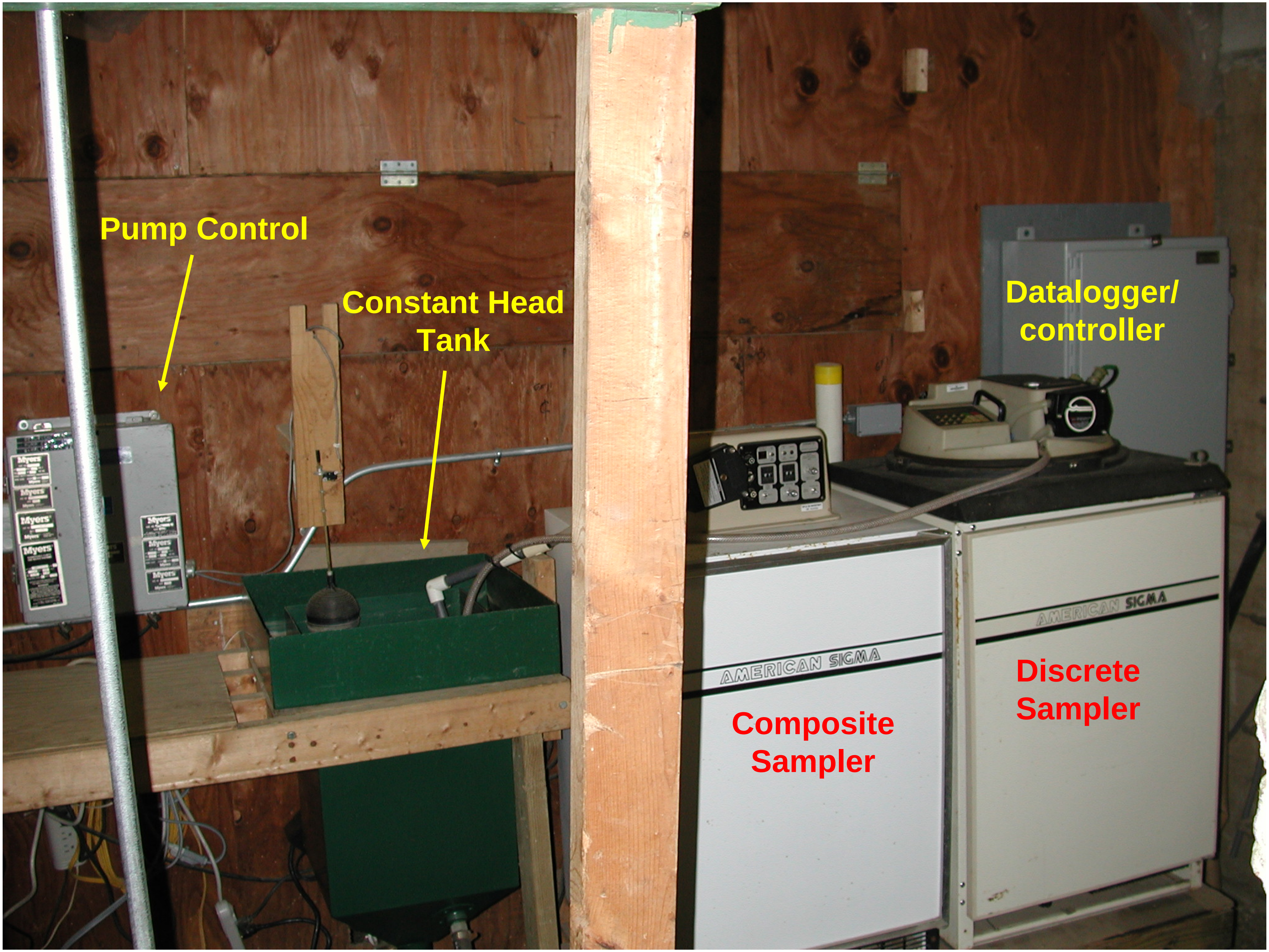
Pressure Transducer Installation at Little Falls Pump Station




Potomac River Looking
Upstream from Chain Bridge

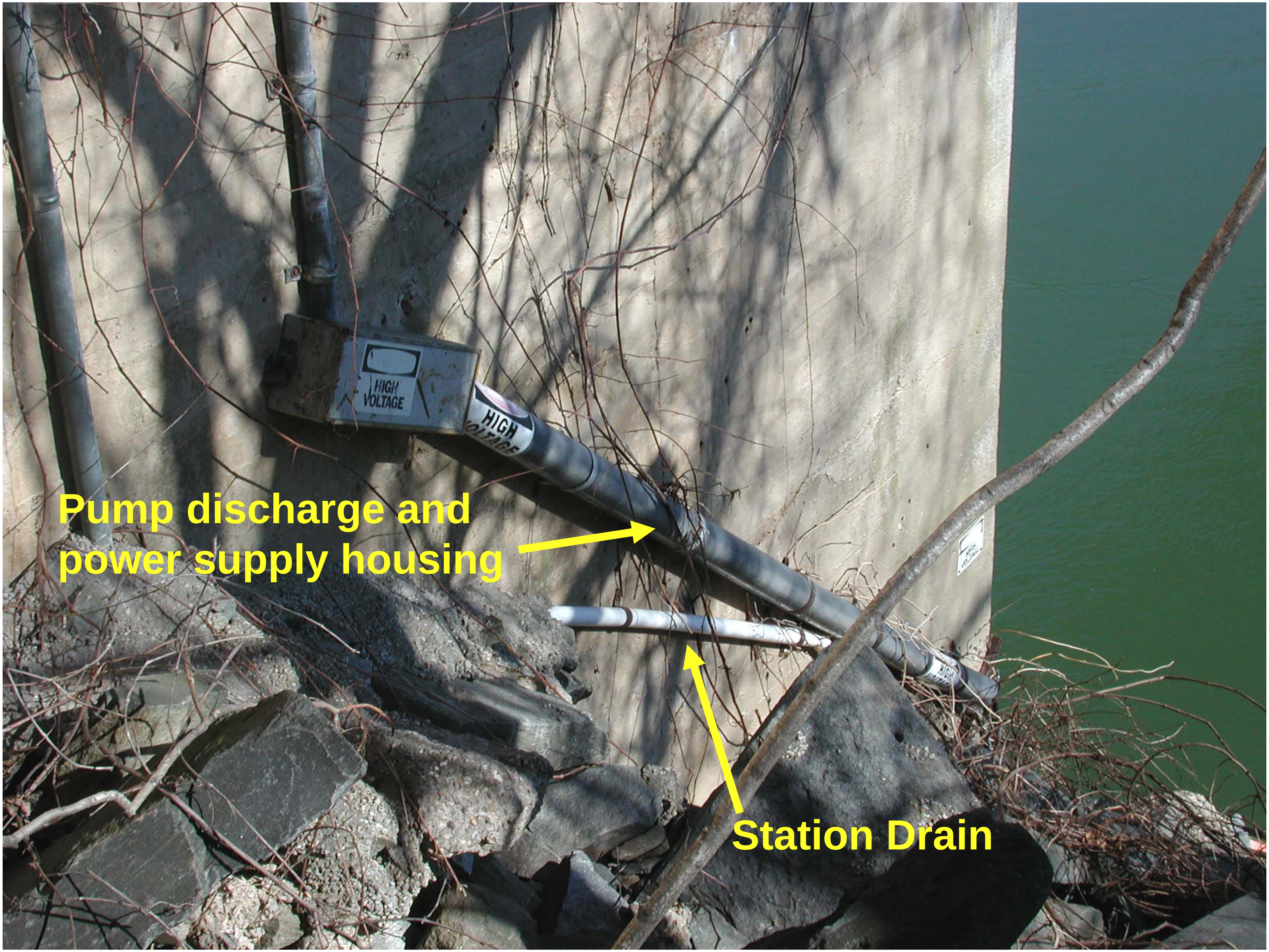

Potomac River looking north from Virginia shore at Chain Bridge


Storm flow in Potomac
River at Chain Bridge


Pump Control
Constant Head Tank
Datalogger/ controller
Composite Sampler
Discrete Sampler
AMERICAN SIGMA
AMERICAN SIGMA


YSI Multiparameter Probe
6000
Environmental Monitoring System
YSI Water Quality Systems
Myers
Myers
Myers


Composite and Discrete Samplers


Pump discharge and power supply housing
Station Drain
HIGH VOLTAGE
HIGH VOLTAGE


Submersible pump and
flexible intake line

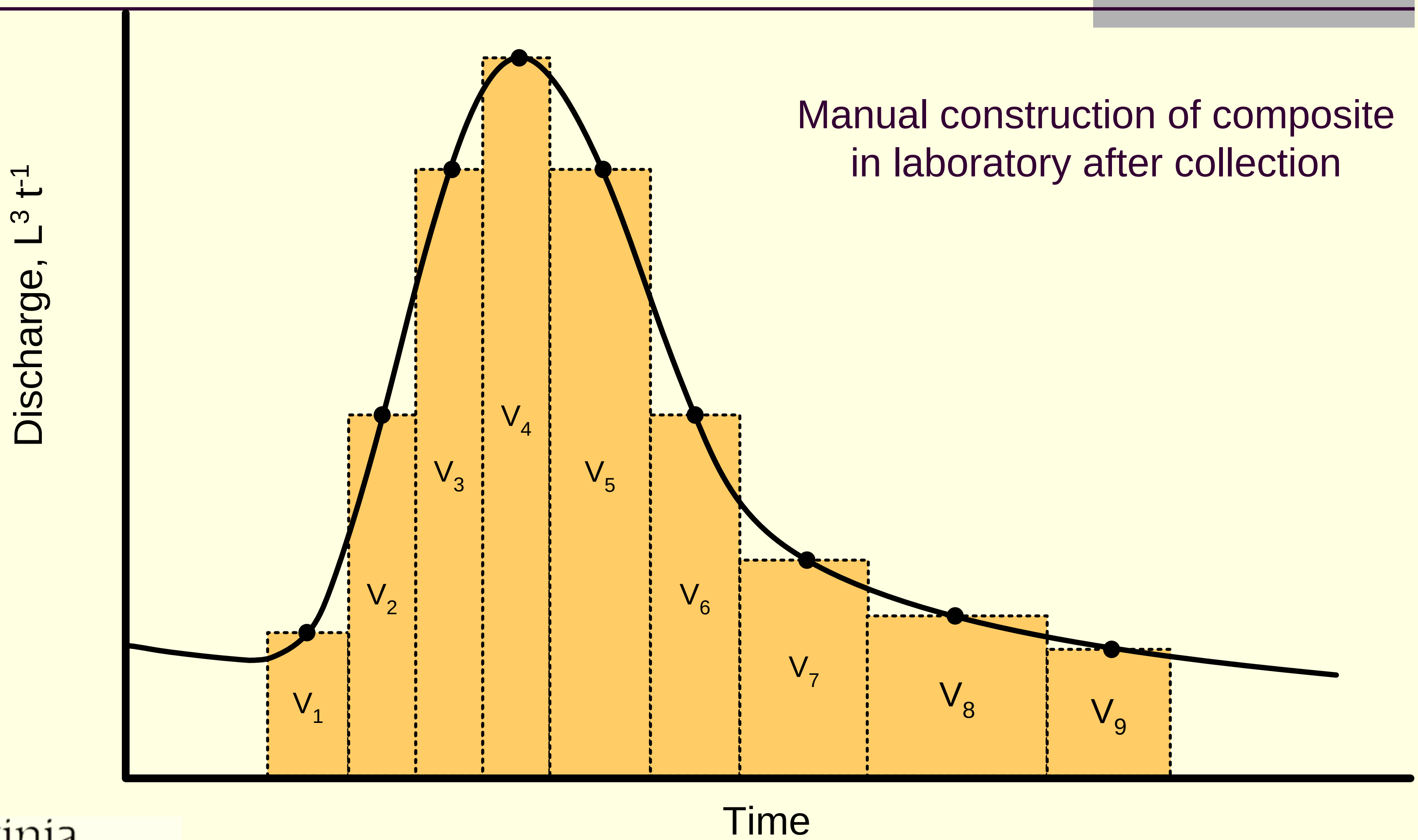
Current Sampling Program - I

- Manual collection of baseflow samples
  - Grab samples
  - Frequency
    - Weekly: April to November
    - Bi-weekly: December to March

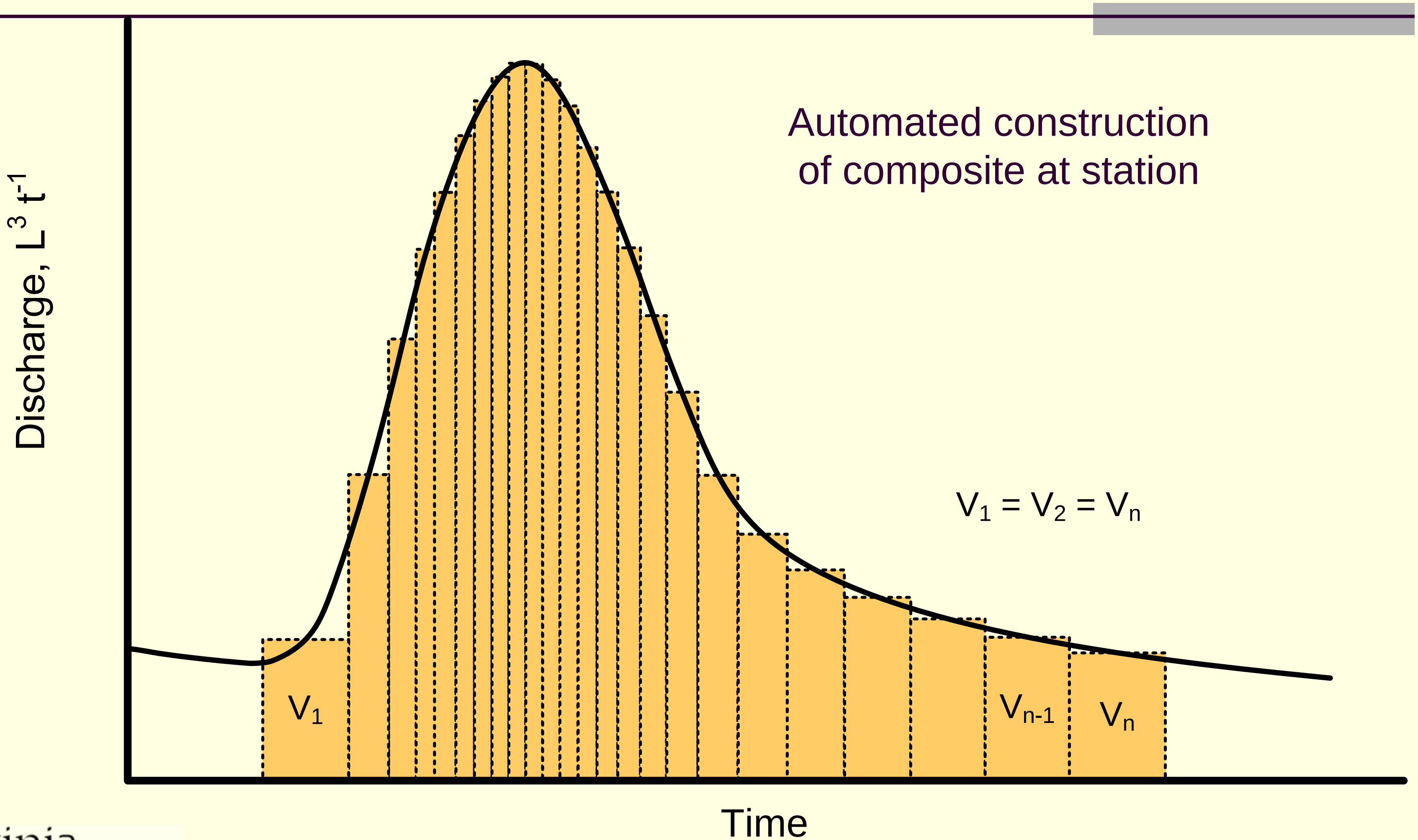
Current Sampling Program - II

- Automated collection of stormflow samples
  - Attempt is to collect every storm
  - Two side-by-side samplers
  - One sampler performs compositing
    - If equipment malfunctions, storm samples are collected and composited manually
  - Discrete storm samples (5 per storm) are also collected for approximately 5 events per year *via* the second sampler (started in November 1995)

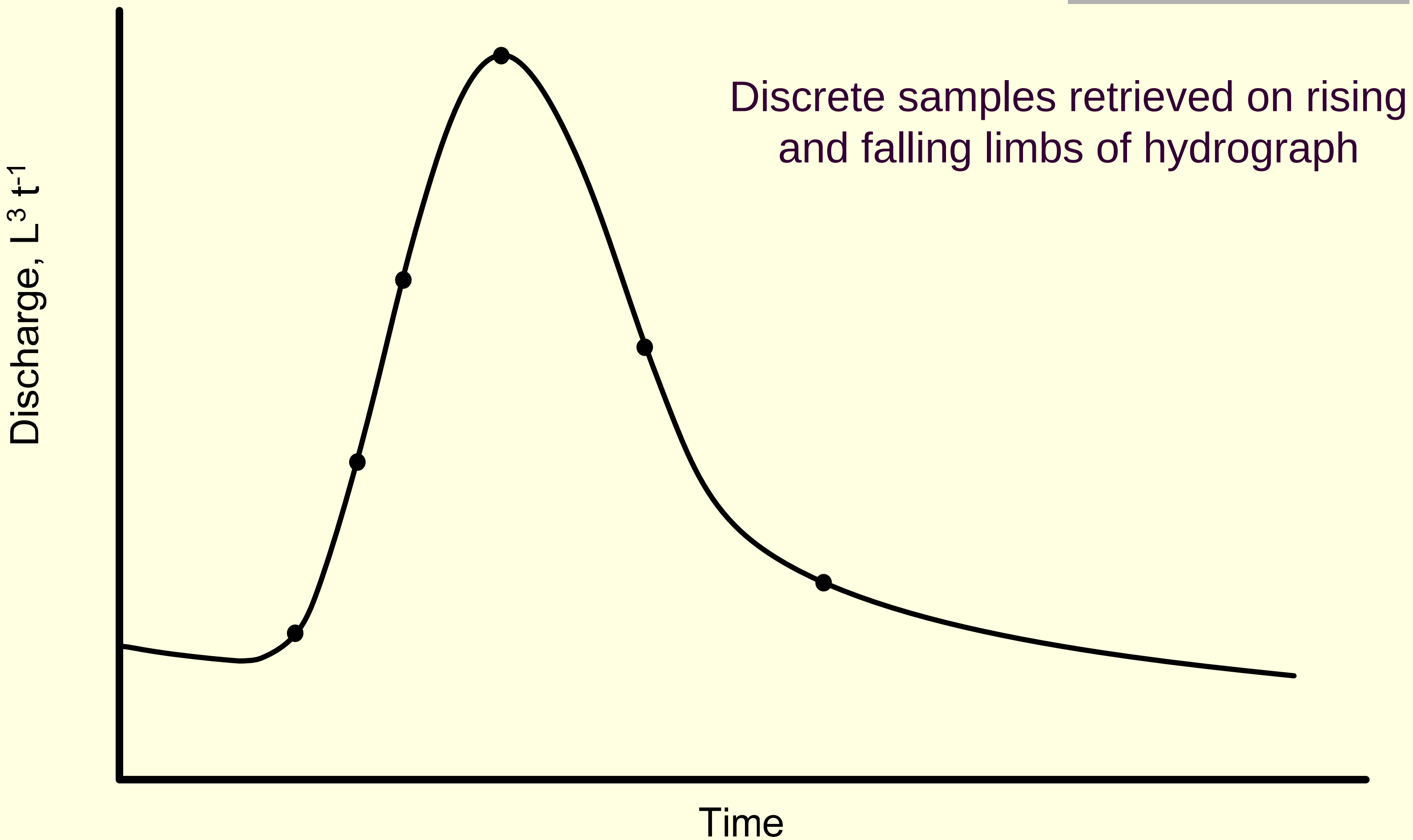
Schematic of Sequential-Discrete Sampling Method



Schematic of OWML Storm Compositing Method (flow weighted)



Schematic of Discrete Storm Sampling



Current List of Parameters Measured

Flow	Temperature	Conductivity
Dissolved oxygen	pH	Total alkalinity
Total hardness	Turbidity	Fecal coliforms and E. coli
Total organic carbon	Dissolved organic carbon	Chemical oxygen demand
Total suspended solids	Nitrate and nitrite nitrogen	Ammonia nitrogen
Total nitrogen	Total soluble nitrogen	Total phosphorus
Total soluble phosphorus	Soluble reactive phosphorus	Soluble reactive silica

OWML Method of Computing Loads - I

- Between baseflow samples, concentrations are linearly interpolated (except for storm periods, which are handled separately).
- These concentrations are then multiplied by daily flows to get daily loads.
- For partial days (*i.e.*, when a storm either commences or ends), only the non-storm flow is used for baseflow loads for that day.
- If an entire day consists of stormflow, then the baseflow load is zero (no baseflow separation used).

OWML Method of Computing Loads - II

- Storm loads are computed by multiplying entire storm volume by composite flow-weighted concentration.
- Baseflow and stormflow loads are then totaled for each day, and can then be totaled by month or year or other time interval.
- Concentrations for missed storms are estimated by using a distribution of concentration *versus* flow for all measured storms.

Sample Counts

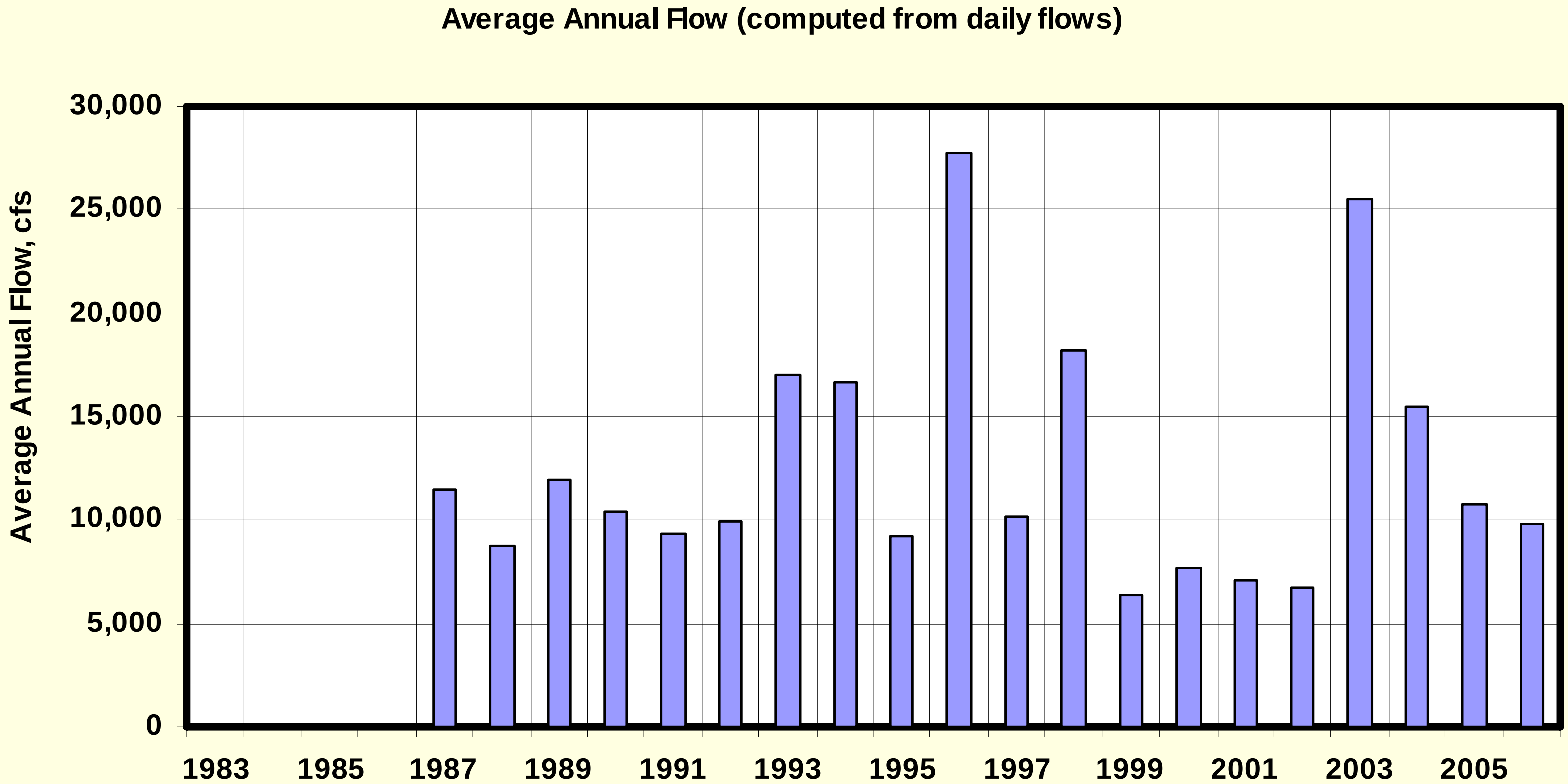
- Average **annual** number of samples collected by OWML:
  - Storm composites, 1983 – 2006:
    ~12/year (299 total)
  - Ambient samples, 1983 – 2006:
    ~40/year (965 total)
  - Discrete storm samples, 1997 – 2006:
    ~39/year (392 total)
  - **Total samples in 24 years (1983-2006): 1,656**

USGS Estimation Process

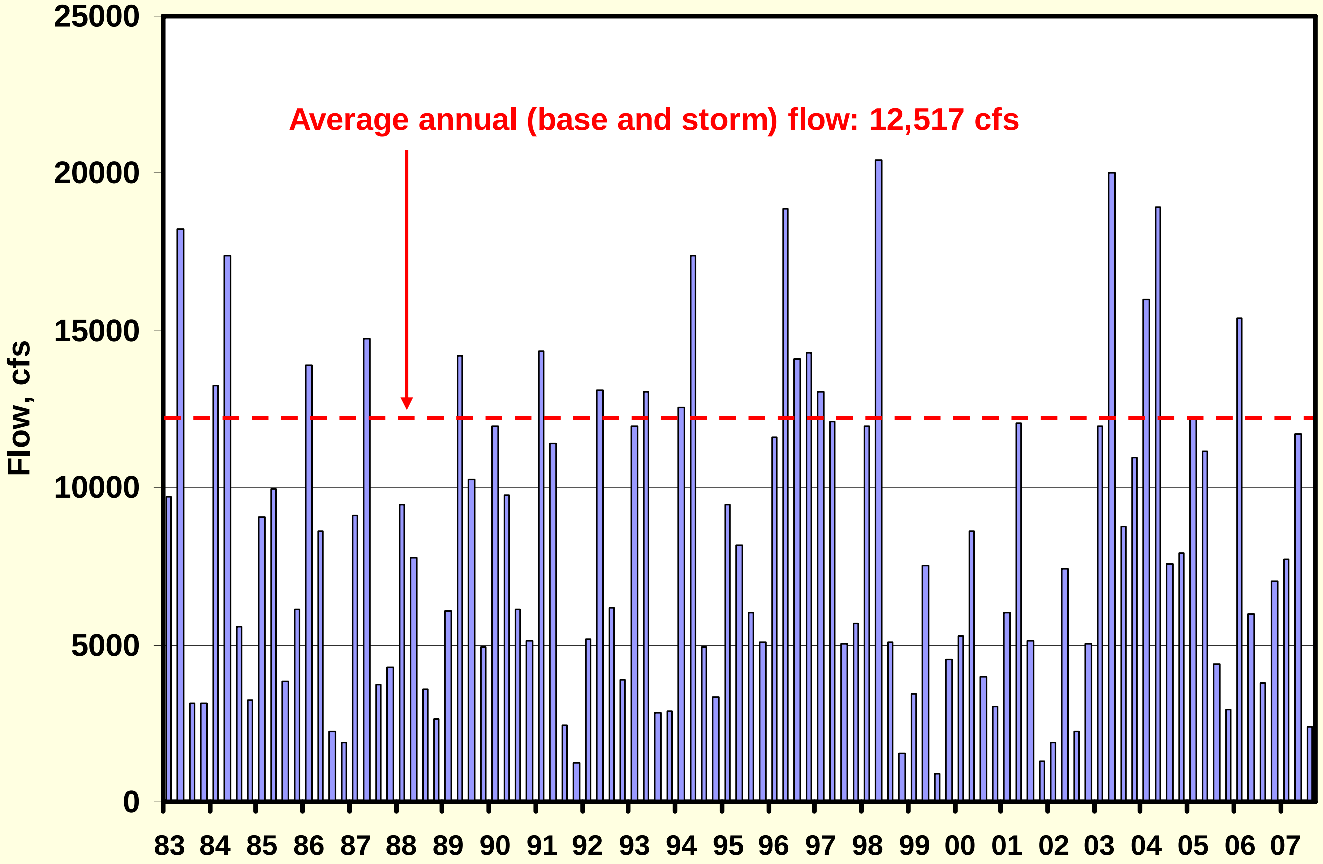
- Collection of 12-18 grab samples per year, distributed randomly between base- and stormflow
- ESTIMATOR software used to compute estimated loads

Selected Results

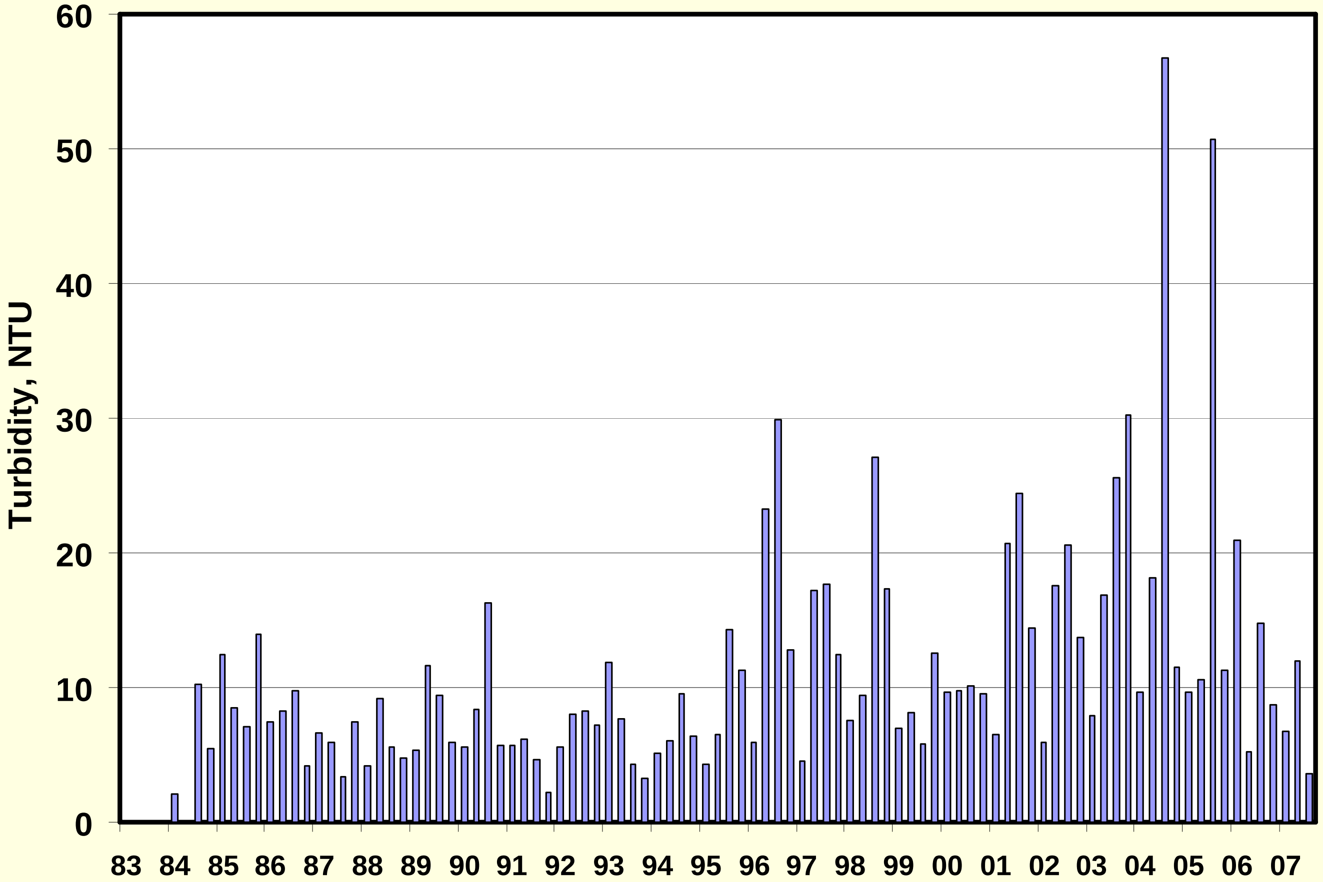
Average Annual Flow



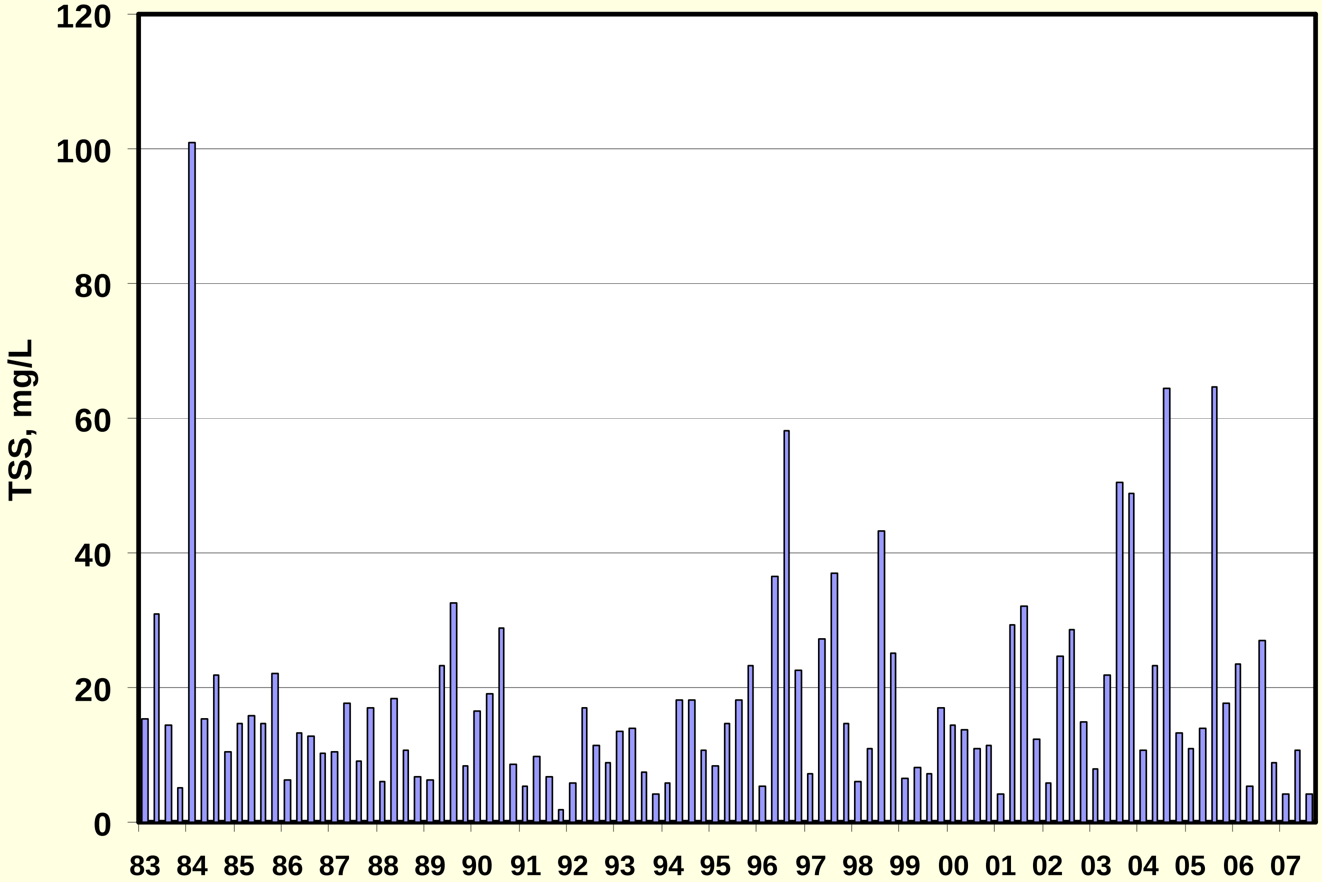
Seasonal Average Non-Storm Flow



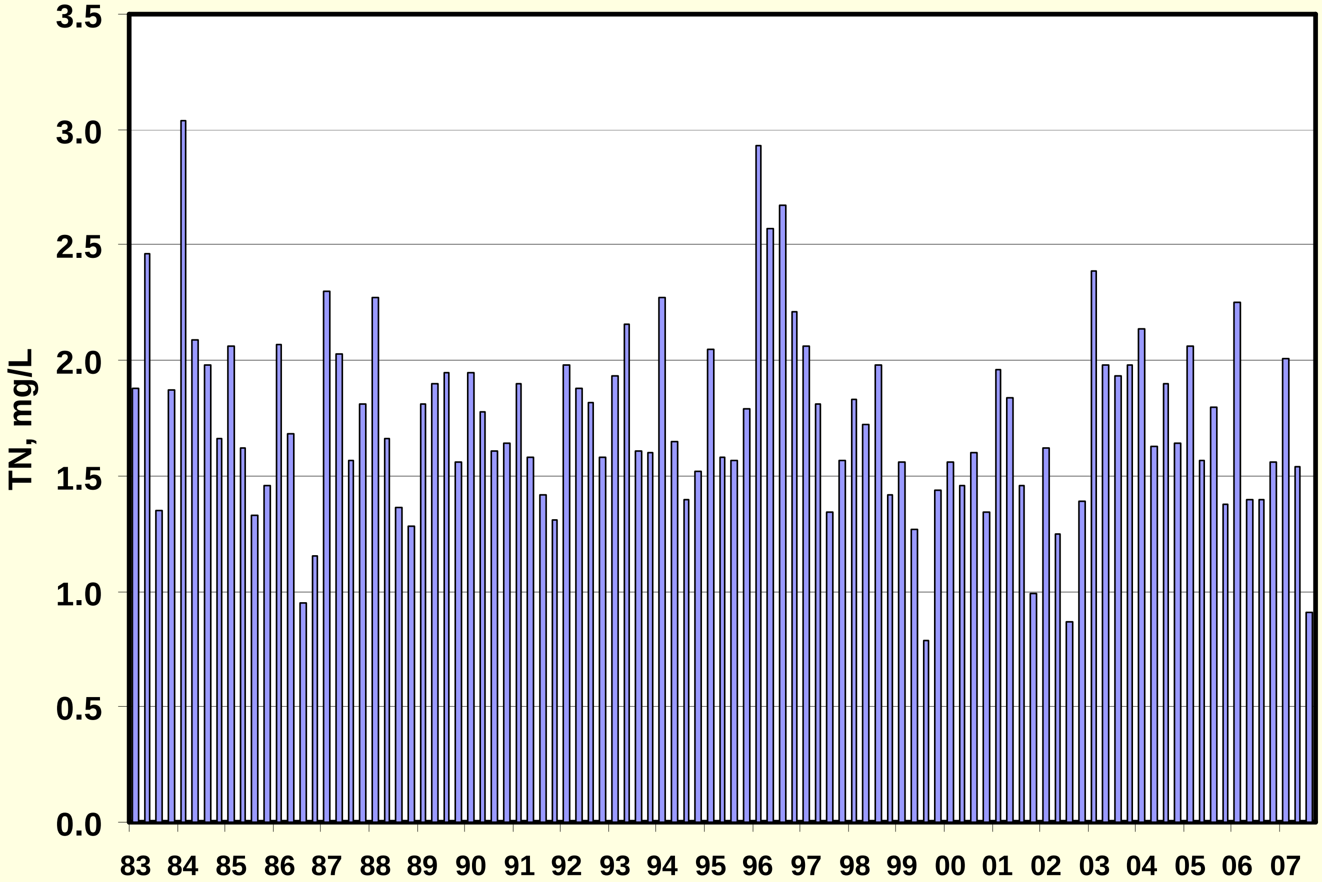
Seasonal Non-Storm Average: Turbidity



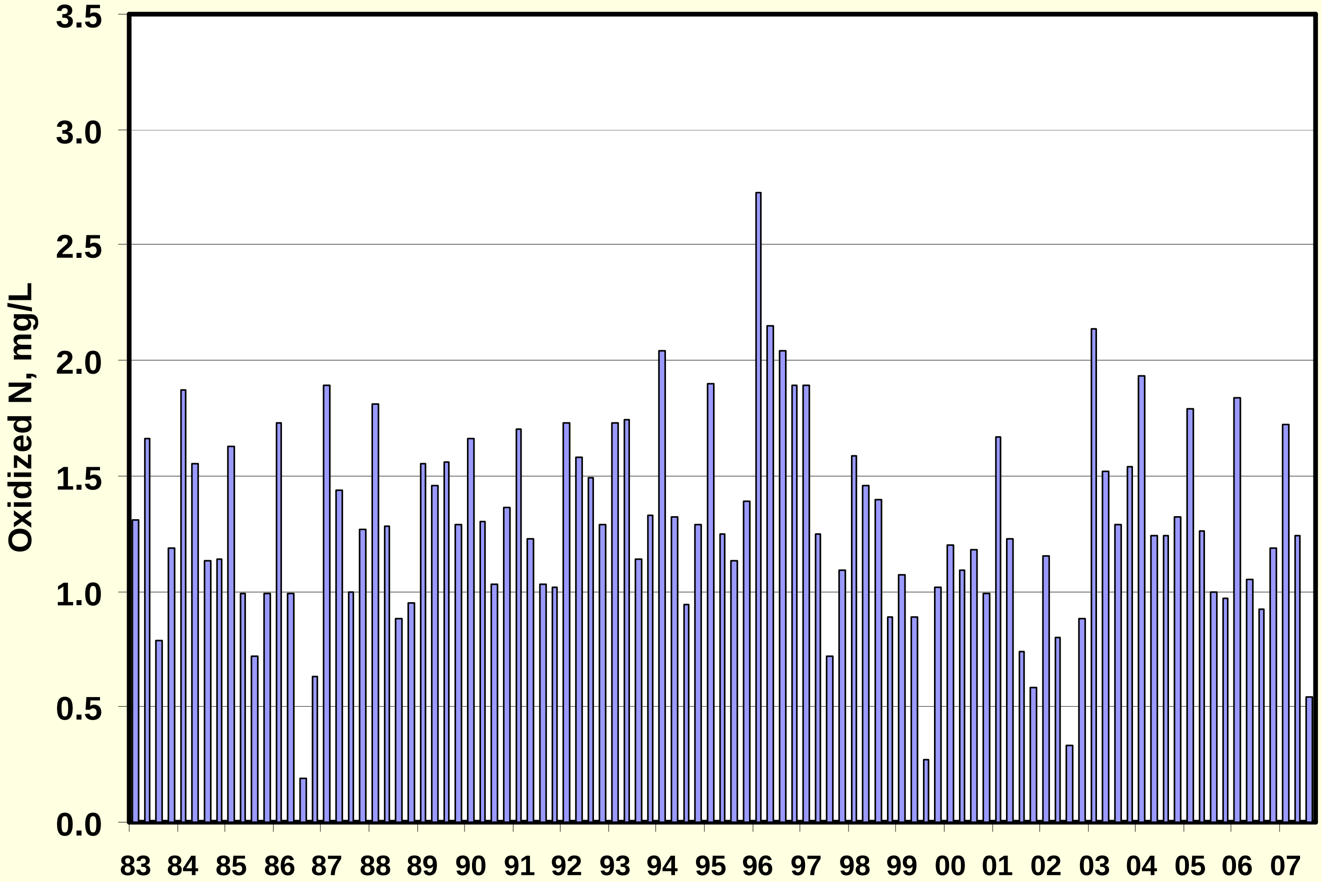
Seasonal Non-Storm Average: TSS



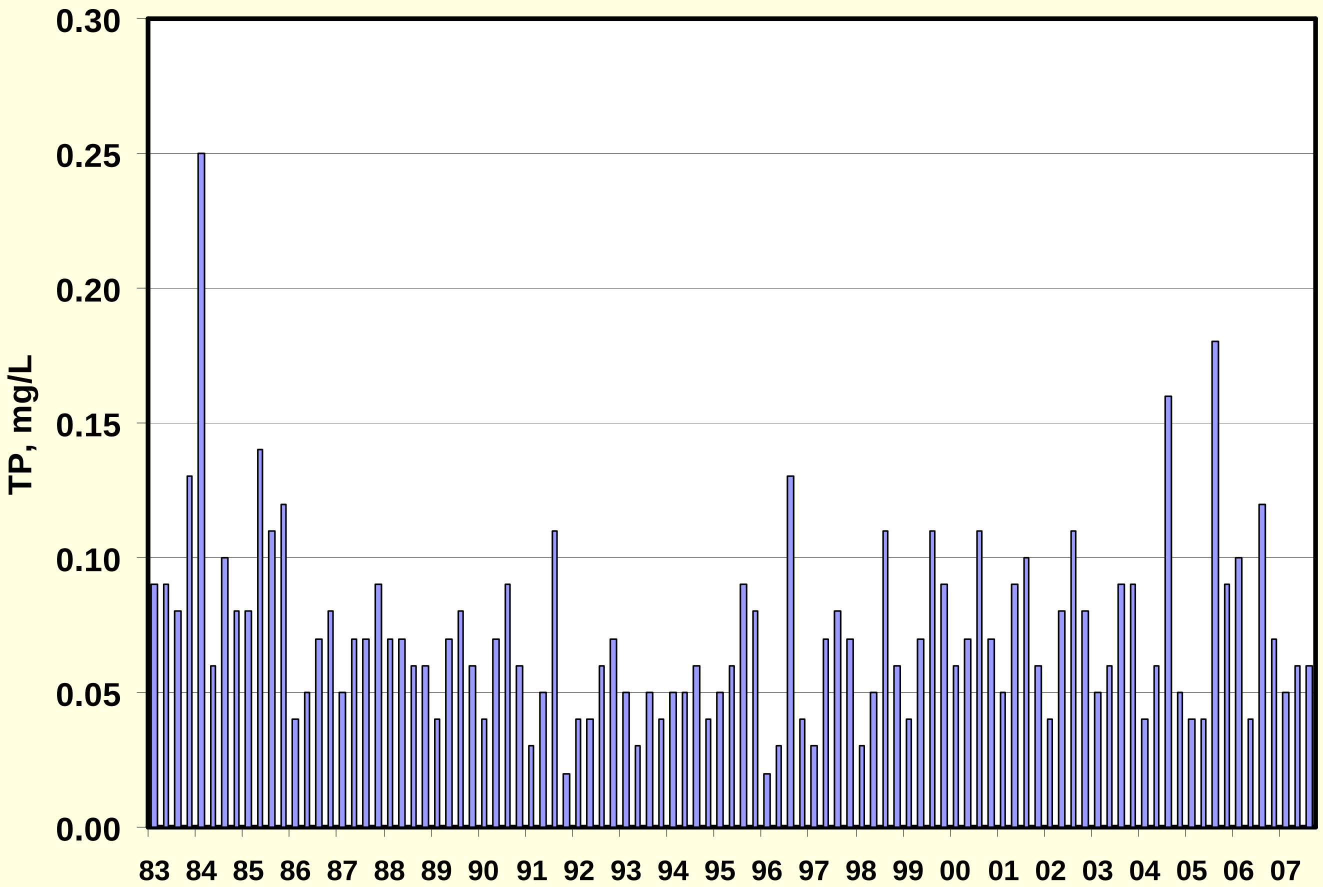
Seasonal Non-Storm Average: Total Nitrogen



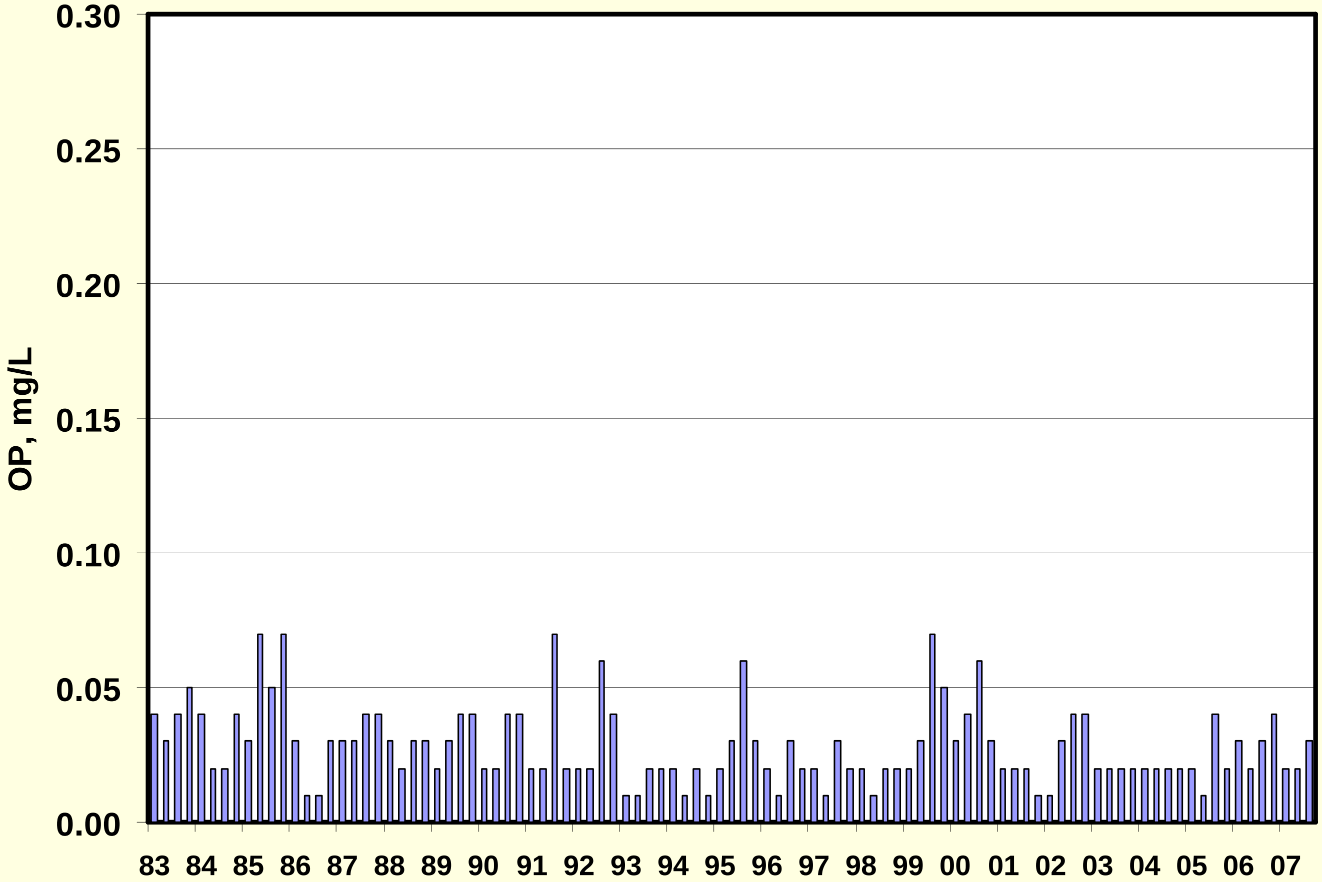
Seasonal Non-Storm Average: Oxidized Nitrogen



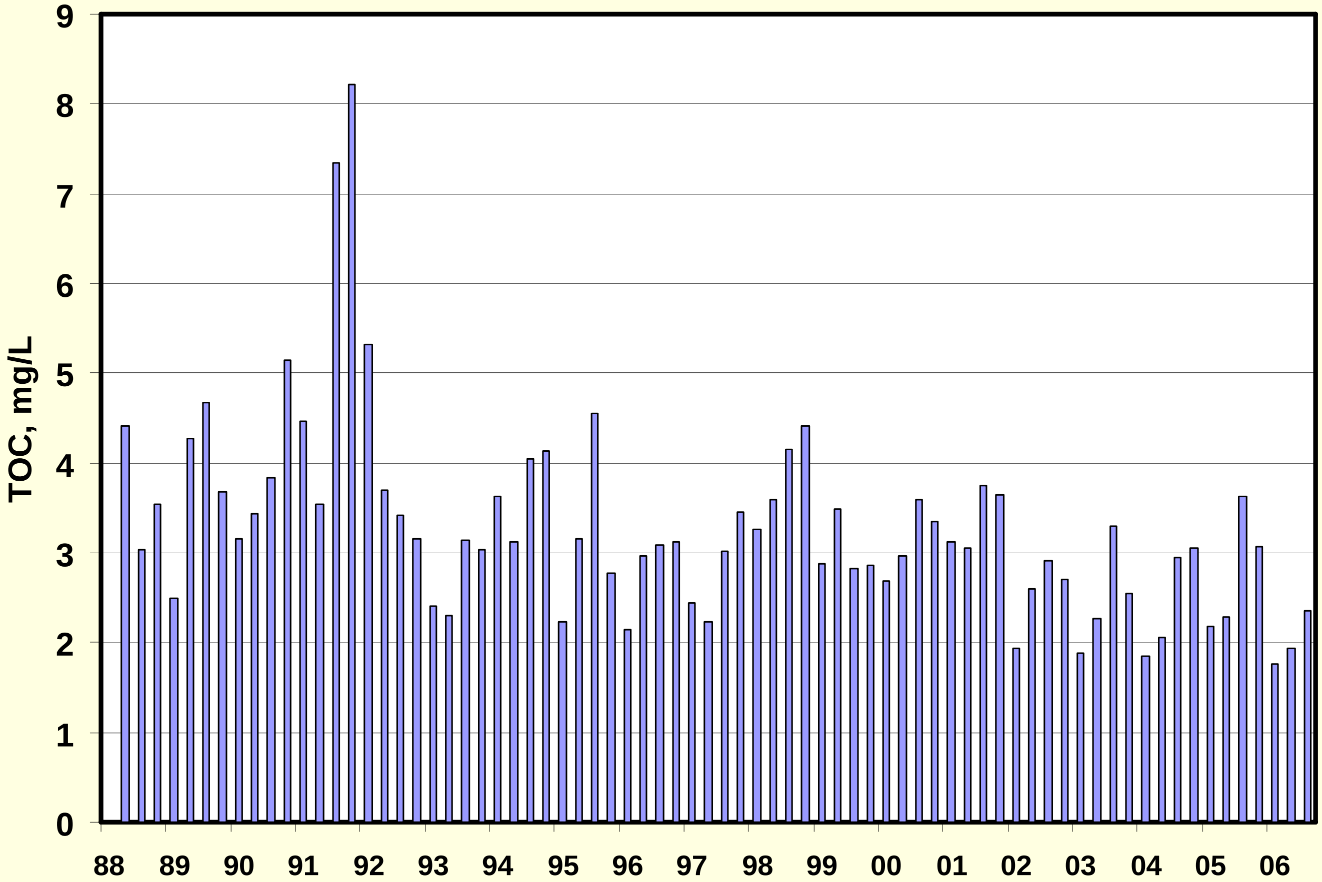
Seasonal Non-Storm Average: Total Phosphorus



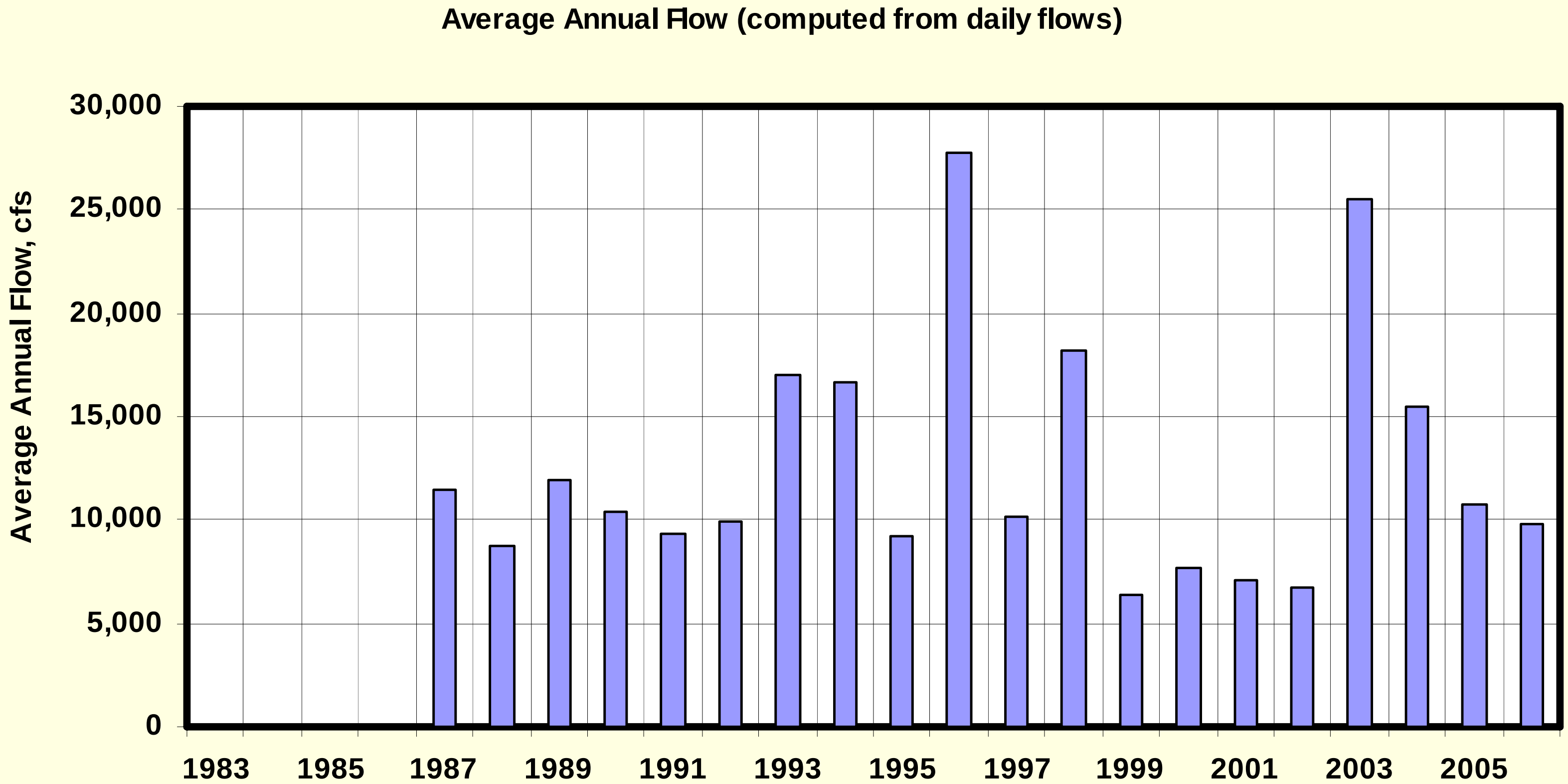
Seasonal Non-Storm Average: Orthophosphate Phosphorus



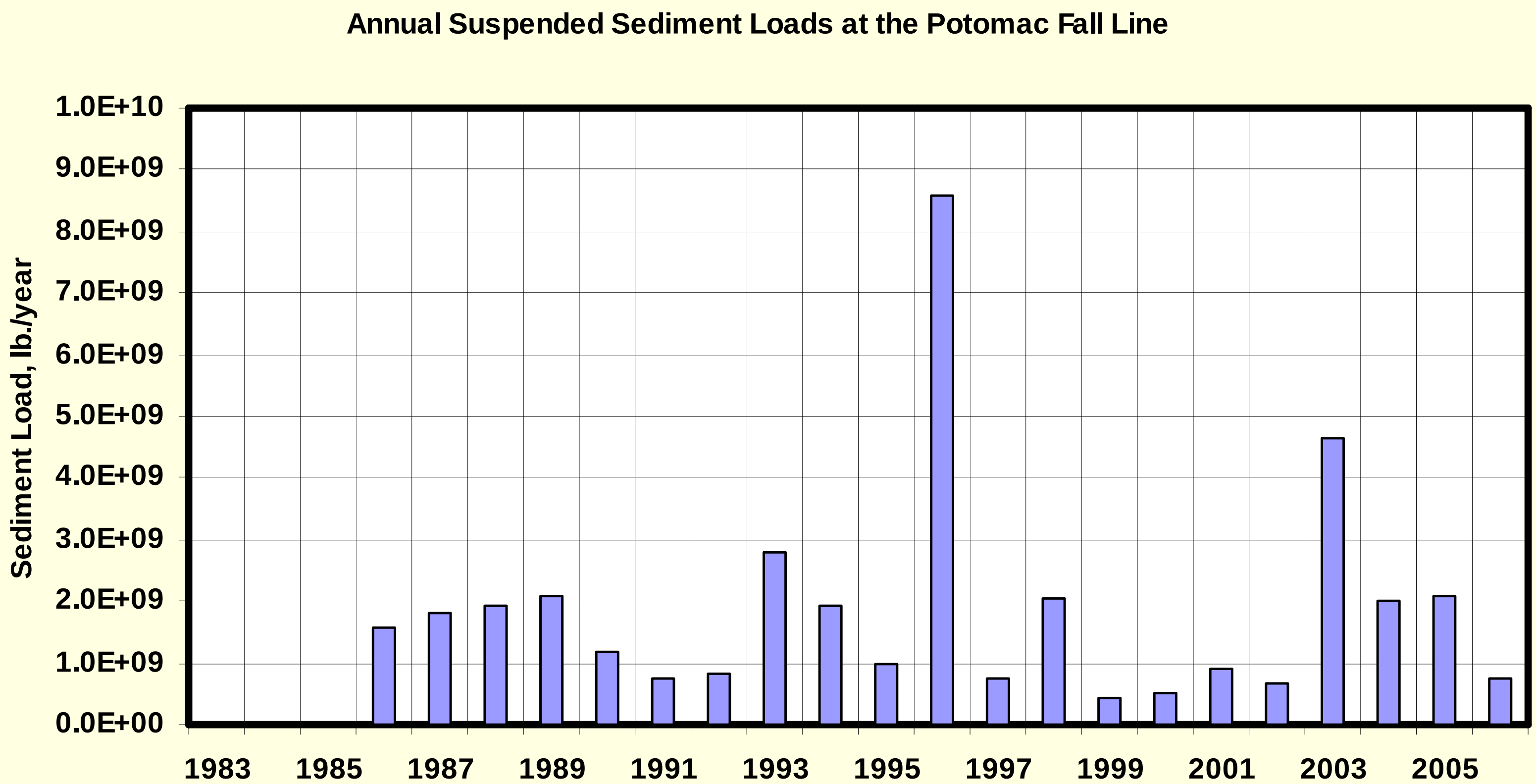
Seasonal Non-Storm Average: Total Organic Carbon



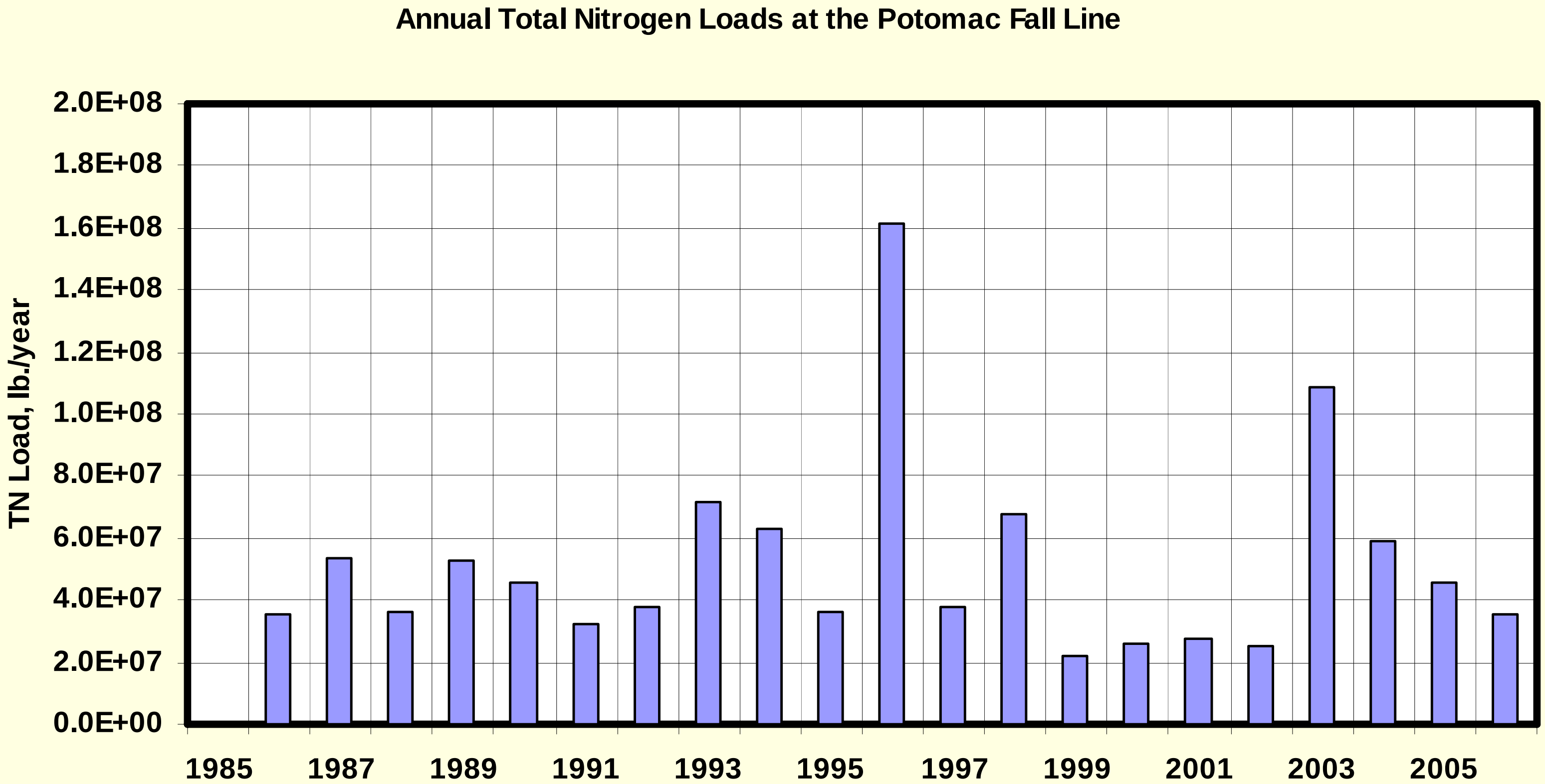
Average Annual Flow



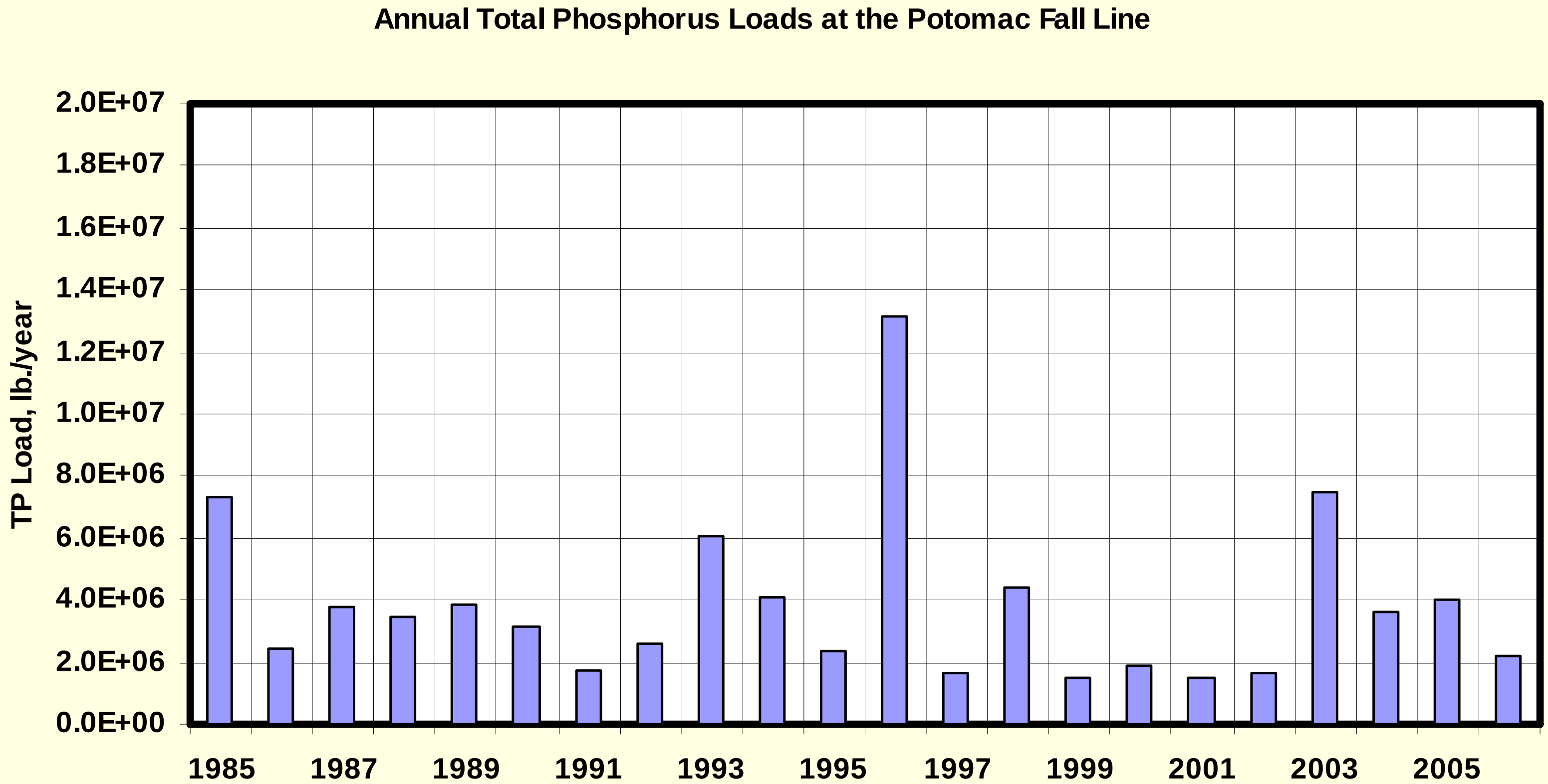
Annual Suspended Sediment Loads



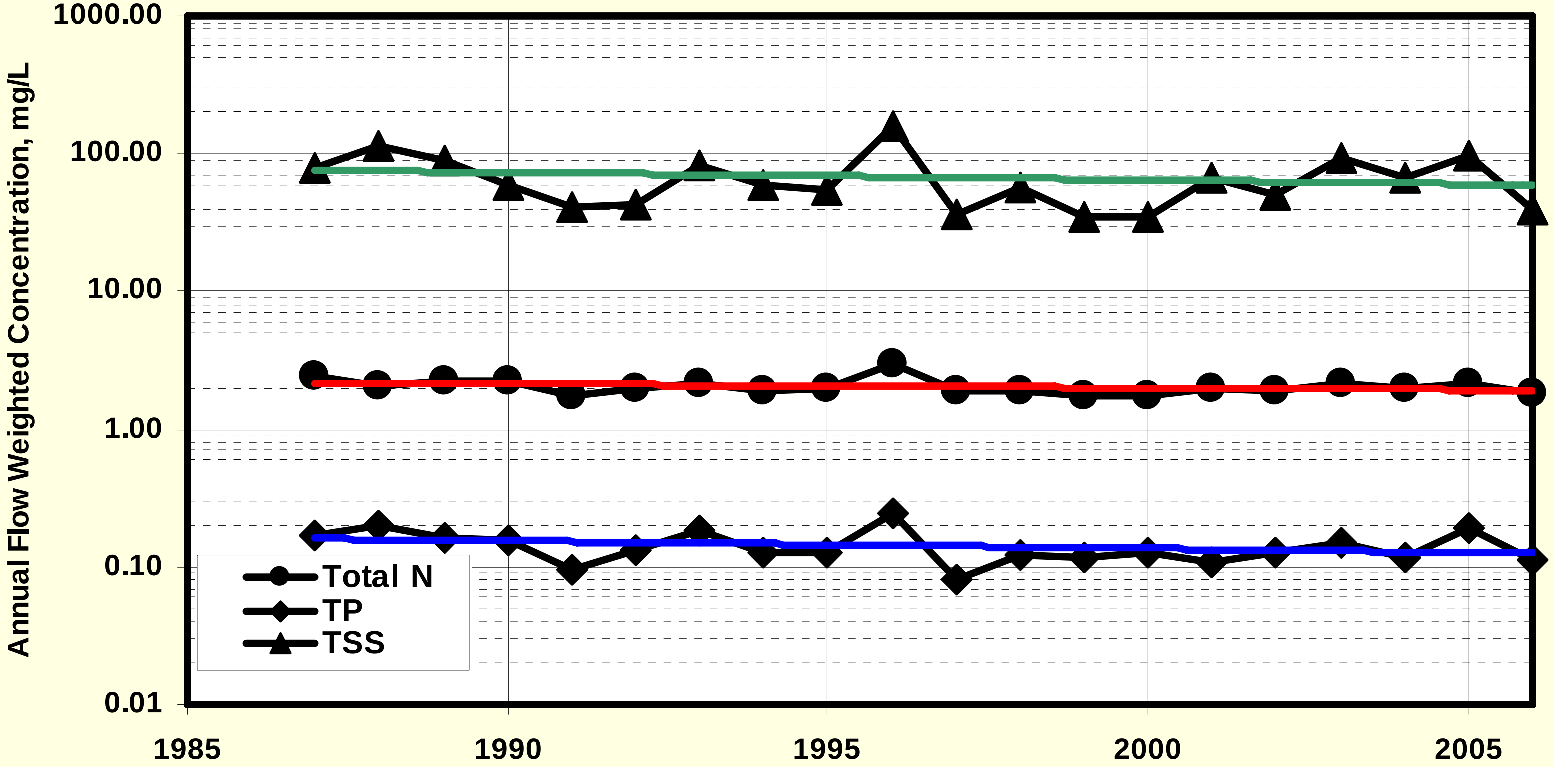
Annual Total Nitrogen Loads



Annual Total Phosphorus Loads



Annual Flow Weighted Concentration Trends



Benefits of Current Program - I

- Provides real loading data with high sampling frequency, thus reducing uncertainty in estimates.
- The total loads in each storm can be computed with great accuracy.
- For those storms where discrete samples have been collected:
  - Provides a way of determining if the flow hydrograph and load curves are in phase or not.
  - Allows for determination of rising and falling limb loads.

Benefits of Current Program - II

- Provides greater insurance against uncertainty, whether real or perceived.
- The sampling of all storms results in the “outliers” or “non-normal” storms being better described.
- Similarly, the sampling of non-normal years will be better described.
- Program stakeholders are in an improved position to assess trends in key pollutant loads.

Current Status (2007)

- The Potomac monitoring program at Chain Bridge has collected a large database that can be used in various ways, and the monitoring program continues as before.
- OWML is in the process of making some field data available on the web.
- Plans to transition to GOES (geostationary operational environmental satellite) in near future.

Parameters That May be Added in the Future

- The following are either required for Chesapeake Bay Water Quality Model (WQ) or Watershed (WS) Model
  - Particulate inorganic phosphorus (WQ + WS)
  - Particulate organic carbon (WQ)
  - Particulate inorganic carbon (WQ + WS)
  - Volatile suspended solids (WQ + WS)
  - BOD_5 (WS)
  - Chlorophyll *a* (WQ + WS)
  - Particle size (WS + WS, once storm per quarter)
- In addition, particulate nitrogen is a parameter that AMQAW recommends for measurement.