TECHNICAL STUDIES IN THE SINCLAIR AND DYES INLET WATERSHED

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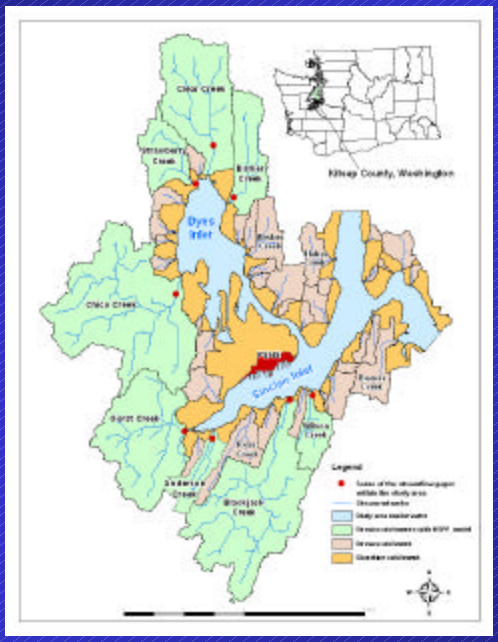
November 2005

SINCLAIR DYES INLET WATERSHED

Puget Sound, Washington

SINCLAIR DYES INLET WATERSHED



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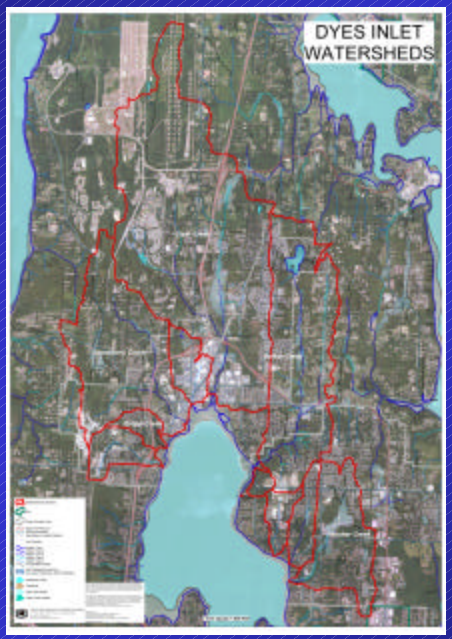
STORM EVENT SAMPLING

WATERSHED ANALYSIS AREA



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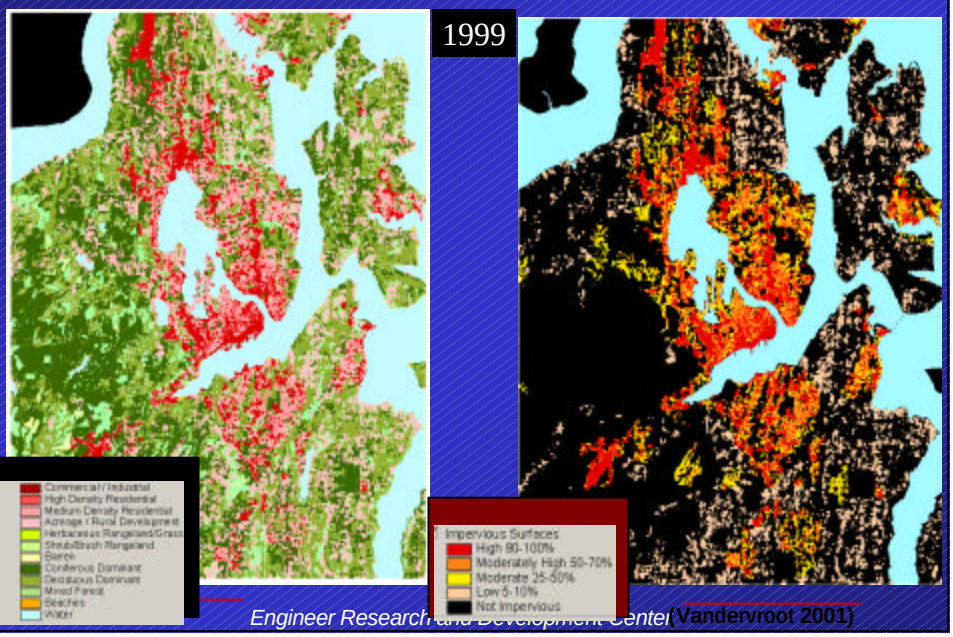
Watershed Development



Engineer Research and Development Center (Vandervroot 2001)

Barker Creek Instream Flow Study

- Washington Department of Fish and Wildlife
  - Hal Beecher, Steve Boessow, Terra Hegy, Bob Vadas
- Kitsap County
  - Richard Bazzel, Keith Folkerts, Paul Nelson

ENVVEST

Puget Sound Naval Shipyard & Intermediate Maintenance Facility ENVironmental inVESTment (ENVVEST) project - develop and demonstrate alternative strategies for protecting and improving the ecological integrity of Sinclair and Dyes Inlets and their surrounding watershed in the Puget Sound, WA

Key project elements include the development of a unified monitoring program, electronic database, and integrated model for the Sinclair-Dyes Inlet watershed

US Army Corps of Engineers

Engineer Research and Development Center

PROJECT PARTICIPANTS

Technical Team

- PSNS & IMF
- Navy's Marine Environmental Support Office
- Ecology
- EPA
- Battelle Marine Sciences Lab
- Army Engineer Research & Development Center
- University of Washington
- Kitsap Public Utilities District
- The Environmental Company
- Computer Sciences Corp.
- Applied Biomonitoring

Technical Stakeholders

- Navy Region Northwest
- Cities of Bremerton, Port Orchard, and Bainbridge Island
- Kitsap County Surface and Storm Water Management
- Kitsap County Health District
- Kitsap Dept. of Community Development
- Suquamish Tribe
- Department of Health
- Department of Fish and Wildlife
- Department of Transportation
- Karcher Creek Sewer District

ENVVEST CONTRIBUTORS/PARTICIPANTS

- U.S. Navy
  - Puget Sound Naval Shipyard and Intermediate Maintenance Facility
  - Space and Naval Warfare Systems Center
  - Navy Region Northwest
  - Naval Facilities Engineering Command Engineering Field Activity Northwest
- U.S. EPA
  - Region X
  - Manchester Environmental Laboratory
- U.S. Army Corps of Engineers
  - Engineer Research and Development Center
- Government - State
  - Washington State Department of Ecology Northwest Regional Office
  - Environmental Assessment Program
  - Manchester Environmental Laboratory
  - Washington State Department of Health Food Safety and Shellfish Program
- Government - Local (City, County)
  - City of Bremerton
  - City of Port Orchard
  - City of Bainbridge Island
  - Karcher Creek Sewer District
  - Kitsap County Health District
  - Kitsap County Surface and Storm Water Management
  - Kitsap Public Utilities District
- Government - Tribes
  - Suquamish Tribe
- Consultants
  - Pacific Northwest National Laboratory Battelle Marine Sciences
  - The Environmental Company
  - University of Washington Applied Physics Laboratory

COOPERATIVE STORM EVENT MONITORING

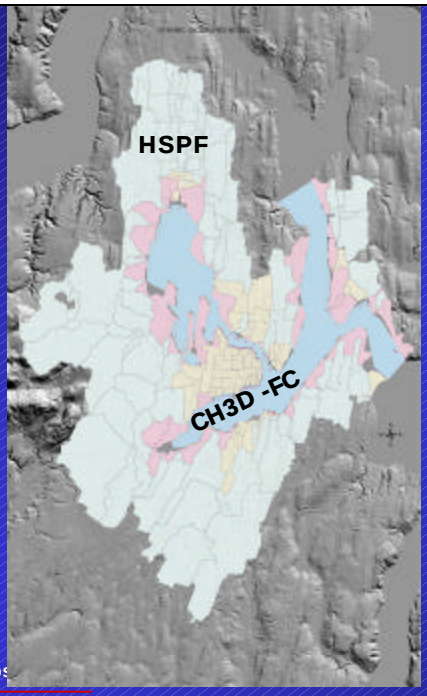
COOPERATING WITH CITIES AND COUNTY TO:

- **SAMPLE REPRESENTATIVE STORM EVENTS**
- **COLLECT DATA ON HYDROLOGY AND WATER QUALITY PARAMETERS**
- **RELATE LANDUSE TO ENVIRONMENTAL QUALITY**
  - **FC**
  - **Metals (Cu, Hg)**
  - **Toxic Organics (PAHs, PCBs)**
  - **Nutrients (Dissolved Oxygen)**

MONITORING

AMBIENT MARINE SAMPLING

INTEGRATED MODEL



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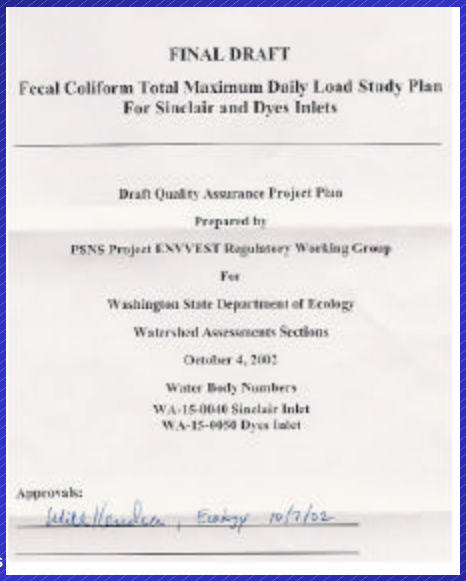
ENVIRONMENTAL INVESTMENT PROJECT



FINAL DRAFT

Fecal Coliform Total Maximum Daily Load Study Plan
For Sinclair and Dyes Inlets

Draft Quality Assurance Project Plan

Prepared by

PSNS Project ENVVEST Regulatory Working Group

For

Washington State Department of Ecology

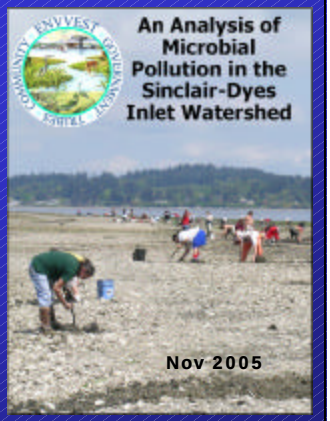
Watershed Assessments Sections

October 4, 2002

Water Body Numbers
WA-15-0040 Sinclair Inlet
WA-15-0050 Dyes Inlet

Approvals:

Ecology 10/7/02



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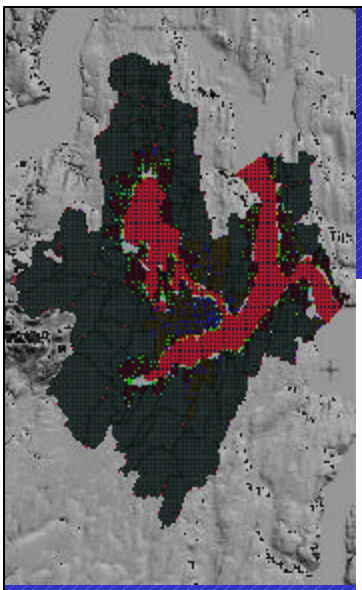
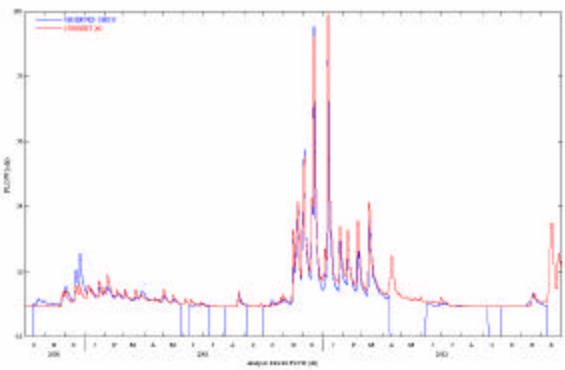


WILDCAT CREEK



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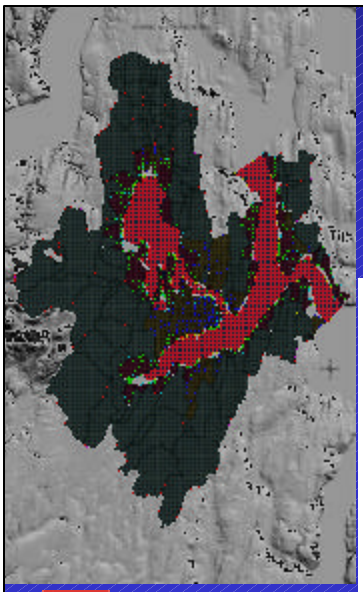
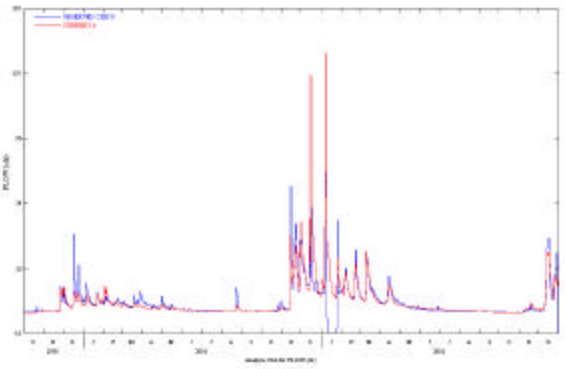


DICKERSON CREEK



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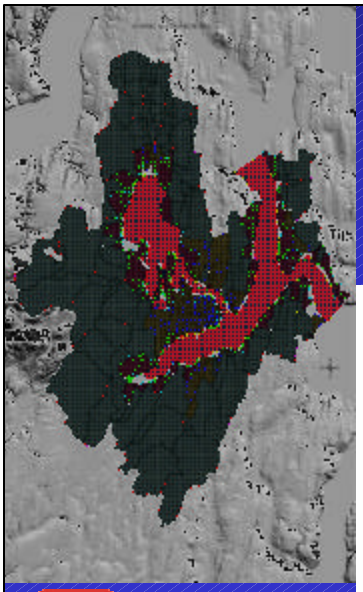
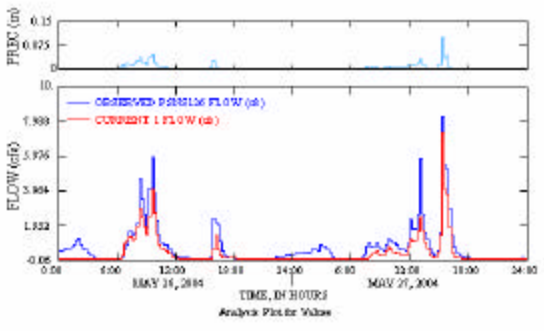


PSNS (126)



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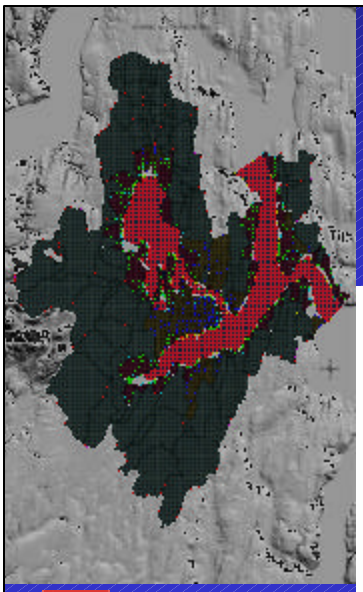
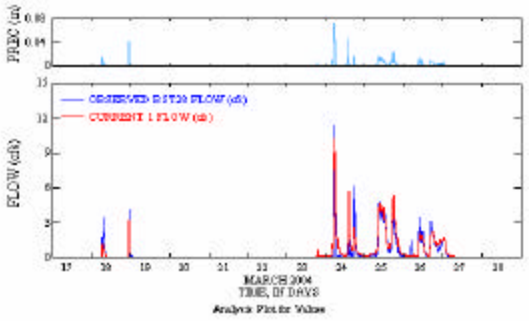


CALLOW AVENUE



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SIMULATING FC LOADING

FLOW DATA

- Volume of water discharged (cubic feet per second – cfs)
- Only limited number of streams and storm water outfalls are gauged
- Watershed model predicts flows for all “pour points”

CONCENTRATION DATA

- FC cfu/100 ml being discharged
- No data for many streams and outfalls
- Estimate concentration from existing data

LOAD = FLOW X CONCENTRATION

- FC cfu/day (millions of counts)

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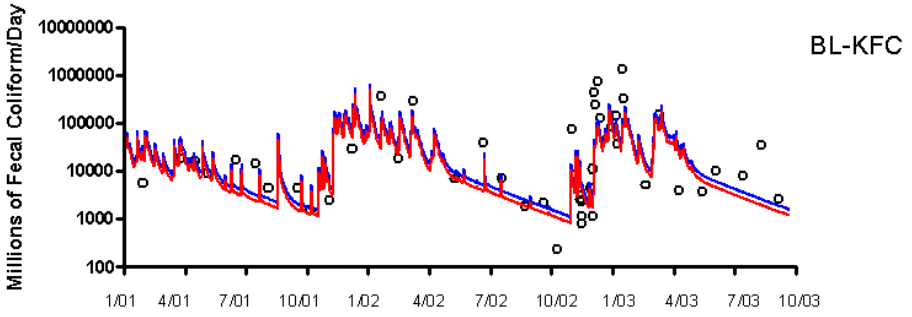
Predicting FC Loading

Blackjack Creek (Mouth)



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Estimated from data
Predicted

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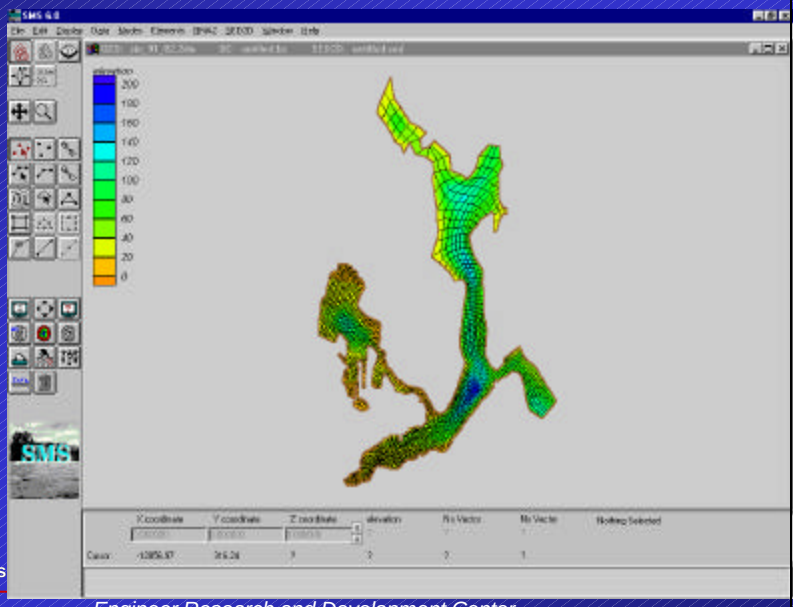
CH3D GRID



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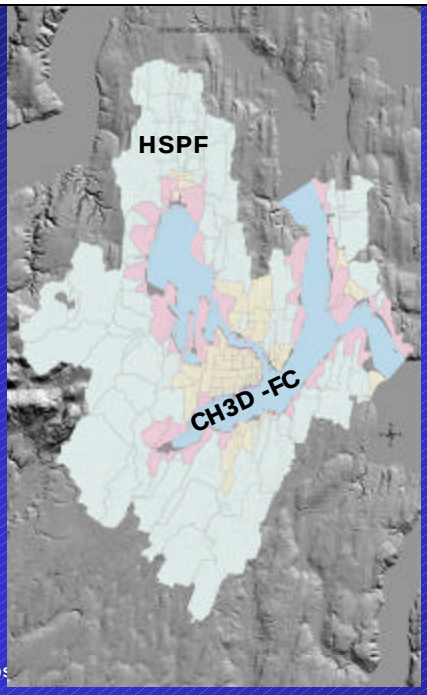

Fecal Coliform Modeling Results

SIMULATE ALL SOURCES
- TREATMENT PLANTS
- STREAMS
- STORM WATER
- SHORELINE DRAINAGE

VERIFY MODEL PREDICTION

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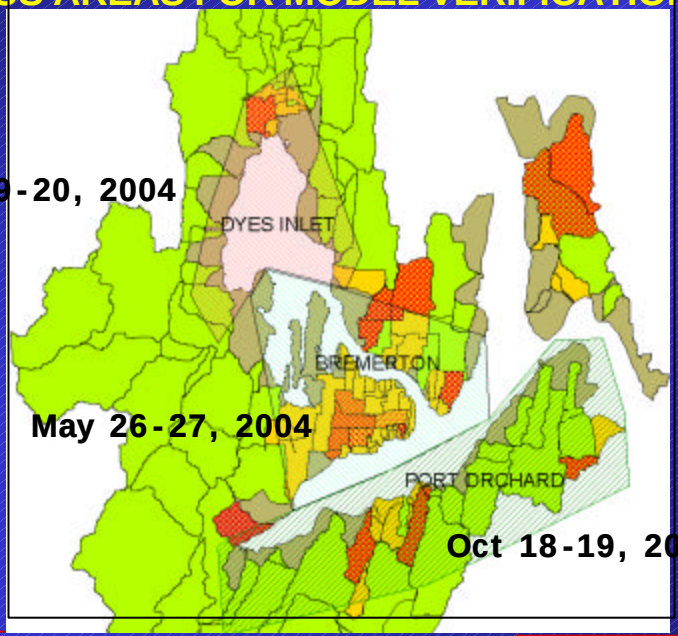
FOCUS AREAS FOR MODEL VERIFICATION



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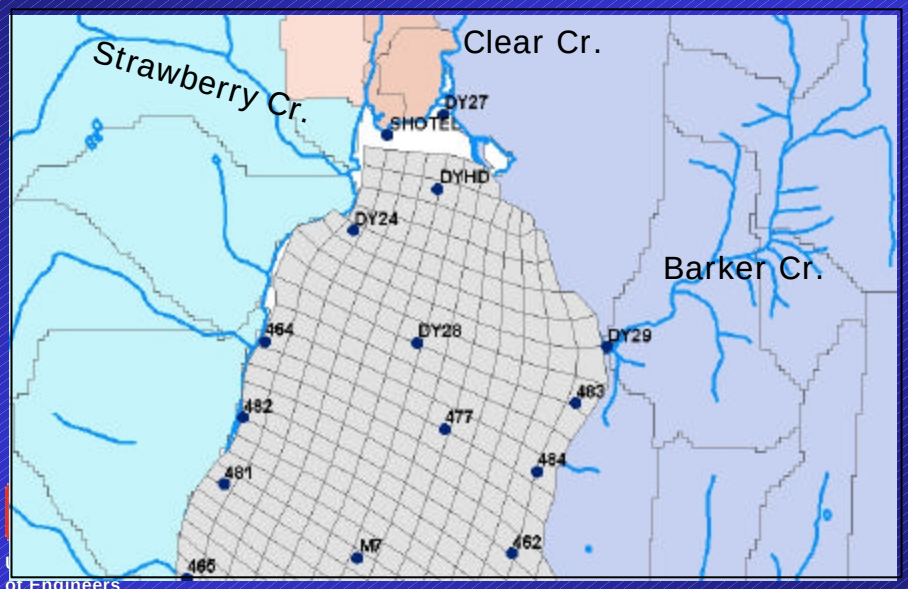
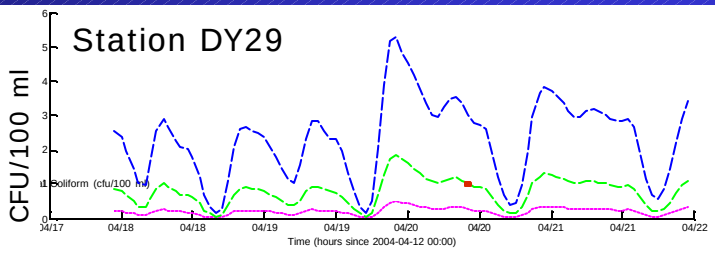
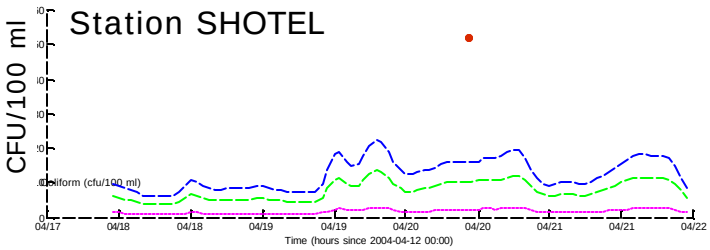
COMPARING MODEL RESULTS TO FIELD DATA

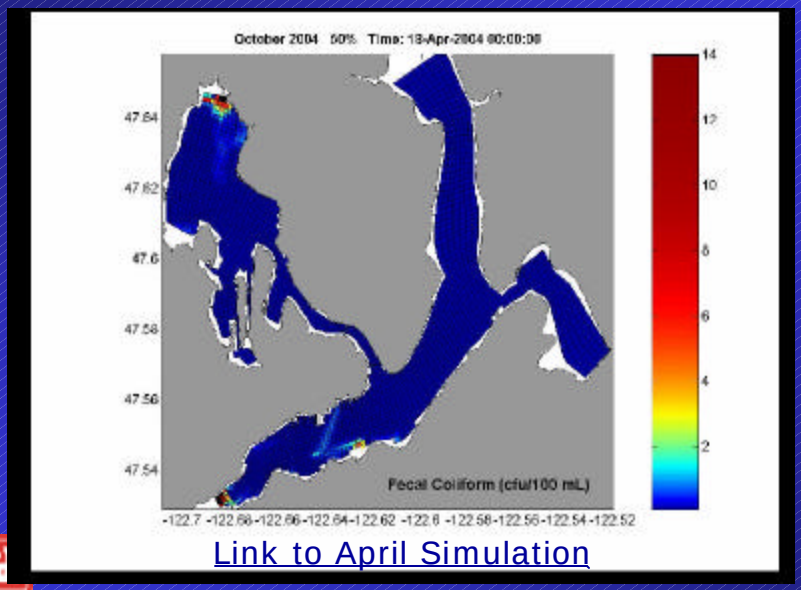


APRIL 2004





SIMULATION OF STORM EVENTS



Link to April Simulation

Link to May Simulation

Link to Oct Simulation

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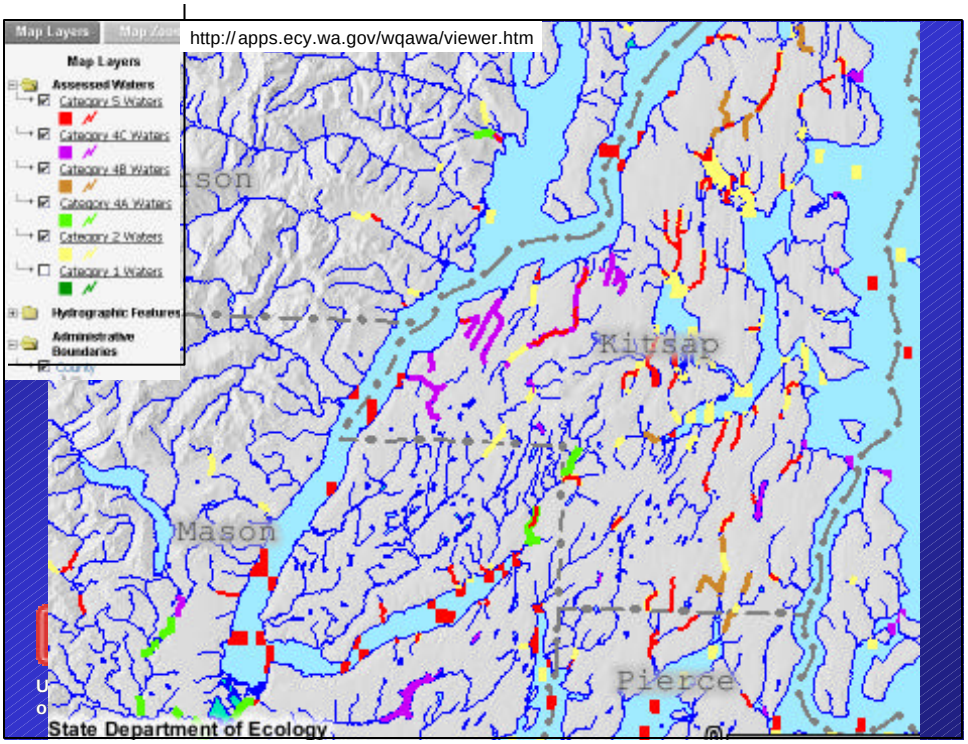
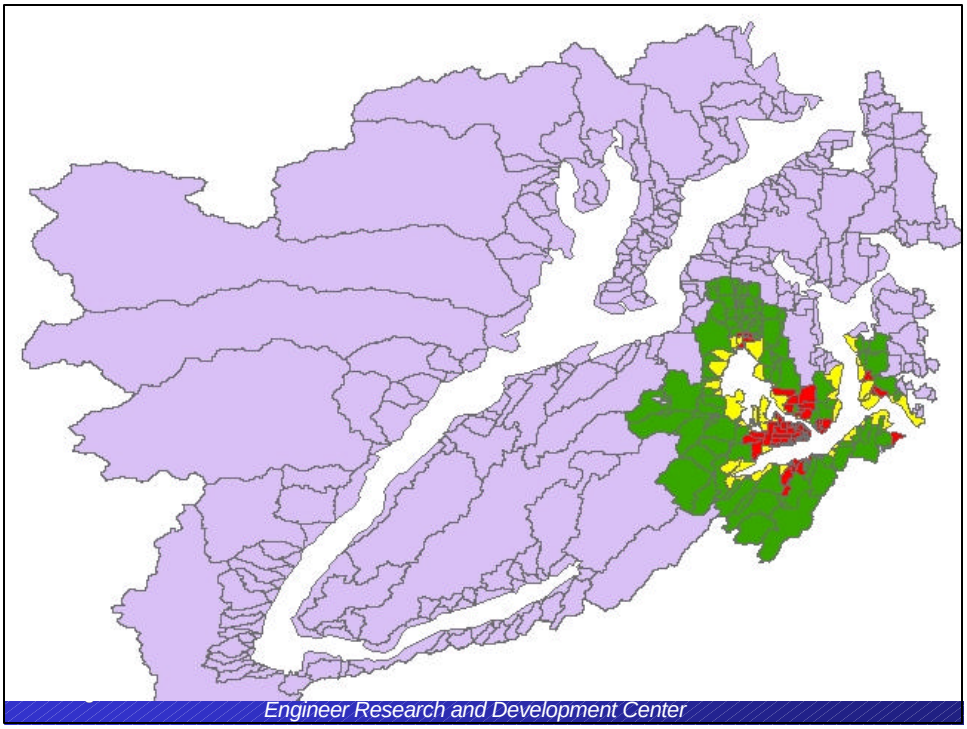


State Department of Ecology

LESSONS LEARNED

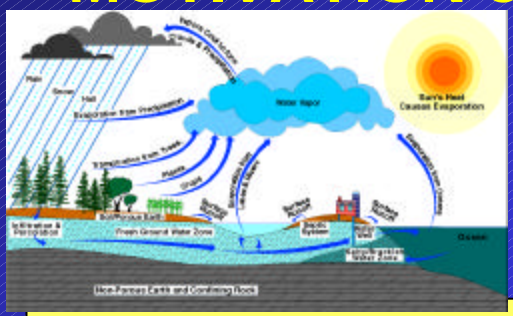
- OPTIMIZE SAMPLING OBJECTIVES
  - STREAMS, STORMWATER, EVENTS
- TRANSFER PARAMETERS
  - FROM MONITORED TO AREAS WITH NO DATA
- STAKEHOLDER PARTICIPATION
- POOL RESOURCES AND DATA TO GET A BETTER PRODUCT

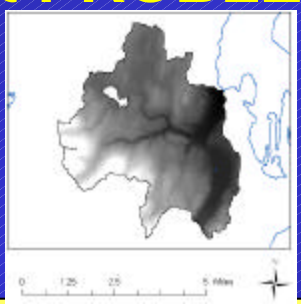


NEXT STEPS FOR FC MODELING

- COMPLETE EVALUATION OF MODEL VERIFICATION RESULTS
- SIMULATE COMPLETE TRACE FOR WATER YEAR 2003 (OCT 1, 2002 – SEP 30, 2003)
- IDENTIFY CRITICAL CONDITIONS FOR FC LOADING
- DESIGN MODELING SCENARIOS FOR TMDL
- COMPLETE MODELING REPORTS

MOTIVATION & PROBLEM





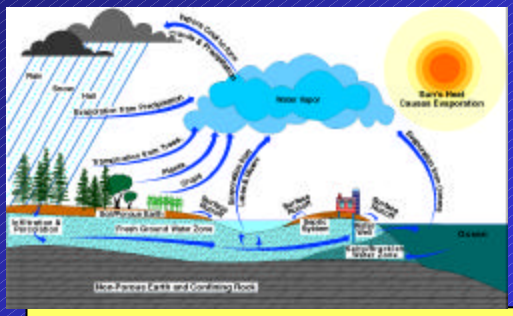
DETAILED LANDSCAPE INFO. ENCAPSULATED IN GIS COVERAGES

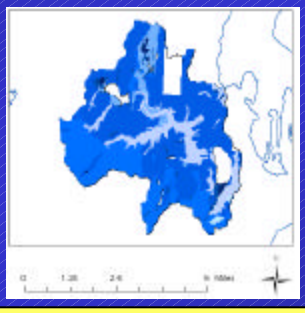
GIS

MODEL INPUT FILE

HIGHLY PARAMETERIZED MODEL

MOTIVATION & PROBLEM





DETAILED LANDSCAPE INFO. ENCAPSULATED IN GIS COVERAGES

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MODEL INPUT FILE

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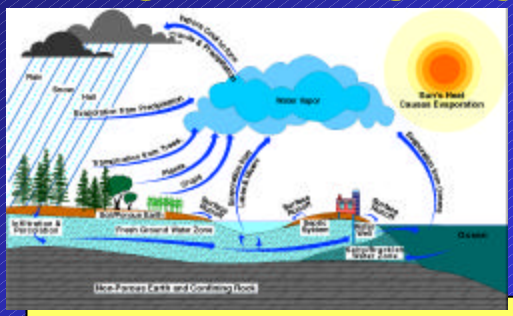
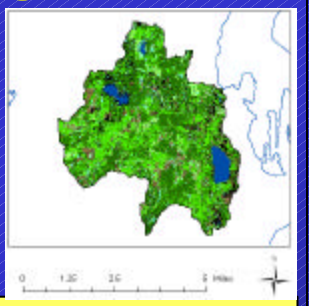
HIGHLY PARAMETERIZED MODEL

US Army Corps of Engineers

Engineer Research and Development Center

MOTIVATION & PROBLEM





DETAILED LANDSCAPE INFO. ENCAPSULATED IN GIS COVERAGES

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MODEL INPUT FILE

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HIGHLY PARAMETERIZED MODEL

US Army Corps of Engineers

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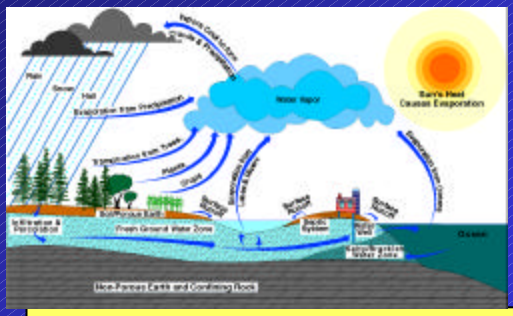
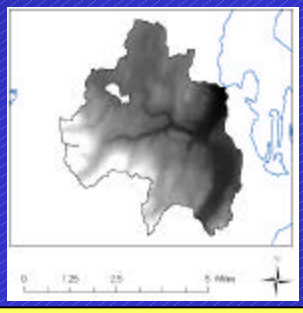
MOTIVATION & PROBLEM





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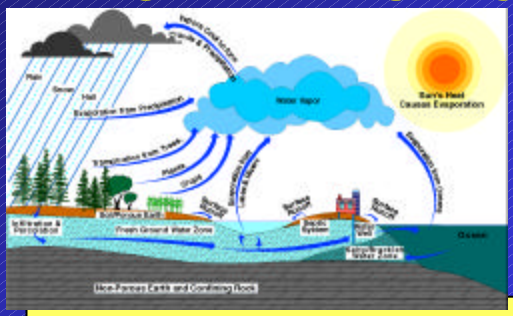
MODEL INPUT FILE

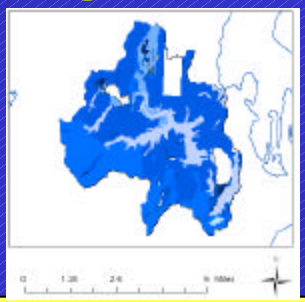
HIGHLY PARAMETERIZED MODEL

US Army Corps of Engineers

Engineer Research and Development Center

MOTIVATION & PROBLEM





DETAILED LANDSCAPE INFO. ENCAPSULATED IN GIS COVERAGES

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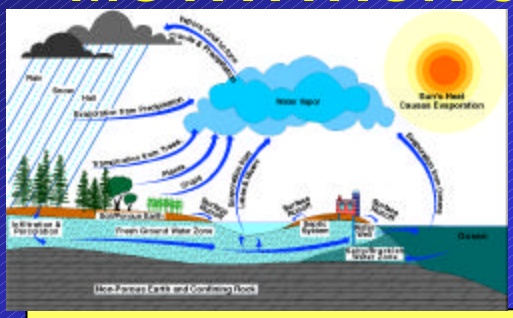
MODEL INPUT FILE

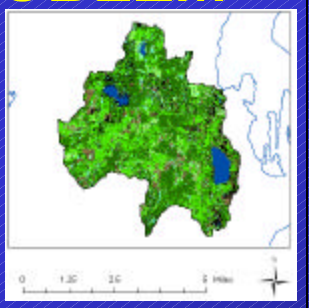
HIGHLY PARAMETERIZED MODEL

US Army Corps of Engineers

Engineer Research and Development Center

MOTIVATION & PROBLEM





DETAILED LANDSCAPE INFO. ENCAPSULATED IN GIS COVERAGES

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MODEL INPUT FILE

HIGHLY PARAMETERIZED MODEL

REGULARIZATION

- A MEASURE OR ADDITIONAL CONSTRAINT THAT IS TAKEN TO ENSURE THAT A STABLE SOLUTION IS OBTAINED TO AN OTHERWISE ILL-POSED INVERSE PROBLEM
- THE PROBLEMS OUTLINED ABOVE CAN BE OVERCOME THROUGH THE USE OF PARAMETER ESTIMATION ALGORITHMS THAT ALLOW MATHEMATICAL REGULARIZATION TO BE IMPLEMENTED AS PART OF THE PARAMETER ESTIMATION PROCESS ITSELF.

REGULARIZATION

- TRUNCATED SINGULAR VALUE DECOMPOSITION (TSVD)
- TIKHONOV REGULARIZATION

EXAMPLE

Doherty, J., Skahill, B., (2005). "An Advanced Regularization Methodology for Use in Watershed Model Calibration" In revision for publication in Journal of Hydrology.

SUMMARY OF REGULARIZATION PRESENTATION

- REGULARIZATION IS A MEASURE OR ADDITIONAL CONSTRAINT THAT IS TAKEN TO ENSURE THAT A STABLE SOLUTION IS OBTAINED TO AN OTHERWISE ILL-POSED INVERSE PROBLEM
- WITH REGULARIZATION, THERE IS A TRADE OFF BETWEEN FITTING THE DATA IN EXCHANGE FOR SOLUTION STABILITY
- REGULARIZATION ELIMINATES THE NEED FOR "PREEMPTIVE PARSIMONIZING" AHEAD OF THE CALIBRATION PROCESS
- THE RESULT IS A STABLE PROCESS THAT ALLOWS MAXIMUM RECEPTIVITY OF PARAMETERS TO BOTH "HARD INFORMATION" PROVIDED BY THE MEASUREMENT DATASET AND "SOFT DATA" EMBODIED IN A MODELER'S UNDERESTANDING OF THE AREA, ENCAPSULATED IN THE SET OF REGULARIZATION CONSTRAINTS

CONSEQUENT TO REGULARIZED INVERSION

- PREDICTIVE ERROR VARIANCE MAY BE COMPUTED