2003 Freshwater Program

Major Projects Overview and Status

February 27, 2003

King County

Department of Natural Resources and Parks
Water and Land Resources Division
Science Section
King Street Center, KSC-NR-0600
201 South Jackson Street, Suite 600
Seattle, WA 98104
206-296-6519 TTY Relay: 711
dnr.metrokc.gov/wlr

2003 Freshwater Program

Major Projects Overview and Status

Submitted by:

Larry Jones
King County Water and Land Resources Division
Department of Natural Resources and Parks

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1. FRESHWATER PROGRAM OVERVIEW

The Freshwater Program is entering the final two years (2004 and 2005) of activity. This report provides an overview and status of products, tasks and activities, which have taken place in the year 2003. The program study area consists of the greater Lake Washington watershed including the Lake Sammamish and Cedar River Basins; and the Green-Duwamish watershed. No Marine drainages are included in the program.

The Freshwater Program can be separated into three activity levels:

1. Collecting and analyzing environmental information;

2. Developing computer simulation models, including model integration, associated data management systems, other analytical tools and methodologies for evaluating current and future water resource conditions; and

3. Assessing potential risks to ecosystems and human health which includes assessing TMDL s (total maximum daily loads) for the Greater Lake Washington and Green – Duwamish watersheds.

Collecting environmental information includes the chemical, physical and biological analysis of water, sediment, and tissue samples, and includes measuring rainfall, water temperature and water quantity. Additional information also includes data on Land Activity, Land Cover, and Population Growth.

These data collection projects will be in addition to data collected under existing long-term monitoring programs, such as the major lakes and streams programs. The data will be used together with the long-term monitoring programs to fill any data gaps as required to meet Freshwater program objectives.

These data will be compiled into focused studies that report trends or conditions in specific geographic locations within WRIA 8 and/or 9 on specific issues such as:

- Urbanization effects on in-lake phosphorus concentrations;
- Bioaccumulation of contaminants in Lake Washington fish;
- Loading of conventional parameters (temperature, dissolved oxygen, sediments) and bacteria and metals to rivers and streams; and,
- Benthic Macroinvertebrates because benthic communities are reflective of local sediment, water quality, hydrologic and habitat conditions.

Water resource models will be developed at the watershed level and for specific receiving water bodies like Lake Washington, Lake Sammamish, the Sammamish River, and Green-Duwamish River. These watershed and receiving water models will be integrated, such that the outputs from watershed models will provide input to receiving water models at the boundaries of the major rivers and lakes. Information derived from models and focused studies will allow clients to assess the effectiveness, sustainability, potential risk, uncertainties, and tradeoffs associated with proposed management actions. Once the suite of water quality and quantity models is developed they will be used to provide information to clients, risk assessments, and to optimize the long-term monitoring program for the large lakes and streams.

2003 FRESHWATER PROJECT STATUS

I. Data base development and Data Management

▪ Habitat Inventory database	**Completed**	
▪ RUSS Buoy database version 1 (Access Version) (Was not listed in 2002 report)	**Completed 2002**	**A. Garba and R. Blomquist**
▪ RUSS Buoy database version 2 (SQL Version)	**Completed 2003**	**A. Garba and R. Blomquist**
▪ Data Management Findings of Fact for the King County Water		
▪ and Land Resources Divisions Science and Data Management		
▪ Unit (Battelle) (Was not listed in 2002 report)	**Completed 2/02**	**T. Georgianna /L. Jones**
▪ Data Management Alternatives for the King County Science, Monitoring and Data Management Unit (Battelle) (Was not listed in 2002 report)	**Completed 3/02**	**T. Georgianna /L. Jones**
▪ Benthic database	**Start 1/04 TBD**	**D. Henderson**
▪ Analysis Data Base (SQL LIMs Data)	**Due 3rd quarter 2004**	**A. Garba**

II. Reports planned for completion in 2002 is given below.

▪ Cyanobacteria Sampling and Analysis Plan	**Completed 6/03**	**Jon Frodge**
▪ Lake Washington Water Quality Report	**Completed 10/03**	**Bouchard and Frodge**
▪ Human Resource Use Survey	**Draft Completed 9/2003**	
▪ Lake Sammamish Water Quality Report	**Due 3rd quarter 2004**	**D. Bouchard**
▪ Lake Union Water Quality Report	**Due 4th quarter 2004**	**D. Bouchard**
▪ Sammamish River Water and Sediment Quality Report	**Due 3rd quarter 2004**	**Jenée Colton**
▪ Sediment Quality Report, Lakes Sammamish, Union, and Washington	**Due 3rd Quarter 2004**	**(UW Kari Moshenberg)**
▪ 520 Bridge SAP	**Monitoring Completed**	**Dean Wilson**
▪ Streams Monitoring SAP	**Completed**	**Dean Wilson**
▪ Quantitative Phytoplankton Study SAP	**Completed**	**Dean Wilson**
▪ Lake Washington Baseline Sediment Study SAP	**Completed**	**Dean Wilson**

▪ Lake Sammamish Baseline Sediment Study SAP	**Completed**	**Dean Wilson**
▪ Lake Union Baseline Sediment Study SAP	**Due 3rd quarter 2004**	**Dean Wilson**
▪ 2003 Small Steams Toxicity Study SAP Addendum	**Completed**	**Dean Wilson**

III. Reports planned for completion in 2003, 2004 and 2005

▪ UW Stream Phosphorus	**Completed 2003**	
▪ SWAMP Annual Report, 2002	**Completed 6/03**	
▪ WSU -Ecological Effects of Pesticides	**Completed 8/03**	
▪ Green River Watershed 2000-2002 Water Quality Data Report	**Due 4th quarter 2003**	
▪ 520 Bridge Runoff Study	**Due 4th quarter 2004**	**D. Wilson**
▪ USGS Toxicity Report SWAMP(WRIA 8)	**Due 2nd quarter 04**	**D. Wilson**
▪ Microbial Source Tracking	**Due 4th quarter 2004**	**D. Henderson**
▪ Green River Temperature Report	**Due 1st quarter 2004**	**D. Henderson / Eric Ferguson**
▪ 2002 Macroinvertebrate Report	**Due 1st quarter 2004**	**D. Henderson**
▪ Green River Watershed 2003 Water Quality Report	**Due 3rd quarter 2004**	**D. Henderson**
▪ 2003 Macroinvertebrate Report	**Due 4th quarter 2004**	**D. Henderson**
▪ Water Quality Loadings' Report	**Due 2nd quarter 2005**	**D. Henderson**
▪ Long-Term Monitoring Plan Recommendations Report	**Due 4th quarter 2005**	**D. Henderson, D. Wilson, K. Bourbonaise L. Jones**
▪ Small Streams Toxicity/Pesticide Study 1999 – 2003	**Due 2004 final TBD**	**D. Wilson**
▪ Modeling Bioaccumulation of PCB's, Pesticides and TBT in Lake Washington Fishes, Invertebrates and Plankton	**Due 2004 final TBD**	**Jennifer McKintyre (UW) see D. Lester**

IV. Lakes Modeling

▪ Lake Washington Hydrodynamics Model (Includes Lake Union)	**Completed 2003**	**Kevin Schock**

▪ Lake Sammamish Hydrodynamics Model	**Completed 2003**	**Kevin Schock / Curtis DeGasperi**
▪ Sammamish River Hydrodynamics and Temp Model	**Completed 2003**	**C. DeGasperi**
▪ *UW Eutrophication Model	**Due 4th Quarter 2004**	
▪ *UW Phytoplankton Dynamics Model	**Due 4th Quarter 2004**	
▪ *UW Contaminant Bioaccumulation Modeling	**Due 2nd Quarter 2004**	
▪ *UW Bioenergetics Model (prickly sculpin)	**Due 2nd Quarter 2004**	
▪ UW/KC Temp/DO Concentration on Salmonids	**Due 2nd quarter 2004**	**(Hans Berge)**
▪ *Lakes Model /UW model integration project	**Due 4th quarter 2005**	**Tom Georgianna**

(See Page 4 for project overview)

V. Watershed Modeling Jeff Burkey (all Models)

NOTE: About 40~50 models will be built either from existing HSPF models or newly created. Detailed Calibrated Basins Status Using Local Data

▪ Newaukum	**Completed**
▪ Little Bear	**Completed**
▪ North Creek	**Completed**
▪ Swamp Creek	**Completed**
▪ Springbrook /Black River	**Completed**
▪ Soos Creek	**Due 1st quarter 2004**
▪ Issaquah	**Due 1st quarter 2004**
▪ Hamm Creek	**Due 2nd quarter 2004**

Previously Calibrated Models

▪ Mill Creek	**Due 3rd quarter 2004**
▪ Cedar River	**Due 2nd Quarter 2004**
▪ E. Lake Sammamish	**Due 2nd quarter 2004**

- Bear/Evans Creek **Due 3rd quarter 2004**
- Kelsey Creek **Due 2nd quarter 2004**
- May Creek **Due 2nd quarter 2004**
- Coal Creek **Due 3rd quarter 2004**
- Thornton Creek **Due 3rd quarter 2004**

New Models Using Regional or Near by Parameterization

- Lower Green Drainages **Due 3rd quarter 2004**
- Sammamish River Drainages **Due 3rd quarter 2004**
- Lake Washington Drainages **Due 3rd quarter 2004**

VI. Risk Model Final 1st quarter 2005 D. Lester /D. Henderson

- Screening Level Ecological Risk Assessment **In work/2005 completion**
- Screening Level Human Health Risk Assessment **In work/2005 completion**
- Detailed Ecological Risk Assessment **Due 4th quarter 2005**
- Detailed Human Health Risk Assessment **Due 4th quarter 2005**

VII. Habitat

- Habitat Assessment, Bear Creek **Completed 5/02**
- Habitat Assessment—Mussels: Bear and Cottage Creeks **Completed 4/02**
- Green/Duwamish Watershed Water Temp Report **Completed 6/02**
- Coho Pre-Spawn Mortality Study **Monitoring Completed 2003** **D. Wilson**
- Freshwater Mussel Study **Due 2004** **B. Brenner**

VIII. Integrated Water Resources Modeling System Project Phase III T. Georgianna

▪ Integrated Water Resources Modeling System Functional		
▪ Requirements Specifications Report (Battelle)	**Completed 3/03**	**L. Jones**
▪ Integrated Water Resource Modeling System Project	**Due 4th quarter 2005**	**T. Georgianna**
▪ Integrated System Operating and Maintenance Shakedown program	**Complete 2006**	**T. Georgianna**

IX. Climate Data Project TBD

- Determine climate data needs for modeling and/or
- Develop work program for climate model development and/or
- Prepare project as a new 2005 budget initiative.

X. 2005 Budget New Initiatives and/or request for Budget increase February, 2004

- Prepare 2005 budget and 2006 close out projection
- Prepare new budget initiatives, projects and programs
- Prepare request for 2005 and/or 2006 budget increase/adjustment

XI. WRIA Support 2004

▪ Technical Committee Support	**Ongoing**
▪ Grant Coordination e.g. SRFB	**Ongoing**
▪ TDML Strategic Plan support	**Ongoing**
▪ EDT (Ecological Diagnosis and Treatment) Modeling	**Ongoing**

XII. Other Projects and Programs

- Peer Review Process **2005**

The Freshwater Program will be completed in 2005 with the Integrated Water Resource Modeling System undergoing final shakedown in 2006, and remaining efforts closing out.

Lifetime budget: $12,326,000
Expenditure to Date: ..... $6,781,428.
2004 Budget: ..... $2,895,000.
2005 Budget (Est.): ..... $2,042,000.
2006 Budget (Est.): ..... $608,000.

2. DATA MANAGEMENT

Data Management is an integral part of the Freshwater Program. Proper data management systems and techniques are required to maintain and evaluate existing monitoring data, newly collected monitoring data, and model output data. As part of this work two documents were completed in 2002:

1. Data Management Findings of Fact for the King county Water and land Resources Division Science and Data Management Unit-February 2002;
2. Data Management Alternatives for the King County Science Monitoring and Data Management Unit – March 2002.

A new habitat inventory database, as well as Lakes Buoy databases, has also been completed. Two new databases – Laboratory Information SQL database and the Benthic database – are scheduled for development in 2004.

Data Management is too large of an issue to be fully addressed within the scope and budget of the Freshwater Program. Therefore, additional funding and a different approach are required to meet the needs identified in the above reports. The data bases management baseline requirements are being addressed as part of the Integrated Water Resource Modeling program and other resources are being focused on those databases needed to support model operations.

STAFF

- Ahmed Garba
- Tom Georgianna
- Larry Jones

CONSULTANTS

- Battelle – Pacific Northwest National Laboratories
  - Cost – $270,000

3. HYDROLOGIC MONITORING FRESHWATER PROGRAM

STATUS

In 2003, the King County WLRD gauging program continued to collect hydrologic data at recording stream gages and weather stations for the Freshwater Program. Streamflow data was collected from 16 significant tributary streams to Lake Washington and Lake Sammamish. In the Green River watershed, streamflow was measured at 12 sites. Automatic water quality sampling equipment was maintained at nine of the gages for the Green River water quality assessment. A water quality study of runoff from the 520 bridge deck was conducted in 2003. The gauging program assisted in the collection of water quality samples for a toxicity study in the Lake Washington watershed and a study of coho pre-spawn mortality in the Green/Duwamish. Two weather stations were operated to estimate evaporation/transpiration for hydrologic modeling. The gauging program collected and managed stream temperature data from 34 sites in the Green/Duwamish watershed for the Green River temperature study. Data collected by the gauging program is stored in SQL database managed by the Science Section Data Management Group.

In 2003, 17 stream gages and 34 rain gages that had been operated for the Freshwater Program were supported by the SWM fund to fulfill NPDES stormwater permit requirements.

CHANGE CONDITIONS

In 2004, the remainder of the remainder of the hydrologic monitoring that was supported by the Freshwater Program in 2003 has been shifted to SWM fund support. Some sites will be discontinued as other priorities require gauging resources.

BACKGROUND

Data collected by WLRD gauging program are used regionally in the Puget Sound area for design of capital projects for WTD and DOT, watershed studies, monitoring of construction projects including Urban Planned Developments, fisheries in-stream flow analysis, flood prediction, and groundwater studies. Meteorological data are used for input to hydrologic computer models, for correlation of peak flows to storm return frequency, and water quality studies. Streamflow data are used for hydrologic model calibration, calculation of pollutant loading, and engineering design. Within King County, other primary customers of the gauging program are WTD Infiltration and Inflow Program, WLR rural reconnaissance, WTD Surface Water Engineering and Engineering Section, WLR Master Drainage Plan program, WLR Small Lakes program, and the Solid Waste Division.

The program shares data with other agencies and provides technical assistance for the data collection at sites of mutual interest. For example, resources are shared and technical assistance is provided to Seattle Public Utilities for hydrologic data collection on streams in the Seattle area. The gauging team consists of an engineer and four technicians. They work closely with other hydrologists, ecologists, and water quality planners in the WLRD Science section.

STAFF

- David Funke
- Dave Smith

- Howard Hama
- Brendan Grant
- Bob Keating

Table 1. Gauging 2003

GAUGING 2003		
Activity	**Milestone**	**Annual Products**
WTD CAP	Support Green WQA sampling	Keep samplers at 10 sites going
	Support SWAMP data collection	Supply hydrologic data to modelers
	Support I & I monitoring	Supply data from 55 rain gages
Data Management	Allow network wide access to hydro data	improved database

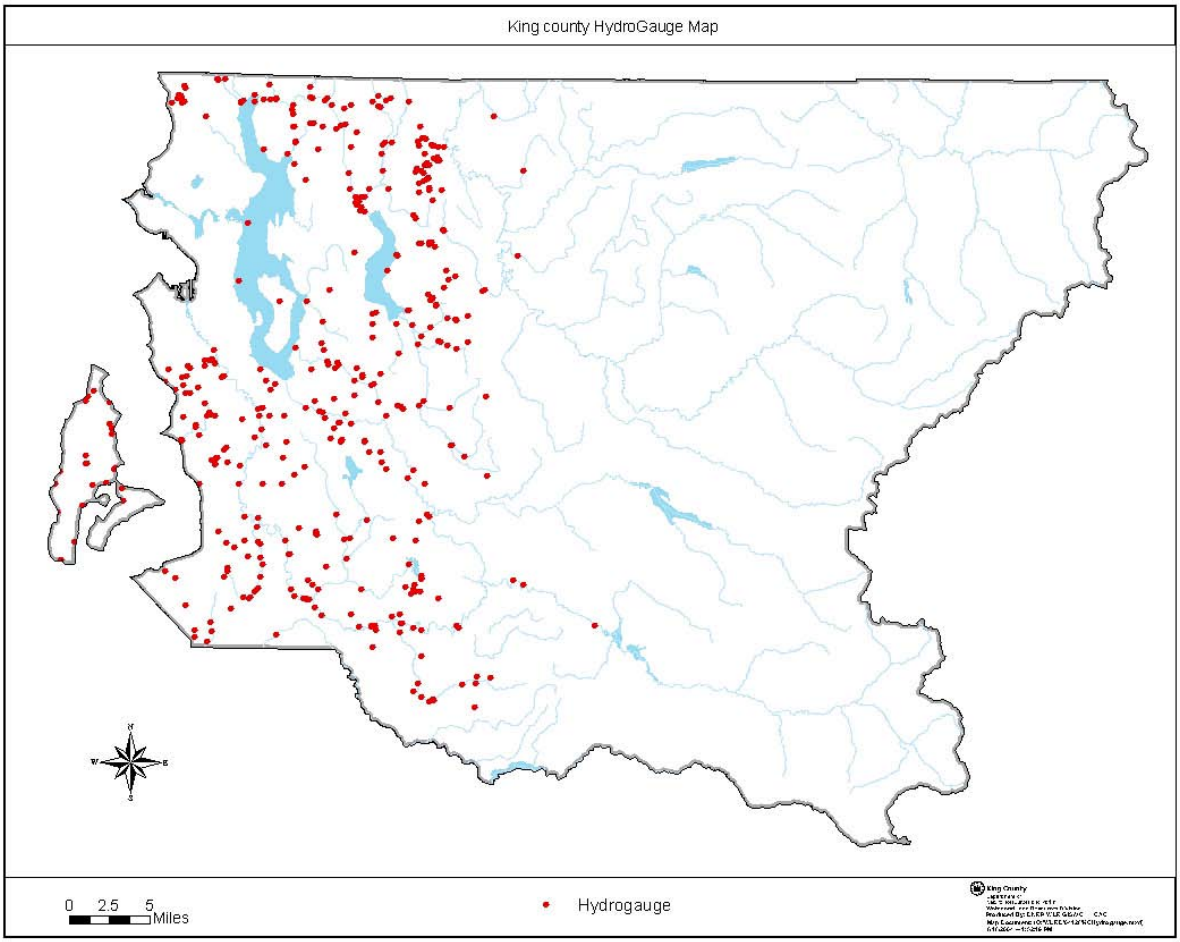

Figure 1. Gauging Map

4. INTEGRATED WATER RESOURCE MODELING SYSTEM PROJECT

INTRODUCTION

The Integrated Water Resources Modeling System project consists of integrating various computational Models, into a system that optimizes interaction between the multiple models. The project consists of evaluating, designing, developing, implementing, and maintaining software modules that will efficiently stream data between environmental databases, numerical and analytical models and visualization software, and to simplify operation of project models in sequence or in isolation.

The integrated mathematical simulation modeling project will:

- Model impacts of future actions that may potentially have an impact on regional water quality;
- Provide a predictive tools to evaluate water quality and quantity impacts of various land use and facility siting options;
- Provide a long-term comprehensive water quality and quantity analysis tool;
- Determine the present water quality of lakes, streams and other water resource areas e.g., wetlands, shorelines, and beaches;
- Identify short- and long-term water quality trends;
- Provide tools and methodology for identifying existing or potential water quality problems and suggesting corrective measures.

Five types of models will be initially integrated and two may be phased into the system at a later date:

1. Land use/Land cover models - used to simulate urban growth, land cover, non-permeable surface, water resource usage, and associated pollution generation. The initial work on this model will be data specific and model development is optional depending on other agency partners such as the Puget Sound Regional Council (PSRC). The model can be incorporated into UrbanSIM, which is presently being developed by the PSRC via a contract with the University of Washington.
2. Watershed models – used to simulate land-use effects on stream and groundwater quantity and quality.
3. Lake Models – used to simulate hydrodynamics and water quality in Lakes Sammamish, Washington, and Union.
4. River models – used to simulate hydrodynamics and water quality in the Sammamish, Green, Cedar, and Duwamish Rivers.
5. Ecological and Human Health Risk Assessment Models – used to identify the potential risk associated with exposure to contaminants in surface waters.
6. Estuary model – used to simulate the Duwamish River-Elliot Bay area. This model will not be integrated at this time.
7. Climate model – this is an optional model and will not be developed at this time. The purpose of the model is to simulate local climate change and atmospheric conditions including the resulting impact on water resources. Utilizing existing climate data systems is being explored as an interim solution.

In addition, multiple secondary models will support the primary seven listed above; e.g., trophic and bioenergetics models for the lakes; the HEC-RAS (Hydrologic Engineering Center - River Analysis System) model for complex hydraulics; and time series generation models that are required to fulfill watershed model data input. The system is designed to incorporate additional models in the future; e.g., in-stream habitat and fish population dynamics.

CONSULTANTS

Battelle Memorial Institute Pacific Northwest Division operating under prime contract NO. DE-ACO6-76RLO1830 for the U.S. Department of Energy has been retained via a government to government Agreement.

- Contract (total) budget $2,141,736
- Contract Schedule 2001 through 2006.
- Expenditure To-Date $845,015*
- 2004 budget (est.) $713,196
- 2005 budget (est.) $523,524
- 2006 budget (est.) $60,000

(*Note: Include assessment of Data Management Issues. Also see Section 2, Data Management)

STAFF

- Tom Georgianna
- Larry Jones
- Ahmed Garba
- Jeff Burkey
- Curtis DeGasperi
- Kevin Schock
- Jon Frodge

5. MAJOR LAKES – AMBIENT MONITORING PROGRAM

The Freshwater program supports the collection and analysis of a variety of water, sediment, tissue, and organism samples. The King County Environmental Lab (KCEL) collects and analyzes the majority of these samples. The KCEL collected 675 water samples and analyzed at least 129 different parameters in 2001. These samples were collected to support specific capitol projects and as part of the ongoing long-term monitoring programs in King County Lakes and Streams.

This program was designed to protect the significant investment in water quality improvements and protection made by the people of King County. Several pump stations and combined sewer overflows are on or near the shores of the lakes, miles of sewer pipelines lie on the bottom of Lake Washington and Lake Sammamish, and most of the influent streams are crossed by one or more sewer pipelines. Thus, ongoing monitoring will safeguard the quality of the Lakes. Additionally, the Major Lakes Program will determine and document how the lakes in King County respond over time to watershed activities and inputs, lake nutrient cycles, ecological interactions, and seasonal or year-to-year variability in weather.

Freshwater Program funds have expanded the ongoing ambient water quality-monitoring program to include quarterly analysis of low level total and dissolved metals, organic and conventional parameters in streams and major lakes. In addition to the water sampling and analysis program, the lab collects and analyzes sediment samples, conducts water and sediment bioassays, and collects benthic invertebrates in the lakes and streams.

A major monitoring effort was conducted related to the Interstate 520 Bridge. The Freshwater team monitored storm-water runoff quantity from one down spout and collected water quality samples from three locations. This information will provide data on road runoff characteristics and potential long-term impacts to water quality.

In July of 2000, King County purchased five RUSS™ buoys (Remote Underwater Sampling Station) designed to remotely collect water quality data from lakes. Two of these buoys were placed in Lake Sammamish and three were placed in Lake Washington. The buoys are designed to automatically collect water column profile data, 1 to 4 times a day, 365 days a year. Probes on the buoys measure water temperature, pH, conductivity, dissolved oxygen, and chlorophyll A (through fluorometry). In 2001, approximately 2600 data profiles were downloaded from the RUSS buoys. Data from the buoys will support development of water quality and quantity models for Lakes Sammamish, Union, Washington, and the Sammamish River. Additionally, these data are used for citizen information and education activities.

In 2004, the following reports are due:

- The Lake Union Water Quality Report
- The Lake Sammamish Water Quality Report
- The Sammamish river Water and Sediment Quality report
- The Lakes Sammamish, Union and Washington Sediment Quality Report

KING COUNTY STAFF

- Jon Frodge

- Deborah Bouchard
- Bob Brenner
- Rob Blomquist
- John Blaine
- Jeff Droker
- Stephanie Hess
- Bob Kruger
- Kevin Li
- Judy Ochs
- Marc Patten
- Jean Power
- David Robinson
- Scott Mickelson
- Katherine Bourbonnais

6. LAKES MODELS AND RECEIVING WATER MODELS

INTRODUCTION

The Freshwater Program modeling component provides water quality, quantity and biological conditions predictive capabilities, based on land use changes and local meteorological conditions. The water models include the CH3D hydrodynamic and CE-QUAL-ICM water quality models to simulate 3-dimensional hydrodynamics and water quality in Lakes Sammamish, Union, and Washington.

The 2-dimensional hydrodynamic and water quality model CE-QUAL-W2 has been selected to simulate conditions in the Sammamish River and is currently being calibrated. This model has also been selected to model the main-stem Green River as part of the Green River Water Quality Assessment.

All of the above non-proprietary models were developed and are supported by the U.S. Army Corps of Engineers Engineering Research and Development Center (ACOE-ERDC) and Waterways Experiment Station (ACOE-WES) in Vicksburg, Mississippi.

The Lake Washington 3-Dimensional modeling grid has been finalized and calibrated data available for Lake Washington for the period 1995-1997. The CH3D/CE-QUAL-ICM model of Lake Sammamish has also been initiated and will be completed in 2004. The Lake Washington model configuration includes Lake Union and the Ship Canal. A separate, more detailed Lake Union model is planned for the future.

The Sammamish River CE-QUAL-W2 model has been configured and calibrated for flow, dissolved oxygen, pH, nutrients, phytoplankton, fecal coliform, and suspended solids.

CONSULTANTS

- U.S. Army Corp of Engineers

BUDGET AND COST

- $175,000 expended through 2003
- New contract amount for 2004 estimated at $20,000

KING COUNTY STAFF

- Kevin Schock
- Curtis DeGasperi

7. LAND ACTIVITY AND LAND COVER MODELS

INTRODUCTION

This section discusses two modeling efforts: the Urban Simulated Integrated Model (UrbanSIM) and the Land Cover and Activity Model. These efforts relate to:

1. Land Demographics and Land Activity (UrbanSIM) – population by land activity e.g., employment number of employees; employment locations and employment activity (e.g., industrial, commercial, government); or number of individuals by dwelling types e.g., single family, multifamily, vacant or growth areas.
2. Land Cover and Activity – describes and identifies impervious or various levels of pervious e.g., Grass, forest, bare earth, and the purpose of the land e.g., industrial vs. single family; recreational field vs. natural open space. The model is structured to predict the probability of a single cell changing from one discrete land cover class to another class. This is based on the present land cover class function of that cell, a set of attributes of the cell, and the specific development event predicted by the development model within the cell.

URBANSIM MODEL

The Freshwater program has been coordinating and collaborating with the Puget Sound Regional Council's (PSRC) Technology Forum and the University of Washington via the University's Center for Urban Simulation and Policy Analysis (CUSPA) to determine how King County's predictive needs will coordinate with the Urban Simulated Integrated Model (UrbanSim). Securing information from UrbanSIM would enhance the predictive capability of King County's Integrated Water Resource Modeling System. Linking hydrologic, biological, and chemical aspects of the Lakes Model, River Models and Watershed Models to the framework of UrbanSim, will provide county planners with the ability to make decisions about how urbanization (development and population growth) in King County will affect water quality and quantity (based on predictions of the IWRMS).

The University of Washington's and PSRC's UrbanSim, project is designed to enable planners and policymakers to forecast the future effects of current housing, land use and transportation decisions. It will provide elected officials and others to have more complete information about the long-term effects of different policies, and to be able to evaluate those policies according to their own values and interests.

The Freshwater program will use the tool for assessing existing water resource conditions and making current long-term decisions with some reasonable expectation about the likely consequences of policy, population growth, and land activity choices.

Phase 1 of the UrbanSIM project was structured from January - June 2003, to focus on compiling the base-year database for the model application. Phase 2 began in July 2003 and will run through June 2004, and will focus on making the model operational within the region.

LAND COVER MODEL

This model is also a part of the current effort lead by the UW to develop and implement UrbanSim in the Central Puget Sound Region. It is being built based on two projects currently under development at the UW Urban Ecology Research Laboratory:

1. The NSF (National Science Foundation) Biocomplexity land cover change modeling project; and
2. The NSF funded empirical study on the impact of urban patterns on ecosystem dynamics focusing on bird diversity and aquatic macroinvertebrates.

The proposed land cover change model will be integrated with UrbanSim, and is being developed in coordination with the Puget Sound Regional Synthesis Model (PRISM). PRISM (a University of Washington product) provides the general framework for operationalizing linkages with other biophysical modeling components.

King County's Freshwater Program is only financing phase one of the Land Cover Model. In this effort, King County will be used as a basis for the scientific foundation and technical specifications for modeling land cover change in Central Puget Sound. The finished product (Phase 3) will provide local and regional agencies in Central Puget Sound with a realistic tool to assess land transformation and human-induced stresses under alternative policy scenarios.

The objective of this first phase is to use existing land cover data from 1991 and 1999 developed by the Urban Ecology Research Laboratory to develop the basic model specification through exploratory data analysis of a large number of potential predictor variables. The UW teams will work together with King County and Puget Sound Regional Council Forum to elucidate the modeling needs and objectives for the final operational products. A land cover change model will be prototyped and partially integrated with the UrbanSim development model.

One of King County's primary efforts is focused on Empirical modeling of Total and Effective Impervious Area. The effort will also finalize land cover types within King County, including data collection.

The UW team will use high-resolution imagery to model the relationship between land cover, land use, and effective impervious area. Impervious surface will be estimated at three spatial scales: Basin scale, Subbasin scale, and 150 m block scale. The impervious surface will be mapped using both remote sensing and geographic information systems (GIS) techniques and several data sources including:

- Landsat Images
- Ikonos Data
- Digital Ortho Photography
- Land Use Parcel Data
- Road Network Data
- Digital Elevation Models

Classification Schema Development – The UW team will work with King County personnel to translate the UrbanSim development categories and land cover classes into a combined classification schema that will support King County watershed water quantity/quality modeling efforts.

Data Collection and Development – The UW team will collect and prepare the data for implementing the variables and assess the status of available data in relation to the data requirements. Metrics developed by King County personnel to relate land use/land cover classes to the ecological health of stream and river systems will be calculated.

STAFF AND CONSULTANTS

- University of Washington – UrbanSIM – Paul Waddel
- University of Washington – Land Cover Change model – Marina Alberti
- PSRC – Mark Simonson and Larry Blain
- King County Jeff Burkey and Larry Jones

COST

- UrbanSIM (PSRC financing est. $1.5 mill) Contract (total) budget
  - Contract Schedule 2002 through 2005
- University of Washington Land Cover Model (prototype)
  - Contract Schedule 12/2003 through 12/2004.
  - Budget $183,000 Contact (total) King County
  - Expenditure To-Date $30,000

8. BENTHIC MACROINVERTEBRATE MONITORING AND ASSESSMENT

MACROINVERTEBRATE (AQUATIC BUGS/INSECTS)

The Expanded Macroinvertebrate Monitoring Program has been completed. A revised program will be implemented in the summer of 2004. A final report on the 2002 expanded monitoring program will be available in June 2004. Another report on the 2003 data collection effort will be available June 2005.

BACKGROUND

Aquatic macroinvertebrates are aquatic animals without backbones that are visible to the naked eye, including insects, crustaceans, worms, snails, and clams. Benthic macroinvertebrates spend all or most of their lives living in or on the bottom of streambeds and other substrates such as logs or plants in the stream channels.

Benthic macroinvertebrates are monitored because they are good indicators of the biological health of stream systems and play a crucial role in the stream ecosystem. Since they complete most of or all of their life cycle in the aquatic environment and they are relatively sedentary, benthic communities are reflective of local sediment, water quality, hydrologic and habitat conditions.

PURPOSE AND METHOD

Biological monitoring of aquatic insect communities, as an indicator of general water quality conditions, was conducted in the Green River and Sammamish and Lake Washington watersheds during August and September of 2002 and 2003. King County Staff and interns monitored locations in over 150 sites in 18 watershed subbasins. This monitoring program expanded on the existing benthic macroinvertebrate-monitoring program already conducted by King County.

King County uses a method called the Benthic Index of Biotic Integrity (B-IBI) as a report card for measuring benthic aquatic invertebrate community health, and for the stream ecosystem as a whole. However B-IBI scores may vary across a watershed and region based on physical conditions. Therefore, in addition to water quality, habitat (e.g., substrate, flow, and riparian vegetation) must be evaluated as well.

LOCATIONS

The study area was comprised of wadeable steams located in the greater Lake Washington and Green-Duwamish River watersheds. It did not include the mainstem portion of the Cedar, Sammamish, or Green-Duwamish rivers, and saltwater drainages.

DELIVERABLES

SAP (Sampling and Analysis Plan) .....Completed

Monitoring .....Completed

2002 Final Report ..... Second Quarter 2004

2003 Final Report ..... Second Quarter 2005

STAFF 2002 AND 2003 KING COUNTY

- John Brooker
- Kari Osterhaug
- Jim Toole
- Jean Power
- Jessica Kuchan
- Other King County Staff and,
- King County Summer Interns

2004 STAFF

- Karen Fevold
- Jean Power
- Richard Jack
- Doug Henderson

CONSULTANTS

- Rhithron Associates Inc. – taxonomic Identification Lab
- Costs $51,225
- Leska Fore – Statistical Design
- Costs – $5,277
- EVS consultants
- Costs $37,850

9. MICROBIAL SOURCE TRACKING (MST) OR WATER MICROBIOLOGY

INTRODUCTION

Water microbiology or Microbial Source tracing (MST) is being conducted to collect a variety of samples representative of different environmental conditions. Samples are being analyzed for Fecal Coliform bacteria, Enterococcus bacteria and E. coli bacteria. Microbial Source tracking (MST) is being conducted to identify host species for bacteria in the watershed in limited locations. Sampling began in January 2003 and will continue in 2004. A final report will be completed in 2005.

BACKGROUND

A preliminary review of a small portion of Green-Duwamish water quality data collected during storm events in 2001 and 2002 generally shows that loadings and concentrations of Fecal Coliform, *E. coli* and *Enterococcus* increase and decrease with storm flows. This result suggests that bacterial concentrations and loadings are related to precipitation and flows. However, since no clear quantitative relationship between flow-related variables and bacterial concentrations has been established to date other unidentified factors may also be associated with variation in bacterial concentrations in the Green River watershed. Microbial Source-Tracking (MST) is being used to investigate the relationship between bacterial sources and land use in the Green River and tributaries.

Land use may be one of the primary factors determining the specific types and sources of bacterial loadings. Land use and cover types may be useful as a surrogate to predict these sources. Sources that may be related to land use include agricultural animals (pasture and agricultural land), septic systems (rural residential), pets (suburban areas) and wildlife/birds (forested and rural areas). In order to elucidate these potential relationships, it was found necessary to identify the sources of bacteria in the Green River and its tributaries and correlate them to land uses. Creeks used in the study include Newaukum, Springbrook and Soos (also see Table 2).

STUDY FOCUS AND BENEFITS

The present microbial source tracking study will collect information on bacterial sources and land uses associated with bacterial populations. This will provide baseline information that may be used to focus future studies to address the human health and ecological implications. Further, MST can be used to assist in setting, and evaluating progress in achieving, TMDLs (Total mass Daily Loads) for fecal coliforms in the mainstem reaches and streams that are on the 303(d) list (see pages 14-16).

SCHEDULE

The final report will be issued in mid-2005

KING COUNTY STAFF

- Doug Henderson
- Greg Ma
- Fritz Grothkopp
- Lorin Reinelt
- John Brooker

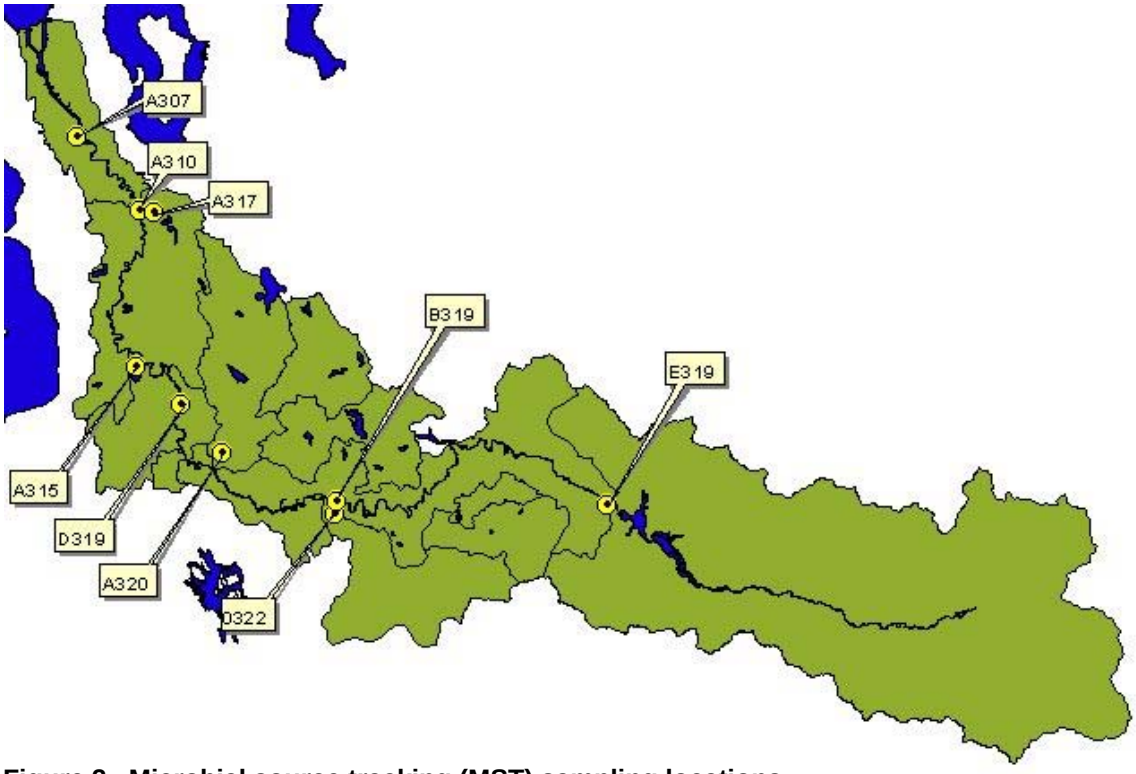

Figure 2. Microbial source tracking (MST) sampling locations.

Table 2. Microbial source tracking (MST) sampling locations.

Locator	Description
A307	Hamm Creek-Lower Duwamish
A310	Mainstem Lower Green River
A317	Mouth Springbrook Creek
A315	Mouth Mill Creek
D319	Middle Mainstem Green River just below Olson Creek confluence
A320	Mouth of Soos Creek
B319	Middle Mainstem Green River near 277th street Bridge
0322	Mouth of Newaukum Creek
E319	Below Howard Hanson Dam (Tacoma Diversion Dam)

10. ECOLOGICAL AND HUMAN HEALTH RISK ASSESSMENT

The Ecological and Human Health Risk Assessment is being conducted to help focus future monitoring efforts, prioritize monitoring locations and water quality parameters, fill data gaps, for possible future actions. Future actions are activities, programs, and methods required to mitigate ecological and human health impacts due to:

1. Pollution or
2. Lack of appropriate controls (e.g., laws and regulations, man-made solutions) to effectively provide environmental balance.

In summary, the risk assessment evaluates the potential for water quality parameters to affect the health of aquatic organisms, birds, mammals, and people.

Four (4) risk assessments will be completed based on field data and modeled data for two watersheds. The work has been divided into three phases: (1) problem formulation, (2) analysis–a screening level risk assessment (SLRA), and (3) risk characterization or detailed level risk assessment. Two assessments each for the greater Lake Washington watershed and the Green-Duwamish watershed.

1. For the problem formulation phase, the assessment purpose is articulated, the problem is defined, and a plan for analyzing and characterizing risk is determined (U.S. EPA 1998). Initial work for developing the problem formulation included integrating available information on sources, stressors, effects, and ecosystem and receptor characteristics. An outline of the problem formulation for both the ecological and human health risk assessments was completed in 2001.
2. The purpose of the Screening Level Risk Assessment (SLRA) is to identify stressors (i.e., chemicals or physical properties that may potentially impact aquatic life, wildlife, or human health). This will be done using a deterministic approach. This work should be completed first quarter 2005.
3. The Detailed Risk Assessment will use the stressors identified as part of the SLRA to evaluate the magnitude of the potential impacts to aquatic life, wildlife, and human health. The Assessment will include a spatial component to identify the specific areas of a watershed requiring mitigating actions. The Detailed Risk assessments will be completed fourth quarter 2005.

RISK MODEL

The scope of work for developing the risk assessment model calls for developing the preprocessing mechanism (e.g., spatial and temporal aggregations) and developing a SQL Server based application to calculate and store risk estimates. Potential impact determinations will be made using both the measured data and the concentration estimates from the model simulations.

PRODUCT SCHEDULE

Ecological Screening Level Risk Assessment ..... 1st Quarter 2005

Human Health Screening Level Risk Assessment ..... 1st Quarter 2005

Two Detailed Ecological Risk Assessment .....4th Quarter 2005 – final

Two Detailed Human Health Risk Assessment .....4th Quarter 2005 – final

(Note: The assessments maybe completed sooner for the greater Lake Washington watershed.)

CONSULTANT ASSISTANCE

Parametrix, Inc. was retained in May of 2001 to conduct both a screening level and detailed ecological and human health risk assessment within the study area including data management support, supplemental report writing, and public meeting coordination when required.

- Contract (total) budget $1,233,142.
- Contract Schedule 2001 through 2005.
- Expenditure To-Date $455,627.
- 2004 budget (est.) $225,000
- 2005 budget (est.) $425,000

STAFF AND TEAM MEMBERS

- Deborah Lester
- Doug Henderson
- Jenée Colton
- Dean Wilson
- Richard Jack

11. SMALL STREAMS TOXICITY AND PESTICIDE STUDY

The Small Streams Toxicity/Pesticide Study is a five-year study (1999–2003) intended to assess the possible biological implications associated with the presence of pesticides in selected small streams in King County. This study was begun after recent studies detected the presence of pesticides in storm runoff and surface waters in King County and elsewhere. While pesticides have been a concern in the surface waters draining agricultural areas, these studies have shown that small urban and suburban streams can contain high concentrations of a wide variety of pesticides during storm runoff periods. This has led to the hypothesis that chemicals applied to lawns and landscapes are consistently making their way into the aquatic environment through non-point runoff. Many of the pesticides present in these urban or suburban streams do not have water quality standards or guidelines.

STATUS

There are two products due in 2004: the USGS Toxicity Report for the greater Lake Washington watershed and the King County Small Streams Toxicity and Pesticide Study 1999–2003. The USGS report will consist of the chemical analysis and results of Pesticides monitoring and it will be forwarded to the Science Section. King County Science will then compare these report findings to toxicity monitoring conducted by King County's Environmental Laboratories. Data will primarily be used to determine the prevalence of toxicity at stream sites. A secondary use of the data will be to compare toxicity detection with the presence of chemical pollutants and gain further insight as to the possible cause(s) of detected toxicity. Specifically, the Science Section will compare the results to Water Quality standards and effects Thresholds and develop the 1999–2003 final report.

BACKGROUND

The United States Geological Survey (USGS) and the Washington Department of Ecology (Ecology) have been studying the ambient distribution of pesticides in the Puget Sound Region for much of this decade under the National Water Quality Assessment Program (NAWQA). Much of this work has involved storm sampling, in effect monitoring current trends in non-point source pollution focusing on small suburban streams. The highest number of pesticide detections has occurred in the urban/suburban setting, particularly in watersheds with a high percentage of residential land use. This has led to the conclusion that chemicals from lawns and landscapes are consistently making their way into non-point run off.

In the spring of 1998 King County collaborated with the USGS and Ecology to test for toxicity in Lyon Creek, a small stream located in Lake Forest Park. This testing was conducted alongside the USGS/Ecology pesticides testing. Acute toxicity was detected for both the algae Selenastrum and the water flea Daphnia in this sample. These detections violated State Water Quality Standards and were suspected to be linked to pesticides present in the sample.

In 1999, Sampling and Testing was conducted which consisted of four sampling events during four seasons: spring, summer, fall, and late fall. All but summer sampling were storm events. All samples were analyzed for toxicity, pesticides, total suspended solids, and metals. In addition, selected sites were tested for Base/Neutral/Acid (BNA) compounds, a standard list of organic pollutants.

It was noted that lawn care products sales peaks in the spring, with a secondary peak in the fall. The timing of the sampling events were selected with this in mind. Three test sites were selected for spring

and two test sites for summer, fall, and winter. A reference site was included for each sampling event/season.

Sites are selected based on previous pesticide data. Site selection was intentionally biased towards the most contaminated (pesticides) sites, to increase the probability of detecting toxicity and other pollutants that could be present. Also, one site with previously low detected pesticides was selected as a point of comparison and a reference site was also be sampled.

The Small Streams Toxicity/Pesticide Study included analysis of: about 150 different pesticides, dissolved and total metals, and other contaminants; toxicity using up to three different test species (*Ceriodaphnia dubia*, *Lemna minor*, and *Selenastrum capricornutum*); dissolved and total organic carbon and total suspended solids. Samples were collected during spring storms, summer baseflows, and fall storms. Sampling was conducted during five years: 1999, 2000, 2001, 2002 and 2003.

In 1999, samples were collected from Lyon, Juanita, Lewis, and Rock Creeks. In 2000, Lyon, Swamp, and Little Bear creeks, were sampled. Additionally, a small tributary draining into the Sammamish River near 124th street in the Sammamish Valley was tested one time during summer baseflow conditions. In 2001, Big Bear and Issaquah Creeks were sampled. And in 2002 North, Little Bear, and the 124th street Creeks were sampled. In 2003, Kelsey, may, and Taylor Creeks were sampled. Rock Creek was tested for pesticides in 1999 and then it was used as the reference stream for toxicity testing during each year of the study. Additionally, a set of effects threshold levels were identified for all contaminants detected during this study that do not have water quality standards.

CONSULTING PARTNERS

- United States Geological Survey (USGS)
- Agreement Cost total through 2003 – $128,873.
- 2004 budget -- $30,403.

1999	5,910
2000	33,060
2001	34,000
2002	37,500
2003	18,403

- Washington State Department of Ecology
- Work completed in 2003
- Agreement Costs total through $38,709

1999	
2000	8,096
2001	20,464
2002	4,776
2003	5,373

KING COUNTY STAFF

- Dean Wilson
- Doug Henderson
- Deborah Lester
- Jim Buckley

12. TMDL: TOTAL MAXIMUM DAILY LOAD

INTRODUCTION

Total Maximum Daily Loads (TMDLs) or "Water Cleanup Plans" is a water quality planning and implementation tool required under Section 303(d) of the Clean Water Act. Through the use of a scientifically-based process, these plans specify the amount of a pollutant that can be discharged to a water body to meet water quality standards and protect beneficial uses. TMDLs address all pollutant sources in a watershed, including both point and nonpoint sources. A TMDL project will typically address multiple parameters or 303d listed segments within a single watershed.

The County itself is not authorized to "develop or set" TMDLs – only Washington State Department of Ecology (WSDOE) can establish TMDLs for listed water bodies. A baseline objective for the TMDL work in King County is collecting the best data possible in order to have the clearest picture of water quality problems and potential sources that should be addressed through management actions. This information can then be turned over to WSDOE for them to use in developing a TMDL, and be made available to other jurisdictions.

The foundation for participating in TMDL activities is already being built through our existing monitoring and modeling work in WRIAs 8 and 9. All of the parameters that exceed water quality standards and are listed on the 1998 303d list (or the proposed 2002/4 list) in WRIA 8 and 9 waterbodies, currently being monitored and modeled as part of the Freshwater program and the ambient monitoring program.

TOTAL MASS DAILY LOADS CLEAN WATER ACT (BASIS, ROLE, AND RESPONSIBILITY OF METROPOLITAN KING COUNTY FOR SCIENCE UNIT)

The National Academy of Science (NAS) noted that the need to make designated use or criteria decisions on a waterbody or a watershed-specific basis requires an appropriate water quality standard must be defined before a TMDL is developed. Also, the TMDL must be defined within the framework of the Clean Water Act (CWA).

The above condition is termed "Use Attainability Analysis (UAA)." A Use Attainability Analyses result in "best available science" (BAS) being applied to the TMDL process using existing waterbody and watershed-specific data to define appropriate water quality standards. In addition, they can address community values using existing information and the flexibility in the Clean Water Act. The resulting standards can then be adjusted over time through adaptive management, if necessary.

A Use Attainability Analysis (UAA) determines if impairment is caused by natural contaminants, non-removable physical conditions, legacy pollutants, or natural conditions. Further, and perhaps more importantly, a UAA allows for the participation of watershed stakeholders and for the appropriate use designation to reflect a social consensus, as noted in the report: Appropriate use designation for a state's waterbodies is a policy decision that can be informed by technical analysis. However, a final selection will reflect a social consensus made in consideration of the current condition of the watershed, its predisturbance condition, the advantages derived from a certain designated use, and the costs of achieving the designated use. The NAS report cites a common situation encountered by municipal members to highlight the fact that appropriate use designations will "unavoidably" need to reflect a social consensus:

> *"In many areas of the United States, human activities have radically altered the landscape and aquatic ecosystems, such that an appropriate designated use may not necessarily be the aquatic life condition that was present in a watershed's predisturbance condition, which may be unattainable. For example, a reproducing trout fishery in downtown Washington, D.C., may be desired, but may not be attainable because of the development history of the area or the altered hydrologic regime of the waterbody."*

Thus, requiring a UAA can legitimize the TMDL Program by identifying a true and specific description of a desired endpoint for a waterbody, and avoiding the inefficient and ineffective pursuit of unattainable goals.

PROGRAM STATUS

In 2000, The Freshwater Program began collecting low level metals and organics data in both the lake sediments and water column. These data were not available in the past. Some of these newly sampled parameters might exceed standards, which could potentially result in additional listings. No freshwater sediment standards are yet in place, although King County is working directly with WDOE on this as part of Freshwater major lakes program.

King County is working with WDOE in exploring two different TMDL management approaches in implementing the TMDL process. In WRIA 8, a reach by reach methodology of applying TMDLs and developing management actions will be used. In WRIA 9, a basin-wide TMDL is proposed that would address multiple parameters, and consider solutions such as "pollutant trading" as part of management actions. The data collection and analysis of parameters is similar for both approaches. The evaluation of TMDL management methodologies for efficiencies and effectiveness in implementing TMDLs is the difference between the two WRIA approaches.

The Freshwater Program will have sufficient data on most of the parameters and modeling on the 303d listed waterbodies in WRIAs 8 and 9 to provide sufficient data for WDOE to develop TMDLs in those waterbodies. It is expected that some additional data will be available from other jurisdictions.

KING COUNTY FRESHWATER STAFF COORDINATORS

- Lorin Reinelt
- Jon Frodge

13. UW LAKE MODELS

INTRODUCTION

The Freshwater Program is funding two models currently under development at the University of Washington; the Mid- Trophic Model and the Upper-Trophic level models. Dr. Michael Brett of the School of Civil and Environmental Engineering is coordinating the mid-trophic level model. Dr. David Beauchamp of the School of Aquatic and Fisheries Science is coordinating the upper trophic level model.

Mid- Trophic Level Model – The objective of this model is to develop a mechanistic model of nutrient phyto-zooplankton dynamics in Lakes Washington, Sammamish, and Union. This phytoplankton model is important when predicting how future modifications of nutrient, phytoplankton, and zooplankton concentrations and/or their exchange rates will affect water quality.

Upper-Trophic Level Models – The objective of this model is to evaluate how changes in lake transparency might alter predation losses or growth of juvenile chinook, kokanee, sockeye, and alternatively, evaluate how changes in upper trophic levels may affect lake transparency. This model will help water quality planners examine potential consequences of different water withdrawal and/or wastewater management options for Lakes Washington and Sammamish.

At some point in the future an effort will be made to incorporate the mid-trophic and the upper trophic models; after that, integrating these models into the receiving water model for lakes Washington and Sammamish. Once these models are fully folded into the integrated system they can be used to investigate current water quality conditions and model future management scenarios.

MID-TROPHIC WORK ELEMENTS AND DELIVERABLES

Modeling phytoplankton dynamics in Lakes Washington, Sammamish, and Union includes the developing of numerical models of phytoplankton dynamics and their dependence on nutrient loading and lakes seasonal cycles. A eutrophication model for Lake Washington consisting of seventeen state variables and two spatial compartments (epilimnion and hypolimnion) is also being constructed and calibrated. This model is going to be integrated with the hydrodynamic and fish.

Work is underway investigating the relationship between temperature and dissolved oxygen concentrations on the seasonal distribution of native salmonids and their prey in Lake Sammamish. This work utilizes the RUSS buoy data, in combination with intensive fisheries and split-beam hydroacoustic survey data collected in 2002 and 2003. This work is to be completed in second quarter of 2004.

Analyzing the hydrodynamics and biological processes in Lake Washington is to be completed in 2004. While this research program includes other lake systems (Sammamish and Union), the focus is on Lake Washington. Based on intense field measurements together with the simulation models, basic and comprehensive behaviors of the lake-dynamics and biological processes are being identified, which include the Lake's seasonal response, as well as short-term extreme events such as strong and/or heavy runoff.

UPPER-TROPHIC WORK ELEMENTS AND DELIVERABLES

Modeling food web dynamics of Lake Washington and Lake Sammamish has an anticipated completion date in 2004. A first-cut estimate of seasonal and annual consumption rates have been quantified for the major predatory and benthic invertebrate feeding fishes (N. pike, minnow, cutthroat trout, yellow perch,

peamouth, prickly sculpin), based on existing data. These consumption estimates are scaled to individuals, and also reported as annual consumption from a size-structured population of 1,000 fish from each species to provide some standard "unit predation demand index."

Based on this information and literature information on yellow perch growth and diet in Lake Washington, and general bioaccumulation rates in yellow perch, an initial model for bio-accumulation in yellow perch has been conceptualized. A bio-energetics model for prickly sculpin has been parameterized and applied to the Lake Washington population based on historic data. Work is under way exploring the ability to apply this model to contemporary data collected through the 1990s as part of the Lake Washington Ecosystem studies for sockeye enhancement and now chinook conservation. Evaluating contaminant bioaccumulation by fishes and other organisms representing different trophic levels in the Lake Washington food web will assist in identifying environmental risks and mitigating actions required to maintain a health water resource.

UW STAFF AND STUDENTS

- Dr. Michael Brett
- Dr. David Beauchamp
- Dr. Yeh
- Michael Mazur
- Jennifer McIntyre

KING COUNTY STAFF

- Jon Frodge
- Kevin Schock
- Curtis DeGasperi
- Hans Berge

BUDGET

- Total Lifetime
  - Mid-Trophic $139,131 thru 2004
  - Upper Trophic $391,934 thru 2004

SCHEDULE

2000 through 2004

14. GREEN/DUWAMISH RIVER SYSTEM WATER QUALITY MONITORING PROGRAM

PROGRAM SCOPE

A comprehensive water quality-monitoring program has been completed. The program began in 2001 and water quality data was collected each year through 2003. The project focus is on

- Water quality and quantity and land cover variability – measuring in-stream water quality parameter concentrations resulting from different land use/land cover types within the stream drainage area e.g., agriculture areas, industrial areas, residential areas, and forest;
- Measuring in-stream water quality parameter concentrations as a function of the rise, peak, and fall of the corresponding stream hydrograph to determine peak concentrations and variability within a storm;
- Measuring in-stream water quality parameter concentrations in different geographic areas of the watershed throughout the year, including mouths of major tributaries and boundary conditions of the Green River mainstem;
- Measuring in-stream water quality parameter concentrations during both storm and baseflow conditions; and,
- Collecting sufficient data to allow development and calibration of a water quality model for the Green River watershed.

Water quality parameters were grouped into six general categories: microbiology, conventionals, nutrients, metals, organics, and in-stream measurements. Specifics for each category are listed below:

- Microbiology – Fecal coliform, enterococcus, and E. coli.
- Conventionals – Alkalinity, biochemical oxygen demand, total suspended solids, turbidity and total and dissolved organic carbon.
- Nutrients – Ammonia, total nitrogen, nitrate/nitrite nitrogen, orthophosphorus, and total phosphorus.
- Metals – Total and dissolved aluminum, arsenic, cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, and zinc; and total hardness.
- In-stream parameters – Temperature, pH, dissolved oxygen, and specific conductance.

WATER QUALITY RECONNAISSANCE SAMPLING/STORM SAMPLING PROJECT

A reconnaissance storm water-monitoring program has been completed. The program began in 2001 and storm water quality data was collected each year between October and May through 2003. The project focus is on storm water quality and quantity and land cover variability. Specifically, under storm conditions what is the quality and quantity storm-water runoff into receiving waters from different land cover and land uses e.g., agriculture areas, industrial areas, residential areas, and forest. This program required more intensive sampling during storms to examine storm variability and monitoring of smaller catchments where one or several landuse / landcover types could be isolated. Discrete sampling was conducted during storms at 4-5 sites at regular intervals (e.g., 2–4 hours) for determining peak storm concentrations and storm loadings for a given catchment.

This program required more intensive sampling during storms to examine storm variability and monitoring of smaller catchments where one or several landuse/landcover types could be isolated. Discrete sampling was conducted during storms at 4–5 sites at regular intervals (e.g., 4 hours) for determining peak storm concentrations and storm loadings for a given catchments

PARAMETERS

Water quality parameters for this project can be grouped into the following categories: Microbiology, conventionals, nutrients, metals, in-stream measurements, and organics.

- Microbiology – Fecal coliform, enterococcus, and E. coli.
- Conventionals – Alkalinity, biochemical oxygen demand, total suspended solids, turbidity, and total and dissolved organic carbon.
- Nutrients – Ammonia, total nitrogen, nitrate/nitrite nitrogen, orthophosphorus, and total phosphorus.
- Metals – Total and dissolved aluminum, arsenic, cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, and zinc; and total hardness.
- In-stream parameters – Temperature, pH, dissolved oxygen, and specific conductance.

The priority pollutant organics that were collected included: base/neutral/acid organic compounds, Chlorinated Pesticides/PCBs, Organochlorine Herbicides, and Organophosphorus Pesticides.

TEMPERATURE AND DISSOLVED OXYGEN STUDIES

Expanded monitoring for stream Temperature and Dissolved Oxygen was completed in 2003. An expanded program was undertaken to supplement the information collected in the freshwater ambient monitoring program. The expanded temperature and Dissolved Oxygen (DO) sampling program was implemented under the Green – Duwamish Water Quality Assessment. The program was designed to identify stream reaches where water temperature may be detrimental to fish, and where cool water inputs help maintain favorable habitat conditions. Both programs use continuously recording data loggers to characterize the daily fluctuations in temperature and Dissolved Oxygen.

Final reports describing methods, results and recommendations will be completed in the first quarter of 2004.

DELIVERABLES

- Data report is due 2nd Quarter 2004
- The final report is due 3rd Quarter 2004.
- Data report for 2003 is due 4th Quarter 2004

KING COUNTY STAFF

- John Brooker
- Jeff Burkey
- Colin Elliott
- Eric Ferguson
- David Funke
- Fritz Grothkopp
- Doug Henderson
- Lorin Reinelt
- Stephanie Hess

CONSULTANTS

- Taylor Associate, Inc.
- Budget total – $324,799
- Expended – $234,829
- 2004 (est.) – $ 90,000
- Herrera Environmental
- Budget total through 2006 $316,309 *
- 2004 budget $158,304
- University of Washington – Dissolved Oxygen (DO)
    - Costs $10,000

(*Note: includes work on Macroinvertebrates and other Activities.)