

A Partial Summary of 2008 USGS Activities Related to the FHWA and State Highway Agencies

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Introduction

Part of the mission of the U.S. Geological Survey (USGS) is to assess the quantity, quality, and trends of the Nation's water resources, to advance the understanding of natural processes related to these resources, and to provide information that will assist resource managers and policymakers in making sound decisions. The USGS has a long history of jointly funded investigations with the Federal Highway Administration (FHWA) and State highway agencies to provide data and information to address various issues related to water resources and the Nation's transportation infrastructure. These issues cover a wide spectrum and include items such as regional flow statistics, flood documentation, regional stream characteristics, bridge scour, and water-quality assessments.

The following table and text provides a partial summary of current or recently completed USGS activities related to highway issues. Table 1 organizes the current and recent activities into categories and subcategories and gives a quick overview of the USGS programs and the State and (or) Federal agencies that are helping sponsor the programs. The text following table 1 provides more detailed information on the various activities. The text initially describes activities that have been, or are being conducted on a national level and is followed by state activities listed alphabetically by State. If you should have questions regarding this information, please contact Charles Berenbrock (ceberenb@usgs.gov).

Table 1. Partial summary of USGS activities related to the FHWA and State Highway Agencies

Project Type	Sponsoring Agencies/States
Regional Flow Frequency/Statistics Investigations	
- National Flood Frequency Program	USGS
- StreamStats Program/automated basin characteristics	AZ, CA, CT, CO, DE, HI, IL, ID, IN, KS, KY, MA, MD, MN, MS, NC, NH, NJ, NM, NY, OH, OK, OR, PA, RI, SD, TN, UT, VT, WA, WI
- Investigation of rural flow-frequency	AL, CA, CO, FL, GA, HI, IA, KS, MA, MS, NC, NH, NM, NY, OK, OR, PA, SC, SD, TN, UT, VA, WI, WV
- Investigation of urban flow-frequency	AL, KS
- Investigation of small watershed flow-frequency	IA, KS, ME, TX, VA
- Investigation of hydrograph timing, rainfall hyetographs, and rainfall-duration-frequency maps	TX
Bridge Scour and Sediment Transport	
- National Bridge Scour Project	
- Scour at Contracted Bridge Sites	NCHRP
- Near real time scour monitoring	AK, GA, NJ
- Data collection and analysis	AK, AL, ME, MS, MT, NJ, SC, FHWA
- Investigation of Scour in cohesive soils using the EFA	IL, SC
- Channel stability and scour assessment	AK, MO, MT, NJ, SD
- Investigation/modeling of sediment transport	TN, TX
- Investigation of bio-engineered bank protection and A-jacks scour countermeasures	OR
Hydrologic and Hydraulic River Investigations	
- Investigation of bridge site hydrology and hydraulics	AL, GA, MN, MS, MO
- Investigation and modeling of multi-dimensional flows	AK, ND, PA
- Flood documentation	IA, ID, NM, NV, NY, PA, TN
Stream Characteristic Investigations	
- Regional channel characteristics/bankfull discharge	PA, VA, WV
- Investigation of Manning's roughness coefficients	
Gages	
- Tidal gages	
- Crest stage gages to estimate annual peak flows	AK, GA, HI, IA, KS, LA, ME, MI, MN, MS, MO, MT, NV, NJ, NM, NY, ND, OH, PA, SC, SD, TN, VT, VA, WI, WV
- Continuous-record discharge and stage gages	AK, FL, HI, IN, IA, IN, LA, ME, MD, MI, MN, MS, MO, MT, NH, ND, NJ, PA, SC, TN, VT, WV
- Real time monitoring network on hurricane evacuation routes; monitors stage, rain, wind, and traffic count	LA
Water Quality/Environmental Investigations	
- Evaluation of Stormwater Runoff Models	FHWA, MA
- Monitor water quality/quantity at selected sites	HI, MA, ME, MN, MT, NC, NV, SC, TN, VT, WI
- Investigation of wetland impact/remediation	MT, PA
- Investigation of stream restoration	PA
- Investigation of the impact of deicing chemicals	VT
- Investigation of habit impact by bridge pier	PA
- Investigation of BMP	SC, WI
- Investigation of potential impacts of highway construction to the GW aquifer	AR

Partial Summary of USGS National Activities

Scour at Contracted Bridge Sites (NCHRP and University of Louisville)

The objective of NCHRP Project 24-14 was to collect field data from which processes affecting scour magnitude in contracted bridge openings could be identified, to support verification of physical and numerical model studies, and to improve guidelines for applying scour-prediction methods at contracted bridge sites. Detailed data were collected at 15 bridge sites and predicted scour based on one- and two-dimensional flow models were compared to measured scour. Results of this investigation are documented in report cited below and will be posted as an NCHRP web document in January 2006:

Wagner, C.R., Mueller, D.S., Parola, A. C., Hagerty, D. J., and S.T. Benedict, 2006, NCHRP Project 24-14 Scour at Contracted Bridges: Transportation Research Board, National Research Council, Washington D.C. [p. 288]. On-line at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w83.pdf

National Streamflow Information Program (NSIP)

NSIP—a USGS network effort to identify and fund only with Federal dollars those long-term streamgages that address Federal interests and to upgrade streamgaging technology—faired well in the 2008 budget. Congress increased NSIP appropriations by \$3.5M, or about 21%. The increase will be used to expand the network, speed implementation of StreamStats, and help pilot a hazards warning system for flood and debris flows and maintain a mobile storm-surge network for the Gulf Coast. The NSIP program description and list of proposed NSIP streamgages is on-line at <http://water.usgs.gov/nsip/>. A general information product on the mission and goals of NSIP is on-line at <http://pubs.usgs.gov/gip/70/>. It also includes internet links to streamflow data and information.

The National Water-Quality Monitoring Network

Another network effort is now taking form in response to recommendations of the Presidents Commission on Ocean Policy and the President's Ocean Action Plan. This is a coordinated effort led by the National Ocean and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA), and the USGS working through the National Water Quality Monitoring Council (NWQMC) to develop an integrated system of long-term streamgages, water-quality and ecological monitoring sites with standardized monitoring techniques, parameters, and data-dissemination portals. The network will link elements of Federal, State, and local monitoring networks to reduce duplication and strengthen coverage. The network design will focus on water and ecological issues affecting coastal waters and ocean environments. Pilot projects are anticipated in FY2008. The NWQMC report describing the network is available at <http://acwi.gov/monitoring/network/index.html>.

Flood-Frequency Analysis Using Bulletin 17B Guidelines

Flood-frequency analysis provides information about the magnitude and frequency of selected flood discharges. Bulletin 17B of the Hydrology Subcommittee of the Interagency Advisory Committee on Water Data (1982) defines procedures recommended to provide a consistent approach for determining flood-flow frequency from peak-flow records. The procedures include methods for improving skew estimates using regional skew information, tests for high and low outliers, adjustments for low outliers and zero flows, and methods for incorporating historic peak-flow information. The Peak flow Frequency analysis program (PeakFQ) implements the Bulletin 17B recommended procedures for flood-frequency analysis of streamflow records. The program has been updated and now provides an interactive Windows interface to PeakFQ. Also the program can be run from a batch-style processing on DOS, UNIX and Linux operating systems. The PeakFQ program is available at <http://water.usgs.gov/software/peakfq.html> and documentation is available at <http://pubs.usgs.gov/tm/2006/tm4b4/>. PeakFQ is being currently modified to include the Expected Moments Algorithm (EMA). EMA is a highly efficient approach for capturing the information contained in historical flood data, particularly paleoflood data. EMA provides a way to incorporate historical information, paleoflood

information, truncated data sets, censored data, low and (or) high outliers, and zero flows into flood-frequency analysis.

National Streamflow Statistics

The National Streamflow Statistics (NSS) Program is a Microsoft Windows-based computer program¹ written in Visual Basic programming language that has been created by the USGS to provide an easily accessible graphical user interface (GUI) to estimate high and low streamflow statistics for ungaged sites across the United States. NSS is a replacement for the National Flood Frequency (NFF) Program. The name change from NFF to NSS is the direct result of enhancements to the program, which now provides estimates for low-flow duration/frequency in addition to flood-frequency estimates such as the 100-year flood.

The NSS program has four components—a GUI, an equation calculation routine, a database, and a help feature. The GUI allows users to control the operation of the software and present results. The equation calculation routine computes streamflow statistics using basin and climatic characteristics entered by the user and provides tabling and graphing capabilities that graph frequency and hydrographs. The database contains all the information needed, such as the regression coefficients and standard errors, to solve more than 3,000 regression equations. The help facility contains the NSS Program User's manual, a link to the NSS program Web page, and version information.

Regression equations for estimating flood-frequency statistics of peak flows for rural and naturally flowing rivers are available for all 50 U.S. States including the Commonwealth of Puerto Rico and the island of Tutuila, American Samoa. Regression equations for estimating flood-frequency statistics of peak flows for urban streams are available in NSS for 20 U.S. States. Regression equations for estimating low-flow duration and (or) frequency are also currently available in NSS for 23 U.S. States. All equations contained in NSS were reviewed by USGS and were generally prepared in cooperation with state and local transportation, environmental, and/or water resource management agencies in each state.

The NSS program and documentation can be downloaded from the Internet at <http://water.usgs.gov/software/nss.html>. A fact sheet that describes the NSS program was published in 2007 and can be downloaded at <http://pubs.usgs.gov/fs/2007/3010/>. If you should have questions regarding this information, please contact Dr. Robert Holmes (bholmes@usgs.gov)

StreamStats Program

StreamStats (<http://streamstats.usgs.gov>) is a Geographic Information Systems-based Web application that was developed by the U.S. Geological Survey (USGS) Office of Surface Water (OSW) that greatly reduces the time needed for users to obtain streamflow statistics, basin characteristics, and other information for USGS data-collection stations and for ungaged sites. This information is needed for use by engineers, land and water-resource managers, biologists, and many others to help guide decisions in their everyday work. Users can select data-collection station locations shown on a map interface in a Web browser window to obtain previously published information for the stations. Users can also select any location along a stream to obtain the drainage-basin boundary, basin and climatic characteristics, and estimated streamflow statistics for that location. The estimates for ungaged sites are determined from USGS regional regression equations and usually can be obtained in only a few minutes.

As of October, 2008, StreamStats was available to the public in 15 states, Washington, Oregon, Idaho, Utah, Colorado, Tennessee, Indiana, Illinois, Ohio, Pennsylvania, Maryland, Delaware, Connecticut, Massachusetts, and Vermont. The application also was implemented and undergoing quality assurance in preparation for public release in California, New Jersey, North Carolina (a pilot area), and Kentucky. Plans for fiscal year 2009 include implementing New York, New Jersey, Minnesota, North Carolina, Rhode Island, Hawaii, Mississippi, South Dakota, New Hampshire, Wisconsin, and Oklahoma.

StreamStats Version 2 was released on October 23, 2008, for Massachusetts and Utah, that provides several enhancements, including the abilities to (1) navigate the stream network to locate upstream or downstream streamgaging stations, dams, point discharges and other water-related features and get information about those features, (2) estimate flows at ungaged sites based on the flows at nearby streamgaging stations, (3) change the basin characteristics for an ungaged site and obtain new estimates of flow statistics that reflect the changed basin characteristics, and (4) access StreamStats functionality from other Web or desktop GIS applications remotely by use of Web services. Initially, these new abilities were working only for the Connecticut River Basin area in Massachusetts. All current state applications will be converted to Version 2 as quickly as possible and all new states will be implemented in Version 2.

Evaluation and Update of the Federal Highway Administration (FHWA) Pollutant Loadings Model for Highway Stormwater Runoff

Valid, current, and technically defensible stormwater runoff models are needed to (1) interpret data collected by field studies, (2) support existing highway and urban runoff planning processes, (3) meet National Pollutant Discharge Elimination System (NPDES) requirements, and (4) provide methods for calculation of Total Maximum Daily Loads (TMDLs) in a systematic and economic manner. The FHWA formulated a model to predict pollutant loadings and impacts from highway stormwater runoff in 1990. Unfortunately, the 1990 FHWA model has several limitations that affect the use of the model; defensibility and representativeness of model results, and documentation of model results. The 1990 FHWA model was written for the DOS operating system, and does not always work on more recent (Windows 2000/XP) operating systems. The model was based on data collected from the mid 1970's through the mid 1980's. Changes in materials used to build roads and vehicles, the advent of vehicular emission controls, and changes in the formulation of fuels and lubricants have substantially changed the composition of runoff in the last 20 years. Research also indicates that water-quality monitoring methods may substantially effect measurements of concentrations, flows, and the resultant calculation of runoff loads.

The 1990 FHWA model was framed as a dilution model with the assumption that background concentrations were zero. This approach was chosen to examine the effects of highway runoff on receiving waters and to highlight the potential effects of best management practices (BMPs) on receiving waters. Currently (2006), however, regulators and decision makers will not accept a model with a background concentration of zero, and regulators are focusing on concentrations at low-flows such as the 7Q10 or 4B3, which are included in state and federal water-quality standards. This study will evaluate the 1990 FHWA model and update the model using new information and data. More specifically, the study will implement a Monte Carlo model in a new software platform as a prototype for a new national model, update the existing model with more recent streamflow and water-quality information, and expand the model to address regulatory concerns. This model will provide a "best estimate" (mean or median) and confidence intervals for expected EMCs. The model also will utilize this EMC estimate and estimates of precipitation, and runoff coefficients to produce a population of estimates for loads based on the location and site characteristics of highway sites of interest.

Standard tools and techniques for obtaining and processing information and data about highway runoff quality and quantity and the quality and quantity of upstream flow in the receiving waters were needed to support this new national FHWA model. The USGS in cooperation with the FHWA has developed and tested a highway runoff database as well as computer applications that can be used to automatically download and process water-quality and streamflow data from the USGS National Water Information System (NWIS) Web. The following is a brief summary of each product and its current status:

- **Highway-Runoff Database (HRDB v. 1.0): A Data Warehouse and Preprocessor for the Stochastic Empirical Loading and Dilution Model.**

Status: In Second Stage of Technical Review

The highway-runoff database application was developed to serve as a data warehouse for highway-

runoff data-sets that can be used to facilitate estimation of statistical properties of runoff coefficients, runoff-quality statistics, and relations between water-quality variables in highway runoff. This highway runoff database currently includes over 39,000 event mean concentration values from analysis of more than 100 different water-quality constituents. These EMC values were collected at 100 highway-runoff monitoring sites in the conterminous United States during more than 2,600 storm events as documented in 6 highway-runoff quality data sets. The user may select and export water-quality data in tab-delimited or comma-delimited format. The user may generate water-quality statistics for data with censored values by use of the robust Regression on Order Statistics (ROS) method. The user may export paired water-quality data in a format suitable for regression analysis. Finally, the user may export precipitation, runoff flow, and runoff coefficient data in tab-delimited format. In each case the user may select data from different sites and different data sets based on highway-runoff monitoring site characteristics.

- **Kendall-Theil Robust Line (KTRLine--version 1.0)--A Visual Basic Program for Calculating and Graphing Robust-Nonparametric Estimates of Linear-Regression Coefficients Between Two Continuous-Variables.**

Status: Report Published

The Kendall-Theil robust line program was developed because this nonparametric method is resistant to the effects of outliers and nonnormality in residuals that commonly characterize water-quality data sets. A single-segment model or a multi-segment model may be specified. The program was developed to provide regression equations with an error component for stochastic data generation because nonparametric multi-segment regression tools are not available with the software that is commonly used to develop regression models. The report is available from <http://pubs.usgs.gov/tm/2006/tm4a7/>. Also a Visual Basic Program for calculating and graphing robust nonparametric estimates of linear-regression coefficients between two continuous variables is available from the report's Web site.

- **Methods for Compilation and Interpretation of Data for Development of Transport Curves for Planning-Level Estimates of Water-Quality at Unmonitored Sites in the Conterminous United States.**

Status: In Second Stage of Technical Review

This report documents methods for data compilation and analysis of water-quality-transport curves that meet data-quality-objectives for planning-level estimates of stream water-quality at unmonitored sites in the 84 U.S. EPA ecoregions in the conterminous U.S. Transport curves are regression relations used to estimate constituent concentrations from measured or estimated water discharge values. This national synthesis effort was based on data available on the USGS National Water Information System (NWIS) Web. A total of 24,581 surface-water-quality monitoring stations with drainage areas ranging from 0.002 to 1,040 square miles were identified throughout the conterminous U.S. and cataloged for retrieval of water-quality data. A total of 252 regional transport curves were developed for suspended sediment, total phosphorus, and total hardness. Four computer applications were developed to download, process, and build a database of about 1.2 million paired streamflow and water quality measurements for 14 water-quality constituents commonly measured in runoff studies. The user may utilize the regional regression models, or develop their own regional, local, or site-specific estimates with these data and methods.

- **Methods for Compilation and Interpretation of Data for Development of Transport Curves for Planning-Level Estimates of Streamflow at Unmonitored Sites in the Conterminous United States.**

Status: In Preparation

This report documents methods for data compilation and analysis of streamflow statistics that meet data-quality-objectives for planning-level estimates of streamflow at unmonitored sites in the 84 U.S. EPA ecoregions in the conterminous United States. This national synthesis effort was based on data available on the USGS National Water Information System (NWIS) Web. Streamflow statistics are available in a database for 2,783 USGS streamflow-gaging stations within the conterminous United States that were selected because they have at least 24 years of daily discharge records during the period 1961-2004 and drainage areas ranging from 10-500 square miles. The streamflow statistics were calculated using standard methods. Four computer applications were developed to download, process, and build a database of summary statistics for USGS streamflow-gaging stations that may be used to estimate a population of streamflows by ecoregion or by using selected gaging stations. The user may choose regional statistics, or develop their own regional, local, or site-specific estimates with these data and methods.

- **Stochastic Empirical Loading and Dilution Model (SELDM).**

Status: In Preparation

The stochastic empirical loading and dilution model (SELDM) is a Monte Carlo model that uses local or regional statistics to generate a population of concentrations and discharge volumes to simulate a large number of storm events. The resulting storm-event statistics can be used to estimate flows, concentrations, and loads of the constituents of concern. SELDM will provide information to assess potential effects of runoff on receiving waters. It will also provide statistical estimates of annual loads from highway runoff and resultant downstream concentrations and loads. The model will use statistical estimates of storm-event precipitation characteristics, upstream discharge, runoff-coefficient statistics by impervious fraction, upstream water quality, the quantity and quality of highway runoff, and modification of highway runoff quality and quantity by BMPs.

The SELDM application is being implemented as a database application with a graphical-user interface to facilitate generation of input-data sets from regional data (by ecoregion) or available local data based on the latitude and longitude of the site of interest. This approach also facilitates scenario testing and sensitivity analysis. The graphical-user interface is in the alpha test phase. The underlying numerical methods have been developed and tested the components are being integrated with the graphical-user interface to facilitate and documentation is in preparation.

The SELDM project has developed several reports which are (or will soon be) on the project web site. For more information please contact Gregory E. Granato (ggranato@usgs.gov) and visit the project web site (<http://ma.water.usgs.gov/fhwa/>).

These estimates will provide the information necessary to estimate the probability of exceeding a water-quality standard. The stochastic empirical loading and dilution model is designed as a database application that will facilitate generation of local or regional planning-level estimates based on site-specific characteristics.

- **National Synthesis on Potential Sources, Fate and Transport, and Potential Effects of Chloride in Surface- and Ground-Water Resources of the Conterminous United States** (<http://ma.water.usgs.gov/fhwa/Cl.htm>)

Status: Active.

The Chloride (Cl) ion is receiving increasing attention as population growth makes increasing demands on available water resources and anthropogenic activities increase solute loads in natural waters. Cl is a growing concern because anthropogenic inputs may increase Cl concentrations to the USEPA taste criterion for potable waters (250 mg/L) and to the USEPA suggested limits of 230 mg/L

for chronic aquatic life exposure and 860 mg/L for acute aquatic life exposure in surface waters. The Cl ion is ubiquitous in natural waters, has a wide variety of sources, readily moves through surface and ground waters, and is difficult to remove from runoff and water supplies. Cl concentrations in natural waters range from less than 1 mg/L in pristine water bodies without atmospheric or geologic Cl sources to about 275,000 mg/l in continental brines. This national synthesis is a cooperative effort between the USGS and Federal Highway Administration designed to provide the information necessary for watershed managers to assess all potential sources of Cl in a given watershed as part of a total water and solute budget. This will include information necessary to develop a localized water budget; to develop water-quality transport curves; to estimate natural, agricultural, and anthropogenic sources of Cl; to examine interrelationships among water-quality constituents and to use the National Water Information System Web to identify and interpret available ground-water, surface-water and water-quality data. This effort also will provide a summary of field methods including geophysical techniques and automated monitoring of runoff, streamflow, and ground water. For more information please contact Gregory E. Granato (ggranato@usgs.gov) and visit the project web page (<http://ma.water.usgs.gov/fhwa/Cl.htm>).

- **FHWA/USGS NDAMS web page** (<http://ma.water.usgs.gov/fhwa/>)

Status: On-line and active.

We have maintained the FHWA/USGS NDAMS web page (which receives about 130,000 visits per year) since 1996. In 2005 the Stochastic Empirical Loading and Dilution Model WEB page was developed. The Web page posts the 1990 FHWA model, documentation (which was scanned into PDF format), and data on-line.

Partial Summary of USGS Water Science Center Activities Supported by State Highway Agencies

Alabama

- Continuation of hydrologic and hydraulic analyses and data collection at various bridge sites.
- The Alabama depth frequency study is an update of the 1985 study. New depth regression equations are being developed based on the results of the recently completed state-wide flood frequency study (2007). The project is an 2008-2010 project with a report planned for Oct of 2010.
- The Alabama urban flood frequency study is an update of the 1982 study. New regression equations (for peak flow for 2–500 year recurrence intervals) are being developed for urban sites in Alabama. This is an 08–09 project. Report is planned for release in Oct. 2009.
- **Recent publications**
Hedgecock, T.S., 2004, Magnitude and frequency of floods on small rural streams in Alabama: U.S. Geological Survey Scientific Investigations Report 2004–5135, 10 p.
(<http://pubs.usgs.gov/sir/2004/5135>)
Clear-water Contraction Scour at Selected Bridge Sites in the Black Prairie Belt of the Coastal Plain in Alabama, 2006, by K.G. Lee and T.S. Hedgecock (<http://pubs.usgs.gov/sir/2007/5260/>). In this study we documented observed scour at the 25 sites having the worst (deepest) scour in the overbank portion of the bridge for this particular soil region. We developed envelop curves for clear-water contraction scour from this data and the hydraulic properties computed for the sites.

Alaska

A program with Alaska Department of Transportation and Public Facilities (ADOT&PF) that focuses on streambed scour monitoring and modeling had these accomplishments in 2008:

- Collected streambed scour data in response to flooding in August 2008. Scour website was successfully utilized to monitor stage and bed elevation during flooding at the Salcha River and to direct field personnel to areas of flooding. Channel bathymetry data were collected at or near flood peaks at two scour critical sites.
- Monitored near real time pier scour at 19 sites around Alaska with pier-mounted sonars.
- Surveyed channel crossings at 51 scour-critical bridges.
- Initiated a study of scour at 47 tidal bridges.
- **Recent Publications**
Conaway, J.S. and Brabets, T.P., 2008, Copper River Channel Migration and its Effects on the Copper River Highway, Alaska: in Proceedings of the 2008 World Environmental and Water Resources Congress, May 12-16, 2008, Honolulu, Hawaii, 13 p.
Conaway, J.S. and Knapp, M.W., 2008, Comparison of scour evaluations to streambed scour monitoring data at bridges in Alaska: in Proceedings of the 2008 National Hydraulic Engineering Conference, August 25-29, 2008, Portland, Maine, 1 p.
- Alaska streambed scour website: http://ak.water.usgs.gov/usgs_scour/
- Another study with ADOT&PF examines the geomorphology and river dynamics of the lower Copper River. In 2008, MD_SWMS was applied at two locations where the Copper River was impacting the Copper River Highway. At Bridge 339, a channel shift resulted in increased flow through the bridge, exceeding the design discharge. MD_SWMS is being used to assist ADOT&PF in examining possible betterments such as guide banks or extension of the bridge. At Mile 44, MD_SWMS is being used to assist ADOT&PF in assessing the feasibility of placing a dike near the highway to divert flow of the Copper River away from the Copper River Highway.

Arizona

- In planning stages of a multi-year project for upgrading a portion of the State's flood-frequency equations and implementing StreamStats.
- Development of new guidelines for estimating Manning's roughness coefficient, and vegetation maintenance plan guidelines for vegetated urban channels in Maricopa County. This project has been completed and a report published. Phillips, J.V. and Tadayon, Saeid, Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and

Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona: U.S. Geological Survey Scientific Investigations Report 2006-5108, 49 p. (November 2006)
(<http://pubs.usgs.gov/sir/2006/5108/>)

Arkansas

- A 3-year study that began in 2006 is underway in cooperation with Arkansas State Highway and Transportation Department (AHTD). The study is located at Springs National Park in central Arkansas. AHTD and the National Park Service have concerns that the blasting of the hills to make a road in the park might cause cracks deep within the earth that will affect the flow system of the Hot Springs.

California

- No highway related projects at this time.
- However, as part of the Multi-Hazards Demonstration Project for Southern California, the USGS is producing debris-flow hazard maps for areas burned by wildfire in October-November 2007. Rapid-deployment streamflow gages and precipitation gages also were installed in burned areas for hazard-mitigation purposes.
- Also a proposal has been recently presented to Cal Trans for a cooperative effort in developing state-wide flood-frequency regression equations and to implement StreamStats in California.

Colorado

- The USGS Colorado Water Science Center (CWSC), in cooperation with the Colorado Department of Transportation (CDOT) and Colorado Water Conservation Board, is implementing StreamStats in Colorado during fiscal years 2007-2009. Implementation is occurring in a phased schedule. The central mountain region of Colorado is currently available at <http://water.usgs.gov/osw/streamstats/colorado.html>, and the remainder of the state will be operational by 2009. The StreamStats datasets are being developed at the 1:24,000 scale using high resolution National Hydrography Dataset (NHD), 10 meter digital elevation data, and the Watershed Basin Dataset developed by the USEPA.
- The regionalized streamflow equations for Colorado are being re-computed in conjunction with the development of StreamStats. Initial work with StreamStats identified bias in how previous studies computed the predictor variables such as drainage area, channel slope, mean-basin elevation, and mean-annual precipitation. In addition, one to two decades of additional streamflow data has been collected since the previous peak-flow and low-flow regionalized streamflow equations were computed and an update was needed.

Connecticut

- No highway related projects at this time.

Delaware

- No highway related projects at this time.

District of Columbia

- No highway related projects at this time.

Florida

- Updating flood frequencies for all gages and developing regional flood-frequency relations for streams in Florida for the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-years. It has been more than 25 years since flood-frequency characteristics of streams were last evaluated and described. The length of the project is for 48 months.

Georgia

- Ongoing statewide flood and bridge-site studies at sites selected by GADOT. Open-File Reports publish as needed.
- The project to Update Rural Flood Frequency Equations for Georgia in conjunction with South Carolina and North Carolina for which the regionalization will be based on watershed boundaries

rather than political boundaries is ongoing and planned to be completed in FY2009. Contact Tony Gotvald (agotvald@usgs.gov) concerning this project.

- Maintain a statewide network of 50 crest-stage gages as part of an ongoing flood-frequency study.

Hawaii

- Operates a network of 37 crest-stage gages to monitor peak stages and discharges at or near highway crossings on the islands of Kauai, Molokai, Maui, and Hawaii. The peak-flow data collected at these stations adds significantly to peak-flow data collected at continuous stations and improves regional coverage of peak-flow measurements in Hawaii.
- Monitors storm-water quality and quantity from a portion of the H-3 freeway near Aiea, and receiving water bodies. Water-quality samples are collected quarterly, during storms, at 5 stations, and streamflow is continuously monitored with telemetry at 3 of these stations. Two of the stream stations are now collecting suspended-sediment samples for daily sediment records. Two telemetered raingages are also operated as part of this project.
- Monitors storm-water quality and quantity from a portion of the H-1 freeway near the University of Hawaii Manoa campus. A real-time storm-water monitoring station and raingage are now in operation.
- Updating flood-frequency estimating equations for ungaged streams in Hawaii. Results from this project will be incorporated into the Stream Stats package.

- **Recent Publications**

Young-Smith, S.T.M., and Jamison, M.T.J., 2007, Rainfall, streamflow, and water-quality data during stormwater monitoring, Halawa Stream drainage basin, Oahu, Hawaii, July 1, 2006 to June 30, 2007: U.S. Geological Survey Open-File Report 2007-1213, 30p.

(<http://pubs.usgs.gov/of/2007/1213/>)

Wolff, R. H., and Wong, M. F., 2008, Effects of the H-3 highway stormwater runoff on the water quality of Halawa Stream, Oahu, Hawaii, November 1998 to August 2004: U.S. Geological Survey Scientific Investigations Report 2008-5034, 78p.

(<http://pubs.usgs.gov/sir/2008/5034/>)

Presley, T. K., Jamison, M. T.J., and Young, S T.M., 2008, Rainfall, discharge, and water-quality data during stormwater monitoring, July 1, 2007, to June 30, 2008; Halawa Stream drainage basin and the H-1 storm drain, Oahu, Hawaii: U.S. Geological Survey Open-File Report 2008-1233, 56p. (<http://pubs.usgs.gov/of/2008/1233/>)

Idaho

- Provided the Idaho Transportation Department (ITD) an indirect estimate for peak flow and revised flood frequency statistics in support of a highway bridge hydraulics evaluation and HEC-RAS model for Lightning Creek, Idaho.
- Also provided ITD a technical review of the HEC-RAS model that was developed for Lightning Creek by their consultant.
- USGS flood frequency statistics (NSS) and the Streamstats programs are currently being used by ITD in the design of their Idaho Bridge Watch program (an early-warning bridge scour monitoring program based on the Q25 and Q50). The StreamStats website for Idaho is at <http://water.usgs.gov/osw/streamstats/idaho.html>.

Illinois

- Illinois StreamStats--The USGS Illinois Water Science Center (IWSC), in cooperation with Illinois Department of Transportation (IDOT), received funding through the Illinois Transportation Center to start the Illinois StreamStats project in FY2006. The Illinois Department of Natural Resources-Office of Water Resources is also a cooperating partner. The peak flood discharge results returned from the StreamStats website will be compared to the published values (Soong and others, 2004, Estimating Flood-Peak Discharge Magnitudes and Frequencies for Rural Streams in Illinois: U.S. Geological Survey Scientific Investigations Report 2004-5103, 147 p.), and corrections applied if necessary. IDOT has participated in testing at bridge sites. The StreamStats website is completed for Illinois (<http://water.usgs.gov/osw/streamstats/indiana.html>).

- Field Verification of SRICOS-EFA for Illinois Streams--The Scour Rate In Cohesive Soils-Erosion Function Apparatus (SRICOS-EFA) Methodology outlined in the National Cooperative Highway Research Program Report 24-15, provides a potentially useful methodology for assessing scour in cohesive sediments, but field validation data for the method are limited. The overall objective of this study is to test the SRICOS-EFA method for estimating scour depth of cohesive soils in Illinois streams. The project is in progress with sites selected, data collection and laboratory testing completed, and modeling underway.

Indiana

- INDOT cooperatively funds 22 continuous-record gaging stations.

Iowa

- Cooperatively funds 26 continuous-record gaging stations.
- Cooperatively funds 87 crest-stage gages.
- Cooperatively funds ongoing flood-profiles project to document water-surface profiles of significant flood events. The flood of June 2008 was very extensive across eastern and central Iowa which lead to a massive flood profile project to document floods at over 80 bridges in the Iowa River, Cedar River, and Upper Iowa River basins; the project duration is from July 2008 through May 2010.
- Iowa StreamStats—A 2006-2010 investigation to develop and evaluate flood-frequency discharge estimation methods for rural, ungaged streams in Iowa with drainage areas less than 50 square miles identified several needs that, if addressed, would provide an easier implementation of the regression equations for users. First, there is a need to develop the same hydrologic regions for both small- and large-basin regression equations. Secondly, there is a need to reduce the transition zone between small- and large-basin regression equations. And lastly, there is a need to provide a Web-based application that makes it easier for users to apply the various regression equations. The project has been extended to update flood frequency estimations using the new high-flow data from the June 2008 flood. The Project began in 2006.

Kansas

- The Kansas Water Science Center streamflow statistics project has provided improved estimates versus the ungaged regression equations for 5427 stream segments for flood frequency and various duration flows.
- The Kansas StreamStats is on the web at <http://ks.water.usgs.gov/Kansas/studies/strmstats/>.
- Cooperatively funds 34 crest-stage gages.
- The Kansas Water Science Center continues to verify theoretical stage-discharge ratings using direct measurement of flow at Flood Alert streamgages operated by Johnson County. Once the ratings for all stations are verified, peak-flow information can be used to develop flood-frequency equations for urban sites.
- Currently, there are few active streamgages (<30) in Kansas with drainage areas less than 32 mi² used to compute flood frequency. National Weather Service radar precipitation estimates from significant storms were used to locate peak runoff events on streams in Eastern Kansas. The peak discharge at these selected sites was measured by indirect methods. The relation between discharge per unit area (Q/DA) was related to the probability of the precipitation event, and other basin characteristics. These relations were tested to determine if flood frequency equations developed using gaged data from streams less than 32 and less than 5.4 mi² using the Q/DA relations were valid. The precipitation/flood frequency determinations at 28 sites were compared to the traditional flood frequency equations, flood-frequency equations using Q/DA, and the rational method equations. The newly developed Q/DA equations were superior to the other methods in this comparison. The full report can be found at <http://pubs.usgs.gov/sir/2008/5112/>.

Kentucky

- No highway related projects at this time.

Louisiana

- A cooperative program with the Louisiana Department of Transportation and Development (LA DOTD) to operate 10 continuous real-time streamflow data collection stations, 13 real-time stage stations, 17 non-recording crest-stage gages, and 7 non-recording flood-profile gages.
- Cooperative program with LA DOTD to operate 12 real-time monitoring network gages specifically located on major hurricane evacuation routes. These gages monitor water-levels, precipitation, and wind speed. The gage can eventually be used to transmit traffic volume and average speed data for LA DOTD. Wind speed information could be used to make informed decisions on bridge overpass closure, and water-level information would be used to make informed decisions on closing evacuation routes due to flooding. This network is expected to expand to 22 sites in the future.
- **Sustainable Yield of Selected Streams, Lakes, and Reservoirs in Louisiana**—Because of recent droughts, various government agencies, communities, and private groups are considering various streams, lakes, and reservoirs in Louisiana for alternate or emergency supplies of freshwater for municipal, industrial, or agricultural use. However, the amounts of available water required for local needs may be inadequate or unreliable from many of these sources, especially during drought conditions. In addition, excessive water withdrawals may result in adverse environmental, economic, or social impacts. The USGS in cooperation with the U.S. Department of Transportation is conducting a study to estimate the sustainable yield of selected streams, lakes, and reservoirs in Louisiana.
- **Watershed Response Monitoring on Bundicks Lake**—Bundick Lake was formed in 1961 when the dam was constructed on Bundick Creek. After construction, when the normal pool elevation was reached, private camps, piers, loading ramps, docks, and other structures were built along the perimeter of the Lake. The normal fluctuations in water level can interrupt the use of these features, and in some cases, result in damages to structures not designed to accommodate the changing water-levels. The users of these structures have generated interest in regulating the water level of the lake. Lake-side land owners are requesting that water levels in the lake be lowered prior to heavy rainfall events that increase lake levels. Monitoring of the Bundick Creek watershed is necessary to provide an estimate of potential increase in lake levels during rainfall events and trigger water releases to lower the lake level. This study is in cooperation with the U.S. Department of Transportation.

Maine

- **The Effect of road-salt on bedrock wells**—USGS and MaineDOT are studying possible long-term effects of road-salting practices on the quality of bedrock ground water. USGS is using geophysical data, water-quality analyses, and continuously recorded water level, water temperature, and specific conductance data from 4 wells to understand the roles of fractures on the persistence of chloride in bedrock. The project, scheduled for 2 years, started in September 2007. As of this update, data are being transmitted real time from four sites. Early data show that (1) specific conductance is highly correlated with chloride concentration; (2) a distinct transition zone between salty and fresh water exists, and this zone moves vertically with time but corresponds generally to the depth at which active fractures exist; (3) during many recharge events – even during the summer – specific conductance fluctuates in proportion to water-level rise, but not always; and (4) response time of specific conductance to changes in water levels varies by well.
- **Impact of peak-flow stationarity on bridge design**—The USGS is determining how peak flow estimates (such as the 50-year peak flow) vary when different periods are used for the computation of the peak flow estimates. As part of the project, maximum annual streamflow-trend magnitudes have been investigated for 28 regulated and unregulated streams in Maine that have at least 50 years of data. This 2-year project started in October, 2007.
- **Small-watershed data collection**—Peak-flow data collection (crest-stage gages) continues on 13 streams, all with basins less than one square mile. Nine sites have 8 complete years of data collection, three sites have 7 complete years of data collection, and three have less than 4 years of data. In addition, 7 new seasonal rain gages have been installed to prepare for a future time-of-concentration study. Five basins were selected for rain gages and two rain gages have been installed in each of two basins; one rain gage near the flow monitoring point and the other in the headwaters of the basin.

- **Continuous streamflow data collection**—Continuous data collection continues at 10 USGS streamflow gages. In addition, 9 new streamflow gages and one tide gage were installed during the last year.
- **Recent Publications**
 - Lombard, P.J., and Hodgkins, G.A., 2008, Comparison of observed and predicted abutment scour at selected bridges in Maine: U.S. Geological Survey Scientific Investigations Report 2008-5099, 23 p. <http://pubs.usgs.gov/sir/2008/5099/>

Maryland

- MDSHA provided about 50 percent funding for 13 streamgaging stations during fiscal year 2008.
- Streamstats was implemented for the Patapsco and Gunpowder watersheds in Maryland during FY-2007. (<http://water.usgs.gov/osw/streamstats/maryland.html>)

Massachusetts

- Continued to evaluate and update the Federal Highway Administration (FHWA) pollutant loadings model for highway stormwater runoff for the continuous US (cooperator— FHWA).
- Continued assessment of stormwater discharges for state highways in Massachusetts for use in the Federal Highway Administration (FHWA) pollutant loading model (cooperator— Massachusetts Highway Department). The purpose of the project is to document current concentrations of suspended sediment, particle size, selected dissolved ions, total nutrients, selected total-recoverable metals, and semivolatile compounds in highway runoff discharge from common highway-drainage conveyance structures in Massachusetts from eight highways during a 2.5-year period. This study will also evaluate the potential transferability of these data to other highway sites by relating constituent concentrations to average daily traffic volumes. These data will be used to populate the Federal Highway Administration highway-runoff database which serves as a preprocessor for the Federal Highway Administration pollutant loading model (currently being developed by the USGS under agreement with FHWA), which will be used for estimating highway-runoff concentrations and loads throughout Massachusetts. Highway-runoff data collected from 12 locations on 8 Massachusetts highways from 2005 through 2007 were analyzed. A report is planned for publication in 2010.
- Effectiveness of catch basin hoods for retaining floatable debris, oil and grease, and total petroleum hydrocarbons in highway catch-basin sumps (cooperator— Massachusetts Highway Department). Samples of floatable debris were collected during a 6-month period in 2008 from six catch-basin outfalls along Interstate 93, in Boston, Massachusetts. Water samples will be collected and analyzed for oil and grease, and total petroleum hydrocarbons during 2009. A report is planned for publication in 2010.
- Updating equations for estimating the magnitude and frequency of floods for streams in Massachusetts (cooperator— Massachusetts Highway Department). Project is pending final approval.

Michigan

- The Michigan Water Science Center operates 10 continuous record streamgages and 5 crest-stage gages for the Michigan Department of Transportation.

Minnesota

- Operating a network of 77 crest-stage gages and one continuous discharge gage for flood frequency analysis.
- A new Flood Frequency Report on Small Streams for MN. This report is in review planned for publication in FY 09.
- Minnesota will implement StreamStats in FY 09
- Provide hydraulic investigation support as requested, including bridge scour.
- Continued writing an investigative report that summarizes baseline water-quality conditions for a multi-year cooperative investigation of the effects of a proposed four-lane divided highway on the water quality and hydrology of relatively pristine streams and wetlands that drain to a large lake

important for fisheries and tourism. The highway expansion has been delayed due to funding cuts, so an interpretive report will summarize only pre-construction conditions.

- The Basin Characteristics project/Minnesota Department of Natural Resources Lakeshed Project prepares (http://www.dnr.state.mn.us/watersheds/lakeshed_project.html) hydrologically enhanced 12 1:24,000 Digital Elevation Model (DEM) data for use with automated basin characteristic and flood frequency ArcHydro extension. The Basin Characteristics project is updating basin characteristics for over 10,000 level 4-7 HUs in Minnesota and surrounding States.
- Stream-Slope Research: Testing automated methods of generating stream-slopes with DEMs and LiDAR, against the manual, semi-manual, and traditional survey methods.
- All basin characteristics data is available on-line at the Minnesota Watershed Information Project <http://gisdmnspl.cr.usgs.gov/watershed/index.htm>. This web page allows users to get basin characteristics and watershed areas for over 10,000 level 4-7 watersheds in and around Minnesota.

Mississippi

- Continue to provide streamflow records, hydrologic analyses of basins, and hydraulic analyses of the flooding potential at selected stream crossings, known as bridge-site studies. Scour analyses are also conducted at selected sites.
- Continue to operate and maintain 95 crest-stage gages.
- Continue to operate scour monitoring instrumentation at a coastal bridge. Streambed soundings obtained at this and other selected bridges to document scour.
- Continue to prepare an updated version of the 1991 flood-frequency reports to include the use of GIS determined basin characteristics for development of regional flood-frequency equations and the implementation of StreamStats. In 2008, completed development of 1:24,000-scale watershed boundary dataset for the State attributed with watershed and subwatershed boundaries, codes, names, and areas.
- The Mississippi Automated Resource Information System (MARIS) completed the 10-m DEMs for Mississippi. The DEMs were not considered complete until they had been reviewed and approved by the USGS National Geospatial Technical Operations Center located in Rolla, MO.
- **Recent Publications**
 - Wilson, K.V., Jr., Clair, M.G., II, Turnipseed, D.P., and Rebich, R.A., in press, Watershed boundary dataset for Mississippi: U.S. Geological Survey Scientific Investigations Map 3020: Scale 1:500,000.
 - Wilson, K.V., Jr., Clair, M.G., II, Turnipseed, D.P., and Rebich, R.A., in press, Development of a watershed boundary dataset for Mississippi: U.S. Geological Survey Open-File Report 2008-1198, xx p.

Missouri

- Operated a network of 38 crest-stage gages to be used with future flood frequency study.
- Operation and maintenance of 7 stream-gaging stations as part of the state-wide stream-gaging network.
- Hydraulic analysis at selected bridge sites. Completed one analysis using a two-dimensional hydraulic model at a complex site, documented in Huizinga, R.J., 2008, Hydrologic analysis and two-dimensional simulation of flow at State Highway 17 crossing the Gasconade River near Waynesville, Missouri: U.S. Geological Survey Scientific Investigations Report 2008-5194, 41 p. (<http://pubs.usgs.gov/sir/2008/5194/>)
- Installed two near-real-time bathymetric scour sensors at a gaged sites: Chariton River near Novinger, Missouri and Mississippi River at Mehlville, Missouri. These are both scour-critical sites and the monitoring is part of MoDOT's action plan for remediation. Mississippi River site is being supplemented with periodic bathymetric surveys of pier with sensor and other nearby, unmonitored piers using multibeam fathometer.

Montana

- Bridge-scour data collection and analysis program ongoing since 1991. As part of this program, near real-time scour monitoring is being conducted at four sites.
- Small-stream peak-discharge data collection program ongoing since 1955. Currently operating 96 crest-stage gages and 3 flood-hydrograph continuous-record streamflow gages.
- Ongoing cooperative project to investigate the hydrology of selected wetland areas affected by proposed highway projects.

Nebraska

- No highway related projects at this time.

Nevada

- Maintain a Statewide network of 24 crest-stage gages.
- USGS and Nevada Department of Transportation entered into an agreement in FY06 to compute sediment loads in the Clear Creek Drainage. This study will assess the impact of runoff from a U.S. Highway. The study is event driven where the sample collection intensifies during snowmelt and summer thunderstorms. The report will be published in FY09.
- A web based flood chronology of the Carson River Basin in cooperation with the State of Nevada and FEMA is available at <http://nevada.usgs.gov/crfd/index.htm>. The web site shows frequency plots, lists of flood discharge with Return Periods or Recurrence Intervals, and digital photographs of floods in the Carson River Basin.
- **Recent Publications**
 - Crompton, E.J., 2008, Traveltime data for the Truckee River between Tahoe City, California, and Vista, Nevada, 2006 and 2007: U.S. Geological Survey Open-File Report 2008-1084, 12 p. <http://pubs.usgs.gov/of/2008/1084/>

New Hampshire

- A 2-year study began in FY07 in cooperation with New Hampshire DOT to update regression equations for estimating flood-flow frequency on unregulated, rural streams and to implement StreamStats for the state of New Hampshire.
- New Hampshire Department of Transportation (NHDOT) funds approximately one-third of New Hampshire's stream-gaging network.

New Jersey

- Operate and maintain 40 crest-stage gages on small drainage basins of less than 2 square miles, and 15 older crest-stage gages under 9 square miles in drainage area. After 10-years of record have been recorded, a study to compare the gaged results with the various flood magnitude and frequency estimation methods will be initiated.
- A bridge scour data collection project with the New Jersey Department of Transportation was started in April 2008. The general objectives of this program are to monitor and validate the effects of scour at NJDOT bridge structures designated as scour critical and to obtain updated flow and velocity data. This will be a long-term project with additional monitoring locations added each year. The monitoring work started in FY2008 includes:
 - Continuous-record discharge gaging stations at 5 locations will be used to improve models to calculate scour. Gage height and discharge data available in near real-time from <http://nj.usgs.gov>
 - Continuous monitoring of streambed elevations at selected locations near bridge piers and abutments at 3 sites. The effects of scour at these bridge sites will be evaluated by NJDOT by monitoring streambed elevations over time at selected locations. Streambed elevation will be made available in near real-time in the near future.
 - Survey channel cross-sections at multiple locations upstream and downstream of 8 bridges to monitor changes in channel geometry over time.
 - Crest-stage gages installed at 3 stream sites to record peak stage and discharge.

New Mexico

- **Flood Analysis**
 - Operate and maintain the New Mexico crest-stage gage network of 86 gages. Received funding for the expansion of the crest-stage gage network to 100 gages in the next 2 years. Fifty-two of the crest-stage gages operated in ephemeral streams around the State are currently equipped with automated pressure transducers. Seventeen additional pressure transducers will be installed in existing gages this year.
 - Updated estimates of peak discharge magnitude for gaging stations in the region and regional equations for estimation of peak discharge and frequency at ungaged sites. Results are published in Waltemeyer, S.D., 2008, " Analysis of the Magnitude and Frequency of Peak Discharge and Maximum Observed Peak Discharge in New Mexico and Surrounding Areas: USGS Scientific Investigations Report 2008-5119 (<http://pubs.usgs.gov/sir/2008/5119/>).
 - Continued documentation of notable floods through collection of flood information such as peak stages and discharges by indirect measurements at miscellaneous flooded sites.
- **Streamstats**
 - The USGS Web application for stream information for New Mexico has been funded by the USGS in cooperation with the New Mexico Department of Transportation for FY 2006-2010. Information about StreamStats can be found at <http://water.usgs.gov/osw/streamstats/>
 - The StreamStats project has identified a "pilot area" for submission to the National StreamStats Team for their web-site completion in order to have a functioning web-site example of the StreamStats program.
 - GIS data has been completed for this pilot area. As soon as the Basin Characteristics data are verified and entered into the geodatabase, the pilot area project will be submitted to the web-site team for their final data loading and then become available for review and testing.

New York

- Documentation of notable floods through collection of flood information such as peak stages and discharges at discontinued gages, flood profiles along flooded streams, and indirect flood discharge measurements at miscellaneous flooded sites.
- Heavy rain during June 2006 resulted in record flooding in the Delaware, Susquehanna and Mohawk River basins. This event resulted in 100- to greater than 500-year recurrence intervals in the Delaware, Susquehanna and Mohawk River basins. Several indirect measurements were made and a flood report to document this flooding is in review and should be available soon.
- Maintain a statewide network of 48 crest-stage gages.
- USGS continues to support GIS software included on a DVD in the report of updated flood-frequency relations for New York (Lumia, 2006) to provide an automated method of calculating flood frequency discharges until STREAMSTATS is available in New York.
- A continued effort to use GIS techniques and coverages to automate the computation of flood discharges at any unregulated site on streams in New York using STREAMSTATS is in progress.
- An effort to update a report showing the maximum known stages and discharges at nearly 1500 gaging stations in New York is in progress. Recurrence intervals will be assigned to each peak discharge, where feasible. The scope of this report was revised to include peaks from the 2006 water year due to significant flooding in 2006.
- USGS is assisting the NYSDOT in the developing an RFP to use natural brine for use in highway de-icing in the Syracuse, NY area. The USGS NY WSC is a member of the Technical Advisory Group for this project and also helped NYSDOT site and drill the well, and provided the spec's for the brine pump. Start of this project is planned for the 2008-2009 snow season.
- USGS NY WSC is working with the State Emergency Management Office, NYSDOT, NYSGS, and others to propose development of a statewide landslide susceptibility mapping project. The mapping project is currently on hold, but landslide monitoring continues in and around the Tully Valley, New York area. Two fact sheets are being prepared on the landslides in Tully Valley, NY.
- **Recent Publications**

Lumia, R., Freehafer, D.A., and Smith, M.J., 2006 Magnitude and Frequency of floods in New York: U.S. Geological Survey Scientific Investigation Report 2006-5112, 152p. (<http://pubs.usgs.gov/sir/2006/5112/>)

Mulvihill, C.I., Filipowicz, A., Coleman, A. and B.P. Baldigo, 2007, Regionalized Equations for Bankfull Discharge and Channel Characteristics of Streams in New York State— Hydrologic Regions 1 and 2 in the Adirondack Region of Northern New York: U.S. Geological Survey Scientific Investigations Report 2007-5189, 18 p., online only. (<http://pubs.usgs.gov/sir/2007/5189/pdf/SIR2007-5189.pdf>)

Mulvihill, C.I. and Baldigo, B.P., 2007, Regionalized equations for bankfull-discharge and channel characteristics of streams in New York State--Hydrologic region 3 east of the Hudson River U.S. Geological Survey Scientific Investigations Report 2007-5227, 15 p., online only. (<http://pubs.usgs.gov/sir/2007/5227/pdf/pdf/SIR2007-5227.pdf>)

Suro, T.P. and Firda, G.D., 2006, Flood of April 2-3, 2005 in the Neversink River Basin, New York: U.S. Geological Survey Open-File Report 2006-1319, 90 p. (<http://pubs.usgs.gov/of/2006/1319/>)

Suro, T.P. and Firda, G.D., 2007, Flood of April 2-3, 2005 in the Esopus River Basin, New York: U.S. Geological Survey Open-File Report 2007-1036, 90 (<http://pubs.usgs.gov/of/2007/1036/>)

North Carolina

- The multi-state project to update rural flood-frequency relations for North Carolina in conjunction with the USGS WSC offices in South Carolina and Georgia is nearing completion, and reports are being drafted for publication. The updated relations are based on regionalization derived from watershed boundaries that cross state lines. Reports should be published in early 2009. Contact Curtis Weaver (jcweaver@usgs.gov) concerning this project.
- Continued to operate a continuous water-quality streamflow gaging station on Goose Creek at Fairview, NC (02124692) just outside of Charlotte in cooperation with the NCDOT. The gaging station has been in operation since 1999 to monitor the water-quality effects of an interstate bypass that runs through the Goose Creek watershed where the presence of the Federally Endangered Carolina heelsplitter mussel has been documented. The site is also being used to develop a continuous rating of sediment load by directly measuring a sediment surrogate (turbidity). Contact Hana Blumenfeld (hblumenf@usgs.gov) concerning this project.
- The USGS, in cooperation with the North Carolina Department of Transportation (NCDOT), is conducting a pilot project to develop and implement NHDPlus and StreamStats applications for the Upper French Broad River basin in western North Carolina. The pilot project utilizes a local resolution NHD product, 20-foot DEMs (derived from LIDAR data), and the most current regional streamflow regression equations, and datasets of landscape characteristics. Basin characteristics developed for the streamflow regression application, including National Oceanic and Atmospheric Association (NOAA) rainfall intensity data, topographic variables (for example slope and drainage area) and best available land cover classifications, are being incorporated into StreamStats and NHDPlus tables. Issues and recommendations on dataset development and application implementation for future similar use of high resolution datasets will be documented.
- The NC WSC has also been very involved in providing technical modeling support to the PA WSC on a habitat assessment study with PennDOT. Details are given in the PA WSC summary of FHWA activities.
- **Recent Publications**
Wagner, C.R., 2007, Simulation of water-surface elevations and velocity distributions at the U.S. Highway 13 Bridge over the Tar River at Greenville, North Carolina, using one- and two-dimensional steady-state hydraulic models, U.S. Geological Survey, Scientific Investigations Report 2007-5263, 33 pp. (<http://pubs.usgs.gov/sir/2007/5263/pdf/SIR2007-5263.pdf>)

North Dakota

- A network of 28 crest stage gages was operated in cooperation with the North Dakota Department of Transportation. The purpose of the network is to provide annual discharge peaks on small basins with less than 100 square miles. These data can then be used to improve our knowledge about flood frequencies on small basins and refine predictive regression equations.

- Operated one lake stage gage and one continuous-record discharge gage.
- A two-dimensional unsteady flow model for Devils Lake, North Dakota, is being developed in cooperation with the North Dakota Department of Transportation and the North Dakota State Water Commission. The objectives are to develop and apply a circulation model of Devils Lake. The model is being calibrated using data collected in 2006. The model will provide information on water movement patterns, lake level variations, and transport of dissolved materials throughout the lake under variety of weather, inflow, and lake-level conditions. The unsteady flow model will be calibrated and ready for simulations in the Spring of 2009.
- The StreamStats application is being developing for North Dakota. This work began in July 2008 and will be completed by December 2011.

Ohio

- A network of 18 crest-stage gages was operated in cooperation with the Ohio DOT and the Ohio Department of Natural Resources. The crest-stage gage data will be used to augment existing flood-frequency information available for Ohio.
- A brochure describing surface water in Ohio has been published. The brochure also describes research in support of highway projects. Morris, J.R. 2008, Surface water: U.S. Geological Survey, 4 p. (http://www.pdfdownload.org/pdf2html/pdf2html.php?url=http%3A%2F%2Foh.water.usgs.gov%2Freports%2Fowsc_2008_brochures%2FSurface_water_2008_OH_Web.pdf&images=yes)
- A StreamStats application has being developed for Ohio. A report describing the application for Ohio has been published. Koltun, G.F., Kula, S.P., and Puskas, B.M., 2006, A streamflow statistics (StreamStats) Web application for Ohio: U.S. Geological Survey Investigations Report 2006-5312, 62 p. (<http://pubs.usgs.gov/sir/2006/5312>)

Oklahoma

- StreamStats is being developing for Oklahoma to:
 - Automatically measure basin and climatic characteristics for ungaged sites using GIS.
 - Provide published streamflow statistics, basin and climatic characteristics, and other information for data-collection stations contained in published streamflow statistics reports.
 - Provide estimates of flood-frequency statistics, basin and climatic characteristics, and other information for user-selected points on ungaged streams.
 - Link to USGS NWIS on line data.
 - This work began in July 2005 and will be completed June 2009.

Oregon

- The investigation of existing bio-engineered sites at four gaging stations in Oregon to document how bio-engineered bank protection performs over a range of hydraulic conditions was completed in 2007. The stage, discharge, and velocity information, combined with the covering, design and construction of the bio-engineered bank protection installations was evaluated for improving current design procedures. A USGS Memo describing the USGS role in the project has been released. This memo was included in an ODOT report in 2008.
- Completed data analysis for estimating streamflow characteristics using regression equations, including flow duration and low-flow at ungaged sites for the entire state of Oregon. These coverages and equations will be implemented into Oregon StreamStats. A report describing this work has been published. Risley, John, Stonewall, Adam, and Haluska, Tana, 2008, Estimating flow-duration and low-flow frequency statistics for unregulated streams in Oregon: U.S. Geological Survey Scientific Investigations Report 2008-5126 (<http://pubs.usgs.gov/sir/2008/5126/>).

Pennsylvania

- **StreamStats**— The current application of StreamStats for Pennsylvania is at <http://water.usgs.gov/osw/streamstats/pennsylvania.html>. StreamStats for Pennsylvania can be used to estimate the following flow statistics:
 - a) Low-flows: 7-day, 10-year; 7-day, 2-year; 30-day, 10-year; 30-day, 2-year; 90-day, 10-year
 - b) Base-flows: 10-year, 25-year, and 50-year recurrence intervals

- c) Mean flows: including the harmonic mean and mean annual flow
- d) Flood-flows: 2- year, 5- year, 10- year, 50- year, 100- year, and 500-year recurrence intervals. The application also can be used to determine selected basin characteristics at ungaged sites throughout the state.
- **Alternative streamflow measurement methods**—Continuous radar is being used to collect water-surface velocities at the Susquehanna River at Bloomsburg, Pa. (01538700) gaging station. A method of streamflow determination using a single-point surface-velocity method is being tested. The use of this instrument and the method is ideal especially during unsteady flow events such as those created by debris and ice jams and will help to provide real-time streamflow estimates throughout the year without the need for a series of flow measurements. Additional velocity data are being collected in open-water and ice-cover conditions at other sites that are a high-priority for the National Weather Service. The additional data will be corroborated with recently acquired acoustic velocity meters and an enhanced radar antenna.
- **Flood inundation mapping**—Development of flood inundation maps for selected water-surface elevations at National Weather Service (NWS) flood forecast points in the Susquehanna River basin. The initial study is located on the West Branch Susquehanna River at Jersey Shore, Pa. The final inundation map will be displayed on the NWS Advanced Hydrologic Prediction Service web site. Paper versions of the flood-inundation plates will be made available upon request to county and local emergency management agencies.
- **Aquatic habitat**—Investigation and modeling of velocity and streambed configuration in relation to mussel habitat and bridge-pier design in the Allegheny River at Foxburg, Pa. A journal article describing the results of the study is near completion.
- **Stream restoration**—Erosion and sedimentation, hydrologic alterations, channel/streambank modification, and the associated effects on aquatic habitat have been identified as threats in the French Creek basin in Crawford County, and are especially problematic in Wymans Run, a tributary to French Creek. Streambank erosion and sedimentation are evident throughout the watershed and contribute to flooding upstream of PA 285 bridge. Hydrologic alterations within the floodplain near the bridge, and channel modifications through the reach upstream of the bridge also factor into the flooding problems. Changes to hydrologic and sediment-transport dynamics may have adversely affected the conveyance within the channel, and its ability to transport sediment. The hydraulic impact of various stream restoration and flood control measures along the main stem of Wymans Run for a range of streamflows will be evaluated with a one-dimensional model. Results will be delivered in a USGS report that is currently being prepared.
- **Wetland monitoring**—The Valley Creek Highway Encroachment project involves monitoring of a constructed wetland, stabilized stream reach in Valley Forge National Historical Park, and a planted riparian buffer began in 2000 and concluded in 2006. A USGS report describing the results of the study is near completion.
- **Gages**—A network of crest-stage and continuous-record streamgages are operated statewide to provide real-time and historical stage and streamflow data to support real-time flood-warning and forecasting efforts. The network will also be used in the development of statistics to describe and predict low-flow and peak-flow conditions.

Puerto Rico

- No highway related projects at this time.

Rhode Island

- No highway related projects at this time.

South Carolina

- Operates 6 continuous-record gaging stations and 49 partial-record crest-stage stations. (Number of gaging stations fluctuates slightly from year to year.)
- **Live-bed pier and contraction scour envelope curves**

In October 2005, the U.S. Geological Survey (USGS) and South Carolina Department of Transportation (SCDOT) began a cooperative program to investigate live-bed pier and contraction scour in the Piedmont and Coastal Plain of South Carolina. The purpose and objectives of this project include (1) the documentation of historic occurrences of live-bed pier scour and contraction

scour at approximately 80 bridges in the Piedmont and Coastal Plain of South Carolina using ground penetrating radar; focus will be given to old bridges and bridges that have had large floods; (2) a comparison of observed scour with predicted scour in order to assess the scour prediction methods of HEC-18; (3) the investigation of various physical relations that may help explain live-bed scour processes in South Carolina; and (4) if possible, the development of envelope curves for evaluating the potential for live-bed pier and contraction scour in South Carolina. Data have been collected at 78 bridges. Analysis of the field data is near completion with final report publication in 2009.

- **Calibration of clear-water abutment scour equations using field data**

Research conducted by the USGS in cooperation with the Federal Highway Administration and the Maryland State Highway Administration has identified the critical velocity variable as a potential source of error for selected clear-water abutment scour equations. Preliminary results indicate that performance of these equations could improve if a better method for estimating this variable was used. A literature review indicated that current practice for estimating critical velocity is poorly defined, has limited field verification, and is unlikely to see improvement in the near future. Therefore, a direct way to develop a method for estimating critical velocity that will lead to improved scour prediction equations is not readily available. However, it is possible to indirectly evaluate critical velocity and in turn improve the scour prediction equations by calibrating the equations with field data. To accomplish the calibration, the clear-water abutment scour equations are used to back-calculate the critical velocity required to force the equation to match measured scour. These back-calculated critical velocities can then be used to develop an improved method for estimating critical velocity. Field data from South Carolina and the USGS National Bridge Scour Database, including 224 measurements of abutment scour, will be used in the calibration and validation analysis. Preliminary results indicate that the calibration will improve the performance of the clear-water abutment-scour equations. Additionally, the results suggest that better performance for other bridge-scour equations can be achieved by using a similar procedure.

- **Rural flood frequency investigation**

Overview & Objective(s): The objectives of this project are to (1) update magnitudes and frequencies of peak streamflow of unregulated and possibly regulated streams in SC, when adequate data are available; (2) in coordination with the USGS NC and GA Water Science Centers (WSC), establish consistent physiographic regions at the state boundaries; (3) in coordination with the USGS NC and GA WSC, attempt to develop a method for obtaining generalized skews using skew coefficients computed from gaging stations having more than 25 years of record; (4) coordination and concurrence with the USGS NC and GA WSC on the explanatory variables for the physiographic regions at the state boundaries; and (5) update the regional rural-flood-frequency equations for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence intervals.

Status: In cooperation with the USGS Office of Surface Water and researchers at Cornell University, a regional generalized skew analysis that included 489 stations with 25 or more years of record was done using Bayesian generalized least-squares regression. The analysis resulted in a constant generalized skew for the Southeastern Region included in this investigation. The regional model has an equivalent record length of 69 years, which is much improved over the equivalent record length of only 17 years from the Bulletin 17B generalized skew map.

Annual peak-flow data through September 2006 were analyzed for 943 streamgage stations having 10 or more years of record on rural streams in South Carolina, Georgia, North Carolina and adjacent parts of Alabama, Florida, Tennessee, and Virginia. Of those 943 stations, 828 were included in the final database, which was used in a generalized least-squares regression analysis resulting in a set of regression equations that can be used to estimate the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year recurrence interval flows for rural ungaged basins in SC, GA, and NC. The explanatory variables for the equations are drainage area and percent draining each region. The investigation includes 5 hydrologic regions that were determined from EPA Level III and IV ecoregions. Traditional USGS flood-frequency regression equations have been developed by region and therefore, often excluded stations that drained from more than one region and used a questionable weighting method for ungaged sites that drained from more than one region. The approach used in this

investigation allows for the estimating of recurrence-interval flows at ungaged sites draining from one or more hydrologic regions.

Recent & Planned Products: This investigation will result in 3 USGS Scientific Investigation Reports: one each for SC, GA, and NC. The reports will have the same title except being distinguished by volume. For example, the SC report will be titled "Magnitude and frequency of rural floods in the Southeastern United States, 2006: Volume 3, South Carolina". Some sections of the reports will be identical but other sections will be unique to each respective state. The GA and NC reports (volume 1 and 2, respectively) are currently in review. Much of the SC report is written while additional ancillary analyses are on going (e.g. regulated flood frequency analysis and maximum flood analysis).

- **Characterization of storm runoff from selected South Carolina Department of Transportation (SCDOT) Maintenance Yards**

The SCDOT operates maintenance yards throughout the State. At this time, the SCDOT has no data to define the quality of stormwater leaving these sites. To provide these data, the USGS will conduct an investigation identify and quantify constituents that are transported in stormwater runoff from two maintenance yards and a section shed. The two maintenance yards, located in North Charleston and Conway, S.C., represent facilities where equipment and road maintenance materials are stored and that conduct complete equipment repair operations. The section shed, located in Ballentine, S.C., (about 15 miles west of Columbia) is a facility that stores equipment and road maintenance material. Water-quality samples and flow measurements of stormwater runoff will be collected at these sites. In addition to identifying and quantifying constituents that are transported in stormwater runoff from SCDOT maintenance facilities, the information collected in this investigation also may be used by the SCDOT in the development of stormwater management plans and to address future, potential National Pollutant Discharge Elimination System (NPDES) permit requirements to characterize and mitigate stormwater quality at these sites. This project was selected for funding by the SCDOT Research and Development Executive Committee (RDEC), and tentative project start date is April 1, 2009.

The objective of this investigation is to collect sufficient stormwater water-quality and flow data to document the type, concentration, and load of selected constituents transported from SCDOT maintenance yards by stormwater runoff. Water-quality samples will be taken from 1 to 3 locations at each site. A total of 6 sites will be sampled. The total sample locations at each facility are Ballentine (1), North Charleston (2), and Conway (3). Over a two-year period, one sample per season (winter, spring, summer, and fall) will be collected at each site as a flow-weighted composite or a grab sample, as appropriate. A total of eight samples will be collected at each location. These samples will be analyzed for selected constituents including suspended sediment, total suspended solids, turbidity, total organic carbon, biochemical oxygen demand, selected metals, nutrients, oil and grease, and polyaromatic hydrocarbons. Flow measurements will be made at the time of sampling in order to composite the samples and compute constituent load leaving the yards. Rainfall data also will be collected at each site. The results of the investigation will be published during the final year of the study.

- **Recent publications**

Conlon, K.J., and Journey, C.A., 2008, Evaluation of four structural best management practices for highway runoff in Beaufort and Colleton Counties, South Carolina, 2005–2006: U.S. Geological Survey Scientific Investigations Report 2008–5150, 121 p.
(<http://pubs.water.usgs.gov/sir2008-5150>)

South Dakota

- Operate a network of about 50 crest-stage gages for the purpose of peak-flow analysis.
- A statewide update of peak-flow frequency estimates for gaged streams in the state was completed in July, 2008. Results are provided in Scientific Investigations Report 2008-5104, which was published as an online-only report. The citation is: SIR 2008-5104: Peak-flow Frequency Estimates Based Data through Water Year 2001 for Selected Streamflow-Gaging Stations in South Dakota, 2003–07 (<http://pubs.usgs.gov/sir/2008/5104/>)

- Work has been completed on a multi-year study initiated in 2003 to evaluate scour potential at bridges on primary highways using a combination of Level 1.5 and Level 2 analyses. Results are provided in Scientific Investigations Report 2008-5161, which was published as an online-only report. The citation is: SIR 2008-5161: Estimation of Potential Bridge Scour at Bridges on State Routes in South Dakota, 2003–07 (<http://pubs.usgs.gov/sir/2008/5161/>)
- Implementation of StreamStats in South Dakota was initiated in 2005 and was recently extended to continue through 2009 to allow incorporation of high-resolution topographic data that currently are scheduled for production for selected critical areas. A separate project (with different cooperators) to develop a 6th level Hydrologic Unit Map for South Dakota has now been completed and will serve as another cornerstone for StreamStats digital base layers.
- A recent reconnaissance-level study demonstrated the utility of using paleoflood hydrology techniques to improve flood-frequency estimates for the Black Hills area of South Dakota. A subsequent study phase that involves three other cooperating agencies (besides SDDOT and USGS) has now been implemented within four major stream basins in the area. The primary approach involves extrapolation of peak-flow records through stratigraphic analysis and age dating of flood slackwater deposits that provide chronologies of very large flood events that may date back as much as several millennia. Results of the reconnaissance-level study are provided through an online-only report that is available via the SDDOT Office of Research web site at: http://www.state.sd.us/Applications/HR19ResearchProjects/oneproject_search.asp?projectnbr=SD2005-12
- SDDOT and USGS currently are planning for two new project starts. One project will involve analysis of potential bridge scour for sites along secondary roads. One component of this work will be to develop regression equations specific to South Dakota for bridge velocity and head loss. The other project will involve updating statewide regression equations for estimating peak-flow magnitudes and frequencies for ungaged streams, which will expedite efforts for the other planned project.

Tennessee

- Providing hydraulic interpretative support and miscellaneous flood-measurement support to Tennessee Department of Transportation (TDOT) as needed.
- Operating an ongoing network of 40+ crest-stage gages at or near highway crossings and operating another 15 stage-discharge gages across the state for the purpose of flood-frequency analysis and general resource evaluation.
- Routinely updating basin characteristics files and statewide flood-frequency equations for ungaged streams in Tennessee. Our most recent update was based on the region-of-influence statistical model and was completed in FY 2003.
- Continuously monitoring turbidity and relating turbidity to sediment concentrations on a stream in West Tennessee. This was initiated in FY2004.
- Large-scale study of the effects of highway construction on stream ecology throughout Tennessee—looking specifically at sediment export from disturbed areas, the efficiency of sediment control structures (EPSCs) at construction sites, sediment transport processes, the effects of sediment on downstream habitat and biotic communities, and improved methods for monitoring sediment-related effects. This work began in FY2004 and should continue through FY2012.
- Refining GIS coverages and enhancing tools and analytical protocols for the Tennessee Streamstats page (<http://water.usgs.gov/osw/streamstats/tennessee.html>). This page was completed and released in 2007. We are currently working to improve high-flow and low-flow equations by incorporating GIS-based basin characterization and adapting Streamstats to handle a Region of Influence (ROI) computational approach. This work should be completed in FY2008. Additional modifications planned for FY2008-09 include improved characterization of shallow closed depressions in karst terrains.

Texas

- **Bed Mobility in Edwards Plateau, Central Texas (FY05-08): ON-GOING**

The SW research group with the Texas Water Science Center has completed a peer-to-peer research consortium with Texas Tech University, Lamar University, and University of Houston in a project funded by the Texas Department of Transportation to investigate gravel transport phenomena within the Plateau. Gravel transport within high gradient streams is contributing to recurring infrastructure damage in the study area. The Department hopes that the research will contribute to enhanced design guidance on bridges and low-water crossings. The primary USGS focus will be on spatial documentation of gravel transport through imagery and field investigations. Contact Frank T. Heitmuller (ftheitmu@usgs.gov) for further information.

Heitmuller, F.T., and Asquith, W.H., 2008, Potential for bed-material entrainment in selected streams of the Edwards Plateau---Edwards, Kimble, and Real Counties, Texas, and vicinity: U.S. Geological Survey Scientific Investigations Report 2008-5017, 76 p. (<http://pubs.usgs.gov/sir/2008/5017/>)

Heitmuller, F.T., and Asquith, W.H., 2008, Bed-material entrainment and associated transportation infrastructure problems in streams of the Edwards Plateau, Central Texas: U.S. Geological Survey Fact Sheet 2008-3047, 4 p. (<http://pubs.usgs.gov/fs/2008/3047/>)

- **Rational Method Assessment (FY08--10): ON-GOING**

The SW research group with the Texas Water Science Center has been engaged in a peer-to-peer research consortium with Lamar University and University of Houston in a project funded by the Texas Department of Transportation to investigate the rational method for small to moderately sized rural and urban watersheds in Texas. Over 20,000 storms from about 200 watersheds around Texas and the United States have been "parsed" through the algebra of the rational method. No research results yet to report.

- **Refinement of Flood-Frequency Relations (FY07--09): ON-GOING**

The SW research group with the Texas Water Science Center has been engaged in a peer-to-peer research consortium with Texas Tech University in a project funded by the Texas Department of Transportation to develop statewide regional regression equations to estimate peak-streamflow frequency for ungaged locations (focused on undeveloped watersheds) in Texas using L-moment-based analysis of at-site annual peak streamflow values. The scope of the project includes 1,030 streamflow-gaging stations and various methods (technologies) for estimation of watershed characteristics. This project is intended to produce one or more additional equation ensembles from those developed in the mid 1990s. As of this writing, the core report is in review, but an ancillary report (shown below) has been published. The tentative message is that through site-specific L-moment of approximately 638 streamflow-gaging stations, we recover a regional ensemble of quantile-based regression equations that are ****extremely**** similar to those derived a decade ago using "wide latitude of interpretation" of Bulletin 17B guidelines.

Asquith, W.H., and Thompson, D.B., 2008, Alternative regression equations for estimation of annual peak-streamflow frequency for undeveloped watersheds in Texas using PRESS minimization: U.S. Geological Survey Scientific Investigations Report 2008-5084, 40 p. (<http://pubs.usgs.gov/sir/2008/5084/>)

Asquith, W.H., 2007, L-moments of the generalized lambda distribution: Computational Statistics and Data Analysis, vol. 51, p. 4,484-4,496.

- **Assessment of Watershed Subdivision on Hydrologic Modeling (FY08--10): ON-GOING**

The SW research group with the Texas Water Science Center has been engaged in a peer-to-peer research consortium with Texas Tech University, Lamar University, and University of Houston in a project funded by the Texas Department of Transportation to investigate the effects of watershed subdivision on hydrologic models and to provide guidance (if possible) as to how or why subdivision should be done. The project is effectively ended and final reporting efforts are wrapping up.

- **Unit Hydrographs for Texas (FY01-07): COMPLETED**

The SW research group with the Texas Water Science Center has been engaged in a peer-to-peer research consortium with Texas Tech University, Lamar University, and University of Houston in a project from about 2001–2007 funded by the Texas Department of Transportation to investigate the timing characteristics for unit hydrographs on small to moderately sized rural and urban watersheds in Texas. Unit hydrographs for 93 watersheds in Texas have been estimated through a myriad of techniques including linear programming, instantaneous unit hydrograph, and gamma distribution fitting to peak and time to peak values. The project has been on going for many years and several publications are completed or in progress. The last two years of the project involved assessment of loss models for engineering design applications.

Asquith, W.H., and Roussel, M.C., 2007, An initial-abstraction, constant-loss model for unit hydrograph modeling for applicable watersheds in Texas: U.S. Geological Survey Scientific Investigations Report 2007–5243, 82 p. (<http://pubs.usgs.gov/sir/2007/5243/>)

Asquith, W.H., Cleveland, T.G., Xing, Fang, Thompson, D.B., 2006, Unit hydrograph estimation for applicable Texas watersheds: Texas Department of Transportation Research Report 0–4193–4, Center for Multidisciplinary Research in Transportation, Texas Tech University.

Asquith, W.H., Thompson, D.B., Cleveland, T.G., and Fang, Xing, 2004, Synthesis of rainfall and runoff data used for Texas Department of Transportation Research Projects 0–4193 and 0–4194: U.S. Geological Survey Open-File Report 2004–1035, 1,050 p. (<http://pubs.usgs.gov/of/2004/1035/>)

Asquith, W.H., and Roussel, M.C., 2003, Atlas of interoccurrence intervals for selected thresholds of daily precipitation in Texas: U.S. Geological Survey Water-Resources Investigations 03–4281, 204 p. (<http://pubs.usgs.gov/wri/wri03-4281/>)

Cleveland, T.G., He, Xin, Asquith, W.H., Fang, Xing, and Thompson, D.B., 2006, Instantaneous unit hydrograph selection for rainfall-runoff modeling of small watersheds in North and South Central Texas: ASCE Journal of Irrigation and Drainage, Sept–Oct 2006, p. 479–485.

- **Small Watershed Gaging Program: (FY06-10, and three more 5-year increments)**

The Texas Department of Transportation and the USGS have returned in earnest to small watershed data collection. A program of about 50 crest-stage gages have been funded to record flood peaks on small watersheds in western Texas. About ten of these gages will have autonomous stage recording and rainfall for production of rainfall and runoff data sets to drive the TxDOT research program in future decades. Three of the gages also will be operated as continuous real-time (conventional gages).

Utah

- Completed an update of the peak-flow regression equations for the state of Utah in 2008, a cooperative investigation with the Utah Department of Transportation. The USGS StreamStats program is undergoing implementation for Utah and will include the new peak-flow equations.

- **Recent Publications**

Kenney, T.A., Wilkowske, C.D., and Wright, S.J., 2007, Methods for estimating magnitude and frequency of peak flows for natural streams in Utah: U.S. Geological Survey Scientific Investigations Report 2007-5158. (<http://pubs.usgs.gov/sir/2007/5158/>)

Vermont

- Vermont Agency of Transportation (VTrans) is currently funding a network of 29 crest-stage gages located in small headwater watersheds throughout the state.
- VTrans is funding two streamgaging stations (Potash Brook in South Burlington, VT and Allen Brook in Williston, VT) for continuing research of storm water management on small urban streams.
- A cooperative investigation between VTrans and the USGS began in Fiscal Year 2005 to investigate the effects of road salting on stream quality. During Fiscal Years 2006 to 2008, monitoring of stream water-quality (continuous conductance and discrete samples for chloride, sodium and calcium) and discharge were performed at 3 streams at locations upstream and downstream of state highways and data were analyzed. In Fiscal Year 2009, a USGS interpretative report will be prepared summarizing the results of the study.

Virginia

- Continuation of Annual Flood Peaks of Streams in Virginia—The objectives of the study are to update annual flood-peak data in preparation for a flood frequency analysis study.
- Maintain and operate a network of 45 crest-stage gages to determine annual peak flows, document extreme flow events, and improve flood frequency estimates.
- Collection of stream geomorphic data in the Piedmont physiographic province at USGS streamflow-gaging stations to be used in the development of regional channel geometry curves.

- **Recent Publications**

Krstolic, J.L., and Chaplin, J.J., 2007, Bankfull regional curves for streams in the non-urban, non-tidal Coastal Plain Physiographic Province, Virginia and Maryland: U.S. Geological Survey Scientific Investigations Report 2007–5162, 48 p. (<http://pubs.usgs.gov/sir/2007/5162/>)

Hayes, D.C., and Wiegand, Ute, 2006, Drainage areas of selected streams in Virginia: U.S. Geological Survey Open-File Report 2006–1308, 51 p. (<http://pubs.usgs.gov/of/2006/1308/>)

Washington

- No highway related projects at his time.

West Virginia

- A network of crest-stage gages will continue to be operated in cooperation with WVDOT to provide on-going peak-flow data for flood-frequency information and analysis.
- WVDOT provides funding in support of operating and maintaining the streamflow-gaging stations.
- Cooperated with WVDOT on an investigation of stream geomorphology in the Appalachian Plateaus physiographic province.
- WVDOT provided funding for a flood-frequency investigation that follows the WRC guidelines and including development of a State skew map.

- **Recent Publications:**

Paybins, K.S., 2007, Basin characteristics for selected streamflow-gaging stations in and near West Virginia: U.S. Geological Survey Open-File Report 2008-1087, 9 p. (<http://pubs.usgs.gov/of/2008/1087>)

Atkins, J.T., Jr., Wiley, J.B., and Paybins, K.S., 2008, Generalized skew coefficients of annual peak flows for rural, unregulated streams in West Virginia, U.S. Geological Survey Open-File Report 2008-1304 (to be published on the web)

Wisconsin

- **Flood Frequency**

- A network of 89 crest-stage gages will continue to be operated in cooperation with WisDOT to provide on-going peak-flow data for flood-frequency information and analysis.
- Updated frequency estimates for 32 gages with large floods in June of 2008.
- Continued working on updating the regression equations using GIS-based basin characteristics. Decided to hold the report to incorporate large floods that occurred during the 2008 water year. Revised report will be printed in FY2009.
- Attended training for processing GIS data for the StreamStats application, which allows for automated determination of basin characteristics and flood frequency analysis for ungaged sites.
- Expect implementation of StreamStats during FY2009.

- **Evaluation of Storm Water Treatment Technologies for Highway Runoff**

Comparing Structural BMPs at Milwaukee's Historic Third Ward River Walk and I-794 Freeway Test Site -The Wisconsin Department of Transportation (WisDOT) is required to improve the quality of runoff from roadways under their control as part of the National Pollution Discharge Elimination System (NPDES) and an agreement with the Wisconsin Department of Natural Resources (WDNR). In addition, future state and federal regulations will prescribe new performance standards for non-

point runoff management and calculation requirements for total maximum daily loads (TMDLs) of contaminants discharging in watershed basins.

One way to improve the quality of roadway runoff, particularly in urban areas, is to use structural Best Management Practices (BMPs). There are several commercially available BMPs that could be used, but these new technologies lack field performance testing and validation, especially in Wisconsin type climates. So it is essential to field test these devices to determine their contaminant removal efficiency and practical application for WisDOT.

This study is funded by the National Cooperative Highway Research Program and is being conducted by the WisDOT in cooperation with the U.S. Geological Survey. The objective of this study will evaluate two structural BMPs to determine their removal efficiency. Data collection and analysis is complete and a final report will be available in 2009.

- **Pollutant Loadings to Storm Water Run-Off from Highways**

The Impact of a Highway Sweeping Program-Phase II - This study is in cooperation with the National Cooperative Highway Research Program and is being conducted by the WisDOT in cooperation with the U.S. Geological Survey. The study site is located on USH 151 near IH 90/94/39, in Madison WI. The objective of this study is a continuation of a previous highway sweeping study that will evaluate the effectiveness of a highway-sweeping program as a best management practice (BMP) for reducing pollutant levels. Phase II would address the data collection and analysis issues that occurred during the Phase I study by using new technology for monitoring and calibrating flow, eliminating freeway median area, improved sample processing and change in laboratory procedures for particle size distribution.

Phase I Report

Waschbusch, R.J. 2003, Data and Method of a 1999-2000 Street Sweeping Study on an Urban Freeway in Milwaukee County, Wisconsin, U. S. Geological Survey Open File Report 03-03, 41 p. (<http://pubs.er.usgs.gov/usgspubs/ofr/ofr0393>)

Data collection is complete and a final report on Phase II will be available in 2009.

- **Evaluation of Storm Water Treatment Technologies for Parking-lot Runoff**

The Wisconsin Department of Transportation (WisDOT) has a Cooperative Agreement with the Wisconsin Department of Natural Resources (WDNR) (November 2002), Trans401 (December 2002), and NR 216 (September 2002), that require the Department to establish a Storm water Management program to reduce Total Suspended Solid (TSS) loading from highway surfaces. The regulations require the Department evaluate and assess best management practices (BMPs). This study is made possible by a partnership with the Madison Gas and Electric Company (MG&E), United States Geological Survey (USGS), Stormwater Management Inc., and the Wisconsin Department of Natural Resources (WDNR). The site is a parking lot located in downtown Madison, WI at the MG&E facilities plant and the BMP to be evaluated is gravity filtration.

This study would complement research just completed on a filtration BMP called the StormFilter (Evaluation of Storm Water Treatment Technologies for Highway Runoff, under the direction of Wendy Braun, WDOT). The StormFilter was evaluated using runoff from Highway 794 in Milwaukee. A 45 percent reduction in TSS loads was observed for the 30 storms used for the evaluation. Before these results are applied to other highways or DOT facilities, such as park and rides, maintenance yards and rest areas, it must be determined if the findings are unique to the characteristics of the runoff from elevated freeways.

Data collection is complete and a final report is scheduled to be available in 2009.

Wyoming

- No highway related projects at this time.