A Partial Summary of 2013 USGS Activities of Interest to the FHWA and State Highway Agencies

Robert Mason (rrmason@usgs.gov)

Transportation Research Board 93rd Annual Meeting

AFB60 Committee Meeting

January14, 2014

(Electronic version of this document located at: http://water.usgs.gov/osw/TRB/index.html)

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 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. For example, on a national scale the USGS is supporting efforts to enhance and maintain the National Streamflow Statistics Program, the StreamStats flow statistics application and delivery tool, and WaterAlert, a tool for automatic notification of threshold exceedance for stream stage, streamflow, and other water-related data collected by USGS.

On a regional scale, the USGS is conducting investigations to update Bulletin 17B skew maps, to define channel characteristics at bankfull discharge, and to document storm tide as a result of major coastal storms. Current locally focused investigations include the examination of rural, urban, and small watershed flow frequency; the documentation of extreme inland floods along with flood-frequency updates; and the development of flood inundation maps to assist with the protection of public infrastructure, such as roads and bridges, and to improve public safety.

The following table and text provide 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 Robert Mason (rrmason@usgs.gov).

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

Project Type	Sponsoring Agencies/States
Regional Flow Frequency/Statistics Investigations	
National Streamflow Statistics (NSS) Program	USGS
StreamStats Program/automated basin characteristics	Implemented: AL, AR, AZ (delineations and basin characteristics only), CA, CO, CT, DE, HI, IA, ID, IL, IN, KY, MA, MD, MN, NC, NH, NJ, NM, NY, OH, OK, OR, PA, RI, SD, TN, UT, VT, WA In progress: AK, GA, KS, ME, MS, MT, ND, VA, WI, WV
Investigation of rural flow-frequency	CA, GU, HI, IA, KS, LA, MO, MA, ME, MT, MS, NC, NE, NM, NY, OK, OR, PA, SD, TN, TX, VA, WA, WI, WV, FEMA
Investigation of urban flow-frequency	IL, KS, NC, SC, VA
Investigation of small watershed flow-frequency	KS, ME, MT, TN, TX, WA
Non-stationarity of peak flows	ME
Updating Bulletin 17B Regional Skew Map	AK, AZ, MO, WA (for Pacific Northwest)
Development of urban dimensionless unit hydrograph	MO
Bridge Scour and Sediment Transport	
Evaluation of abutment-scour equations	SC, NCHRP
Near real time scour monitoring	AK, MO, MS, MT, NJ
Data collection and analysis	AK, ME, MN, MO, MS, MT, , NJ, NV, SC, SD, WA, FHWA
Investigation of scour in cohesive soils using the EFA	IL
Channel stability and scour assessment	AK, IN, MO, MS, MT, ND, NJ, , SD, TN, WA
Investigation/modeling of sediment transport	MT, ND, TN, , WA
Investigation of bio-engineered bank protection and A-jacks scour countermeasures	TN
Hydrologic and Hydraulic River Investigations	
Investigation of bridge site hydrology and hydraulics	AL, , MN, MT, MS,
Investigation and modeling of multi-dimensional flows	AK, ID, ND, PA, WA
Flood documentation	IA, IN, MN, MT, NE, NM, NY, NV, OR, PA, TN, , WI
Operational flood inundation mapping	GA, IL, IN, KS, ME, MI, MO, MS, NC, NH, NJ, NY, OH, PA,
Stream Characteristic Investigations	
Regional channel characteristics/bankfull discharge	ID, NY, OR, TX, WV
Tidal Gages and Streamgages	
Tidal gages	FL, NC
Crest stage gages to estimate annual peak flows	AK, AL, FL, GA, GU, HI, IA, ID, KS, LA, ME, MI, MN, MS, MO, MT, NV, NJ, NM, NY, OH, PA, SC, SD, TN, TX, UT, VT, VA, WI, WV

Continuous-record discharge and stage gages	AK, GU, HI, IA, ID, IN, LA, ME, MD, MI, MN, MS, MO, MT, NC, NH, NJ, PA, SC, TN, TX, UT, VT, WV
Water Quality and Environmental Investigations	
Evaluation of stormwater runoff models	MA, OR, TX, FHWA
Monitor water quality/quantity at selected sites	FL, HI, ID, MA, ME, MI, MN, MO, MT, NC, NE, NV, PA, SC, TN, UT, VT, WA, WI
Investigation of wetland impact/remediation	MT, WA
Investigation of stream restoration	ID, MT, NE, TN, WA
Investigation of the effect of deicing chemicals	NC, OR, FHWA
Investigation of BMP	OR, TN, WI, FHWA
Investigation of potential impacts of highway culvert construction to the natural conditions of streams	AL, TN

Partial Summary of USGS National Activities

USGS WaterAlert and WaterNow

The USGS has continues to provide a very popular water-threshold exceedance notification program. The system sends email or text messages when water levels or water-quality conditions meet user-specified criteria. Criteria can include greater-than, less-than, within, and out-of-range thresholds. Reporting frequencies can include once-per-event, once-per-day, or once-per-hour messaging while the condition lasts. In 2012, the process was started to link subscribers with the USGS Flood Inundation Mapping Program Map Viewer (http://wim.usgs.gov/FIMI/) to help users select high-flow thresholds of interest. These maps, where available, along with NWS E-19 information sets provide locations and descriptions of local features such as roads or structures in the vicinity of streamgages and river stages that affect those features. The USGS WaterAlert system can be accessed at *http://water.usgs.gov/wateralert/*.

A complimentary interactive USGS query and alert feature called WaterNow has also been developed. This system allows users to query any realtime USGS streamgage and request reports of the most recent measurement values for any data collected at the streamgage of interest. The query and response can be sent and received using any device with email and text message capabilities.

National Streamflow Information Program (NSIP)

This USGS program is an umbrella over all streamflow information activities of the USGS. The program has five major goals - (1) to maintain a stable streamgage network to provide federally needed streamflow information, (2) to provide better understanding of floods and droughts, (3) to perform periodic regional and national assessments of streamflow information, (4) to enhance the delivery of streamflow information and products, and (5) to develop and evaluate new technologies and methods for obtaining streamflow information.

NSIP was virtually flat funded in 2011. In FY 2012, program funding was increased by $2.5M to help stabilize the streamgage network, however in 2013 the NSIP funding was decreased by about $2M due to sequestration. The NSIP is currently funded at about 24 percent of the design funding level.The NSIP program description and list of proposed NSIP streamgages are on-line at http://water.usgs.gov/nsip/. Additional publications on the mission and goals of NSIP are on-line at http://water.usgs.gov/nsip/reports.html Also available on the NSIP web pages are internet links to real-time and historical streamflow data and information.

The National Water-Quality Monitoring Network

Another network effort has now taken 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 focuses on water and ecological issues affecting coastal waters and ocean environments. Network concepts have been piloted and implemented in San Francisco Bay, Lake Michigan, and Delaware Estuary. Two additional demonstration studies started in 2012 and were active in 2013 in Albemarle Sound and Puget Sound. The NWQMC report describing the network is available at http://acwi.gov/monitoring/network/index.html.

Updated Flood-Frequency Analysis Guidelines

Flood-frequency analysis provides information about the magnitude and frequency of flood discharges. Bulletin 17B, which was written by the Hydrology Subcommittee of the Interagency Advisory Committee on Water Data (1982), defines procedures that provide a uniform and 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. In the near future, the Advisory Committee on Water Information, Subcommittee on Hydrology, Hydrologic Frequency Analysis Workgroup will consider a number of changes to the Bulletin 17B including the Expected Moments Algorithm (EMA) and a new multiple low outlier test based on a generalization of the Grubbs-Beck test. EMA is a highly efficient approach for capturing the information contained in historical flood data and other censored (incomplete) datasets.

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. PeakFQ has been modified to include the EMA and the new multiple low outlier test.

Contact Tim Cohn (TACohn@USGS.gov) for more information about the USGS contributions to the effort.

Updated Flood-Frequency Regional Skew Map

The USGS is working with FEMA and various state and local agencies to update the National flood-frequency skew map now used in Bulletin 17B. Since the first map was published in 1976, some 35 years of additional streamflow information has accumulated, and better spatial estimation procedures have been developed (Stedinger and Griffis, 2008). A new statistical technique, Bayesian Generalized Least Squares (B-GLS) regression, is being used to estimate new regional skewness values. Thus far, this technique has been used in studies in: the Southeastern U.S. (South Carolina, North Carolina, and Georgia), California, and Iowa. Projects are underway in Missouri, Arizona, Nevada, New England, the Pacific Northwest (Oregon and Washington) and Alaska. Instead of updating the map on a state-by-state basis, we would like to update the map on a multi-state, hydrologic basis with the eventual goal of updating the entire the maps for the entire Nation. Some states in the Missouri River Basin, New

England, and the Pacific Northwest have initiated efforts, but we have been unable to establish a coordinated effort.

Contact Andrea Veilleux (aveilleux@usgs.gov) if you have questions related to efforts related to updating the National flood-frequency skew map.

Contact Robert Mason (rrmason@usgs.gov) for general information about the flood-frequency program.

National Streamflow Statistics

The National Streamflow Statistics (NSS) Program is a Microsoft Windows-based computer program created by the USGS to estimate high and low streamflow statistics for ungaged sites across the United States. NSS provides estimates for low-flow duration and frequency estimates in addition to flood-frequency estimates such as the 100-year flood.

The NSS program has a graphical user interface (GUI) and an equation calculation routine. The equation calculation routine computes streamflow statistics using basin and climatic characteristics entered by the user. The GUI allows users to control the operation of the software and presents results. It also provides tabling and graphing capabilities that graph frequency and hydrographs. The database contains all the information needed, such as the regression equations and standard errors, to solve more than 5,700 regression equations.

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. State-specific regression equations for estimating flood-frequency statistics of peak flows for urban streams are available in NSS for 15 U.S. States. In addition, nationwide urban regression equations are available. Regression equations for estimating low-flow duration and (or) frequency are also currently available in NSS for 31 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/.

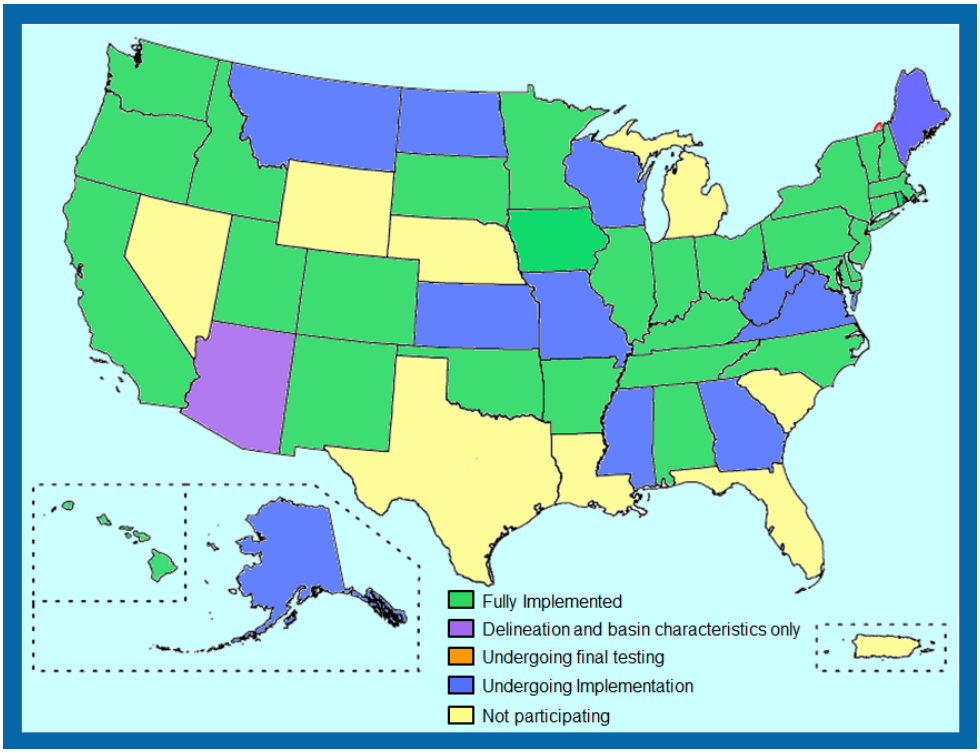
A fact sheet that describes the NSS program was published in 2007 and can be downloaded at: http://pubs.usgs.gov/fs/2007/3010/. Efforts are currently underway to update the documentation to match recent upgrades to the program.

If you should have questions regarding this information, please contact Todd Koenig (tkoenig@usgs.gov).

StreamStats Program

StreamStats (http://streamstats.usgs.gov) is a Geographic Information Systems-based Web application, developed by the U.S. Geological Survey (USGS) Office of Surface Water (OSW), which 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 also can 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.



(Accessed at http://water.usgs.gov/osw/streamstats/ssonline.html, December 2, 2013)

As of December 2013, StreamStats was available to the public for 31 states – Alabama, Arizona (delineations and basin characteristics only), Arkansas, California, Colorado, Connecticut, Delaware, Hawaii, Idaho, Illinois, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New Mexico (partial area), New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Dakota, Tennessee, Utah, Vermont, and Washington. An application also was released for the Connecticut River Basin, which encompasses area in Connecticut, Massachusetts, New Hampshire, and Vermont. This application is the first to be based on a river basin rather than a state. It was created to allow basin delineations and to compute basin characteristics needed as input to the Connecticut River UnImpacted Streamflow Estimation (CRUISE) tool. CRUISE is a spreadsheet program that estimates daily streamflow time series for user-selected ungaged sites using information from an index streamgage and the basin characteristics provided by StreamStats. Further information on CRUISE can be obtained at http://webdmamrl.er.usgs.gov/s1/sarch/ctrtool/index.html.

A similar application is in development for the Delaware River Basin, which encompasses area in Delaware, New Jersey, Pennsylvania, and New York.

In addition to the ability to delineate drainage basins and obtain estimates of streamflow statistics for user-selected ungaged sites, StreamStats also has 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, (4) obtain graphs of land-surface and stream-channel elevation profiles, (5) trace the path of a drop of water or a hazardous-waste spill from a point on the land surface to where it reaches a stream, and then downstream through the stream network, and (6) access StreamStats functionality from other Web or desktop GIS applications remotely by use of Web services. This functionality has not yet been fully implemented for all states. In addition, Maryland StreamStats allows users to obtain summaries of water use activities within the drainage basins for user-selected sites.

Plans for fiscal year 2013 include state-wide implementation of Georgia, Kansas, Maine, Mississippi, Montana, North Dakota, Virginia, and Wisconsin, and the Delaware River Basin. Updates to regression equations and/or supporting GIS datasets will be made to the applications for California, Delaware, Hawaii, Kentucky, Massachusetts, New Jersey, Oregon, Pennsylvania, Rhode Island, South Dakota, Tennessee, Vermont, and Washington.

Performance and Effectiveness of Scour Countermeasures

Scour countermeasures have become a major part of Federal Highway Administration's (FHWA's) national bridge scour program and are considered vital in reducing the vulnerability of bridges to scour. However, due to the lack of field verification of the performance and effectiveness of these countermeasures, there remains uncertainty in the reliability of scour countermeasures for protecting foundations, especially for use at new bridges. FHWA, therefore, has teamed with the U.S. Geological Survey (USGS) to conduct a comprehensive, national, investigation of scour countermeasures. Through this investigation FHWA hopes to evaluate and improve its published guidance and technical procedures for the selection, design, construction and maintenance of scour countermeasures and possibly reevaluate its policy of not using scour countermeasures at new bridge piers.

For this project, the USGS will perform various levels of site evaluations at approximately 100 bridges with scour countermeasures across the Nation. Some of the techniques to be used include stream side investigations and underwater reconnaissance using state-of-the-art survey techniques such as terrestrial LIDAR, multi-beam bathymetry and side-scan sonar. The USGS will document each evaluation in templates and then summarize its findings in an official USGS Scientific Investigations Report. As a complement to the USGS site evaluations, the J. Sterling Jones Hydraulics Research Laboratory (HRL) will run hydraulic physical models and computational fluid dynamics (CFD) on several bridge sites. The goal of these lab tests is to test and model at high flows the stability and performance of the as-built

countermeasures observed in the field. These results will also be used to evaluate FHWA guidance on scour countermeasure design.

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

The purpose of the project is to develop and implement a new version of the FHWA water quality model. The U.S. Geological Survey (USGS) in cooperation with the FHWA has developed a new model the Stochastic Empirical, Loading and Dilution Model (SELDM). SELDM uses available data and stochastic Monte Carlo methods to generate planning-level estimates of event mean concentrations (EMCs), discharges, and loads from the highway (or another land use) and in the receiving waters upstream of the highway-runoff outfall. These values are then used to calculate the EMCs, discharges, and loads downstream of the highway-runoff outfall using mass balance methods.

These estimates can be used to evaluate highway-runoff discharges as a potential source of water-quality constituents, the potential effects of runoff loads on receiving-water quality, and the potential effectiveness of Best Management Practices (BMPs) for reducing the effects of highway runoff on receiving waters. Statistics for streamflow, precipitation, runoff coefficients, highway water quality and upstream water quality are needed to develop planning level estimates for use with SELDM. The USGS developed a series of reports and (associated) computer programs to provide planning level estimates of stormflow and water quality and to refine such estimates with local or site-specific data.

The model was published as version 1.0.0 in the spring of 2013 and was updated to version 1.0.1 in the fall of 2013. A series of on-line training sessions were presented in the summer of 2013 and a classroom training session was presented in September 2013. Classroom training sessions are being planned in Washington D.C. during April 2014, in Portland Oregon during May 2014, and in Iowa City, Iowa in August 2014. There also will be on-line training sessions to be announced during 2014 Information about the model is available on the website http://webdmamrl.er.usgs.gov/g1/FHWA/SELDM.htm

SELDM Model Publications:

Granato, G.E., 2014, The Stochastic Empirical Loading and Dilution Model (SELDM) for analysis of flows, concentrations, and loads of highway runoff constituents: Compendium of Papers for the Transportation Research Board 93rd Annual Meeting, January 12-16, 2014, Washington, D.C., 19 p.

Granato, G.E., 2013, Stochastic Empirical, Loading and Dilution Model (SELDM) Version 1.0.0: Techniques and Methods of the U.S. Geological Survey, book 4, chap. C3, 31 p. with CD-ROM (The FHWA reference number is FHWA-HEP-09-006)

Granato, G.E., 2010, Methods for development of planning-level estimates of stormflow at unmonitored stream sites in the conterminous United States: FHWA-HEP-09-005, 90 p. with CD-ROM

Granato, G.E., 2009, Computer programs for obtaining and analyzing daily mean streamflow data from the U.S. Geological Survey National Water Information System Web Site: U.S. Geological Survey Open-File Report 2008–1362, 123 p. with CD-ROM

Granato, G.E., and Cazenas, P.A., 2009, Highway-Runoff Database (HRDB Version 1.0)--A data warehouse and preprocessor for the stochastic empirical loading and dilution model: Washington, D.C., U.S. Department of Transportation, Federal Highway Administration, FHWA-HEP-09-004, 57 p. with CD-ROM

Granato, G.E., Carlson, C.S., and Sniderman, B.S., 2009, Methods for development of planning-level stream-water-quality estimates at unmonitored sites in the conterminous United States: Washington, D.C., U.S. Department of Transportation, Federal Highway Administration, FHWA-HEP-09-003, 53 p. with CD-ROM

Granato, G.E., 2006, 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: Techniques and Methods of the U.S. Geological Survey, book 4, chap. A7, 31 p. with CD-ROM

National Synthesis on Potential Sources, Fate and Transport, and Potential Effects of Chloride in Surface- and Ground-Water Resources of the Conterminous United States

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's 250 mg/L taste criterion for potable waters, the 230 mg/L chronic criterion for aquatic life, or the 860 mg/L acute criterion for aquatic life. 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. 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 groundwater, 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. Of 275 reports that have been complied, about 165 reports have been cataloged and reviewed. Water-quality transport curves for dissolved chloride have been developed for 84 USEPA Nutrient Ecoregions. The report is in preparation and will be published in September 2014.

Web pages:

The project web page: http://webdmamrl.er.usgs.gov/g1/FHWA/Cl.htm.
Deicing bibliography: http://webdmamrl.er.usgs.gov/g1/FHWA/qw/salt.htm

Performance metrics of low-impact development (LID) methods and other structural best management practices (BMPs) for reducing the effect of runoff from linear transportation projects

This project will provide information and statistics that can be used to calculate potential benefits of LID and conventional BMPs using the Stochastic Empirical Loading and Dilution Model (SELDM). SELDM is designed to provide a generalized stochastic representation of BMP treatment mechanisms. BMP treatment mechanisms included in SELDM are flow reduction, hydrograph extension, and water-quality modification. These performance criteria may represent the net effect of one structural BMP or a treatment train of several structural and nonstructural BMPs. This project will provide statistics that can be entered into SELDM so that highway engineers can test different BMPs in a simple point and click environment. This project also will provide BMP performance estimator tools to calculate statistics that are necessary for use with SELDM so that highway engineers and scientists can update the selections in SELDM as new data become available.

Publications:

Granato, G.E., 2014 (in review), Statistics for stochastic modeling of volume reduction, hydrograph extension, and water-quality treatment by structural stormwater runoff best management practices (BMPs): U.S. Geological Survey Scientific Investigations Report 2014–XXXX, X p.

Granato, G.E., 2012, Estimating basin lagtime and hydrograph-timing indexes used to characterize stormflows for runoff-quality analysis: U.S. Geological Survey Scientific Investigations Report 2012–5110, 47 p. http://pubs.usgs.gov/sir/2012/5110/

Partial Summary of USGS Water Science Center Activities of Interest to State Highway Agencies

To obtain more detailed information about state-based activities from a USGS Water Science Center, visit http://water.usgs.gov/ and select a state from "Water Science by State".

Alabama

Hydrologic and Hydraulic investigations: various bridge sites in Alabama (including crest-stage gage data collection effort for urban streams).

Culvert Impacts Study: A study to look at the impacts that culvert construction has on geomorphology, sediment concentrations in streams during storm events, turbidity, and benthic invertebrate populations. The study is set up to look at three phases - before, during, and 2-year post construction.

Recent Publications

Hedgecock, T.S., and Lee, K.G., 2010, Magnitude and frequency of floods for urban streams in Alabama, 2007: U.S. Geological Survey Scientific Investigations Report 2010–5012, 17 p. Available online at: http://pubs.usgs.gov/sir/2010/5012/.

Lee, K.G., and Hedgecock, T.S., 2010, Flood-depth frequency relations for rural streams in Alabama, 2003: U.S. Geological Survey Scientific Investigations Report 2010–5066, 25 p. Available online at: http://pubs.usgs.gov/sir/2010/5066/.

Alaska

2013 Summary of Alaska Bridge Scour Project:

- Collected and evaluated real-time streambed and water surface elevation data at 17 scour-critical bridges in order to monitor pier scour and assess seasonal flow impacts to stream bed geometry
- Collected repeat soundings and observations at four bridges that experienced flood and scour events
- Conducted field surveys at 20 additional bridges with unknown foundations in order to assess the vulnerability of the bridge site to scour. Data collected included channel geometry, sediment size, and discharge measurements that will be used to develop and calibrate hydraulic models.
- Developed hydraulic models and scour assessments for 17 bridges with unknown foundations surveyed in 2012 and drafted a report on these results.
- Collected extensive bathymetry data at Bridge 339 on the Copper River Highway in order to evaluate stream channel changes over the last two years and help DOT to assess bridge replacement options.

- Collected time-lapse imagery of channel change at Bridge 339 on the Copper River Highway.

Arizona

In Arizona, the existing regional regression equations used for estimating magnitude and frequency of floods were developed using peak-flow from streamflow records and watershed data through 1986. Since then, 25 years of additional peak-flow data have been collected and advanced geographical information system (GIS) data and tools are available for identifying watershed characteristics related to flood hydrology in Arizona.

The AzWSC is in the final year of a project that includes the implementation of StreamStats and the updating of flood frequency relations for Arizona. In addition to flood frequencies, flood volume probabilities will be determined for selected sites. The project is in cooperation with Maricopa County and other counties throughout the state. Project completion is anticipated this year.

Arkansas

No highway related projects at this time.

California

Planned studies include the proposal of a low-flow study and/or development of regional equations for duration flows.

Additiional work into Flood Inundation Mapping is being explored.

Recent Publications

Sneed, Michelle, Brandt, Justin, and Solt, Mike, 2013, Land subsidence along the Delta-Mendota Canal in the northern part of the San Joaquin Valley, California, 2003–10: U.S. Geological Survey Scientific Investigations Report 2013–5142, 87 p., http://pubs.usgs.gov/sir/2013/5142/.

Minear, J.Toby, Wright, Scott A., 2013, Hydraulic and Geomorphic Assessment of the Merced River and Historic Bridges in Eastern Yosemite Valley, Yosemite National Park, California: Sacramento, California, United States Geological Survey, Open-File Report 2013-1016, 74 p.

Colorado

In 2013, the Colorado Water Science Center (CWSC), in cooperation with the Colorado Department of Transportation (CDOT) operated hydrologic monitoring stations in the vicinity of two recent wildfires (High Park Fire near Fort Collins and Waldo Canyon Fire near Colorado Springs). The stations provide data for interpretation of post-wildfire conditions such as land-condition changes, potential streamflow and sediment runoff including debris flow, and real-time hazard information to assist CDOT and other agencies with early flood warning. The early warning system installed in Waldo Canyon, which includes a streamgage, precipitation gage, and a real-time camera is designed to provide CDOT with information

needed to close U.S. Highway 24, if needed in response to flood or debris flow. Additionally, not previously reported estimates of post-wildfire debris-flow probability and volume were modeled for the High Park Fire and Waldo Canyon Fire in response to 2-, 10-, and 25-year recurrence rainstorms of 1-hour duration, and a similar debris-flow hazard analysis was done for the West Fork Fire Complex near South Fork in southwestern Colorado. Potential debris flows from the High Park Fire, Waldo Canyon Fire, and West Fork Fire Complex have the potential to impact roadways such as Colorado Highway 14, U.S. Highway 24, and U.S. Highway 160, respectively, as well as local county and forest roads. The potential impact of post-wildfire flood and debris-flows to highways, roads, bridges, and culverts is substantial. Estimated post-wildfire debris-flow volumes in response to some rainstorms exceeded 100,000 cubic meters.

In 2013, the CWSC, in cooperation with CDOT completed the development of a Web-based historic flood information database for Colorado. The database uses an ARCGIS map interface to facilitate easy access to USGS data including indirect streamflow measurements published in USGS Water-Supply Papers and USGS Data Reports, indirect streamflow measurements stored in USGS offices, paleoflood measurements published in scientific journals, and the peak flood of record information at all USGS gages in Colorado available from the USGS National Water Information System. The Web-based Colorado flood database provides CDOT engineers involved in road and bridge design with access to data that have been collected for a specific location or basin of interest, as well as access to future data through annual database updates through 2016. The Colorado Flood Database is available at http://cwscpublic2.cr.usgs.gov/projects/coflood/COFloodMap.html. The Colorado Flood Database could serve as a national template for USGS to serve flood data over the internet similar to the way that StreamStats provides the results of USGS peak-flow- and low-flow regressions equations on a statewide basis. The CWSC in cooperation with CDOT also initiated a project to use paleoflood and streamflow data to update the flood-frequency equations in the Plains hydrologic region in eastern Colorado. Previously collected and new paleoflood data will be analyzed along with existing flood data to provide peak discharge estimates needed to update the regional-flood equations for eastern Colorado. A USGS Scientific Investigations Report will be published in 2015 to document the methods and results of the paleoflood study.

References

Kohn, M.S., Jarrett, R.D., Krammes, G.S. and Mommandi, Amanullah, 2013, Web-based flood database for Colorado, water years 1867 through 2011: U.S. Geological Survey Open-File Report 2012-1225.

Verdin, K.L., Dupree, J.A., and Stevens, M.R., Postwildfire debris-flow hazard assessment of the area burned by the 2013 West Fork Fire Complex, southwestern Colorado: U.S. Geological Survey Open-File Report 2013-1259.

Verdin, K.L., Dupree, J.A., and Elliott, J.G., Probability and volume of potential postwildfire debris flows in the 2012 Waldo Canyon Burn Area near Colorado Springs, Colorado: U.S. Geological Survey Open File Report 2012-1158.

Verdin, K.L., Dupree, J.A., and Elliott, J.G., Probability and volume of potential postwildfire debris flows in the 2012 High Park Burn Area near Fort Collins, Colorado: U.S. Geological Survey Open-File Report 2012-1148.

Connecticut

Chloride (Cl) concentrations and loads and general water chemistry were assessed to evaluate potential effects of road-deicer applications on stream-water quality in four small (less 5.98 mi^2) watersheds intersected by Interstate 95 in southeastern Connecticut from 2008-11. Water-quality samples were collected and specific conductance was measured continuously at paired water-quality monitoring sites to observed conditions upstream and downstream of I-95. Streamflow and water-quality data were compared with weather data and with the timing, amount, and composition of deicers applied to state highways.

Cl concentrations at the eight water-quality monitoring sites during winter storms peaked as high as 270 mg/L in the predominantly forested and undeveloped watersheds, and were well below the U.S. EPA recommended chloride toxicity criteria. Cl concentration peaks (1) varied with the type of winter storm event and were highest during or after winter storms of frozen precipitation and rain, in which the rain or melt water effectively washes off the deicers; and (2) correlated positively with the duration of deicer application but generally not with streamflow. A multiple linear regression model was developed to describe the variability of the natural log of peak Cl concentrations. Five significant variables best explained the variability in the natural log of the peak chloride concentration after deicing events: (1) snow on ground before deicing event; (2) precipitation type; (3) specific conductance in baseflow; (4) highway lane miles divided by watershed area; and (5) amount of Cl amount from deicers applied to State roads per lane mile.

Preliminary report:

Brown, C.J., Mullaney, J.R., Morrison, J., Mondazzi, R., 2011, Preliminary assessment of chloride concentrations, loads, and yields in selected watersheds along the Interstate 95 corridor, southeastern, Connecticut, 2008-09: U.S. Geological Survey Open-File Report 2011-1018, 41 p. Available online at : http://pubs.usgs.gov/of/2011/1018.

Final report:

Brown, C.J., Mullaney, J.R., Morrison, Jonathan, Martin, J.R., and Trombley, T.J., (in review), Chloride in Streams of Watersheds Along Interstate 95, Southeastern Connecticut, 2008–11--Loads, Local Comparisons with Groundwater, and Factors Affecting Peak Concentrations: U.S. Geological Survey Scientific Investigations Report XXXX-XX, XX p.

Delaware

No highway related projects at this time.

District of Columbia

No highway related projects at this time.

Florida

During fiscal year 2013, the Florida Water Science Center continued a baseline monitoring project in collaboration with the Florida DOT to better understand the current hydrologic setting of the Cecil Webb and Yucca Pens managed areas. The hydrology of these two areas has been altered by recent development that includes the corridor of Interstate Highway 75 (I-75). Construction and surveying of 16 Staff and Crest Stage Gages to monitor water level peaks within manged areas, 2 real-time stage stations, and 2 tidal flow/salinity/temperature stations within Charlotte Harbor Preserve State Park, one also recording rainfall and air temperature data, has been completed. Monitoring projected completion July 30, 2014.

Georgia

The USGS in cooperation with the Georgia Department of Transportation and Georgia Environmental Protection Division is in the process of implementing StreamStats for Georgia. StreamStats is expected to be fully implemented in Georgia in September 2014.

Georgia Water Science Center maintains a statewide network of 60 crest-stage gages as part of an ongoing flood-frequency study.

Recent Publications

Gotvald, A.J and Knaak, A.E., 2011, Magnitude and frequency of floods for urban and small rural streams in Georgia, 2008: U.S. Geological Survey Open-File Report 2011-5042, 39 p. Available online at: http://pubs.usgs.gov/sir/2011/5042/.

Guam

The Pacific Islands Water Science Center operates a network of 2 crest-stage gages in Guam to monitor peak stages and discharges at or near highway crossings. The peak-flow data collected at these gages adds significantly to peak-flow data collected at continuous-recording streamflow monitoring stations and improves regional coverage of peak-flow measurements.

The Pacific Islands Water Science Center operates 6 stream-flow monitoring stations in Guam. Data from these gages are used for post-flood analysis.

The Pacific Islands Water Science Center operates 3 real-time rain gages and one real-time reservoir monitoring station in Guam. Data from these gages are used to aid flood warning and flood forecasting.

Hawaii

The Pacific Islands Water Science Center operates a network of 66 crest-stage gages to monitor peak stages and discharges at or near highway crossings on the islands of Kaua`i, Oahu, Moloka`i, Maui, and Hawai`i. The peak-flow data collected at these gages adds significantly to peak-flow data collected at continuous-recording streamflow monitoring stations and improves regional coverage of peak-flow measurements in Hawai`i.

The WSC also monitors rainfall, streamflow, and daily suspended-sediment concentration and load in North Halawa Stream to study impacts in the H-3 freeway corridor and receiving water bodies.

The WSC operates 19 real-time rain gages, 53 real-time streamflow monitoring stations, and 7 reservoir monitoring stations on the islands of Kaua`i, Oahu, Moloka`i, Maui, and Hawai`i. Data from these gages are used to aid in flood warning, flood forecasting, and post-flood analysis.

Idaho

The Idaho Transportation Department uses the Idaho StreamStats web site extensively in the design of their Idaho Bridge Watch program (an early-warning bridge scour monitoring program based on the Q25 and Q50) as well as for other transportation-related design projects. The Idaho StreamStats website is at http://water.usgs.gov/osw/streamstats/idaho.html

The BLM and USGS wrapped-up their project to define minimum streamflows or streamflow statistics needed to maintain outstanding remarkable values within stream segments designated “Wild & Scenic” in southwest Idaho. The water right proposal was intended to protect the rivers in the study area from future development and excessive water demands. Unfortunately, the study area currently lacked sufficient streamflow data, and streamflow statistics obtained from the U.S. Geological Survey StreamStats program are imprecise for this purpose. The USGS Idaho Water Science Center collected short-term streamflow data at selected locations and indexed those stations to streamflow data collected at long-term streamgages to produce exceedance probability distributions and synthetic streamflow records, as shown in the Wood and Fosness report below..

The Idaho Water Science Center is collecting streamflow, sediment, bathymetry, and videography data from the Kootenai River in Northern Idaho in support of the Kootenai River Habitat Restoration Program being conducted by the Kootenai Tribe of Idaho to restore listed Kootenai White Sturgeon. The information that the USGS is providing will be used to guide project remediation design and to evaluate changes resulting from remedial efforts. A multidimensional hydraulic flow model was developed for the spawning reach of the Kootenai River and will continue to be calibrated and used as a tool to predict changes to the channel morphology following remedial modifications.

In late FY13/early FY14, in cooperation with Blaine County in Idaho, the USGS developed a debris flow model to estimate the probability of occurrence, volume, and combined hazard ranking of debris flows in a heavily burned area near Ketchum Idaho. The model used topographic, soil, burn severity, and storm (rainfall) intensity variables to estimate the probability and volume of debris flows that may threaten homes and transportation routes in response to precipitation events. .

Recent Publications

Wood, M.S., and Fosness, R.L., 2013, Streamflow monitoring and statistics for development of water rights claims for Wild and Scenic Rivers, Owyhee Canyonlands Wilderness, Idaho, 2012: U.S. Geological Survey Scientific Investigations Report 2013–5212, 66 p.

Skinner, K.D., 2013, Post-fire debris-flow hazard assessment of the area burned by the 2013 Beaver Creek fire, near Hailey, central Idaho: U.S. Geological Survey Open-File Report 2013-1273, 11 p., 9 pls.

Illinois

Pier and Contraction Scour in Cohesive Soils: In Straub and Over (2010), the results of testing the Scour Rate In Cohesive Soils-Erosion Function Apparatus (SRICOS-EFA) method for estimating scour depth of cohesive soils at 15 bridges in Illinois were presented. In the current study, a component of the SRICOS-EFA method, which includes the calculation of the maximum contraction and pier scour, known as Zmax, is further tested for 15 additional bridge sites. The sites meet geotechnical criteria for cohesive soils, and were modeled with scour depths calculated using SRICOS Zmax, HEC-18 and the Illinois DOT cohesive soil reduction-factor method. The results were compared to measured scour data. The hydraulic parameters for the Zmax calculation are obtained from HEC-RAS/HEC-18. The soil parameter (critical shear stress) is from the relationship published in the 2010 report, which requires input of a laboratory-determined compressive soil strength, Qu. An evaluation of the relation of laboratory with field Qu values has been completed to develop a correlation to allow field Qu values to be used to provide the critical shear stress. The final report was published in 2013.

Urban Flood Frequency: The rural regional flood-frequency (F-F) equations for Illinois (IL) that were developed by the USGS and implemented in the online tool, StreamStats (SS) are widely used throughout the State to compute peak discharges for design of bridges, culverts, and other purposes. With increased urbanization, especially in northeastern IL, regional F-F equations that include the effects of urbanization are needed. The most recent urban regional F-F equations for IL were published in 1979 and are not implemented in SS because the data and methods have been superseded. The USACE recently funded the adjustment of the annual peak discharge time series records at gages in northeastern IL to 2010 land-use conditions. These time series utilize new streamflow, land-use, and precipitation data to represent current conditions. These time series are being analyzed to develop an accurate and easy-to-use method of determining peak discharges for design and reference. The analysis enables the transfer of urbanization effects to other regions in IL, and the implementation of the

methods in the IL SS. This project is in cooperation with the Illinois Center for Transportation and is to be completed by January 2016.

Flood inundation map libraries for four USGS streamgage sites (two with collocated NWS flood forecast points) that can assist with highway, road, and bridge operations during floods have been published and can be accessed from http://il.water.usgs.gov/ifhp/ These map libraries were completed in cooperation with various local agencies.

Recent Publications

Straub, T.D., Over, T.M., and Domanski, M.M., 2013, Ultimate Pier and Contraction Scour Prediction in Cohesive Soils at Selected Bridges in Illinois, Illinois Center for Transportation Report FHWA-ICT-13-025, 40p. http://ict.illinois.edu/Publications/report%20files/FHWA-ICT-13-025.pdf

Straub, T.D., and Over, T.M., 2010, Pier and Contraction Scour Prediction in Cohesive Soils at Selected Bridges in Illinois: Illinois Center for Transportation Report FHWA-ICT-10-074, 119 p. http://ict.illinois.edu/Publications/report%20files/FHWA-ICT-10-074.pdf

Murphy, E.A. and Sharpe, J.B., 2013, Flood-inundation maps for the DuPage River from Plainfield to Shorewood, Illinois, 2013: U.S. Geological Survey Scientific Investigations Map 3275, 9 sheets, 8-p. pamphlet, http://dx.doi.org/10.3133/sim/3275.

Indiana

In 2013 the USGS operated 26 streamgages in cooperation with the Indiana DOT.

Flood inundation map libraries have been developed for 7 USGS streamgage sites and collocated NWS flood forecast points, to assist with highway, road, and bridge operations during floods. One library was published in 2012, 4 in 2013 and an additional 2 were completed pending technical or USGS approving official review. All are scheduled to be complete by the end of 2014.

The USGS is participating in an Indiana Silver Jackets Hazard Mitigation Taskforce Fluvial Erosion Hazard (FEH) project. This multi-year project, started in 2011 and continued through 2012, is providing science-based tools for the use of federal, state, and local agencies in mitigation of hazards caused by riverine erosion. Tools include regional curves for use in assessing stream stability and a bridge screening tool that can be used to assess the erosion potential at bridge sites. A key stakeholder group for use of FEH products is transportation officials.

Recent Publications

Fowler, K.K., and Bunch, A.R., 2013, Flood-inundation maps for the Iroquois River at Rensselaer, Indiana: U.S. Geological Survey Scientific Investigations Map 3246, 9 map sheets, 8-p pamphlet, available at http://pubs.usgs.gov/sim/3246.

Lombard, P.J., 2013, Flood-inundation maps for the Wabash River at Terre Haute, Indiana: U.S. Geological Survey Scientific Investigations Map 3232, 22 sheets, 7-p. pamphlet, http://pubs.usgs/gov/sim/3232/.

Lombard, P.J., 2013, Flood-inundation maps for the East Fork White River at Columbus, Indiana: U.S. Geological Survey Scientific Investigations Map 3255, 15 sheets, 8-p. pamphlet, http://pubs.usgs/gov/sim/2013/3255/.

Menke, C.D., Bunch, A.R., and Kim, M.H., 2013, Flood-inundation maps for the Tippecanoe River near Delphi, Indiana: U.S. Geological Survey Scientific Investigations Map 3243, 13 sheets, 9-p. pamphlet, available at http://pubs.usgs.gov/sim/3243.

Robinson, B.A., 2013, Recent (circa 1998 to 2011) channel-migration rates of selected streams in Indiana: U.S. Geological Survey, Scientific Investigations Report 2013–5168, 14 p. plus 1 app., http://pubs.usgs.gov/sir/2013/5168/.

Robinson, B.A., 2013, Regional bankfull-channel dimensions of non-urban wadeable streams in Indiana: U.S. Geological Survey, Scientific Investigations Report 2013–5078, 33 p., available only at http://pubs.usgs.gov/sir/2013/5078.

Iowa

The Iowa Water Science Center cooperatively funds 26 continuous-record gaging stations and 88 crest-stage gages.

Iowa WSC cooperatively funds ongoing flood-profiles project to document water-surface-elevation profiles of significant flood events. A compilation report has been prepared and is currently receiving peer review. This report summarizes 46 USGS flood-profile reports that were published for streams in Iowa during a 50-year period from 1963 to 2012. Streams in Iowa that have been selected for the preparation of flood-profile reports typically have drainage areas of 100 mi^2 or greater and have annual exceedance probabilities of less than 2-4 percent, or recurrence intervals greater than 25-50 years. This report summarizes flood-profile measurements, the content of flood-profiles reports, streams that were profiled in the reports, and annual exceedance-probability estimates of observed flood events.

Iowa StreamStats: The results of a study to develop a comprehensive flood-estimation method for unregulated, rural streams in Iowa were published in 2013. Regression equations for estimating annual exceedance-probability discharges (AEPDs) were developed for use in Iowa. The regression equations relate AEPDs to physical and climatic characteristics of drainage basins. The regression equations developed from the study were implemented in the USGS StreamStats program. A report presents 24 regional regression equations that can be used to estimate eight selected annual exceedance-probability statistics for ungaged sites in Iowa. The report also presents the results of a regional skew analysis performed for Iowa to develop updated regional skew coefficients for all streamgages in the State. AEPDs computed for 518 streamgages using the new EMA annual exceedance-probability analysis are

presented in the report. The accuracy and limitations of the regression equations and the methodology used to develop the equations are described in the report.

Recent Publications:

Eash, D.A., Barnes, K.K., and Veilleux, A.G., 2013, Methods for estimating annual exceedance-probability discharges for streams in Iowa, based on data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2013–5086, 63 p. with appendix. Report is available at http://pubs.usgs.gov/sir/2013/5086/.

Kansas

The Kansas Water Science Center began a project to add Kansas to the USGS National Streamstats Program which provides users with access to an assortment of analytical tools that are useful for water-resources planning and management, and for engineering design applications, such as the design of bridges.

The Kansas Water Science Center operated 5 crest-stage gages in small drainage basins, some urban and some rural, for use in future flood frequency determinations. Annual peaks for 2012 were compiled and published in the USGS Peak Flow File.

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.

Analysis of Flood Magnitude and Frequency in Louisiana: Streamflow statistics are used by government agencies, engineers, scientists, and environmental groups for the purpose of water management, permitting, and design. The primary source of streamflow data are streamgages operated by the USGS. The magnitude and frequency for floods are primary in considering bridge design. The USGS proposes update flood frequency statistic at gaging stations, and provide updated regression equations to estimate flood frequency at ungaged sites.

Water Use in Louisiana: Historical and current water-use data are essential for analysis of water allocations, environmental effects, and future development of our water resources. State and local governments, private industries, and Federal Agencies use water-use data in Ground-Water modeling, Water-Use projections, and in assessments of water resources in a particular area. Collection of these data provides up-to-date information for major water users throughout Louisiana and promotes improved reporting, quality, and accuracy of data provided by these facilities.

Simulation of Ground-Water Flow in the "1,500-Foot" and "2,000-Foot" Sands and Movement of Saltwater in the "2,000-Foot" Sand of the Baton Rouge Area, Louisiana: Saltwater encroachment has been detected in six aquifers, including the "1,500-ft" and "2,000-ft" sands, north of the Baton Rouge fault in East Baton Rouge Parish. The encroachment is in response to groundwater withdrawals, primarily for public supply and industrial uses, in Baton Rouge. Additional information is needed for water planners and managers in the Baton Rouge area to make decisions on future management of ground-water resources in the area. The impact of the pumping wells on ground-water flow and the northward encroachment of saltwater are not well known. The time and route for saltwater to travel from the fault to pumping centers is not known. The need for and possible locations of additional pumping wells, injection wells, or observation wells is not known. A computer model has been proposed to simulate past, current, and a variety of possible future conditions in the "1,500-foot" and "2,000-foot" sands. Such a model would pro-vide a tool to water planners and managers to evaluate possible management alternatives, and in-crease the understanding of saltwater movement in aquifers in similar hydrogeologic settings.

Development and maintenance of a computer model to simulate groundwater flow and saltwater encroachment in the Baton Rouge Sands: Ten aquifers beneath the Baton Rouge area are used for freshwater supplies and are variably impacted by water-level declines and/or saltwater encroachment. Long-term water-level declines have occurred in most of these aquifers and saltwater encroachment has been detected. The USGS recently developed a computer model to simulate past, current, and a variety of possible future conditions in the "1,500-foot" and "2,000-foot" sands. Over the next 10 years, this model will be updated, modified, and recalibrated to accurately simulate groundwater conditions in all 10 Baton Rouge sands. The model will provide a tool for water planners and managers to assess the impacts of pumpage changes on all the aquifers.

Trends in Groundwater levels and Stream discharge in Louisiana, 2000- 2010: Louisiana has abundant supplies of fresh ground-water and surface-water. However, increasing withdrawals of water and subsequent affects are a concern to public officials. Knowledge of water-level and surface-water discharge trends will help water managers optimize ground-water and surface-water resources.

Maine

Methods for computing a wide range of flows, from very low to very high flows; suitable for estimating flow-duration curves at ungaged locations in Maine: Variable flow statistics at USGS streamflow gages are being derived on annual and monthly bases; spanning a wide range of exceedance probabilities (e.g. 0.01, 0.05, 0.10, 0.25, 0.50, 0.75, 0.90, 0.95, 0.99). Derived regression equations will be published in a USGS Scientific Investigations Report. Not only will these regression equations provide managers and engineers with more complete flow information at ungaged locations, they provide the means for estimating flow duration curves at ungaged locations. With this ability, it paves the way for the development of more sophisticated methods for flow estimation at ungaged locations.

Evaluating the use of field indicators for computing design streamflows for small ungaged streams in Maine: The USGS, in cooperation with MaineDOT, is testing the feasibility and accuracy of methods to estimate streamflows for ungaged streams in Maine, using easy-to-measure field indicators in the vicinity of the site of interest, including culvert rust lines and channel width. To date, field reconnaissance and data collection have been completed and analyses are partly complete; analyses will be completed in FY2014.

Implementing a Web-Based Streamflow Statistics Tool for Maine: Streamstats: The USGS, in cooperation with MaineDOT, is implementing a web-based interactive tool named StreamStats for Maine. This tool will provide descriptive information and previously published streamflow statistics and basin characteristics for USGS streamgages and will allow for delineating drainage basins, determining basin characteristics and providing reproducible streamflow statistics for any stream location within Maine for which applicable streamflow regression equations have been published. The bulk of the GIS processing is being completed this fiscal year and is well underway.

Small-watershed data collection: Peak-flow data collection (crest-stage gages) continues on 13 streams, all with basins less than one square mile. Eight sites have 13 complete years of data collection, three sites have 12 complete years of data collection, and two have less than 9 years of data. In addition, 10 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 18 USGS streamflow gages.

Recent Publications

Hodgkins, G.A., and Dudley, R.W., 2013, Modeled future peak streamflows in four coastal Maine rivers: U.S. Geological Survey Scientific Investigations Report 2013-5080, 18 p.

Hodgkins, G.A., and Dudley, R.W., 2013, Modeled future peak streamflows in four coastal Maine rivers: U.S. Geological Survey Fact Sheet 2013-3021, 4 p.

Maryland

Fourteen streamgages were operated cooperatively with the Maryland State Highway Administration (MDSHA).

Massachusetts

Flood Frequency Analysis: The study will improve estimates of annual exceedance probability flood magnitudes at streamgages and ungaged sites in Massachusetts by using current available data with new analysis techniques and will serve the statistics and predictive equations on the on-line Streamstats web application. Estimates of the 20, 10, 4, 2, 1, 0.5, and 0.2 percent annual exceedance probability

flood flows will be generated for selected streamgages in Massachusetts and neighboring states; Predictive equations for use at ungaged sites will be developed by using the best-fit explanatory basin characteristics.

Characterization of Total Nutrients and Suspended Sediment Concentrations in Stormwater Runoff from Bridge Decks in Eastern Massachusetts: While extensive information exists on stormwater runoff from Massachusetts highways as a whole, available information focused on bridge deck runoff is lacking. Therefore, the primary objective of this investigation is to characterize concentrations and loads of total phosphorus and suspended sediment from at least three bridges in Eastern Massachusetts over a two year period. This study also will evaluate the potential transferability of these data to other highway sites by performing a statistical comparison with previous highway runoff data (U.S. Geological Survey Scientific Investigations Report 2009-5269) in relation to traffic volume and total imperviousness surrounding the bridge location (1-mile radius). These new data will be entered into an updated version of the Federal Highway Runoff Database (FHWA-HEP-09-004), which will be used to support model estimates of loads and concentrations for phosphorus and suspended sediment from bridge-deck runoff for the proposed monitoring sites.

Michigan

A network of 8 streamgages and 5 crest-stage gages were operated in cooperation with Michigan Department of Transportation. In addition, 25 other crest-stage gages located at or near highway crossings provide peak stage and streamflow information that is available for local and state transportation agencies. Peak-flow data from the crest-stage gage network is also used to augment data collected at 150 additional continuous-recording streamgages operated in Michigan and enhances coverage of peak-flow measurements in the region.

Minnesota

The USGS Minnesota Water Science Center operates a network of 79 crest-stage gages that record peak-flow at or near highway crossings. Two of those crest-stage gages provide real-time stage for hydropower and flood warnings. The peak-flow data collected at these stations augments data collected at the 155 continuous recording stations operated in Minnesota and enhances coverage of peak-flow measurements in the region.

StreamStats operation and maintenance for FY 13 included adding a “Zoom To” bridge location utility that will allow users of StreamStats to select a bridge from a list and zoom to that location.

MN WSC provided hydraulic investigation support, and bridge scour monitoring as requested.

The U. S. Geological Survey, in cooperation with the White Bear Lake Conservation District, Minnesota Pollution Control Agency and other state, county, municipal, and regional planning agencies, watershed organizations, and private organizations, conducted a one-year study to characterize groundwater and surface-water interactions in White Bear Lake and their effect on water levels in the lake. Between

2010 and 2011, White Bear Lake and other lakes in the northeastern portion of the Twin Cities metropolitan area were at historically low levels. Water samples were collected for major constituent and stable isotope analyses from White Bear Lake and other nearby lakes. Results from these analysis indicated that sodium and chloride concentrations were higher in surface water from small lakes that border roads that are heavily salted during the winter months. The application of road salt application is a likely explanation for the high sodium and chloride concentrations observed in the lakes. The Minnesota Department of Transportation has been concerned about the effects of road salting on water resources, and with lake levels in areas of Minnesota where there are lakes that are rising to the point of overtopping roads. The White Bear Lake study is in review and is expected to be published this winter.

USGS is collecting sediment and streamflow data that are used by the Department of Natural Resources to validate statewide stream restoration directives. The DNR, Division of Ecological and Water Resources, uses HEC-RAS models to improve culvert designs at stream/road crossings in order to improve ecological function, water quality, and ensure channel and floodplain connectivity. Proper culvert design and placement is needed to ensure transport of water and sediment in such a manner that the stream is able to maintain its dimension, pattern, and profile over an extended time without either aggrading or degrading. HEC-RAS modeling is used to simulate transport of streamflow and sediment through bridges, culverts, piers, and dams. Validation of the model through measured streamflow and sediment data are critical to successful bridge and culvert designs, and when needed the restoration of damaged stream systems.

The USGS, in cooperation with the Minnesota Department of Natural Resources is conducting a study to develop region regression equations for flow-duration curves in the state. The results of the study will enable hydrologists to simulate flow conditions at ungaged locations and will assist in efforts such as ecological flows and TMDLs.

Recent Publications

Kessler, Erich W.; Lorenz, David L.; Sanocki, Christopher A., 2013. Methods and results of peak-flow frequency analyses for streamgages in and bordering Minnesota, through water year 2011: USGS Scientific Investigations Report: 2013-5110

Czuba, Christiana R.; Fallon, James D.; Kessler, Erich W., 2012, Floods of June 2012 in northeastern Minnesota 2012: USGS Scientific Investigations Report: 2012-5283

Brooks, K. N.; Fallon, J. D.; Lorenz, D. L.; Stark, J. R.; Menard, Jason, 2011, Flooding and Flood Management, in Water policy in Minnesota--Issues, incentives, and action, Easter, K. William and Perry, Jim eds.: RFF Press, New York, 308 p.

Mississippi

The USGS Mississippi Water Science Center had a number of continuing projects into 2013, including:

- providing 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.
- operating and maintaining 98 crest-stage gages and 2 flood hydrograph gages.
- operating a near-real-time scour monitoring gage at a coastal bridge. Streambed soundings are obtained at this and other selected bridges to document scour.
- preparing 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. Expected Moments Algorithm (EMA) will also be included in the analyses to complete the study in FY 2014.

During 2013, MS WSC personnel flagged, surveyed, and provided high-water marks for about a dozen road crossings of Turkey Creek, Harrison Co., for use by a consultant preparing a 2-D flow model for MDOT.

In late FY 2010, MS WSC began a 3-year cooperative project with the City of Hattiesburg and other city, county, and State agencies to produce a digital library of flood-inundation maps to visually determine the areal extent of flooding corresponding to a NWS-forecasted Leaf River stage.

The project consists of two parts. Part one was completed in 2012 and included a 1-D flow model of the Leaf River through the city, which is described in the publications listed below and in the interactive inundation mapper available at http://wim.usgs.gov/FIMI/

Part two includes expansion of the flow model upstream of the city to include a major tributary, Bouie River. The reports listed below and the inundation mapper will be revised to include Bouie River in FY 2014.

Recent Publications

Storm, J.B., 2012, Flood inundation mapping for the Leaf River at the city of Hattiesburg, MS [abs.]: Proceedings of the 2012 Mississippi Water Resources Conference, Jackson, Mississippi, April 3-4, 2012, p.129, available online at http://www.wrri.msstate.edu/pdf/2012_wrri_proceedings.pdf

Storm, J.B., 2012, Flood-inundation maps for the Leaf River at Hattiesburg, Mississippi: U.S. Geological Survey Scientific Investigations Map 3228, 8 p. pamphlet, 13 sheet

Missouri

Ongoing activities of the Missouri Water Science Center in 2013 included:

- continued operation of a network of 38 crest-stage gages.

- continued operation and maintenance of the statewide network of streamgages, 7 of which are operated in cooperation with MoDOT.
- Continued operation of near-real-time scour monitors at Chariton River near Novinger, Missouri, and at both main channel piers of Missouri River at Jefferson City, Missouri.
- Completion of bathymetric surveys at the site of a new bridge for US 59 over the Missouri River at Atchison, KS for Kansas DOT.

Revision of rural regression equations for Missouri: Existing regression equations for rural basins in Missouri are based on skew values derived from data through the 1973 water year. Since then 37 years of additional data has been collected to improve the accuracy of the skew map. The Bulletin 17B skew map does not distinguish between model and sampling errors in the data. Thus, it is likely that station skews are over weighted resulting in a bias in the final streamgage flood frequency analyses. Historical floods were primarily ignored in the 1995 study because of the limited methodology of treating censored data. An in-depth analysis of historical information and use of historical peaks is needed. Development of areal comparisons of peak runoff rates is also needed for historical floods. Results will be used to extend streamgage records. Bayesian Generalized Least Squares technique for regional skew analyses will be performed to develop more accurate skew(s) values for Missouri. Expected Moments Algorithm (EMA) released in November 2007 by the USGS will be used to analyze censored data more rigorously. Record extension improves the accuracy and reliability of at-site streamgage flood frequency analyses. Extending streamgage records where historical flood events have been recorded will result in much improved at-site flood frequency estimates. Revision of the skew map will improve the accuracy of at-site flood frequency estimates and resulting regional regression equations. The EMA technique improves the estimation of flood frequency discharges for streamgage records that include censored data such as historical events and less-than-value discharges. About 25 percent of the streamgages in Missouri have censored data.

Development of dimensionless unit hydrographs for urban areas in Missouri: Streamflow data collected at streamgages inherently reflect unique characteristics of the basin upstream, such as peak magnitude, lag time, flow volume, and baseflow. These components can be defined for a basin and used to develop a unit hydrograph for the basin, which is the hydrograph that would result from a basin given a unit (1 inch) of rainfall excess over the basin. A unit hydrograph can be a useful part of the process of watershed modeling or design of stormwater-management structures. Flood hydrographs may be used to determine the water-surface elevation and duration of inundation at and upstream from roadways and drainage structures, as well as to estimate flood volumes for combined sewer systems. The primary objective of this study is to develop a new dimensionless unit hydrograph for urban basins in Missouri, using parameters similar to the recently-revised urban flood frequency equations and developing new regression equations to compute peak discharge (based on rainfall), unit hydrograph peak discharge and time to peak using the Gamma unit hydrograph, and storm volume based on selected basin and flow characteristics. These equations can be used to determine unit hydrographs and flood volumes at urban ungaged sites for a given design storm.

Recent Publications

Huizinga, R.J., 2013, Results of repeat bathymetric and velocimetric surveys at the Amelia Earhart Bridge on U.S. Highway 59 over the Missouri River at Atchison, Kansas, 2009–2013: U.S. Geological Survey Scientific Investigations Report 2013–5177, 50 p., at http://pubs.usgs.gov/sir/2013/5177.

Montana

The MTWSC provided contaminant time of travel information to the MT Dept of Transportation and the MT Dept of Environmental Quality for a chemical release to a tributary of the Yellowstone River resulting from a traffic accident.

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 to assist with infrastructure design is currently operating 86 crest-stage gages.

A cooperative project continues to investigate the hydrology of selected wetland areas affected by proposed and recently constructed highway projects.

MTWSC continues to monitor scour and related hydraulic conditions at the I-90 bridge near the mouth of the Blackfoot River following the 2008 removal of Milltown Dam, which was located just downstream on the Clark Fork.

MT WSC is determining flood-frequency estimates and the impact of climate change for more than 660 USGS gaging stations in Montana based on data through water year 2011.

Nebraska

NEWSC cooperated with the NDOR to conduct sequential bathymetric surveys of the Missouri River using a multi-beam echosounder at all 16 highway bridges along the Nebraska-Iowa/South Dakota/Missouri border to monitor the effects of scour on bridge infrastructure during the 2011 Missouri flood during FY11. The report will be published in FY14.

Several studies investigating the cumulative effects of human activities such as transportation infrastructure on the lower Platte River corridor ecosystem are being conducted in cooperation with local, state, and federal agencies. Techniques such as time-lapse photography, sediment sampling over time, and sediment transport modeling are being used to study impacts on geomorphology and habitat on river reaches at or near bridges.

A study is underway to update peak-flow frequency analyses for streamgages in Nebraska. This project would be the first step in a phased approach to implement StreamStats in Nebraska.

Recent Publications

Alexander, Jason S.; Schultze, Devin M.; Zelt, Ronald B. Emergent sandbar dynamics in the lower Platte River in eastern Nebraska: methods and results of pilot study, 2011: USGS Scientific Investigations Report: 2013-5031, 54 p. Available online at http://pubs.er.usgs.gov/publication/sir20135031.

Nevada

NV Water Science Center maintains a Statewide network of crest-stage gages: 24 with the Nevada Department of Transportation and 4 with the US Army Corps of Engineers. A report describing flood frequencies at crest-stage gage locations is to be published in FY14.

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. A Scientific Information Report was published in FY09. A three-year agreement with the Nevada Department of Transportation to continue monitoring sediment and selected water quality constituents in the Clear Creek drainage was signed in October 2009. The report for the continuation of this project will be published in FY14. A new agreement to continue the study to extend the project through FY16 was signed in August 2013.

New Hampshire

New Hampshire Department of Transportation (NHDOT) funds approximately one-third of New Hampshire's stream-gaging network.

In response to concerns about nitrate contamination of groundwater from roadway rock blasting, the New Hampshire Department of Transportation (NHDOT) asked the USGS to conduct a study of the concentrations and isotopic compositions of nitrate and other nitrogen compounds in groundwater. Using the isotopic signature of these compounds, nitrate derived from septic system (human waste) sources can be differentiated from nitrate that is sourced from blasting agents (ammonium nitrate and fuel oil). This study will help the NHDOT determine when it is responsible for nitrogen (nitrate) contamination of groundwater as a result of their roadway construction efforts that involve blasting for rock removal. Additional water chemistry data will used to corroborate findings and to develop relations between isotopic data and more commonly collected constituents in groundwater.

Publications:

Olson, S.A., and Bent, G.C., 2013, Annual exceedance probabilities of the peak discharges of 2011 at streamgages in Vermont and selected streamgages in New Hampshire, western Massachusetts, and northeastern New York: U.S. Geological Survey Scientific Investigations Report 2013–5187, 17 p., http://dx.doi.org/10.3133/sir20135187.

New Jersey

A bridge scour data collection project 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 is a long-term project with additional monitoring locations added this year. The monitoring work being done in FY2013 includes:

- Operate and maintain continuous-record discharge gaging stations at 10 locations to provide discharge data to improve models to calculate scour. Gage height and discharge data available in near real-time on our website at http://nj.usgs.gov/index.html
- Continuous monitoring of streambed elevations at selected locations near bridge piers and abutments at 2 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 is available in near real-time from our website: http://waterdata.usgs.gov/nj/nwis/current/?type=bridge&group_key=basin_cd
- Survey channel cross-sections at multiple locations upstream and downstream of the bridge at the gages and at bridges at an additional 20 sites to monitor changes in channel geometry over time.
- A crest-stage gage is operated and maintained at one bridge to record peak stage and discharge.
- An Acoustic Doppler Velocity Meter was operated and maintained to record a continuous-record of velocity at one gaging station.

New Mexico

Flood Analysis:

- Operate and maintain the New Mexico crest-stage gage network of 85 gages in ephemeral streams around the State. Fifty-two of the crest-stage gages in the network are currently equipped with automated pressure transducers.
- Continued documentation of notable floods through collection of flood information such as high-water marks, peak stages and discharges by indirect measurements at miscellaneous flooded sites.

StreamStats:

- New Mexico StreamStats development has been partially funded through FY 2013 by the USGS in cooperation with the USDA (Forest Service, Southwestern Region) and the New Mexico Department of Transportation (NMDOT). Information about the StreamStats program can be found at: http://water.usgs.gov/osw/streamstats/new_mexico.html.

- A New Mexico StreamStats pilot area (the portion of the San Juan Basin within New Mexico) is complete, tested, and available online (see web page link above). Coverage should be expanded to include the entire State of New Mexico by the end of FY13 using recently released NHD-Plus Version 2 data. Basic basin characteristics will be available at release and more advanced features could be added in the future.

New York

Transportation-related activities in the New York Water Science Center during 2013 included:

- Documenting 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.
- Maintaining a statewide network of 40 crest-stage gages to determine annual peak flows.
- Completing a flood inundation mapping project for Delhi, NY and work on another project has been funded by the New York State Department of Environmental Conservation for Prattsville, NY, a community heavily damage by Hurricane Irene.
- Implementing the use of GIS techniques to automate the computation of estimated flood frequency discharges at any unregulated stream location in New York using StreamStats.
- Working with the State Emergency Management Office, NYSDOT, NYSGS, and others to develop a statewide landslide susceptibility mapping project. Schenectady County was completed in 2008, but continuation of the project is currently on-hold due to lack of funding.
- Monitoring landslides in and around the Tully Valley, New York area.

Recent Publications

Coon, W.F., and Breaker, B.K., 2012, Flood-inundation maps for the West Branch Delaware River, Delhi, New York, 2012: U.S. Geological Survey Scientific Investigations Map 3216, 9 p. pamphlet, 10 sheets, scale 1:20,000. Available online at http://pubs.usgs.gov/sim/3216

Mulvihill, C. I. and B. P. Baldigo, 2012. Optimizing bankfull discharge and hydraulic geometry relations for streams in New York State. Journal of the American Water Resources Association. v.48, pg 449-463.

Wall, G.R.,, Murray, P.M., Lumia, R.,and Suro, T.P, In Preparation, Maximum Known Stages and Discharges of New York Streams and their Annual Exceedance Probabilities through September 2011.

North Carolina

The USGS North Carolina Water Science Center (NCWSC) continues to maintain and provide the statewide USGS StreamStats application for North Carolina, which was completed in June 2012 in cooperation with the North Carolina Department of Transportation (NCDOT). A USGS Fact Sheet documenting the statewide StreamStats application was published in early December 2012. Usage of the NC StreamStats application outside of the USGS continues to grow with positive feedback being received from external users.

The NCWSC continued to provide support during 2013 to the USGS South Carolina Water Science Center (SCWSC) as part of an on-going urban flood-frequency study being conducted by the SCWSC. The FF statistics developed for the NC sites in 2012 were combined with sites from adjacent or nearby states to develop techniques for estimating urban FF statistics at ungaged sites. The NCWSC assisted in the review of the updated techniques and provided a co-author review of the draft report, which is scheduled to be published by calendar end 2013 or early 2014.

The NCWSC continues to collect data in order to establish baseline bed-sediment chemistry and water-quality conditions and the associated circulation dynamics of Currituck Sound in northeastern North Carolina in the vicinity of the planned alignment of the proposed Mid-Currituck Bridge. These data will be used to evaluate the environmental effects associated with the bridge construction and bridge deck stormwater runoff on Currituck Sound in the second phase of the study. As a result of delays in bridge construction, sampling to establish baseline conditions has been extended to cover a 26-month period leading up to the planned start of bridge construction. Samples are being analyzed for a wide range of constituents that are both informative and applicable to the receiving waters and are mainly those analytes that were identified as parameters of concern in the recently completed study that characterized bridge deck stormwater runoff across North Carolina (Wagner and others, 2011). The analytes being sampled for include metals, nutrients, pH, suspended solids, polycyclic aromatic hydrocarbons (PAHs) and other organic compounds.

The NCWSC continues to operate continuous streamflow gaging stations on Goose Creek at Fairview, NC (USGS Sta. 02124692) and Waxhaw Creek near Jackson, NC (USGS Sta. 02147126) just outside of Charlotte in cooperation with the NCDOT.

Recent Publications

Wagner, C.R., Fitzgerald, S.A., Sherrell, R.D., Harned, D.A., Staub, E.L., Pointer, B.H., and Wehmeyer, L.L., 2011, Characterization of stormwater runoff from bridges in North Carolina and the effects of bridge deck runoff on receiving streams: U.S. Geological Survey Scientific Investigations Report 2011–5180, 95 p. + 8 appendix tables. Available online at: http://pubs.usgs.gov/sir/2011/5180/.

Weaver, J.C., Terziotti, Silvia, Kolb, K.R., and Wagner, C.R., 2012, StreamStats in North Carolina – A water-resources Web application: U.S. Geological Survey Fact Sheet 2012-3137, 4 p. Available online at: http://pubs.usgs.gov/fs/2012/3137/.

North Dakota

The Upper Missouri River regularly received annual peak flows above 100,000 cubic feet per second prior to the completion of the Garrison Dam. Annual peak flows consistently have been between 30,000 and 45,000 cfs following dam completion. The largest flood since dam regulation occurred in 2011 following an abnormally high snow pack season and a week-long rain event in the headwaters. The dam releases have had a discernible impact on the Missouri River throughout this section.

The 2011 flood has highlighted the critical need for quantifying the complex interaction between the regional geomorphology and human activities. It is necessary to first understand and quantify the historical impacts of the dams in order to determine the impact of the 2011 flood on the channel configuration, morphology, and sediment dynamics.

A study by the USGS was initiated in 2012 to: (1) determine channel trajectory following dam closure and subsequent dam operation to provide a baseline for flood studies; (2) determine flood impacts on islands, sand bars, and infrastructure; (3) predict channel change through time around the Bismarck-Mandan area through numerical modeling; (4) assess the post-flood delta for potential ice jam issues and quantify reservoir sedimentation; (5) determine the sources, sinks, and loads of sediment throughout the free-flowing reach; and (6) determine flood impacts on in-channel and floodplain large woody debris and standing trees for island maintenance, sediment balance, fisheries, and navigation interests. Field data collection and data analyses were conducted in 2013 and the project will be completed in December 2014. Several reports and journal articles are planned to describe the study findings; one article was published in Anthropecene in October 2013:

> Katherine J. Skalak, Adam J. Benthem, Edward R. Schenk, Cliff R. Hupp, Joel M. Galloway, Rochelle A. Nustad, Gregg J. Wiche, Large dams and alluvial rivers in the Anthropocene: The impacts of the Garrison and Oahe Dams on the Upper Missouri River, Anthropocene, Volume 2, October 2013, Pages 51-64, ISSN 2213-3054, available online at http://dx.doi.org/10.1016/j.ancene.2013.10.002.

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.

The U.S. Geological Survey (USGS) Ohio Water Science Center and a coalition of seven partner agencies (including the Ohio DOT) recently finished developing a state-of-the-art advanced flood-warning system for about 40 stream miles in Licking County, Ohio. The objectives of the work were to (1) enhance the flood-forecasting ability of NWS by reestablishing a previously discontinued streamgage, upgrading an existing lake-level gage, and installing new streamgages, (2) develop static flood-inundation boundaries

for a range of stages along selected reaches of four streams that will be linked to NWS flood forecasts and served on the NWS Advanced Hydrologic Prediction Service (AHPS) Web pages, (3) facilitate advanced flood warning to the area of Buckeye Lake and Interstate 70 by developing an unsteady-flow hydraulic model to be used by the NWS in conjunction with NWS forecast flows, and (4) publish a report detailing the methods used in and results from development of the system. The report on the study was released in September 2012.

Recent Publications:

Ostheimer, C.J., 2012, Development of a flood-warning system and flood-inundation mapping in Licking County, Ohio: U.S. Geological Survey Scientific Investigations Report 2012–5137, 13 p., 39 pl. Available online at: http://pubs.usgs.gov/sir/2012/5137/.

Oklahoma

StreamStats is fully operational, and public availability occurred in 2011.

The Oklahoma Water Science Center, in cooperation with the Oklahoma Department of Transportation, is currently working on a project which will create a Web-based flood database for Oklahoma. The objectives of this project are to develop (1) a digital database of USGS and ODOT historical flood information, and (2) a web-based mapping interface (using the ESRI JavaScript API) that will facilitate access to this information and result in improved flood-frequency statistic estimation for structural design in Oklahoma. Data sources of historical flood information include: the peak flood of record at all USGS gages, published USGS indirect measurements from Tortorelli and McCabe (2001), unpublished USGS and ODOT indirect measurements, and selected ancillary data and documents related to historical flooding.

Oregon

SELDM: In FY2012 ORWSC began a two-year coop study with the Oregon Department of Transportation (ODOT) to implement the Stochastic Empirical Loading and Dilution Model (SELDM) in Oregon. SELDM will be used to estimate combinations of contaminant loads and concentrations from upstream basins and highway runoff affecting the water quality of receiving streams (Granato, in press). Specific objectives of the ORWSC study are to: 1) Develop and refine local precipitation and hydrologic geospatial data layers needed for SELDM, 2) Install precipitation and hydrologic geospatial data layers into the Oregon StreamStats site, 3) Develop and compile upstream basin and highway water-quality transport curves and data sets for Oregon applications, and 4) Evaluate the impacts of storm water runoff on downstream water quality at five Oregon highway sites using SELDM and Best Management Practices (BMP). ODOT funding for study was completed in FY 2013. A USGS SIR report for the study is currently in review (Risley and Granato, in review).

StreamStats: Currently the Oregon StreamStats site includes equations for estimating 2-, 5-, 10-, 25-, 50-, 100-, and 500-year flood frequencies in western Oregon (Cooper, 2005). For the entire state, StreamStats can also compute basin characteristics needed to estimate low-flow frequency (7Q2, 7Q10)

and flow duration (5^{th}, 10^{th}, 25^{th}, 50^{th}, and 95^{th}) statistics from equations currently installed in the NSS program (Risley and others, 2008). StreamStats will soon have the capability of computing those low-frequency and flow duration statistics automatically.

Recent Publications:

Cooper, R.M., 2005, Estimation of peak discharges for rural, unregulated streams in western Oregon: U.S. Geological Survey Scientific Investigations Report 2005-5116, 134 p. Available online at: http://pubs.er.usgs.gov/publication/sir20055116.

Granato, G.E., 2013, Stochastic Empirical, Loading and Dilution Model (SELDM) Version 1.0.0: Techniques and Methods of the U.S. Geological Survey, book 4, chap. C3, 112 p. with CD-ROM (The FHWA reference number is FHWA-HEP-09-006)

Risley, J.C, and Granato, G.E., in review, Assessing Potential Effects of Highway Runoff on Receiving-Water Quality at Selected Sites in Oregon with the Stochastic Empirical Loading and Dilution Model (SELDM): U.S. Geological Survey Scientific Investigations Report

Risley, J., Stonewall, A., and Haluska, T., 2008, Estimating flow-duration and low-flow frequency statistics for unregulated streams in Oregon: U.S. Geological Survey Scientific Investigations Report 2008-5126, 22 p.

Pennsylvania

StreamStats: The current application of StreamStats for Pennsylvania is located at http://water.usgs.gov/osw/streamstats/pennsylvania.html. StreamStats for Pennsylvania can be used to estimate the following flow statistics:

- Low-flows: 7-day, 10-year; 7-day, 2-year; 30-day, 10-year; 30-day, 2-year; 90-day, 10-year
- Base-flows: 10-year, 25-year, and 50-year recurrence intervals
- Mean flows: including the harmonic mean and mean annual flow
- Flood-flows: 2- year, 5- year, 10- year, 50- year, 100- year, and 500-year recurrence intervals.

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 studies on the West Branch Susquehanna River at Lewisburg and Milton, and Susquehanna River at Harrisburg are in the final stages of completion and will be completed in early 2014. The final inundation maps for Lewisburg and Milton will be displayed on the USGS Flood Inundation Mapper (FIMI) and on the Susquehanna River Basin Commission Inundation Mapping Viewer (SimV). The Harrisburg inundation maps will be displayed on the NWS Advanced Hydrologic Prediction Service web site (AHPS), FIMI, and SimV.

Flood flow statistics: Peak annual exceedances were computed for 40 streamgages in Pennsylvania with a recorded 2011 peak greater than the 0.04 annual exceedance. These statistics will be included in a regional USGS report documenting 2011 flooding in the Northeast, to be completed in 2014.

Enhanced storm response: The Pennsylvania Water Science Center purchased four RTK-GPS units and spare storm surge sensors in 2013 to collect future storm event and elevation data more efficiently.

Streamgages: A cooperative network of peak-flow and continuous-record streamgages is operated statewide to provide real-time and historical stage and streamflow data to support real-time flood-warning and forecasting efforts. Streamflow data collected from streamgages in the network will also be used in the development of streamflow statistics to describe and predict low-flow and peak-flow conditions. These streamflow statistics are critical to the design of structures in, over, and near waterways. Stations located within the Pennsylvania network and the data collected at each streamgage can be viewed at the National Water Information System Web Interface (NWISWeb).

Recent Publications

Hoffman, Scott A., Roland, Mark A., Schalk, Luther F., Fulton, John W., 2013, Velocity, water-quality, and bathymetric surveys of the Grays Landing and Maxwell Navigation Pools, and Selected Tributaries to the Monongahela River, Pennsylvania, 2010–11: U.S. Geological Survey Data Series: 784, 12 p., http://pubs.er.usgs.gov/publication/ds784

Puerto Rico

No highway related projects at this time.

Rhode Island

No highway related projects at this time.

South Carolina

The South Carolina Water Science Center operates 7 continuous-record gaging stations and 48 partial-record crest-stage stations. (Number of gaging stations fluctuates slightly from year to year.)

Evaluation of recently developed NCHRP abutment-scour equations: The U.S. Geological survey (USGS) in cooperation with the National Cooperative Highway Research Program (NCHRP) began an investigation (2012) to evaluate the performance of recently developed abutment-scour equations (NCHRP Projects 24-15(2) and 24-20) using 329 field measurements of abutment scour collected in South Carolina (Benedict, 2003), Maine (Lombard and Hodgkins, 2008), Alabama (Lee and Hedgecock, 2008), and the USGS National Bridge Scour Database (NBSD; http://water.usgs.gov/osw/techniques/bs/BSDMS/index.html, accessed December 11, 2012; Wagner and others, 2006). Results from the analysis will identify performance characteristics for each scour-prediction method and

will help formulate application guidance. The project started in October 2012 and will be completed January 2015

Development of a manual to integrate findings of previous field investigations of bridge scour: The USGS, in cooperation with the SCDOT, conducted a series of three field investigations of bridge scour (Benedict, 2003; Benedict and Caldwell, 2006; Benedict and Caldwell, 2009) with the goal of collecting historic scour measurements to better understand regional trends of scour within South Carolina. Data collected in these investigations were used to develop envelope curves defining the upper bound of pier, abutment, and contraction scour. The new investigation will conduct additional research on the field data and use previous and new findings to develop an integrated procedure for applying the South Carolina bridge-scour envelope curves to help assess scour potential at riverine bridges in South Carolina. The project started in December 2012 and will be completed January 2016.

As part of this investigation, field measurements of pier, abutment, and contraction scour, previously collected from various parts of the United States, are being compiled into a digital database, and these data will be used to verify the trends of the South Carolina bridge-scour envelope curves. This effort has produced several large databases that include 1,805 pier-scour and 375 abutment-scour field measurements. The compiled field data (in spreadsheet format) offer an extensive database and valuable resource to engineers and researchers seeking to understand the trends of scour in the field, and plans are underway to publish these data. Preliminary comparison of the compiled field data with the South Carolina bridge-scour envelope curves verifies that the envelope curves are reasonable.

Urban flood-frequency investigation: Urbanization can produce significant changes in the flood-frequency characteristics of streams; consequently, rural basin flood-frequency relations are typically not applicable to urban streams. Updates and improvements of South Carolina's highway infrastructure at stream crossings require an ongoing understanding of flood characteristics, especially for urban watersheds. In addition, urban planners and engineers need current information for establishing flood-insurance rates and other water-resource management decisions. One of the tools necessary for such management are techniques that allow for the estimation of the magnitude and frequency of floods at sites on urban streams where gaged data are not available.

In May 2010, the USGS South Carolina Water Science Center began a cooperative investigation with the SCDOT to update urban flood-frequency estimates in South Carolina. The specific objectives of the investigation are to: (1) update the magnitude and frequencies of peak-flows at urban stations, (2) update basin characteristics for the urban stations using consistent geographical information system methods, and (3) update the regional urban-flood-frequency equations for the 50-, 20-, 10-, 4-, 2-, 1-, 0.5-, and 0.2-percent chance exceedance flows. Similar to the rural flood-frequency investigation which was completed in 2009, the urban investigation will include urban stations from South Carolina, North Carolina, and Georgia. In addition, the urban study will include stations from the inner Coastal Plain of New Jersey. The inclusion of urban stations from New Jersey will allow for a substantial expansion of the

drainage area size for which the Coastal Plain flood-frequency regression equations will be applicable. The project report is expected to be released in the first quarter of calendar year 2014.

Characterization of storm runoff from selected SCDOT Maintenance Yards: The SCDOT operates maintenance yards throughout the State. Prior to this investigation, the SCDOT had no data to define the quality of stormwater leaving these sites. To provide these data, the USGS, in cooperation with the SCDOT, began a 4-year investigation in October 2009 to 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, S.C.) is a facility that stores equipment and road maintenance material. Water-quality samples, rainfall data, and flow measurements of stormwater runoff were collected at these sites to date. The water-quality samples were 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. A USGS Scientific Investigations report is currently being written and the planned publication date is October 2013. 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. The project report is expected to be released in the first quarter of calendar year 2014.

Bridge Deck Stormwater Runoff: In South Carolina, stormwater runoff from highways may be treated by structural or non-structural systems. Some stormwater may enter receiving waters without treatment such as from bridge deck scuppers. The impact of this discharge if any may be driven by the daily traffic volume or atmospheric deposition from surrounding industry. Even though numerous studies have been conducted to analyze the impacts of stormwater from highways and, to a lesser extent, bridges to receiving waters, at this time (2013) no specific studies have been conducted in South Carolina. In June 2013, the USGS South Carolina Water Science Center (SCWSC), in cooperation with the SCDOT, began a 4.75-year investigation in South Carolina on stormwater quality. This investigation is anticipated to end in March 2018 (FY2018). The purpose of this study is to quantify the downstream changes in receiving water-quality conditions during periods of observable stormwater runoff from 6 selected bridge deck locations in South Carolina. The information collected might help to estimate or predict changes in water quality at bridge crossings with similar characteristics. Additionally, comparison of sediment-quality conditions and benthic macroinvertebrate community structure at upstream and downstream locations from selected bridge decks will assess cumulative impact of bridge deck runoff effects on receiving water. Data collection begins in January 2014. Data will be collected from two bridges during calendar years 2014, 2015, and 2016. Data analysis will be ongoing throughout the data-collection phase and during part of calendar year 2017. A USGS Scientific Investigations Report documenting the investigation will be published. The tentative publication date is spring 2018.

FHWA Bridge Scour Countermeasures: The South Carolina WSC has been selected to participate as a team member in the USGS cooperative effort with the FHWA to conduct a comprehensive, national, investigation of scour countermeasures. Details regarding this project are described in the report section, "Partial Summary of USGS National Activities."

South Dakota

Crest stage gage network: The South Dakota Water Science Center operates a network of about 50 crest-stage gages for the purpose of peak-flow analysis.

Streamstats: Developmental efforts for StreamStats in South Dakota were initiated in 2005. This project has since been ongoing, primarily to address changing circumstances such as allowing incorporation of increased availability of higher-resolution topographic data. Full-scale implementation of the StreamStats application was achieved in 2013 following resolution of minor problems with the application for determination of basin characteristics.

Paleoflood hydrology: A study was completed during 2011 that used paleoflood hydrology techniques to improve peak-flow frequency estimates for several major drainages in the Black Hills of western South Dakota (Harden and others, 2011). This area was devastated by catastrophic flash flooding during 1972 that caused at least 238 deaths and was a primary impetus for the study. The study approach primarily involved extrapolation of peak-flow records through stratigraphic analysis and age dating of flood slack-water deposits, which were used to develop chronologies of very large flood events that pre-date observed peak-flow records. The study provided clear geologic evidence of multiple floods as large and even larger than those of 1972 during recent millennia within the study area. A short fact sheet (Driscoll and others, 2012) that provides a lay-reader summary of study results was published during 2012 was widely distributed as part of activities commemorating the 1972 floods.

A new paleoflood study phase for the southern part of the Black Hills area was recently initiated in cooperation with the SDDOT Office of Research. It is anticipated that field investigations will be initiated during 2014 and will be ongoing for several subsequent years.

Bridge Scour: SDDOT and USGS also have been collaborating for several years on a project involving analysis of potential bridge scour for sites along local government roads. Field work for this project was completed during 2012 and results will be included in a final report that is nearly complete, with publication anticipated early in 2014.

Recent Publications

Harden, T.M., O'Connor, J.E., Driscoll, D.G., and Stamm, J.F., 2011, Flood-frequency analyses from paleoflood investigations for Spring, Rapid, Boxelder, and Elk Creeks, Black Hills, western South Dakota: U.S. Geological Survey Scientific Investigations Report 2011–5131, 136 p. http://pubs.usgs.gov/sir/2011/5131/

Driscoll, D.G., Huft, D.L., and O'Connor, J.E., 2012, Extreme floods in the Black Hills area—New insights from recent research: Pierre, S. Dak., South Dakota Department of Transportation, 4 p. http://www.sddot.com/business/research/projects/docs/SD2008-01_Fact_Sheet_06-11-12.pdf

Tennessee

The following items summarize the transportation-related work of the Tennessee Water Science Center in 2013:

- Providing hydraulic interpretative support and miscellaneous flood-measurement support to Tennessee Department of Transportation (TDOT) as needed.
- Operating an ongoing network of 33 crest-stage gages at or near highway crossings and operating another 12 stage-discharge gages across the state for the purpose of flood-frequency analysis and general resource evaluation.
- Statewide update of flood-frequency prediction methods for ungaged streams in Tennessee. Recent peak streamflow data, improved flood-frequency computations, and GIS-calculated basin characteristics will be incorporated into the original flood-frequency region-of-influence statistical model completed in FY2003. This work began in FY2014 and will continue through FY2016.
- 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 will continue through FY2014.
- 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.
- Developing and applying GIS techniques to identify karst features on a regional scale and producing a GIS karst dataset for Tennessee. The dataset of karst features will span the eastern 2/3 of Tennessee classified as karst and will include closed depressions and their watersheds. The GIS techniques will be applied to the highest-resolution and most accurate digital elevation datasets available for Tennessee. This work began in FY2009 and will end in FY2014.
- Initiating a review of State-funded stream relocation and restoration projects that will identify design objectives that have and have not been achieved and types of structures and channel configurations that have been stable, have needed repair, or have been destroyed. This work will lead to a report on successful approaches to stream channel management in Tennessee physiographic regions, and will be completed in FY2016.

- Initiating a study of seepage from acid-rock outcrops exposed by road construction. The study will examine flow rates and composition of seepage, surface and subsurface flow paths to streams, and possible mitigation measures. The study will continue through FY2016.

Texas

Measurement File Data Mining and Regionalization (FY10–13, 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 (Ted Cleveland), University of Houston (Kyle Strom), and University of Texas at San Antonio (Hatim Sharif and Xiaofeng Liu) in a project funded by the Texas Department of Transportation to investigate the approximately 90,000 entries for 427 stations of discharge, top width, area, and mean velocity for the streamflow measurement database in Texas. The purpose of this research is to develop tools (equations) to generalize the relation between mean velocity and a given discharge along with hydraulic, watershed, and channel properties to help guide TxDOT designers in analysis and review of hydraulic models. Another purpose is to generalized the relation between discharge and hydraulic, watershed, and channel properties. For the former, an equation such as Vbar=a * (Qdesign)^b * (TopWidth)^c * (OtherStuff)^(etc) could be forthcoming and in the later, an equation such as Q=a * (CrossArea)^b * (TopWidth)^c * (ChannelClassification)^d * (OtherStuff)^(etc). Statistical analysis suggests that with cross-section area, top width, and mean annual precipitation that near 0.25log10 error in discharge estimation might be possible and hence useful in a variety of investigative and interpretative settings.

The final report is in progress as led by University colleagues, but USGS has authored a now approved chapter for publication. The chapter citation follows although the title of the report is subject to revision.

Small Watershed Gaging Program (FY06–13 and on-going): The Texas Department of Transportation and the USGS returned for FY06–13 (five-year increments) to small watershed data collection through a cooperative program. The program was recently extended into FY11–15. A network of about 51 crest-stage gages for flood-peak recording 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. About three of the gages with also be operated as continuous real-time (conventional gages). An emergent contribution to hydraulic computations from this project is the development of an R-based implementation "capR" of the FORTRAN-based USGS-Culvert Analysis Program (CAP). Numerous extensions have been made. We have a functional tool that can readily process time series of contemporaneous headwater and tailwater conditions. To date, we have computed discharge for almost 500 peaks combined between annual and quarterly maximum series. A large USGS Scientific Investigations Report has completed USGS peer-review and we are hopeful for release of this rather complex report by mid 2014.

Recent Publications

Asquith, W.H., 2013, Parameter Estimation for the 4-parameter asymmetric exponential power distribution by the method of L-moments using R: Computational Statistics and Data Analysis, http://dx.doi.org/10.1016/j.csda.2012.12.013

Asquith, W.H., 2014, Regression models of discharge and mean velocity associated with median-streamflow conditions from a U.S. Geological Survey discharge measurement database in Texas: ASCE Journal of Hydrologic Engineering, [scheduled for January 2014 issue].

Asquith, W.H., and Burley, T.E., 2013, Evaluation of main-channel slope and proximal slope for statistical regionalization of U.S. Geological Survey discharge measurements associated with direct-runoff conditions in Texas, *in* Cleveland, T.G., Liu, X., Sharif, H.O., and Strom, K.B., 2013, Statistical properties and regional analysis of empirical flow parameters in Texas as obtained from U.S. Geological Survey discharge measurement databases—Tools for assessment of hydraulic models: Texas Department of Transportation Research Report 0–6654–1, chapter X, pp. XX–XX. (Title of report subject to revision.)

Asquith, W.H., Herrmann, G.R., and Cleveland, T.G., 2013, Generalized additive regression models of discharge and mean velocity generally associated with direct-runoff conditions in Texas—The utility of the U.S. Geological Survey discharge measurement database: ASCE Journal of Hydrologic Engineering, v. 18, no. 10, pp. 1331–1348, http://dx.doi.org/10.1061/(ASCE)HE.1943-5584.0000635

Harwell, G.R., Asquith, W.H., 2011, Annual peak streamflow and ancillary data for small watersheds in central and western Texas: U.S. Geological Survey Fact Sheet 2011-3082, 4 p. http://pubs.usgs.gov/fs/2011/3082/

Utah

Great Salt Lake in Utah is divided into a north part and south part by a rock-fill railroad causeway constructed 1959 and now owned and operated by Union Pacific. The USGS Utah Water Science Center is providing science support to assessments of the potential effects of planned alteration and structural improvements of existing flow-through structures in the causeway on the fragile lake ecology. The current flow-characteristics of the causeway control, in part, the balance of salt concentration in the north and south arms of the lake. Plans are being developed by Union Pacific and other stakeholders to replace the aquatic function of existing culverts in the bridge with a new causeway breach as a requirement of construction permitting. The USGS Utah Water Science Center will assist the Utah Department of Environmental Quality in the review and assessment of modifications of an existing USGS lake salt-balance model and application of that model to the investigation of potential effects of changes in causeway flow through structures on flow and salt balance between the north and south arms of the lake and assess possible monitoring approaches to observe and accurately define post construction conditions.

Vermont

Vermont Agency of Transportation (VTrans) is currently funding a network of 28 crest-stage gages located in small headwater watersheds throughout the state.

VTrans funds approximately one-third of Vermont's stream-gaging network.

In Vermont, the USGS is updating the regression equations for estimating flood frequency at unregulated, rural rivers and streams in the state. Streamstats will be updated as well. This project is funded by FEMA. The equations will be published in Spring of 2014.

Publications:

Olson, S.A., and Bent, G.C., 2013, Annual exceedance probabilities of the peak discharges of 2011 at streamgages in Vermont and selected streamgages in New Hampshire, western Massachusetts, and northeastern New York: U.S. Geological Survey Scientific Investigations Report 2013–5187, 17 p., http://dx.doi.org/10.3133/sir20135187.

Virginia

A network of 17 crest-stage gages continue to be operated in coordination with the Virginia Department of Transportation (VDOT) to determine annual peak flows, document extreme flow events, and improve flood frequency estimates.

The USGS has completed the evaluation of Peak Flows in Virginia's urban basins and has developed models that describe Virginia urban area annual peak flow per square mile based on basin percent urban area and square mile basin drainage area We are in the final phase of this effort, the Scientific Investigations Report Methods and Equations for Estimating Peak Flow Per Square Mile in Virginia's Urban Basins is under review and will be published in February 2014. A cooperative effort to implement StreamStats in Virginia is nearing completion. StreamStats is expected to be fully implemented in 2014.

Recent Publications

Austin, S.H., Krstolic, J.L., Wiegand, Ute, Peak-Flow Characteristics of Virginia Streams, U.S Geological Survey Scientific Investigations Report, 2011-5144, 106 p. Available online at: http://pubs.er.usgs.gov/publication/sir20115144

Washington

Stormwater Workgroup: The WAWSC participates in a multiagency Stormwater Workgroup (SWG), which includes the Washington State Department of Transportation. This workgroup is chartered under the Puget Sound Ecosystem Monitoring program, and is developing a coordinated stormwater-monitoring program in the Puget Sound area called the Regional Stormwater Minitoring Program. Federal, State, and local agencies, Native American Tribes, business, and environmental groups are represented on the workgroup.

Initial USGS support for the SWG included an analysis of the streamflow-gaging network for monitoring stormwater in small streams in the Puget Sound basin, Washington, as described in USGS Scientific Investigation Report 2012-5020. Follow-up work in 2013 includes tabulated physical attributes of gages and ungaged areas in the Puget Sound lowlands.

Also in FY2013, The WAWSC participated in the "Roads and Highways Subgroup" of the SWG. This subgroup generated recommendations for regional stormwater monitoring related to roads and highways that include priority BMP effectiveness studies and source identification and diagnostic studies.

Flood Frequency: In cooperation with the Washington State Departments of Transportation and Ecology, WAWSC initiated a study to develop a tool to estimate flood frequencies and magnitudes in ungaged watersheds in Washington State, and to determine if there are trends in flood frequencies and magnitudes in the state.

Timing and depth of scour and fill: WAWSC published a journal article (http://www.sciencedirect.com/science/article/pii/S002216941300379X) describing the development and application of accelerometer scour monitors (ASMs) to record the timing and depth of scour and fill in a gravel-bedded river.

In cooperation with the Seattle Public Utilities, WAWSC initiated Phase II of a study in the Cedar River that includes determining the depth of streambed scour potentially affecting salmon egg pockets using the accelerometer scour monitors (ASMs) developed by Gendaszek and others (2013) to measure the timing of scour to discrete levels of the streambed.

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.

Wisconsin

Effectiveness of Grass Swales at Reducing Stormwater Runoff from Urban Highways in Wisconsin: 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 Stormwater Management program to reduce Total Suspended Solid (TSS) loading from highway surfaces. The purpose of this study is to evaluate the performance of grass swales as a stormwater management practice. The primary objective of this study will be focused on measuring the effectiveness of grass swales at reducing stormwater runoff flowing from urban highways. It will evaluate the infiltrative capacity of grass swales and their

potential to reduce pollutants such as TSS. This will be done by monitoring a section of grass swale separated into two contributing components: 1) vegetated side slopes and, 2) grassed channel. An additional section will be instrumented to monitor the grass swale as a whole.

Another goal is to transfer the results from this study to determine if Wisconsin DOT is meeting federal and state standards. The state of Wisconsin allows the use of computer models to determine both volume and TSS reduction. By isolating individual parts of grass swales, parameters in models can be modified to simulate the site conditions.

- Progress in FY2012 included 1) making measurements and collecting samples to determine infiltration rates and pollutant reductions from the swale site, 2) characterizing the soils in the swale through geoprobing and double ring infiltration test, and 3) installing level loggers between the middle and downstream flume.
- Progress in FY2013 included 1) measuring and collecting samples to determine infiltration rates and pollutant reductions from the swale site and 2) finishing characterizing the soils in the swale through geoprobing and double ring infiltration test.
- Plans for FY2014 include finishing the monitoring in June (unless extended a year) and completing a draft of the report. Report writing is in progress.

Flood Frequency Analysis in Wisconsin: A network of 91 crest-stage gages were operated in cooperation with WisDOT to provide on-going peak-flow data for flood-frequency information and analysis.

Wisconsin WSC completed frequency estimates for 367 gages with at least 10 years of record through the 2010 water year, including 47 regulated sites. The analyses used a new skewness map developed in FY2011.

Regression equations were developed using GIS-based basin characteristics and data through the 2010 water year. The updated “Flood Frequency in Wisconsin” report is in review, should be published in early 2014.

Wisconsin WSC worked with StreamStats personnel to determine the steps necessary to implement StreamStats for the State. GIS data is expected to be delivered by the end of December 2013. Expect implementation of StreamStats in 2014.

Bridge Scour: WisDOT is evaluating sites to determine a new location for monitoring bridge scour using acoustic distance-sensing equipment.

Wyoming

No highway related projects at this time.