A Partial Summary of 2014 USGS Activities of Interest to the FHWA and State Highway Agencies

Robert Mason (rrmason@usgs.gov)

Transportation Research Board 94th Annual Meeting

AFB60 Committee Meeting

January 14, 2015

(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, CA, CO, CT, DE, GA, 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, KS, ME, MO, MS, MT, ND, SC, VA, WI, WV
Investigation of rural flow-frequency	AR, CA, GU, HI, ID, KS, LA, MO, MA, ME, MN, MT, MS, NC, NE, NM, NY, OK, OR, PA, SD, TN, TX, VA, WA, WI, WV, FEMA
Investigation of urban flow-frequency	IL, NC, SC, VA
Investigation of small watershed flow-frequency	IA, KS, LA, ME, MT, TN, TX, WA
Non-stationarity of peak flows	ME
Updating Bulletin 17B Regional Skew Map	AK, AZ, MO, WA/ID (for Pacific Northwest)
Development of urban dimensionless unit hydrograph	MO
Bridge Scour and Sediment Transport	
FHWA scour countermeasures field investigation	AL, ID, KY, MO, NC, SC
Evaluation of abutment-scour equations	SC, NCHRP
Near real time scour monitoring	AK, MO, MS, MT, NJ
Data collection and analysis	AK, ID, ME, MN, MO, MS, MT, , NJ, NV, SC, UT, WA, FHWA
Channel stability and scour assessment	AK, ID, IN, MO, MS, MT, ND, NJ, , SD, TN, WA
Investigation/modeling of sediment transport	ID, LA, MN, 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
Flood documentation	CO, IA, IN, MN, MT, NE, NM, NY, NV, OR, PA, TN, WI
Operational flood inundation mapping	GA, ID, IL, IN, LA, ME, MI, MN, MO, MS, NC, NH, NJ, NY, PA,
Manning's n verification	AZ
Stream Characteristic Investigations	
Regional channel characteristics/bankfull discharge	CO, ID, NY, OR, TX, WV
Tidal Gages and Streamgages	
Tidal gages	FL, LA, NC
Crest stage gages to estimate annual peak flows	AK, AL, AR, FL, GA, GU, HI, IA, ID, IN, 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, LA, MA, ME, MI, MN, MO, MT, NC, NE, NV, PA, SC, TN, UT, VT, WA, WI
Investigation of wetland impact/remediation	LA, 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, WA, WI, FHWA
Investigation of potential impacts of highway culvert construction to the natural conditions of streams	AL, TN
Investigation of the potential effects of runoff from bridges to receiving waters	SC

Partial Summary of USGS National Activities

USGS WaterAlert and WaterNow

The USGS 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 National Weather Service 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 real-time 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, funding was increased by $2.3M to help stabilize the streamgage network, but 2013 NSIP funding was decreased by about $2M due to sequestration. In 2014, the NSIP funding increased by about $6M and is currently funded at about 27 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 Monitoring Network for U.S. Coastal Waters and Tributaries

The goal of the National Monitoring Network (NMN) effort is to provide information about inland influences on coastal waters for improved management of coastal ecosystem health. Formed in response to recommendations of the President's Commission on Ocean Policy and the President's Ocean Action Plan, the NMN 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), the NMN seeks to develop a "network of networks" that link elements of Federal, State, and local monitoring networks to reduce duplication and strengthen coverage to provide an integrated system of long-term streamgages, water-quality and ecological monitoring sites with standardized monitoring techniques, parameters, and data-dissemination portals. In 2012, two studies to demonstrate network concepts began in Albemarle Sound and Puget Sound. Three pilot studies were completed in 2011 in San Francisco Bay, Lake Michigan, and Delaware Estuary. Current NMN efforts include supporting four long-term USGS monitoring sites, continued development of the Water Quality Portal (http://www.waterqualitydata.us/index.jsp), and updating an inventory of existing monitoring networks. For more information on the network, visit the NMN homepage 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 datasets.

The Peak flow FreQuency analysis program (PeakFQ) implements the Bulletin 17B recommended procedures for flood-frequency analysis of streamflow records. The program was updated in 2014 to include EMA and the new multiple low outlier test. A Windows version is available at http://water.usgs.gov/software/PeakFQ/. The program is also available for batch-style processing on DOS, UNIX and Linux operating systems.

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, over 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, Iowa, Missouri and Arizona. Projects are underway in New England, Alaska, the Pacific Northwest (Oregon, Washington, and Idaho), Arkansas-Louisiana (joint study), and planning has begun for projects encompassing multiple states in the Missouri River Basin and the Upper Mississippi River Basin. Instead of updating the map on a state-by-state basis, we intend to update the map on a multi-state, hydrologic basis with the eventual goal of updating maps for the entire Nation.

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 present high and low streamflow estimation equations for ungaged sites across the United States. Equations and their solutions in NSS provide low-flow duration and frequency estimates in addition to flood-frequency estimates such as the 100-year flood.

The NSS program has an equation database, 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, including the regression equations and standard errors, to solve more than 6,300 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 16 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 34 States. All equations contained in NSS were reviewed by USGS and were typically 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/.

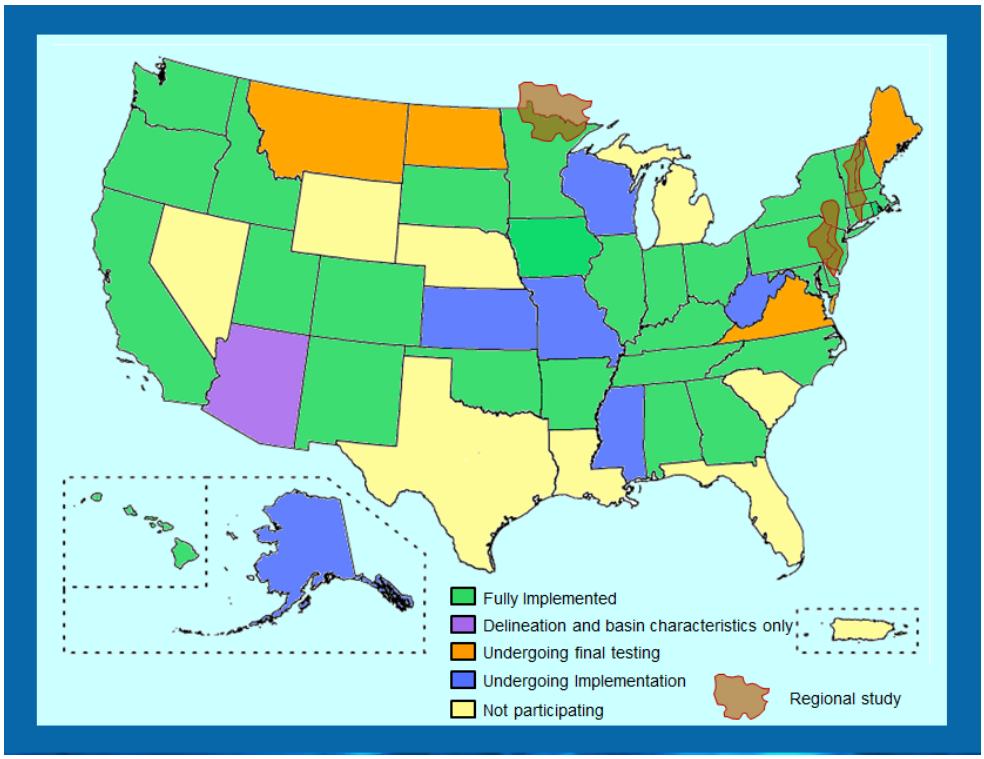
If you should have questions regarding this information, please contact Todd Koenig (tkoenig@usgs.gov).

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 used 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.

In addition to the ability to delineate drainage basins and obtain estimates of streamflow statistics for user-selected ungaged sites, StreamStats also has the ability 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. In addition, StreamStats for Maryland, and soon the Delaware River Basin, allows users to obtain summaries of water use activities within the drainage basins for user-selected sites.

As of December 2014, StreamStats is available to the public for 32 states. An application also is available for the Connecticut River Basin, which encompasses area in Connecticut, Massachusetts, New Hampshire, and Vermont. Applications are under development for 11 states and two river basins including the Delaware River Basin, which encompasses area in Delaware, Pennsylvania, New Jersey, and New York; and the Rainy River basin, which encompasses area In Minnesota and the Canadian provinces of Manitoba and Ontario. See the map and table below to determine the status for individual state and river basin applications.



(Accessed at http://water.usgs.gov/osw/streamstats/ssonline.html, December 8, 2014)

Great strides were made during fiscal year 2014 in developing a new version of StreamStats, which will be version 3. This new version, in which a single national user interface replaces separate user interfaces for each state, is expected to be released during the winter of 2015. With version 3, all StreamStats functionality will be available as web services for use by other applications. Instructions for making use of the web services, and for submitting batches of sites for analysis, will be provided in updated documentation on the StreamStats web site. In addition, StreamStats will provide about 100 new or updated non-interpretive streamflow statistics for about 18,500 USGS streamgages. The non-interpretive statistics will include flow-duration percentiles of daily mean flows, and means, medians, minimums, maximums, and standard deviations of annual, monthly, and daily flow time series for the streamgages. Peak-flow (for example, the 0.01-percent probability peak flow, or 100-year flood) and low-flow frequency statistics (for example, the 7-day, 10-year low flow), which are interpretive statistics, also will be updated for many stations.

State	Implemented	Planned for FY15 completion	To be implemented after FY15	New equations in FY15	Comments
Alabama	X				
Alaska		X			Cook Inlet Basin only
Arizona	X				Delineations and basin characteristics only
Arkansas	X				
California	X			X	Adding new peak-flow equations
Colorado	X				
Connecticut	X				
Delaware	X				
Florida					No effort underway
Georgia	X			X	Adding new urban peak-flow equations
Hawaii	X			X	Adding low-flow equations for Maui
Idaho	X				
Illinois	X			X	Adding new flow-duration equations
Indiana	X			X	Adding new flow-duration equations
Iowa	X			X	Adding low-flow equations
Kansas		X			
Kentucky	X			X	Adding low, mean, and bankfull flow equations
Louisiana					No effort underway
Maine		X			
Maryland	X				
Massachusetts	X			X	Adding new peak-flow and bankfull equations
Michigan					
Minnesota	X			X	Adding new peak-flow equations
Missouri			X		
Mississippi		X			
Montana		X			
Nebraska					No effort underway
Nevada					No effort underway
New Hampshire	X			X	Adding groundwater recharge equations
New Jersey	X			X	Adding low-flow equations
New Mexico	X				Only northwest NM available
New York	X				
North Carolina	X			X	Adding new urban peak-flow equations
North Dakota		X			
Ohio	X				
Oklahoma	X				
Oregon	X			X	Adding low-flow equations
Pennsylvania	X				
Puerto Rico					No effort underway
Rhode Island	X			X	Adding low-flow equations
South Carolina			X		
South Dakota	X				
Tennessee	X				
Texas					No effort underway
Utah	X				
Vermont	X			X	Adding new peak-flow equations
Virginia		X			
Washington	X			X	Adding low-flow equations
West Virginia		X			
Wisconsin		X			
Wyoming					No effort underway
River Basin					
Connecticut	X				
Delaware		X			
Rainy			X		

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. FHWA will identify the bridge locations and provide technical assistance; USGS will conduct the evaluations, document each evaluation in templates, make all data available to FHWA via the web, and summarize data and findings in a series of official USGS reports (2 open-file reports and a final 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.

Training and technical support for the FHWA-USGS Stochastic Empirical Loading and Dilution Model (SELDM)

The purpose of the project is to help State DOTs and decision makers adopt and use SELDM by providing training and technical support for the model. The USGS in cooperation with the FHWA has developed and delivered a 3-day classroom training course, an abbreviated half-day training class, and a series of webinars. The 3-day training courses were delivered in Northborough MA, Washington DC, and Portland OR. To date, 57 people from across the Nation who work for State DOTs, USEPA, USGS, and other agencies have attended the 3-day classes. The half-day class was delivered in Iowa City, Iowa to 12 people from FHWA, state DOTs, universities, and consulting companies. The webinars were delivered to 354 people from across the Nation who work for State DOTs, USEPA, USGS, and other agencies. Currently, one 3-day class in Colorado and a series of webinars are planned for 2015.

A graphical post-processor for SELDM output also will be developed as part of this project. The post-processor will extract model results from the SELDM output and generate graphs that can be used to communicate the results of modeling efforts. We will be looking for software beta testers and reviewers for the documentation in the second half of 2015.

Publications:

Granato, G.E., and Jones, S.C., 2014, Stochastic Empirical Loading and Dilution Model for analysis of flows, concentrations, and loads of highway runoff constituents: Transportation Research Record, Journal of the Transportation Research Board, No. 2436, p. 139-147.

Risley, J.C., and Granato, G.E., 2014, 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 2014–5099, 74 p.

Web page:

http://webdmamrl.er.usgs.gov/g1/FHWA/SELDM.htm

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. The report is in review and will be published before September 2015.

Publication:

Granato, G.E., Desimone, L.A., Barbaro, J.R., and Jeznach, L.C. 2015 (in review), Methods for evaluating potential sources of chloride in surface waters and groundwaters of the conterminous United States: U.S. Geological Survey Open-File Report 2014-XXXX, X p.

Web pages:

The project web page: http://webdmamrl.er.usgs.gov/g1/FHWA/Cl.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, 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 2014–5037, 37 p., http://pubs.usgs.gov/sir/2014/5037

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 the "Water Science Centers" drop-down link.

Alabama

Hydrologic and Hydraulic investigations: various bridge sites in Alabama, including crest-stage gage (CSG) 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:

- Continued continuous monitoring and evaluation of streambed change and water surface elevations at 17 scour-critical bridges around Alaska.
- Established a new continuous monitoring site on the Copper River Delta and surveyed detailed channel bathymetry around the bridge.
- Collected time-lapse imagery of flood flows and channel change at 3 scour critical bridges, set up time-lapse cameras to collect river ice observations at 4 sites in the fall of 2014.
- Collected flood and/or post-flood soundings and observations at 4 sites that experienced flood and scour events.
- For bridges with unknown foundations, revised hydraulic models and report for 17 scour critical bridges visited in 2012 (including revisiting 6 bridges to collect additional data), developed flood

frequency relationships and model geometry for 20 bridges surveyed in 2013, and conducted field surveys at an additional 17 bridges.

Arizona

The AzWSC is concluding 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.

The AzWSC is initiating an n-verification study in Maricopa County aimed at quantifying the roughness effects of in-channel vegetation. The study will employ Continuous Slope-Area gages and direct discharge measurements to determine Manning's roughness over a range of flows at several sites. Recording pressure transducers will be installed in the Gila River for use with the Flood Control District of Maricopa County's flow model to calibrate roughness. The project is in cooperation with the FCDMC, the Salt River Project (water supplier to Maricopa County), and possibly ADOT.

Arkansas

The USGS Arkansas Water Science Center (AR-WSC) began a Crest Stage Gage (CSG) data collection project with the Arkansas Highway and Transportation Department (AHTD), installing 52 new gages in FY 2013 and 2014. Operation will begin in FY 2015. This is a reestablishment of a CSG project that was discontinued in 2004.

During FY 2014, AR-WSC partnered with the US Army Corps of Engineers Little Rock District and AHTD to update the flood frequency statistics for Arkansas. That project began in the spring of 2014 and will conclude in December, 2015. The project will add two decades of additional peak flow data for regional flood regression estimating equations which were last updated in 1994.

California

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

Additional 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., http://pubs.usgs.gov/of/2013/1016/

Colorado

In 2014, the Colorado Water Science Center (CWSC), in cooperation with the Colorado Department of Transportation (CDOT) continued to operate hydrologic monitoring stations in the vicinity of the recent Waldo Canyon wildfire 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.

In 2014, the CWSC, in cooperation with CDOT updated and maintained a Web-based historic flood information database for Colorado. The database was completed in 2013 and 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.

Also in 2014, the CWSC in cooperation with CDOT 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 2014, 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). Recent work includes construction and surveying of 16 Staff and Crest Stage Gages to monitor water level peaks within managed 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. Monitoring was completed on June 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 December 2014.

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

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 8 rain gages of which 3 have real-time telemetry, and one real-time reservoir monitoring station in Guam. Data from these gages are used to aid flood warning and flood forecasting.

Hawai'i

The Pacific Islands Water Science Center operates a network of 62 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 20 real-time rain gages, 59 real-time streamflow monitoring stations, and 8 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 Idaho Water Science Center (IDWSC) is updating peak flow frequency statistics and regional regression equations for relatively unregulated streams in Idaho. The project is funded by the Idaho Transportation Department and will provide more accurate, updated information to Federal, State, regional and local cooperators on peak flow frequency in Idaho rivers, which is often needed for designing infrastructure, determining flood elevations and flood zones, and managing aquatic habitat. The updated statistics and equations will be published and integrated with Idaho StreamStats in FY16/17. In a related effort, the IDWSC is working with Washington Water Science Center and Office of Surface Water staff to develop a revised regional skew map for the Pacific Northwest. Information from the skew map will be used to update the state-specific peak flow frequency statistics.

The IDWSC is actively involved in the Idaho Chapter of the Silver Jackets, a coalition of federal and state agencies that work together to develop comprehensive and sustainable solutions to Idaho's flood hazard issues. The IDWSC is chairing a Silver Jackets subcommittee to develop a plan to develop, prioritize, and deploy a cache of rapid deployment gages, which are temporary water level sensors or

precipitation gages which can be deployed at a moment's notice to provide hydrologic information to emergency and transportation managers prior to and during floods. The Idaho Transportation Department is a member of the subcommittee. The IDWSC is also discussing a proposal with the Idaho Silver Jackets to develop a StreamStats-based contaminant time-of-travel tool. The tool is a web- and GIS-based application that could be used to simulate a contaminant spill in a river and determine how long it would take the spill to migrate downstream to a point of interest. Several Idaho Silver Jackets agencies have expressed interest in developing a tool to assist with disaster response and transportation planning.

The BLM and USGS continue to operate a 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 (2013) and Wood (2014) reports below. The USGS continues to collect streamflow data and plans to update the equations and statistics published in Wood and Fosness (2013) at a later date.

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.

The IDWSC is participating in a national bridge scour study, previously described in the section titled "Performance and Effectiveness of Scour Countermeasures". The IDWSC will visit selected bridges in the western United States and report on the countermeasure, bridge, and channel characteristics. The project website is at http://water.usgs.gov/osw/techniques/bs/scour_fhwa/.

Recent Publications

Wood, M.S., 2014, Streamflow statistics for development of water rights claims for the Jarbidge Wild and Scenic River, Owyhee Canyonlands Wilderness, Idaho, 2013-14: a supplement to Scientific Investigations Report 2013-5212, 14 p.

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., http://dx.doi.org/10.3133/ofr20131273.

Illinois

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 on urbanized watersheds for design and reference. The analysis will enable 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.

Two recently completed projects for which recent publications are also listed below are:

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 are presented. The report also presents techniques developed to estimate streamflow at ungaged sites. In Straub and others (2013), the results of using the SRICOS-EFA method to predict ultimate scour prediction on an additional 15 bridge sites in Illinois are presented. Also, results of the comparison of historic IDOT laboratory and field values of unconfined compressive strength of soils (Qu) are presented.

Flood inundation map libraries for four USGS streamgage sites (three 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

Over, T.M., Soong, D.T., and Su, T.Y., 2014, Identifying and adjusting for effects of urbanization on peak streamflows, oral presentation, FHWA National Hydraulic Engineering Conference, Iowa City, Iowa, August 19-22, 2014.

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.

Soong, D.T., Murphy, E.A., and Sharpe, J.B., 2012, Flood-inundation maps for a 1.6-mile reach of Salt Creek, Wood Dale, Illinois: U.S. Geological Survey Scientific Investigations Map 3185, 8 p. pamphlet, 14 sheets, scale 1:6,500.

Murphy, E.A., Soong, D.T., and Sharpe, J.B., 2012, Flood-inundation maps for a nine-mile reach of the Des Plaines River from Riverwoods to Mettawa, Illinois: U.S. Geological Survey Scientific Investigations Report 2012–5227, 17 p., available only at http://pubs.usgs.gov/sir/2012/5227.

Murphy, E.A., Sharpe, J.B., and Soong, D.T., 2012, Ohio River backwater flood-inundation maps for the Saline and Wabash Rivers in southern Illinois (ver. 1.1, September 2014): U.S. Geological Survey Scientific Investigations Report 2012–5212, 20 p., available only at http://pubs.usgs.gov/sir/2012/5212.

Indiana

In 2014 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. Five libraries were published in 2013. One was published in 2014, and one was completed in 2014 pending USGS approving official review. All previously mentioned 7 libraries were scheduled to be completed by the end of 2014. An additional 6 libraries will be developed and are scheduled to be complete by mid-2017. A half-day workshop/training for use of flood inundation map libraries and use of available tools from USGS and NWS was provided to DOT staff in April 2014. This workshop showed how these map libraries and tools can be used in flood response and mitigation applications. 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 2014, 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

Coon, W.F., 2013, Flood-inundation maps for the Flatrock River at Columbus, Indiana, 2012: U.S. Geological Survey Scientific Investigations Map 3241, 12 p., 12 sheets, available only at http://pubs.usgs.gov/sim/3241.

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.

Fowler, K.K., 2014, Flood-inundation maps for the East Fork White River near Bedford, Indiana: U.S. Geological Survey Scientific Investigations Map 3274, 20 sheets, 8-p. pamphlet, http://dx.doi.org/10.3133/sim3274.

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 real-time streamgaging stations and 80 crest-stage gages with the Iowa Department of Transportation Highway Research Board. There are 21 real-time crest-stage gages and the remaining are non-real-time.

Flood Profiles: Iowa WSC cooperatively funds an ongoing flood-profiles project to document water-surface-elevation profiles of significant flood events. A compilation report summarizing 47 USGS flood-profile reports that were published for streams in Iowa during a 50-year period from 1963 to 2012 was published in 2014. 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 (recurrence intervals greater than 25-50 years). The 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.

Statistical Summary of Selected Iowa Streamflow Data: The Iowa WSC will soon publish two sets of statistics: (1) long-term for the entire period of record and (2) recent-term for the 1984-2013 period of record. The statistics will be computed for streamflow data collected at continuous-record streamgages in Iowa with at least 10 years of record. The statistics will be computed on the daily mean and annual instantaneous peak values of streamflow data collected through water year 2013. The following daily-flow statistics will be computed: monthly and annual flow durations; probability of the highest annual 1-, 3-, 7-, 15-, and 30-consecutive day high discharges; probability of the lowest annual 1-, 3-, 7-, 14-, 30-, 60-, 90-, 120-, and 183-consecutive day low discharges; probability of the lowest annual 1-, 7-, 14-, and 30-consecutive day seasonal low discharges; and Kendall's Tau trend analyses of annual flow durations and consecutive day low and high discharges. Long-term and recent-term hydrographs of annual-mean and average daily-mean discharges will be included with the streamflow statistics for each streamgage. Instantaneous peak-flow probabilities will be computed for unregulated streamgages using the weighted independent estimates (WIE) program in which annual exceedance-probability estimates computed using the expected moments algorithm (EMA) program with the multiple Grubbs-Beck test for detecting low outliers will be weighted with annual exceedance-probability estimates computed using regional-regression equations. A trend analysis will be provided for the annual instantaneous peak discharges.

Flood-Estimation Comparisons for Small Drainage Basins in Iowa: The Iowa WSC will perform two sets of flood-estimation comparisons. First, flood estimates calculated from five different flood-estimation methods for streamgages in Iowa with drainage areas less than 2 square miles will be compared to flood estimates calculated at the streamgages using expected moments algorithm/multiple Grubbs-Beck test (EMA/MGB), annual-exceedance-probability (AEP) streamgage analyses. The five flood-estimation methods include (1) StreamStats multi-variable estimates, (2) single-variable estimates from the Iowa 2013 peak-flow report, (3) Iowa Runoff Chart estimates, (4) estimates from the report WRIR 87-4132, and (5) TR-55 rainfall-runoff model estimates. Second, flood estimates calculated from four different flood-estimation methods for streamgages in Iowa with drainage areas between about 2 and 20 square miles will be compared to flood estimates calculated at the streamgages using EMA/MGB, AEP streamgage analyses. The four flood-estimation methods include the previously mentioned methods with the exception of the Iowa Runoff Chart method. Only streamgages included in the Iowa 2013 peak-flow study that meet all U.S. Geological Survey requirements for AEP streamgage analyses will be included in the study. Eighty streamgages have been selected for inclusion in this study. Twenty-five of these streamgages have drainage areas less than 2 square miles and 55 of them have drainage areas between about 2 and 20 square miles.

Recent Publications:

Eash, D.A., 2014, Summary of U.S. Geological Survey reports documenting flood profiles of streams in Iowa, 1963–2012: U.S. Geological Survey Scientific Investigations Report 2014–5085, 32 p. Report is available at http://pubs.usgs.gov/sir/2014/5085/.

Kansas

Streamflow Statistics: The Kansas Water Science Center is working on 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.

Flood Frequency: In cooperation with the Kansas Department of Transportation, FEMA and the US Army Corps of Engineers, the Kansas WSC initiated a study that will improve estimates of annual exceedance probability flood magnitudes at streamgages and ungaged sites in Kansas by using current available data with new analysis techniques.

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 2013 were compiled and published in the USGS Peak Flow File.

Kentucky

No highway related projects at this time.

Louisiana

Monitoring: The USGS maintains cooperative programs with the Louisiana Department of Transportation and Development (LADOTD) and many other local, State, or Federal agencies to operate 75 stage sites, 44 discharge sites, 46 water-quality sites in the coastal zone, 9 crest-stage gages (CSGs), and 69 flood-profile gages in Louisiana. Many of the sites provide continuous records that are available on the internet in near real time.

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 a primary consideration in bridge design. The USGS, in cooperation with the LADOTD, currently is updating flood-frequency statistics at gaging stations, and developing 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 for groundwater and surface-water modeling, development of water-need projections, and assessments of water needs and availability. Withdrawals of water from groundwater and surface water sources throughout Louisiana currently are being compiled and estimated on an annual basis through cooperative programs with the LADOTD and the Louisiana Dept. of Natural Resources.

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, in cooperation with the LADOTD, the Capital Area Ground Water Conservation Commission, and the City of Baton Rouge/Parish of East Baton Rouge, 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 groundwater 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. The USGS, in cooperation with the Louisiana Dept. of Transportation and Development, currently is documenting 10-year surface-water discharge and groundwater-level trends.

Water quality of the Atchafalaya and Lower Mississippi Rivers, 1994-2014: Existing data collected by the USGS in Louisiana from 3 primary sites on the Mississippi River main stem and 3 sites in the Atchafalaya River system are being used to evaluate concentrations of major ions, nutrients, pesticides, pharmaceuticals, waster products, and trace metals. This study will provide information to water managers enabling informed decisions regarding the current overall water quality of the Mississippi/Atchafalaya River system in Louisiana.

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, developed regression equations to estimate peak streamflows with annual exceedance probabilities from 99- to 0.2-percent for small streams in Maine with drainage areas from 0.3 to 12 square miles. Field indicators such as culvert rust lines and bankfull widths were tested for use in the regression equations but were either not commonly found in the field (rust lines) or did not explain enough of the variability in the streamflow statistics to warrant inclusion in the final equations (bankfull width). The final report is in review and will be published in FY2015.

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 final site and report should be available to the public in FY2015.

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 14 complete years of data collection, three sites have 13 complete years of data collection, and two have less than 10 years of data. In addition, 10 seasonal rain gages have been installed to prepare for a future small watershed time-of-concentration study. Five basins were selected for rain gages and two rain gages have been installed in each basin: 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

Massachusetts Flood Frequency Analysis: A study to update the magnitude of 50-, 20-, 10-, 4-, 2-, 1-, 0.5-, and 0.2-percent annual exceedance probability (AEP) floods is being conducted in cooperation with

the Massachusetts Department of Transportation. The last comprehensive regional AEP flood flows for Massachusetts were computed from data up to 1976. The new analysis reports AEP flows using data up through 2013 at 222 streamgages in Massachusetts and surrounding states. New streamgage AEP flows were determined from a weighted at-site skew with a recently competed regional skew for New England, updated techniques that use Expected Moments Algorithm (EMA), and censoring for multiple low outliers. Of the 222 streamgages reported, 199 streamgages were used in a regional analysis to develop equations for computing AEP flows at ungagged sites. The analysis was made using generalized least squares regression methods. The significant explanatory variables were drainage area, mean elevation, and percent of the basin area in open water and wetlands. A report documenting the work is in progress and is expected to be published later this year. After publication, the updated database of at-site AEP flows, along with the regional equations for computing flows at ungagged sites, will be made available in the point-and-click environment of the web-based USGS StreamStats application.

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, total nitrogen, and suspended sediment from 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 locations. 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, nitrogen, and suspended sediment from bridge-deck runoff for the proposed monitoring sites. Three bridge-deck monitoring stations were installed late in water year 2014 and several flow-proportional composite samples were subsequently collected. Data collection will continue for about 2 years.

Michigan

As of December 2014, a network of 8 streamgages and 4 crest-stage gages were operated in cooperation with Michigan Department of Transportation. In spring 2014, Michigan Water Science Center took advantage of increased NSIP funding, converting a crest-stage gage previously operated by MDOT into a continuous-record streamgage. In addition, 6 other crest-stage gages, including 5 that are record stage continuously, are located at or near highway crossings and 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 about 160 additional continuous-recording streamgages operated in Michigan and enhances coverage of peak-flow measurements in the region.

Minnesota

The U.S. Geological Survey (USGS) Minnesota Water Science Center (MNWSC) 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. The project was cooperatively funded by the USGS and the Minnesota Department of Transportation (MNDOT).

MNWSC provided hydraulic investigation support, and bridge scour monitoring as requested. This work is funded by MNDOT.

The MNWSC will publish a report in 2016 titled, "Techniques for Estimating Peak Flow on Small Streams in Minnesota". This report requires large amounts of data generation and collection for the process of identifying the critical characteristics needed for estimating flood frequencies in Minnesota. This project will publish flood frequency statistics for all gaging stations with 10 or more years of high flow data. The report will be in cooperation with the MNDOT.

The MNWSC produced digital flood-inundation maps for a 6.3-mile reach of the Mississippi River in Saint Paul, Minnesota. These were developed through a multi-agency effort by the USGS in cooperation with the U.S. Army Corps of Engineers and in collaboration with the National Weather Service. The inundation maps, which can be accessed through the USGS Flood Inundation Mapping Science Web site at http://water.usgs.gov/osw/flood_inundation/ and the National Weather Service Advanced Hydrologic Prediction Service site at http://water.weather.gov/ahps/inundation.php, depict estimates of the areal extent and depth of flooding corresponding to selected water levels (stages) at the USGS streamgage at the Mississippi River at Saint Paul (05331000). The National Weather Service forecasted peak-stage information at the streamgage that can be used in conjunction with the maps developed in this study to show predicted areas of flood inundation.

USGS is collecting sediment and streamflow data that are used by the Minnesota Department of Natural Resources (MNDNR) to validate statewide stream restoration directives. The MNDNR Division of Ecological and Water Resources uses HEC-RAS models to improve culvert designs at stream/road crossings in order to improve ecological function and 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 MNDNR 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. This work is cooperatively funded by the USGS and the Minnesota Pollution Control Agency.

Recent Publications

Kessler, E.W., Lorenz, D.L., and Sanocki, C.A., 2013, Methods and results of peak-flow frequency analyses for streamgages in and bordering Minnesota, through water year 2011: U.S. Geological Survey Scientific Investigations Report 2013–5110, 43 p., http://pubs.usgs.gov/sir/2013/5110/.

Ellison, C.A., Savage, B.E., and Johnson, G.D., 2014, Suspended-sediment concentrations, loads, total suspended solids, turbidity, and particle-size fractions for selected rivers in Minnesota, 2007 through 2011: U.S. Geological Survey Scientific Investigations Report 2013–5205, 43 p., http://dx.doi.org/10.3133/sir20135205.

Czuba, C.R., Fallon, J.D., Lewis, C.R., and Cooper, D.F., 2014, Development of flood-inundation maps for the Mississippi River in Saint Paul, Minnesota: U.S. Geological Survey Scientific Investigations Report 2014–5079, 24 p., http://dx.doi.org/10.3133/sir20145079.

Mississippi

The Mississippi office had the following projects during 2014:

- 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. Using LiDAR for additional cross section data at sites as it becomes available across the State.
- Operating and maintaining 98 CSGs and 2 flood hydrograph gages.
- Operating a near-real-time scour monitoring gage at a coastal bridge. Streambed soundings and bathymetric surveys 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 2015.

Following the flood of April 2014 in central MS, the Mississippi office recovered high-water marks (HWMs) at 18 road crossings in the Richland Creek, Dabbs Creek and Strong River basins. All of these are tributaries to the Pearl River. Two flood-discharge measurements were made at sites where recent bridge-site studies had been provided to MDOT as part of a verification process as flooding occurs.

In September 2014, HWMs were flagged and surveyed at a dozen sites in Desoto County (just South of Memphis, TN) to document the flooding resulting from a large rainfall event. Indirect estimates of peak discharge were made at two of the sites.

Also during the April 2014 flooding, the Mississippi office used acoustic-Doppler current profilers (ADCPs) to measure velocity, depths and discharge for the following four sites on the Pearl River:

- Interstate 20 at Jackson
- Interstate 55 at Jackson
- State Highway 25 at Jackson
- State Highway 43 near Canton

Maps showing depth and velocity data at each site were provided to MDOT.

In late FY 2010, the Mississippi office 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 was completed in 2014 and deliverables included a 1-D flow model of the Leaf and Bouie Rivers at the City of Hattiesburg, a digital library of 13 inundation maps at 1 foot intervals ranging from flood stage to the peak of record flood, and a Scientific Investigations Map published report. The inundation maps and accompanying report are available at: http://wimcloud.usgs.gov/apps/FIM/FloodInundationMapper.html.

Recent Publications

Storm, J.B., 2014, An expanded model—Flood-inundation maps for the Leaf River at Hattiesburg, Mississippi, 2013: U.S. Geological Survey Scientific Investigations Map 3300, 13 sheets, 8-p. pamphlet.

Storm, J.B., 2014, Flood inundation mapping to aid emergency management planning in the cities of Hattiesburg and Petal [abs.]: Proceedings of the 2014 Mississippi Water Resources Conference, Jackson, Mississippi, April 1-2, 2014.

Missouri

Ongoing activities of the Missouri Water Science Center in 2014 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.
- Ongoing bathymetric surveys at Missouri and Mississippi River bridge sites.

Completed the revision of rural regression equations for Missouri: Previous regression equations for rural basins in Missouri were 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 were 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 was needed. Development of areal comparisons of peak runoff rates was also needed for historical floods. Results will be used to extend streamgage records. Bayesian Generalized Least Squares technique for regional skew analyses has been performed to develop more accurate skew(s) values for Missouri. Expected Moments Algorithm (EMA) released in November 2007 by the USGS has been 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.

Completed 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 objectives of this study included 1) developing a new dimensionless unit hydrograph for urban basins in Missouri using parameters similar to the recently-revised urban flood frequency equations and 2) 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

Densmore, B.K., Burton, B.L., Dietsch, B.J., Cannia, J.C., and Huizinga, R.J., 2014, Monitoring of levees, bridges, pipelines, and other critical infrastructure during the 2011 flooding in the Mississippi River Basin: U.S. Geological Survey Professional Paper 1798–J, 28 p., http://dx.doi.org/10.3133/pp1798J.

Huizinga, R.J., 2014, Bathymetric and velocimetric surveys at highway bridges crossing the Missouri River between Kansas City and St. Louis, Missouri, April–May, 2013: U.S. Geological Survey Scientific Investigations Report 2014–5116, 79 p., http://dx.doi.org/10.3133/sir20145116.

Huizinga, R.J., 2014, An initial abstraction and constant loss model, and methods for estimating unit hydrographs, peak streamflows, and flood volumes for urban basins in Missouri: U.S. Geological Survey Scientific Investigations Report 2014–5193, 59 p., http://dx.doi.org/10.3133/sir20145193.

Southard, R.E., and Veilleux, A.G., 2014, Methods for estimating annual exceedance-probability discharges and largest recorded floods for unregulated streams in rural Missouri: U.S. Geological Survey Scientific Investigations Report 2014–5165, 39 p., http://dx.doi.org/10.3133/sir20145165.

Montana

Bridge-scour data collection and analysis program ongoing since 1991. As part of this program, near real-time scour monitoring is being conducted at four sites.

Small-stream peak-discharge data collection program ongoing since 1955 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. Two reports related to this project were published in 2014.

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 using the Expected Moments Algorithm (EMA) and a new multiple low outlier test based on a generalization of the Grubbs-Beck test. This project would be the first step in a phased approach to implement StreamStats in Nebraska.

Flood inundation map libraries are being developed for a reach of the Papillion Creek in Omaha which includes two streamgages. The National Weather Service will begin forecasting at one of the streamgages on the study reach in FY15. This study will provide cooperators with a flood planning tool for road and bridge construction and operation.

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.

Densmore, B.K., Burton, B.L., Dietsch, B.J., Cannia, J.C., and Huizinga, R.J., 2014, Monitoring of levees, bridges, pipelines, and other critical infrastructure during the 2011 flooding in the Mississippi River Basin: U.S. Geological Survey Professional Paper 1798–J, 28 p., http://dx.doi.org/10.3133/pp1798J.

Dietsch, B.J., Densmore, B.K., and Strauch, K.R., 2014, Repeated multibeam echosounder hydrographic surveys of 15 selected bridge crossings along the Missouri River from Niobrara to Rulo, Nebraska, during the flood of 2011: U.S. Geological Survey Scientific Investigations Report 2014–5062, p. 153, http://dx.doi.org/10.3133/sir20145062.

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. Peak stages recorded at the crest-stage gages are computed to discharge peaks by direct or indirect measurements, or by application of stage-discharge ratings.

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 FY15. A new agreement to continue the study to extend the project through FY16 was signed in August 2013.

New Hampshire

NHDOT – USGS Sources of Nitrate to Wells: A project to help determine sources of nitrate to wells in the vicinity of active roadway blasting is in its second of two years. Sampling was completed between April 2013 and October 2014 for the USGS and New Hampshire Department of Transportation (NHDOT) study. Concentrations and isotopic compositions of nitrate and other nitrogen compounds in groundwater are being used to identify sources of nitrate such that 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. A journal article is slated to be published by the end of December 2015.

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 FY2014 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 10 gaging locations and at bridges at an additional 2 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 2014 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 FY 2014 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.
- Currently updating the existing regional skew map for New York (http://ny.water.usgs.gov/pubs/wri/wri004022/WRIR00-4022.pdf).
- Beta-testing a climate scenario tool that piggy-backs on StreamStats capabilities and allows a user to select an array of future precipitation scenarios from available downscaled climate models. Future precipitation estimates are used with existing regional regression equations for NY to assess the future change in flood-frequency discharges from current conditions.

- A flood inundation mapping project, in cooperation with the NYS DEC, is underway along the Schoharie Creek in Prattsville, NY, a community heavily damaged by Hurricane Irene..

- 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

Wall, G.R., Murray, P.M., Lumia, Richard, and Suro, T.P., 2014, Maximum known stages and discharges of New York streams and their annual exceedance probabilities through September 2011: U.S. Geological Survey Scientific Investigations Report 2014–5084, 16 p., http://dx.doi.org/10.3133/sir20145084.

Lumia, Richard, Firda, G.D., and Smith, T.L., 2014, Floods of 2011 in New York: U.S. Geological Survey Scientific Investigations Report 2014–5058, 236 p., http://dx.doi.org/10.3133/sir20145058.

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.

North Carolina

The USGS South Atlantic Water Science Center (SAWSC) Raleigh unit – formerly the 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). Efforts are still on-going to have the application updated to provide users with flood-frequency statistics and techniques from a recently published report on flood frequency in urban and small rural basins in Georgia, South Carolina, and North Carolina (Feaster and others, 2014; see below). Use of the NC StreamStats application outside of the USGS continues to result in positive feedback being received from external users.

In May 2010, the USGS SAWSC began a cooperative investigation with the SCDOT to update urban flood-frequency estimates in South Carolina. The specific objectives of the investigation were 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 included urban stations from South Carolina, North Carolina, and Georgia. In addition, the urban study included stations from the inner Coastal Plain of New Jersey. The inclusion of urban stations from New Jersey allowed for a substantial expansion of the drainage area size for which the Coastal Plain flood-frequency regression equations are applicable. During the study, the SAWSC Raleigh unit assisted in the determination of flood-frequency statistics at streamgages in North Carolina and provided reviews of the updated techniques and report during the draft stage. The project report and a companion fact sheet were released in March 2014. The report citations along with the Internet links are listed below.

The SAWSC Raleigh unit 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. 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. The analytes being sampled include metals, nutrients, pH, suspended solids, polycyclic aromatic hydrocarbons (PAHs) and other organic compounds. In association with the water-quality data collection, the SAWSC Raleigh unit also collects stage-only and wind speed/direction data for the Currituck Sound on the east bank at Corolla, NC (USGS Sta. 02043433).

The SAWSC Raleigh unit 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

Feaster, T.D., Gotvald, A.J., and Weaver, J.C., 2014, Methods for estimating the magnitude and frequency of floods for urban and small, rural streams in Georgia, South Carolina, and North Carolina, 2011 (ver. 1.1, March 2014): U.S. Geological Survey Scientific Investigations Report 2014–5030, 104 p., http://dx.doi.org/10.3133/sir20145030.

Feaster, T.D., Gotvald, A.J., and Weaver, J.C., 2014, Estimating flood magnitude and frequency for urban and small, rural streams in Georgia, South Carolina, and North Carolina, 2011: U.S. Geological Survey Fact Sheet 2014–3015, 2 p., http://dx.doi.org/10.3133/fs20143015.

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; including two that have already been published:

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.

Schenk, E.R., Skalak, K.J., Benthem, A.J., Dietsch, B.J., Woodward, B.K., Wiche, G.J., Galloway, J.M., Nustad, R.A., and Hupp, C.R., 2014, Geomorphic change on the Missouri River during the flood of 2011: U.S. Geological Survey Professional Paper 1798–I, 25 p., http://dx.doi.org/10.3133/pp1798I.

StreamStats: The current application of StreamStats for North Dakota is located at http://ssdev.cr.usgs.gov/ss_dev/. Streamflow statistics in StreamStats for North Dakota are currently in development.

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.

Oklahoma

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

The Oklahoma Water Science Center, in cooperation with the Oklahoma Department of Transportation, completed a Web-based flood database for Oklahoma. The objectives of this project were 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 facilitates access to this information and results 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, unpublished USGS and ODOT indirect measurements, and selected ancillary data and documents related to historical flooding.

The web-based product produced from this study is available here:
http://ok.water.usgs.gov/projects/dbflood/

The USGS Oklahoma Water Science Center, in cooperation with the Oklahoma Department of Transportation, initiated a study to update and develop new regional regressions for estimating rural flood-frequency statistics in the Oklahoma Panhandle. The objectives of the study are to: (1) delineate and define the extent of the Oklahoma Panhandle/Northwest region where StreamStats is suspected (by State engineers) to compute unreasonable estimates of flood-frequency statistics ; (2) review previous flood-frequency regression studies in Oklahoma and Kansas, (3) develop new flood-frequency regression equations for the Panhandle/Northwest region of Oklahoma, (4) publish a peer-reviewed USGS report describing methods and results of equation review and development, and (5) incorporate new regional flood-frequency regression equations into StreamStats. In terms of scope, the project will consider about 30 streamflow-gaging stations located in the Oklahoma Panhandle and surrounding counties of Oklahoma, Kansas, and Texas. The time period covered by the study will be the irrigation-affected period covering water years 1978 to 2013.

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 is used to estimate combinations of contaminant loads and concentrations from upstream basins and highway runoff affecting the water quality of receiving streams (Granato, 2013). Specific objectives of the ORWSC study were 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 has been published as listed below.

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., 2014, 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 2014–5099, 74 p., http://dx.doi.org/10.3133/sir20145099.

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 have been recently completed. The inundation maps for Lewisburg and Milton are available on the USGS National Flood Inundation Mapping (FIM) Program and on the Susquehanna River Basin Commission Inundation Mapping Viewer (SimV). The Harrisburg inundation maps are available on the NWS Advanced Hydrologic Prediction Service web site (AHPS), FIM, 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 2015.

Bathymetry: A bathymetric survey of a lake in Chester County has been completed and a report with a digital contour map of Chambers Lake will be available in 2015. An area/capacity table referenced to a range of lake elevations will be developed.

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 (http://waterdata.usgs.gov/pa/nwis/rt).

Recent Publications

Roland, M.A., Underwood, S.M., Thomas, C.M., Miller, J.F, Pratt, B.A., Hogan, L.G., and Wnek, P.A., 2014, Flood-inundation maps for the Susquehanna River near Harrisburg, Pennsylvania, 2013: U.S. Geological Survey Scientific Investigations Report 2014–5046, 17 p., *http://dx.doi.org/10.3133/sir20145046*.

Roland, M.A., and Hoffman, S.A., 2014, Flood-inundation maps for the West Branch Susquehanna River near the Boroughs of Lewisburg and Milton, Pennsylvania, 2013: U.S. Geological Survey Scientific Investigations Report 2014–5094, 13 p., http://pubs.er.usgs.gov/publication/sir20145094.

Puerto Rico

The Puerto Rico Authority of Highways and Transportation provides funding for a network of surface water and water quality stations.

Rhode Island

Please see the Massachusetts section for USGS efforts in Massachusetts and Rhode Island.

South Carolina

Gaging stations: The South Carolina Data Program of the U.S. Geological Survey (USGS) South Atlantic Water Science Center (SAWSC), in cooperation with the South Carolina Department of Transportation (SCDOT), operates 7 real-time continuous record streamflow stations, 1 continuous record water-quality

station, and 47 partial record crest-stage stations. (Number of gaging stations fluctuates slightly from year to year.)

Evaluation of recently developed NCHRP abutment-scour equations: The USGS SAWSC, 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 July 2015.

Development of a manual to integrate findings of previous field investigations of bridge scour: The USGS SAWSC, 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 a large database that includes 1,805 pier-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 pier scour in the field. Preliminary comparison of the compiled field data with the South Carolina pier-scour envelope curves verifies that the envelope curves are reasonable.

Publication of the 2014 USGS Pier-Scour Database (PSDb-2014): The USGS SAWSC, in cooperation with the SCDOT, conducted a literature review to identify potential sources of published pier-scour data, and selected data were compiled into a digital spreadsheet called the 2014 USGS Pier-Scour Database (PSDb-2014) consisting of 569 laboratory and 1,858 field measurements. These data encompass a wide range of laboratory and field conditions and represent field data from 23 States within the United States and from 6 other countries. The digital spreadsheet is available on the Internet and offers a valuable resource to engineers and researchers seeking to understand pier-scour relations in the laboratory and field. The report citation along with the Internet link is listed below.

Benedict, S.T., and Caldwell, A.W., 2014, A pier-scour database—2,427 field and laboratory measurements of pier scour: U.S. Geological Survey Data Series 845, 22 p., http://dx.doi.org/10.3133/ds845.

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 Atlantic 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 were 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 included urban stations from South Carolina, North Carolina, and Georgia. In addition, the urban study included stations from the inner Coastal Plain of New Jersey. The inclusion of urban stations from New Jersey allowed for a substantial expansion of the drainage area size for which the Coastal Plain flood-frequency regression equations are applicable. The project report was released in March 2014 and the report citation along with the Internet link is listed below.

Feaster, T.D., Gotvald, A.J., and Weaver, J.C., 2014, Methods for estimating the magnitude and frequency of floods for urban and small, rural streams in Georgia, South Carolina, and North Carolina, 2011 (ver. 1.1, March 2014): U.S. Geological Survey Scientific Investigations Report 2014–5030, 104 p., http://pubs.usgs.gov/sir/2014/5030/.

In addition, USGS Fact Sheet 2014-3015, "Estimating flood magnitude and frequency for urban and small, rural streams in Georgia, South Carolina, and North Carolina, 2011," also was published and can be accessed at http://pubs.usgs.gov/fs/2014/3015/.

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 polycyclic aromatic hydrocarbons. 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 was released in 2014 and the report citation along with the Internet link is listed below.

Journey, C.A., and Conlon, K.J., 2013, Characterization of stormwater at selected South Carolina Department of Transportation maintenance yard and section shed facilities in Ballentine, Conway, and North Charleston, South Carolina, 2010–2012: U.S. Geological Survey Scientific Investigations Report 2013–5175, 82 p., http://dx.doi.org/10.3133/sir20135175.

In addition, USGS Fact Sheet 2014-3011, "Characterization of stormwater at selected South Carolina Department of Transportation maintenance yards and section shed facilities in Ballentine, Conway, and North Charleston, South Carolina, 2010-12," also was published and can be accessed at http://pubs.usgs.gov/fs/2014/3011/.

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, prior to this investigation, no specific studies had been conducted in South Carolina. In June 2013, the USGS South Atlantic Water Science Center, 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 began 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 USGS SAWSC 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, Performance and Effectiveness of Scour Countermeasures."

South Carolina StreamStats Program: The USGS SAWSC, in cooperation with the SCDOT, began the StreamStats project on October 1, 2014. This project will incorporate LiDAR derived data for the elevation data as well as updating the NHD and WBD with that data. This project has an end date of April 2018. Details regarding this project are described in the report section, "Partial Summary of USGS National Activities, StreamStats Program".

South Dakota

Crest stage gage network: In cooperation with the South Dakota Department of Transportation (SDDOT), 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 was ongoing for a number of years, primarily to address circumstances such as allowing incorporation of increased availability of higher-resolution topographic data and addressing difficulties the application for determination of basin characteristics. Full-scale implementation of the StreamStats application was achieved in 2013, and maintenance-level activities have continued since then.

Bridge Scour: SDDOT and USGS have collaborated for several years on a project involving analysis of potential bridge scour for sites along local government roads. All project activities have now been completed and results have now been published in a final report (Thompson and others, 2014).

Statewide flood-frequency analysis: USGS recently initiated a new project in cooperation with SDDOT to perform a statewide update for South Dakota. The project will involve (1) updating at-site flood-frequency analyses for all appropriate sites (using data through water year 2013) and (2) developing statewide regional regression equations for estimating peak-flow magnitude and frequency relations for ungaged streams. As part of this effort, South Dakota is working with a number of other states in the Great Plains and Upper Midwest to pursue a regional-scale effort for development of new skew coefficients. A coordinated effort is underway among a large block of contiguous states, with a goal of having updated skew coefficients that can be incorporated in the at-site frequency analyses.

Recent Publications

Thompson, R.F., Wattier, C.M., Liggett, R.R., and Truax, R.A., 2014, Estimation of potential scour at bridges on local government roads in South Dakota, 2009–12: U.S. Geological Survey Scientific Investigations Report 2013–5233, 22 p. http://pubs.usgs.gov/sir/2013/5233/.

Tennessee

Tennessee had the following projects during 2014:

- 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 (CSGs) 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.
- 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.
- Continuing 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.
- Continuing 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 (FY 2010–2013, completed): The SW research group with the Texas Water Science Center 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 was 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 was to generalized the relation between discharge and hydraulic, watershed, and channel properties.

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., Strom, K.B., Sharif, H., and Liu, X. 2013, "Empirical Flow Parameters: A Tool for Hydraulic Model Validity Assessment," Technical Report FHWA/TX-14/0-6654-1, chapter A, pp. 129Ð145.

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: 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].

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, v. 19, no. 1, pp. 108-122, [http://dx.doi.org/10.1061/(ASCE)HE.1943-5584.0000715].

Small Watershed Gaging Program (FY2006–2014 and on-going): The Texas Department of Transportation and the USGS cooperate on 5-year increments on a small watershed data-collection program. The program is currently extended through FY15. A new agreement for FY 2016-2020 should start to manifest about March 2015. The program is comprised of 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 will also be operated as continuous real-time (conventional gages). Well over 600 measurements of peak discharge have been made thus far.

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/.

Asquith, W.H., 2014, Parameter estimation for the 4-parameter asymmetric exponential power distribution by the method of L-moments using R: Special Section: Statistical Algorithms and Software in R, Guest eds.: P. Filzmoser, C. Gatu, and A. Zeileis, Computational Statistics and Data Analysis, v. 71, pp. 955-970, http://dx.doi.org/10.1016/j.csda.2012.12.013.

Updated Rainfall Intensity-Duration Frequency Coefficients by County in Texas (FY 2014-2015): The SW research group with the Texas Water Science Center is engaged in peer-to-peer research with Texas Tech University (Ted Cleveland) to refine and implement various previously published USGS reports (circa 2004) in Texas that include dimensionless rainfall hyetographs and depth-duration frequency of rainfall annual maxima. This particular study integrates the results of the prior studies, refined as necessary through additional quality-control and quality-assurance steps, into special spreadsheet macros to replace and extend a quite venerable spreadsheet (circa late 1980s) for intensity-duration frequency of rainfall estimation for durations from 10 minutes to 24 hours. The principle product of this project will be lookup tables by county (254 counties in Texas) of three coefficients in a nonlinear equation unique for each of six return periods (2, 5, 10, 25, 50, and 100 years).

Utah

Great Salt Lake in Utah is divided into a north part and south part by a rock-fill railroad causeway constructed in 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 approximately two-thirds of a network of 28 crest-stage gages located in small headwater watersheds throughout the state. VTrans funds one-third of the cooperative agreement for the state share of the Vermont's stream-gaging network.

Publications:

Olson, S.A., 2014, Estimation of flood discharges at selected annual exceedance probabilities for unregulated, rural streams in Vermont, with a section on Vermont regional skew regression, by Veilleux, A.G.: U.S. Geological Survey Scientific Investigations Report 2014–5078, 27 p. plus appendixes, http://dx.doi.org/10.3133/sir20145078.

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. A Scientific Investigations Report was published in 2014 describing the findings. A cooperative effort to implement StreamStats in Virginia is nearing completion. StreamStats is expected to be fully implemented in 2015.

The USGS is currently involved in preliminary efforts to assist VDOT bridge redesign across the Commonwealth. VDOT will provide geotechnical data, while the USGS provides hydrologic data for the designs.

Recent Publications

Austin, S.H., 2014, Methods and equations for estimating peak streamflow per square mile in Virginia's urban basins: U.S. Geological Survey Scientific Investigations Report 2014–5090, 25 p., http://dx.doi.org/10.3133/sir20145090.

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 USGS Washington Water Science Center (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 Monitoring Program (RSMP). Federal, State, and local agencies, Native American Tribes, business, and environmental groups are represented on the workgroup. USGS assisted with site selection for the RSMP in 2014, and will be conducting water-quality and stream-ecology monitoring for the RSMP in 2015.

USGS staff continued their participation in the "Roads and Highways Subgroup" of the SWG that generated recommendations for regional stormwater monitoring related to roads and highways that include priority best management practice (BMP) effectiveness studies and source identification and diagnostic studies. In 2014, those recommendations were incorporated into WSDOT's reissued municipal stormwater NPDES permit. The new permit includes a requirement to participate in the RSMP, and WSDOT chose to contribute to the RSMP pooled funds account for status and trends

monitoring in receiving waters, to monitor additional parameters, and to monitor additional sites.

Flood Frequency: In cooperation with the Washington State Departments of Transportation and Ecology, WAWSC is continuing 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: In cooperation with the Seattle Public Utilities, WAWSC continued 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 streamflow-gaging stations.

Development of StreamStats in West Virginia was initiated in 2014. It is expected to take two years for development to be completed.

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.

- Progress for FY2014 monitoring was extended for one year. Report writing is in progress.

- Plans for FY2015 monitoring have been extended through June of 2015 when report writing is expected to finish. Wisconsin WSC will cooperate with WinSLAMM models to incorporate grass swales and filter strips data into modeling routines. Then calibrate and test WinSLAMM for WisDOT.

Evaluation of Bioretention Swale at Reducing Highway Runoff Pollutant Concentrations and Loads Waukesha, Wi: 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 bioretention swales as a stormwater management practice. The primary objective of this study will be focused on measuring the effectiveness of bioretention swales at reducing stormwater runoff flowing from urban highways. It will evaluate the infiltrative capacity of bioretention swales and their potential to reduce pollutants such as TSS. This study will evaluate two sections with different engineered soil mixtures: first mixture is using the Bioretention Technical Standard (1004) mix of 75 percent sand and 25 percent compost and the second mixture is 18-in. of sand at the bottom and 6-in. of the 75/25 compost mixture.

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 bioretention swales, parameters in models can be modified to simulate the site conditions.

This study will be used validate the modifications made to the Bioretention Technical Standard 1004. Owing to a study in Neenah WI, the State of Wisconsin modified the amount of engineering compost from 50 to 25 percent, and is in the process of reducing the requirement of 3 feet of engineered soil to 2 feet. This study will validate or modify those changes made to the technical standards.

- Progress in FY2014: installed most of the monitoring equipment in the spring and started monitoring for water quantity and quality.

- Plans for FY2015: 1) finish install and making measurements and collecting samples to determine infiltration rates and pollutant reductions from the bioswale sites, 2) characterizing the soils in the bioswale through soil testing and double ring infiltration test.

Evaluating the Water Quantity and Quality Benefits of Permeable Pavement: The USGS, in cooperation with the Wisconsin State Department of Transportation other Wisconsin Department of Natural Resources, has initiated a multi-year research project that will evaluate the water quality benefits of three variations of permeable pavement: pavers, concrete, and asphalt. The following are the specific objectives:

- Determine if the infiltration rate in each pavement surface changes over time.
- Measure the residence time in the storage layer for different events.
- Understand how each surface responds to accumulating ice and snow with less salt use.
- Calibrate the permeable pavement routines in the Windows Source Load and Management Model (WinSLAMM) with the results from the study
- Use the results of the study to help develop a technical standard for the use of permeable pavement in the state of Wisconsin.

Construction of the test site began in May of 2014 and was finished by September. All equipment has been installed to measure discharge, temperature, and water-quality. Future work will quantify water-quantity and quality response from each surface over a range of precipitation and snowmelt events through 2018.

Wyoming

No highway related projects at this time.