A Partial Summary of 2018 USGS Activities of Interest to the FHWA and State Highway Agencies

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Introduction and summary of current projects

The U.S. Geological Survey (USGS) serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life. The USGS does much of this work in cooperation with State and Federal transportation and regulatory agencies as well as many land and water management agencies. As part of these efforts, 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, the USGS enhances and maintains the on-line StreamStats flow statistics application in cooperation with many State transportation agencies; this tool has been used for analysis of hydrology, hydraulics and water quality across the Nation. In addition, the USGS enhances and maintains the National Streamflow Statistics Program, the WaterAlert, a tool for automatic notification of threshold exceedance for stream stage, streamflow, and other water- related data collected by USGS. The USGS is concluding efforts to update the Federal Guidelines for Flood Frequency Determinations (Bulletin 17B) and the USGS PeakFQ Program and will continue to support these tools in the future.

The following table and text provide a partial summary of current or recently completed USGS activities related to highway issues. Table 1 lists the type of research by generalized subject and provides a list of States and (or) Federal agencies that are helping sponsor scientific investigations on each subject. The text following Table 1 provides more information about activities that have been or are being conducted on a national level and is followed by a partial list of reports published in 2018 that may be of interest to the transportation community. Open access to more than 150,000 publications written by USGS scientists since 1879 are available on-line at the USGS Publications Warehouse (https://pubs.er.usgs.gov/). Many of these reports are applicable to one or more transportation

research need. If you should have questions regarding this information, please contact Julie Kiang (jkiang@usgs.gov), Robert Mason (rrmason@usgs.gov), and/or Gregory Granato (ggranato@usgs.gov).

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

Subject	**Agency (FHWA or State DOT)**
Ecology	CA, FL, SC, SC
Flood frequency	FHWA, AK, AL, CT, GA, GA, LA, NM, OK, OK, SC, SC, SD, WI
Groundwater	AR, CA, LA, SC
Hazards	FHWA, CA
Hydraulics	AK, AL, AL, MO, MT, SD, WV
Peak flow	CO, IL, MO, MT, OK, PA, SD, TX, VA
Scour	FHWA, AK, CO, MS, MT
SELDM	FHWA, CA, CT, MA, NC, NV, OR, RI
Streamflow	AK, AR, AZ, CO, DE, GA, HI, IA, IN, LA, MD, MI, MN, MO, MS, MT, NC, NJ, NM, NV, NY, OR, SC, SD, TN, VA, VT, WV
StreamStats	CO, CT, IL, MA, MT, NC, OH, PA, RI, SC
Water Quality	CT, MA, MD, NC, NV, SC, WI

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, water-quality conditions, or rainfall meet user-specified criteria at real-time USGS hydrologic data collection sites. Criteria can include greater-than, less-than, within, and out-of-range thresholds. Reporting frequencies can include once-per-day or once-per-hour alerting 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 thresholds of interest. These maps, where available, along with National Weather Service E-19 flood stage information, 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 complementary interactive USGS query and alert feature called WaterNow is also available for users to query any real-time USGS hydrologic data collection site and request reports of the most recent values for any data collected at the site of interest. The query and response can be sent and received using any device with email or text message capabilities. Information about the USGS WaterNow system is available at: http://water.usgs.gov/waternow/

Groundwater and Streamflow Information Program (GWSIP)

The U.S. Geological Survey (USGS) operates more than 8,200 near real-time streamgages in the National Streamflow Network (NSN) in cooperation with Federal, State, local, regional, tribal, non-governmental and industrial partners. The USGS provides a continuous source of streamflow information that is used in countless ways by governmental organizations, private industries, and the general public (https://www.usgs.gov/gwsip).

Historically, the collection and dissemination of hydrologic information have been managed through multiple USGS programs, which were combined in 2016 into GWSIP, including in large part, the Cooperative Matching Funds (CMF, formerly the Cooperative Water Program) and the Federal Priority Streamgages (FPS, formerly the National Streamflow Information Program). The goal of GWSIP is to enhance its comprehensiveness and interdisciplinary value and more effectively represent key components of the hydrologic cycle including surface water, groundwater, evapotranspiration, precipitation, and some water quality and sediment (Super Gages).

One of the highest goals of the USGS is to maintain long-term stability of a "federal needs backbone network of streamgages" (a total of 4,760 streamgages as defined in the original NSIP design, now managed as FPS) for long-term tracking and forecasting/modeling of streamflow conditions in the future in response to changes in land use, water use, and climate. Specifically, consistent and systematically-collected information is paramount to meet the full gamut of Federal water priorities and

responsibilities over the long term (previously defined by the NSIP) related to:

- Forecasting extreme hydrologic events (floods and droughts);
- Monitoring water flows across international, interstate, and tribal borders needed to address inter-jurisdictional and court adjudicated water rights and other legal responsibilities;
- Tracking streamflow, water quality, and habitat in major river basins, such as those discharging into key estuaries or draining heavily populated areas; and
- Tracking long-term streamflow trends and causes, such as relating to population growth and changes in land use, water use, and climate.

In 2018, approximately 3,460 streamgages of the more than 8,200 streamgage network met these strategic long-term Federal priorities and responsibilities. These Federal Priority Streamgages were funded by the GWSIP (approximately 1/3 of the funding) and USGS partners (the remaining 2/3 of the funding). In 2018, a total of approximately 1,264 of these streamgages were fully funded by the USGS (through FPS). Support for a full "federal needs backbone network of streamgages" requires about $125M, requiring an additional $100 million dollars annually.

Beginning in 2016, the USGS has aligned its budget structure to the Water Science Strategy by consolidating the previous seven programs into four major program areas. The first, which has been discussed previously, GWSIP, focuses on observing and delivering water data. The other three programs, National Water Quality Program; Water Availability and Use Science Program; and Water Resources Research Act; all focus on understanding, predicting and delivering. The USGS Water Science Strategy (URL: http://pubs.usgs.gov/of/2012/1066/of2012-1066.pdf) identifies water science goals and objectives that serve the Nation and address the water challenges for the future. The Strategy outlines areas where hydrologic science can make substantial contributions to the Nation and identifies opportunities for the USGS to better use its hydrologic science capabilities to advance healthy watersheds and sustainable, secure water supplies and to minimize impacts of water-related hazards.

GWSIP will encompass the USGS objectives to provide long-term, national networks for observation of the vital components of the hydrologic cycle and include activities such as the USGS streamgaging network, flood monitoring and inundation science, including response to other Hazards. GWSIP also includes the National Groundwater Monitoring Network and USGS Climate Response Network. The USGS is working through the Advisory Committee for water Information (ACWI) Subcommittee on Hydrology (SOH) on the Streamflow Information Collaborative" to discuss the USGS streamgage network, including suggestions for improvement in the network, its operations and funding, as well as, other information and data needed to improve streamflow information for the nation. Interested state and local agencies, other Federal agencies, and other interested parties can participate as a member of the collaborative. Please contact Chad Wagner (cwagner@usgs.gov) for more information.

Flood Response Activities

The USGS, as the nation's premier earth science agency, is expected by cooperators, emergency management agencies, news media, and the public to provide hydrologic information prior to, during, and after flooding, with a particular expectation that USGS will disseminate near real-time flood data and flood summaries on the World Wide Web. The role of the USGS related to flood response activities has greatly expanded over the years as commitments at all levels of government have increased. In addition, USGS has a responsibility to advance scientific understanding of floods and public risk awareness both internally in its own scientific studies as well as collaboratively with outside agencies, academics, and non-profits. Accordingly, USGS must prepare for and respond decisively and consistently to flood events, including post-flood scientific study when appropriate.

During major floods, the USGS deploys field crews to measure flood flows at streamgages and other locations of interest (such as breached levees, chemical spills, etc.). Flood-related data are available at the following locations:

- https://waterdata.usgs.gov: time series stage, streamflow, and water quality data and at-site measurements
- https://stn.wim.usgs.gov/FEV/: a national event-based tool for viewing and downloading storm tides sensor data and high-water mark data
- https://water.usgs.gov/wateralert/: user-customized alerts
- https://waterwatch.usgs.gov: situational awareness maps and tools
- https://water.usgs.gov/floods: a national website on major flooding events

While the USGS streamgage network is large, during an emergency, a streamgage may not exist where it is most needed. The needs include flood control reservoir operation, flood forecasting, flood fight operations, road closure, and emergency management, including evacuations. To meet this need, USGS develops, builds, and maintains a cache of rapid deployment streamgages (RDG) that can be installed to collect and transmit near real-time data within hours to days of a recognized need. They can be installed quickly and with minimal impacts to bridges and structures, and data will begin appearing on the web within minutes of installation.

If additional data is needed for calibration of models or documenting flood peaks, USGS technicians can install small water-level sensors in opportunistic networks. These have been used to document storm-tide flooding where the local coastal conditions prohibit a network of larger sensors. Over 550 USGS storm tide sensors and RDG's were installed in the 2018 water year to monitor and measure the effects of major storms including Nate, Florence, Isaac, Michael, and a number of other significant events.

High water marks (HWMs) are also instrumental in post-flood analyses. After an event, USGS technicians survey HWMs according to the standards in the recently published USGS Techniques and Methods

manual: Identifying and Preserving High-Water Mark Data (https://pubs.er.usgs.gov/publication/tm3A24). In the 2018 water year, the USGS collected and documented nearly 1,500 high-water marks, which are now stored with marks from many past events and accessible at the USGS Flood Event Viewer at http://stn.wim.usgs.gov/FEV/.

Many federal, state, and local partners use the data that USGS collects for modelling, peak verification, flood inundation mapping, flood frequency computation (discussed further below), emergency management, and public education. USGS scientists and technicians are also involved in documenting extreme floods (see http://water.usgs.gov/floods/reports/) and flood inundation studies (see https://wim.usgs.gov/FIMI).

Contact Bob Holmes (bholmes@USGS.gov), the USGS National Flood Hazard Coordinator, for more information.

Updated Flood-Frequency Analysis Guidelines

Flood-frequency analysis provides information about the magnitude and frequency of flood discharges. New guidelines were published this year as Guidelines for Determining Flood Flow Frequency, Bulletin 17C as a product of a team organized under the Advisory Committee on Water Information's Subcommittee on Hydrology, Hydrologic Frequency Analysis Workgroup.

The report defines procedures that provide a uniform and consistent approach for determining flood-flow frequency from peak-flow records. Improvements include more detailed representations of flood data, an improved computational algorithm, better screening for statistical outliers, improved methods for incorporation of regional information, and improved accuracy of confidence limits. The enhancements combine to provide more robust estimation of flood frequency. The updated methods are particularly valuable when new regional information is available or when historical flood records or paleoflood information are available. Note that while the estimation methods have been improved, the framework for flood frequency analysis has not been changed. As a result, Bulletin 17C methods allow continuity with previous studies. The new guidelines can be obtained at https://acwi.gov/hydrology/Frequency/b17c/.

The Peak flow FreQuency analysis program (PeakFQ) implements the Bulletin 17C recommended procedures for flood-frequency analysis of streamflow records. A Windows version is available at http://water.usgs.gov/software/PeakFQ/.

Contact Julie Kiang (jkiang@USGS.gov) for more information about the USGS contributions to the effort.

Updated Flood-Frequency Regional Skew Map

The regional skew is the third moment of the log Pearson Type III distribution and is a measure of the asymmetry of the distribution. The skew is very sensitive to extreme events, such as large floods. Thus, in flood frequency analysis, the skew becomes significant because interest is focused on the right-hand tail of the distribution. However, the span of available years of recorded flood data at a given gage site is usually too short to provide a highly reliable estimate of the skew. To improve the precision, Bulletin 17C recommends weighting the at-site skew with a regional skew. The USGS is working with FEMA and various state and local agencies to update the National flood- frequency skew map provided with Bulletin 17B. Since the first map was published in 1976, over 40 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. USGS is applying the new methods to update skew estimates on a multi-state, hydrologic basis with the eventual goal of updating skew estimates for the entire Nation. The current status of regional skew updates is available at https://acwi.gov/hydrology/Frequency/b17c/supplementary- materials/reports.html.

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

Non-Stationarity in Flood Frequency Analyses

Flood frequency estimates are a major consideration in hydrologic design of culverts, bridges, and other infrastructure. In using historically observed peak flows to determine the peak design flow, the standard methods assume that the peak design flow will occur in the future with the same probability and magnitude as determined from the historical analysis. With changes to climate, land cover, snowpack, and agricultural and land drainage practices occurring across the United States and potential future changes, the assumption of stationarity in the observed peak flow record may not be valid.

Potential changes to floods may be the result of many factors, some of which operate at the watershed scale (such as changes to land-drainage or urbanization), some of which operate at the regional scale (such as changes to snowpack) and some of which operate at the global scale (such as changes to climate and large-scale weather patterns). USGS is using its extensive database of streamflow information and its site-specific knowledge about individual gages in cooperation with FHWA to advance the state of knowledge in three gap areas:

- **Characterize changes in peak flows:** In this study, we are extending on previous analyses by using data from long-record stream gages, to study observed trends - whatever the cause. We will also extend previous work which has shown that the observed changes depend on the magnitude of the flood event being studied.
- **Diagnose and attribute changes in flood frequency:** To the degree possible, this study is attributing the observed flood trends to changes in both climate-based metrics as well as land-cover characteristics such as artificial land drainage and urbanization and other land cover change.
- **Adjusting flood-frequency analysis for observed and projected change:** The study will include an assessment of different methods for incorporating trends into flood frequency analysis.

Contact Julie Kiang (jkiang@usgs.gov) for more information.

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 7,000 regression equations.

Regression equations for estimating flood-frequency statistics of peak flows for rural and naturally flowing rivers are available for all 50 United States as well as 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 18 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 37 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.

Efforts are currently underway to convert the stand-alone program into a web-based service that can be accessed without downloading or installing any files. Contact Peter McCarthy at the email address below for more information or if you would like to volunteer to test the new system.

The NSS program and documentation can be downloaded from the Internet at: http://water.usgs.gov/software/NSS/.

If you have questions regarding this information, please contact Peter McCarthy (pmccarth@usgs.gov).

StreamStats Program

StreamStats (https://water.usgs.gov/osw/streamstats/) is a Geographic Information Systems-based Web application, developed by the 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 the location. The estimates for ungaged sites are determined from USGS regional-regression equations and usually can be obtained in only a few minutes.

As of December 2018, StreamStats is available to the public for 41 states with full functionality (fig.1). Currently (2019) StreamStats applications are undergoing implementation in Puerto Rico, West Virginia, and Wyoming. Applications also are available for two states and four river basins that allow only basin delineations and computation of basin characteristics. The four river basins are the Connecticut River Basin, which encompasses area in Connecticut, Massachusetts, New Hampshire, and Vermont; the Delaware RiverBasin, which encompasses area in Delaware, Maryland, New Jersey, New York, and Pennsylvania; and the Rainy River Basin, which encompasses area in northern Minnesota and the Canadian provinces of Manitoba and Ontario and the Platte River Basin in Nebraska. In addition, new equations will be added for many states, and streamflow statistics served by StreamStats for many USGS streamgages will be updated. See the map below to determine the status for individual state and river basin applications.

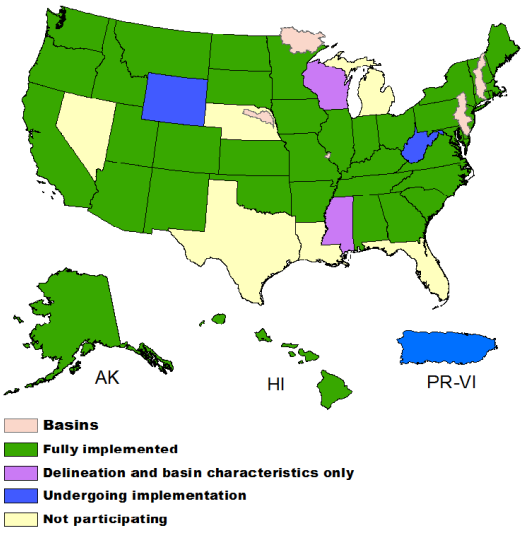

Figure 1. Status of StreamStats implementation on December 31, 2018

If you would like to learn more about StreamStats, please contact Peter McCarthy (pmccarth@usgs.gov).

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, lack of field verification of the performance and effectiveness of these countermeasures leaves 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 complete 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, which is in the last stages of completion, the USGS has performed various levels of site evaluations at approximately 34 bridges with scour countermeasures across the Nation; USGS and FHWA teams have assessed bridges in Florida, Missouri, Idaho, Iowa, Missouri/Illinois (border bridge), Indiana/Illinois (border bridge), Missouri/Tennessee (border bridge), South Carolina, Iowa, Montana, New Jersey, Pennsylvania, and Connecticut. Some of the techniques used included stream-side investigations and underwater reconnaissance using state-of-the-art survey techniques such as terrestrial LiDAR, multi-beam bathymetry and side-scan sonar. At a small subset of these sites, USGS and FHWA personnel returned and actively pushed the limits of technology to collect additional very-high resolution sonar data that has not been readily available until this time. FHWA personnel worked with USGS to identify bridge locations and provide technical assistance at all levels; USGS scientists conducted the evaluations, documented each evaluation in templates, made all data and approved metadata available to FHWA via the web, and summarized data and findings in a series of official USGS reports (2 open-file reports and a final scientific-investigations report).

All field work is now complete; the first report was published in 2017 and the final reports (final open-file report and scientific-investigations report documenting methods) are currently in review – the citation for the published report is:

> Dudunake, T.J., Huizinga , R.J., and Fosness, R.L., 2017, Bridge scour countermeasure assessments at select bridges in the United States, 2014–16 (ver. 1.1, October 2017): U.S. Geological Survey Open-File Report 2017-1048, 10 p., https://doi.org/10.3133/ofr20171048.

As a complement to the USGS site evaluations, the J. Sterling Jones Hydraulics Research Laboratory (HRL) continues to run hydraulic physical models and computational fluid dynamics (CFD) on several bridge sites. The goal of these lab tests is, and will continue to be, 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.

Please contact Peter Cinotto (pcinotto@usgs.gov) to learn more.

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. In 2018 the 3-day training course was delivered in Portland Oregon. To date, 172 people from across the Nation who work for State DOTs, USEPA, USGS, and other agencies have attended the 3-day classes in person and 32 attended the three-day class remotely by webinar. This project also supported two Water Environment & Reuse Foundation webinars with about 120 participants. This FHWA National Technical Support Project also is helping SELDM studies in CA, CT, MA, NC, NV, and RI

Work in 2019 will include more updates to the highway-runoff database, presentation of case studies at conferences, outreach to Universities to share SELDM training materials, and coordination/cooperation with research projects being done by the NCHRP and International BMP database teams.

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 first half of FY 2019.

Publications:

Granato, G.E., and Jones, S.C., 2019, Simulating runoff quality with the Highway-Runoff Database and the Stochastic Empirical Loading and Dilution Model: Transportation Research Record, Journal of the Transportation Research Board, *in press*

Smith, K.P., Sorenson, J.R., and Granato, G.E., 2018, Characterization of stormwater runoff from bridge decks in eastern Massachusetts, 2014–16: U.S. Geological Survey Scientific Investigations Report 2018–5033, 73 p. https://doi.org/10.3133/sir20185033

Stonewall, A.J., Granato, G.E., and Haluska, T.L., 2018, Assessing roadway contributions to stormwater flows, concentrations and loads by using the StreamStats application: Transportation Research Record, Journal of the Transportation Research Board, 9 p. https://doi.org/10.1177/0361198118758679

Web page (with links to the published reports):

https://doi.org/10.5066/F7TT4P3G

USGS Surface Velocity Workgroup

Objectives: The purpose of the Surface Velocity Work Group ("Surf Board") is to assist the USGS Water Mission Area (WMA) in its overall mission to identify and develop new, advanced streamflow and velocity measurement and monitoring methods, provide guidance and training to most effectively deploy and use them, and to evaluate the trade-offs in the quality of the resulting data. The Surf Board membership includes USGS scientists from each region as well as representation from international partners including Environment and Climate Change Canada; the Centro de Estudios y Tecnología del Agua (CETA) in Córdoba, Argentina; Électricité de France (EDF), and Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture (IRSTEA).

The objectives of this work group include evaluating and testing Image Velocimetry and Surface Velocity Radar (SVR) techniques as well as developing training materials and guidance for their proper application. The work should result in less-costly techniques suitable for flood measurement and, potentially, an expanded flood-monitoring network for both operation decision making and long-term flood characterization.

Interested persons should contact Frank Engel (fengel@usgs.gov) to learn more.

Selected References

Fulton, J., & Ostrowski, J. (2008). Measuring real-time streamflow using emerging technologies: Radar, hydroacoustics, and the probability concept. *Journal of Hydrology*, 357(1–2), 1–10. https://doi.org/10.1016/j.jhydrol.2008.03.028

Le Coz, J., Patalano, A., Collins, D., Guillén, N. F., García, C. M., Smart, G. M., Braud, I. (2016). Crowd-sourced data for flood hydrology: feedback from recent citizen science projects in Argentina, France and New Zealand. Journal of Hydrology, In Press. http://doi.org/10.1016/j.jhydrol.2016.07.036

Lewis, Q. W., Lindroth, E. M., & Rhoads, B. L. (2018). Integrating unmanned aerial systems and LSPIV for rapid, cost-effective stream gauging. *Journal of Hydrology*, 560, 230–246. https://doi.org/10.1016/j.jhydrol.2018.03.008

Welber, M., Le Coz, J., Laronne, J., Zolezzi, G., Zamler, D., Dramais, G., Salvaro, M. (2016). Field assessment of noncontact stream gauging using portable surface velocity radars (SVR). Water Resources Research, 52, 1108–1126. http://doi.org/10.1002/2015WR017906

Dobson, D. W., Todd Holland, K., & Calantoni, J. (2014). Fast, large-scale, particle image velocimetry-based estimations of river surface velocity. Computers and Geosciences, 70, 35–43. http://doi.org/10.1016/j.cageo.2014.05.007

Le Boursicaud, R., Pénard, L., Hauet, A., Thollet, F., & Le Coz, J. (2015). Gauging extreme floods on YouTube: application of LSPIV to home movies for the post-event determination of stream discharges. Hydrological Processes, 105(July 2015). http://doi.org/10.1002/hyp.10532

Selected USGS publications from 2018

In 2018, the USGS produced 2,308 publications that are available on line from the USGS Publications Warehouse (https://pubs.er.usgs.gov/). Open access to more than 150,000 publications written by USGS scientists since 1879 are available on-line at the Publications Warehouse. Many of these reports may contain information useful for DOT decisionmakers. For example the search-link " https://pubs.er.usgs.gov/search?q=highway " yields a list of more than 1,300 potentially relevant publications and the search link "https://pubs.er.usgs.gov/search?q=scour " yields a list of more than 1,000 potentially relevant publications.

Ecology

Arnold, Erin M., Steven E. Hanser, Tempe Regan, Jeremy Thompson, Melinda Lowe, Angela Kociolek, James R. Belthoff, 2018, Spatial, road geometric and biotic factors associated with Barn Owl mortality along an interstate highway: IBIS https://doi.org/10.1111/ibi.12593

Becker, Sarah, Scott Jackson, Adrian Jordaan, and Allison Roy, 2018, Impacts of tidal road-stream crossings on aquatic organism passage: U.S. Fish and Wildlife Service Report 131-2018, 57 p. https://pubs.er.usgs.gov/publication/70201103

Flood frequency

Kohn, M.S., Stevens, M.R., Mommandi, Amanullah, and Khan, A.R., 2017, Peak discharge, flood frequency, and peak stage of floods on Big Cottonwood Creek at U.S. Highway 50 near Coaldale, Colorado, and Fountain Creek below U.S. Highway 24 in Colorado Springs, Colorado, 2016: U.S. Geological Survey Scientific Investigations Report 2017–5107, 58 p., https://doi.org/10.3133/sir20175107.

Hazards

Manier, D.J., and O'Donnell, M., 2018, Compilation and assessment of resource values and hazards to inform transportation planning and associated land-use planning: U.S. Geological Survey Scientific Investigations Report 2018–5039, 53 p., https://doi.org/10.3133/sir20185039.

Hydraulics

Bera, Maitreyee, and Ortel, T.W., 2018, Processing of next generation weather radar-multisensor precipitation estimates and quantitative precipitation forecast data for the DuPage County streamflow simulation system: U.S. Geological Survey Open-File Report 2017–1159, 16 p., https://doi.org/10.3133/ofr20171159.

Huizinga, R.J., 2017, Bathymetric and velocimetric surveys at highway bridges crossing the Missouri and Mississippi Rivers near St. Louis, Missouri, May 23–27, 2016: U.S. Geological Survey Scientific Investigations Report 2017–5076, 102 p., https://doi.org/10.3133/sir20175076.

Lukasz, B.S., 2018, Hydrologic conditions in Kansas, water year 2017: U.S. Geological Survey Fact Sheet 2018–3060, 6 p., https://doi.org/10.3133/fs20183060.

Peak flow

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