ADVANCES

in Hydrologic Engineering

Fall 2013

Director's Comments

By Christopher N. Dunn, P.E., D.WRE

Welcome to the Fall 2013 edition of the HEC newsletter. In spite of the recent furlough, HEC was fortunate enough to be fully funded and so it was full steam ahead for us. I know others within USACE and outside USACE were not as fortunate but in the end, everyone was paid so I'm not sure what the point was of keeping the federal workers at home. And the sad thing is that we may get to do this all over again in mid-January.

As we fast approach our 50th anniversary (June 2014) we are making plans for a celebration. I would love to throw a big party, invite all the past HEC employees and friends that we have worked with over the years but budgetary and fiscal constraints being what they are, we will be limited to a much more modest affair. On 27 June 2014, HEC will host an open house. The open house will be open to the public so people who were curious about what is up those steps, can come up and see what we do. We will have booths set up and hosted by HEC employees. The people at the booths can talk about what they do and maybe have a video loop displayed on the monitors behind them. We plan to have a number of professionally created posters displayed throughout the Center. After the 50th anniversary the posters may be moved into the classroom. Coincidentally, the lease for our space is being

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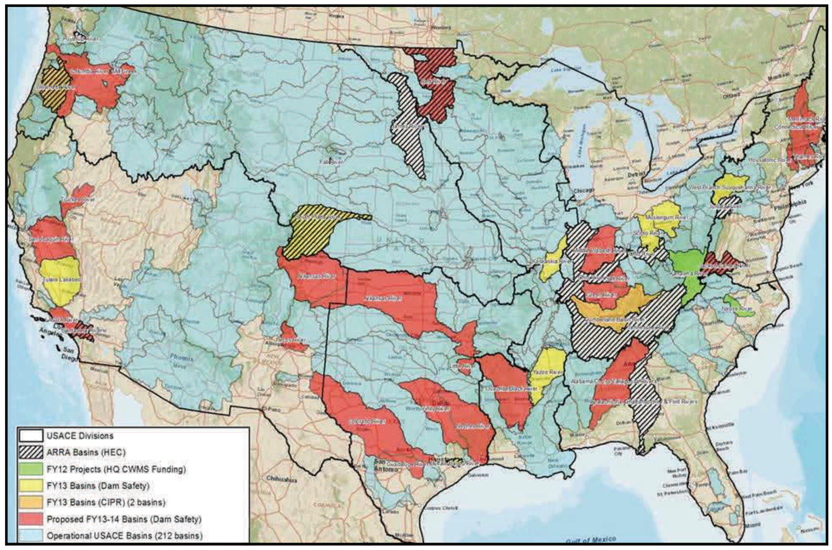
CWMS National Implementation Plan

By George (Chan) Modini, P.E.



CWMS National Implementation Plan

USACE is responsible for managing nearly 700 of the nation's water control projects - a mission that affects the lives and property of millions of Americans. With the best -available technology, USACE can expand and enhance its capabilities to manage flood risk, navigation conditions, water supply, electric power production, water quality, and the environment.

CWMS (Corps Water Management System), is an automated information system (AIS) that supports the USACE (U.S. Army Corps of Engineers) Water Management mission. CMWS consists of software and hardware that integrates data acquisition and database storage, incorporates a forecast modeling suite, and a reporting system. CMWS includes hydrologic software that supports watershed stream flow forecasting and routing, reservoir operation decision support, river profile modeling, and related inundated area determination to include consequence/damage analysis. Real time and/or forecasted conditions are disseminated via the reporting system. The currently fielded version of CWMS is Version 2.1. Version 3.0 of CWMS will be released in Spring 2014. Version 3.0 will include many new features such as access to the Native Model Interfaces, a new Meteorological Visualization Precipitation Tool (MVPT), and a new Report Generation Interface (RGI).

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US Army Corps of Engineers
Hydrologic Engineering Center

renewed and it seems like we may be getting new carpeting, fresh paint, etc., so the Center may have a different look and feel. Of course, during the open house light refreshments will be served. Later that evening, after the open house, current and past HEC employees and their families and friends are expecting to gather at a local restaurant for a no host dinner (details to be addressed later). It will be a time for reminiscing and also looking into the future. It should be a lot of fun, but work needs to be done. We will need to prepare an agenda for the festivities, so if you have ideas, please let us know. Finally, we along with David Ford Consulting are preparing an HEC 50th anniversary History Book memorializing HEC's fifty years of service to the hydrologic engineering profession and USACE. We are encouraging people to submit stores about their experiences with HEC so that they may be included in the History Book. If you have such stories that you are willing to share, please submit them to HEC at penni.r.baker@usace.army.mil.

While the History Book and the anniversary are looking into our past, HEC's work continues to look into the future. The way I see it, HECs mission is to move state-of-the-art into the state-of-the-practice. I see us doing this in so many ways: distributed and cloud computing; two-dimensional hydraulic modeling; parameter sampling for risk and uncertainty analysis; and, constantly improving the ability to view, edit and evaluate data and results to improve the understanding of the material. One example of advancing the technology that will allow the field to make decisions faster, while taking uncertainties into consideration and meeting USACE policy, is through the development of the Watershed Analysis Tool (HEC-WAT). HEC-WAT has been features in previous editions of the HEC Newsletter so I won't go into great detail here, but what is noteworthy is how we continue to improve HEC-WAT's performance. In our original attempts to run HEC-WAT on a relatively simple reach running only the hydrologic sampler, the fragility curve sampler and running HEC-RAS and HEC-FIA, it took one laptop computer 39 hours to run 500 iterations. Now taking advantage of cloud computing we can run 5,000 iterations in 45 minutes using 50 machines. In addition, it takes 9.85 hours to run on one computer or, 1.45 hours on the sixteen machines in our classroom. Why is this important? Another goal of HECs is to create tools for field offices to use and by improving the compute speed of the Monte Carlo process, we will better ensure that the field will be able to perform these computations in their offices without having to resort to high performance computing or sending computations to the cloud which may not meet current or future Army IT security requirements. Our goal is to have the district offices be able to makes these computes independently. Not all of the compute efficiencies come from cloud computing or sending runs to multiple computers. We have made significant improvements to our software which has improved the speed at which they run individually and within a larger comprehensive compute like HEC-WAT. So even if a District does not plan on running HEC-WAT, they can take advantage of the improved performance of the individual pieces of software.

Another way HEC's efforts may improve the USACE overall program is through the CWMS (Corps Water Management System) National Implementation Plan (NIP). The story of the CWMS NIP is described in this edition of the Newsletter, but the point I want to emphasize is the benefits the implementation of CWMS will have on many other USACE missions. From a Civil Works perspective it is not difficult to imagine how these fully developed, calibrated models (i.e., HEC-HMS, HEC-RAS, HEC-ResSim, HEC-FIA) built for water management could be used for other purposes. As the Federal government looks for ways to reduce costs, it only makes sense to reuse these models as much as possible. Certainly, the models would have to be adjusted for the specific mission's purposes but at least the model will be in the correct projection using the correct datum and should be of sufficient detail to be near ready for their study. These watershed based models will cover a large portion of the United States and so they should have wide applicability. The biggest challenge is to convince others of these benefits so that the funding to perform the impletions can continue.

I certainly hope you enjoy this Newsletter, and as always if you have questions or would like to know more about HEC, please just let us know.

Chris Dunn, P.E. D.WRE
Director

US Army Corps of Engineers
Hydrologic Engineering Center
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Water Resource Systems Chief: Lea Adams, P.E.

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While CWMS has most of the features water managers need to perform operational analyses on a daily basis, for a number of reasons, CWMS is not consistently or fully implemented throughout the nation. After the devastating floods of 2010 and 2011, USACE leadership asked what could have been done to better prepare and react to these types of system-wide events that require extensive communication, collaboration and modeling. The answer: fully implement CWMS.

Therefore, at the request of USACE leadership, Mr. Stockton and MG Walsh, USACE initiated the CWMS National Implementation Plan (NIP). This plan is the first effort to provide the field with a consistent set of models and tools to accomplish the USACE water management mission. With this objective in mind, the Hydrologic Engineering Center (HEC) teamed up with the Modeling, Mapping, and Consequences (MMC) Center to support NIP. The National Implementation Charter was developed and subsequently approved in FY 2012. In the charter, implementation of CWMS across all 212 USACE watersheds, was scheduled, with an expected completion of five to ten years, depending on the level of funding. Some other identified benefits of this program include capacity building of the hydrologic, hydraulic, and water management cadre across USACE, support to the Dam Safety and Critical Infrastructure Protection and Resilience (CIPR) programs and the creation of a model library with models built with consistent datum and projection that can be leveraged for other studies and projects and help meet the objectives of the planning transformation effort.

With this partnership, HEC provides Program Management of the CWMS AIS, while the MMC provides project management for the NIP effort. Project management responsibilities of the MMC include production and implementation of CWMS for the 212 watersheds. These responsibilities include developing Standard Operating Procedures (SOPs) and guidelines, training personnel, and providing the manpower production resources (project teams) to fully implement CWMS across USACE in a robust, consistent, efficient and timely manner. Project teams consist of anywhere from eleven to thirteen members depending on complexity of the watershed. For many project team members this may be a once in a career opportunity to learn about the USACE water management mission outside office boundaries and a chance to network and build relationships with the cadre across the Nation. Project team responsibilities include documentation, developing the suite of models, integrating the models in CWMS, and setting up the CWMS watershed to incorporate stored data acquired by the automated information system component of CWMS. The suite of models that the teams develop include: HEC-HMS, HEC-ResSim, HEC-RAS, and HEC-FIA. The models and CWMS implementations are being completed by using the SOPs and guidelines maintained by HEC and MMC.

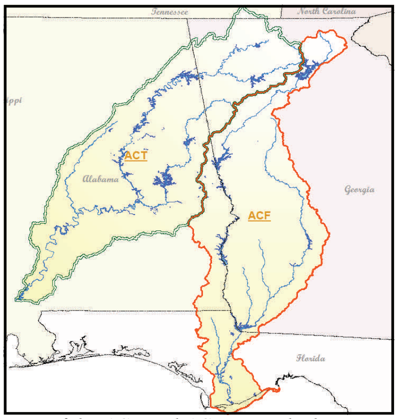
As of October 2013, CWMS implementations for forty-eight watersheds (see figure) are in various stages of planning or completion. Under the American Recovery and Reinvestment Act (ARRA), during FY 2009, CWMS implementations were completed for eight basins. These eight basins were the Santa Ana River; Puyallup River; Upper Missouri River tributaries; Buffalo Bayou; Red River of the North; Apalachicola, Chattahoochee, and Flint Rivers; Cumberland, Tennessee and lower Ohio Rivers; and, Jackson and James Rivers. Under the ARRA effort, three partial implementations were also done. These were: the Willamette, Juniata, and the American Rivers. During FY 2012, funding from USACE HQ allowed for the completion of the American River and two pilot basins, the Neuse and Kanawha Rivers. Funding from the Dam Safety program during FY 2013 allowed for the formation of seven teams to complete CWMS implementations for another eight basins. These included the Muskingum and Scioto Rivers; Buffalo Bayou; South Platte River; West Branch Susquehanna River; Kaskaskia River; Yazoo River; and, Tulare Lake basin. Note due to dam safety needs additional work needed to be done for the Buffalo Bayou River (ARRA). The latter basins are scheduled to be completed by the end of the first quarter of FY 2014. Also in FY 2013, two more basins, the Willamette River and Cumberland River, were funded for completion by the CIPR program. During FY 2014, fifteen teams will be formed to complete CWMS implementations for twenty watersheds by the second quarter of FY 2015. The basins are San Joaquin River; Colorado River; Connecticut River; Merrimack River; Red River; Neches and Guadalupe River; Green River; Ouachita River; Mill Creek; Truckee River; Santa Ana River; Los Angeles County Drainage Area (LACDA); Arkansas River; Trinity River; Pecos and Arkansas Rivers; Little River; Housatonic; and, Jackson and James Rivers. Questions regarding NIP should be directed to the HEC Director, Christopher Dunn (christopher.n.dunn@usace.army.mil).

Willamette River Basin

Water Quality Modeling of the ACT and ACF Watersheds

By Todd Steissberg, PhD

For more than twenty years, the Hydrologic Engineering Center (CEIWR-HEC) has supported Mobile (CESAM) District's Water Control Manual Update Studies of the Alabama-Coosa-Tallapoosa (ACT) and Apalachicola-Chattahoochee-Flint (ACF) watersheds, which comprise major portions of Alabama and Georgia and a part of Florida. Water



Map of the ACT and ACF watersheds

allocation in these basins has been the subject of much controversy, litigation, and study for decades. CEIWR-HEC and its contractors, Resource Management Associates (RMA) and WEST Consultants, performed extensive hydrologic and water quality modeling of these watersheds. A major portion of this work was funded by the American Recovery and Reinvestment Act (ARRA) of 2009.

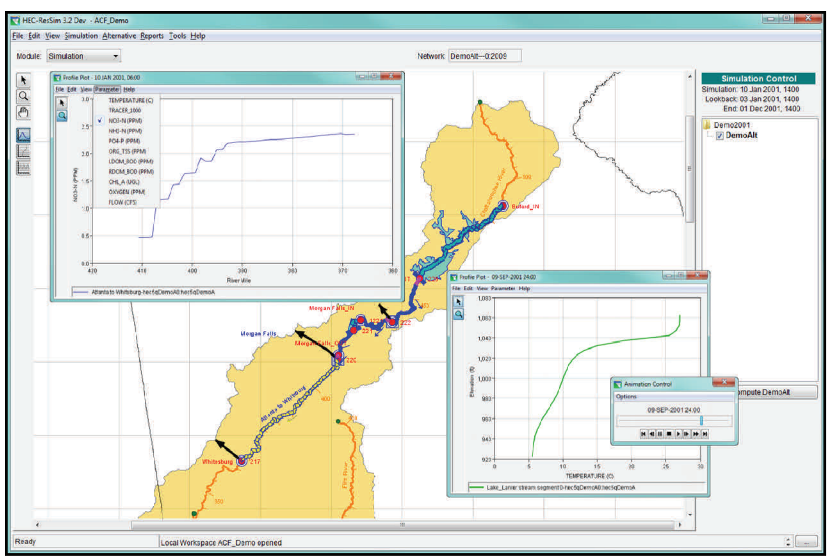
HEC-ResSim (Reservoir System Simulation) models of the ACT and ACF were developed by CEIWR-HEC and WEST to simulate project operations for baseline ("no action") conditions and several alternative operating plans. Each watershed was simulated over almost seventy years of record (1939 - 2008) to compute lake levels and river flows throughout the ACT and ACF basins, for baseline ("no action") conditions and a several alternative operating plans.

HEC-5Q (HEC-5 Simulation of Flood Control and Conservation Systems, Water Quality Analysis) models of the ACT and ACF were developed by CEIWR-HEC and RMA. The model results were then incorporated into the environmental analysis by CESAM and their Contractor, Tetra Tech, preparing a Draft Environmental Impact Statement (EIS) for each watershed. The purpose of these models was to evaluate the relative impacts of each of several proposed basin water management plans on long-term, system-wide, stream and reservoir water quality. HEC-5Q was selected as a logical choice for these studies because it is a widely used and accepted model, it is compatible with HEC-ResSim, and it has been used for previous analyses of these watersheds.

HEC-5Q follows well-known solutions for key water quality parameters. HEC-5Q can model reservoirs in one or two dimensions. One-dimensional models, which assume no lateral or longitudinal variation, compute the vertical variation of water quality in a water body over time. The depth of analysis possible from its results is restricted, but one-dimensional models relieve heavy burdens regarding prohibitively long computation time and large input data requirements. Two-dimensional models allow segmenting a water body longitudinally as well as vertically, still assuming no lateral variation. HEC-5Q simulated the reservoirs of both watersheds in one dimension if longitudinal variation was expected to be negligible. Otherwise, two dimensions were used to simulate long reservoirs and river reaches.

Each HEC-5Q model simulated several water quality parameters, including water temperature, dissolved oxygen, ammonia-nitrogen, nitrate-nitrogen, phosphate-phosphorous, chlorophyll-a, Biochemical Oxygen Demand (BOD), and particulate organic matter, using a six-hour time step to capture diurnal variations. Point-source (wastewater) and non-point-source inflow quality data sets were developed from database information compiled during this analysis. The EPA's (U.S. Environmental Protection Agency) BASINS model was used to compute tributary stream inflows and water quality loadings.

CEIWR-HEC and RMA developed an HEC-5Q "plug-in" for HEC-ResSim to link the two models, providing an integrated environment for modeling and visualization of results. The new software enabled



HEC-ResSim watershed of the ACF showing vertical and longitudinal profile plots of simulated water quality results.

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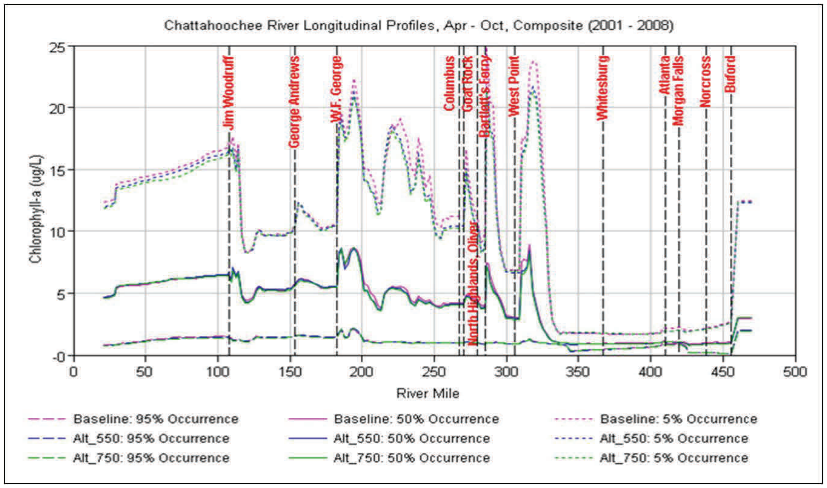


Longitudinal occurrence profiles of chlorophyll-a during a growing season over the 2001 - 2008 modeling period.

HEC-ResSim-computed flows to be seamlessly input into the HEC-5Q model for each basin. After running a simulation, the modeler can display time series plots, animated vertical profiles, and longitudinal profiles of the simulated water quality variables, as shown in the figure below. Each HEC-5Q model was aligned to work with its corresponding HEC-ResSim model. Following completion or revision of a set of HEC-ResSim alternatives, ACT and ACF flows and water reservoir levels computed by HEC-ResSim were input into HEC-5Q to simulate the water quality for the impacts analyses of both watersheds.

HEC-5Q's simplified inputs and calculation, and connection to HEC-ResSim, make possible relative comparisons of the water quality impacts of water management alternatives broadly across the basin.

The HEC-5Q models of the ACT and ACF were evaluated for the period of 2001 - 2008, which captured the effects of recent population, water usage, and land use on pollution levels. The evaluation ensured that the model exhibited the tendencies seen in the observed data and that the model was sufficient to provide reasonable long-term estimates of water quality through the ACF system. The 2001 - 2008 modeling period encompassed years where hydrologic conditions were representative of "normal" in-stream flows, as well as years with high flow or drought conditions.

Post-processing programs were created to compute the percent exceedance of each water quality parameter at selected locations and summarize these as longitudinal profiles of exceedance along the entire river system. To avoid confusion with the water quality definition of exceedance as a violation of a standard, the percentage of occurrence was derived by subtracting the exceedance level from 100 percent. While a 95 percent exceedance level indicates that 95 percent of values are greater than the concentration at that level, the 95 percent occurrence level indicates that 95 percent of values are *less* than that level. Occurrence profiles, such as the one shown on this page, enable analysis of water quality variability along each river reach, and aides in the determination of the effects that discharges (point-source and non-point-source) might have on a water quality parameter. Peak values may shift longitudinally during a drought ("dry") year compared with a flood ("wet") year.

Several Jython (www.jython.org, www.python.org) scripts were created to summarize results and generate time series and profile plots for analysis and reporting. Longitudinal occurrence profiles of each water quality parameter were plotted for a combination of three hydrologic periods (wet, dry, and normal), three growing season definitions (Georgia, Alabama, U.S. Fish and Wildlife Service), and three time intervals (weekly, weekday, and weekend periods, to analyze hydropower effects).

Water management alternatives were revised periodically throughout this study, and new alternatives were created and simulated by HEC-ResSim and HEC-5Q. The tools and methodologies that have been developed have greatly facilitated the ability to perform a water quality study in a timely fashion. Both ACT and ACF HEC-5Q models have completed Agency Technical Review (ATR). The ACT model is currently in the final stages of Independent External Peer Review (IEPR) and public review. More detailed information on these studies can be found at the Master Water Control Manual Update web sites for the ACT (http://www.sam.usace.army.mil/Missions/PlanningEnvironmental/ACFMasterWaterControlManualUpdate) and the ACF (http://www.sam.usace.army.mil/Missions/PlanningEnvironmental/ACFMasterWaterControlManualUpdate). The metrics, tools, and techniques developed for the ACT and ACF can be adapted and applied to future water quality modeling studies in other watersheds.

National Reservoir Survey

By John Hickey, PhD, P.E.

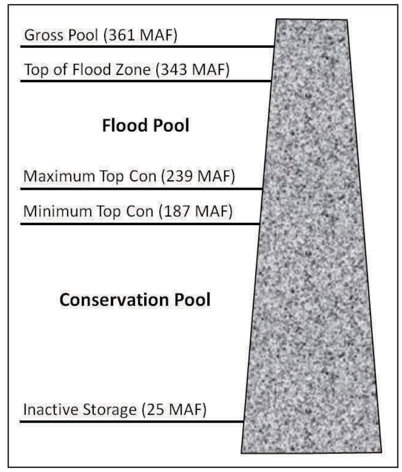
Surface water reservoirs, despite all being fundamentally comprised of an area to hold water and a structure to impound it, are amazingly diverse. In the United States, the most comprehensive database of reservoir information is less about the water and more about the structures. This National Inventory of Dams (NID) contains information (e.g., location, owner, type, height, storage, spillway characteristics, and many others) for eighty-four,134 structures that impound surface water in the United States, Puerto Rico, and the U.S. Virgin Islands (the NID homepage is http://geo.usace.army.mil/pgis/f?p=397:12).

Operational purposes in NID are described succinctly. For example, purposes for Oroville Dam, a structure on the Feather River in California, are simply noted as "CISHR", which is short for flood Control, Irrigation, water Supply, Hydroelectric, and Recreation. Apart from an identification of the purpose of a reservoir, the NID offers little detail on how water is actually managed, which makes it difficult to quantitatively inform basic questions about collections of reservoirs, including: How much water is managed? How is storage allocated among different operating purposes? When water is released, what purpose or purposes does it serve? What policies guide releases?

In 2008, to inform these and other questions, a national reservoir survey was initiated by the Corps to: 1) compile a database to examine the status of water management from local, regional, and national perspectives; 2) provide an engineering and scientific foundation for a national adaptive management program for reservoir operations; and 3) assemble baseline data for investigating the evolution of reservoir operational policies.

The survey covered three subject areas: water supply, water management, and sediment management. Recently, a fourth portion regarding environmental and water quality management concerns at reservoirs was added and is currently underway. The water management portion was led by HEC and consisted of a series of reservoir-specific questions designed to inform the status of many facets of the Corps' water management function. This portion queried all reservoirs in the United States with federally authorized flood storage.

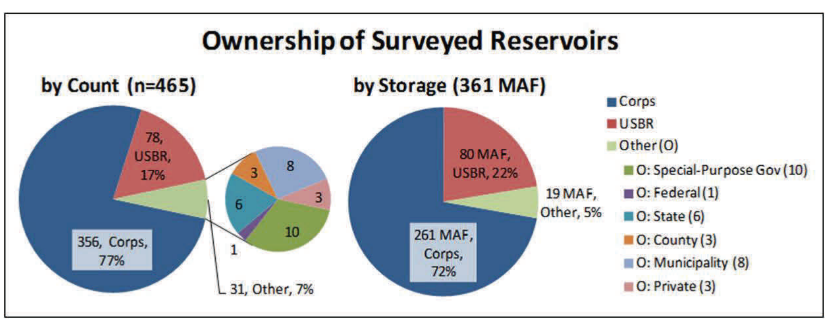
The process for compiling water management data was to coordinate with responding offices, review submissions, and revisit with responders until all data were deemed complete and of sufficient quality and detail to be used in analyses without reservation. This effort spanned more than four years. When all coordination and review were completed, the informational database included 465 reservoirs with a combined total storage of 361 MAF. Of the 465 surveyed reservoirs, 356 are owned and operated by the Corps and 109 are owned and operated by others, with the Corps having responsibility for prescribing management of the federal flood storage of those projects. A breakdown of the ownership of surveyed reservoirs by count and total storage is shown in the figure below, while the combined storage allocations of all 465 reservoirs are shown above.



Combined storage allocations of the 465 surveyed reservoirs.

Analyses of the databases are currently ongoing. The results of these analyses could be used for a number of purposes such as reservoir reoperations studies. The analyses include evaluation of reservoir release decisions, operational policies, fish passage, temperature management, and storage allocations. Results from all parts of the survey are being detailed in a report by the Corps' Institute for Water Resources scheduled for publication in 2014.

HEC would like to thank the forty-one Corps offices (nine Division offices, two from Northwestern Division, and thirty-two Districts) that contributed to the water management survey. It was a significant and challenging effort, which would not have been possible without your support.



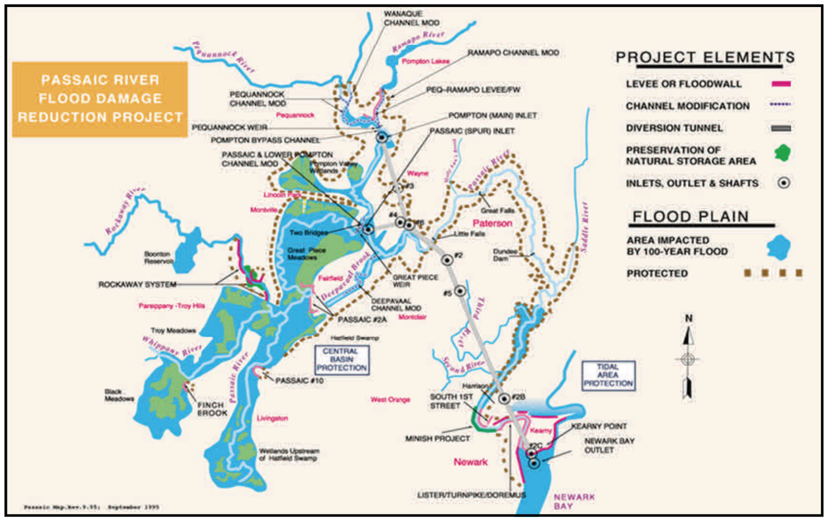
Ownership of reservoirs with federally authorized flood storage based on count and total (gross pool) storage.

Tunnel Modeling with HEC-RAS

By D. Michael Gee, PhD, P.E.

Application of unsteady flow models to the Passaic River basin in New Jersey has a long history. The motivation for doing the modeling is to evaluate the impacts of structural flood control improvements. The focus of the structural alternatives is the construction of flood relief tunnels that will evacuate flows from the upper watershed into Newark Bay. The earliest application of an unsteady flow model to this area was the NWS (National Weather Service) DWOPER (*Dynamic Wave Operational Model*; Fread, 1978) model in the early 1980's (*Flood Routing Through a Flat Complex Floodplain Using a One-Dimensional Unsteady Flow Computer Program; CEIWR-HEC*, TP-93, December 1993, John Peters). This application was an attempt to use an unsteady flow model to capture the complex interaction of tributary flow hydrographs in low slope streams. The application of unsteady flow modeling to this area was substantially advanced in 1995 - 1996 with the use of UNET (*One-Dimensional Unsteady Flow Through a Full Network of Open Channels*). At that time UNET was the USACE unsteady flow model supported by CEIWR-HEC. The Passaic UNET model was subsequently transformed and updated into a HEC-RAS model in 2012. The UNET geometric model was imported into an HEC-RAS geometric model and some of the geometry updated with current FEMA (U.S. Federal Emergency Management Agency) cross sections. Also, the updated HEC-RAS model includes geo-referencing and using GIS (Geographic Information Systems) to export the simulation results for use in flood damage computations.

A number of complex structural solutions to flooding problems are being evaluated with the HEC-RAS model. The model contains fourteen rivers, twenty-three reaches, about 1,200 cross sections, 125 bridges, fourteen inline and lateral structures, and six storage areas. The unsteady flow flood modeling encompassed about a ten-day simulation at computational time steps of one to five minutes. The figure below displays a small portion of the HEC-RAS model that focuses on part of the Lower Passaic River and the tunnel alignment.



Passaic River Flood Damage Reduction Project - Currently Authorized Plan Dual Inlet Tunnel (Plan 30E)

The schematic of the model was developed using the HEC-RAS Geometric Data Editor following the UNET reach connectivity. Then the UNET cross sections were imported into the HEC-RAS model reach by reach. The bridge modeling was then adapted as necessary to HEC-RAS, which allows for more detailed bridge modeling than was in the UNET data. Generally, this involved evaluating the bridge geometry and selecting an appropriate HEC-RAS modeling technique. Several iterations were made to get the ineffective flow areas and HTAB

HEC-RAS Model - Lower Passaic River & Tunnel Alignment

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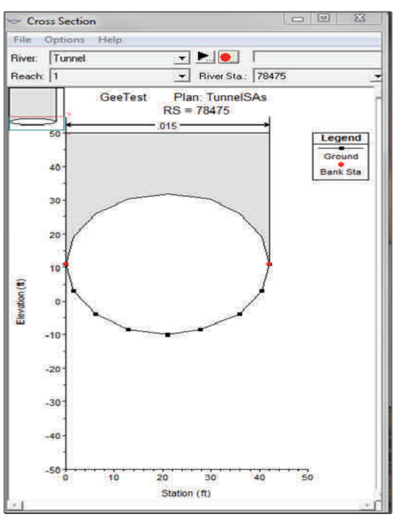
(**H**ydraulic **Tab**le) parameters appropriate for HEC-RAS. The model was then geo-referenced by the New York District (CENAN). After applying datum adjustments to the HEC-RAS model, the geometry for several reaches was updated using recently developed FEMA floodplain steady flow HEC-RAS data.

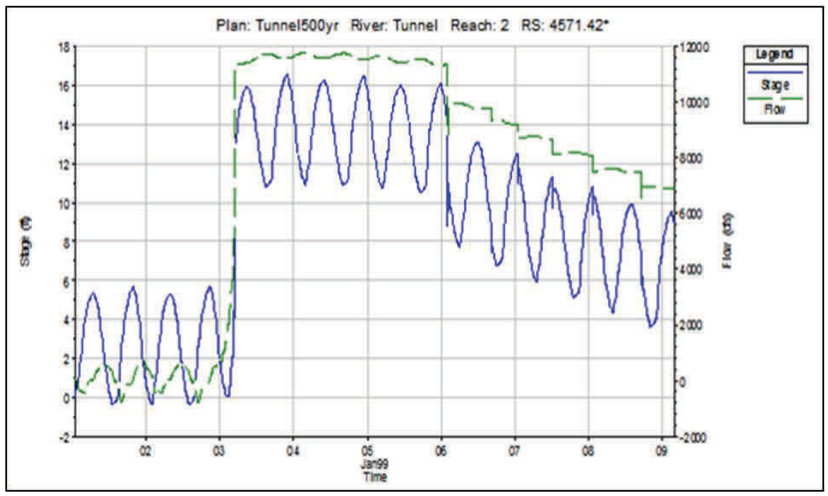
The tunnels and intake structures were then added to the HEC-RAS model. The intake gate structures were modeled based on information from the GDM (General Design Memoranda). The tunnel inlets are being modeled with lateral structures with gates. The gates operate on an opening schedule based on a water surface elevation in the reach upstream of the inlet structure. The tunnels were modeled as "cross sections with lids". This feature of HEC-RAS allows for unsteady flow simulation for reaches that may have either open channel flow or pressure flow. The figure below displays a tunnel cross section.



HEC-RAS Model - Tunnel Cross Section

The upstream and lateral inflows to the reaches are frequency hydrographs computed by HEC-HMS (CEIWR-HEC, Hydrologic Modeling Systems) and the downstream boundary condition is a tidal elevation in Newark Bay. The HEC-RAS model is now complete and providing information for project economic evaluations. The use of a physically-based unsteady flow model is necessary for the evaluations of structural alternatives for hypothetical floods. This HEC-RAS model will be enhanced in the future to analyze the impacts of levee and channel modifications as well as tunnel inlet gate operations.

An example of the computed stage and flow hydrographs near the downstream end of the tunnel is shown in the figure below. The effects of the upstream flood hydrographs, gate operations and the tidal boundary condition are evident. While the tunnel is under pressure, the stage that HEC-RAS reports should be interpreted as the hydraulic grade line elevation.

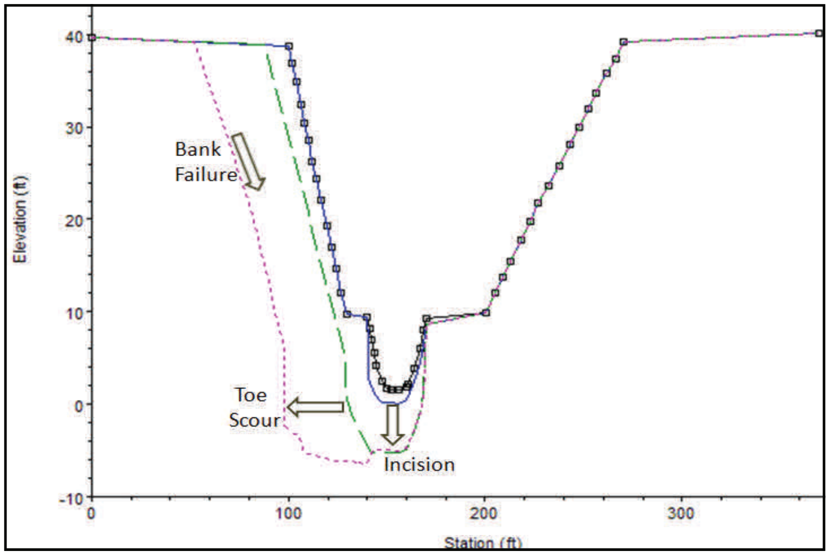


HEC-RAS Model - Computed Stage & Flow Hydrographs, Downstream End of Tunnel

The USDA-ARS Bank Stability and Toe Erosion Model (BSTEM) in HEC-RAS

By Stanford Gibson, PhD

HEC-RAS Version 4.0 (released March 2008) included mobile bed sediment transport capabilities for the first time. Since then, these capacities have been successfully applied to a wide variety of flood-damage reduction, dredging, reservoir and restoration projects. However, these methods only allowed vertical cross-section adjustment, limiting simulated sediment processes to channel deposition and incision. Previous versions of HEC-RAS could not model bank failure or channel widening. This can be a substantial limitation because bank failure and toe scour processes are important channel adjustment mechanisms and contribute significant sediment to many systems.



Cross section change over time computed by BSTEM integrated with HEC-RAS sediment transport. HEC-RAS can now compute feedbacks between vertical incision, lateral toe scour and geotechnical bank failures processes

To expand the utility of the model, CEIWR-HEC (Hydrologic engineering Center) worked with several partners to include the Department of Agriculture-Agricultural Research Service (USDA-ARS) Bank Stability and Toe Erosion Model (BSTEM) in HEC-RAS. This is a powerful model linkage because channel incision or deposition now interacts with bank failure processes and routs sediment loads from bank failures downstream. For example, HEC-RAS can now capture the impact of channel incision on bank stability or simulate the deposition of scoured bank materials in downstream reaches or reservoirs. By coupling these models, these important process interactions can be simulated within the HEC-RAS modeling framework.

Pilot studies using these tools are under way or immanent. These include a Missouri River Recovery Program (CENWO) study to evaluate banks that migrated by over 100 ft during the 2011 event, the Jameson Chute Channel Widening Model (CENWK), a sediment-load estimation on a stretch of the Minnesota River (CEMVP and the Minnesota DNR), and a study by the Australia Rivers Institute and Cardno ENTRIX on the role of streambank erosion on sediment loads to the Great Barrier Reef. In August 2013, these capabilities were included in the initial offering of an Advanced HEC-RAS Sediment workshop (which also included unsteady sediment transport capabilities, using operational rules with sediment, and other new sediment features in Version 4.2) that included representatives from the Omaha, Kansas City, and St. Louis Districts.

The integration of HEC-RAS and BSTEM has been a substantial undertaking including multiple contributors in the USACE, the private sector, other Federal agencies, and even international interests. Andrew Simon (PhD - Cardno ENTRIX, formerly of USDA-ARS) partnered with CEIWR-HEC to initiate, envision and facilitate the integration. Eddy Langendoen (PhD - USDA-ARS) has provided essential technical support and advice throughout the process. The integration utilized code developed by Rob Thomas (PhD - University of Hull, formerly of University of Tennessee) and Yong Lai (PhD - USBR), funded by the Bureau of Reclamation and the Taiwanese Water Resources Agency, with input from Yavuz Ozeren (PhD - University of Mississippi). John Shelly (PhD - CENWK) and Paul Boyd (PhD - CENWO) provided District guidance and feedback on the development. Stanford Gibson (PhD - CEIWR-HEC) and Steve Piper (Resource Management Associates (RMA)) worked on the integrated HEC-RAS code. Funding for the development, troubleshooting, and documentation of the integrated HEC-RAS/BSTEM product has come from multiple sources including two USACE Research and Development (R&D) programs (Regional Sediment Management and Flood & Coastal Storm Damage Reduction), the Australia Rivers Institute, and the Missouri River Recovery Program.

The integrated software is fully documented (with User's and Technical Reference manuals) and is currently available for alpha testing. If your district has an application for integrated channel routing and bank failure modeling, contact Stanford Gibson (stanford.gibson@usace.army.mil) to receive an alpha test version of the software and documentation.

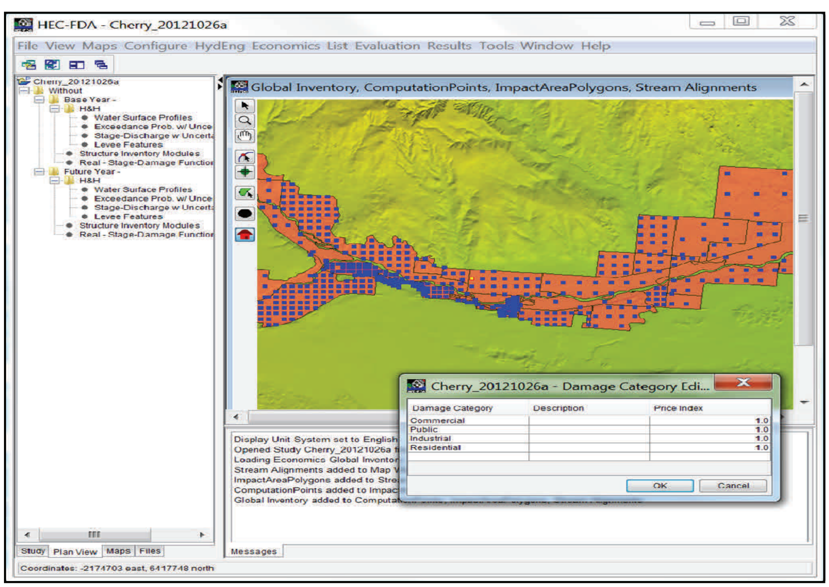
HEC-FDA Software Status

By Robert Carl, P.E.

The HEC-FDA (Flood Damage Reduction Analysis) software has been around for more than fifteen years. HEC-FDA is designed to assist U.S. Army Corps of Engineers (USACE) study members in using risk analysis procedures for formulating and evaluating flood risk management measures, as outlined in EM 1110-2-1619 and ER 1105-2-101. The software is a probability-based analysis procedure using annual peak discharge or stage-probability functions, stage-discharge rating curves, computed stage-aggregated damage curves and levee information to compute expected annual damage, equivalent annual damage, and project performance. The most recent Planning Center of Expertise-certified Version 1.2.5a was released in October 2010. CEIWR-HEC is currently working on two updated versions of the program, Versions 1.4 and 2.0.

HEC-FDA Version 1.4 incorporates three significant updates to : 1) addition of data output in tab-delimited text files; 2) a revised method for calculating uncertainty about graphical probability curves; and 3) data in memo fields stored as text in tab-delimited format. The graphical user interface (GUI) in Version 1.4 is unchanged, but results displayed in the GUI are now also written to text files in a tab delimited format so results can be readily imported into Excel® for formatting and inclusion in reports. The second major change in Version 1.4 is the method of calculating uncertainty about graphical discharge- and stage-probability curves. HEC-FDA Version 1.4 replaces the order statistics from Version 1.2.5a with a simpler calculation based on the equivalent length of record and slope of the probability function. One of the downsides of the order statistics methodology was that often when the equivalent length of record is varied over a wide range of years (e.g., 15 - 150 years), the associated standard errors about the curve will sometimes decrease, and then unexpectedly increase. This problem generates inconsistent results for the expected annual damage (EAD), annual exceedance probability (AEP), and the conditional nonexceedance probability (CNP). As a result, the equivalent length of record was found to inappropriately affect design levee heights; the new calculation methodology in Version 1.4 rectifies this problem. The third major change in Version 1.4 is the database software has been rewritten so that, with the exception of water surface profiles, all data previously written in binary format to memo fields are now written and read in a tab delimited format. This allows the user to view and edit the databases using Excel®, Microsoft Access® or Visual dBASE®. USACE is currently in the process of certifying HEC-FDA Version 1.4 in coordination with the FRM-PCX (Flood Risk Management - Planning enter of Expertise). A team of experts, both inside and outside USACE, is formally reviewing the program and at this point in time, it appears that there will be no "show stoppers" preventing recommendation of certification of Version 1.4. The FRM-PCX will make its determination first, then forward to USACE Headquarters for final approval. Once final approval has been received from USACE HQ, Version 1.4 will be released.

HEC-FDA Version 2.0 is computationally unchanged from Version 1.4, but will have a new GUI written in Java. The interface dialogs are very similar to those of Version 1.4, but some improvements will be apparent to the user. For example, multiple damage categories will be entered/ edited in a table rather than in a dialog containing only the current damage category. In addition, the new GUI provides the long-awaited ability to copy and paste data in the GUI tables. Version 2.0 supports geospatial display of the study area and is capable of displaying many layers of data such as topographic data, impact area polygons, structure inventories, etc. Currently, many features developed for Version 1.4 have also been implemented in Version 2.0, including the import of HEC-RAS water surface profile data, entering/ editing input data such as probability, rating, and damage functions, and display of EAD output results. CEIWR-HEC will provide a Beta version of HEC-FDA Version 2.0 later in FY2014.



HEC- FDA Version 2.0

Water Resource Systems Division Chief, Ms. Lea Adams

By Diane Cuming

August of 2013 brought the Institute for Water Resources (CEIWR) Hydrologic Engineering Center (CEIWR-HEC) a new Chief for the Water Resource Systems (CEIWR-WRS) Division, Ms. Lea Adams, Professional Engineer (P.E.). Ms. Adams transferred from the U.S. Army Corps of Engineers (USACE), Sacramento District (CESPK), where she began her federal career in October 2006. Starting in 2010, she served first as Chief, Hydraulic Design Section, then as Chief, Hydraulic Analysis Section at CESPK. During that time, she led twenty-one engineers in execution of a complex water resource and flood risk management program and oversaw 7 million dollars in labor and contracts annually. Her primary responsibility was to provide staff professional guidance on numerous challenging dam safety and flood risk management projects while maintaining frequent communication with other key agencies within the water resources community. Technical work performed during her time at CESPK covered a wide variety of hydraulic engineering tasks: one- and two-dimensional hydraulic modeling of riverine floodplains, sediment transport analyses, bank protection design, dam spillway designs and risk and uncertainty analyses. This technical work supported over forty-five ongoing studies within the Sections at CESPK, including standard USACE Civil Works studies that addressed flood risk management as well as dam safety analyses for several high -risk dams within CESPK. She also worked closely with CEPSK Hydrology and Hydraulic (H&H) engineering experts, State of California, Department of Water Resources (DWR) staff, and professional consultants to develop innovative methods to apply results from the Central Valley Hydrology Study to flood risk management studies. Ms. Adams further strengthened the USACE-DWR partnership by leading Hydraulic Analysis staff in providing quality assurance services for the Central Valley Floodplain Evaluation and Delineation Study, a six-year, 40 million dollar specialized technical study to generate new hydraulic models for the Central Valley. Ms. Adams was actively involved with the USACE Planning Associates program while at CESPK and conducted multiple presentations on flood risk analysis methods.

From July to November of 2012, Ms. Adams completed a developmental assignment as the Endowed Chair for the South Pacific Division (CESPD) Regional Integration Team at USACE Headquarters in Washington D.C. This augmented her engineering background with on-the-job learning opportunities in the Planning and Programs business areas within USACE. In the Endowed Chair position, she facilitated policy reviews of numerous planning documents and cost sharing agreements. With her H&H background, she provided specialized technical assistance to both USACE Headquarters staff in the Office of Water Project Review and staff in the Assistant Secretary of the Army - Civil Works office regarding highly technical flood risk hazard information on multiple CESPD projects (e.g., Sutter and Orestimba feasibility studies, Isabella Dam Safety study). She gained a broader understanding of the ongoing Planning Modernization effort, state of funding for USACE, and the inner workings of Headquarters as well as local sponsor concerns.

Ms. Adams's private sector experience included one year as a senior engineer at the environmental firm Jones & Stokes, located in Sacramento, CA. She served as lead and technical expert for H&H engineering analyses in support of various environmental restoration and permitting projects throughout California, Oregon and Washington. Typical projects included stream restoration design for fish passage and habitat, floodplain impact analyses, hydrologic impact analyses and riverine hydraulic analyses, as well as CEQA/NEPA (California Environmental Quality Act/National Environmental Policy Act) document writing. Prior to working at Jones & Stokes, she spent ten years with Northwest Hydraulic Consultants (NHC) in both their Seattle, Washington and Sacramento, California offices. While at NHC, she developed extensive expertise as both an engineer and project manager while working on a wide range of H&H engineering projects. She supported and eventually led large-scale hydrologic modeling studies, bridge scour analyses, riverine analyses, fish ladder designs, and numerous detailed floodplain analyses. Representative projects include multiple FEMA (U.S. Federal Emergency Management Agency) floodplain mapping studies, water quality-related reviews within the Tahoe basin, and analyses of fish ladder and spillway weir designs on Columbia River dams.

Ms. Adams earned her Master's Degree from the University of Washington, Seattle in 1995, and her Bachelor's Degree from the University of California, Davis in 1993. Ms. Adams also holds a P.E. License in the states of California and Washington.

Ms. Adams will have a busy road ahead managing CEIWR-WRS. She will be managing a staff that consists of, one (1) Information Technology Specialist, seven (7) Hydraulic Engineers, one (1) Economist, two (2) Pathways

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students and a nationally recognized subject matter expert in hydrologic engineering and water resources planning with a special emphasis in Flood Risk Management (FRM). Under Lea's direction, CEIWR-WRS manages the training and technology transfer activities of CEIWR-HEC, and develops and integrates analytical methods for water resource planning activities. Technical and functional responsibilities of CEIWR-WRS are the training program administration; reservoir systems; water resource systems optimization; flood damage analysis; risked-based analysis; river/ecosystem restoration; and watershed studies.

We are proud to have Ms. Lea Adams as part of the engineering staff and joining the management team. She brings a wealth of knowledge with her and we look forward to a long and successful stay.

PROSPECT Training Program

PROSPECT Training Course Changes

By Lea Adams, P.E.

The Hydrologic Engineering Center (HEC) presents approximately ten (10) to twelve (12) Proponent-Sponsored Engineer Corps Training (PROSPECT) training courses per fiscal year. Several changes have recently been made to the training program, as the USACE Learning Center (ULC) has been directed to work towards greater cost efficiency.

Perhaps the most significant change for students and their parent organizations is that the ULC is now requiring payment at the time of registration. This requirement, along with reduced training budgets across the agency, may have contributed to reduced initial enrollment in several HEC classes for FY 2014. As a result, the courses annotated with an * below may be cancelled if the number of students fails to meet the minimum needed to financially support the course. Registration will remain open until at least 90 days prior to a course start date, so increased enrollment later in the FY remains a possibility. If you would like to be considered for any of the courses below please contact Mr. Matt McPherson (Matthew.McPherson@usace.army.mil).

Course Number	Course Title (all classes located in Davis, CA)	Dates
*178	Hydrologic Modeling with HEC-HMS	2 - 6 December 2013
155	CWMS Modeling for Real-Time Water Management	27 - 31 January 2014
*188	Unsteady Flow Analysis with HEC-RAS	3 - 7 February 2014
*098	Reservoir System Analysis with HEC-ResSim	24 - 28 February 2014
209	Risk Analysis for Flood Risk Management	3 - 7 March 2014
*320	H&H for Dam Safety Studies	24 - 28 March 2014
*161	Hydrologic Analysis for Ecosystem Restoration	7 - 11 April 2014
*114	Steady Flow with HEC-RAS	14 - 18 April 2014
219	Hydrologic Engineering Applications for GIS	28 April - 2 May 2014
*060	Consequence Estimation with HEC-FIA	5 - 9 May 2014
*152	Water Data Management with HEC-DSSVue	7 - 11 July 2014
123	Flood Frequency Analysis	14 - 18 July 2014
352	Advanced 1D/2D Modeling with HEC-RAS	18 - 22 August 2014

**Currently under enrolled, and may be cancelled.*