ADVANCES
in Hydrologic Engineering
Spring 2013

Director's Comments

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

Welcome to the Spring 2013 edition of the HEC Newsletter. It has been a while since our last Newsletter so there is much to tell. In this edition, you will read about advances to our software and also some of the interesting projects we are working on and activities we are involved in.

However, before I start describing some of the projects and activities, I have a question for you. I have been asked if the Newsletter is the best way to let you know about HEC. If you have an opinion, we would like to hear from you. We are interested in negative or positive comments. We are also interested in hearing ideas about other ways we could get the word out. If you are willing, please reply to penni.r.baker@usace.army.mil and we will take the appropriate action.

One of the biggest activities over the last year was the initiation of the CWMS National Implementation Plan. As many of you probably already know, the Corps Water Management System (CWMS) is a comprehensive data acquisition and hydrologic modeling system developed to support USACE water control operators' short-term decision making by providing access to real time data and modeling. HEC first released CWMS in 2002 and has updated the tool on a nearly annual basis in order to support the thirty USACE offices

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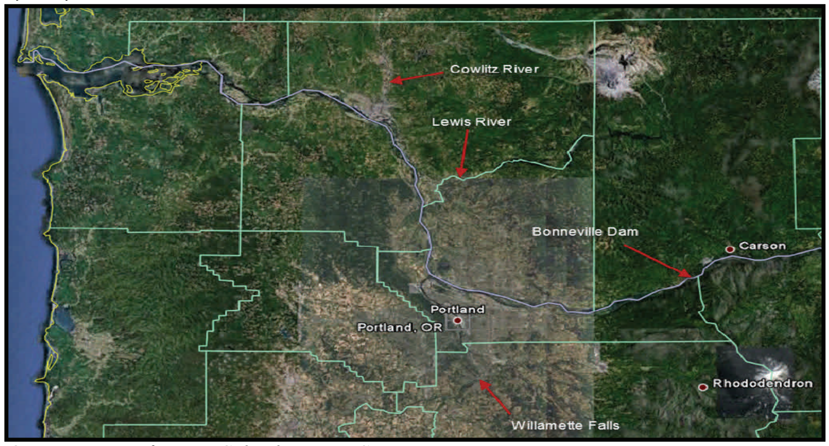
Unsteady Flow Hydraulic Model of the Lower Columbia River System

By Gary Brunner, P.E., D. WRE



Overview map of Lower Columbia River System

The Hydrologic Engineering Center (CEIWR-HEC), on behalf of the U.S. Army Corps of Engineers (USACE), Portland District (CENWP) Hydrology and Hydraulics Branch, has completed an unsteady-flow hydraulic model of the Lower Columbia River System from the outflow of Bonneville Dam to the Pacific Ocean (River Miles 146.1 to 0.0). The model also includes a portion of the major tributaries that flow into the Columbia River below Bonneville Dam. The modeled tributaries are: Willamette, Cowlitz, Lewis, Multnomah Channel, Columbia Slough, Youngs, Westport, West-Kerry, Will-Ross, Wallooskee, Skipanon, Lewis and Clark, Lake, Klaskanine, Johnson, John Day, Grays, Deer, and Coal rivers.

Model Purposes

The purpose of this hydraulic model is to predict water levels that will occur under low probability exceedance events, from the zero-damage event up to the 0.2% annual exceedance event (500 year). The model uses the outflow from Bonneville dam as its main upstream boundary condition, as well as flow hydrographs computed for each of the major tributaries modeled. The downstream boundary condition is a tidal stage hydrograph. HEC-RAS (River Analysis System) in conjunction with RAS Mapper (a tool available from the HEC-RAS interface) produces water surface profiles, hydrographs, stage-discharge curves, and inundation grids. These results are used by HEC-FIA (Flood Impact Analysis), which estimates the consequences of flooding.

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that have water management responsibilities.

However, for various reasons, CWMS still has not been fully implemented within all 213 watersheds for which USACE has water management responsibility. To address this issue, HEC initiated the CWMS National Implementation Plan. Through this plan, HEC, along with the USACE Modeling, Mapping and Consequence Production Center (MMC), is helping to implement CWMS for the 213 basins in an effort to have a consistent standardized decision support tool for real-time operations across USACE. The fully implemented CWMS will provide water managers the capability to evaluate in real-time the economic, life-loss and hydrologic impacts of what-if scenarios from a system context.

The MMC and HEC work dovetails with other USACE efforts such as CorpsMap, eGIS and the National Water Management database, all of which enable strong upward reporting capability of real-time status, forecasting and potential hydrologic, loss-of-life and economic impacts. A model library will be built to house the models, data and supporting documentation that could be used to support the USACE Planning Transformation efforts as well as the CWMS National Implementation Plan. The duration required to complete this large effort will depend on the level of funding received but could likely take five to ten years before it is finished.

Participation in IWRSS or the Integrated Water Resources Sciences and Services is another activity HEC is particularly excited about. IWRSS is a new business model for interagency collaboration. Currently, IWRSS brings the U.S. Geological Survey (USGS), the National Weather Service (NWS) and the USACE together to share resources to help solve the nation's water resources issues. In the future other Federal agencies with complementary water resources missions could partner through IWRSS as well. IWRSS's overarching objective is to enable a broad, interactive national water resources information system to serve as a reliable and authoritative means for adaptive water related planning, preparedness and response activities. The goals are to 1) integrate information delivery and simplify access to data, 2) increase accuracy and timeliness of water information, and 3) provide summit-to-the-sea high resolution water resources information and forecasts.

Two initial charters have been written to support and help define the IWRSS effort. The first charter is the National Flood Inundation Mapping (NFIM) charter. The second was written to stand up the System Interoperability and Data Synchronization Requirements Team (SIDSRT). Interagency teams, including members of the HEC staff, are currently addressing the tasks described in the charters. The Charters speak directly to improving and coordinating the development and sharing of data and flood inundation mapping. A third Charter is being prepared which will address the potential development of a National Water Model.

The implementation of the charters represents initial activities that address the IWRSS goals and they also support the Federal Support Toolbox for Integrated Water Resources Management. The Federal Support Toolbox is another multi-agency effort initiated to bring the resources, models, tools, publications and data of the various agencies together in one place. For more information on the Federal Support Toolbox, please go to http://www.watertoolbox.us.

For the past several years, HEC has also been a significant participant in the Columbia River Treaty (CRT) 2014/2024 Study. The CRT is an agreement between the United States and Canada whose purpose is to provide flood control and power benefits to U.S. and Canada. The study is a regional effort within CENWD, requiring close coordination among the Division and the three Districts within the Columbia River Basin; Portland, Seattle and Walla Walla. A major emphasis of the study is the development of a comprehensive, systems evaluation approach for the Columbia River Basin to understand the flood risk management details of the current and potential future treaty operating scenarios as related to flood damages, hydropower, and system performance.

Working on such a large study has allowed HEC to assist in a number of ways. HEC has supported the study project development teams, including the Hydrology and Hydraulics, Plan Formulation and Integration sub-teams; has provided technical and policy guidance, coordinated and developed the HEC-WAT (Watershed Analysis Tool) and HEC-ResSim (Reservoir System Simulation) software features specific to CRT; and, provided overall risk assessment methods to the CRT team.

However, the most significant product developed by HEC for the

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ADVANCES is an unofficial publication authorized under the provisions of AR 360-1 and published biannually by the U.S. Army Corps of Engineers, Institute for Water Resources, Hydrologic Engineering Center, 609 Second Street, Davis, CA 95616-4687. Telephone: (530) 756-1104; FAX: (530) 756-8250. Views and opinions expressed in this publication are not necessarily those of the Department of the Army.

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CRT has to be the HEC-WAT model with its FRA (Flood Risk Compute) option. The software is being used to evaluate treaty alternatives using EAD (Expected Annual Damage) and other performance criteria. The base condition includes an evaluation of the current treaty flood control operations (until 2024), and an evaluation of the base conditions from 2025 to 2075. The HEC-WAT models have been developed with the flexibility to evaluate numerous hydrologic scenarios, including climate change, and numerous operational modifications during any time period.

While originally constructed to help Project Delivery Teams perform system wide studies more collaboratively through coordinated modeling building and intuitive model editing and review, HEC-WAT now does much more. In the near future, the HEC-WAT will include a number of additional capabilities to support lifecycle and additional uncertainty analyses. With the addition of these features, HEC-WAT will for the first time provide USACE with a tool that supports many if not all the system, watershed, life-cycle and risk analysis requirements USACE has required for years. With its distributed computing capabilities, HEC-WAT with its FRA compute option can now successfully use over 100 virtual machines to run a full systems analysis with uncertainty for the entire Columbia River watershed for 50,000 events. No small feat.

Other software advancements that occurred since the last Newsletter include the release of HEC-ResPRM (Prescriptive Reservoir Model) Version 1.0, HEC-RPT (Regime Prescription Tool) Version 2.0, and HEC-FIA (Flood Impact Analysis) Version 2.2. The releases of both HEC-ResPRM and HEC-FIA are provisional releases as they await USACE certification. That means you can still use the tools but only on a limited basis. The software cannot be used to compute a benefit to cost ratio for decision making.

HEC-ResPRM is a reservoir system operations optimization software package developed to assist planners, operators, and managers with reservoir operation planning and decision-making. HEC-RPT is designed to facilitate entry, viewing, and documentation of flow recommendations in real-time and public settings and HEC-FIA analyzes the consequences from a flood event and can estimate damage to structures and contents, losses to agriculture, and also the potential for life loss. HEC-FIA can also look at dam failure events and evaluate the consequences to support risk assessments for dams. HEC-FIA uses simplified LIFE-Sim to evaluate the impact to human life. More information about HEC-FIA can be found later in this Newsletter.

Last year also saw improvements in most of our tools including some significant enhancements in HEC-RAS (River Analysis System), HEC-HMS (Hydrologic Modeling System), HEC-FDA (Flood Damage Reduction Analysis), HEC-EFM (Ecosystem Functions Model) and its companion tools, and finally, HEC-RTS or (Real-Time Simulation). Of special note is HEC-RTS which is software being developed that includes the data visualization and modeling capabilities of the CWMS software but it is being prepared for a public release. HEC-RTS is scheduled for release in FY 2014. An update on CWMS and RTS can be found later in the Newsletter.

The descriptions above tell about just a sample of the software development activities we are working on. For a more complete description of these tools, their enhancements and many of our other products, please visit our newly revised website, http://www.hec.usace.army.mil. The HEC website has been revised to follow USACE standards so you have a similar experience regardless of which USACE website you visit.

Finally, while HEC continues to perform the bulk of its work for domestic clients, our International program continues to grow. In the past year and a half, we have been involved in approximately twenty-five International projects. HEC performed reimbursable work, participated in conferences and workshops, built models, performed training and hosted foreign professionals. We also provided support to UNESCO and the World Meteorological Organization (WMO). Nearly all corners of the globe were touched. With my trip to South Africa, I personally have now been to five continents, with only Antarctica and Australia to go. Not all of our International assistance is conducted overseas. HEC hosted visitors from Japan, Russia and South Korea. The expectation is this program will continue to grow as we are working on agreements with Thailand and Taiwan and have growing collaboration with the Netherlands, the Mekong River Commission and with the UNESCO Center hosted at the Institute for Water Resources called ICIWaRM or the International Center for Integrated Water Resources Management. While preparing for International travel can be time consuming, the work is always rewarding once you are there.

In closing, in spite of the austerity restrictions that continue to be imposed such as those on government travel, conference attendance and participation and IT standardization, HEC continues to strive to provide tools and services that help you perform your job. We will continue to look for ways to

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bring state-of-the-art into state-of-the-practice such as two-dimensional modeling in HEC-RAS and distributed computing in HEC-WAT so that you can perform your studies faster and more economically yet still provide all the information required of the client and USACE policy.

As always, if you have suggestions on how HEC could provide enhanced service and/or make our products better, faster and more efficient we are interested in hearing from you.

Chris Dunn, P.E., D. WRE
Director

PROSPECT Training Program

FY 2014 Proposed PROSPECT Training Program

By Penni Baker

The PROSPECT (Proponent-Sponsored Engineer Corps Training) program for FY 2013 is winding down with two courses left - "Advanced Steady Flow Analysis with HEC-RAS" (3-7 June 2013) and "Statistical Methods in Hydrology" (8-12 July 2013). There are still spaces available in the latter course.

CEIWR-HEC has submitted our proposed FY 2014 PROSPECT training program to the USACE Learning Center (ULC). The ULC is located in Huntsville, Alabama and will shortly start conducting a survey which will help decide which courses will be taught during FY 2014. Only courses that have enough subscriptions will be taught. Therefore, it is very important that you complete the survey for each course you wish to attend. For your review and use, CEIWR-HEC has provided the proposed FY 2014 course schedule (see the table below). If you are interested in one or more of the courses, please let the training program in your District/Division know so that they can report your interest to the ULC. To register for our courses, please contact the appropriate party in your office or contact ULC, http://ulc.usace.army.mil. Registration is handled by Training and Operations (CEHR-P-RG). Course descriptions are provided at the ULC site (http://ulc.usace.army.mil/CrsSchedule.aspx). A short description along with a course agenda is also provided on HEC's web site (http://www.hec.usace.army.mil/training/course_list.html). To obtain enrollment information, please contact the USACE Learning Center. When doing so, please note the course number, name, data, and location, and contact:

USACE Learning Center
550 Sparkman Drive, NW
Huntsville, AL 35816-3416
Phone: (256) 895-7401
FAX: (256) 895-7469

CEIWR-HEC's FY 2014 Proposed PROSPECT Training Program

Course Number	Course Title (all classes located in Davis, CA)	Dates
164	Water and the Watershed	28 October - 1 November 2013
114	Steady Flow with HEC-RAS	4 - 8 November 2013
122	Sediment Transport Analysis with HEC-RAS	18 - 22 November 2013
178	Hydrologic Modeling with HEC-HMS	2 - 6 December 2013
139	Water Quality Modeling with HEC-RAS	14 - 16 January 2014
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
219	Hydrologic Engineering Applications for GIS	28 April - 2 May 2014
060	Consequence Estimation with HEC-FIA	5 - 9 May 2014
067	Advanced Steady Flow Analysis with HEC-RAS	2 - 6 June 2014
152	Water Data Management with HEC-DSSVue	7 - 11 July 2014
123	Flood Frequency Analysis	14 - 18 July 2014
043	Water Resource Analysis Using HEC-WAT	28 July - 1 August 2014
352	Advanced 1D/2D Modeling with HEC-RAS	18 - 22 August 2014

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Hydraulic modeling of flood events is a task within the Flood Risk Assessment (FRA) phase of the Columbia River Treaty 2014/2024 Review Program (CRT). The FRA is formulated to answer these key questions:

1. What is the current level of flood risk in the Columbia River Basin?
2. What will the resulting flood risk be in the absence of assured Treaty storage from Canada?
3. What data and tools will be needed to develop and evaluate alternatives to the current Treaty provisions in future study phases?

The hydraulic model will support the evaluation of flood risks under existing and future conditions in the Columbia River and tributaries as they are influenced by CRT storage.

Hydrology

Flood runoff on the Lower Columbia River Basin is primarily the result of spring snowmelt rather than specific storm events. However, weather conditions during the critical snowmelt period, such as below normal spring temperatures, rain-on-snow, or above normal temperatures, may retard or increase the melting process and the runoff rates. Historical high flows have come from the upper Columbia River Basin, but on occasion large flows have also come out of the Willamette Basin. For example, the flood in February of 1996 was predominately a large flow event from the Willamette River, with a peak flow in the 420,000 to 460,000 cfs (cubic feet per second) range, combined with a flow over 400,000 cfs coming down the Columbia River.

Model Geometry Data

Terrain data was obtained using LiDAR (Light Detection And Ranging) topographic data for much of the Columbia River Basin with extents equal to or greater than the FEMA (Federal Emergency Management Agency) Q3 500-year floodplain coverage. The one-meter LiDAR was converted to feet and modified to an ESRI grid format with a spatial reference of NAD 1983 Albers. Bathymetric data was also surveyed during 2010, for the Columbia River and the Willamette River. Both data sources were combined together to develop a terrain model with a grid resolution of one meter. Bathymetric data was not acquired for all of the tributaries modeled. Channel cross section hydro-survey data was obtained from previously developed hydraulic models for the Cowlitz and Lewis River systems. Channel data for all of the other tributaries was estimated by measuring channel top-widths from Google Earth® and then cutting a reasonable trapezoidal channel into the section using the HEC-RAS channel modification tools.

Channel and floodplain geometry needed by the HEC-RAS model were extracted from a one-meter DEM (Digital Elevation Model) and aerial imagery data using HEC-GeoRAS. Additional data not extracted by HEC-GeoRAS was defined in the HEC-RAS model, such as detailed channel data for areas where no bathymetric data was available. HEC-GeoRAS utilizes user-defined GIS (Geographic Information System) layers to extract information from the terrain data. For example, a GIS layer of cross-section cut lines is needed so that HEC-GeoRAS knows where to extract cross-section information from the terrain data. The table below contains a list of the GIS layers that were created, by digitizing lines and polygons, as well as a brief description of importance.

The geometric data generated by HEC-GeoRAS was imported into HEC-RAS. This data included the river system schematic (main Columbia River and all tributaries), station-elevation points for cross-

Description of GIS layers created to extract information for hydraulic modeling

GIS Layers	Description
Stream Centerline	The stream network is comprised of stream centerlines for the Main Columbia River and all major tributaries. Stream centerlines identify the connectivity between different streams for flood routing and are used to establish the river and reach name for cross sections and hydraulic structures within HEC-RAS.
Main Channel Bank Lines	Main channel bank lines establish the separation of the main low flow channel and the overbank areas (floodplain areas)
Flow Path Centerlines	Flow path centerlines define the center-of-mass of flow in the left overbank, channel, and right overbank areas. Flow path centerlines are used to compute the lengths between adjacent cross sections.
Cross-Section Cut Lines	Cross-section cut lines establish the location and extent for extracting station-elevation data from the terrain model for the channel cross- sections. Cross-sections were added at locations in order to capture changes in the channel and floodplain geometry as well as define an adequate floodplain boundary for mapping purposes.
Bridges/Culverts	Bridge and culvert cut lines establish the location and extent for extracting station-elevation data from the terrain model for describing the top-of-deck profile of the bridge or culvert. For this model bridges were not modeled as they were deemed high enough to not affect the water surface profiles.
Ineffective Flow Areas	Polygons were created defining areas in the floodplain that do not actively convey water. HEC-GeoRAS overlays the ineffective flow areas with the cross-section cut lines to determine the portion of the cross-section that does not actively convey water.
Lateral Structures	Lateral structure cut lines define the location and extent of natural and man-made structures (levees) where water can flow out into overbank areas, or areas protected by levees. The majority of the levees in this system were modeled as Lateral Structures. Station-elevation data was extracted from the terrain model for the top of the lateral structure.
Storage Areas	Storage areas were used to model areas behind levees, as well as storage for tributaries, that were not specifically modeled as separate routing reaches. Polygons were created defining the extents of all storage areas and used to extract the elevation -storage data from the terrain model. Lateral structures and storage area connections were used to connect the storage areas to the main channel.
Storage Area Connections	Storage Area Connections are used to define a hydraulic structure between two storage areas. Storage Area Connections are often used to model interior levees, significant roads, or natural high ground that will prevent water from going from one area to another.

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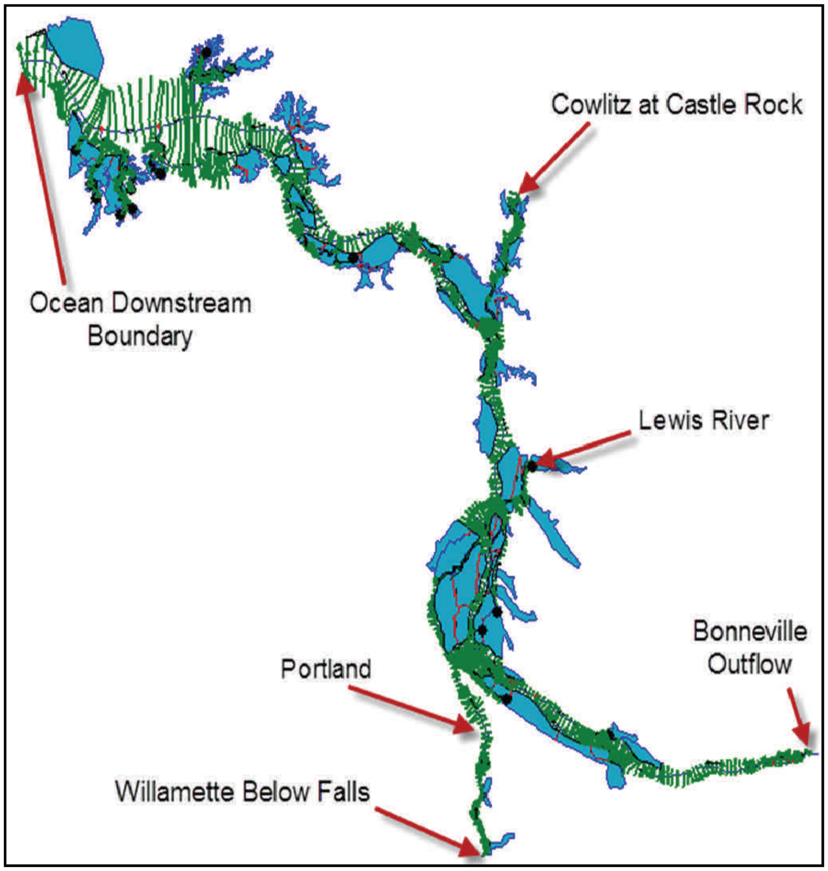
sections, reach lengths between cross-sections, ineffective flow areas in the floodplain, station-elevation location and station-elevation information for lateral and inline structures, and elevation-storage information for storage areas. Additional data was entered into the HEC-RAS model based on information provided by CENWP. Data obtained from aerial photography, and from using standard engineering equations was used to estimate model parameters. The model schematic, as depicted in HEC-RAS, is shown to the right. This model has thirty-four different rivers with eighty different river reaches defined within the system.

Initial estimates of Manning's n values for the main channels were estimated from previously developed HEC-RAS models, visualization of the river using Google Earth®, and hydraulic modeling experience gained from other studies. Main channel Manning's n values were estimated for the channel as a whole, rather than separate values for the channel bottom and the channel banks. A large portion of the river corridor has extensive thick brush and trees on the banks of the main channel. Channel Manning's n values were estimated by weighting the base n value of the bottom with larger n values for the channel banks. Overbank Manning's n values were estimated by using aerial images to define areas of similar land use, then assigning an n value for that land use type. A few examples of the n value assignments used are: thick forested areas were assigned an n value of 0.10; urban areas with high densities of building were assigned a value of 0.15; and, open fields with grass was assigned values of 0.05. After all of the cross sections were assigned initial Manning's n value estimates, further refinement of the Manning's n values was made during the model calibration process. Model calibration is described in the following section. A table showing the range of Manning's n values for the major rivers is shown below.



HEC-RAS Schematic of the Lower Columbia River System

Manning's n Value Ranges for Main Channels

River Name	Main Channel Manning's n	Overbank Manning's n
Columbia River	0.028 - 0.035	0.05 - 0.10
Willamette River	0.03 - 0.039	0.05 - 0.15
Cowlitz River	0.025 - 0.031	0.05 - 0.10
Lewis River	0.032	0.05 - 0.10
All Other Channels	0.03	0.05 – 0.15

Lateral structures were used to model all of the levees that are directly along any of the modeled rivers. Lateral structures are connected from a river reach, to an area behind the levee (modeled as storage areas). Separate lateral structures (208) were defined and entered into the HEC-RAS model to represent reaches of levee systems. The lateral structures were laid out in HEC-GeoRAS either by hand drawing them, or by following existing levee shapefile drawings developed by the CENWP levee team. The terrain data for the lateral structures (levees) were originally extracted from the one meter DEM data and imported into HEC-RAS. However, detailed surveys were made of most of the levees (those that protected property and human life). Detailed survey data was provided in an Excel® spreadsheet, which was copied into the HEC-RAS Lateral Structure Editor for each of the levees.

Storage areas (160) were used to model protected areas behind the levees, as well as available storage in smaller tributaries that would incur backwater from the Columbia River. The lateral structure feature in HEC-RAS was used to connect the main channel to a storage area.

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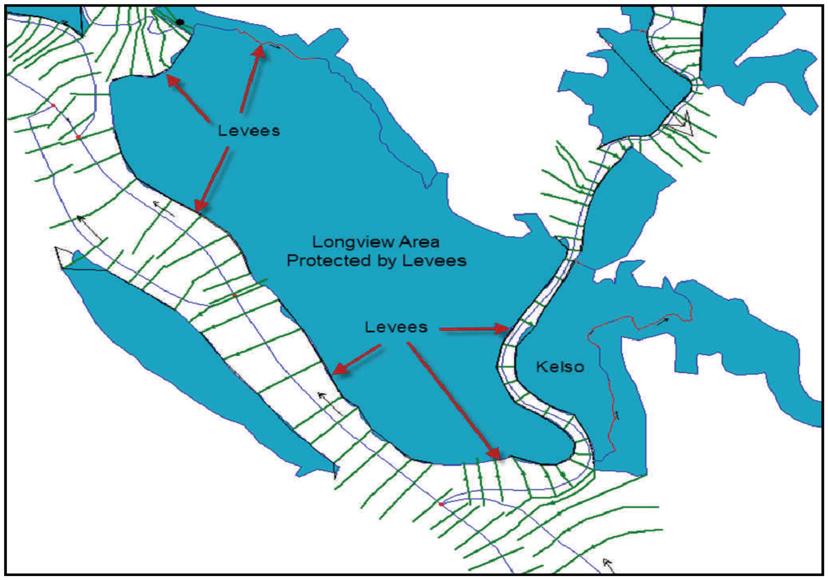
The figure to the right depicts the use of several lateral structures, along multiple river reaches, and storage areas to model the typical situation of levees protecting a valued property. This figure shows the levees protecting the Longview area along the Columbia River, Cowlitz River, and Coal Creek.



Example of Storage Areas and Lateral Structures used to Model Protected Areas

Model Calibration and Validation

Calibration and verification flow and stage data were obtained from CENWP. This data consists of USGS (U.S. Geological Survey) gages, NOAA (National Oceanic and Atmospheric Administration) gages, and CENWP owned and operated gages. Three events were used for calibration and two events were used for model verification. The calibration events were the 1996 flood event (which had a record gaged flow on the Willamette), the Spring 1997 flood (this was a big flow on the Columbia River Mainstem), and the May 2008 to February 2009 event (this was a typical flow on the Columbia, but a large flow on the Cowlitz River). In addition to gaged data, an extensive set of high water marks and a flood inundation boundary shapefile was available for the 1996 flood event. The high water marks and the flood inundation boundary were used to calibrate the model between gages and in areas where there was no gaged data. Verification events were the 2006 and 2010 runoff periods.

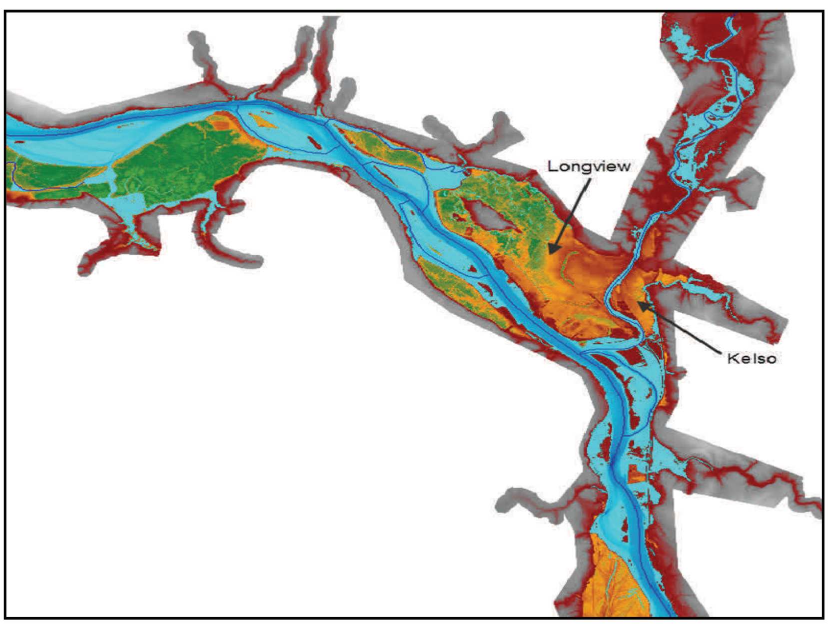
The calibrated model was used to validate the results using the 2006 and 2010 flood events. The computed peak stages, observed peak stages, differences in computed minus observed stages, and the timing differences of when the peak stages occurred (computed time minus observed time) at gaged locations for each flood event was evaluated.

Inundation Mapping

Inundation mapping was set up for the lower Columbia River Basin using the HEC-RAS Mapper capabilities. Inundation maps were developed for maximum stages for all six events modeled. In addition, RAS Mapper was used to develop arrival time grids and recession grids, which are used in HEC-FIA for estimating population impacted and loss of life. An example inundation map is shown below in the figure.

Conclusions

A very complicated and detailed model has been built for the Lower Columbia River system and major tributaries. This model shows the utility and power of HEC-RAS for application to complicated systems. This model was developed by Gary Brunner of HEC, with assistance from Christopher Nygaard of the Portland District. Chris's knowledge of the river system greatly assisted in making this model more detailed and accurate, and in general a much better model.



Inundation Map of Longview (Oregon) Area for February 1996 Flood

Coupling HEC-RAS and MODFLOW using OpenMI

By Jon Fenske, P.E.

The efficient coupling of the river hydraulics model HEC-RAS with the USGS groundwater flow model MODFLOW in conjunction with a practical, user-friendly interface provides a much needed, state-of-the-art, non-proprietary tool for simulating surface water/ groundwater interaction. Both HEC-RAS and MODFLOW are considered to be the standards of the profession. HEC-RAS/MODFLOW provides a set of physically based simulation capabilities not available in either stand-alone model. In addition to the channel flow simulation capabilities of HEC-RAS, the integrated model supports the surface-groundwater exchange and groundwater flow simulation capabilities of MODFLOW. The open-source OpenMI (Open Modeling Interface Environment) library is used to facilitate data exchange between HEC-RAS and MODFLOW. Data represented on different geometries (such as lines and polygons) is mapped and exchanged seamlessly at the time-step level. The linked system supports iteration over one or more time steps, moderating and monitoring data as the exchange occurs for an iteration until the tolerance criteria is satisfied.

South Florida Water Management District (SFWMD)

HEC-RAS/MODFLOW has been successfully applied to the C-4 Canal Basin in southern Florida; and, the Russian River in northern California. A Memorandum of Agreement (MOA) between CEIWR-HEC and SFWMD included work to assist in the development and application of an HEC-RAS/MODFLOW model at the C-4 Canal Basin. The C-4 Basin project consists of 620 miles of canals and waterways along with gates, pumps, storage areas, and a highly conductive shallow aquifer where small changes in channel stage directly impact groundwater storage (see the following figure). The C-4 Basin project was

C-4 Canal System in south Florida

constructed to address extensive flooding problems in Miami-Dade County. The goal of the C-4 system is to relocate excess water so it could be absorbed into the groundwater or held in reserve. The HEC-RAS/MODFLOW model was calibrated to past flood events and will be used to address operational issues.

Sonoma County Water Agency (SCWA)

An MOA was completed between CEIWR-HEC and SCWA to develop an HEC-RAS/MODFLOW model of the Russian River at the Wohler-Mirabel groundwater pumping complex. The MOA also provided for training to SCWA on the use of HEC-RAS, MODFLOW, and the coupled model. The HEC-RAS/MODFLOW model will be used to address operational issues and to assist in locating additional groundwater pumping wells. SCWA is the primary provider of potable water for over 600,000 people in Sonoma and Marin counties in northern California. The Agency's primary responsibilities as a water supplier include operation of the Russian River groundwater pumping complex and water transmission system. SCWA pumping from the wells adjacent to the Russian River generally ranges between 140 -180 cfs during summer months. In addition to stresses from high volume pumping wells, the project area also includes sharp changes in river stage in response to the filling of an inflatable dam. Hydrographs that represent measured versus simulated groundwater levels at well MW-93-14 from May 15 to August 31, 2006 were developed. The models have the ability to simulate groundwater response to small changes in channel stage due to changes in groundwater pumping prior to the large change in channel stage due to the dropping (and rising) of the inflatable dam for repairs in mid-July.

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HEC Software

Future Development of Water Management Software

By William Charley, P.E.

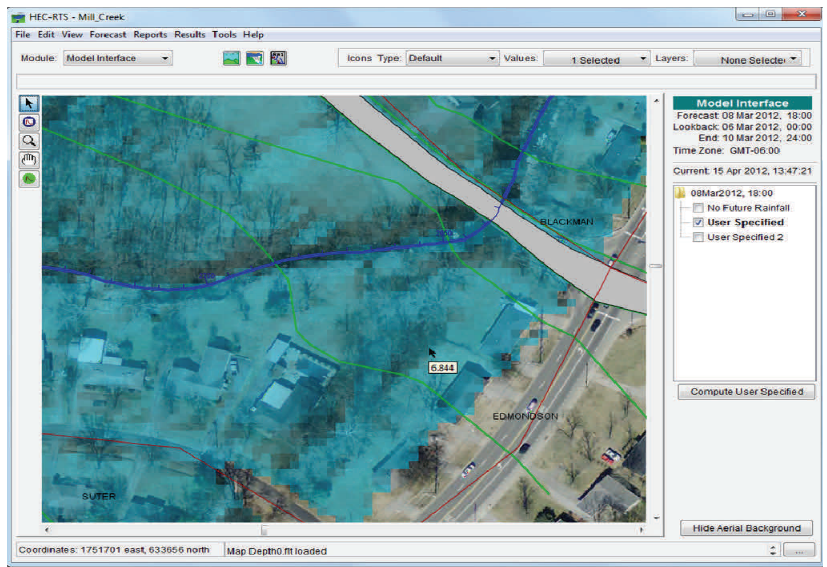
CWMS (Corps Water Management System) is an automated information system that supports the USACE water management mission by providing districts and divisions with a consistent set of tools to collect, process, and store hydrometeorological data and make it available for evaluation and operational forecasting. This integrated system of hardware and software has improved decision making concerning water control management for over a decade. The current version of CWMS is Version 2.1, and this software is available to USACE offices only.

HEC-RTS (Hydrologic Engineering Center's Real-Time Simulation), is a Windows version of CWMS's CAVI (Control and Visualization Interface) that runs on a single computer without requiring an Oracle® database or a UNIX server. HEC-RTS includes the data visualization and modeling capabilities of CWMS, but does not have the data processing, storage, or dissemination capabilities of CWMS and uses HEC-DSS for management of time series data (instead of Oracle®).

Either CWMS or HEC-RTS provides support for operational decision making by providing short-term event forecasts of hydrologic conditions in the watershed. Both pieces of software provide an integrated suite of generalized modeling programs that represent different hydrologic aspects of a watershed. Both pieces of software currently include the following models (listed in sequence of execution for a typical watershed):

- MFP, a simple meteorological model that combines observed gaged or radar-based precipitation with forecasted precipitation from Quantitative Precipitation Forecasts (QPF) and other future precipitation scenarios.
- HEC-HMS, a hydrologic rainfall-runoff model that forecasts uncontrolled flows into and downstream of reservoirs.
- HEC-ResSim, a reservoir flood operations simulation model to simulate rule-based operations; or
- CADSWES RiverWare, a supply-based reservoir operations model
- HEC-RAS, a river hydraulics model that computes river stages and water surface profiles for these scenarios. An inundation boundary and depth map of water in the flood plain can be calculated from the HEC -RAS results using RAS Mapper (a tool of the HEC-RAS software).
- HEC-FIA, a flood impact economic analysis package that computes both potential damages and actions for flood managers to take.

This user-configurable sequence of modeling software allows users to evaluate operational decisions and view and compare hydraulic and economic impacts for various "what if?" scenarios. In the context of the Metropolitan Nashville area, CWMS/HEC-RTS will be run without reservoir modeling, allowing users to evaluate precipitation scenarios; and, view and evaluate potential inundation areas and depths in real-time. CWMS/HEC-RTS will also allow users to modify the HEC-RAS model to reflect debris obstructions and view the resulting inundation areas.



HEC-RTS (Real-Time Simulation) software

Both CWMS and HEC-RTS share the same code, therefore any modifications to one piece of software will appear in the other piece of software. Currently work on future releases of CWMS (Version 3.0) and HEC-RTS includes updating their frameworks to the framework that is being used in the HEC-WAT (Watershed Analysis Tool) software. The framework design allows the use of plug-ins or native model interface (NMI) which will allow a user to have access to the selected software and output. The plug-in API allows for the integration of a particular piece of software to be "fully" integrated (all aspects of the software are available to a user); "loosely" integrated (only certain aspects of the software are available

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Future Development of Water Management Software (continued)

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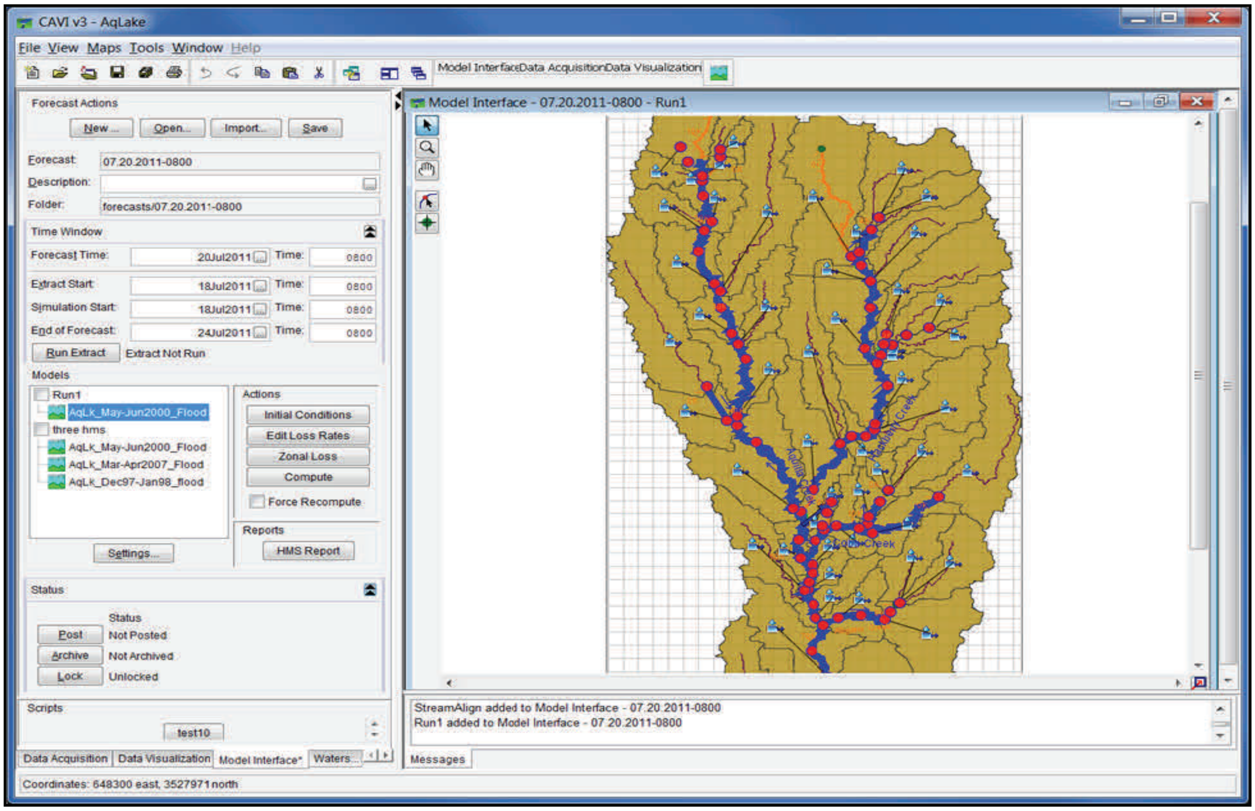


CWMS (Corps Water Management System) Version 3.0

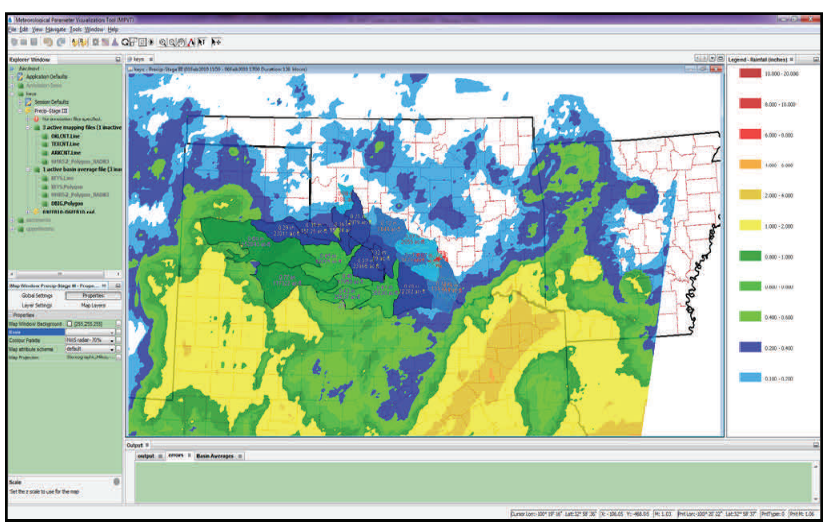
to a user); or, "simply" integrated (just execute the software).

For example, HEC-RAS is a piece of software that is fully integrated with CWMS, so, when a user brings up the Cross Section Editor, that editor will be coming directly from HEC-RAS. From the Map Display of CWMS, the user can right-click on an element and available options from HEC-RAS will be displayed. One of the options is water surface profile plot; when selected, the water surface profile plot displayed is directly coming from HEC-RAS.

The new framework provides several advantages over the previous CWMS framework:

- Generally, faster simulations
- Access to all of the software dialogs
- Access to all software methods
- Access to PC specific programs, such as RAS Mapper (a tool of the HEC-RAS software)
- Real-time flood inundation mapping
- Ability to update modeling programs without needing to update CWMS CAVI or HEC-RTS
- Can continue to use if access to the CWMS server is lost (with data up to the time of the loss)
- Less network traffic is needed.

Currently, Version 3.0 of CWMS is in alpha testing and evaluation. The release of Version 3.0 should be available by late Fall 2013. In addition, a new meteorological data visualization and parameter manipulation tool (MPVT) will be available with Version 3.0 of CWMS and HEC-RTS. This tool displays precipitation and other various meteorological data and allows users to analyze and modify the data before using in CWMS or HEC-RTS.



Parameter Manipulation Tool (MPVT)

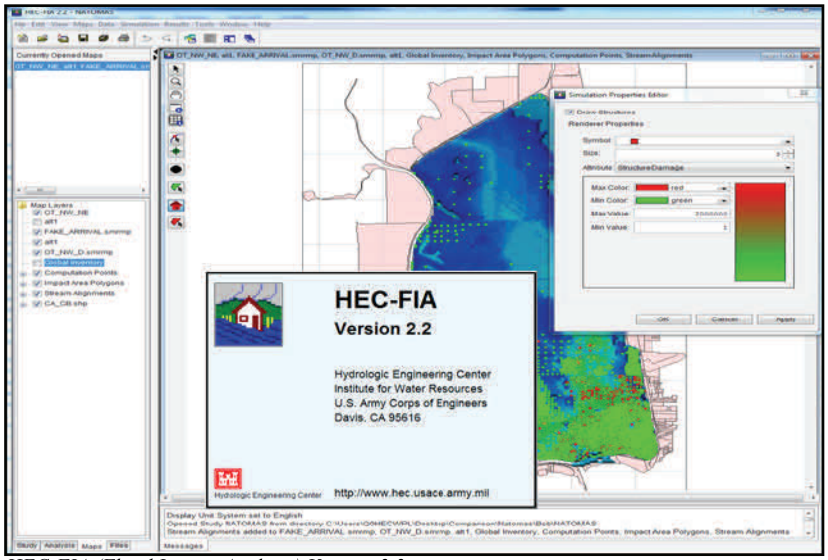
HEC-FIA (Flood Impact Analysis) Software, Version 2.2

By William Lehman

A new piece of software, HEC-FIA (Flood Impact Analysis) Version 2.2 is available on the HEC website. This is a provisional release pending certification by the Flood Risk Management-Planning Center of Expertise (FRM-PCX).

HEC-FIA is a single-event consequence estimation software that uses spatial calculations to estimate economic damage, agricultural impact, and life loss for flooding events. HEC-FIA is one of the easiest, quickest, and most robust life loss estimation platforms available for use. The software employs a simplified version of the LifeSim methodology developed by Bowles and Aboelata for estimating life loss from single events.

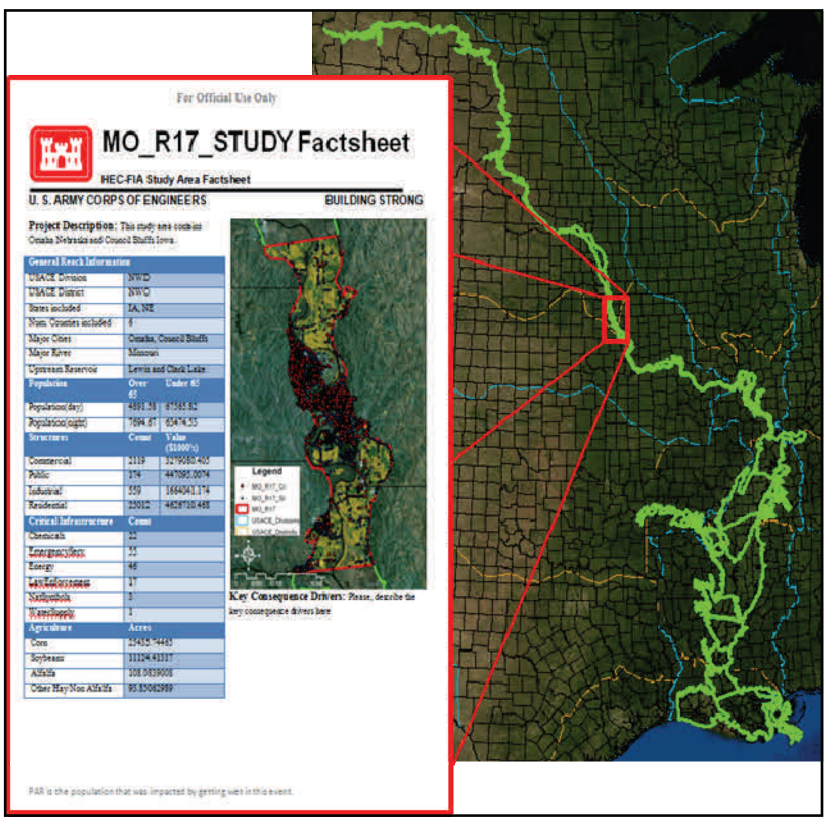
Version 2.2 is the first major release of HEC-FIA since Version 1.5 was released with the Corps Water Management System (CWMS) software. Major improvements include the utilization of point based structure inventories; the ability to import inventories from point, parcel, or HAZUS databases; life loss estimation; and better mapping capabilities. The software program offers many features to help estimate the consequences of dam or levee failure events.



HEC-FIA (Flood Impact Analysis) Version 2.2

Various tools have been developed to assist users in quickly preprocessing data for input into HEC-FIA, or to quickly generate reports in Microsoft Word® documents from an existing HEC-FIA project. These tools are designed to enhance the capabilities of HEC-FIA and increase the ease for incorporating HEC-FIA into the day to day life of a planner.

The HEC-FIA development team submitted certification documentation to the FRM-PCX during the third quarter of FY 2012. Certification will allow results from HEC-FIA to be used in benefit-to-cost-ratios for decision documents regarding civil works projects. Currently, the certification plan is awaiting approval by Headquarters before moving on to internal and external reviews. The certification process is scheduled to be completed in the near future.



Fact Sheet Generator Tool

The Planning Associates Program: An Engineer's Perspective

By Sara O'Connell, P.E.

The USACE Planning Associates (PA) Program is advanced training about water resources planning with the goal of broadening the USACE planner competencies in solving complex water resources problems and challenges. The PA curriculum seeks to strengthen leadership talent through team building; leadership training; training across USACE civil works business lines; cast studies; communication and presentation techniques; networking opportunities with leaders in USACE, the Army, Congress, the Administration, and public and private water resource groups; and, creating individual and group projects. All of this is accomplished over an eleven month period, with twenty weeks of rigorous training for a class that is demographically diverse, and multi- with varying planning experiences.

I, Sara O'Connell, a Research Hydraulic Engineer, at the Hydrologic Engineering Center (CEIWR-HEC) was a member of the 2012 PA class. CEIWR-HEC is involved in USACE water resources planning through the development of software in areas such as flood risk management, ecosystem restoration, reservoir system optimization, and consequence analysis. Other involvement includes updating USACE guidance manuals (e.g., Engineer Circulars (EC); Engineer Manuals (EM), Engineer Regulations (ER), etc.); supporting Planning Centers of Expertise (PCX) - Flood Risk Management and Ecosystem Restoration; performing Agency Technical Reviews (ATR); and, fielding general water resources planning questions from USACE field offices. Although the PA Program is designed to broaden the competency of USACE planners, three CEIWR-HEC engineers have participated in the PA Program in recent years: Beth Faber (2004); Jason Needham (2006, now with CEIWR-RMC); and, myself in 2012. The primary benefit of having CEIWR-HEC employees participate in the program is to enhance understanding and awareness of USACE that will allow CEIWR-HEC to better serve the USACE water resources planning community. For example, with the introduction of SMART Planning, there is need for simpler tools that offer quick estimates and require less detailed analysis. CEIWR-HEC is considering how to use and/or adapt current tools and techniques to meet the goals of SMART Planning. Recent activity has been to update HEC-FDA (Flood Damage Reduction Analysis) Version 2.0 to build quick structure inventories from HAZUS data; and also to define ways to streamline application of existing tools.

USACE Planning Associates Program, Graduating Class of 2012

When I began the PA Program, I quickly discovered that, like most of the hydraulic engineers at CEIWR-HEC, I knew very little about planning and the broad range of activities of USACE. Our first course in planning was like navigating through an alphabet soup of regulation names, numbers, and acronyms (e.g., PGN, DMP, GRR). Most of the class participants already had an understanding of the planning process, or some particular aspect, like the backs of their hands, and therefore they tutored me, as I did my best to catch up. As the year progressed, I grew more familiar with the terminology, the planning process, and USACE in general. Today, I am better equipped to think about what CEIWR-HEC needs as an organization to address the planning process and provide my colleagues at CEIWR-HEC with information that will aide in the development of software, performing technical modeling, or managing of projects that benefit USACE field offices.

Over the course of the PA Program, our class experienced the variety of work that USACE performs for the nation, ranging from hydropower at

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Bonneville Dam to coastal storm damage reduction on the Jersey shore. In the classroom I gained respect for the economic, social, and environmental significance of USACE work, which was further supported by site visits. Observing the scale of commerce at the Port of Mobile and watching barges piled with coal locking through the Kanawha River impressed me with the importance of maintaining our infrastructure. Wading along a coastal Louisiana barrier island ecosystem restoration project and visiting a tribe in Alaska, where I saw the local reliance on small boat harbors, gave me appreciation for the opportunities that USACE has to improve our world and positively impact lives. Our class also spent three weeks in Washington D.C., where I was inspired by the drive and commitment at Headquarters and had the great opportunity to shadow Mr. Steve Stockton for a day. I was able to see a bigger picture of USACE in the context of our government through visits to Capitol Hill, the OMB, and the ASA's office. These personal connections I made through visiting USACE projects and observing the civil works process gave me an enhanced respect for the many different forms of the service that USACE provides to the nation and the effort involved in its delivery.

The PA Program strengthens relationships and improves communication across USACE. The program encourages heartfelt conversations about the issues that USACE faces, and ideas are shared from many different perspectives. I encountered frustrations between planners and engineers and consequently got to hear more engineer jokes than I ever knew existed! I saw how points of view differed based on how the different aspects of the problem had different focuses. The opportunity to work and learn with others in this way creates understanding across disciplines, and I am now an engineer who embraces the USACE planning perspective. SMART Planning does not imply abandoning good technical work, but it means clearly understanding and identifying the risks that have to be accepted in order to achieve the end goal of completing projects on time and in budget, or learning to say "no" to projects.

Finally, the PA Program affords the opportunity to develop extremely useful team building, communication, and problem solving skills. The 2012 PA class had ten members, all from different regions, backgrounds, and life experiences, which made for an interesting and dynamic team. We spent long hours living and working together, and there were some incredibly challenging aspects to this travel- and stress-intensive environment, but we learned how to support each other and interact in ways that maintained team spirit. I was able to develop skills such as how to work closely with others, promote positivity, manage conflict, and ultimately, get the job done. Since USACE has been going through a Planning Modernization process, our class was provided with an intimate view of the ways change is being developed and enacted, and we had the opportunity to contribute directly to the process, as our final project was directed towards supporting the SMART Planning movement. One of the most challenging moments came when, after a great deal of negotiation, we had finally reached consensus on a final project proposal, only to discover that the task we proposed was already being conducted. However, we had learned to think on our toes, remaining flexible and optimistic, and were quickly able to create a revised proposal. Although challenging, it was exciting to be involved in the process and to respond to constantly changing demands.

Overall, my experience in the PA Program was incredible! The year held a wonderful mix of different challenges and experiences for learning and growth. Possibly the most inspiring aspect of the PA Program was the chance to meet and talk to the many talented, committed, and hard working people who dedicate themselves to making USACE the best it can be. I am incredibly grateful to have been accepted into the program, and I am working hard to apply those lessons learned to support the mission of CEIWR-HEC.