Advanced Hydrologic Prediction Service (AHPS)

Program Plan

October 15, 2004

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Introduction

This document provides an overview of the Advanced Hydrologic Prediction Service (AHPS) and serves as a guide for the AHPS program. The document will be reviewed and updated annually to reflect the current state of AHPS and provide a road map for future implementation.

Background

The 21st century offers NOAA and the NWS a challenge to expand its focus to provide more and better information to manage all water resources. Fresh water forecasting and decision making tools are crucial to the nation's well-being and interest as well as the future of our commerce. The Advanced Hydrologic Prediction Service (AHPS) is the NWS program to modernize the river forecasting capability and expand it to new waterways. It will feature new science and technology that will expand and provide additional capabilities that will make available new and better decision making tools that will help predict the impact of all phenomena affecting the nation's fresh water supply. Regional estimates of drought, snow, river flow, soil moisture content, pollutant dispersion, and inflow to coastal estuaries will enhance the health and safety of our fresh water supply. A new generation of user-friendly information and forecasting tools will be used by a variety of customers to help them make better and more informed water wise decisions. This information will also help us manage our precious water resources and to secure the well-being of the nation.

AHPS priorities are to sustain current NWS hydrological services, deliver more precise forecasts with magnitude and certainty of occurrence information, leverage collaborative research to infuse new science and provide better water forecasting products and information for more informed decision making to benefit the public and the Nation's commerce. Through AHPS, the NWS will deliver:

- ***Better forecast accuracy*** **–** by incorporating new verified science into hydrologic modeling operations and more effectively coupling atmospheric and hydrologic models and forecast information on all time scales.

- ***More specific and timely information on fast-rising floods*** **–** by using tools which make it easier to: (a) rapidly identify small basins affected by heavy rainfall, identify excessive runoff locations, and predict the extent and timing of the resulting inundation, and (b) forecast the impacts of dam failures.

- ***New types of forecast information*** **–** by incorporating new techniques for quantifying forecast certainty and conveying this information in products which specify the probability of reaching various water levels.

- ***Longer forecast horizons*** **–** by regularly issuing hydrologic forecast products and information covering one to two weeks into the future and beyond.

- ***Easier to use products*** **–** by delivering information in new and easier to understand formats, including graphics.

- ***Increased, more timely, and consistent access to products and information*** **–** through the expanded use of advanced information and communications technologies.

- ***Expanded outreach*** **–** by engaging partners and customers in all aspects of the hydrologic services improvement effort.

AHPS will provide a comprehensive set of tools and information in the following areas to help decision makers make informed decisions.

1. Short- to long-term probabilistic forecasts including low-flow and drought information
    - Short-term 1-5 days
    - Medium-term 6-14 days
    - Long-term monthly and seasonal
2. Flash-flood services
3. Flood-forecast mapping at Selected locations

AHPS Implementation Strategy

AHPS forecasting services will be provided to customers as “Basic,” “Enhanced” and “Partnered” services. This approach allows the NWS to provide immediate benefit to its customers and increase those benefits with the parallel development and implementation of new (verified) science into operations. AHPS forecasting services will be provided to customers as “Basic,” “Enhanced” and “Partnered” services. These categories of services are defined as:

- Basic services will be provided at all AHPS forecast locations. Basic services are defined as:
    - At flood forecast locations: provide enhanced forecast information including observed and forecast river levels and/or flow, when available, in graphical format, as well as probabilistic forecast information
    - At water supply forecast points: provide water supply volume forecasts in graphical format

- Enhanced services to be implemented at all appropriate AHPS forecast locations.
    - Flash-flood forecasts; or
    - Short- to long-term forecasts which include low-flow and drought information

- Partnered services to be implemented at the most appropriate AHPS forecast locations. The partnered services are financed by both federal and other funding sources such as state and local governments. Partnered services include:
  - Flood-forecast mapping.

Field Services Implementation

River and flood forecasts and probabilistic outlook information are now provided for approximately 3,400 locations. Of these locations, AHPS information was available at 717 locations at the end of Fiscal Year (FY) 2003. By the end of FY 2013, AHPS information will be available for 4,011 forecast locations.

AHPS Implementation Activities & Envisioned Schedule

National implementation of AHPS is currently underway. Research and development of new AHPS features are also underway. Appendix I depicts the schedule for the provision of basic AHPS services and the expansion to additional sites.

AHPS and other NWS hydrologic programs are being integrated into a NOAA hydrologic strategic focus area. NOAA is in the process of incorporating separate component hydrologic programs to produce an integrated capability. The NWS Strategic Plan and management direction clearly demonstrate a commitment to the NOAA corporate initiatives. Recently, NOAA defined hydrology as a priority to help achieve its goal for providing better and more integrated information to enhance management of the Nation’s water resources. AHPS is a key component of the NOAA hydrology strategic objectives.

Short – to Long Term Forecast Services

Short-to long term forecast services aim to improve forecast accuracy and provide longer forecast horizons and uncertainty information with easier to use products. Improving forecast accuracy will be accomplished with improved modeling, improved calibration procedures and with distributed hydrologic modeling. Providing longer forecast horizons and uncertainty information will be accomplished with enhancements to the Ensemble Streamflow Prediction system. The end goal is to provide a seamless and consistent probabilistic forecast for all lead times which accounts for all sources of uncertainty at the distributed modeling element scale.

Meteorological Inputs to Hydrologic Forecasting System

The intermediate operational capability is to quantify the forecast uncertainty of all hydrologic forcing inputs including precipitation, temperature, potential evaporation and freezing heights for all forecast lead times at the distributed modeling element scale. The full operational capability is the incorporation of bias and spread corrected hydrologic forcing input ensembles from global and regional models using adequate downscaling processes.

The current National Weather Service River Forecast System supports three modes of operations; a calibration system, a deterministic forecast system, and a probabilistic forecast system. One identified shortcoming is that between the calibration system and the forecasting system NWSRFS uses different sources of data and different processing routines to compute Mean Areal Temperature (MAT). In this way the model is calibrated with MAT data processed in one way and used operationally with MAT processed differently. Another shortcoming of the deterministic forecasting system is the current source for potential evaporation data is becoming obsolete. New methods to estimate potential evaporation must be explored. The current probabilistic forecasting system integrates meteorological forecasts/climate outlooks from NCEP/CPC to adjust the historical temperature and climate time series to generate precipitation and temperature ensembles. However, there are some limitations in the current procedure: the climate time series are too noisy and too sparse to represent properly the probable future events, and the system needs to integrate other available meteorological forecasts, for which the uncertainty needs to be quantified.

The functional requirements outlined below derive a plan to address the shortcomings of both the deterministic and probabilistic meteorological inputs. The deterministic requirements address developing a unified MAT processing system to be used in both calibration and operations and the exploration of satellites as a new data source to estimate potential evaporation. The functional requirements for the probabilistic meteorological inputs are shown in stages. During the first stage, the current procedure will be enhanced by applying a smoothing algorithm to the historical time series in order to get more appropriate climatology forecasts. In the next stage, the system will incorporate the skill of available meteorological forecasts. This process is based on modeling the joint probability distribution of forecasts and observations for each time step for each forecasting point. The probability distribution of future events that may occur for a particular forecast is then derived from the joint distribution and is used to rescale the climatologic forecasts. By rescaling climatologic values, the underlying space-time patterns between any two points and between any two variables (e.g., precipitation and temperature) are preserved. The final stage will be the incorporation of bias- and spread-corrected hydrologic forcing input ensembles from global and regional climate models using adequate downscaling processes. These ensembles may replace the interim ensemble pre-processor outputs of the previous stage.

1. Deterministic Meteorological Inputs
    a. Unify MAT Processing
        i. Develop a unified MAT process to be used in both the calibration system and the operational forecasting system (in both the observed and forecast time horizon).
        ii. Prototype and validate the unified MAT process in an operational setting.
        iii. Implement the unified MAT process into AWIPS operational baseline.
        iv. Document operational unified MAT process.
        v. Train RFC staff on the operational unified MAT process.
    b. Improved Potential Evapotranspiration estimation
        i. Investigate and validate the use of satellite based estimates of surface net radiation to improve forecast model estimates of potential evaporation
        ii. Implement satellite derived estimates of potential evaporation into AWIPS operational baseline
        iii. Document operational satellite derived estimates of potential evaporation.
        iv. Train RFC staff on the operational satellite derived estimates of potential evaporation.
2. Probabilistic Meteorological Inputs
    a. Create seamless (1 hr – 365 days) precipitation and temperature ensembles that remove the climatological noise and allow for long term climate adjustments.
        i. Develop calibration procedures for smoothed climatology across all time horizons. (Complete)
        ii. Develop ensemble generation procedures for smoothed climatology across all time horizons allowing for long term climate adjustments. (Complete)
        iii. Develop prototypes and validate calibration and ensemble generation components of using smoothed climatology. (Ongoing)
        iv. Implement calibration and ensemble generation of smooth climatology into operations. (Ongoing)
        v. Document operational calibration and ensemble generation processes using smoothed climatology. (Ongoing)

vi. Train RFC staff on operational methods and procedures to remove climatological noise in seamless precipitation and temperature ensembles.

b. Incorporate the skill of the short term precipitation (QPF) and temperature (QTF) meteorological forecasts into the ensembles generated with removed noise.
    i. Develop calibration procedures to incorporate the skill of the QPF/QTF when the forecast is available into precipitation and temperature ensembles. (Complete)
    ii. Develop ensemble generation procedures that incorporate the skill of the QPF/QTF forecast when the forecast is available into precipitation and temperature ensembles. (Complete)
    iii. Develop prototypes and validate the calibration and ensemble generation components of incorporating the skill of the QPF/QTF forecasts into the precipitation and temperature ensembles. (Ongoing)
    iv. Implement the calibration and ensemble generation procedures which incorporate the skill of the QPF/QTF forecasts into the operational calibration and ensemble generation procedures. (Ongoing)
    v. Document the operational calibration and ensemble generation procedures which incorporate the skill of the QPF/QTF forecasts. (Ongoing)
    vi. Train RFC staff on operational methods and procedures to incorporate the skill of the QPF/QTF forecast into ensembles of precipitation and temperature.

c. Incorporate the skill of the HPC 1-5 day, 6-10 day and 8-14 day meteorological forecasts into the ensembles when QPF/QTF is not available.
    i. Develop calibration procedures to incorporate the skill of the HPC forecast into the precipitation and temperature ensembles.
    ii. Develop ensemble generation procedures that incorporate the skill of the HPC forecast into precipitation and temperature ensembles.
    iii. Develop prototypes and validate the calibration and ensemble generation components of incorporating the skill of the HPC forecasts into the precipitation and temperature ensembles.
    iv. Implement the calibration and ensemble generation procedures which incorporate the skill of the HPC forecasts into the operational calibration and ensemble generation procedures.
    v. Document the operational calibration and ensemble generation procedures which incorporate the skill of the HPC forecasts.
    vi. Train RFC staff on operational methods and procedures to incorporate the skill of the HPC short and medium range forecast into ensembles of precipitation and temperature.

d. Create ensembles for the other hydrologic forcing inputs (potential evaporation, freezing heights…)
    i. Develop calibration procedures to generate ensembles of potential evaporation and freezing heights.

    ii. Develop ensemble generation procedures for potential evaporation and freezing heights.
    iii. Develop prototypes and validate the calibration and ensemble generation procedures for potential evaporation and freezing heights.
    iv. Implement the calibration and ensemble generation procedures of potential evaporation and freezing temperature heights into the operational calibration and ensemble generation procedures.
    v. Document the operational calibration and ensemble generation procedures for potential evaporation and freezing temperature heights.
    vi. Train RFC staff on operational methods and procedures to generate ensembles of other hydrologic forcing inputs.

e. Incorporate the bias and spread corrected hydrologic forcing input ensembles from global and regional climate models using adequate downscaling processes.
    i. Develop adequate downscaling processes to input bias and spread corrected hydrologic forcing input ensembles from global and regional climate models. (ongoing)
    ii. Develop prototypes and validate the downscaling process and the use of bias and spread corrected hydrologic forcing input ensembles from global and regional climate models. (ongoing)
    iii. Implement the downscaling process and the use of bias and spread corrected hydrologic forcing input ensembles from global and regional climate models into the operational calibration and ensemble generation procedures.
    iv. Document the operational calibration and ensemble generation procedures for using downscaled bias and spread corrected hydrologic forcing input ensembles from global and regional climate models.
    v. Train RFC staff on operational methods and procedures incorporating the bias and spread corrected hydrologic forcing inputs from global and regional climate models using adequate downscaling processes

f. The ensemble generation procedures above are a function of the lead time of the available forecast data. Develop procedures to ensure smooth transitions between the different ensemble generation procedures.
    i. Develop adequate procedures to ensure smooth transitions between the different ensemble generation methods
    ii. Develop prototypes and validate the procedures to ensure smooth transitions between different ensemble generation procedures.
    iii. Implement the procedures to ensure smooth transitions between the different ensemble generation methods.
    iv. Document the operational procedures to ensure smooth transitions between different ensemble generation methods.
    v. Train RFC staff on the operational procedures that ensure smooth transitions between different ensemble generation methods

g. Create meteorological ensembles at the appropriate distributed modeling scale.

i. Develop calibration procedures for meteorological ensemble inputs at the distributed modeling scale
ii. Develop ensemble generation procedures for meteorological inputs at the distributed modeling scale.
iii. Develop prototypes and validate calibration and ensemble generation procedures for meteorological inputs at the distributed modeling scale.
iv. Implement calibration and ensemble generation procedures for meteorological inputs at the distributed modeling scale into operations.
v. Document the operational calibration and ensemble generation procedures for meteorological inputs at the distributed modeling scale.
vi. Train RFC staff on the operational calibration and ensemble generation procedures for meteorological inputs at the distributed modeling scale.

Hydrologic Forecasting

The operational capability of the hydrologic forecasting system is to quantify all sources of hydrologic forecast uncertainty including initial conditions, model parameter, and model structure uncertainty for all forecast lead times at the distributed modeling element scale.

The National Weather Service River Forecast System (NWSRFS) supports three modes of operation for hydrologic forecasting; the calibration system, the deterministic forecasting system and the probabilistic forecasting system. To support calibration on the distributed modeling scale the calibration system needs to become more streamlined and automated. To improve accuracy of the hydrologic forecasting system and provide forecasts at the distributed modeling element scale, the deterministic forecasting system must be upgraded to the distributed modeling scale. The probabilistic forecasting system must first be used to understand the different sources of hydrologic uncertainty. Finally, the probabilistic forecasting system must be upgraded to account specifically for each source of hydrologic uncertainty including initial conditions, model parameter and model structure uncertainty.

The functional requirements outlined below derive a plan to address the shortcomings of the calibration, deterministic and probabilistic hydrologic forecasting system. The calibration system enhancements include developing new GUIs to streamline the existing calibration system, combining the redundant double mass analysis function in the various preprocessors, providing a link between the interactive calibration program and the automatic calibration procedures, developing automated calibration procedures including a priori parameters, and adapting all calibration procedures to the distributed modeling element scale. The deterministic hydrologic forecasting system enhancements include the steps necessary to implement distributed modeling operational. These steps include lessons learned from the Distributed Modeling Inter-comparison Project (DMIP) and the goals of DMIP II. Additional steps revolve around moving the research distributed model into operations and necessary enhancements to make distributed modeling a viable operational hydrologic modeling system. The probabilistic hydrologic forecasting system enhancements include first a requirement to study the existing lumped hydrologic uncertainty model to understand the significant sources of hydrologic uncertainty. Final requirements include steps to determine individual sources of hydrologic uncertainty such as initial conditions, model parameter and model structure uncertainty.

1. Calibration System
    a. Develop new GUIs to streamline the existing calibration system programs
        i. Develop GUIs to streamline the existing calibration system programs
        ii. Prototype and validate the GUIs to streamline the existing calibration system programs.
        iii. Implement GUIs and enhancements into operations
        iv. Document operational GUIs and enhancements
        v. Train RFC staff on the operational GUIs
    b. Combine the redundant double mass analysis function in MAP, MAT, MAPE, and PXPP
        i. Develop procedures to combine the redundant double mass analysis function in MAP, MAT, MAPE, and PXPP.
        ii. Prototype and validate the procedures to combine the redundant double mass analysis function in MAP, MAT, MAPE, and PXPP
        iii. Implement the procedures to combine the redundant double mass analysis function in MAP, MAT, MAPE, and PXPP
        iv. Document operational procedures that combine the redundant double mass analysis function in MAP, MAT, MAPE, and PXPP.
        v. Train RFC staff on the operational procedures that combine the redundant double mass analysis function in MAP, MAT, MAPE, and PXPP.
    c. Provide a link between the interactive calibration program and the automatic calibration procedures.
        i. Develop procedures to provide a link between the interactive calibration program and the automatic calibration procedures.
        ii. Prototype and validate the procedures to provide a link between the interactive calibration program and the automatic calibration procedures.
        iii. Implement the procedures to provide a link between the interactive calibration program and the automatic calibration procedures.
        iv. Document operational procedures that provide a link between the interactive calibration program and the automatic calibration procedures.
        v. Train RFC staff on the operational procedures that provide a link between the interactive calibration program and the automatic calibration procedures.
    d. Develop multi-objective automatic optimization methods for model parameter calibration
        i. Develop multi-objective automatic optimization methods for model parameter calibration

        ii. Create prototypes and validate multi-objective automatic optimization methods for model parameter calibration
        iii. Implement multi-objective automatic optimization methods for model parameter calibration into operational calibration system
        iv. Document the operational calibration system with multi-objective automatic optimization methods for model parameter calibration
        v. Train RFC staff on the operational calibration system with multi-objective automatic optimization methods for model parameter calibration
    e. Develop Simplified Line Search (SLS) automatic calibration procedures
        i. Develop a Simplified Line Search (SLS) automatic calibration procedures
        ii. Create prototypes and validate the Simplified Line Search (SLS) automatic calibration procedures.
        iii. Implement the Simplified Line Search (SLS) automatic calibration procedures into the operational calibration system
        iv. Document the operational calibration system with the Simplified Line Search (SLS) automatic calibration procedures
        v. Train RFC staff on the operational calibration system with the Simplified Line Search (SLS) automatic calibration procedures
    f. Research and development of a priori values of model parameters
        i. Develop a method to establish a priori values of model parameters
        ii. Create prototypes and validate the method establishing a priori values of model parameters.
        iii. Implement the method to establish a priori values of model parameters into the operational calibration system
        iv. Document the operational calibration system with the method to establish a priori values of model parameters
        v. Train RFC staff on the operational calibration system with the method to establish a priori values of model parameters
    g. Enhance all calibration procedures to be applicable at the distributed modeling scale.
        i. Develop methods for all calibration procedures at the distributed modeling scale
        ii. Create prototypes and validate methods for calibration at the distributed modeling scale.
        iii. Implement the calibration procedures for the distributed modeling scale into operations.
        iv. Document the operational calibration procedures for the distributed modeling scale.
        v. Train the RFC staff on the operational calibration procedures for the distributed modeling scale.
2. Deterministic Hydrologic Forecasting
    a. Distributed Model Inter-comparison Project (DMIP)
        i. DMIP I

        1. Determine if distributed models provide increased simulation accuracy compared to lumped models.
        2. Determine what level of model complexity is required to realize improvement in basin outlet simulation.
        3. Determine what level of effort is required for distributed model calibration. Determine what improvements are realized compared to non-calibrated and calibrated lumped models.
        4. Determine the potential for distributed models set up for basin outlet simulations to generate meaningful hydrographs at interior locations for flash flood forecasting.
        5. Determine what characteristics identify a basin as one likely to benefit from distributed modeling versus lumped modeling for basin outlet simulations? Determine if these characteristics can be quantified.
        6. Determine how research models behave with forcing data used for operational forecasting
        7. Determine what is the nature and effect of rainfall spatial variability in the DMIP basins
    ii. DMIP II
        1. Confirm the results from DMIP 1 with a longer validation period
        2. Expand model comparisons to a Western U.S. basin with significant snow effects.
        3. Expand analysis to include new sources of validation data, particularly use of soil moisture data.
        4. Improve our understanding of uncertainty, in particular the contributions of different model components (inpu, soil moisture accounting, and routing) to overall uncertainty.
        5. Expand comparison to consider forecast mode in addition to simulation mode.

b. Hydrology Lab Research Modeling System (HL-RMS)
    i. Initial Development of HL-RMS
        1. Develop a distributed model using the 4km Hydrologic Rainfall Analysis Project (HRAP) grid as the basic computational element of a basin. In each grid cell, the Sacramento Soil Moisture Accounting model is used to convert rainfall to runoff. Kinematic routing is used in each grid cell and in river channels to move water through the network to the basin outlet. (Complete)
        2. Develop prototypes and validate the HL-RMS at select RFCs
        3. Implement the Distributed Hydrologic Modeling System (DHMS) operationally.
        4. Document the operational version of the DHMS.
        5. Train RFC staff on the operational version of the DHMS.
    ii. Enhance HL-RMS by including distributed frozen ground modeling capabilities

1. Develop distributed frozen ground modeling capabilities to be included in the existing HL-RMS.
2. Develop prototypes and validate the distributed frozen ground modeling capabilities of HL-RMS at select RFCs.
3. Implement the distributed frozen ground modeling capabilities into the operational DHMS.
4. Document the operational version of the DHMS with the distributed frozen ground modeling capabilities.
5. Train RFC staff on the operational version of the DHMS with the distributed frozen ground modeling capabilities.

iii. Enhance HL-RMS by including distributed snow modeling capabilities
1. Develop distributed snow modeling capabilities to be included in the existing HL-RMS.
2. Develop prototypes and validate the distributed snow modeling capabilities of HL-RMS at select RFCs.
3. Implement the distributed snow modeling capabilities into the operational DHMS.
4. Document the operational version of the DHMS with the distributed snow modeling capabilities.
5. Train RFC staff on the operational version of the DHMS with the distributed snow modeling capabilities.

iv. Enhance HL-RMS by including additional routing techniques.
1. Develop additional routing techniques to be included in the existing HL-RMS.
2. Develop prototypes and validate the additional routing techniques of HL-RMS at select RFCs.
3. Implement the additional routing techniques into the operational DHMS.
4. Document the operational version of the DHMS with the additional routing techniques.
5. Train RFC staff on the operational version of the DHMS with the additional routing techniques.

v. Enhance HL-RMS to include alternative distributed rainfall-runoff techniques.
1. Develop alternative distributed rainfall-runoff techniques to be included in the existing HL-RMS.
2. Develop prototypes and validate the alternative distributed rainfall-runoff techniques of HL-RMS at select RFCs.
3. Implement the alternative distributed rainfall-runoff techniques into the operational DHMS.
4. Document the operational version of the DHMS with the alternative rainfall-runoff techniques.
5. Train the RFC staff on the operational version of the DHMS with the alternative rainfall-runoff techniques.

vi. Enhance HL-RMS to include variational streamflow assimilation.

1. Develop variational streamflow assimilation procedures to be included in the existing HL-RMS.
2. Develop prototypes and validate the variational streamflow assimilation procedures of HL-RMS at select RFCs.
3. Implement the variational streamflow assimilation procedures into the operational DHMS.
4. Document the operational version of the DHMS with the variational streamflow assimilation procedures.
5. Train the RFC staff on the operational version of the DHMS with the variational streamflow assimilation procedures.

vii. Parameterization
1. Develop robust parameterization techniques appropriate for the scale of distributed modeling.
2. Develop prototypes and validate the robust parameterization techniques.
3. Implement the parameterization techniques operationally.
4. Document the operational parameterization for distributed modeling.
5. Train the RFC on the operational parameterization for distributed modeling.

viii. Increase spatial resolution of DHMS to agree with improved radar spatial resolution
1. Develop DHMS with increased spatial resolution.
2. Develop prototypes and validate the increased spatial resolution of DHMS.
3. Implement the DHMS with increased spatial resolution
4. Document the operational DHMS with increased spatial resolution.
5. Train RFC staff on the operational DHMS with increased spatial resolution.

ix. Increase temporal resolution of DHMS to agree with improved radar temporal resolution.
1. Develop DHMS with increased temporal resolution.
2. Develop prototypes and validate the increased temporal resolution of DHMS.
3. Implement the DHMS with increased temporal resolution
4. Document the operational DHMS with increased temporal resolution.
5. Train the RFC staff on the operational DHMS with increased temporal resolution.

3. Probabilistic Hydrological Forecasting
   a. Lumped Hydrologic Uncertainty
      i. Study the existing post-processor to determine the following
         1. Quantify the significance of the different sources of hydrologic uncertainties (initial condition, calibrated parameter, and structure errors).

2. Quantify how well the current post-processor accounts for the uncertainties.
3. Recommend improvements to current post processing system

ii. Develop post-processor with recommended improvements identified in 2.a.i.3
iii. Validate post-processor with recommended improvements
iv. Implement post-processor with recommended improvements into operations
v. Document improvements of post-processor
vi. Train RFC staff on the operationally enhanced post-processor.

b. Initial Conditions Uncertainty
   i. Develop a process that explicitly determines the uncertainty of the initial conditions.
   ii. Validate the process that explicitly determines the uncertainty of the initial conditions.
   iii. Implement the process that explicitly determines the uncertainty of the initial conditions operationally.
   iv. Document the operational process that explicitly determines the uncertainty of the initial conditions.
   v. Train the RFC on the operational process that explicitly determines the uncertainty of the initial conditions.
c. Model Parameters Uncertainty
   i. Develop a process that explicitly determines the uncertainty of the model parameters.
   ii. Validate a process that explicitly determines the uncertainty of the model parameters.
   iii. Implement a process that explicitly determines the uncertainty of the model parameters operationally.
   iv. Document the operational process that explicitly determines the uncertainty of the model parameters.
   v. Train the RFC staff on the operational process that explicitly determines the uncertainty of the model parameters.
d. Model Structure Uncertainty
   i. Develop a process that explicitly determines the uncertainty of the model structure.
   ii. Validate a process that explicitly determines the uncertainty of the model structure.
   iii. Implement a process that explicitly determines the uncertainty of the model structure operationally.
   iv. Document the operational process that explicitly determines the uncertainty of the model structure.
   v. Train the RFC staff on the operational process that explicitly determines the uncertainty of the model structure.
e. Hydrologic Uncertainty at the Distributed Model Scale
   i. Develop a process that explicitly determines the hydrologic uncertainty from all sources at the distributed modeling scale.

ii. Validate a process that explicitly determines the hydrologic uncertainty from all sources at the distributed modeling scale.
iii. Implement a process that explicitly determines the hydrologic uncertainty from all sources at the distributed modeling scale operationally.
iv. Document the operational process that explicitly determines the hydrologic uncertainty from all sources at the distributed modeling scale.
v. Train the RFC staff on the operational process that explicitly determines the hydrologic uncertainty from all sources at the distributed modeling scale.

Reservoir, River Regulation and Hydraulic Models

The operational capability for reservoir, river regulation and hydraulic models is to account for the effect of reservoir operations and other river regulations, quantify the uncertainty from reservoir operations and river regulations, and quantify the uncertainty of the initial conditions, parameters and model structure of the hydraulic models used to simulate and forecast reservoir operations and river regulations. Hydraulic models must produce river stage and flow forecasts and uncertainty information at un-gauged points to support probabilistic forecast mapping. Additionally, the ability to use non-NWSRFS reservoir, river regulation and hydraulic models must be realized.

NWSRFS supports three different reservoir and hydraulic models, RES-SNGL, RES-J and FLDWAV. A limitation of these models is the inability to model river regulations. River regulation presents an extremely complex problem, since water withdrawals and returns to streams may be subject to a web of water rights administration rules; the amount to be withdrawn is typically not known ahead of time. Returns to the river and stream/aquifer interaction may be subjected to pumping from the groundwater, etc. These factors typically do not play a role in flood forecasting, but are increasingly important for the cases of normal flow and drought forecasting. Therefore it is clear that the uncertainty from reservoir operations and streamflow regulations will have to be quantified to produce streamflow ensembles. Additionally, enhancements to FLDWAV are needed to allow compatibility with ensemble processing. FLDWAV is computationally intensive. In order to run it operationally within the ESP system, some improvements are needed to obtain a consistent and workable compromise between efficiency and accuracy (e.g., longer time steps, fewer cross sections). Finally, a major limitation of NWSRFS is the inability to ingest non-NWSRFS reservoir, river regulation and hydraulic models. Specifically, the Army Corps of Engineers has significant expertise and resources dedicated to reservoir, river regulation and hydraulic modeling. The NWSRFS must be updated to allow the ingestion of non-NWSRFS models.

The functional requirements outlined below allow for general enhancements to reservoir river regulation and hydraulic modeling in an effort to improve streamflow forecasting accuracy. These enhancements include the ability to model the effects of ice on streamflow hydraulics and the inclusion of river regulation models. Enhancements to probabilistic hydraulic forecasts are included in the requirements for improvements to FLDWAV and the quantifying of hydraulic parameter, model structure and initial conditions uncertainty. There is also a general requirement to open the architecture of NWSRFS to allow the use of non-NWSRFS reservoir, river regulation and hydraulic models.

1. Ice Modeling
    a. Develop methods and procedures to model the effects of ice on streamflow hydraulics
    b. Prototype and validate the methods and procedures that model the effects of ice on streamflow hydraulics
    c. Implement the ice modeling methods and procedures into operations.
    d. Document the operational version of hydraulic models with ice modeling capabilities.
    e. Train RFC staff on the operational version of hydraulic models with ice modeling capabilities.
2. Sediment/Pollutant
    a. Develop methods and procedures to model sediments and pollutants in streamflow hydraulics
    b. Prototype and validate the methods and procedures that model sediments and pollutants in streamflow hydraulics
    c. Implement the sediment and pollutant models into operational hydraulic models.
    d. Document the operational hydraulic models with sediment and pollutant modeling capabilities.
    e. Train RFC staff on the operational hydraulic models with sediment and pollutant modeling capabilities.
3. Reservoir rules (supports Regulated Streamflow accounting)
    a. Develop methods and procedures to account for river water withdrawals and returns that include rules of operation for the flow regulation structure.
    b. Prototype and validate the methods and procedures that account for regulated streamflow.
    c. Implement the regulated streamflow accounting methods into operations.
    d. Document the operational regulated streamflow accounting.
    e. Train RFC staff on the operational regulated streamflow accounting.
4. Improve efficiency and accuracy of FLDWAV for use within the ensemble system.
    a. Develop procedures that will improve the efficiency of FLDWAV without compromising the accuracy.
    b. Prototype and validate the improved FLDWAV procedures.
    c. Implement the improved FLDWAV procedures into operations.
    d. Document the operational FLDWAV with improved efficiency.
    e. Train the RFC staff on the FLDWAV with improved efficiency.
5. Open architecture to allow the use of non-NWSRFS Reservoir, River Regulation and Hydraulic Models
    a. Develop procedures to open the architecture of NWSRFS to allow for use of Army Corps of Engineers reservoir and hydraulic models

   b. Prototype and validate the use of non-NWSRFS hydraulic and reservoir models in the NWSRFS framework.
   c. Implement the use of non-NWSRFS reservoir and hydraulic models into operations.
   d. Document the operational use of non-NWSRFS hydraulic and reservoir models.
   e. Train RFC staff on the operational use of non-NWSRFS hydraulic and reservoir models.

6. Quantify the uncertainty of Reservoir, River Regulation and Hydraulic Models.
   a. Develop methods and procedures to quantify the hydraulic parameter uncertainty.
   b. Prototype and validate the methods and procedures used to quantify the hydraulic parameter uncertainty.
   c. Implement the hydraulic parameter uncertainty methods into operations.
   d. Document the operational hydraulic parameter uncertainty methods.
   e. Train the RFC staff on the operational hydraulic parameter uncertainty methods.

Architecture

To ensure processing integrity and faster science infusion, an architecture management function needs to be developed and implemented for NWSRFS. The purpose of this effort is to standardize data management and delivery (especially crucial for calibration and verification of the uncertainty processors), and to follow a structured development process.

Use cases will be developed to help discover the complete operational requirements and requirements will be documented and used to develop more useable and maintainable software. The architecture management capability will be built on the completed Workflow Management System (WMS) that has demonstrated the ability to easily replace CRON or manual startup of applications, and to provide a flexible workflow configuration and a logging capability to track status of implementations. This architecture management component is essential to control and unite the developments and enhancements of the different ensemble system components.

The functional requirements outlined below describe specific steps to standardize the data management and delivery; develop an architecture management component to control and unite the developments and enhancements to ensemble forecasting and distributed modeling; provide appropriate GUIs to support a seamless system for ensemble forecasting including calibration, ensemble generation, product dissemination and verification; and provide an open architecture to allow the use of non-NWSRFS models.

1. Standardize data management and delivery
   a. Develop procedures to standardize data management and delivery.
   b. Prototype and validate procedures to standardize data management and delivery.

    c. Implement the standardized data management and delivery operationally.
    d. Document the operational standardized data management and delivery.
2. Develop an architecture management component to control and unite the developments and enhancements of the different ensemble system components to provide a seamless ensemble forecasting system that includes calibration, ensemble generation, product dissemination, and verification.
    a. Develop an architecture management component to control and unite the developments and enhancements of the different ensemble system components.
    b. Prototype and validate the architecture management component.
    c. Implement the architecture management component operationally.
    d. Document the operational architecture management component.
3. Provide appropriate GUIs to support a seamless system for ensemble forecasting including calibration, ensemble generation, product dissemination and verification.
    a. Develop appropriate GUIs to support a seamless system for ensemble forecasting
    b. Prototype and validate the developed GUIs.
    c. Implement the developed GUIs operationally.
    d. Document the operational GUIs developed to support a seamless system for ensemble forecasting.
4. Provide an open architecture to allow the use of non-NWSRFS models.
    a. Develop procedures to open the architecture of NWSRFS to allow for use of non-NWSRFS models.
    b. Prototype and validate the use of non-NWSRFS models in the NWSRFS framework.
    c. Implement the use of non-NWSRFS models into operations.
    d. Document the operational use of non-NWSRFS models.
    e. Train RFC staff on the operational use of non-NWSRFS models.

Ensemble Product Generation and Dissemination

The operational capability is to develop, generate, and deliver useful end-products to all customers using the streamflow and streamflow-related ensemble forecasts produced by the ESP system for all lead times at the distributed modeling element scale.

The Ensemble Streamflow Prediction Analysis and Display Program (ESPADP) was initially developed to provide interactive analysis and display of ESP time series. New functionality is needed to provide the forecasters with quality control of ensemble products. Probabilistic forecasts in terms of ensembles require new end-products to be defined and delivered to the customers, especially since the probabilistic forecasts are helpful to numerous decisions based on risk analysis. Training is also required for forecasters and users given the fact that they are familiar with deterministic forecasts. Therefore, scientific training materials (technical documentation, and user’s guides), will be developed to describe all the components of the ESP system and help forecasters and users to use the short- to long-term probabilistic forecasting services in the most effective way.

Conveying the concept of a probabilistic forecast is not a trivial task. The appropriate design of the user interfaces will ensure the success of any product. We will enlist specialists in Human Factors Engineering, specifically a Sociologist to design the most suitable user interfaces.

The functional requirements outlined below provide steps to improve the ensemble product generation and dissemination. These steps include determining what probabilistic information is relevant to end-users; providing the forecaster the ability to quality control ensemble products in real-time; developing appropriate GUIs and tools to assist the forecaster with ensemble product generation, validation, and dissemination; and finally to provide a national web presence for AHPS products.

1. Determine what probabilistic information is relevant to users
    a. Develop procedures to determine what probabilistic information is relevant to users and the most appropriate ways to communicate the information.
    b. Use developed procedures to determine what probabilistic information is relevant to users and the most appropriate ways to communicate the information.
    c. Write a report describing the most relevant probabilistic information for users and the most appropriate ways to communicate the information.
    d. Implement findings into appropriate GUIs to assist in the ensemble product generation and dissemination.
2. Provide ability to quality control ensemble products in real time.
    a. Develop procedures to quality control and validate the voluminous output of ensemble forecasting in operational time
    b. Prototype and validate the procedures to quality control and validate the ensemble forecasts in operational time.
    c. Implement the procedures to quality control and validate the ensemble forecasts in operational time into operations.
    d. Document the operational quality control and validation procedures for the ensemble forecasting system.
    e. Train RFC staff on the operational quality control and validation procedures for the ensemble forecasting system.
3. Develop appropriate GUI to assist in the ensemble product generation, validation and dissemination.
    a. Develop appropriate GUIs to assist in the ensemble product generation, validation and dissemination including the findings from task 1 and 2.
    b. Prototype and validate GUIs that assist in the ensemble product generation, validation and dissemination.
    c. Implement GUIs that assist in the ensemble product generation, validation and dissemination operationally.
    d. Document the operationally GUIs used to assist the generation, validation and dissemination of ensemble products.
    e. Train RFC staff on the use of operationally GUIs used to assist the generation, validation and dissemination of ensemble products.
4. Provide a national web presence for AHPS products.

a. Enhance Web pages by adding new AHPS forecast locations and updating maps
b. Implement HydroGen into AWIPS
c. Implement National Forecast Location Database
d. Implement the first phase of the AHPS Products and Information Team recommendations.

Data Archive

The operational capability is to support and maintain a national archive database to support the verification of probabilistic forecasts at the distributed modeling element scale. The functional requirements described below describe the steps needed to develop this national archive.

1. Determine data needed to support a verification program of probabilistic products.
2. Develop national archive and database procedures to collect the data needed to verify probabilistic forecasts.
3. Prototype and validate the national archive and database procedures to support verification of probabilistic forecasts.
4. Implement national archive and database procedures to support verification of probabilistic forecasts operationally.
5. Document the operational national archive and database procedures.
6. Train RFC staff on the operational national archive and database procedures.

Verification

The operational capability is to provide detailed analytic verification data and tools to forecasters, researchers and developers to improve operational forecasting and provide a rational justification for research and development efforts. The end goal is to provide verification information to the end-user in an effort to build confidence in streamflow forecasts.

The functional requirements outlined below show steps for improving the operational deterministic verification system and steps for developing a probabilistic verification system.

1. Deterministic
    a. Develop methods and procedures to enhance the existing deterministic verification system
        i. Add persistence calculations to verification software
        ii. Add ability to compute metrics for all physical elements to verification software
        iii. Add ability to compute confidence intervals for metrics to verification software.
        iv. Add useful graphics generation to verification software

    v. Add ability to compute "no mod"forecasts to RFS
    vi. Add ability to do RFS hindcasts
  b. Prototype and validate the enhanced deterministic verification system
  c. Implement the enhanced deterministic verification system into AWIPs baseline operations.
  d. Document the operational enhanced deterministic verification system.
  e. Train RFC staff on the operational enhanced deterministic verification system.
2. Probabilistic
  a. Develop methods and procedures to verify probabilistic forecasts
    i. Develop methods and procedures to verify probabilistic forecasts. (Complete)
    ii. Prototype and validate the program ProbVS which verifies probabilistic streamflow forecasts. (Ongoing)
    iii. Enhance the ProbVS prototype to include GUIs and improved error checking.
    iv. Implement the enhanced ProbVS operationally.
    v. Document the operational ProbVS software
    vi. Train RFC staff on the operational ProbVS.
  b. Enhance ProbVS to verify precipitation and temperature ensembles.
    i. Develop methods and procedures to verify precipitation and temperature ensembles with ProbVS.
    ii. Prototype and validate the procedures to verify precipitation and temperature ensembles with ProbVS.
    iii. Implement the ProbVS with precipitation and temperature ensemble verification operationally.
    iv. Document the operational ProbVS with precipitation and temperature ensemble verification.
    v. Train RFC staff on the operational ProbVS with precipitation and temperature ensemble verification.
  c. Add ability to compute metrics from stored espadp tables and observed time series in ProbVS.
    i. Develop methods and procedures to compute metrics from stored espadp tables and observed time series in ProbVS.
    ii. Prototype and validate the procedures to compute metrics from stored espadp tables and observed time series in ProbVS.
    iii. Implement the ProbVS with procedures to compute metrics from stored espadp tables and observed time series operationally.
    iv. Document the operational ProbVS with procedures to compute metrics from stored espadp tables and observed time series.
    v. Train RFC staff on the operational ProbVS with procedures to compute metrics from stored espadp tables and observed time series
  d. Link ProbVS to the IVP to take advantage of all the IVP calculations
    i. Develop methods and procedures to link ProbVS to IVP.
    ii. Prototype and validate the linking of ProbVS and IVP.
    iii. Implement the ProbVS linked with IVP operationally.
    iv. Document the operational ProbVS linked with IVP.

        v. Train RFC staff on the operational ProbVS linked with IVP.
    e. Add graphics of discrimination, reliability, rank histograms, for fixed locations, time and leadtime to ProbVS.
        i. Develop methods and procedures to add graphics of discrimination, reliability, rank histograms, for fixed locations, time and leadtime to ProbVS.
        ii. Prototype and validate the added graphics in ProbVS.
        iii. Implement the ProbVS with added graphics operationally.
        iv. Document the operational ProbVS with added graphics.
        v. Train RFC staff on the operational ProbVS with added graphics.

Training

Workshops, tele-training and class-room training will be provided to support the implementation of new science and technology. This will ensure that those involved in the support and operation of the program have a sound understanding of system enhancements and upgrades.

The training outlined below describes the basic training needed to support the hydrologic forecasting program. This includes training in basic hydrologic sciences, advanced hydrologic sciences, and hydraulic modeling.

1. Basic Hydrologic Science
    a. Develop a basic hydrologic science course for RFC forecasters and WFO Hydrologic Program Managers. The course content should include the scientific background to understand and use hydrologic forecasting models. Specific subject matter should include data processing and quality control, hydrologic and hydraulic modeling, and GIS and flood plain mapping.
    b. Train RFC forecasters and WFO Hydrologic Program Managers the Basic Hydrologic Science course.
2. Advanced Hydrologic Sciences
    a. Develop an advanced hydrologic science course for RFC Development and Operations Hydrologists (DOHs), select RFC forecasters and WFO Service Hydrologists. The course content should include the necessary scientific background to understand and implement advances in hydrologic forecasting models. Specific subject matter should include ensemble forecasting, distributed hydrologic modeling, and precipitation processing.
    b. Train RFC DOHs, select RFC forecasters and WFO Service Hydrologists the Advanced Hydrologic Sciences course.
3. Hydraulic Modeling
    a. Develop a hydraulic modeling course for RFC and WFO personnel. The course content should include the necessary skills required to perform hydraulic modeling.
    b. Train RFC and WFO personnel on Hydraulic Modeling methods.

Flash Flood Services

To meet the forecast challenges posed by flash floods, AHPS provides a comprehensive set of products and information to provide decision makers with more timely and accurate flash-flood predictions. This information will assist in meeting the Government Performance Results Act (GPRA) goals committed to in the NWS Strategic Plan, and presented in the FY 2004 budget. The goals range from 48 minutes lead time with an accuracy of 88% in FY 2004 to 52 minutes lead time with an accuracy of 90% in FY 2008. AHPS also will augment conventional text-based flash-flood warnings and related products, with graphical watch/warning products and information.

Service enhancements will be realized through the use of the Flash-Flood Monitoring and Prediction (FFMP) system which uses flash-flood guidance along with high-resolution quantitative precipitation estimates (QPE) from radar, ground based gauges, and satellites as well as short-term quantitative precipitation forecasts (QPF) to determine areas of flash flooding. Advanced hydrologic models (distributed), dam failure analysis tools, and processing of high resolution geographic information system (GIS) and hydrometeorological data sets will also allow products to include much more detailed information on the location and magnitude of events. New products for additional locations in smaller basins will contain information in the form of numerical forecast values (e.g., stage or water level) or categorical threat levels (e.g., minor, moderate, major). Training for partners and customers as well as NWS personnel will be developed to support the implementation of new science and technology.

Quantitative Precipitation Estimates/Short Term QPF

The operational capability of Quantitative Precipitations Estimates and short term QPF is to provide accurate precipitation estimates and forecasts at the highest spatial and temporal resolution possible for the United States.

Since the employment of the WSR-88D network, radar-based flash-flood prediction has focused on interpreting information from a single radar. This approach was the most logical one when transmission of digital radar information between forecast offices was limited, and limited functionality existed for automatic merging of precipitation information.

Multisensor QPE (MPE) ingests radar, rain gauge, and satellite observations and synthesizes gridded precipitation fields based on input from a combination of these sources. Multisensor QPE estimates are useful in flash-flood applications because they provide forecasters seamless precipitation fields using data from the nearest radar, as well as ancillary data from gauges and satellites.

Requirements to improve rainfall estimation and forecasting for flash flood services fall into six broad categories. The first category is to implement advancements in radar technology including higher resolution data into quantitative precipitation estimation. The second category includes broad enhancements to MPE to improve rainfall estimation.

These enhancements include adding the mountain mapper functionality, adding local de-biasing techniques, adding satellite rainfall estimates, improving speed and efficiency, and increasing the spatial and temporal resolution. The remaining categories include adding a multi-sensor precipitation nowcaster ability to precipitation estimation, quantifying the uncertainty of radar based quantitative precipitation estimation and quantifying the uncertainty of quantitative precipitation forecasts.

1. Upgrade the NEXRAD Pre-Processing System so that it can support multiple new VCPs, negative elevations, higher resolution data from the RDA, and migration to Linux
    a. Develop methods and procedures to upgrade the NEXRAD PPS to support multiple new VCPs, negative elevations, higher resolution data from the RDA, and migration to Linux.
    b. Prototype and validate methods and procedures to upgrade the NEXRAD PPS to support multiple new VCPs, negative elevations, higher resolution data from the RDA, and migration to Linux.
    c. Implement the upgraded NEXRAD PPS to support multiple new VCPs, negative elevations, higher resolution data from the RDA, and migration to Linux operationally.
    d. Generate a complete set of baseline documentation consistent with NEXRAD standards for the upgraded NEXRAD PPS.
    e. Train RFC staff on the operational upgraded NEXRAD PPS.
2. Enhance the Multisensor Quantitative Precipitation Estimates from MPE to support WFO Flash Flood Services.
    a. Enhance MPE to include Mountain Mapper functionality.
        i. Develop methods and procedures to enhance MPE with the Mountain Mapper functionality.
        ii. Prototype and validate the Mountain Mapper functionality in MPE.
        iii. Implement MPE with Mountain Mapper functionality operationally.
        iv. Document the operational version of MPE with Mountain Mapper functionality.
        v. Train RFC staff on the operational version of MPE with Mountain Mapper functionality.
    b. National implementation of local analysis techniques for merging unbiased radar data with gage rainfall data.
        i. Determine the baseline for a national application that will provide to all the RFCs the unique benefits of local analysis techniques for merging unbiased radar data with gage rainfall data realized by individual RFCs.
        ii. Develop the national baseline application of local analysis techniques for merging unbiased radar data with gage rainfall data.
        iii. Prototype and validate the national baseline application of local analysis techniques for merging unbiased radar data with gage rainfall data.

    iv. Implement the national baseline application of local analysis techniques for merging unbiased radar data with gage rainfall data operationally.
    v. Document the operational national baseline application of local analysis techniques for merging unbiased radar data with gage rainfall data.
    vi. Train RFC staff on the operational national baseline application of local analysis techniques for merging unbiased radar data with gage rainfall data.

c. Integrate satellite information into MPE calculations
    i. Develop methods and procedures to integrate satellite information into MPE calculations.
    ii. Prototype and validate the use of satellite information in MPE calculations
    iii. Implement the use of satellite information in MPE calculations operationally.
    iv. Document the operational use of satellite information in MPE calculations.
    v. Train RFC staff on the operational use of satellite information in MPE calculations.

d. Improve speed and efficiency of MPE field generating processing to facilitate more frequent runs, and for time spans shorter than one hour.
    i. Develop methods and procedures to improve speed and efficiency of MPE field generating processing to facilitate more frequent runs and for time spans shorter than one hour.
    ii. Prototype and validate the methods and procedures to improve speed and efficiency of MPE field generating processing to facilitate more frequent runs and for time spans shorter than one hour.
    iii. Implement the methods and procedures to improve speed and efficiency of MPE field generating processing operationally.

e. Provide the forecaster graphical editing tools to quality control and edit the point data and gridded precipitation estimates in order to produce the highest quality point gage data and gridded fields.
    i. Develop graphical editing tools for the forecaster to quality control and edit the point data and gridded precipitation estimates in order to produce the highest quality point gage data and gridded fields.
    ii. Prototype and validate the graphical editing tools for the forecaster to quality control and edit the point data and gridded precipitation estimates.
    iii. Implement graphical editing tools for the forecaster to quality control and edit the point data and gridded precipitation estimates operationally.
    iv. Document the operational graphical editing tools for the forecaster to quality control and edit the point data and gridded precipitation estimates.

        v. Train RFC staff on the operational graphical editing tools for the forecaster to quality control and edit the point data and gridded precipitation estimates.

   f. Increase MPE space/time resolution to 1 degree x 1 km and less than 1 hour precipitation refresh.

        i. Develop methods and procedures to increase the MPE space/time resolution to 1 degree x 1km and less than 1 hour precipitation refresh.
        ii. Prototype and validate the methods and procedures to increase the MPE space/time resolution to 1 degree x 1km and less than 1 hour precipitation refresh.
        iii. Implement the methods and procedures to increase the MPE space/time resolution to 1 degree x 1km and less than 1 hour precipitation refresh operationally.
        iv. Document the operationally MPE with space/time resolution of 1 degree x 1km and less than 1 hour precipitation refresh.
        v. Train RFC staff on the operational MPE with space/time resolution of 1 degree x 1km and less than 1 hour precipitation refresh.

3. Develop Multisensor Precipitation Nowcaster (MPN)
   a. Develop an enhanced version of the Flash Flood Potential (FFP) rainfall nowcasting algorithm to produce short range (0-3 hours) regional, multi-sensor gridded precipitation forecasts using MPE-WFO products.
   b. Prototype and validate the enhanced version of the Flash Flood Potential (FFP) rainfall nowcasting algorithm used to produce short range (0-3 hours) regional, multi-sensor gridded precipitation forecasts.
   c. Implement the enhanced version of the Flash Flood Potential (FFP) rainfall nowcasting algorithm used to produce short range (0-3 hours) regional, multi-sensor gridded precipitation forecasts into AWIPS operational baseline.
   d. Document the operational enhanced version of the Flash Flood Potential (FFP) rainfall nowcasting algorithm used to produce short range (0-3 hours) regional, multi-sensor gridded precipitation forecasts
   e. Train WFO/RFC staff in the operational use of the enhanced version of the Flash Flood Potential (FFP) rainfall nowcasting algorithm used to produce short range (0-3 hours) regional, multi-sensor gridded precipitation forecasts
4. Improve Quantitative Precipitation Estimation Algorithms by including Dual-polarization radar data.
   a. Develop methods and procedures to improve Quantitative Precipitation Estimation with Dual-polarization Radar data.
   b. Prototype and validate methods and procedures to improve Quantitative Precipitation Estimation with Dual-polarization Radar data.
   c. Implement improved Quantitative Precipitation Estimation procedures with dual-polarization radar data into AWIPS baseline operations.
   d. Document the operational Quantitative Precipitation Estimation procedures with dual-polarization radar data.
   e. Train WFO/RFC staff on the operational Quantitative Precipitation Estimation procedures with dual-polarization radar data.

5. Develop Ensemble/Probabilistic Quantitative Precipitation Estimation (PQPE) as a measure of the uncertainty of Quantitative Precipitation Estimation.
    a. Develop methods and procedures to quantify the uncertainty of Quantitative Precipitation Estimations as Probabilistic Quantitative Precipitation Estimation.
    b. Prototype and validate the Probabilistic Quantitative Precipitation Estimation.
    c. Implement the Probabilistic Quantitative Precipitation Estimation operationally.
    d. Document the operational Probabilistic Quantitative Precipitation Estimation.
    e. Train RFC and WFO staff on the operational Probabilistic Quantitative Precipitation Estimation.
6. Provide a measure of uncertainty in the Quantitative Precipitation Forecast.
    a. Develop procedures based on the use of short and medium range ensemble predictions, to quantify the measure of uncertainty in the manually produced HPC 6 and 24-hr forecasts.
    b. Prototype and validate the procedures developed to quantify the measure of uncertainty in the manually produced HPC 6 and 24-hr forecasts.
    c. Implement the procedures developed to quantify the measure of uncertainty in the manually produced HPC 6 and 24-hr forecasts operationally.
    d. Document the operational procedures to quantify the measure of uncertainty in the manually produced HPC 6 and 24-hr forecasts.
    e. Train RFC and WFO staff on the operational procedures to quantify the measure of uncertainty in the manually produced HPC 6 and 24-hr forecasts.

Flash Flood Guidance

Efforts are ongoing at the national, regional and local levels to enhance performance. This includes the need for accelerated development of new techniques for computing FFG. A more scientific approach was outlined by the National Flash-Flood Guidance Improvement Team (FFGIT). The following recommendations were made by the FFGIT:

1. Improve FFG System Performance
    a. Remove threshold runoff information gaps inside a single RFC’s area of responsibility
        i. Develop methods and procedures to remove threshold runoff information gaps inside a single RFC’s area of responsibility.
        ii. Prototype and validate methods and procedures to remove threshold runoff information gaps inside a single RFC’s area of responsibility.
        iii. Implement methods and procedures to remove threshold runoff information gaps inside a single RFC’s area of responsibility operationally.
        iv. Document the operational methods and procedure procedures to remove threshold runoff information gaps inside a single RFC’s area of responsibility.

    v. Train RFC and WFO staff on the operational methods and procedure procedures to remove threshold runoff information gaps inside a single RFC's area of responsibility.

b. Fix overlapping values of FFG along the shared border between neighboring RFCs.
    i. Develop methods and procedures to fix overlapping values of FFG along the shared border between neighboring RFCs.
    ii. Prototype and validate methods and procedures to fix overlapping values of FFG along the shared border between neighboring RFCs.
    iii. Implement methods and procedures to fix overlapping values of FFG along the shared border between neighboring RFCs operationally.
    iv. Document the operational methods and procedures to fix overlapping values of FFG along the shared border between neighboring RFCs.
    v. Train RFC and WFO staff on the operational methods and procedures to fix overlapping values of FFG along the shared border between neighboring RFCs.

c. Fix inconsistent gridded FFG across adjacent RFC boundaries.
    i. Develop methods and procedures to fix inconsistent gridded FFG across adjacent RFC boundaries.
    ii. Prototype and validate methods and procedures to fix inconsistent gridded FFG across adjacent RFC boundaries.
    iii. Implement methods and procedures to fix inconsistent gridded FFG across adjacent RFC boundaries operationally.
    iv. Document the operational methods and procedures to fix inconsistent gridded FFG across adjacent RFC boundaries.
    v. Train RFC and WFO staff on the operational methods and procedures to fix inconsistent gridded FFG across adjacent RFC boundaries.

d. Create Tools to manually edit FFG product before dissemination
    i. Develop tools and procedures to manually edit FFG product before dissemination
    ii. Prototype and validate the tools and procedures to manually edit FFG product before dissemination
    iii. Implement the tools and procedures to manually edit FFG product before dissemination operationally.
    iv. Document the operational tools and procedures to manually edit FFG product before dissemination.
    v. Train RFC and WFO staff on the operational tools and procedures to manually edit FFG product before dissemination.

e. Improve gridded TRO derivation
    i. Develop methods and procedures to improved gridded TRO.
    ii. Prototype and validate methods and procedures to improve gridded TRO.
    iii. Implement methods and procedures to improve gridded TRO operationally.
    iv. Document the operational methods and procedures to improve gridded TRO.

v. Train RFC and WFO staff on the operational methods and procedures to improve gridded TRO.

2. Develop methodologies to improve FFG where land characteristics and rainfall intensity influence the occurrence of flash flooding more than soil moisture. (CBRFC/WR Flash Flood Potential)
    a. Develop methodologies and procedures to estimate the Flash Flood Potential in areas where land characteristics and rainfall intensity influence the occurrence of flash flooding more than soil moisture.
    b. Prototype and validate the methodologies and procedures to estimate the Flash Flood Potential in areas where land characteristics and rainfall intensity influence the occurrence of flash flooding more than soil moisture.
    c. Implement the methodologies and procedures to estimate the Flash Flood Potential in areas where land characteristics and rainfall intensity influence the occurrence of flash flooding more than soil moisture into AWIPS operational baseline.
    d. Document the operational methodologies and procedures to estimate the Flash Flood Potential in areas where land characteristics and rainfall intensity influence the occurrence of flash flooding more than soil moisture.
    e. Train RFC and WFO staff on the operational methodologies and procedures to estimate the Flash Flood Potential in areas where land characteristics and rainfall intensity influence the occurrence of flash flooding more than soil moisture.
3. Develop Archive of critical FFG data
    a. Determine data needed to support a verification program of FFG.
    b. Develop national archive and database procedures to collect the data needed to verify FFG.
    c. Prototype and validate the national archive and database procedures to support verification of FFG.
    d. Implement national archive and database procedures to support verification of FFG operationally.
    e. Document the operational national archive and database procedures.
    f. Train RFC staff on the operational national archive and database procedures.
4. Develop FFG Verification Program
    a. Develop national FFG verification program.
    b. Prototype and validate the national FFG verification program
    c. Implement the national FFG verification program operationally.
    d. Document the operational national FFG verification program.
    e. Train RFC staff on the operational national FFG verification program.

Basin Legacy Support

The National Severe Storms Laboratory (NSSL) provides basin customization technical support; basin data set access and distribution; and redelineation of basins in areas where significant errors exist within individual Weather Forecast Offices (WFOs). This task has been expanded from the radar centric repository to a seamless hydrologically connected national repository of the FFMP basin and stream dataset. It is envisioned that this data set will work in conjunction with the mosaicked data sources of precipitation. This ongoing support of FFMP in the area of basin mapping will continue until the end of FY05.

1. Establish a National Basin Repository of FFMP GIS datasets
    a. Create a seamless hydrologically-connected FFMP basin and stream dataset for the United States, including Alaska, Hawaii, Puerto Rico, and Guam.
    b. Establish a National Basin Repository computer server hardware and communications infrastructure to allow access to the FFMP GIS datasets mentioned above.
    c. Create instructions for users to download data and prepare it for localization in AWIPS. The instructions will also detail how WFOs can incorporate previously customized basins into the files obtained from the national repository.
    d. Disseminate instructions to WFO staff.
    e. Train WFO staff on accessing FFMP GIS datasets through the National Basin Repository.
2. Provide radar centric FFMP Basins GIS datasets
    a. Create radar centric FFMP Basins GIS datasets for CONUS Sites (complete)
    b. Create radar centric FFMP Basins GIS datasets for OCONUS Sites (complete)
    c. Provide radar centric FFMP Basins GIS datasets for new radars as radars are added to the operational network (ongoing)
    d. Enhance radar centric FFMP Basin GIS datasets to include hydrologic connectivity (complete)
    e. Provide Basin Customization documentation and training. (complete)
    f. Provide Basin Customization Support and Data Access (ongoing)
    g. Update Basin Customization scripts from Avenue (supported in ArcView 3.X) to Visual Basic (supported in ArcView 9.0) (ongoing)

Flash Flood Monitoring and Prediction

Enhancements to the FFMP application will use high resolution QPE from radar, gauge and satellites as well as short-term QPF. The following enhancements will be incorporated into FFMP:

1. Provide multiple radar service back up capabilities.
    a. Develop methods and procedures to allow FFMP to ingest non-dedicated radar data.
    b. Prototype and validate the methods and procedures that allow FFMP to ingest non-dedicated radar data.
    c. Implement methods and procedures that allow FFMP to ingest non-dedicated radar data operationally.
    d. Document the operational use of FFMP ingesting non-dedicated radar data

    e. Develop methods and procedures for WFOs to obtain the basin customization data for non-dedicated radar sites.
    f. Prototype and validate methods and procedures for WFOs to obtain the basin customization data for non-dedicated radar sites.
    g. Implement methods and procedures for WFOs to obtain the basin customization data for non-dedicated radar sites operationally.
    h. Document the operational methods and procedures for WFOs to obtain the basin customization data for non-dedicated radar sites.
    i. Train WFO staff on the operational use of FFMP ingesting non-dedicated radar data and methods and procedures for WFOs to obtain the basin customization data for non-dedicated radar sites.
2. Monitor rainfall in FFMP with higher spatial and temporal resolution radar, satellite and gage mosaicked data. Initial assessment with NSSL's National Mosaic QPESUMS (NMQ)
    a. Develop methods and procedures to generate mosaicked, multi-sensor Quantitative Precipitation Estimates at higher spatial and temporal resolution.
    b. Validate the methods and procedures to generate mosaicked, multi-sensor Quantitative Precipitation Estimates at higher spatial and temporal resolution.
    c. Develop methods and procedures to ingest the mosaicked, multi-sensor Quantitative Precipitation Estimates at higher spatial and temporal resolution on the appropriate grid into FFMP.
    d. Protoype and validate methods and procedures to ingest the mosaicked, multi-sensor Quantitative Precipitation Estimates at higher spatial and temporal resolution on the appropriate grid into FFMP.
    e. Implement the generation of high spatial and temporal resolution precipitation data and the ingestion of the data into FFMP operationally.
    f. Document the operational generation of high spatial and temporal resolution precipitation data and the ingestion of the data into FFMP.
    g. Train WFO staff on the operational use of high spatial and temporal resolution precipitation data in FFMP.
3. Integrate QPF into FFMP
    a. Develop methods and procedures to ingest QPF into FFMP.
    b. Prototype and validate methods and procedures to ingest QPF into FFMP.
    c. Implement methods and procedures to ingest QPF into FFMP operationally.
    d. Document the operational ingestion and use of QPF in FFMP.
    e. Train WFO staff on the operational ingestion and use of QPF in FFMP.
4. Add multiple monitoring time frames and thresholds
    a. Develop methods and procedures add multiple monitoring time frames and thresholds.
    b. Prototype and validate methods and procedures to add multiple monitoring time frames and thresholds.
    c. Implement methods and procedures to add multiple monitoring time frames and thresholds operationally.
    d. Document the operational use of multiple monitoring time frames and thresholds.

    e. Train WFO staff on the operational ingestion use of multiple monitoring time frames and thresholds.
5. Enable multiple user-selectable inputs (e.g. DHR, MPE)
    a. Develop methods and procedures within FFMP to ingest multiple precipitation data input and allow the user to select the appropriate data input for monitoring their area of interest.
    b. Prototype and validate the methods and procedures within FFMP to ingest multiple precipitation data input and allow the user to select the appropriate data input for monitoring their area of interest.
    c. Implement the methods and procedures within FFMP to ingest multiple precipitation data input and allow the user to select the appropriate data input for monitoring their area of interest operationally.
    d. Document the operational methods and procedures within FFMP to ingest multiple precipitation data input and allow the user to select the appropriate data input for monitoring their area of interest.
6. Integrate HydroView in D2D

Hydraulic Modeling and Analysis Tool

The operational capability is to provide timely and accurate dam failure forecasts. The following requirements are proposed to automate the existing methodologies and procedures used to generate dam failure forecasts.

1. Develop an application (DamAT) to automate the functionality of DAMCREST, FLDXS and FLDVIEW to provide timely and accurate dam failure forecasts.
2. Quality control critical input data (dam and town location, dam and reservoir information, field boundaries for the dams)
3. Add the current rule of thumb methods used by field offices to DamAT.
4. Add the regression component that is currently in the CBRFC catalog to DamAT as a measure of comparison.
5. Add a BREACH model component to DamAT to improve dam breach parameters.
6. Expand DamAt to include simplified dynamic routing to improve dam failure forecasts.
7. Prototype and validate the automated and enhanced methodologies of DamAT.
8. Implement the DamAT application into operational AWIPS baseline.
9. Document the operational DamAt application.
10. Train RFC/WFO staff on the operational DamAT application.

Site Specific Model

The site specific model, in conjunction with guidance provided by the River Forecast Center (RFC), will provide Weather Forecast Office (WFO) staff the ability to generate short time-step streamflow predictions. For some forecast points, the 6-hour time step forecasts of the NWSRFS are not granular enough to provide timely and specific stream-based warnings of flash flooding to the public. The site specific model operates on smaller basins with one-hour time steps allowing the WFO staff to provide more timely and specific stream-based forecasts and warnings to the public.

The Sacramento Soil-Moisture Accounting (SAC-SMA) rainfall-runoff model is being incorporated into the Site Specific application which uses the Kansas City API rainfall-runoff model. This will allow Site Specific application to be run with a choice of rainfall-runoff models. Beta testing was initiated at the Southeast River Forecast Center (SERFC) for San Juan, Puerto Rico in March, 2004 with full deployment in August, 2004 following AWIPS Release OB4.

Additional work is needed to support operational use of the Site Specific/SAC-SMA. This includes:

1. Software Tools for Model Calibration
    a. Develop software tools to support the model calibration at the 1 hour temporal resolution and smaller spatial resolution of the Site Specific/SAC-SMA model.
    b. Prototype and validate the software tools developed to support model calibration at the 1 hour temporal resolution and smaller spatial resolution of the Site Specific/SAC-SMA model.
    c. Implement the Site Specific/SAC-SMA model software calibration tools into the operational AWIPS baseline.
    d. Document the operational Site Specific/SAC-SMA model software calibration tools.
    e. Train WFO staff on the operational Site Specific/SAC-SMA model software calibration tools.
2. Maintain Model State Variables
    a. Develop methods and procedures to integrate the variational assimilation (VAR) state adjustment function into the Site Specific/SAC-SMA in an effort to maintain proper model state variables.
    b. Prototype and validate the methods and procedures to integrate the variational assimilation (VAR) state adjustment function into the Site Specific/SAC-SMA in an effort to maintain proper model state variables.
    c. Implement the Site Specific/SAC-SMA with variational assimilation into operational AWIPS baseline software.
    d. Document the operational Site Specific/SAC-SMA with variational assimilation.
    e. Train WFO staff on the operational Site Specific/SAC-SMA with variational assimilation.
3. Implement Snow Modeling Techniques
    a. Develop methods and procedures to integrate snow modeling techniques to the Site Specific/SAC-SMA model.
    b. Prototype and validate the snow modeling techniques in the Site Specific/SAC-SMA model.

   c. Implement the Site Specific/SAC-SMA model with snow modeling techniques into the operational AWIPS baseline.
   d. Document the operational Site Specific/SAC-SMA model with snow modeling techniques
   e. Train WFO staff on the operational Site Specific/ SAC-SMA model with snow modeling techniques.
4. Implement Routing Techniques
   a. Develop methods and procedures to integrate routing techniques to the Site Specific/SAC-SMA model.
   b. Prototype and validate the routing techniques in the Site Specific/SAC-SMA model.
   c. Implement the Site Specific/SAC-SMA model with routing techniques into the operational AWIPS baseline.
   d. Document the operational Site Specific/SAC-SMA model with routing techniques
   e. Train WFO staff on the operational Site Specific/ SAC-SMA model with routing techniques.

Statistical Distributed Modeling

The operational capability is to produce flash flood guidance at the distributed model scale in an effort to predict flash flooding particularly at un-gauged locations.

The basic idea of the statistical-distributed modeling approach is to use retrospective distributed model runs as a measure of flood severity for ungauged locations. To implementation this, a distributed model pre-processor would be run using historical archives of gridded Multi-sensor Precipitation Estimates (MPE), then results would be analyzed to establish flood frequency information for each model element (e.g. grid cells or small subbasins). For any model element, simulation results obtained by running the same distributed model in real-time can be compared to the flood frequency information derived for that element. This frequency based approach allows one to establish an objective measure of risk at the many locations where stage-discharge relationships are unavailable.

For model elements where actual flood damage levels are known and observed streamflow data are available, observed flood frequency information can be used to indicate which modeled flood frequencies are of concern in a given area. Both flood frequency statistics and real-time simulations are produced using the same model, so the comparison is useful even when modeled flows are not a perfect match for reality. Because of this, the method can be tested using a-priori model parameter estimates and may provide improvements relative to the current FFG system without requiring a fully calibrated distributed model.

The requirements outlined below identify steps to explore and develop a statistical distributed model to learn if it can produce improved flash flood guidance.

1) Investigate the use of a statistical distributed model as a means to improve accuracy and lead time of flash flood forecasts.
    a. Develop methods and procedures to create simulated flood frequency information for each model element using a distributed model and an archive of historical data.
    b. Develop methods and procedures to use the simulated flood frequency information with distributed modeling to produce flash flood guidance information.
    c. Prototype and validate the methods and procedures to use the simulated flood frequency information with distributed modeling to produce flash flood guidance information. Compare results with the FFG generated from lumped hydrologic models
    d. Develop methods and procedures for the statistical distributed model output to be easily ingested and understood in FFMP.
    e. Implement the statistical distributed model and the enhanced FFMP into AWIPS baseline operations.
    f. Document the operational statistical distributed model.
    g. Train RFC and WFO staff on the operational statistical distributed model.
2) Investigate the use of probabilistic Quantitative Precipitation Estimates with the Statistical Distributed Model to as a means to generate probabilistic FFG.
    a. Develop methods and procedures to incorporate probabilistic Quantitative Precipitation Estimates into the statistical distributed model to produce probabilistic flash flood guidance information.
    b. Prototype and validate the use of probabilistic Quantitative Precipitation Estimates in the statistical distributed model to produce probabilistic flash flood guidance information.
    c. Develop methods and procedures for probabilistic flash flood guidance information to be ingested into and used by FFMP.
    d. Implement the statistical distributed model with probabilistic Quantitative Precipitation Estimates into AWIPS baseline operations.
    e. Document the operational statistical distributed model with probabilistic Quantitative Precipitation Estimates.
    f. Train RFC/WFO staff on the operational statistical distributed model with probabilistic Quantitative Precipitation Estimates.

Flash Flood Data Archiving

The operational capability is to support and maintain a national archive database to support the verification of flash flood forecasts. A limitation of the current flash flood data archive is that there is no national standard for the observation and verification of a flash flood. The functional requirements described below describe the steps needed to develop this analytical national archive.

1. Develop national analytical standards for observation and detection of flash floods.
2. Validate the national analytical standards for observation and detection of flash floods.

3. Implement national analytical standards for observation and detection of flash floods.

Training

Workshops, tele-training and class-room training will be provided to support the implementation of new science and technology. This will ensure that those involved in the support and operation of the program have a sound understanding of system enhancements and upgrades.

The training outlined below describes the basic training needed to support flash flood services. This includes training in GIS, FFG, FFMP, Basin Customization and Flash Flood/Heavy Rainfall.

1. GIS Training
    a. Develop a basic Geographic Information Systems course for RFC forecasters and WFO Hydrologic Program Managers. The course content should include the background to understand and use Geographic Information Systems with regard to hydrology.
    b. Train RFC forecasters and WFO Hydrologic Program Managers the GIS training.
2. FFG Training
    a. Develop a basic hydrologic science course for RFC forecasters and WFO Hydrologic Program Managers. The course content should include the scientific background to understand and use FFG. Specific subject matter should include underlying science and implementation of FFG, strengths and limitations of FFG, how FFG should be used to address flooding in urban areas, how the science and implementation of FFG are advancing.
    b. Train RFC forecasters and WFO Hydrologic Program Managers the FFG training.
3. Flash Flood Monitoring and Prediction (FFMP) Enhancement training
    a. Develop a Flash Flood Monitoring and Prediction (FFMP) Enhancement training for WFO Hydrologic Program Managers. The course content should include the scientific background to understand and use FFMP. Specific subject matter should include underlying science and implementation of FFMP and how the science and implementation of FFG are advancing.
    b. Train WFO Hydrologic Program Managers the FFMP Enhancement training.
4. Basin Customization
    a. Develop Basin Customization training for WFO Hydrologic Program Managers. The course content should include the skills and tools needed to customize high resolution basins that have been delineated for use with the Flash Flood Monitoring and Prediction application included in AWIPS. Specific subject matter provide the trainee skills to identify, create, alter, and redefine basins to better support local flash flooding needs.
    b. Train WFO Hydrologic Program Managers the FFMP Enhancement training.
5. Flash Flood/ Heavy Precipitation Workshop

a. Develop Flash/ Flood/ Heavy Precipitation Workshop for WFO Hydrologic Program Managers. The course content should include flash flood guidance and the hydrometeorology of flash floods. Specific subject matter should include strengths and limitations of flash flood guidance, events which can lead to the onset of flash flooding, the use of the Flash Flood Monitoring and Prediction (FFMP) application as a decision-making tool during heavy precipitation events; and use case studies as training tools.
b. Train WFO Hydrologic Program Managers the Flash Flood/ Heavy Precipitation Workshop.

Flood Mapping and Graphical Dissemination

Flood Mapping and Graphical Dissemination Services are services that add graphics, animation, GIS and possibly other information display techniques to the flood forecast capability. For example, an animation capability will allow an event scenario to be reviewed through the short-, medium-, and long-term forecast horizons as appropriate.

The methodology used to implement flood-forecast mapping services will depend on the need and available resources in an area. This may range from a single sheet map depicting flood inundation areas to real-time flood-forecast maps using advanced hydrologic and hydraulic models with high resolution GIS and hydro-meteorological data sets to include more detail on the location and magnitude of an event.

Graphical E-19s depicting flood stage, minor, moderate and major flooding

Not aware of any efforts in this mapping area

Library of static maps developed at one foot intervals from a one-dimensional, slope area method hydraulic model

Not aware of any efforts in this mapping area

Real time maps generated from a simplified routing model or steady state hydraulic model.

The operational capability is to provide real time maps of flood forecast information from simplified routing models or steady state hydraulic models.

Real-time flood-forecast maps can be generated using water surface profiles from any hydraulic routing model. NWS uses the Simple Hydraulic Routing Technique (SHRT) model. Dam break flood-forecast maps can be generated using output from the Simplified Dam Break (SMPDBK) model.

A flood-forecast mapping application, FLDVIEW will visually display the flood inundation areas at various forecast points. The current technique has been developed and tested on the Juniata River at Lewistown, PA.

1. Simplified Hydraulic Routing Technique to provide water surface elevation for locations not requiring open channel hydraulic flows
2. Simplified Dam Break
3. FLDVIEW

Real time maps generated from a dynamic routing hydraulic model.

The operational capability is to provide real time maps of flood forecast information from dynamic routing hydraulic models.

Real-time flood-forecast maps can be generated using water surface profiles from any hydraulic routing model. NWSRFS supports the use of the dynamic routing model FLDWAV. A flood-forecast mapping application, FLDVIEW will visually display the flood inundation areas at various forecast points. The current technique has been developed and tested on the Juniata River at Lewistown, PA.

The requirements outlined below including testing and evaluating FLDWAV/FLDVIEW at various locations, implementing FLDVIEW into AWIPS baseline operations, steps and procedures to automate some of the data needs for flood inundation mapping and finally to enhance the flood inundation mapping with geographic data layers.

1. FLDWAV/ FLDVIEW Flood Forecast Mapping Evaluations
    a. Susquehanna River, Lewistown, PA
    b. Tar River, NC
    c. Susquehanna River, Harrisburg, PA
    d. Map 1993 Flood, St. Charles, MO
    e. St. Johns River, FL
2. Integrate NWS flood mapping application (FLDVIEW) to provide flood inundation capabilities to all RFC for providing GIS based flood information
3. Automate the procedure of drawing or importing a river centerline using USGS 1:24000 maps, drawing cross sections along a reach, determining elevations along cross sections using ground grids, creating cross-section elevation profiles (FLDXS)
4. Develop FLDIMS to overlay flood inundation shape files over geographic data layers showing aerial photographs, roads, structures, and other relevant information.

Implement the first phases of the AHPS Product and Information Team recommendations for customer demand enhancements to the hydrology program service delivery

The operational capability is to create a national web presence for AHPS products. The AHPS Product and Information Team outlined phases of recommendations for customer demand enhancements to the hydrology program service delivery. The implementation of the first phase is outlined below.

1. Data basing of AHPS web products configuration information
2. Integrate Customer feedback into enhanced river hydrograph
3. Develop NWS strategy for consistent precipitation graphics

Training

Workshops, tele-training and class-room training will be provided to support the implementation of new science and technology. This will ensure that those involved in the support and operation of the program have a sound understanding of system enhancements and upgrades.

The training outlined below describes the basic training needed to support flood mapping and graphical dissemination services. This includes training in GIS.

1. GIS Users Workshop
    a. Develop a basic Geographic Information Systems course for RFC forecasters and WFO Hydrologic Program Managers. The course content should include the background to understand and use Geographic Information Systems with regard to hydrology.
    b. Train RFC forecasters and WFO Hydrologic Program Managers the GIS training.