Appendix A

Summary of Proceedings for the INFORM Oversight and Implementation Committee Meetings

FIRST OVERSIGHT AND IMPLEMENTATION COMMITTEE MEETING
6 October 2003, Sacramento, California

PRESENT:

Agency Representatives

Paul Fujitani,	Central Valley Operations, U.S. Bureau of Reclamation
Robert Hartman,	California Nevada River Forecast Center, National Weather Service, NOAA
Gary Hester,	California Department of Water Resources
Mona Ismail,	GCAP Inc./CALFED (*through a conference call*)
Borden Johnson,	Sacramento District, U.S. Corps of Engineers
Claudia Nierenberg,	Office of Global Programs, NOAA (*through a conference call*)
Joe O'Hagan,	PIER, California Energy Commission
Eric Strem,	California Nevada River Forecast Center, National Weather Service, NOAA

INFORM Co-PIs and INFORM Core Office Staff

Theresa Carpenter,	Hydrologic Research Center
Aris Georgakakos,	Georgia Water Resources Institute
Kosta Georgakakos,	Hydrologic Research Center
Nick Graham,	Hydrologic Research Center
Jason Sperfslage,	Hydrologic Research Center

The meeting was held at the National Weather Service California Nevada River Forecast Center (CNRFC) Conference Room in the Joint Operations Center (3310 El Camino Ave.), started at 1:00PM and ended at 3:45PM. The meeting consisted of two parts. Part I gave a brief overview of the INFORM Progress, status, strategic planning issues and Oversight and Implementation Committee (OIC) mandate, while Part II focused on general INFORM implementation issues. The Meeting was held in a discussion format with the Co-PIs leading it with a set of discussion issues prepared in a power point

format. The presentation material is attached to become part of this Summary of Meeting Proceedings. Tables A-1 and A-2 present the issues discussed.

Important points made during the meeting by OIC Members in response to the issues identified by the Co-PIs are:

1. Current link of CNRFC models with climate information is through the Climate Prediction Center (CPC) probability outlooks; however, CNRFC would like to move toward the utilization of gridded climate information to generate ensemble streamflow.

2. Designing the INFORM system as a standalone system, at least initially, with a mirror image of the hydrologic modeling framework of CNRFC, and with data links to CNRFC and to management agencies is a reasonable approach.

3. Forecaster adjustments to NCEP synoptic-scale atmospheric forecasts will be treated approximately in the INFORM system, which will use NCEP ETA model products to drive the 0-5 days flow forecasts.

4. It is reasonable to assume that downstream concerns (some involving the Bay Delta) may be approximated in an aggregate way as downstream boundary objectives for the system of INFORM reservoirs.

5. The DSS component of the INFORM demonstration plan is envisioned as a "shared" resource by the management agencies.

6. CALSIM has a monthly resolution and it is not expected that within the time horizon of this project there will be a daily-resolution version available for Co-PI use. The code will be made available to the Co-PIs for INFORM.

7. Given the length of time it has taken the contracting process, and to align the tasks and time line of the three funding agencies, it is reasonable to modify the task and deliverables time line with a new critical review date of 1 March 2004.

OIC Members' comments and suggestions, which require Co-PI action are:

1. It is desirable to include an additional CALFED technical person in INFORM OIC

2. Keep fisheries agencies aware of our planning and OIC Meeting Proceedings (identify contacts through OIC Members)

3. The OIC should include an additional representative from the State Water Project (Gary Hester, member of OIC, will provide a contact person for the Co-Pis)

4. The INFORM implementation plan should be augmented to include the New Bullards Bar Dam on the Yuba River and the Black Butte Dam on Stony Creek, as they significantly contribute to the regulation of the tributary waters of the Sacramento River.

5. OIC should include an additional representative from the Yuba County
6. California Nevada River Forecast Center (CNRFC) Staff and INFORM Co-PI's should approach the National Centers for Environmental Prediction (e.g., Experimental Modeling Center) for the development of a link between CNRFC databases and climate and synoptic scale forecast products and retrospective run output.
7. INFORM Co-PI's and CNRFC Staff should contact Climate Diagnostics Center (CDC) to see if we can utilize their developing work on building a 14-day retrospective forecast database.
8. INFORM Co-PI's will work with CNRFC to finalize the historical hydrometeorological database to be used in INFORM for various calibration and validation tasks.
9. Maximum forecast lead-time for ensemble streamflow forecasts should be one year.
10. The Co-PIs will work with the California Department of Water Resources (DWR) and U.S. Bureau of Reclamation OIC contacts to define the link between the Bay Area management objectives with the objectives of the INFORM reservoirs.
11. After initial discussions with management agency the INFORM Co-PIs will generate a template decision support system design for review by OIC.
12. INFORM Co-PIs will work with DWR OIC member to determine the status and availability of CALSIM codes for use in INFORM.
13. Workshops have been identified as important components of the INFORM project and should be planned far in advance to allow wide participation by the forecast and management Agencies.
14. The INFORM Core Office will establish a secure web site for the exchange of data and information among OIC members and Co-PIs. Pre-approval of all publications by the OIC will be sought.
15. The INFORM Co-PIs will develop a new time line for tasks and deliverables for submission to the three funding agencies (NOAA, CEC, and CALFED).

Table A-1. Part I, INFORM Strategic Planning

Vision Statement

Increase efficiency of water use in Northern California using climate, hydrologic and decision science

Goal and Objectives

Demonstrate the utility of climate and hydrologic forecasts for water resources management in Northern California

Implement integrated forecast-management systems for the Northern California reservoirs

Perform tests with actual data and with management input

Application Area

Integrated System Design

Demonstration Concept

Work Accomplished

Feasibility studies for Folsom with historical data show benefits to management

Contracts in place (NOAA, CEC, CALFED)

Oversight and Implementation Committee in place

Initial technical phase of INFORM in progress

- Downscaling for precipitation

- Hydrologic/Uncertainty Modeling

- Decision Modeling

Folsom System

Time Line of Deliverables

Implementation Strategy

Link climate and weather forecasts of precipitation and temperature to hydrologic models

Link decision models with forecasts and downstream objectives to assess alternative policy options

Run integrated forecast-decision system for selected cases with management input to assess performance

Order of implementation: from individual reservoirs to the four-reservoir system (Folsom, Oroville, Shasta, Trinity)

Collaborative workshops

Oversight and Implementation Committee (OIC)

Provides strategic advice to INFORM Co-PIs on project direction

Provides assistance in the implementation of demonstration project

- Issues that cut across agency mandates

- Issues that influence implementation strategy, plans and timing

Develops collaboration protocol for specific technical issues

Assists Co-PIs in developing and executing the demonstration plan

Meets 2 times per project year and, as required, through an electronic forum

INFORM Core Office

Provides administrative assistance to INFORM Co-PIs and collaborating Agencies

Generates informational printed and web-site material, general interest meeting reports and announcements

Staff

- Kosta Georgakakos, HRC

- Theresa Carpenter, HRC

- Corinne Rice, HRC

Implementation Issues for First OIC Meeting

CNRFC Links to NCEP and climate/weather models

Reservoir management objectives for INFORM

Downstream simulation model (CALSIM-type)

Software/platform/database and links to operations

Collaboration and workshop plans

Follow-on to First OIC Meeting

Meeting Report

Development of any necessary modifications to INFORM Project tasks and timeline, and submission to Funding Agencies for approval

Table A-2. Part II, INFORM Implementation Issues

Implementation Issues for 1st Meeting

Software/platform/database and links to operations

- Hourly Precipitation Data

- Daily Precipitation Data

- Daily Temperature and Pan Data

- Snow Data

- Streamflow Discharge

CNRFC links to NCEP's climate and weather models

Forecast Model and Data

Forecast models and model-specific bias-adjustment algorithms available for quasi-operational use

Availability of retrospective simulation and forecast data

Reliable flow of consistent real-time forecast products

Links to NOAA NCEP (e.g., Experimental Modeling Center)

Climate Forecast Data

Fields: Prec, 10m T, (U, V, T, Q, H, at 700mb and 850mb)

Archive all received from NCEP CMB

Maximum lead time: at least 3 months

Retrieve and store these fields from any retrospective runs (forecast or AMIP) from current version of model

Synoptic Forecast Data

ETA 48 km (12 km?) and GFS

Fields: U, V, T, Q, H (necessary to run dynamic / statistical downscaling models) – Archive all

Request forecast data from NCEP (GFS, ETA 12 km)

Issues to resolve:

What is the relationship of INFORM system to CNRFC models and databases?

Can ensemble weather and climate forecasts be accommodated by CNRFC operational systems?

How do we acquire historical weather and climate (ensemble) forecasts? NCEP as a partner in this effort.

Should we represent Forecaster adjustments to weather and climate forecasts in INFORM?

Decision Support for Drought Forecasting, Assessment, and Management

Decision Support for Flood Forecasting, Assessment, and Management

Integrated Decision Support for Drought and Flood Management

Issues to resolve for reservoir management

Water uses impacted by reservoir management

- Water use type and geographic area

- Relevant Hydrologic Quantity (level, stage, discharge, volume)

- Applicable Time Scale (inter-annual, seasonal, monthly, weekly, daily, hourly)

- Reservoir(s) Involved (water use aggregation where applicable)

- Competing Water Uses (by reservoir and system-wide; information format)

Agencies/NGOs involved – DSS made operational

-Relevant Agencies/NGOs by Water Use and Reservoir

- Operational Process during Droughts, Floods, and Normal Periods

- DSS Demonstration Plan (Distributed? Centralized? Shared?)

Downstream simulation model

Which downstream objectives should we include in INFORM?

Temporal resolution of CALSIM

Links to CNRFC's Downstream Models

Computer code availability

Collaboration and workshop plans

Protocol for collaboration

- Agency contact persons for technical matters for each basin and reservoir

- INFORM Core Office web site for exchange of data, discussion, progress reports and graphics/results

Informational and Training Workshops in Technical Areas (1 per year)

SECOND OVERSIGHT AND IMPLEMENTATION COMMITTEE MEETING

14 April 2004, Sacramento, California

PRESENT:

Agency Representatives

Marchia Bond,	Sacramento District, U.S. Corps of Engineers
Robert Collins,	Sacramento District, U.S. Corps of Engineers
Rebecca Fris,	CALFED (*through a conference call*)
Paul Fujitani,	Central Valley Operations, U.S. Bureau of Reclamation
Robert Hartman,	California Nevada River Forecast Center, National Weather Service, NOAA
Gary Hester,	California Department of Water Resources
Mona Ismail,	GCAP Inc./CALFED (*through a conference call*)
Juniper Neill,	Office of Global Programs, NOAA
Joe O'Hagan,	PIER, California Energy Commission (*through a conference call)*
Eric Strem,	California Nevada River Forecast Center, National Weather Service, NOAA

INFORM Co-PIs and INFORM Project Scientists

Aris Georgakakos,	Georgia Water Resources Institute
Kosta Georgakakos,	Hydrologic Research Center
Nick Graham,	Hydrologic Research Center
Huaming Yao,	Georgia Water Resources Institute

The meeting was held at the National Weather Service California Nevada River Forecast Center (CNRFC) Conference Room in the Joint Operations Center (3310 El Camino Ave.), started at 11:30AM and ended at 1:30PM. The meeting served as the first critical review meeting for INFORM, mandated by the California Energy Commission and

CALFED funding agencies. Summary documents were submitted to the participants prior to the meeting by the INFORM Core Office Staff.

The meeting presentations were made in two parts. Part I consisted of a summary of the INFORM goals, and the work accomplished, as well as for highlighting strategic planning issues, while Part II focused on a demonstration by the Georgia Water Resources Institute (GWRI) Staff of the first version of the reservoir decision support software for Folsom and Oroville. Table A-3 presents the issues discussed in Part I, followed by a summary of the main comments made. This is followed by short summary of the capabilities of the software demonstrated in Part II and of the pertinent comments and suggestions made.

Important points made during Part I of the meeting by OIC Members in response to the issues identified by the Co-PIs are:

1. Stakeholder input significant for the final design of the decision component; Rebecca Fris provides input to the GWRI team for the upcoming stakeholder workshop of May 2004.

2. Upstream reservoirs (e.g., French Meadows and Union Valley within the Folsom watershed and Lake Almanor in the Oroville watershed) are being modeled as part of the CNRFC operations, and the USA Corps of Engineers has inflow and outflow historical data for such modeling efforts. INFORM PIs should consider incorporating this modeling effort even though it was not part of the original INFORM plan. Historical inflow and outflow data from these upstream reservoirs, when existing, can help define an "average management strategy" to be incorporated in the long-range hydrologic forecasts of the downstream larger reservoirs. Alternatively, full decision modeling of these upstream reservoirs may be done incorporating the uncertainty in the management strategy for long-range forecasts.

3. CNRFC Staff and the HRC modeling team should coordinate the request to NCEP for Global Forecast System (GFS) data.

4. DSS component should be released to agencies after the first version is finalized for gaining hands-on experience and for providing feedback to developers regarding the functions and graphical user interface.

The current version of the decision support system for Folsom and Oroville includes a suite of interlinked models that is capable for inflow forecasting and reservoir management at hourly, daily, and seasonal time scales. Hourly, daily, and seasonal reservoir management is addressed through three coupled models: turbine load dispatching, hourly release management within one day, and daily release management within a user specified time seasonal horizon (e.g., 3 months). The purpose of these models is to optimize the efficiency of energy generation while conserving water and meeting all relevant water resources requirements including flood protection, water

supply, drought management, and environmental protection. The DSS is embedded within a user-friendly, graphical interface that links models with data and helps visualize and manage results. A policy assessment model has also been developed and incorporated within the DSS to assess the value and implications of various forecasting schemes, reservoir management policies, and demand scenarios. The demonstration of the decision support system software developed by GWRI showed the following software capabilities:

1. User-data-model interface for data visualization and data management using Excel spreadsheets and MS Access and with user-friendly graphical menus based on visual basic
2. It is designed to run individual reservoirs or system wide.
3. Provides reservoir managers with a variety of quantitative measures that show the effect of various decision policies.
4. Incorporates a baseline ensemble forecasting component and provision for links to the INFORM climate-hydrology ensemble forecasts.
5. Allows the consideration of decisions on different time scales in an objective, consistent and quantitative manner.
6. Allows adaptive operation with decisions updated as frequently as desired.

The discussion that followed the presentation brought up the following comments made by participant agencies:

1. The current version of the decision support system shows promise as a very good tool for exploring the effects of decisions by several stakeholder groups and over different time scales (short term versus long term decisions).
2. A decision must be made to resolve the design trade-off issue of modeling a few large reservoirs in the region in great detail versus focusing on large scale interactions in decision making among all the INFORM reservoirs but with simplifying assumptions as to the decision parameters for each of these reservoirs. A solution to this trade-off issue that could be accommodated within the present funding and performance-time scope of the present INFORM project was considered: to proceed with the integration of all the INFORM reservoirs as originally planned with simplifying assumptions agreed upon by the forecast and management agencies (e.g., what downstream requirements to incorporate, etc.), and at the same time to focus in greater detail in one of these reservoirs for detailed modeling in collaboration with the management agencies of that reservoir. Further discussions will be held between the INFORM team and the participating staff of forecast and management agencies to find a mutually agreeable system configuration and level of modeling detail.

Table A-3. Part I, INFORM Strategic Planning

AGENDA FOR SECOND OIC MEETING

- Part I – Project Status Review

  (Climate – Hydrology – Decision)

- Part II – Demonstration of Reservoir Decision Support Software

  (Folsom and Oroville)

VISION STATEMENT

- Increase efficiency of water use in Northern California using climate, hydrologic and decision science

GOAL AND OBJECTIVES

- Demonstrate the utility of climate and hydrologic forecasts for water resources management in Northern California
- Implement integrated forecast-management systems for the Northern California reservoirs
- Perform tests with actual data and with management input

APPLICATION AREA

INTEGRATED SYSTEM DESIGN

DEMONSTRATION CONCEPT

WORK ACCOMPLISHED

- Coordination and Initial Design of the Weather and Climate Ingest Component
- Design, Implementation and Validation of Precipitation Downscaling Component
- Validation of Operational CNRFC Snow and Hydrology Models for American and Feather Rivers
- Design and Implementation of Stand Alone Ensemble Flow Forecast System for Folsom and (in progress) for Oroville
- Design and Implementation of Decision Support System for Folsom and Oroville Reservoirs

FOLSOM SYSTEM REFERENCE

TIME LINE OF DELIVERABLES

FOLLOW-ON TO 2ND OIC MEETING

- Meeting Report
- Development of any necessary modifications to INFORM Project tasks and timeline, and submission to Funding Agencies for approval
- Continued Agency and Co-PI collaboration by implementation task

CLIMATE COMPONENT

- Reliable probabilistic estimates of observed rainfall categories
- Snowmelt forecasts on the basis of NCEP forecast winds and temperature
- Collaborative activities between HRC, CNRFC and NCEP
- Initial plan of stand-alone climate-downscaling operations
- Validation of orographic downscaling precipitation component for Folsom

HYDROLOGY COMPONENT

- INFORM data inventory status
- Validation of NWS operational hydrologic simulations for Folsom drainage and sub-catchments (climatology, distributional characteristics, event simulations, snowpack)
- Validation of NWS operational hydrologic simulations for Oroville drainage and sub-catchments (climatology, distributional characteristics, event simulations, snowpack)
- On-going hydrologic activities for Folsom and Oroville

DECISION COMPONENT

- Outline of Tasks planned for the Decision Component of INFORM
- Reservoir data for decision support system models
- Description of short- and mid-range decision models
- Examples of short- and mid-range decision models for Folsom and Oroville
- Policy assessment model for Folsom and Oroville and examples
- Graphical user-model DSS interface overview
- Technical workshop for stakeholder agencies and users

THIRD OVERSIGHT AND IMPLEMENTATION COMMITTEE MEETING OF THE INFORM PROJECT

18 April 2005, Sacramento, California

PARTICIPANTS

Agency Representatives

Gary Bardini,	California Department of Water Resources
Robert Collins,	Sacramento District, U.S. Corps of Engineers
Pete Fickenscher,	California Nevada River Forecast Center, National Weather Service, NOAA
Josh Foster	NOAA Office of Global Programs (*through a conference call)*
Paul Fujitani,	Central Valley Operations, U.S. Bureau of Reclamation
Robert Hartman,	California Nevada River Forecast Center, National Weather Service, NOAA
Arthur Hinojosa,	California Department of Water Resources
John King,	California Department of Water Resources
Aaron Miller,	California Department of Water Resources
Claudia Nierenberg	NOAA Office of Global Programs (*through a conference call)*
Joe O'Hagan,	PIER, California Energy Commission
David Parker	California Department of Water Resources
Brendan Reed	California Bay-Delta Authority
Eric Strem,	California Nevada River Forecast Center, National Weather Service, NOAA

INFORM Co-PIs and INFORM Project Scientists

Theresa Carpenter	Hydrologic Research Center
Aris Georgakakos,	Georgia Water Resources Institute
Kosta Georgakakos,	Hydrologic Research Center
Nick Graham,	Hydrologic Research Center
Martin Kistenmacher,	Georgia Water Resources Institute
Huaming Yao,	Georgia Water Resources Institute

LOCATION AND TIME

The meeting was held at the National Weather Service (NWS) California Nevada River Forecast Center (CNRFC) Conference Room in the Joint Operations Center (3310 El Camino Ave.) on the 18th of April 2005. It started at 1:00PM and ended at 4:30PM.

PURPOSE AND INFORMATIONAL MATERIAL

The meeting served as a second critical review meeting for INFORM (Integrated Forecast and Reservoir Management), mandated by the California Energy Commission and CALFED funding agencies. Summary documents were submitted to the participants prior to the meeting by the INFORM Core Office Staff. A detailed INFORM Phase 2 Report was distributed to the meeting participants and was made available at the HRC web site: http://www.hrc-lab.org. The meeting consisted of the presentation of the INFORM project status by the Co-PIs, followed by an open discussion of the issues and strategies for the INFORM implementation completion and demonstration assessment design. The PDF forms of the meeting presentations are available at the aforementioned HRC web site.

INFORM STATUS PRESENTATION

The principle items discussed during the INFORM status presentation are listed in Table A-4. Pressing issues are: *(a)* the availability of climate forecast system high-resolution data from the NOAA/NWS National Centers of Environmental Prediction (NCEP); and *(b)* the availability of remaining reservoir information for the completion of the design of the reservoir management component for the entire INFORM region. A short summary of the first issue and suggested solutions are presented in Table A-5. It was agreed to pursue the high resolution climate data availability through May. If the high resolution data is not made available by that time to implement a statistical downscaling methodology that utilizes monthly climate forecast information that is currently available from NCEP. With respect to the second issue and as part of this OIC meeting, participating operational management agencies agreed to provide the remaining reservoir management information. Lastly, the INFORM PI reminded the OIC participants that INFORM is a five year project as proposed and it now enters the third year (last currently funded year of the project). The INFORM team within the next few months will provide funding agencies continuation/amendment proposals for the completion of the demonstration phase of the project (2 additional years).

DISCUSSION

After the INFORM status presentations, group discussion followed. An important issue discussed was the appropriate balance in depth versus breadth of the INFORM decision support system in view of the remaining project time—one year. With the incorporation of the Bay Delta in the long range planning model, the scope of the original project (demonstration of value of uncertain climate/hydrology forecasts for Trinity, Shasta, Oroville, and Folsom) has significantly expanded to encompass a more realistic

representation of the physical system in the INFORM region and associated management issues. While the project could proceed to incorporate more system and management details, it was felt that a strategy aiming to demonstrate the value of the integrated prediction-decision system using the existing models should take precedence. The following important points were made during the discussion.

1. Rob Hartman mentioned that (as agreed upon during the First INFORM OIC Meeting) the INFORM implementation plan should be augmented to include the New Bullards Bar Dam on the Yuba River and the Black Butte Dam on Stony Creek, as they significantly contribute to the regulation of the tributary waters of the Sacramento River. The GWRI team stated that this enhancement is planned in the next few months.

2. Bob Collins mentioned that it may also be important to model some of the more important smaller reservoirs (e.g., French Meadows and Union Valley within the Folsom watershed and Lake Almanor in the Oroville watershed) for the short term management operations in the region. The GWRI team will need additional information for this modeling effort and will consider the feasibility of modeling them within the remaining time frame of the project.

3. Paul Fujitani expressed concern for the ability of the INFORM project to fully capture the breadth and depth of required modeling of the water management operations in view of the project time frame, and he suggested focusing perhaps on regional long-term decisions rather than both short- and long-term decisions. Art Hinojosa offered that perhaps we can focus on years of a specific type for demonstration purposes. The INFORM development team acknowledged that the issue of breadth versus depth for INFORM is important and that the linkage of long and short range models and decisions under uncertain forecasts that has already been accomplished is a good basis for demonstrating the value of forecast information in the management of the INFORM system. It was agreed that a demonstration strategy should be developed to illustrate the value of the prediction-decision system for long range planning and mid/short range management.

4. Gary Bardini suggested that the INFORM remaining effort should address the following issues: *(a)* resolve the remaining links between climate and hydrology data and forecasts; *(b)* complete the decision model with all agreed upon components for the demonstration effort; *(c)* develop a demonstration strategy with OIC input; *(d)* identify the INFORM components that may directly add value to current operational tools for operational implementation, *(e)* perform a case-by-case assessment of benefits and risks. The group concurred with these suggestions and the INFORM development team recommended (and the OIC members concurred) that the development of the demonstration strategy must be carried out as soon as possible as it may dictate additional model modifications that would be required to address, for example, longer term regional benefits

from seasonal forecasts, or shorter term benefits during reservoir filling for specific sub-systems. It was suggested that another OIC meeting be convened at the end of May or early June to develop the demonstration strategy.

5. Along the lines of demonstration strategy, Rob Hartman suggested that along with average forecast benefits, benefits accrued during extreme events also be evaluated, and an assessment be made of the circumstances for which the INFORM prediction-decision approach would benefit system management. The INFORM development team concurred that this type of analysis should be an integral part of the demonstration strategy discussion.

6. The GWRI team also emphasized that the INFORM DSS is not intended to replace existing tools; rather, it is an additional tool that can screen a wide range of management strategies and identify a set to be evaluated by other more detailed models currently being used.

Table A-4: List of Items of INFORM Project Status Presentation

Meeting Agenda

- Project Status Review – Phase 2
  - Climate
  - Hydrology
  - Decision
- Tomorrow (4/19/05) – Workshop on Decision Support System

Vision Statement

- Increase efficiency of water use in Northern California using climate, hydrologic and decision science

Goal and Objectives

- Demonstrate the utility of climate and hydrologic forecasts for water resources management in Northern California
- Implement integrated forecast-management systems for the Northern California reservoirs using real-time data
- Perform tests with actual data and with management input

Application Area

Integrated System Diagram

Demonstration Concept

Work Accomplished in Phase 2

- Design and tests of GFS ingest component and links to downscaling components
- Regional Validation of Precipitation Downscaling Component
- Design, Implementation and Tests of Temperature Downscaling Component
- Validation of INFORM Forecast System Hydrologic Forecast Component for the Major Reservoir Drainage Areas
- Development and Testing of a Monthly Simulation and Planning Model for the Entire INFORM Region

Refereed Publications

Follow-on to 3rd OIC Meeting

- Meeting Report

- Development of any necessary modifications to INFORM Project tasks and timeline, and submission to Funding Agencies for approval
- Continued Agency and Co-PI collaboration by implementation task

Climate and Weather Components

Major Issues

- Availability of Climate Forecast Model (CFM) twice-daily forecasts and hindcasts – National Centers of Environmental Prediction (NCEP)
- Global Forecast System (GFS) downloads from NCEP servers

Status of Issue resolution - CFS

- NCEP Director indicated that NCEP will review the climate data status and will inform the Co-PIs of twice-daily climate data availability in the near future
- Co-PI's are considering the implementation of an alternative based on the use of monthly CFS ensemble forecasts.

Status of Issue Resolution - GFS

- Systems administrator for NCEP servers and HRC's system administrator are upgrading file transfer software to facilitate real-time downloads
- HRC is implementing complex download software to assure receipt of all available files

INFORM System Climate and Weather Data Components and Links

GFS Driven Mean Areal Precipitation: Software Tests

Precipitation and Temperature Downscaling - Domain

Precipitation Downscaling – Regional Validation

Precipitation Downscaling – Performance Measures

Temperature Downscaling - Model

Temperature Downscaling - Tests

Hydrology Component

INFORM Region and Major Basins

Distributed Tributary Basin System for Oroville – Example for INFORM Hydrology Modeling

Oroville Parameter Files – An Example

Overall Hydrology Model Performance Statistics

Examples of Hydrologic Performance Analysis – Time Series

Examples of Hydrology Performance Analysis – Exceedance Frequency

Examples of Hydrologic Performance Analysis – Daily Scatterplots

Examples of Hydrologic Performance Analysis – Monthly Climatology

Conclusion of Hydrologic Performance Analysis

INFORM Decision Support System

- Decision Support System Framework: Multi-scale, Multi-objective
- Long Range Simulation/Planning Model: Trinity, Shasta, Feather, American, San Joaquin, Bay Delta sub-systems
- Model Inputs: Reservoirs, River and Tributary Nodes, Hydro Power Plants, Water Supply Nodes, Ecosystem Nodes, Water Quality Nodes
- Model Outputs
- Long Range Assessment Model
- Assessments: Adaptive versus Static Management
- Outstanding Issues
- Way Forward

Table A-5: Availability of High Resolution Climate Forecast Data

A) The original design of the INFORM system envisioned the use of 6-hourly data from the NCEP Climate Forecast System (CFS). These data would be composed of

Retrospective forecasts going back to 1981

Operational (real time) forecasts

Ensembles of 5-15 members

Forecasts going out to (at least) 9 month lead times.

B) In discussions with NCEP Environmental Modeling Division management in December 2003 and January 2004 it was indicated that these CFS data would become available during summer, 2004. Subsequent correspondence in September 2004 indicated that the data would be delayed and become available by late winter to early spring, 2005. The actual retrospective forecast simulations were complete by approximately this time. Offers by HRC to purchase and install the necessary equipment to download the data directly at NCEP (inside their firewall and security systems) were not accepted by NCEP for security reasons.

C) Delivery of the Climate Forecast System (CFS) data from NCEP is now significantly behind schedule.

D) Monthly average ensemble retrospective (1981-2004) and operational forecast data is now available from CFS.

E) We are in continuing discussions with NCEP to obtain the 6-hourly data

F) The potential for continued delay in obtaining 6-hourly data requires the development of an alternative strategy using the monthly average data.

G) A candidate procedure is described in the Phase 2 Project Report (pp. 2-1 to 2.5). For a given basin (or set of basins) and a given month, this procedure identifies months in the observed record that are "similar" (in terms of precipitation and/or temperature) with the CFS ensemble output. Actual 6-hourly to daily series of precipitation and temperature from those identified similar months are then used to drive the hydrological component of the INFORM system (which feeds into the decision model). This alternative procedure retains the probabilistic character of the GFS ensemble forecasts and builds on elements of traditional ensemble streamflow prediction (ESP) methodology. This procedure (or variant) will be implemented if no 6-hourly data are available by (approximately) June, 2005.

FOURTH OVERSIGHT AND IMPLEMENTATION COMMITTEE MEETING OF THE INFORM PROJECT

21 SEPTEMBER 2005, Sacramento, California

PARTICIPANTS

Agency Representatives

M. Anderson,	California Department of Water Resources
Gary Bardini,	California Department of Water Resources
Pete Fickenscher,	California Nevada River Forecast Center, National Weather Service, NOAA
Josh Foster,	NOAA Office of Global Programs (*through a conference call)*
Paul Fujitani,	Central Valley Operations, U.S. Bureau of Reclamation
Robert Hartman,	California Nevada River Forecast Center, National Weather Service, NOAA
Arthur Hinojosa,	California Department of Water Resources
Aaron Miller,	California Department of Water Resources
Claudia Nierenberg,	NOAA Office of Global Programs (*through a conference call)*
Maury Roos,	California Department of Water Resources
Eric Strem,	California Nevada River Forecast Center, National Weather Service, NOAA

INFORM Co-PIs and INFORM Project Scientists

Aris Georgakakos,	Georgia Water Resources Institute
Kosta Georgakakos,	Hydrologic Research Center
Nick Graham,	Hydrologic Research Center
Martin Kistenmacher,	Georgia Water Resources Institute
Huaming Yao,	Georgia Water Resources Institute

LOCATION AND TIME

The meeting was held at the National Weather Service (NWS) California Nevada River Forecast Center (CNRFC) Conference Room in the Joint Operations Center (3310 El Camino Ave.) on the 21st of September 2005. It started at 1:00PM and ended at 3:00PM.

PURPOSE AND INFORMATIONAL MATERIAL

The meeting served as a second critical review meeting for INFORM (Integrated Forecast and Reservoir Management), mandated by the California Energy Commission and CALFED funding agencies. Documents with the presentations were submitted to the participants prior to the meeting by the INFORM Core Office Staff. The meeting consisted of the presentation of the INFORM project status by the Co-PIs, followed by an open discussion of the strategy for the INFORM "dry-run" demonstration design for winter 2005-2006. The PDF forms of the meeting presentations are available at the HRC web site: http://www.hrc-lab.org.

INFORM STATUS PRESENTATION

The Co-PIs summarized the status of system development and testing. Real time capability is being added to the forecast component to ingest ensemble forecasts from the Global Forecast System (GFS) of the National Centers of Environmental Predictions (NCEP). The Co-PIs discussed the design of the real time GFS data ingest, dynamic downscaling components to produce gridded and subsequently watershed areal-average surface precipitation and temperature, bias adjustment of the watershed precipitation and temperature and snow, soil and channel modeling with bias adjusted forcing to produce ensemble flow forecasts at various watershed locations including reservoir inflow for the four largest reservoirs in Northern California.

Progress on the decision component has been achieved along two parallel paths: First, the long range management model has been developed and is currently being tested. The model incorporates all major storage facilities along the Trinity, Sacramento, Feather, American, and San Joaquin Rivers, including the Bay Delta. In all, the model includes 10 reservoirs, 11 power plants, 14 river nodes, 15 inflow nodes, and 30 demand nodes. Second, the model is being compared for consistency with CALSIM. In this regard, CALSIM is currently operational at the GWRI facilities and is being used to *(1)* extend the INFORM hydrologic and demand data series, and *(2)* compare its consistency with the INFORM DSS. This effort was undertaken to test and ensure the compatibility of all existing simulation and management tools.

The Co-PIs presented their initial plan for the "dry run" of the winter 2005-2006, which will serve to finalize system components, establish links with operational agencies and define the objectives of the demonstration program of INFORM with real time and near real time runs. It is expected that during the following two years (2006-2008) INFORM will be funded (as originally proposed) to actually perform the

demonstration on the basis of the protocols defined during the "dry run" experiment of winter 2005-2006.

DISCUSSION

After the INFORM status presentations, group discussion followed. Important issues discussed were *(a)* the links anticipated between the operational forecast and management agencies of California and the INFORM system input and output components; and *(b)* the design of the "dry run" demonstration experiments of winter 2005-2006 with particular emphasis on the type of events to concentrate and the type of objective criteria to evaluate the INFORM forecast-decision system relative to the existing operational system.

1. Rob Hartman suggested and the Co-PIs concurred that it would be desirable for the California Nevada River Forecast Center (CNRFC) of the US National Weather Service (NWS) to receive bias adjusted mean areal precipitation and temperature ensemble forecasts and ensemble flow forecasts for various watershed flow points in real time, and to have the INFORM hydrology component use the state variables of the operational hydrologic model runs as initial conditions for the development of the GFS-driven ensemble flow forecasts.

2. Rob Hartman mentioned the existence of historical GFS output for use by INFORM to estimate the bias adjustment component for the mean areal precipitation and temperature on watershed scales.

3. Gary Bardini suggested that the demonstration plan of the winter 2005-2006 "dry run" should be designed to bring to fore the unique features of INFORM: *(a)* integration of uncertainty information in decisions, and *(b)* integration of decisions over different time scales seamlessly.

4. Paul Fujitani suggested questions that may be useful to examine with the demonstration: *How much can we deviate from the flood control diagram? What should the best release policy be in December and in May for Folsom and Shasta in order to maintain summer flows? After a significant inflow event how do we operate to evacuate storage? What is the required period of encroachment for Shasta to meet downstream objectives?*

5. Arthur Hinojosa suggested that INFORM Co-PIs participate in the weekly forum which starts in October pertaining to reservoir operations.

6. Gary Bardini stressed the value of retrospective studies in examining questions of the type: *What is the system impact of aggressive versus conservative reservoir management policies? What should the carry over reservoir storages be and how do these decisions affect water supply reliability and flood risk in the following season?*

7. Paul Fujitani mentioned that it is desirable to have ensemble flow forecasts of unregulated inflow points on the Sacramento River.

8. The Group agreed that a seasonal planning application of the integrated forecast-decision system could be scheduled for January 2006 to support planning decisions for the Spring 2006.

9. The Co-PIs informed the participants that the current submission date of draft final report for the first three funded years of INFORM is in February 2005 and if it remained thus it would not allow the "dry run" experiments to go into the last part of winter and the spring season (important for reservoir management decisions). The Co-PIs proposed and the participants agreed to the submission (to the funding agencies) of a no-cost extension to May for the delivery of the draft final report to allow inclusion of the late winter and spring forecast and management activities in Northern California.

FIFTH OVERSIGHT AND IMPLEMENTATION COMMITTEE MEETING OF THE INFORM PROJECT

29 JUNE 2006, Sacramento, California

PARTICIPANTS

Agency Representatives

John Andrew	California Department of Water Resources
Paul Fujitani,	Central Valley Operations, U.S. Bureau of Reclamation
Robert Hartman,	California Nevada River Forecast Center, National Weather Service, NOAA
Claudia Nierenberg,	NOAA Office of Global Programs (*through a conference call)*
Joe O'Hagan	California Energy Commission
Lloyd Peterson	U.S. Bureau of Reclamation
Eric Strem,	California Nevada River Forecast Center, National Weather Service, NOAA

INFORM Co-PIs and INFORM Project Scientists

Aris Georgakakos,	Georgia Water Resources Institute
Kosta Georgakakos,	Hydrologic Research Center
Nick Graham,	Hydrologic Research Center
Robert Jubach,	Hydrologic Research Center
Huaming Yao,	Georgia Water Resources Institute

LOCATION AND TIME

The meeting consisted of two sessions, a morning presentations session, and an afternoon OIC discussion session. Both sessions were held at the Joint Operations Center (3310 El Camino Ave.) in Sacramento on the 29th of June 2006. The morning session started at 10:00AM and ended at 12:15PM, and the afternoon session started at 1:30PM and ended at 3:30PM.

PURPOSE AND INFORMATIONAL MATERIAL

The meeting served as a second critical review meeting for INFORM (Integrated Forecast and Reservoir Management), mandated by the California Energy Commission

and CALFED funding agencies. Documents with a discussion of the INFORM system implementation was submitted to participants prior to the meeting by the INFORM Core Office Staff. The morning session meeting consisted of the presentation of the INFORM project final report and assessments by the Co-PIs, followed by open discussion, and the afternoon session consisted of a discussion of INFORM results and potential future collaborative directions. The PDF forms of the meeting presentations are available at the HRC web site:

http://www.hrc-lab.org/projects/dsp_projectSubPage.php?subpage=inform.

INFORM STATUS PRESENTATION

The Co-PIs summarized the technical activities of the three-year first phase of INFORM. The final report is being produced and will be submitted for review to funding agencies in July. The Co-PIs discussed the design and implementation of the real time GFS data ingest, dynamic downscaling components to produce gridded and subsequently watershed areal-average surface precipitation and temperature, bias adjustment of the watershed precipitation and temperature, and snow, soil, and channel modeling with bias adjusted forcing to produce ensemble flow forecasts at various watershed locations including reservoir inflow for the four largest reservoirs in Northern California, and the off-line climate forecast processing of INFORM for input to the decision component. Discussion of the INFORM decision component included *(a)* the design of the DSS model hierarchy comprising interlinked models for long range planning, mid range management, short range management, and near real time operations; *(b)* the management concerns incorporated as part of the decision modeling both at reservoir sites and downstream, and *(c)* the strategy for potential use of this component by management agencies to develop risk-based policies for water resources management. Assessments of the INFORM forecasts during the "dry run" of the wet season 2005-2006, and of the benefits of using uncertain forecasts for water management were also presented and discussed. The Co-PIs recommend that during the following two to three years (2006-2009) INFORM funding continues (as originally proposed) to support the system demonstration on the basis of the protocols defined during the "dry run" experiment of winter 2005-2006.

DISCUSSION

The afternoon INFORM session was devoted to group discussion. Important issues discussed were *(a)* the need for continuation of the INFORM assessments with real time data from 2 to 3 future wet and dry seasons for reliable results; *(b)* the links between the operational forecast and management agencies of California and the INFORM system input and output components; and *(c)* the necessary improvements in current INFORM system design to better fit operational forecast and management agency objectives in water resources prediction, planning, and management.

1. Rob Hartman said, and other agency representatives agreed, that the INFORM system is a useful tool for operational forecast and management.

2. Rob Hartman suggested, and the Co-PIs concurred, that for the next phase of INFORM a representative from NCEP should be included in the Oversight and Implementation Committee to provide input and to receive feedback as to the utility of climate forecast system (CFS) operational three-dimensional fields and to facilitate communication with NCEP on data issues and products.

3. Rob Hartman also suggested that for CNRFC it would be very useful to use the INFORM coastal range estimates of precipitation for real time streamflow prediction there (e.g., the Smith and Navarro Rivers). This region is within the precipitation and temperature downscaling grid of the INFORM forecast component, but no hydrologic model computations are effected at present for the coastal streams that drain into the Pacific Ocean.

4. The participants discussed the need for enhancing the ensemble size of the INFORM ensemble forecasts. Due to HRC machine limitations (8-processor computer platform), the current design of INFORM produces an 8-member ensemble of real time precipitation, temperature and flow forecasts, four times daily, out to 16 days with 6-hourly resolution. It was suggested that funds be included in the next phase funding to accommodate at least a 16-porocessor machine to accommodate the current 15-member ensemble size of the ingested global forecast system (GFS) forecasts from NCEP.

5. Paul Fujitani mentioned that at present the large reservoirs in Northern California are operated individually without significant co-ordination (except for the case of Oroville on the Feather River and New Bullards Bar on the Yuba River). A significant INFORM contribution is that it coordinates the operating policies of all these large reservoirs.

6. Lloyd Peterson suggested that a significant application of the INFORM system would be to support the management of reservoirs within the San Joaquin River drainage, especially the Friant Dam and New Melones reservoir (on the Stanislaus River tributary). He further asserted that, with respect to operational management difficulty, the Trinity and Friant reservoirs rank high due to their modest release capacity.

7. Lloyd Peterson and Paul Fujitani also emphasized that the INFORM DSS could be used to support the management of the San Luis reservoir, the Tracy pumping facility, and the water export to the south. The project co-PIs noted that, although some model modifications are needed to support this management objective, such INFORM DSS operational refinements could be carried out as part of the next INFORM phase.

8. There was consensus among the participants that the INFORM demonstration project should continue to provide information to forecast and management agencies through a next phase. Toward this end, it was decided that the Co-PIs develop a draft proposal as a discussion document and a meeting of the OIC be

convened near the end of July 2006 to develop objectives and plans for the next phase of INFORM that reflect the interests of the participating agencies.