NATIONAL WEATHER SERVICE
OFFICE of HYDROLOGIC DEVELOPMENT

PROJECT PLAN

Sacramento Model Enhancement
To
Handle Implications of Frozen Ground on Watershed Runoff

Version 3-7

Revision History

Date	Version	Description	Author
01/04/2005	1.0	Initial Development	T. Varone
01/05/2005	1.1	Technical Edit	M. Smith
01/12/2005	1.4	Gate Directed Changes	T. Varone
01/17/2005	1.5	Gate Directed Changes	T. Varone
01/28/2005	1.6	Edits	T. Varone
05/12/2005	2.1	Combine CONOPS/ORD	T. Varone
06/08/2005	2.2	Upgrade Requirements for Stage 3 completion	T. Varone
06/22/2005	2.3	Add Additional Stage 3 Requirements	M. Smith
06/24/2005	2.4	Edit & add Clarification	T. Varone
07/26/2005	3.1	Additional edit for Gate 3	T. Varone
04/19/2006	3.2	Apply field review comments & additional edits	V. Koren, M. Andre
4/24/2006	3.4	Project modifications put on hold	
6/18/2007	3.5	Revise Document and put into version 5.2 for inclusion into AWIPS	Chris Holte, L. Cajina, J. Gofus
6/29/2007 7/18/2007	3.6	Revise Document including Gate Comments HSEB approval (7/18/2007)	Chris Holte, L. Cajina
01/16/08	3.7	Revise Document for change to release OB9	J. Gofus, L. Cajina

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Current HOSIP Stage: 3

1. IDENTIFICATION

Frozen Ground SAC Model Enhancement Project. (See CONOPS for details about the project description and Scope)

Project ID: NID-05-002-SON-05-001

2. STAGE PLAN

2.1 Approach

Stage 2 – Concept Exploration and Definition Stage
Preliminary research indicated that seasonally frozen ground can have a significant effect on the amount of runoff produced during the winter and spring. Lack of vegetation during the winter, shallow snow cover, and very cold temperatures produce optimal conditions for deep frost penetration. The Sacramento Soil Moisture Accounting model (SAC-SMA), widely used by NOAA/NWS, has a frozen ground component. It is based on an empirical frost index. Research indicates that this empirical frozen ground can be improved resulting in additional model flexibility based on a new frozen ground component as well as improved accuracy of the model which, in turn, improves the prediction of the available water in a basin for a specific point in time. This new version of SAC-SMA is referred to as SAC-SMA-HT or SAC-HT for short, HT standing for "Heat Transfer" The need for these improvements was established through research and analysis. The theory was tested, proven and demonstrated a valid component that reduced biases in certain computed values. This research is documented in the Concept of Operations and Algorithm description.
Stage 3 – Applied Research & Analysis
The Research and Analysis Stage for this project consisted of developing the Algorithm Description document detailing the approach and results and updating the Concept of Operations which summarizes the research results and findings and defines the detailed requirements specification as well as planning the Stage 4 software development plans. The existing requirements will be decomposed and made more detailed where needed in Stage 4. The research was completed, analyzed and documented in the Project Plan, Concept of Operations and the Algorithm Description Document.

Stage 4 - Design & Development
The Development Stage for this project consists of the design, development and testing of the enhancement in the form of an additional NWSRFS operation (SAC-HT, operation 65). The Goal is that this operation will meet the requirements specification in accordance with the OHD development standards and will run successfully in all the different modes listed in the CONOPS.. The NWS-RFC version of SAC-HT will be refined from the prototype by working with field forecasters from North Central River Forecast Center (NCRFC) to develop and prioritize testable feature specifications, build those features, and then test and retest them in order of priority. Since this enhancement is intended to be deployed as part of an AWIPS build (OB9), the development will also be subject to all of the reviews specified in the AWIPS development documentation. Finally updates to user documentation will be provided in support of the development of training material as needed.

2.2 Schedules and Milestones

Stage 2 -Validation	**Dates**
Complete CONOPS	12/29/2004 – 01/04/2005
Complete Project Plan	12/29/2004 – 01/05/2005
Branch Review & Approval	01/04/2005 – 01/12/2005
Δ HOSIP Gate 2	01/12/2005
Stage 3 - Research & Analysis	**Dates**
Complete the Science Documentation	02/02/2005
Complete Functional Requirements in Spec	02/02/2005
E2E Decision Meeting	02/02/2005
Complete Requirements Specification	03/11/2005
Update Project Plan	05/06/2005
Develop Algorithm Description	03/11/2005
Δ First HOSIP Stage III Gate Review	05/03/2006
Update Algorithm Design Document for NWSRFS inclusion in AWIPS 8.3	6/22/2006 – 5/12/2007
Update CONOPS	1/30/2007 – 5/223/2007
Update Project Plan for version and for AWIPS 8.3 project	1/30/2007 – 5/30/2007
Draft Test Plan	5/23/2007 – 5/30/2007
Δ HOSIP Stage III Gate Review	6/27/2007
Stage 4 - Design & Development	**Dates**
Requirements Review (AWIPS SREC)	1/29/08
Design Review (AWIPS SREC)	2/19/08

User Interface Review (AWIPS SREC)	2/19/08
Software Development and Unit Testing	7/16/07 – 4/30/08
Test Plan Review (AWIPS SREC)	4/8/08
Training / User Manual Development	11/15/07 – 7/1/08
Test Procedures Review (AWIPS SREC)	4/8/08
Code Review	3/31/08 – 4/4/08
Functional Testing	11/1/07 – 4/16/08
Prototype Testing at NCRFC and OHRFC	11/19/07 – 4/16/08
Δ SREC Check in	4/30/08
Pre-Integration Testing (PIT)	5/21/08-6/30/08
Documentation Drafted	6/6/08
Integration Readiness Review	6/16/08 – 6/27/08
Software and Documentation Handoff	7/1/08
Δ HOSIP Gate 4	TBD

2.3 Roles, Responsibilities & Estimated Resource Requirements

Role/Name	Responsibility	Hours	Dollars ($)
Stage 2 – Validation*			
HSEB, Scientific Developer	HSEB was responsible for design, development, testing and documentation.	40	$3,416
HSMB, Research Scientist	The HSMB developed the requirements and basic research for the SAC-HT algorithms.	40	$4,040.
HOSIP Administrator	Coordinate HOSIP process and perform review and QA of documentation	20	$1,300.
	Total	***100***	***$8,756.***
Stage 3 - Research & Analysis*			
HSEB: Senior Software Engineer	HSEB developed plan to move Frozen Ground into NWSRFS AWIPS	40	$4,038
HSMB Lead Scientist	It took approximately 20 Hours to develop and update the Algorithm Description Document required to complete HOSIP Stage 3.	20	$2,163
HOSIP Administrator	Coordinated HOSIP process and performed review and QA of	40	$2,596

Role/Name	Responsibility	Hours	Dollars ($)
	documentation		
HSEB: Lee Cajina (PL)	Updated Project Plan, CONOPS, and drafted Test Plan	40	$4,039
HSEB: Joe Gofus (PAL)	Reviewed and coordinated efforts	8	$920
Pedro Restrepo, OHD Senior Scientist and HOSIP Gate 3 keeper	Reviews stage 3 artifacts and approves project at Gate 3	4	462
	Total	***148***	***$14,221***
Stage 4 - Design & Development*			
HSEB Joe Gofus (PAL)	Project planning, management, and oversight. Coordinate reviews and schedules Review documentation	40	$4,615
HSEB (PL): Developer	Design, develop and test the enhancement software Create documentation Support development of training materials	360	$36,346
HSMB: Victor Koren Lead Research Scientist	HSMB scientist will provide support as needed during the development process to review progress, answer questions, provide scientific documentation and support development of software and training material.	124	$13,411
OCWWS/ HSD Hydrologist	Responsible for the development of training materials and assist in the training of the users to apply this enhancement.	16	$1,730
HOSIP Administrator	Coordinate HOSIP process and perform review and QA of documentation	40	$2,596
NCRFC personnel	Review requirements priorities and features of prototype and test prototype, develop training material	40	$4,615
	Total estimated	620	$49,902
**** All figures are estimates***			

2.4 Critical Success Factors

No.		Stages:	2	3	4	All
1	That the developed software is maintainable, meets technical architecture requirements and still meets the scientific constraints.			X		X
2	That the Software produces the same scientific results as the prototype when run in NWSRFS Modes				X	
3	Successful Completion of Design Reviews and Major Milestones				X	
4	Completion of Testing (verifying that all requirements have been met)				X	

No.		Stages:	2	3	4	All
5	That the developed software meets functional requirements as prioritized and refined in cooperation with NCRFC				X	
6	Successful transfer of Software to AWIPS OB9 and demonstration of utility for NWS Hydrology Prediction				X	

2.5 Assumptions and Constraints

No.	Assumptions & Constraints	Stages	2	3	4	All
1	Funding is available to staff project activities				X	
2	Development will be in accordance with policies established by HOSIP, OHD and AWIPS				X	
3	The SAC-HT should be properly calibrated				X	
4	Cooperation from NCRFC and NWS partners				X	

2.6 Risk Assessment and Mitigation

No.	Risk	Mitigation Plan
1	Simultaneous development of the Interactive Calibration Program (ICP).	Close coordination & progress monitoring of the ICP project.
2	Loss of Budget	Lengthen total project time – Will result in delayed demonstration of utility of the SAC-HT Frozen Ground Feature.
3	Insufficient personnel resources to complete the entire project. (unavailability of NCRFC personnel or of AWIPS personnel)	Close monitoring of the project progress with the possibility of adding resources, deferring capabilities to a later build or lengthening the total project time.
4	Data Limitations – Test data and results may not be available to test the ESP and FFG modes of operation.	HSMB may be able to supply test cases. Otherwise, these modes may be delayed until testing can be completed.
5	Unsuccessful prior calibration of SAC-HT	Instructions on the calibration and setup of SAC-HT will be provided to users and efforts will be made to calibrate the models prior to implementation
6	Adoption of the SAC-HT into operations may be delayed due to: • Users will have to develop new parameters from soil	• Use of the new SAC-HT model instead of the existing SAC-SMA/Frozen Ground model should not require any new parameter calibration, assuming the original SAC-SMA/Frozen Ground model was properly calibrated.

No.	Risk	Mitigation Plan
	texture and soil temperature data • The NWS Office of Climate, Weather, and Water Services (OCWWS) will have to be trained on the new feature in order to support field use of the feature.	• Use of the new model is optional because the existing SAC-SMA/Frozen Ground operation is not being eliminated. • HSEB and HSMB personnel will support OCWWS familiarization with the concepts and use of the new model.

2.7 Completion Estimates

The estimates in this section cover the support and maintenance of the software after it has been handed off to AWIPS for deployment.

Activity	Estimate	Hours	Schedule
Support AWIPS Release Testing of the Enhanced Software	HSEB Project Leader or Developer	8 hours	7/2/08-12/12/08
Maintain Operational Software	AWIPS Support Contractor	24 hours /year for 5 years	12/13/08 - onward
Total	Estimate	128 hours, $12,960.00 (O&M)	

Resources	
Completion Date	***7/01/08***
Estimated Funding Requirement	***12,960.00 (five years)***
Operations and Maintenance Costs	*6 hours per quarter*

2.8 HOSIP Stage Status

[The planned completion dates for each stage shall be provided by the Project Area Lead or Group Leader. The actual completion dates and comments shall be completed by HOSIP Admin after the HOSIP Gate.]

	Stage 1	***Stage 2***	***Stage 3***	***Stage 4***
Planned Completion Date	1/29/2004	1/12/2005	5/3/2006	10/24/2007
Actual Completion Date	1/29/2004	1/12/2005	6/27/2007	
Comments	Approved	Approved	Put on Hold/Approved	TBD

3. Appendices

Appendix A – Table of Acronyms

[This appendix will contain an alphabetical listing of acronyms used within the document.]

AWIPS	Advanced Weather Interactive Processor Service
CAT	CHPS Acceleration Team
CHPS	Community Hydrologic Prediction System
CONOPS	Concept of Operations
FEWS	Flood Early Warning System, from Delft Hydraulics
GUI	Graphical User Interface
HL	Hydrology Laboratory
HOSIP	Hydrologic Operations and Service Improvement Process
HSEB	Hydrologic Software Engineering Branch
HSMB	Hydrologic Science and Modeling Branch
ICP	Interactive Calibration Program
MCP	Manual Calibration Program
NCEP	National Centers for Environmental Prediction
NCRFC	North Central Region River Forecast Center
NOAA	National Oceanic Atmospheric Administration
NWS	National Weather Service
NWSRFC	National Weather Service River Forecast Center`
NWSRFS	National Weather Service River Forecast System
OCWWS	Office of Climate, Weather, and Water Services
OHD	Office of Hydrologic Development
QA	Quality Assurance
RFC (s)	River Forecast Center(s)
SAC	Sacramento referring to the Sacramento Model Soil Moisture Accounting Model
SAC-SMA	Sacramento Model Soil Moisture Accounting Model
SAC-HT	Sacramento Model Soil Moisture Accounting Module with Heat Transfer (Frozen Ground enhancements) (short reference)
SAC-SMA-HT	Sacramento Model Soil Moisture Accounting Module with Heat Transfer (Frozen Ground enhancements)
SOA	Services Oriented Architecture
SON	Statement of Need
WFOs	Weather Forecast Offices
XML	Extensible Markup Language