

Decision Support Tool for Resilient Flood Management in the Souris River Basin

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**CDM
Smith**

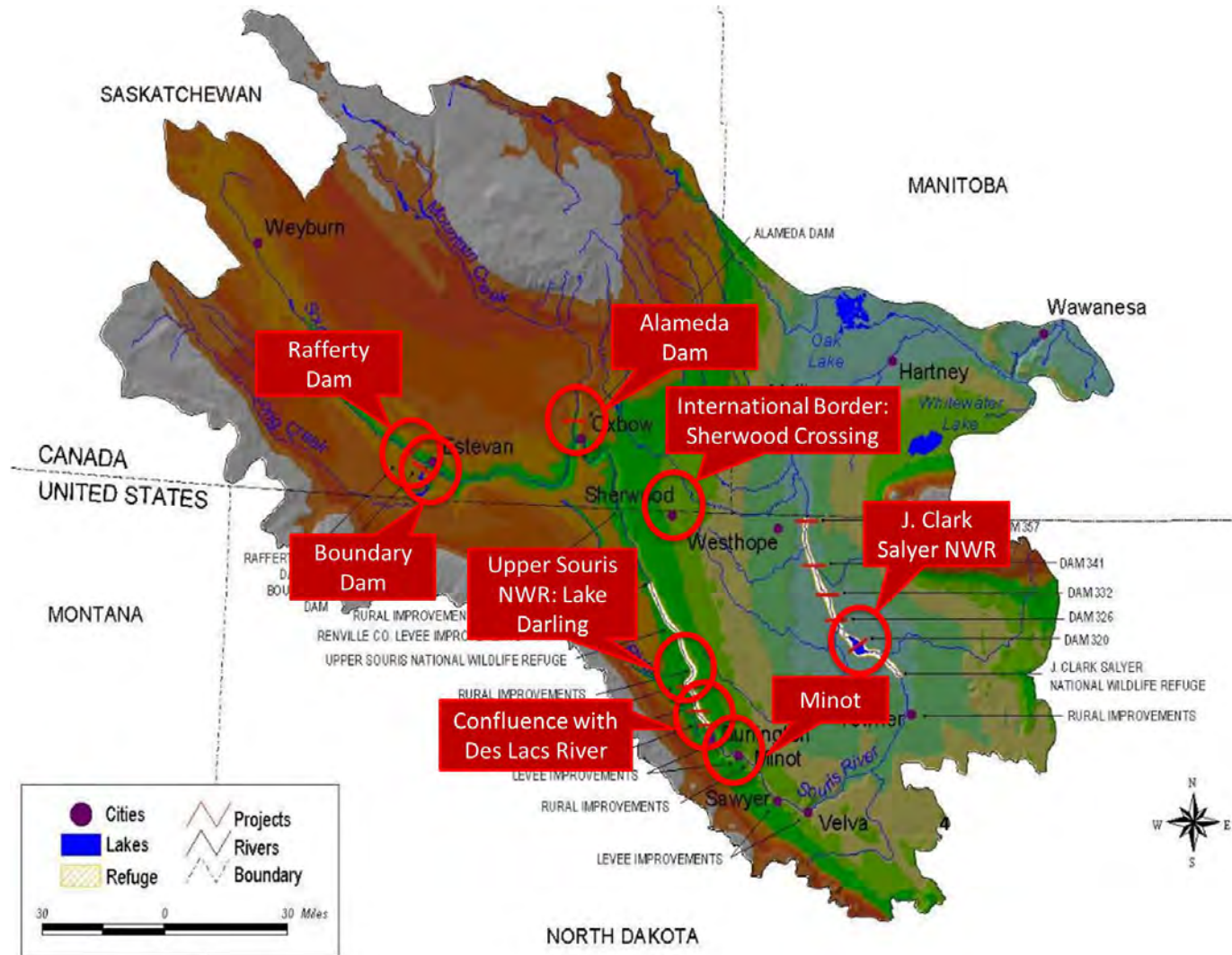
Outline

- Background
- 2011 Flood of Record
- Decision Support Tool (DST) Overview
 - More on STELLA Model
- Alternative Screening
- Benefit-to-Cost Analysis (BCA)



Flooding in Minot June 2011.
USACE Photos

Souris (Mouse) River Flood Control



2011 Flood Event of Record

- Flood of record (27,000cfs) June 2011
 - Near-record snowfall in 2010
 - Near-record rainfall in 2011
 - Significant snowmelt
 - Development in floodplain
 - Shale-oil and gas boom
- > \$500M of damage
 - > 12,000 residents evacuated
 - > 3,100 homes destroyed
- Damages reduced by City of Minot, USACE, USFWS, and National Guard
 - Projected to have been \$880M without interventions



Flooding in Minot July 6, 2011. FEMA Photo



June 2011 damages reduced by City of Minot, USACE, USFWS, and National Guard. USACE Photo

CDM Smith Support

- Support for disaster recovery
- NDRC grant support: \$74M
- Program management
- Guidance for buyouts (300 to 400 properties)
- Decision Support Tool
 - STELLA
 - HEC-RAS

Minot Daily News

#9 — Minot wins \$74.3 million in resiliency competition



Jill Schramm/MDN Mayor Chuck Barney, right speaks at a news conference with now former city manager Lee Staab, left, last January to discuss Minot's award of \$74.3 million in the National Disaster Resilience Competition.

Minot Daily News

Consultant helps city manage grant dollars

CDM Smith continues to help Minot navigate federal disaster programs several years after flood



File photo Steven Wolsfeld with CDM Smith displays a Power Point slide as he delivers a preliminary report on the Souris River Decision Tool to city council members last September.

Decision Support Tool Overview

Facilitates watershed and project level screening for

- Review and refinement of buyout areas
- Floodwall refinement
- New storage facilities
- Refinement of operating guidance for existing storage
- Upper Souris and J. Clark Salyer NWRs in the USA
- Rafferty, Alameda, and Boundary Dams in Canada
- Enhanced Benefit-to-cost (B/C) ratio



Flooding in Souris River Basin June 2011. USACE Photo



Decision Support Tool Benefits

- Provides big picture view of the entire water management system
- Provides supporting documentation for multiple project considerations
- Evaluates alternative refinements quickly
- Makes use of existing H&H tools and models without having to run hundreds of complex scenarios
- Builds on excellent foundation of existing knowledge from stakeholders

H&H Models

- HEC-RAS
- HEC-HMS
- HEC-ResSIM

Operational Schedules

- Reservoirs and dams
- National Wildlife Refuges

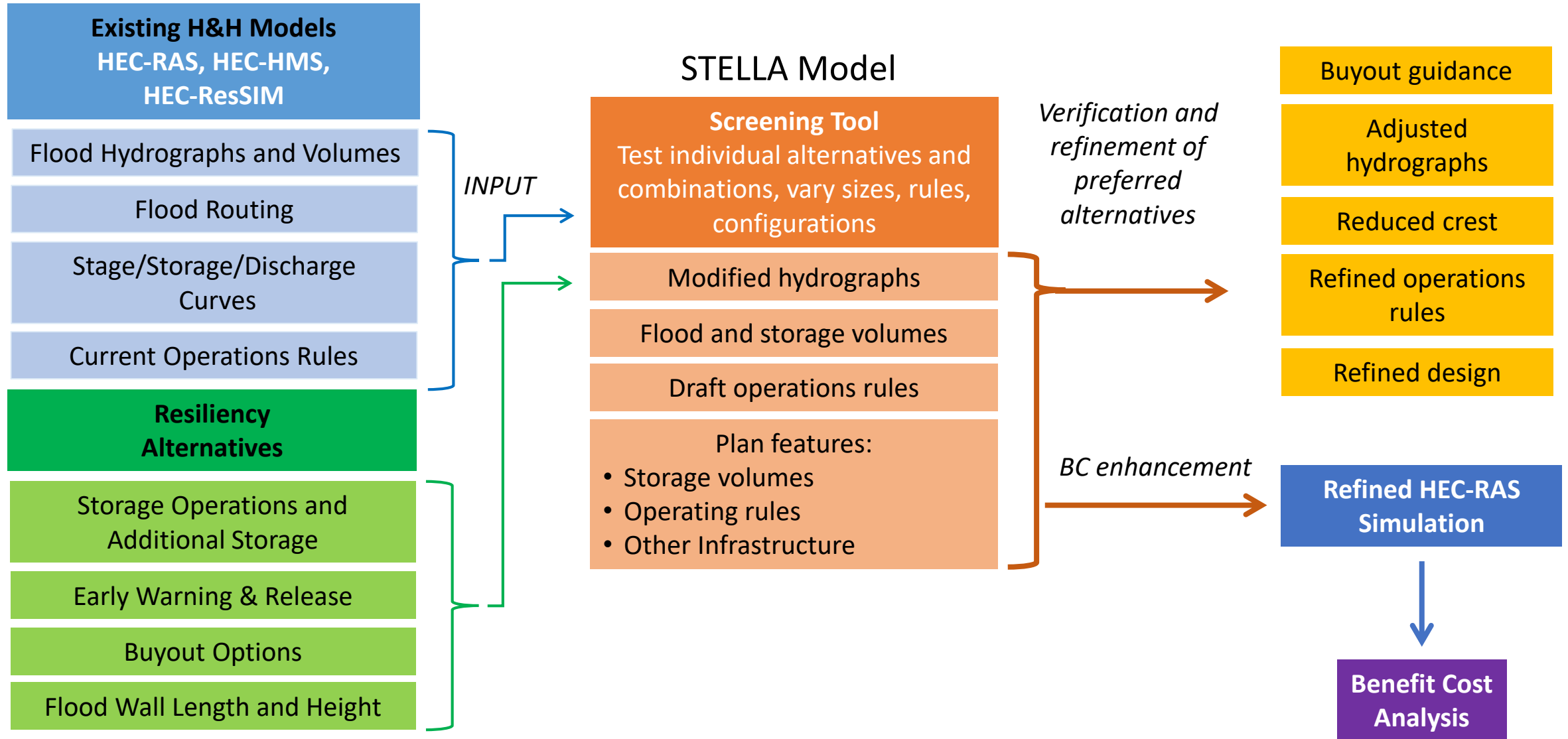
Hydrologic Monitoring

- Meteorological
- Streamflow and stage
- Reservoir levels

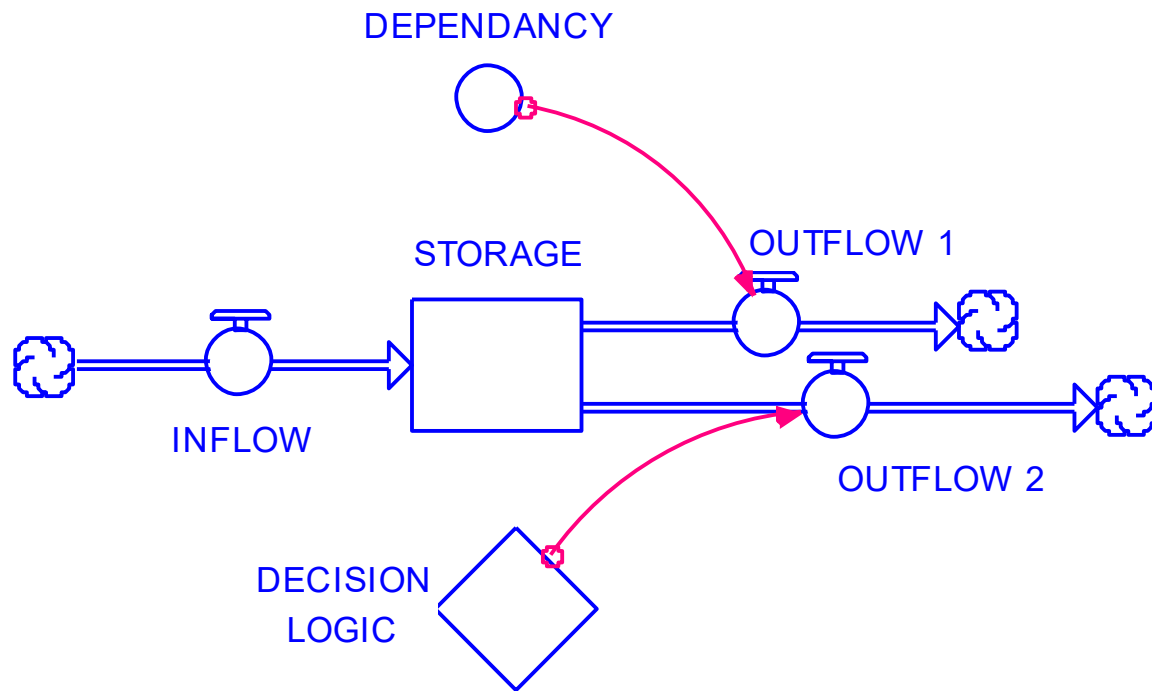
Designs and Plans

Reports and Studies

Steps in the DST Process



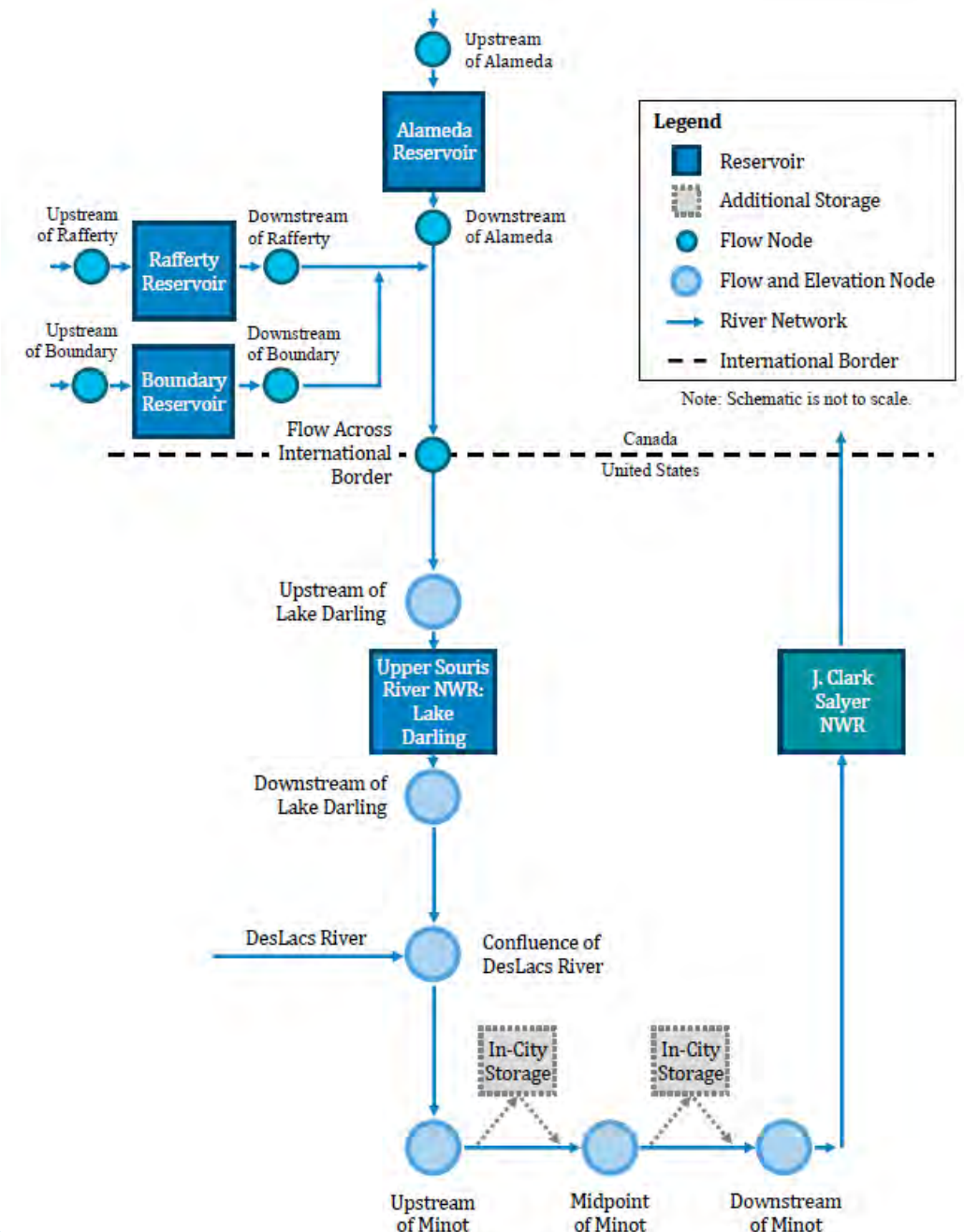
Quick Overview of STELLA



- STELLA = Systems Thinking, Experimental Learning Laboratory with Animation
- Visual programming language for system dynamics modeling
- Graphical representation of a system with 4 building blocks
 - Stocks
 - Flows
 - Converters
 - Connectors

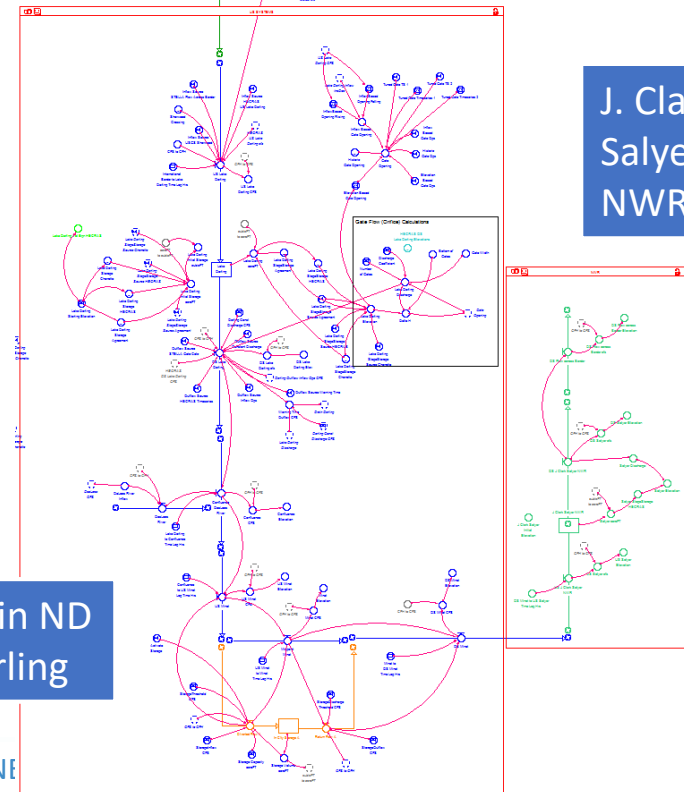
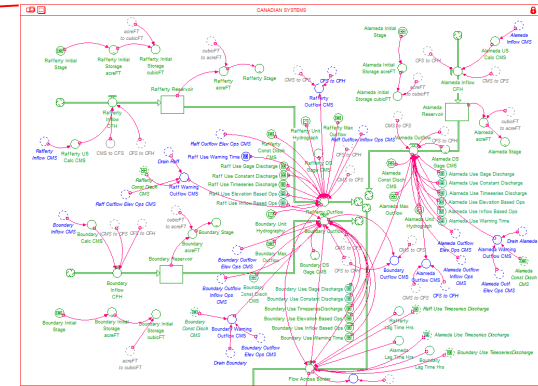
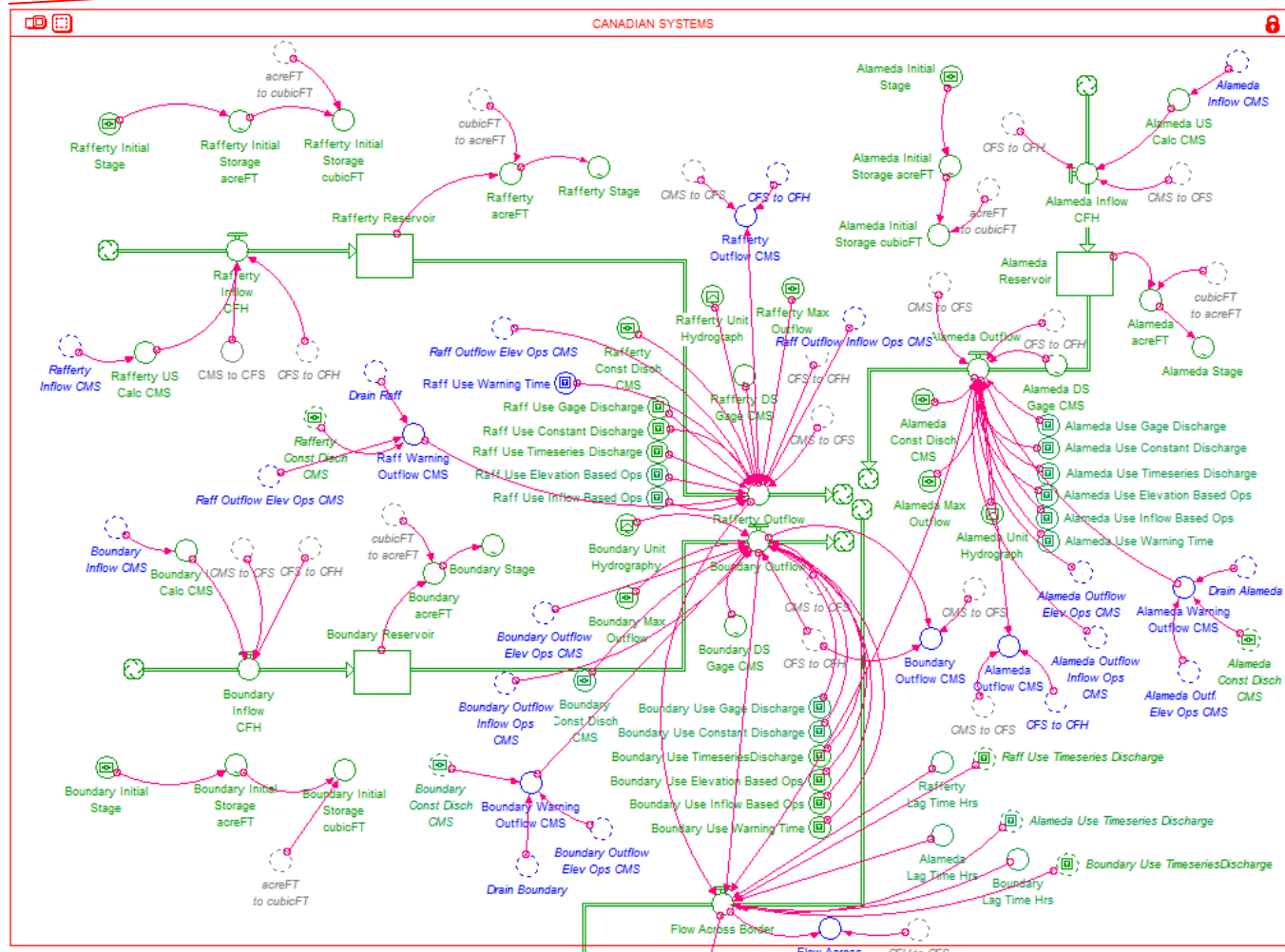
STELLA Model Schematic

- Points of Interest
 - Reservoirs
 - Alameda
 - Rafferty
 - Boundary
 - Lake Darling
 - J. Clark Salyer (multiple impoundments)
- Storage in Minot



More Detailed View of STELLA Model

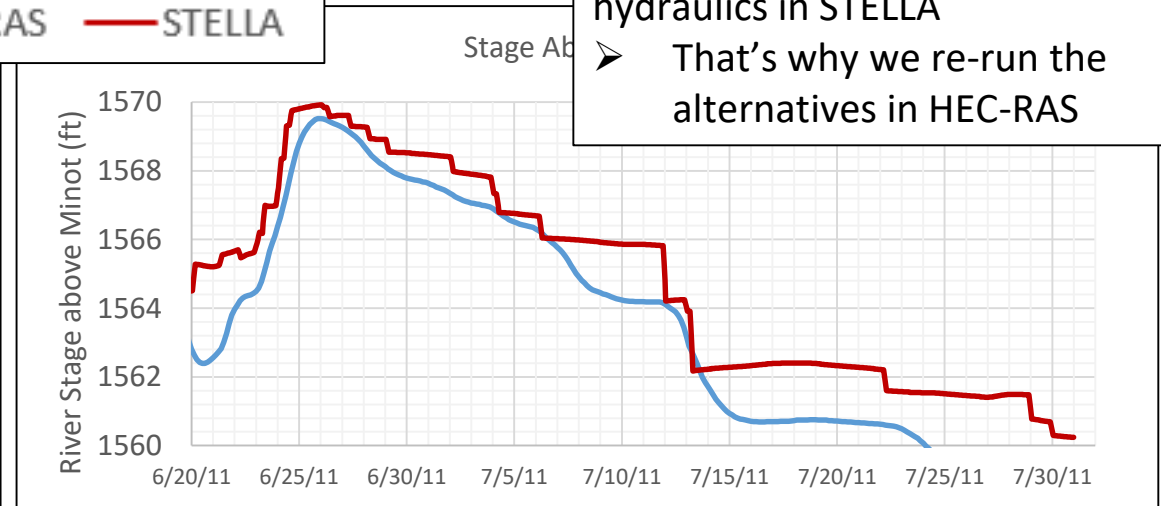
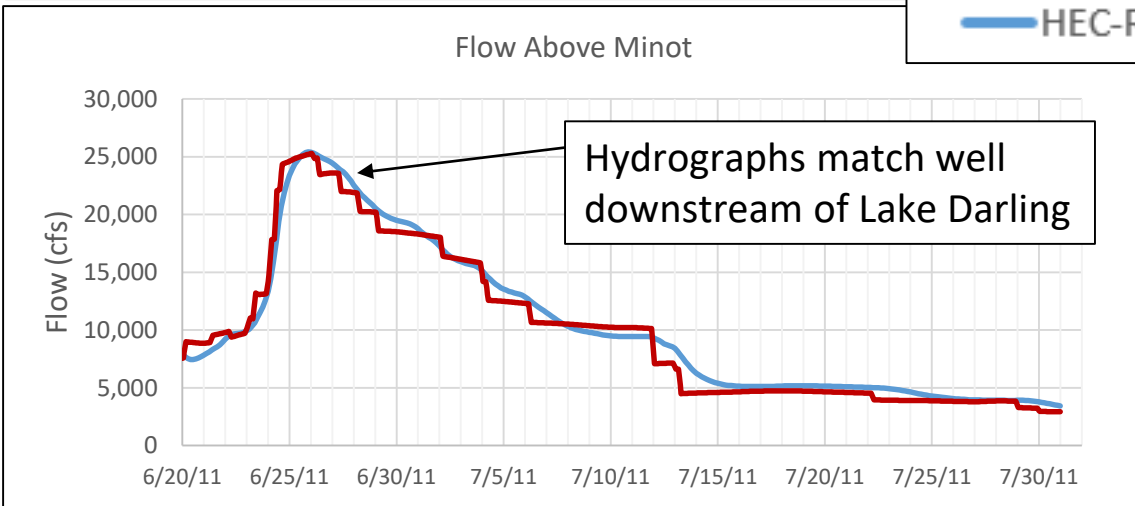
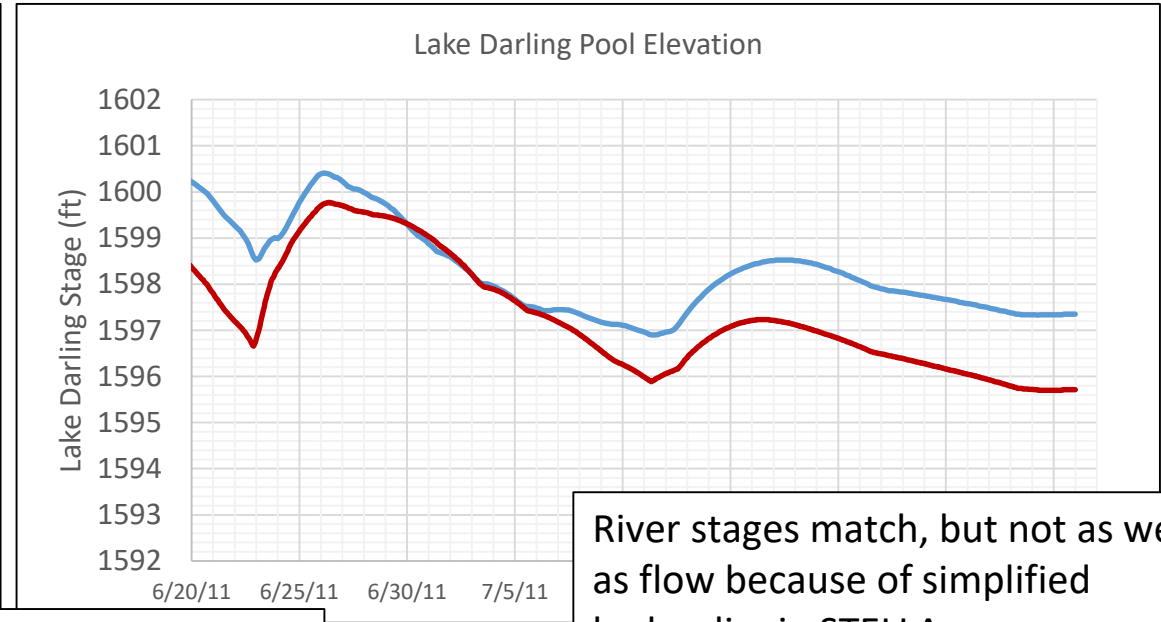
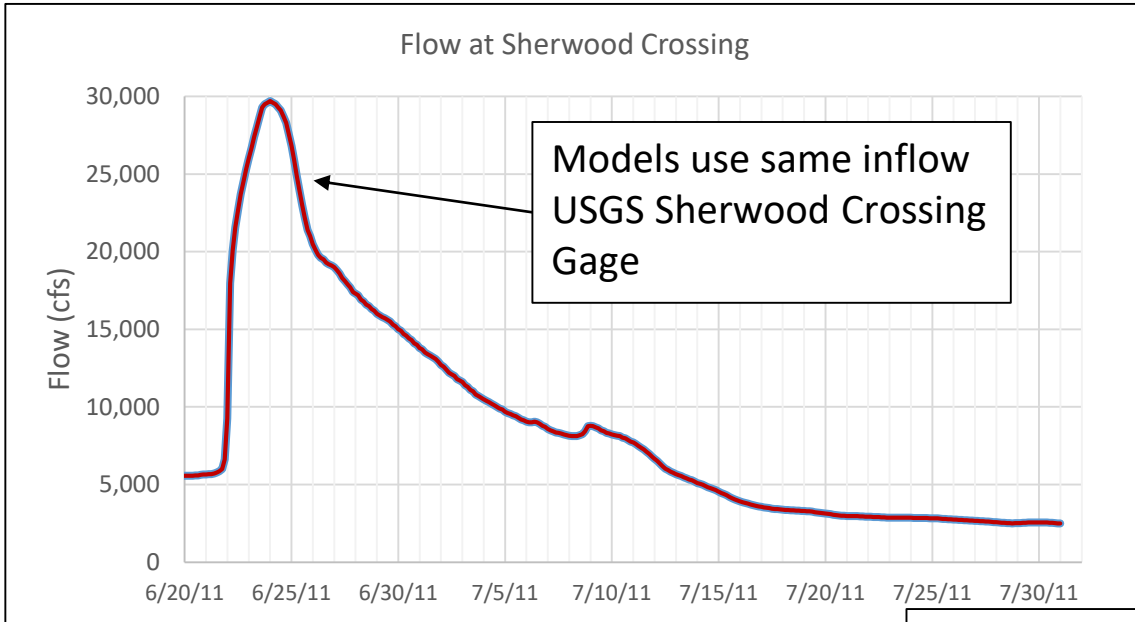
Canadian Reservoirs



J. Clark Salyer
NWR

Souris River in ND
and Lake Darling

Validation of the DST



— HEC-RAS — STELLA

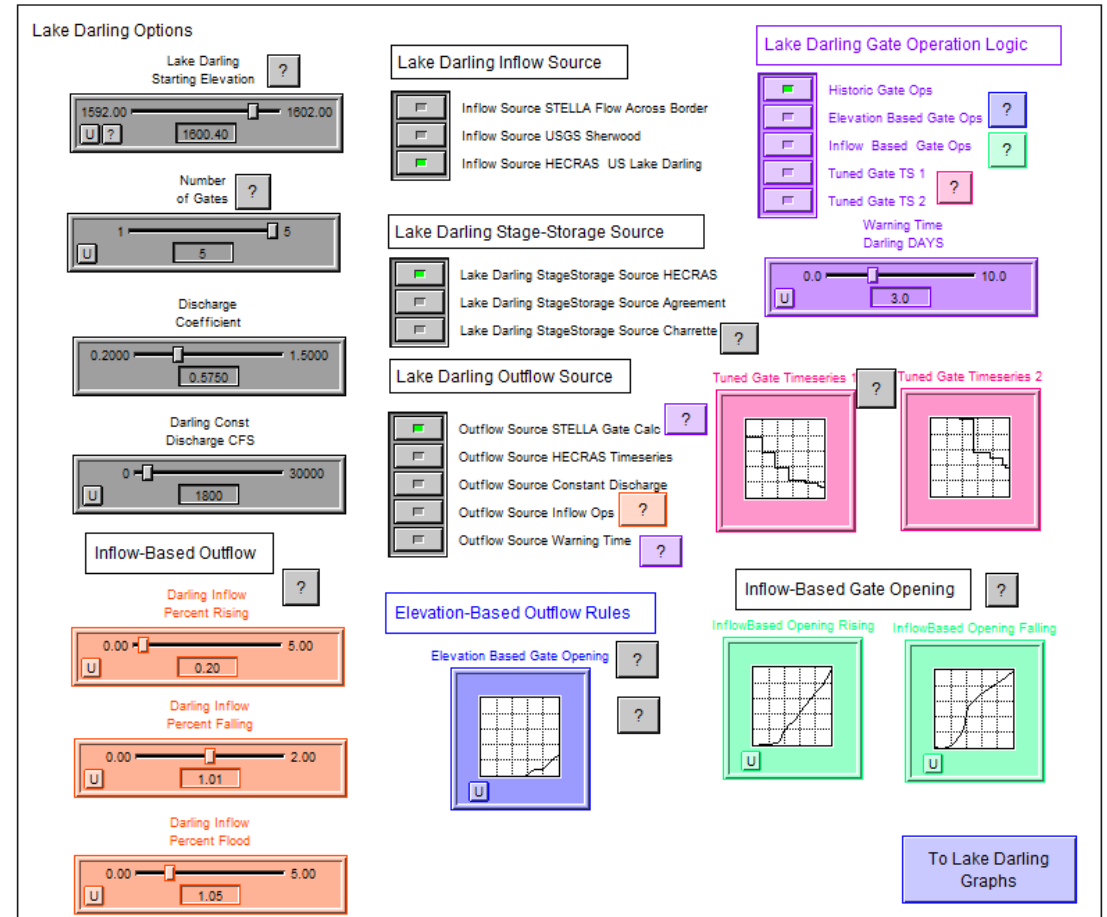
River stages match, but not as well as flow because of simplified hydraulics in STELLA

➤ That's why we re-run the alternatives in HEC-RAS

Scenario Formulation in STELLA

- STELLA helps us ask “what if...?” questions
- User controls for scenario formulation
 - Initial conditions
 - Activation of alternatives
 - Variable operating rules
 - Capacity parameters
 - Simulation period (June 2011, design events)
 - Data sources
- Interactive output – results in seconds!
 - Flood stages throughout the system
 - Flows throughout the system
- Allows for quick screening of alternatives

User Interface for Lake Darling Dam



Alternatives to Mitigate the 2011 Flood of Record

Alternative 1

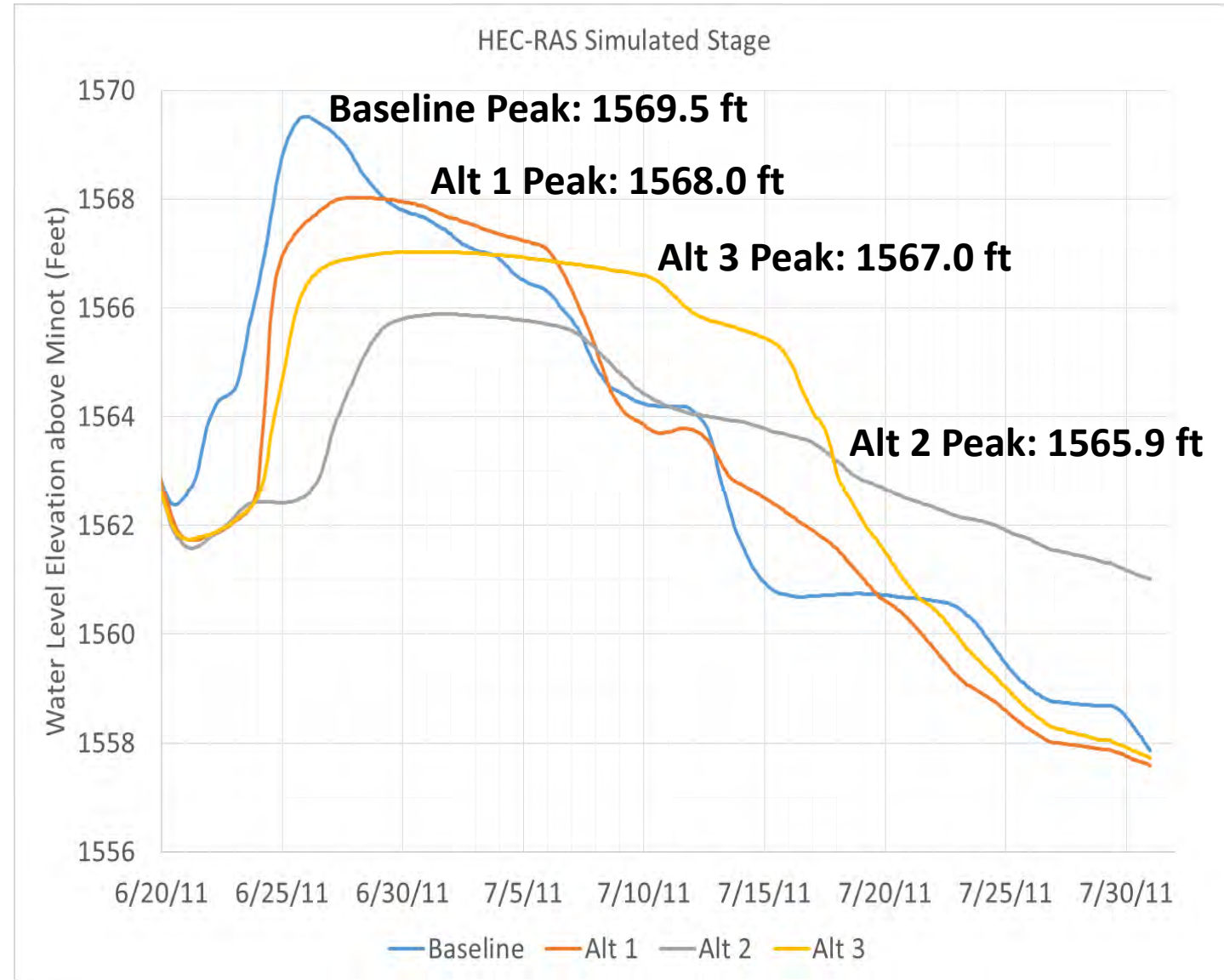
- Change in dam operations at Lake Darling

Alternative 2

- Change in dam operations at Rafferty, Boundary, Alameda, and Lake Darling

Alternative 3

- Increase storage in Lake Darling by raising Maximum Available Flood Level to 1606 feet



Benefits and Costs for Sites and Alternatives

Alternative	Benefits (2015 \$)	Costs (2015 \$)	Net Present Value (Benefits minus Costs)	Benefit-Cost Ratio (Benefits Divided by Costs)
Project and Buyouts				
2015 NDRC Phase 2 Project	\$658,417,000	\$414,758,000	\$243,659,000	1.587
Project plus Buyout of Sites 1, 2, & 4	\$676,627,000	\$421,698,000	\$254,929,000	1.605
Project, Buyouts, and Changes to Upstream Reservoirs				
Alternative 1	\$746,527,000	\$421,698,000	\$324,829,000	1.770
Alternative 2	\$998,211,000	\$421,698,000	\$576,513,000	2.367
Alternative 3	\$825,345,000	\$456,655,000	\$368,690,000	1.807

Key Findings

- Potential to lower flood stages and save costs with operational guidance (\$100M+)
- Reduce flood damage risk with targeted buyouts
- Greater safety factor in flood events
- Agencies that can benefit from DST support:
 - State of North Dakota
 - USFWS
 - ISRJB
 - USACE
 - Canadian Water Security Agency
 - ABRI



Ribbon cutting for Minot Water Treatment Plant Flood Protection Project, 2017. Mouse River Plan Photo



Lake Darling, Upper Souris NWR. USFWS Photo



J. Clark Salyer NWR. USFWS Photo

Acknowledgements



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