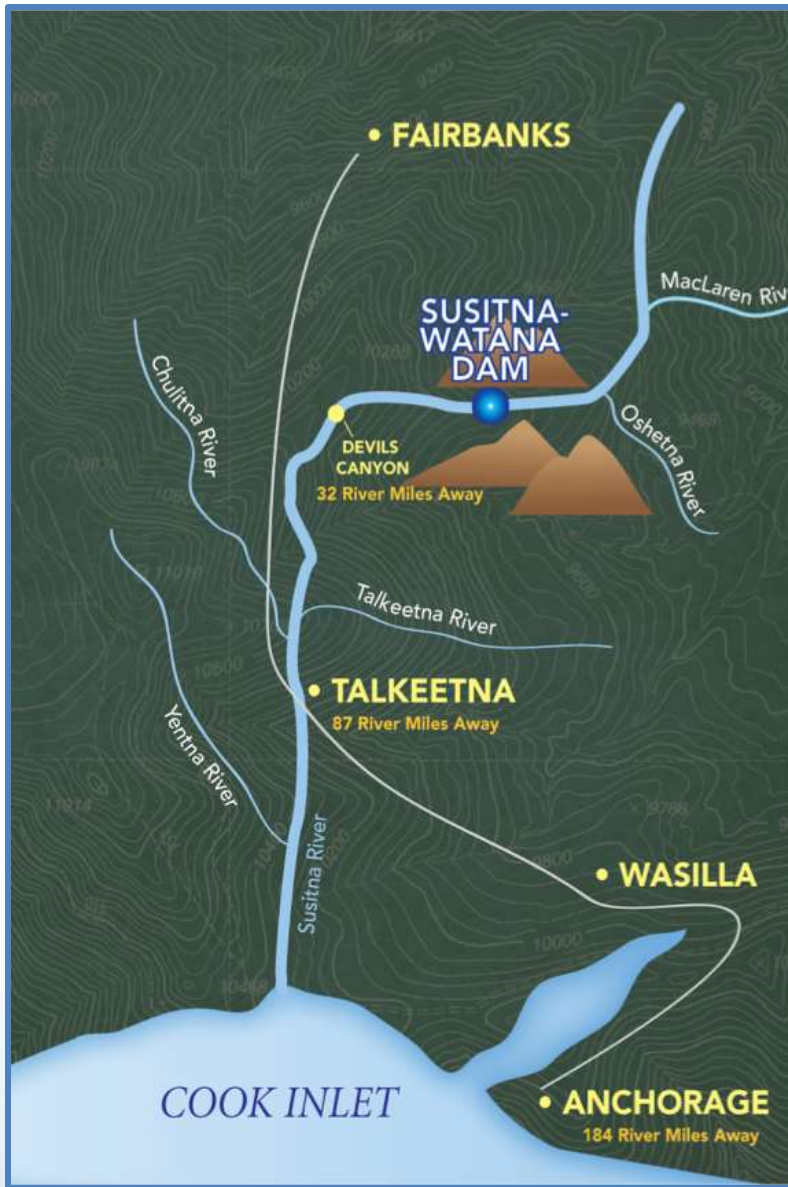


Technical WorkGroup Meeting Q4 2013 TWG

RSP 7.6 *Ice Processes Studies - Update* Dec. 2, 2013

Prepared by:
Jon Zufelt, PhD, PE,
Steve Ertman, PhD, PE
HDR, Inc.



RSP 7.6 – Presentation Overview ²

- *Camera maintenance and prep for Freeze-up*
- *Modeling Integration meetings (Nov 13-15)*
- *Modeling efforts*
 - *Middle River (River1D, River2D)*
 - *Lower River (HEC-RAS)*
- *Fall freeze-up data acquisition program*
- *White paper review of existing hydropower projects*

Camera Maintenance

- *October Maintenance/Prep*
 - *2013 Breakup used 12 cameras*
 - *2 cameras were lost during breakup, 4 cameras did not provide very useful info*
 - *14 cameras prepped for Freeze-up, some positions/views altered to provide better coverage*
 - *Set to 15 minute interval, new batteries/cards*
 - *Locations coordinated with FA GW study cameras*
 - *3 sites to be installed if permits are issued for ANCSA lands*



RSP 7.6 – Q4 2013 Update

Camera Locations (LR)

4



RSP 7.6 – Q4 2013 Update Camera Locations (MR)



RSP 7.6 – Q4 2013 Update

Camera Maintenance

6



Rustic/Susitna Landing sites PRM 64.2/65.2
Provides entire width of river

SUSITNA-WATANA HYDRO *Clean, reliable energy for the next 100 years.*

DRAFT – SUBJECT TO REVISION

RSP 7.6 – Q4 2013 Update

Camera Maintenance

7



DS FA-113 (Oxbow 1) PRM 113
Good view of entire width of river
Historic jamming location

SUSITNA-WATANA HYDRO *Clean, reliable energy for the next 100 years.*

DRAFT – SUBJECT TO REVISION

RSP 7.6 – Q4 2013 Update

Ice Processes Modeling and Analysis

8

- Key Ice Questions:
 - How does ice cover formation, growth, jamming affect main channel and lateral habitats?
 - Will operational scenarios significantly change the ice impacts on main channel and lateral habitats?
 - Freeze-up processes
 - Mid-winter conditions
 - Breakup jamming

ESS40, PRM 106.8

Freeze-up 2012

9

2012/11/10 09:00:44SUSITNA RVR ABV WHISKER CRK RM 103.0, ESS40



ESS40, PRM 106.8

Freeze-up 2012

2012/11/20 15:00:07 SUSITNA RVR ABV WHISKER CRK RM 103.0, ESS40



ESS40, PRM 106.8

Freeze-up 2012



Slough 8A, PRM 127.9

Freeze-up 2012

12



SUSITNA-WA



1 HOUR

SLU8A

NOV.08,12 02:00 PM

DRAFT – SUBJECT TO REVISION

Slough 8A, PRM 127.9 Breakup 2013

13



SUSITNA-WAT



15 MINUTES

SLU8A

MAY.29,13 01:00 PM

DRAFT – SUBJECT TO REVISION

RSP 7.6 – Q4 2013 Update

General Modeling Approach

14

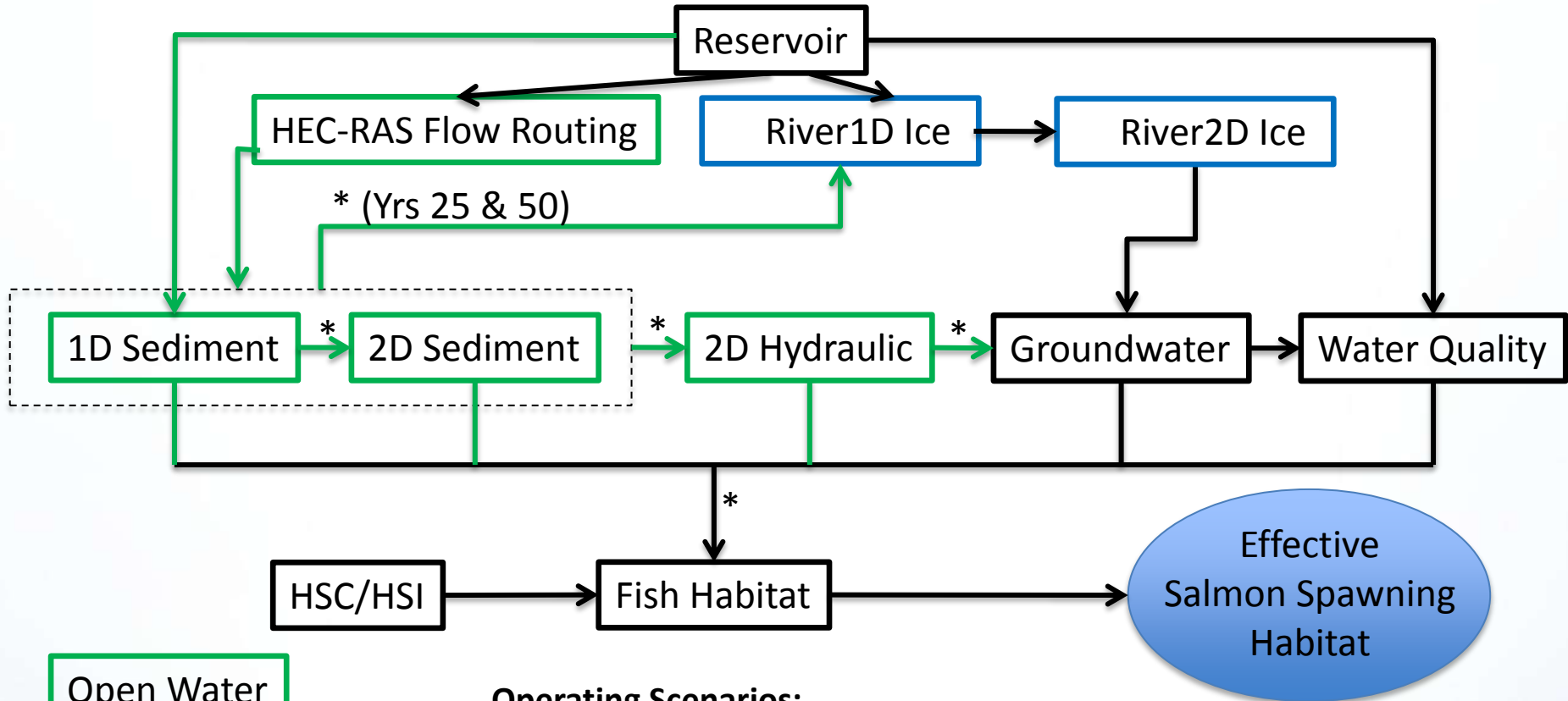


Dynamic ice modeling
Temperature modeling
Ice generation/growth
Discharge
Stage/under-ice depth
Velocity
Ice thickness

Static ice cover (specified)
Temperature modeling
Discharge
Stage/under-ice depth
Velocity (2D)

Ice Processes Modeling Team
Study Lead: Jon Zufelt
Lead Modeler: Steve Ertman
U of A: Faye Hicks, Julia Blackburn

Model dependencies flow chart



- Open Water
- Ice Cover
- Both

Operating Scenarios:

- Base Load
- Intermediate Load Following
- Maximum Load Following
- Run of the River

River1D Hydraulic Overview

- *One-dimensional hydraulic flood-routing model*
- *Detailed compound channels*
 - *Main channel*
 - *Right and left overbanks*
- *Channel resistance (calibration parameter)*
 - *Manning's n*
 - *Roughness height*
- *Simulates steady or unsteady flows*

River1D Hydraulics-- Continued

- *Boundary Conditions*
 - *Upstream Inflow discharge hydrograph*
 - *Lateral inflow discharge hydrographs*
 - *Downstream stage hydrograph or normal depth*
- *Initial Conditions*
 - *Base flow*
 - *Initial water-surface elevation*

River1D Ice-Processes Modeling

- *Conservation of thermal energy*
 - *Heat exchange between water and atmosphere*
 - *Heat exchange between ice and atmosphere*
 - *Heat exchange between ice and water*
- *Frazil ice forms when water drops below 0 °C*
 - *Frazil slush collects below ice cover*
 - *Frazil ice rises as floes and aggregates as new cover*
- *Pore water also freezes to form new ice cover*

River1D Ice-Processes -- Continued

- *Heat transferred to ice cover or frazil slush from atmosphere or water results in melting*
- *Ice front progresses upstream from ice bridges*
 - *Juxtaposition of ice floes traveling downstream*
 - *Bridge locations must be specified ****
- *Channel cross sections occluded by ice and additional hydraulic resistance of ice cover can result in dramatic changes to river stage.*



River1D Ice-Processes Modeling

- *Additional data requirements:*
 - *Air temperature*
 - *Inflow water temperature at upstream boundary*
 - *Inflow ice conditions at upstream boundary*
 - *Suspended frazil concentration*
 - *Surface ice concentration*
 - *Frazil floe thickness*
 - *Solid ice thickness*
 - *Locations and timing of ice bridges*



River1D Ice-Processes Modeling

- *Calibration data requirements:*
 - *Water temperature*
 - *Ice front position with time*
 - *Solid and frazil ice concentrations*
 - *Ice thickness*
- *Output of River Ice-Processes Model*
 - *Water temperature*
 - *River stage*
 - *Ice profile (both position and thickness)*



Ice-Processes Modeling

- ***Capabilities Enhancements for River1D Model***
 - Effort led by Dr. Faye Hicks, River Ice Research Group, University of Alberta (UA)
 - HEC-RAS to River1D geometry file converter
 - Ability to model compound channels (i.e., main channel and left/right overbanks)
 - Ability to model natural cross-section geometry
 - Ability to work directly with Imperial or SI units
 - Updating User Manual to reflect new capabilities.



RSP 7.6 – Q4 2013 Update

River1D Model Middle River

23

- Surveyed geometry at 88 cross sections
 - Main channel only. Awaiting overbank geometry to be developed by others from high-res LiDAR, MatSu LiDAR.
 - Interpolated cross sections at 0.2-mile spacing.
- Main-channel Manning's n from R2's HEC-RAS open-water model. Need overbank roughness.
- Upstream inflow hydrograph from USGS 15291700 (Susitna River above Tsusena Creek).
 - Calibration interval: August 11-17, 2012

River1D Model Middle River – cont'd

- HDR validating lateral inflows at request of UA.
- Steady-flow test run conducted with successful convergence.
- Unsteady, open-water calibration (calibration interval: August 11-17, 2012) matched R2's results.
- Additional in-channel open water calibration runs to be conducted.
- HDR continues to collect and compile winter data to support ice-processes modeling.
- Input data needs for River2D open water modeling identified

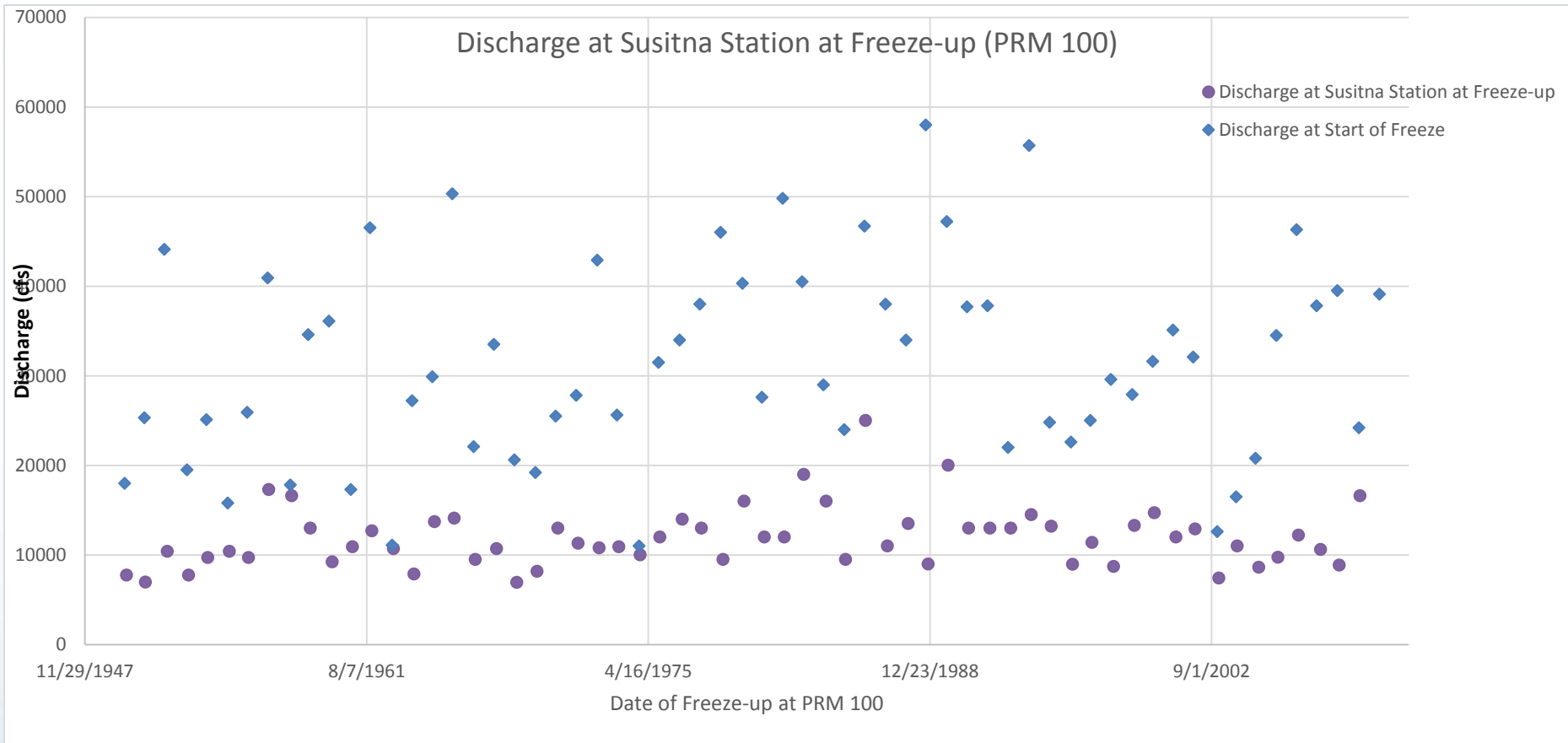


HEC-RAS Modeling -Lower River

- Goal of the Lower River modeling to assess effects of increased winter flows on winter water and ice levels at two sites (Sunshine and Susitna Station)
- Uses existing data gathered in other studies
- In a steady sense, addition of an ice cover at Susitna Station raises the stage 6 feet (corresponds to measured freeze-up PT data)
- Raising January flow from 10K to 18K cfs results in an additional 2 ft of stage (steady model)
- Freeze-up discharges vary widely under natural conditions

RSP 7.6 – Q3 2013 Update

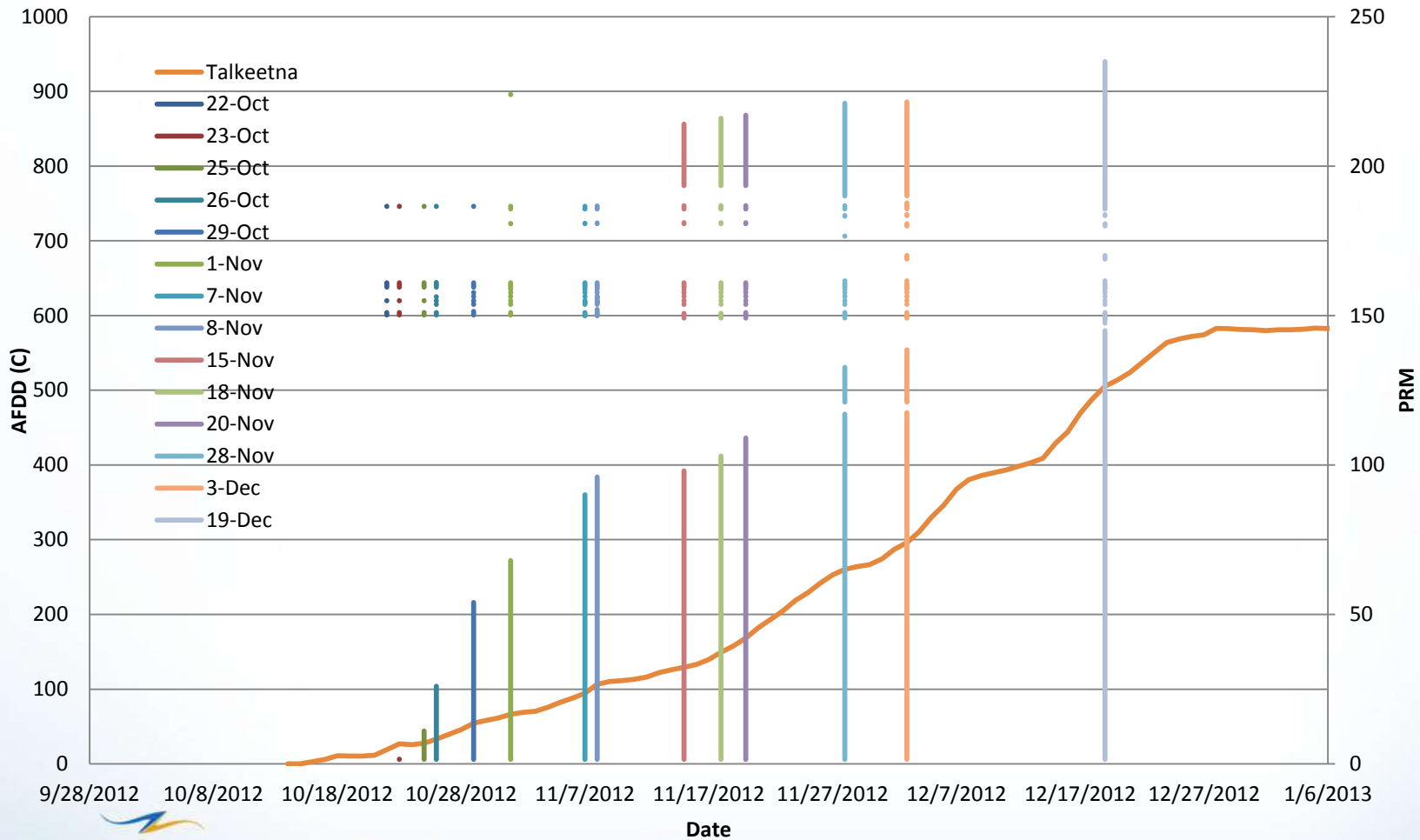
HEC-RAS Modeling -Lower River



RSP 7.6 – Q3 2013 Update

2013 Freeze-up

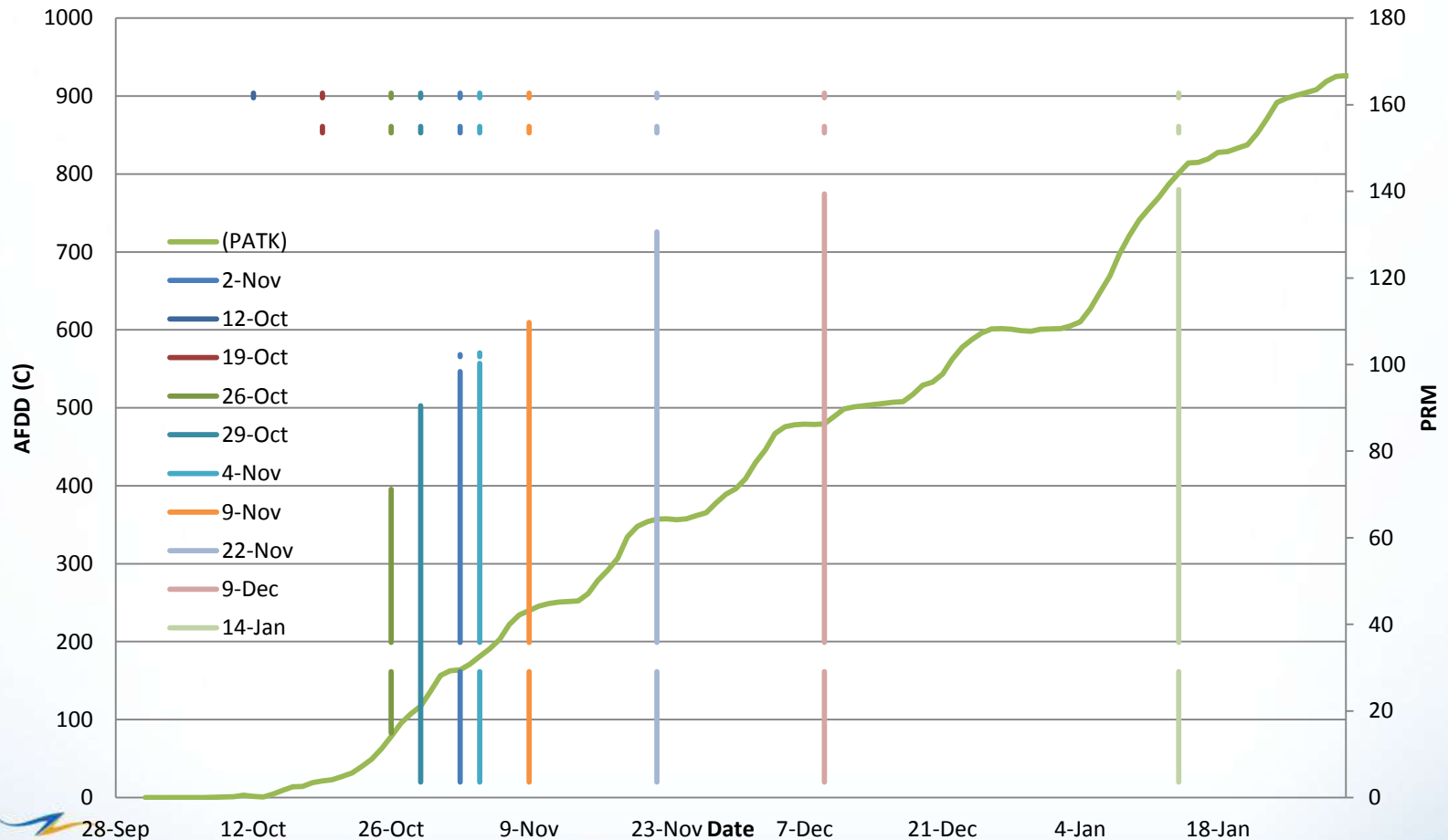
Freeze-up 2012



RSP 7.6 – Q3 2013 Update

2013 Freeze-up

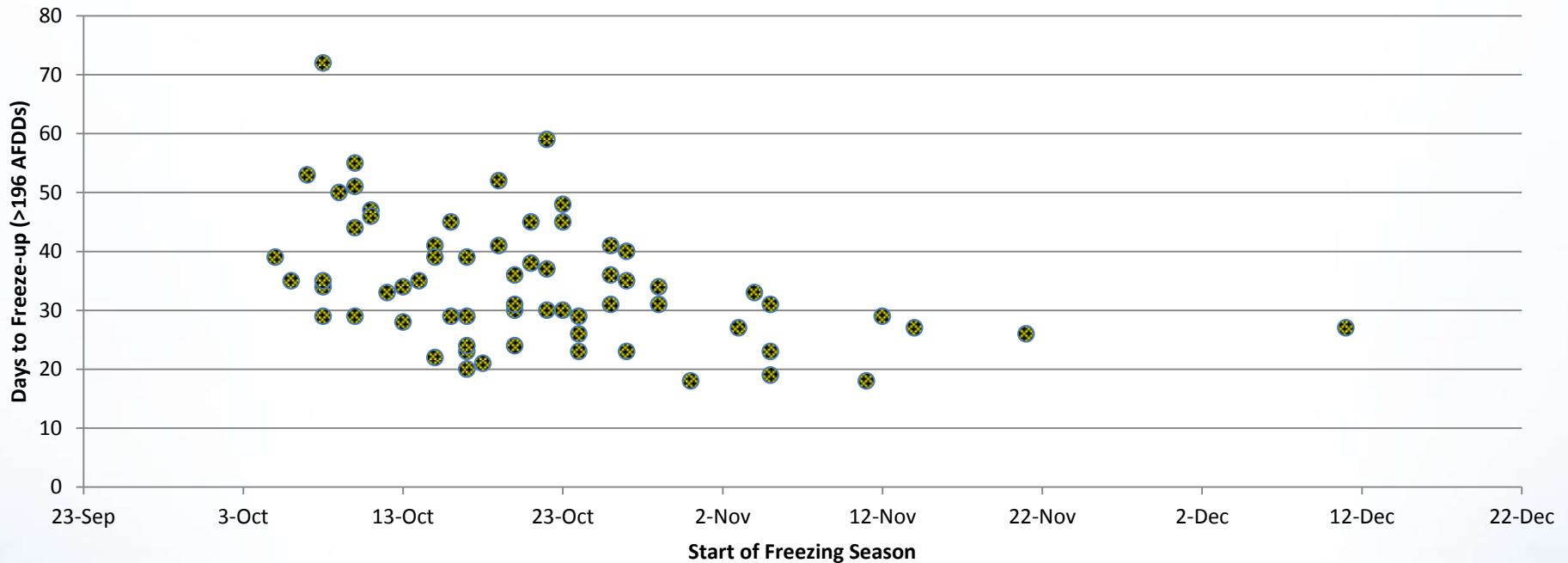
Freeze-up 1982



RSP 7.6 – Q3 2013 Update

2013 Freeze-up

**Number of Days to Freeze
vs.
Freezing Start Date**



Number of days for cover to progress to PRM 100 based on Talkeetna temperatures. Start of Freezing this year is Nov 6, 2013.

RSP 7.6 – Q3 2013 Update

2013 Freeze-up

30



11/06 Lower River – light frazil



11/06 PRM 197 – few areas covered

RSP 7.6 – Q3 2013 Update

2013 Freeze-up



11/12 Su Station



11/12 Massive frazil jams in Canyon

RSP 7.6 – Q3 2013 Update

2013 Freeze-up

32



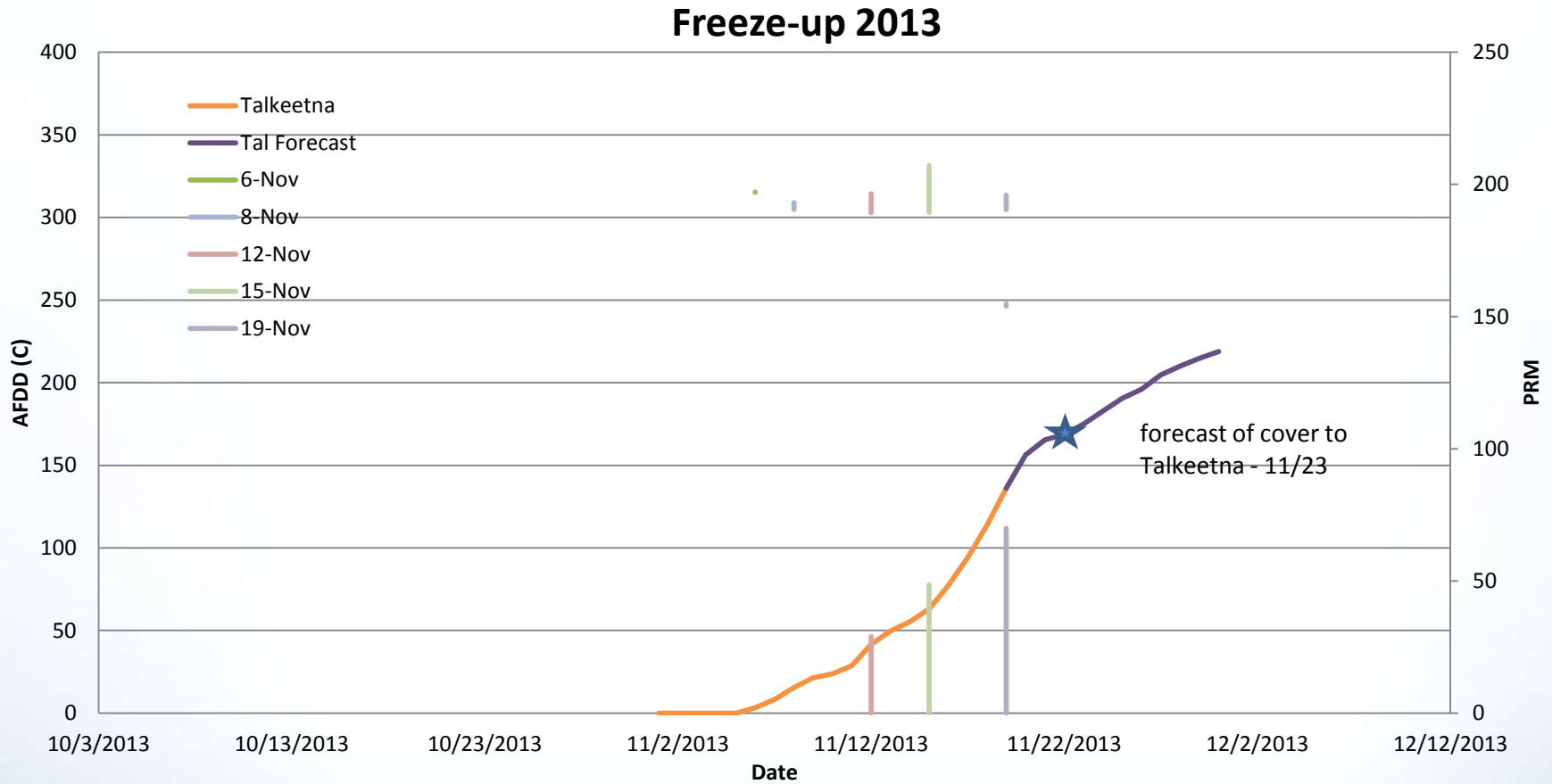
11/19 - Su Station and Yentna River stopped



11/19 - FA 104 Whiskers Slough main channel still open, slough frozen over

RSP 7.6 – Q3 2013 Update

2013 Freeze-up



RSP 7.6 – Q3 2013 Update

2013 Freeze-up

Susitna River Above Whiskers Creek (ESS40):
Water Height over Sensor - Average 15-Minute Values



— Water Height over Sensor (PT1)

From Michael Lilly
As of 0745 this morning

RSP 7.6 – Q3 2013 Update

2013 Freeze-up



Whiskers Slough
On 11/21/2013

RSP 7.6 – Q3 2013 Update

2013 Freeze-up

36



Whiskers Slough
On 11/25/2013

RSP 7.6 – Q3 2013 Update

2013 Freeze-up

37

Devil's Canyon

11/21/2013

11/25/2013



RSP 7.6 – Variances

- *No variances from Approved Study Plan*

RSP 7.6 – Next Steps

Plan for Q1 2104

39

- Continued River1D and River2D modeling (open and ice)
- 2013 Freeze-up observation program results
 - Data compilation for freeze-up modeling
 - Time Lapse Camera downloads when possible
- Open lead surveys in late January, mid-March
- Finalize White paper on impacts of hydropower (and non-hydropower changes) on winter ice regime