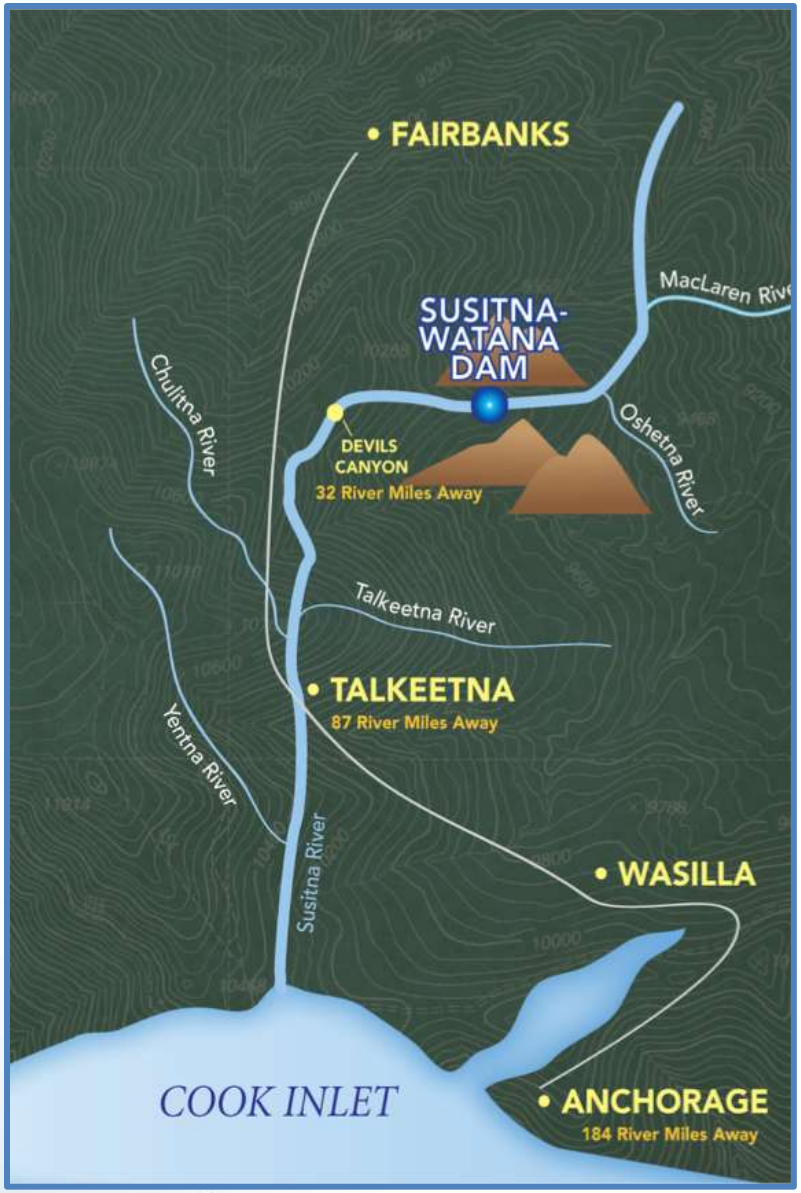


SUSITNA-WATANA HYDRO *Clean, reliable energy for the next 100 years.*

Technical Team Meeting

Riverine Modeling Proof of Concept

River1D Ice Processes Modeling

April 15-17, 2014

Prepared by HDR

Riverine TT Meeting Issues Raised

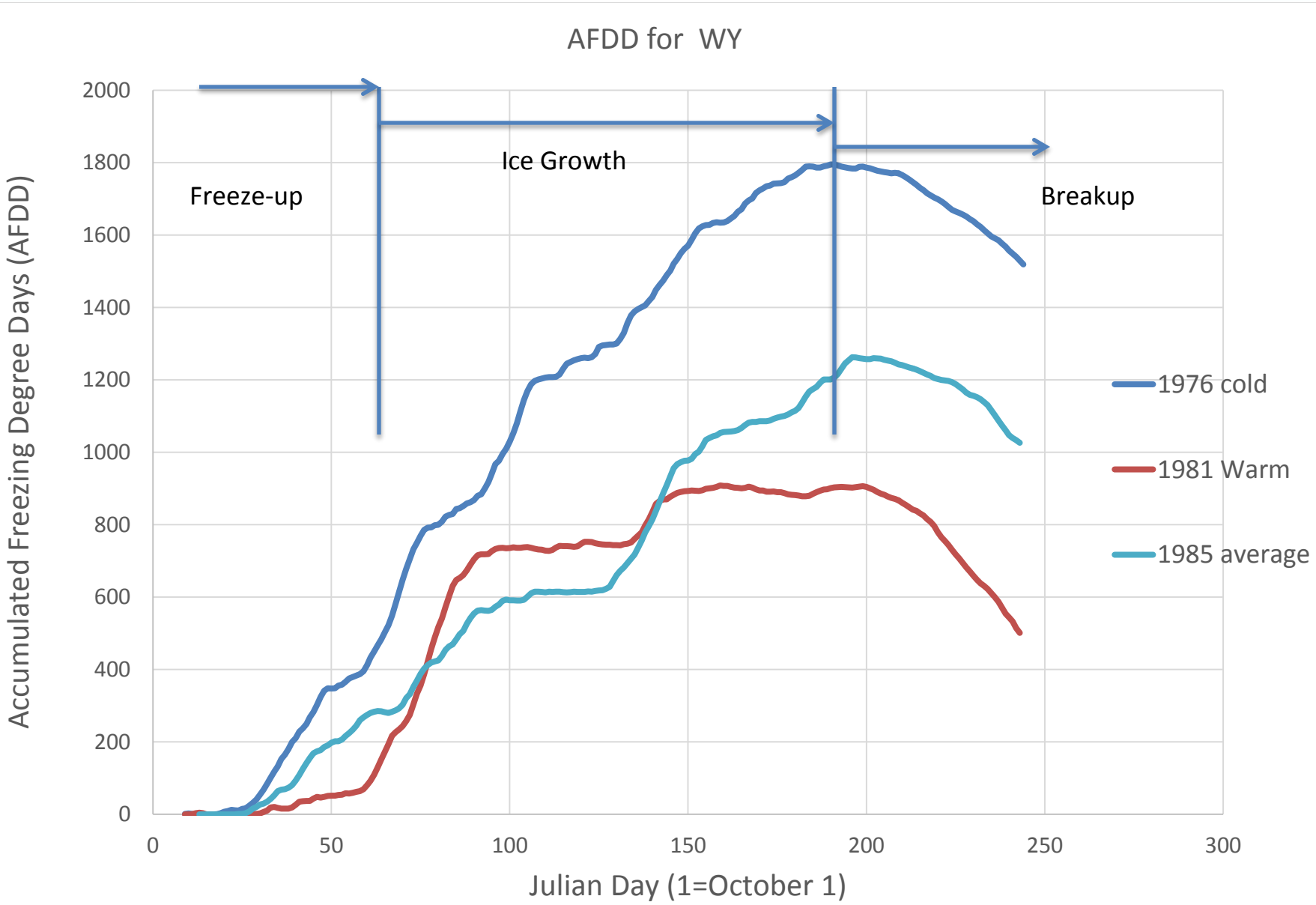
- How are the River1D and River2D models brought together?
- How will the transition from open to ice cover impact access to the lateral habitat? How to model?
- How will seasonal impacts/changes be modeled if River2D is only at specific times?
- How will the effects of load following be modeled?
- What about the dynamic conditions of load following?

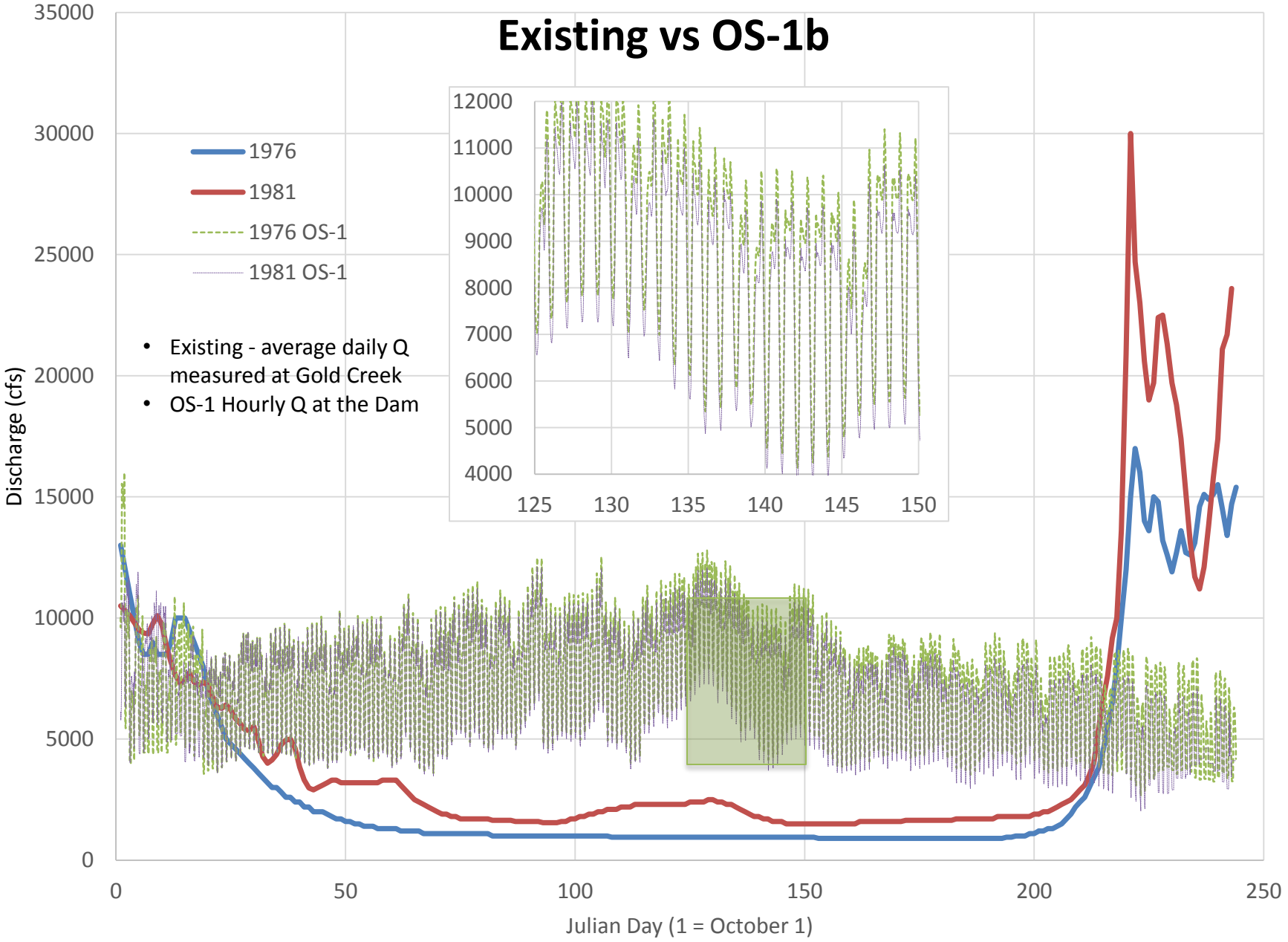
River1D Ice Modeling

- *River1D is a one dimensional hydraulic flood routing model*
- *Includes dynamic ice*
- *Provides output at specific cross section locations*
- *Bulk properties (1D output values) provide input and boundary conditions for River2D*
- *1D unsteady processes can be stepped through in the 2D model*

River1D Ice Modeling

- *Water temperature cool down*
  - *Function of air temperature, water temperature, wind, solar radiation, open water area, discharge*
- *Frazil ice formation*
  - *Function of air temperature, wind, open water area*
- *Frazil ice transport*
  - *Function of discharge, open area, existing covers*
- *Ice accumulation*
  - *Function of air temperature, velocity, river geometry*
- *Ice growth*
  - *Function of air temperature, snow cover*
- *Jam failure and movement/re-jamming*
  - *Function of discharge, under ice shear, ice strength*


AFDD for WY
Freeze-up
Ice Growth
Breakup
Accumulated Freezing Degree Days (AFDD)
Julian Day (1=October 1)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
50
100
150
200
250
300
1976 cold
1981 Warm
1985 average

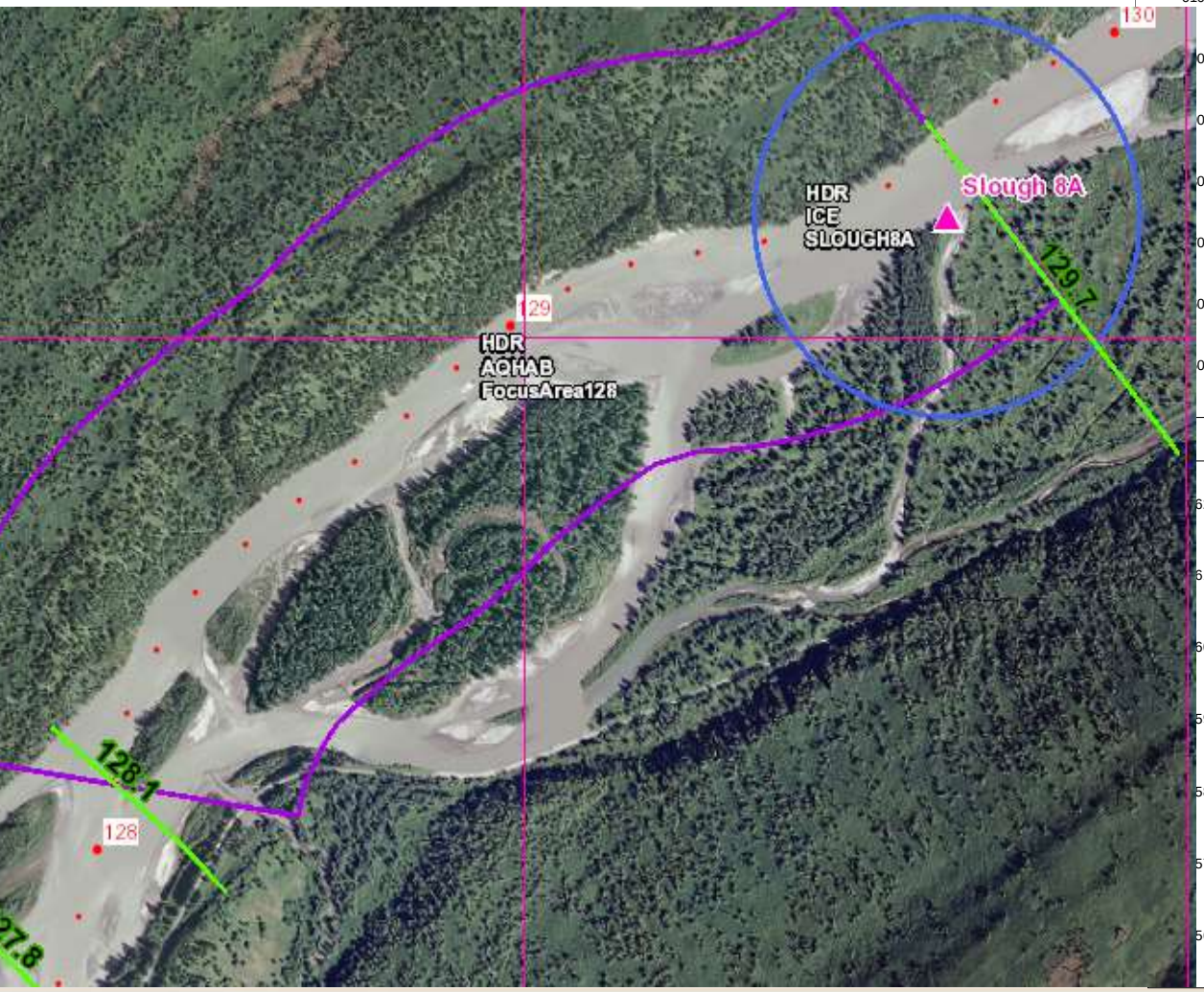

Existing vs OS-1b
1976
1981
1976 OS-1
1981 OS-1
• Existing - average daily Q measured at Gold Creek
• OS-1 Hourly Q at the Dam
Discharge (cfs)
Julian Day (1 = October 1)
0
5000
10000
15000
20000
25000
30000
35000
0
50
100
150
200
250
4000
5000
6000
7000
8000
9000
10000
11000
12000
125
130
135
140
145
150

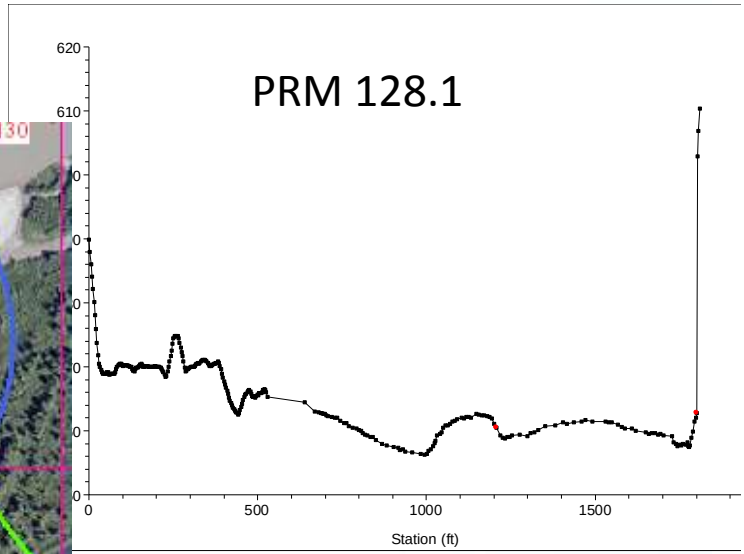
FA-128 (Slough 8A) River1D Modeling Example

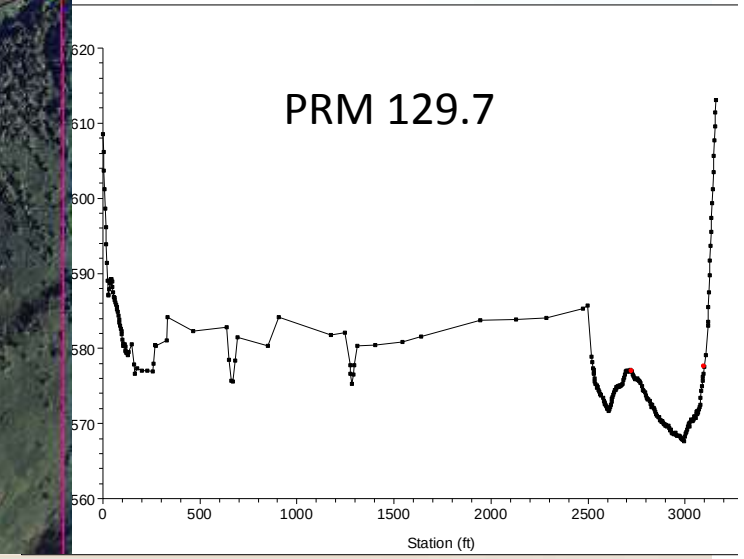
Caveats

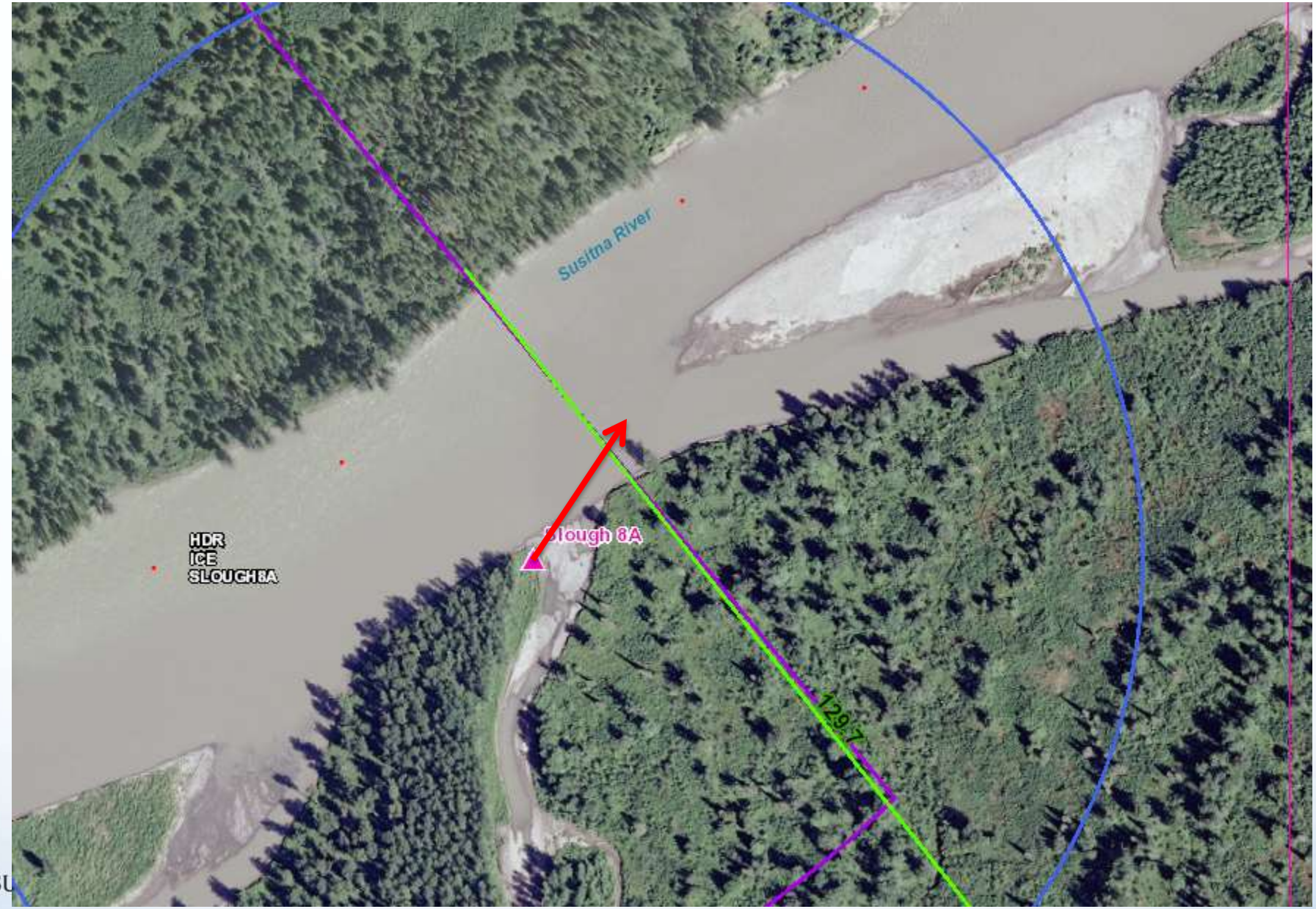
- *River1D model is not yet completed*
- *Proof of Concept by HEC-RAS Simulant, equations*
- *Same geometry files*
- *Similar flow routing equations*
- *Similar ice jamming force balance*
- *Similar ice impacts on flow*
- *HEC-RAS has no water temperature cool down, ice formation, ice transport, ice growth*
- *Water surface level, ice thickness provided as input to River2D*

FA-128 (Slough 8A) River1D Modeling Example








Susitna River
Slough 8A
HDR
ICE
SLOUGH8A
129.7

Slough 8A, PRM 129.7
Freeze-up 2012

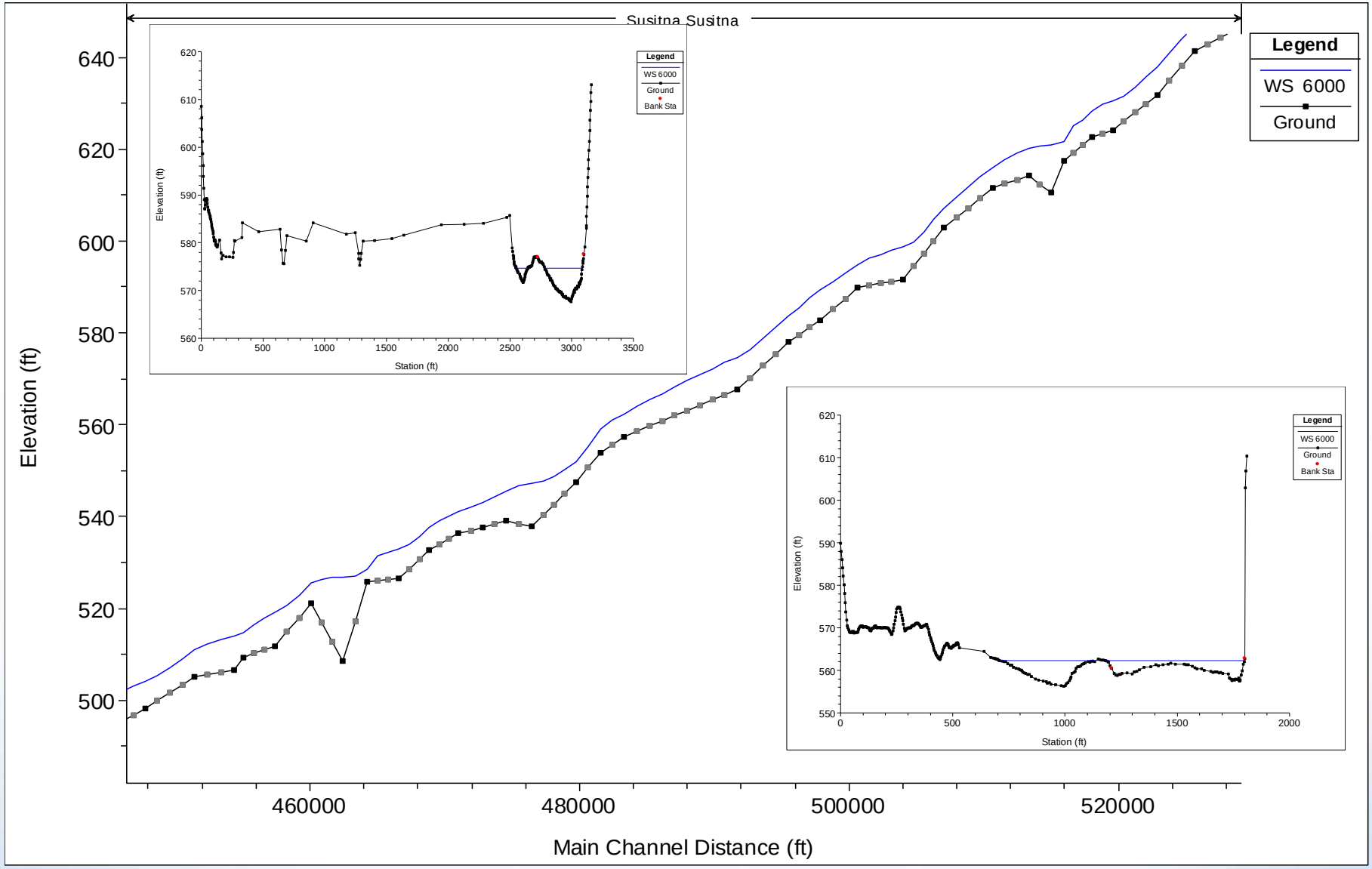
SUSITNA-WATA

Slough 8A, PRM 129.7
Freeze-up 2012

FA-128 (Slough 8A) River1D Modeling Example

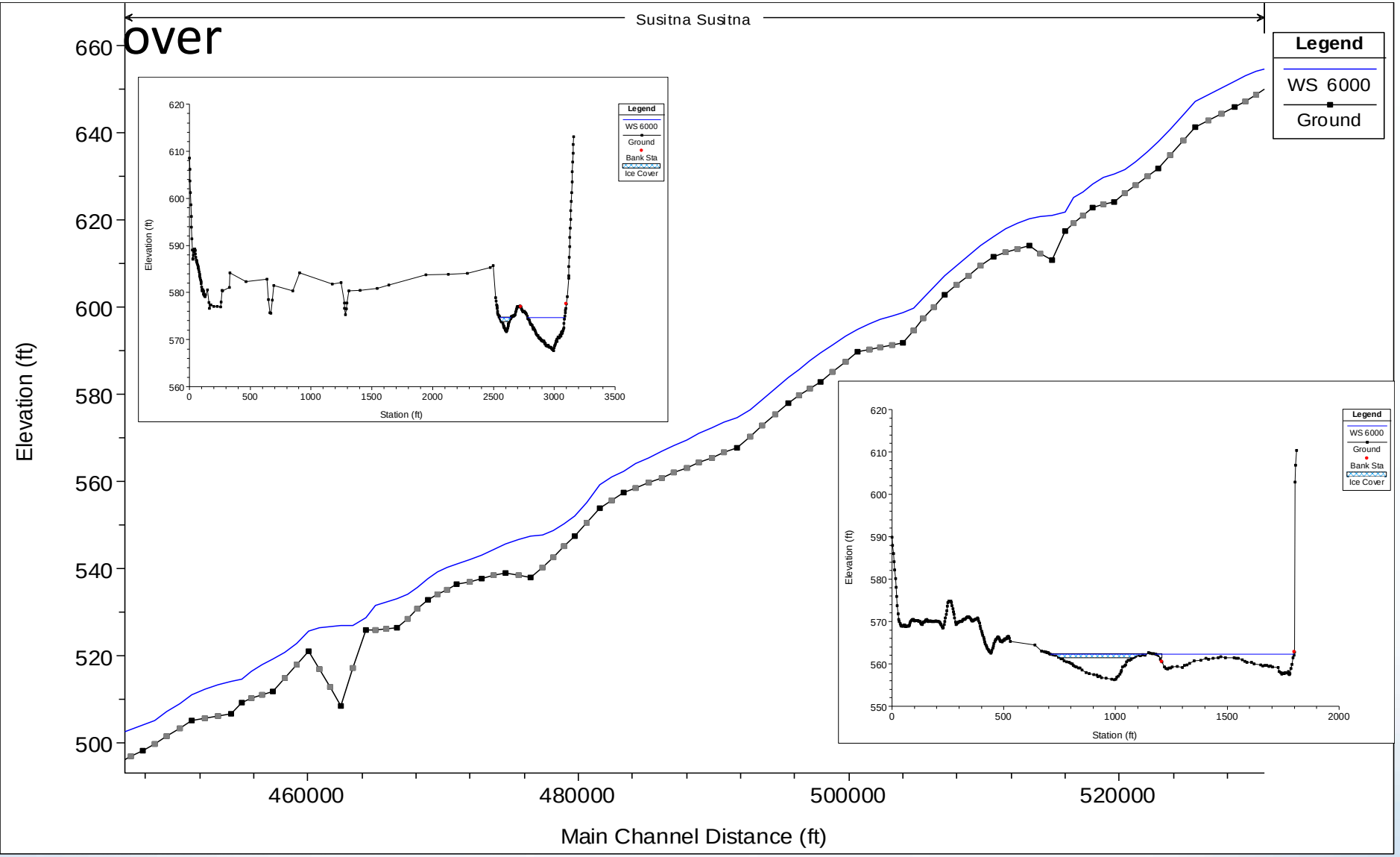
- 6,000 cfs – open water (Gold Creek)
- 6,000 cfs as freeze-up begins (side channels ice over)
  - November 1, 2012
- 6,000 cfs with freeze-up ice cover on main channel
  - November 20, 2012
- 2,000 cfs with freeze-up cover
  - Mid-winter, low flow conditions
- Progression of freeze-up ice cover at FA-128 (Slough 8A), 6,000 cfs
- Unsteady discharge, thermal decay

6,000 cfs – open water (Gold Creek)



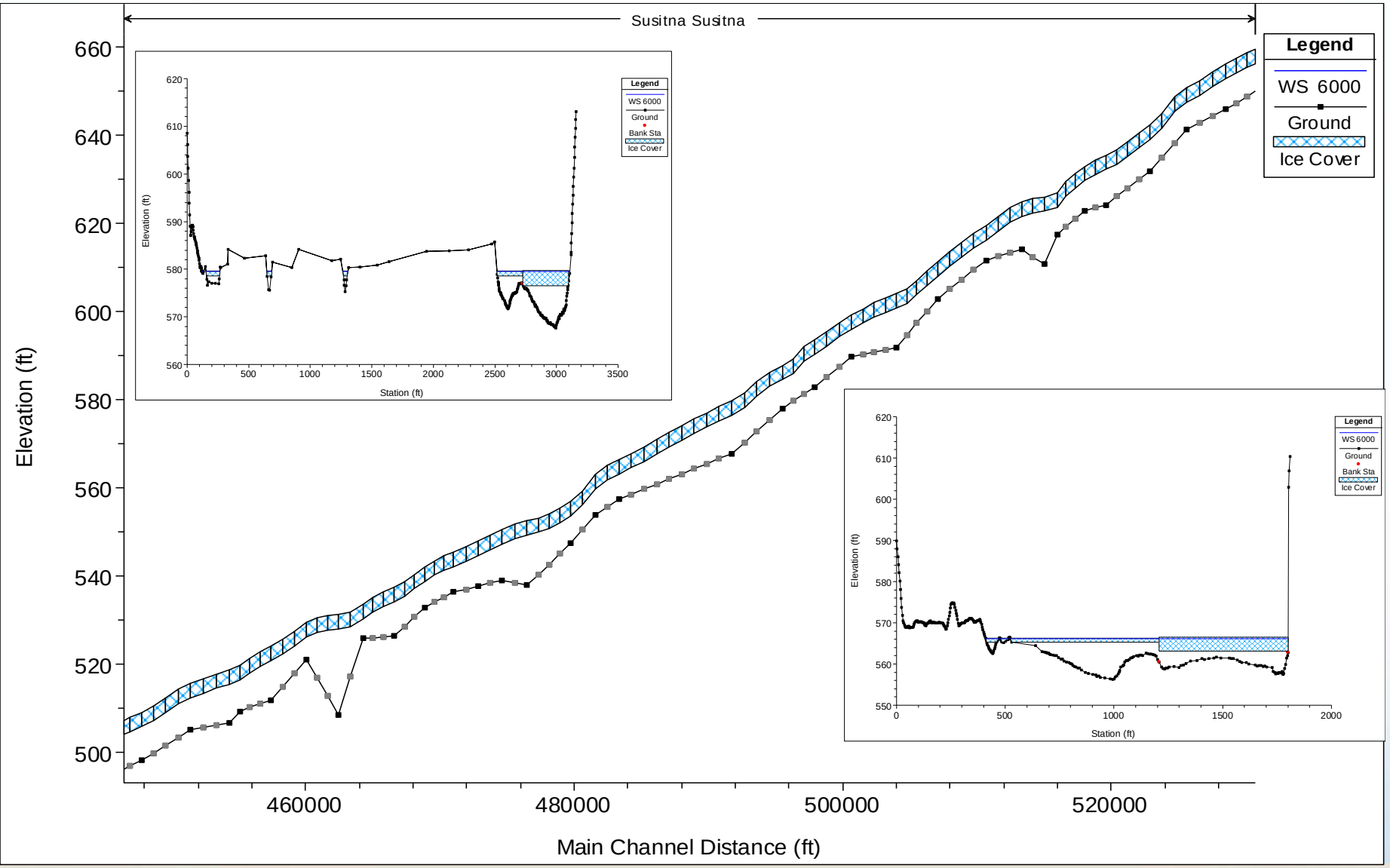
FA-128 (Slough 8A) on November 1, 2012
Early freeze-up conditions, ~6,000 cfs (Gold Creek)
Very close to open water

Early freeze-up, ~6,000 cfs, side channels freeze over



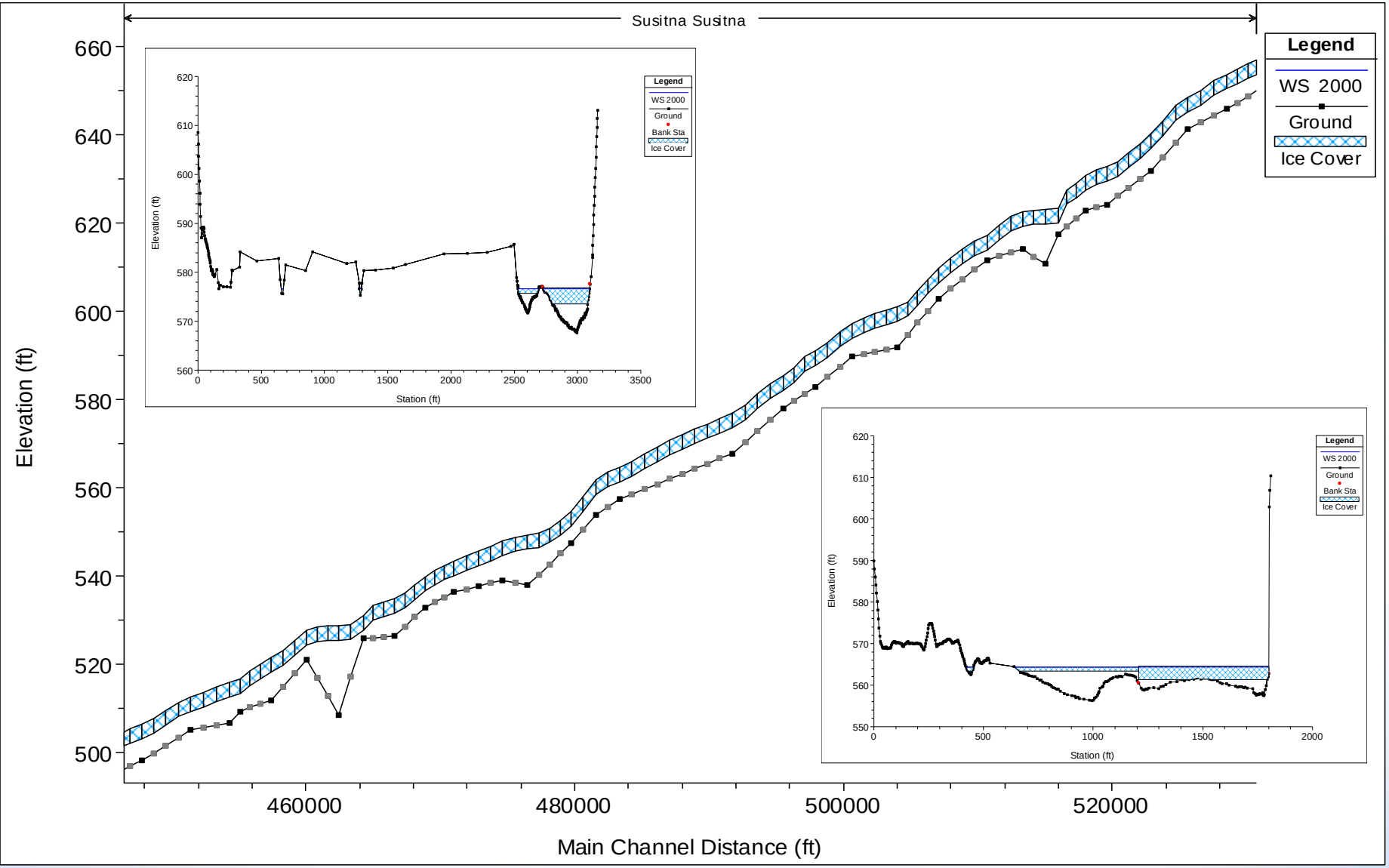
FA-128 (Slough 8A) on November 20, 2012
Sparse ice conditions, <6,000 cfs (Gold Creek)

6,000 cfs, freeze-up ice cover on main channel

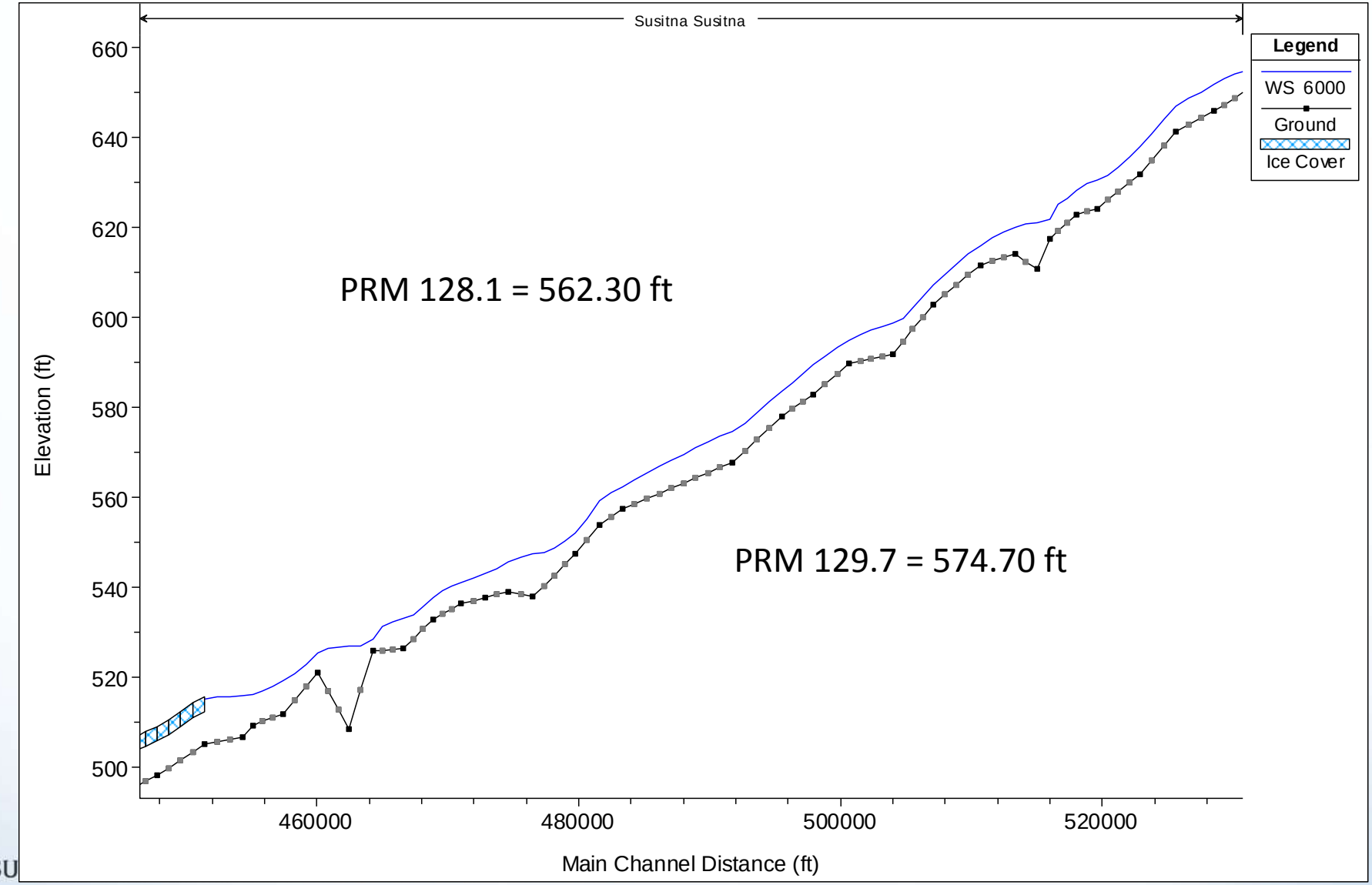


FA-128 (Slough 8A) on December 3, 2012 intermediate ice conditions, <6,000 cfs (Gold Creek)

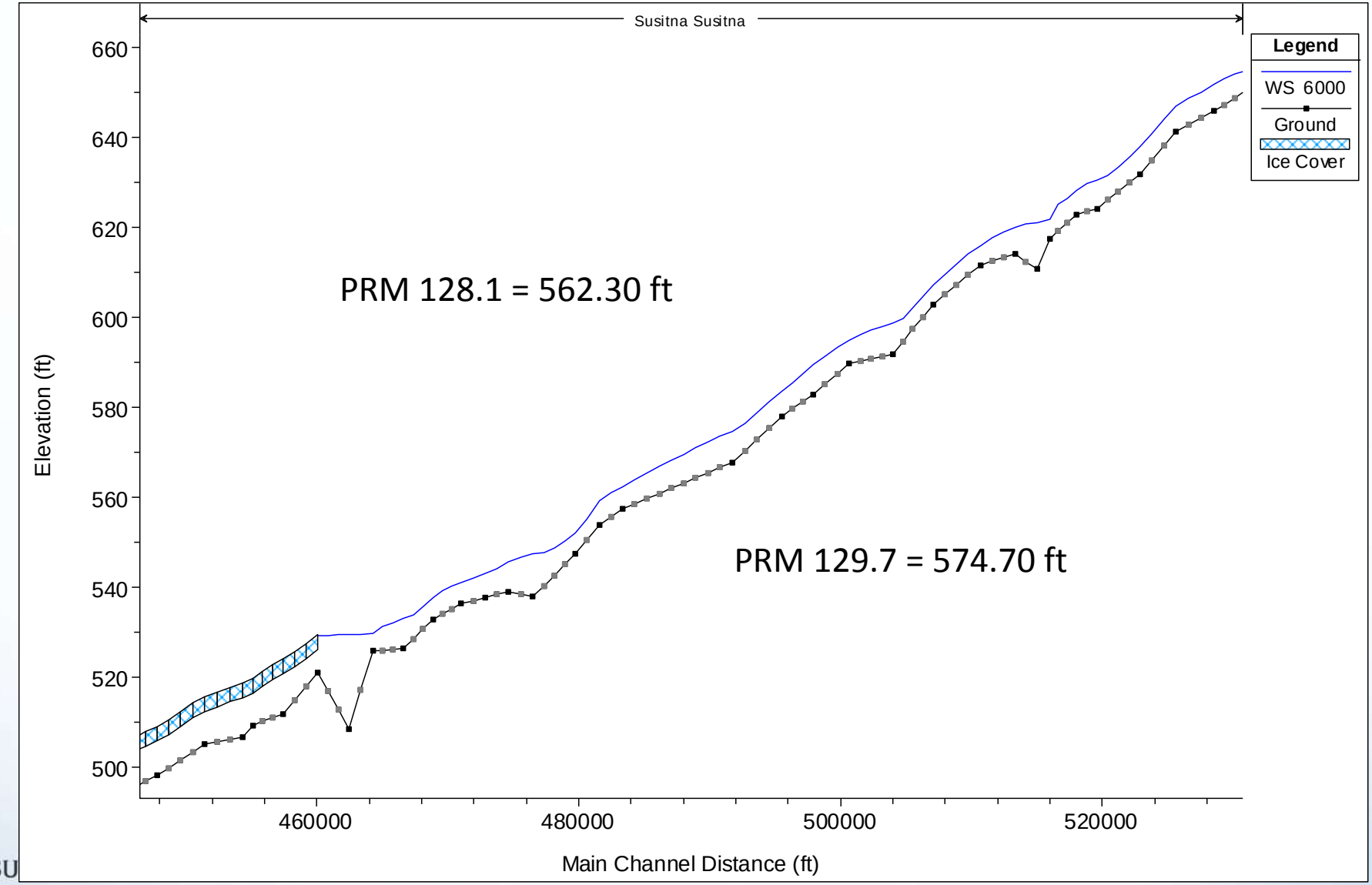
2,000 cfs with freeze-up cover



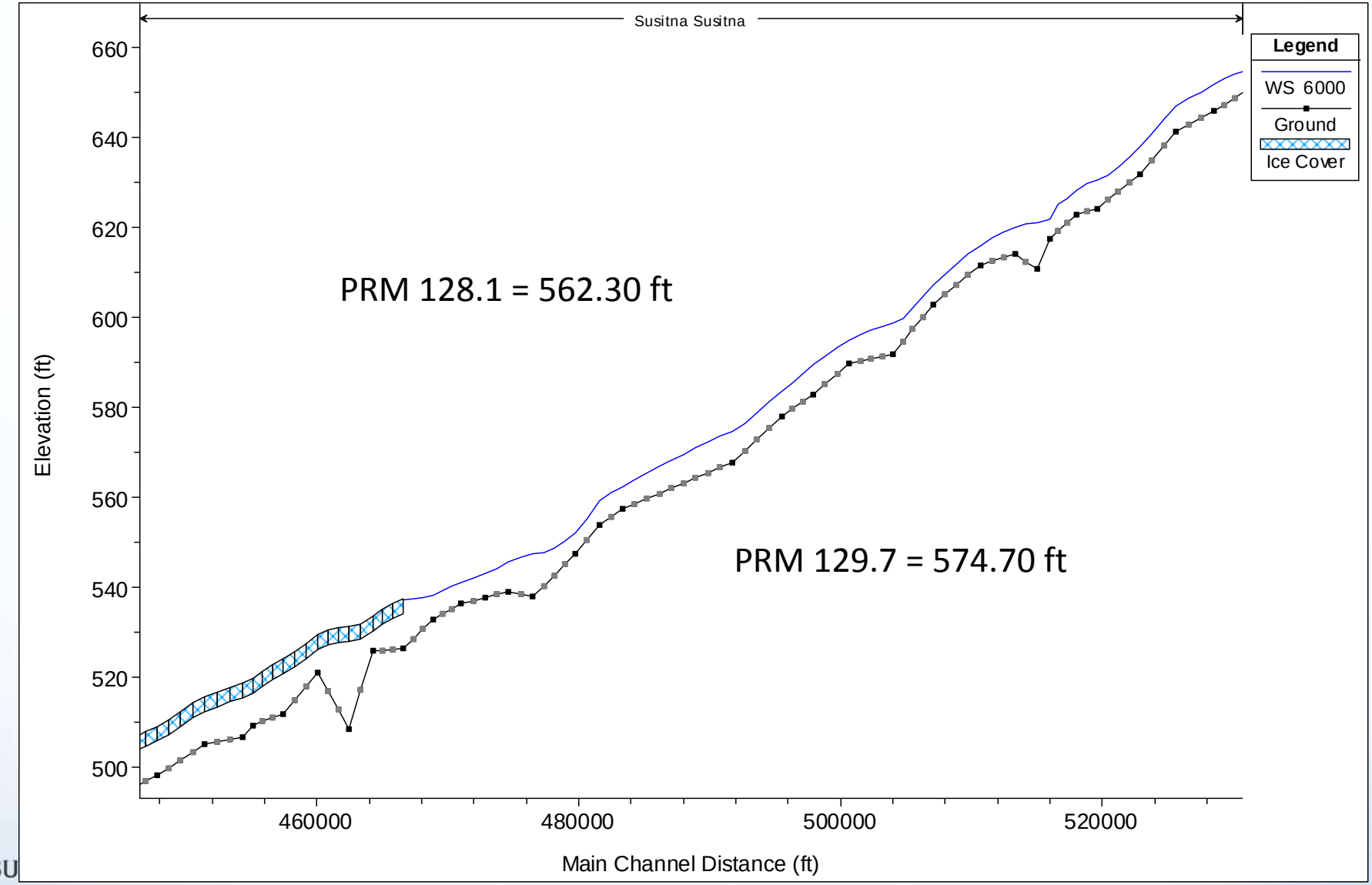
Progression of freeze-up at FA-128 (Slough 8A), 6,000 cfs



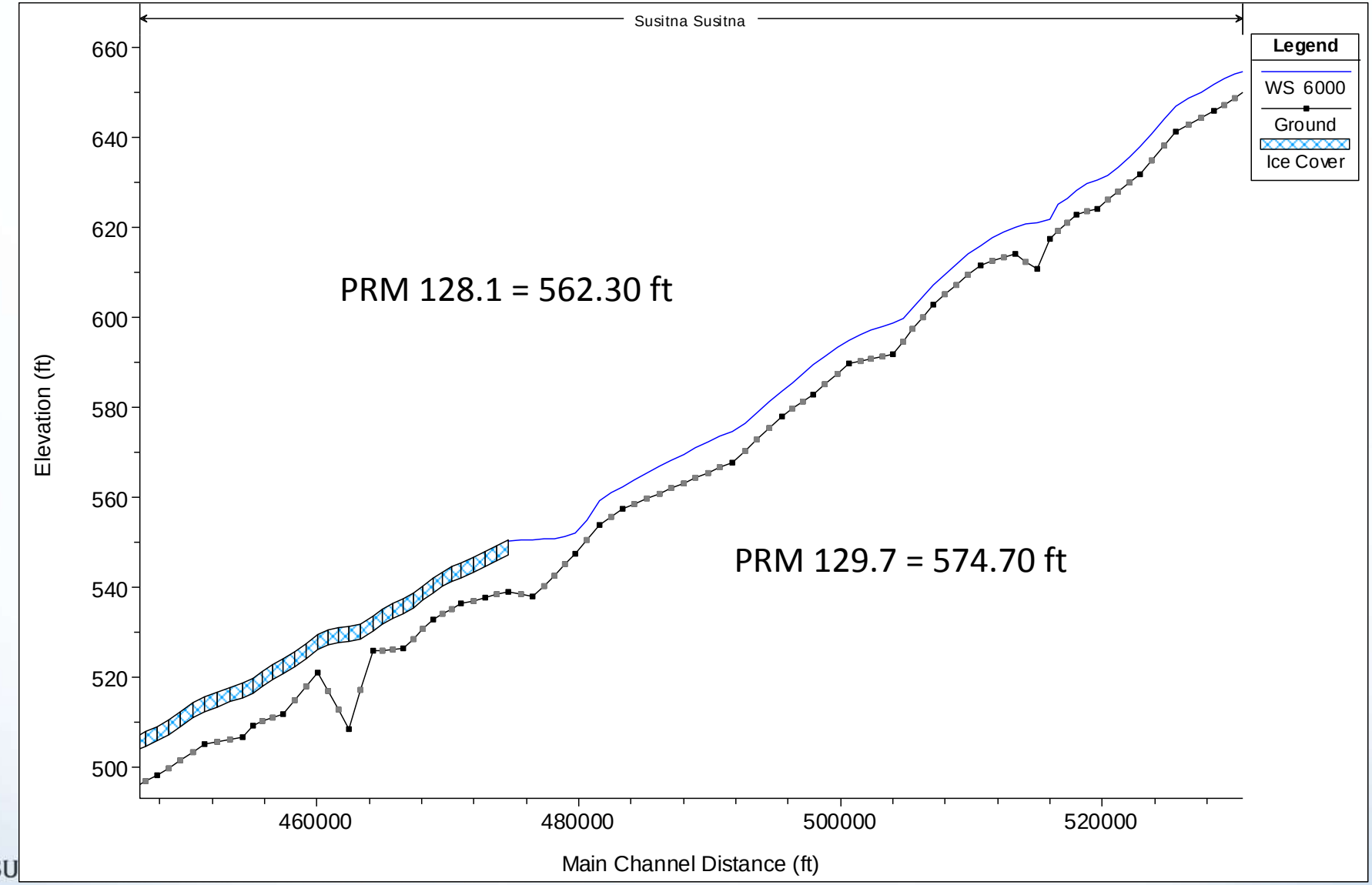
Progression of freeze-up at FA-128 (Slough 8A), 6,000 cfs



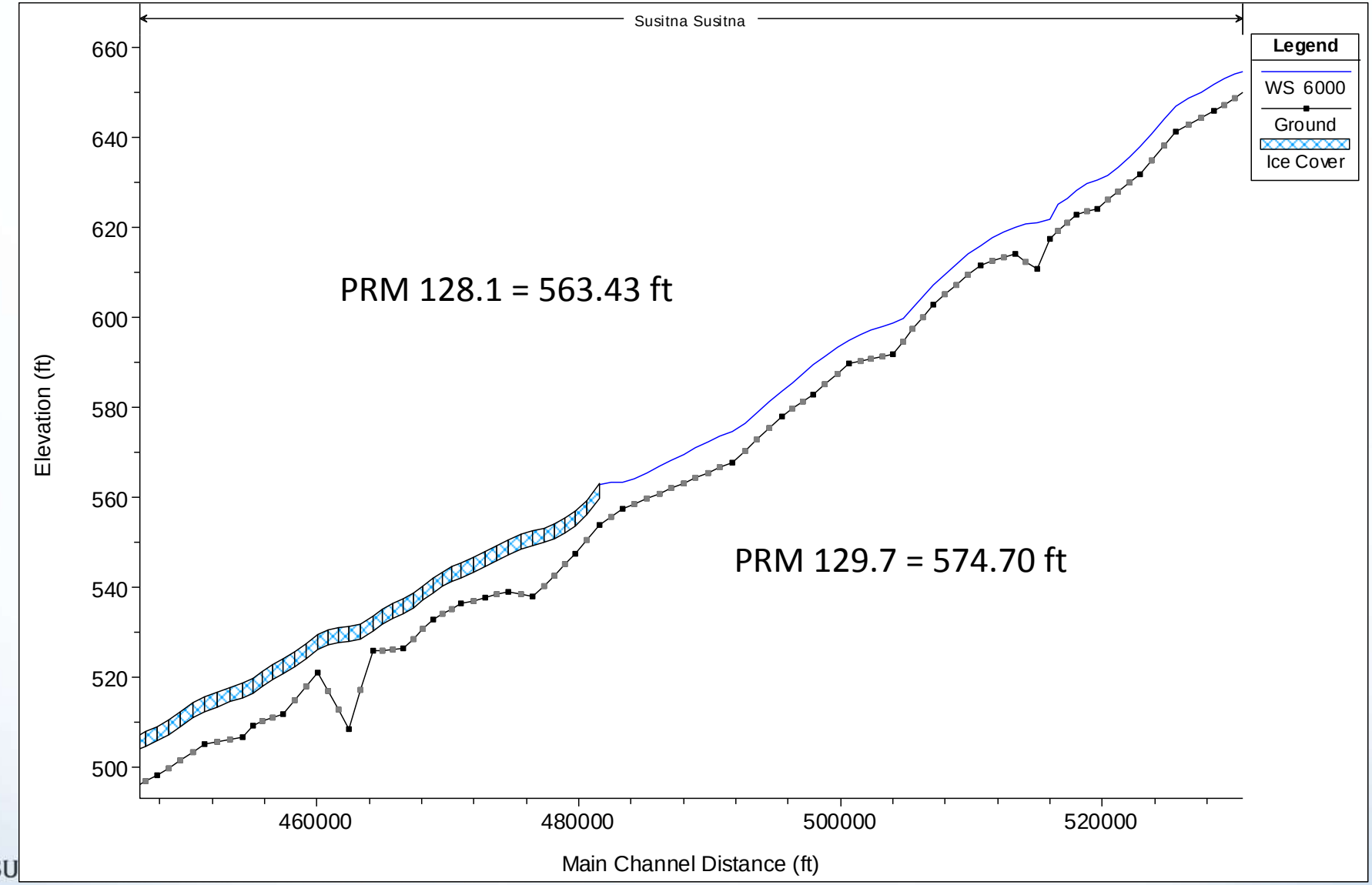
Progression of freeze-up at FA-128 (Slough 8A), 6,000 cfs



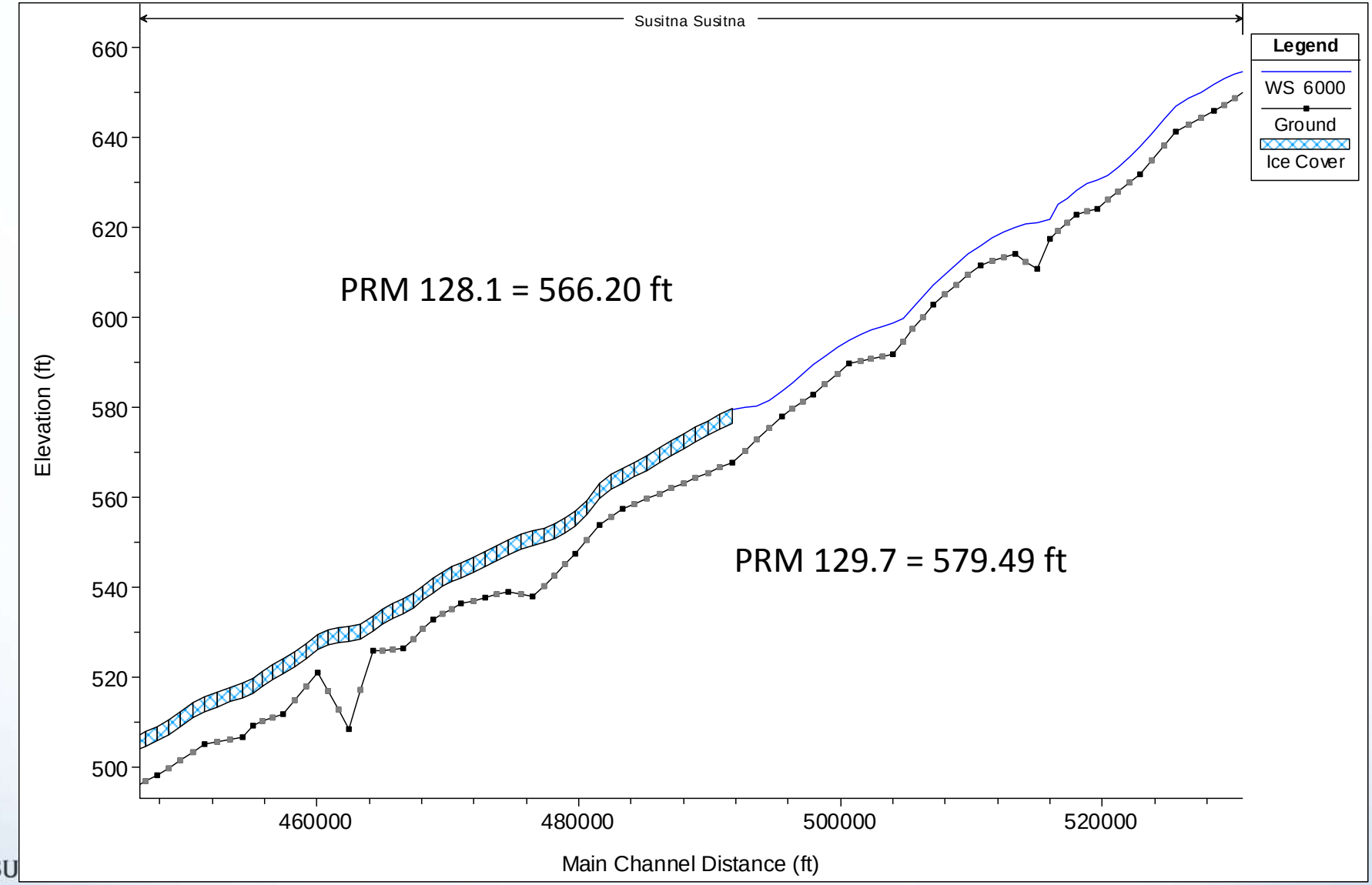
Progression of freeze-up at FA-128 (Slough 8A), 6,000 cfs



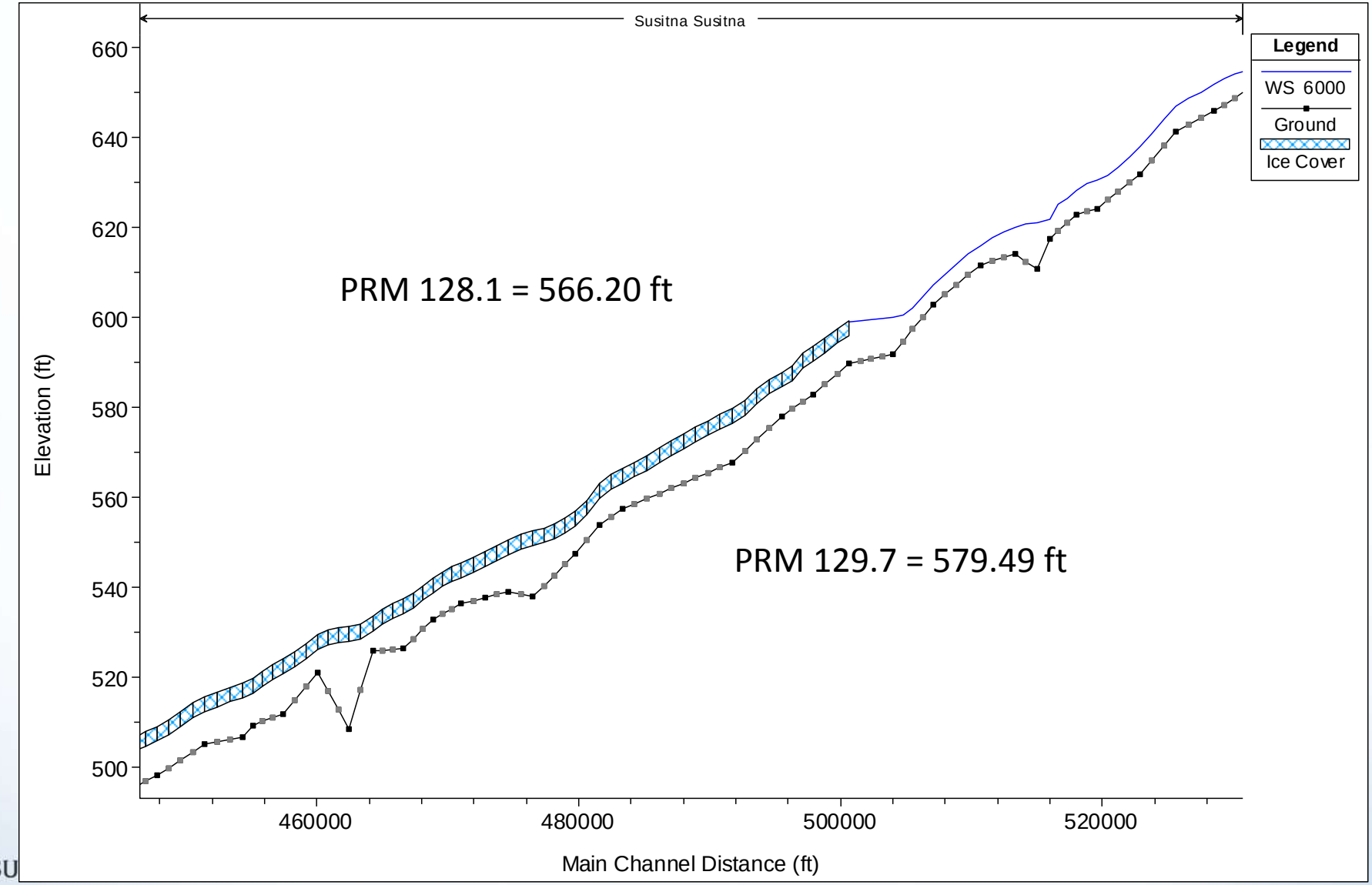
Progression of freeze-up at FA-128 (Slough 8A), 6,000 cfs



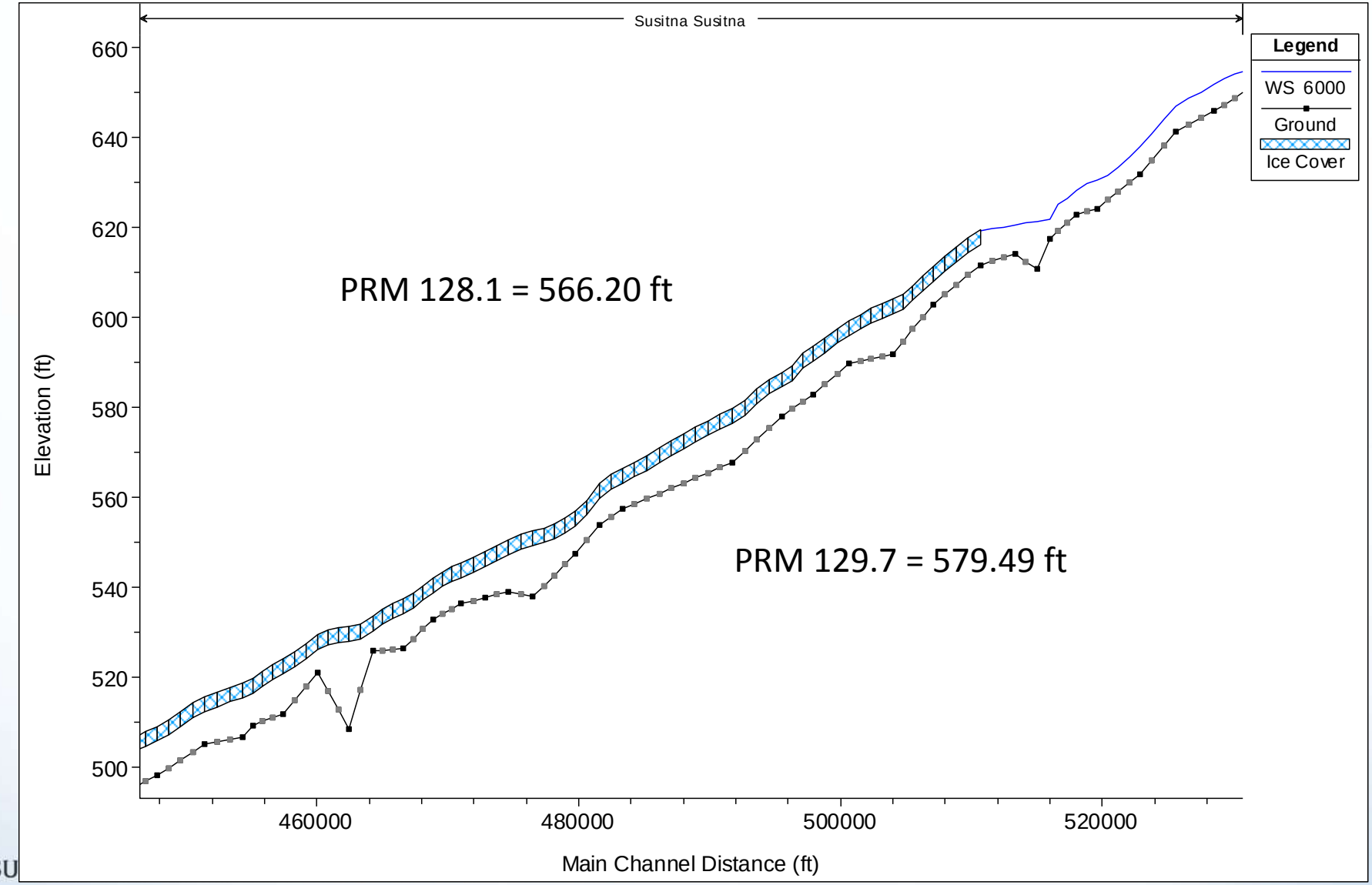
Progression of freeze-up at FA-128 (Slough 8A), 6,000 cfs



Progression of freeze-up at FA-128 (Slough 8A), 6,000 cfs



Progression of freeze-up at FA-128 (Slough 8A), 6,000 cfs



Progression of freeze-up at FA-128 (Slough 8A), 6,000 cfs