



HYDRAULIC MEASUREMENTS IN RESERVOIRS

Capabilities and Limitations

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OVERVIEW

- ✗ Reservoir Characteristics

- ✗ Instruments

 - + Price Current Meters
 - + ADVs

 - + ADCPs / ADPs

- ✗ Performance Measurement

- ✗ Site Specific Measurement Options

 - + Mica

 - + Revelstoke

 - + Hugh Keenleyside

 - + Aberfeldie

RESERVOIR CHARACTERISTICS

✗ Low Velocity Flows

- + Generally in the cm/s range
- + Relatively dynamic in terms of magnitude and direction

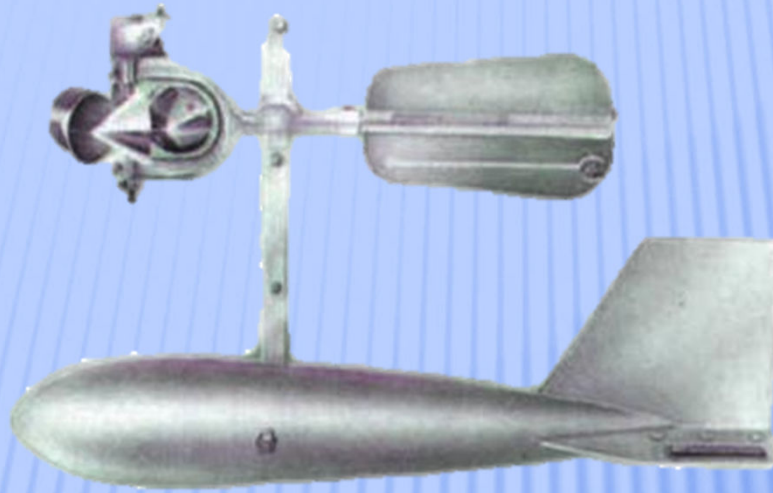
✗ Limnic/River Morphology

- + Depths ranging from a few metres to hundreds of metres
- + Bed cover and roughness
- + Bathymetric slopes

✗ Reservoir Dynamics

- + Waves
- + Surface Seiches

PRICE CURRENT METERS



<http://www.weatherstation.co.in/water-current-meter.htm>

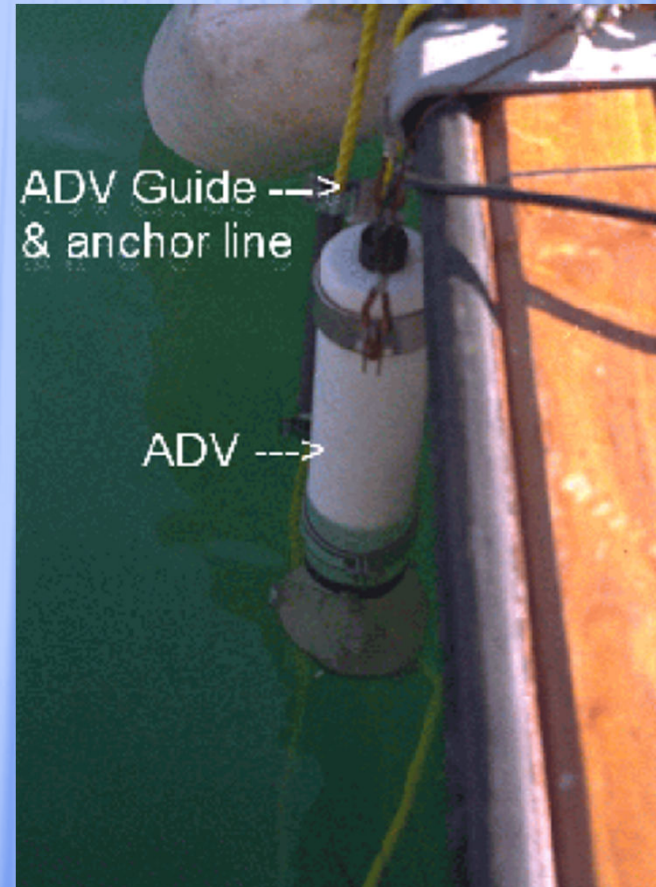
- ✗ Higher Velocity Flows
- ✗ Shallow Depths
- ✗ Steady Unidirectional flows
- ✗ Used for River Gauging

ACOUSTIC DOPPLER VELOCIMETER (ADV)

- ✗ Measures Velocity using the Doppler shift
 - + Requires adequate “seeding”
- ✗ Collects Point Measurements
- ✗ High Resolution, High Accuracy
- ✗ 3D Velocity Measurement
- ✗ High Sampling Frequency
 - + Turbulence

Unit	Accuracy	Sampling Rate (Hz)	Range (m/s)
SonTek Triton ADV	$\pm 1\%$ $\pm 0.1\text{cm/s}$	4	0.1 - 4.8
SonTek Argonaut	$\pm 1\%$ $\pm 0.1\text{cm/s}$	1-25	0.0001 - 4.5
Nortek Vectrino	$\pm 0.5\%$ $\pm 0.1\text{cm/s}$	1-25	0.01 - 4
Nortek Vector	$\pm 0.5\%$ $\pm 0.1\text{cm/s}$	1-64	0.01 - 7

ACOUSTIC DOPPLER VELOCIMETER (ADV)



<http://www.sontek.com/pdf/brochures/argoadvwebversion.pdf>

Vermeyen, T.B., Measuring Selective Withdrawal Characteristics using an Argonaut Acoustic Doppler Velocimeter in Folsom Lake, California, EWRI/IAHR Conference of Hydraulic Measurements and Experimental Methods, Estes Park, Co, July 28- August 1, 2002.

ACOUSTIC DOPPLER CURRENT PROFILER (ADCP)

- ✗ Measures Velocity using the Doppler shift
 - + Requires adequate “seeding”
- ✗ Bottom Tracking
- ✗ Collects Full Velocity Profiles
 - + Depth Cell Size
- ✗ 3D Velocity Measurement
- ✗ Beam Angle
 - + Introduces lateral restrictions from vertical surfaces



<http://www.elecdata.com/waterqual/rdinstruments/rdinstruments.html>



<http://www.laurelindustrial.com.cn/chanpinindexhy.asp?id=309&index=5>

ACOUSTIC DOPPLER CURRENT PROFILER (ADCP)

Unit	Range (m)	Beam Angle (°)	Depth Cell (m)	Accuracy	Bottom Tracking
Sontek ADP	70-120 (500kHz)	20	1.0	1% ±0.5cm/s	YES
RDI Workhorse Sentinel	78-102 (300kHz)	20	2.0	0.30% ±0.3cm/s	YES
RDI Workhorse Rio Grande	100 (600kHz)	20	4.0	0.25% ±0.25cm/s	YES
Nortek Aquadopp	60-90 (400kHz)	25	2-8	1% ±0.5cm/s	NO
RDI Workhorse Long Ranger	267-600 (75kHz)	20	4-32	1% ±0.5cm/s	NO
RDI Ocean Surveyor	375-400 (150kHz)	30	8	1% ±0.5cm/s	YES
Nortek Continental	200 (190kHz)	25	2-20	1% ±0.5cm/s	NO

ACOUSTIC DOPPLER CURRENT PROFILER (ADCP)



http://marine.rutgers.edu/cool/latte/images/moorings_lrg.jpg



Bathymetry Measurement at Hugh Keenleyside – Boat Deployment

ACOUSTIC DOPPLER CURRENT PROFILER (ADCP)



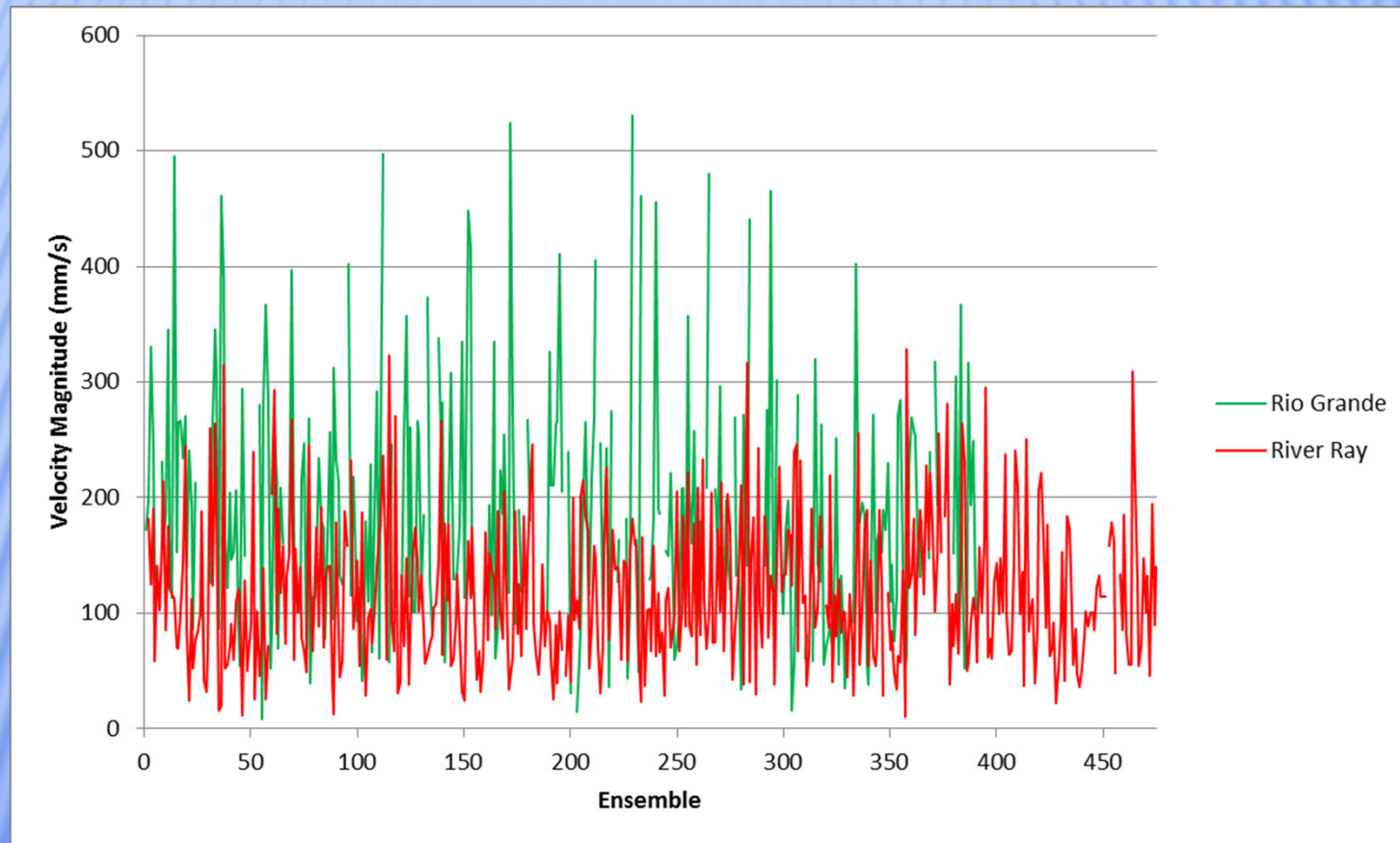
Hydraulic Measurements at Hugh Keenleyside – Guideline Deployment



Hydraulic Measurements at Aberfeldie– Guideline Deployment

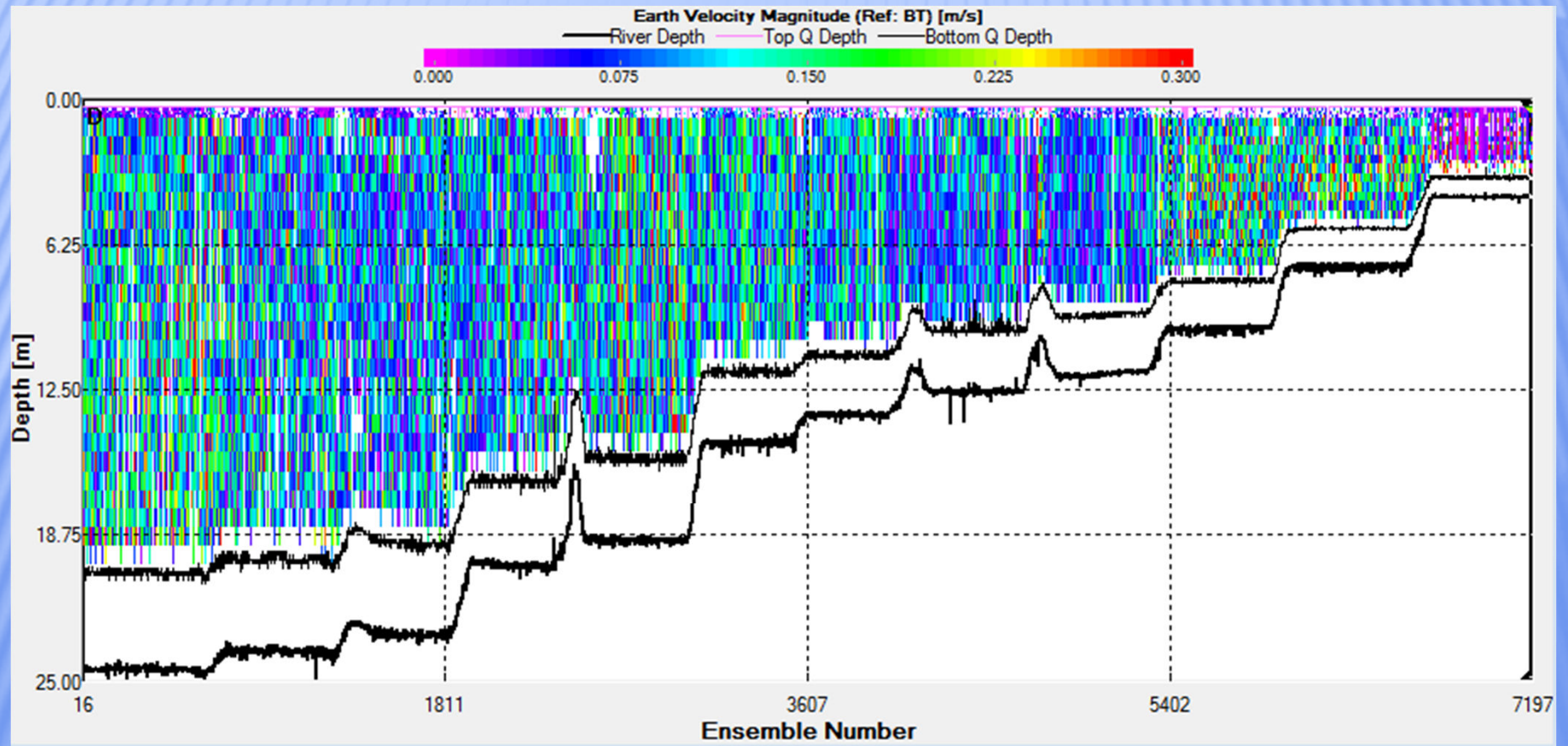
VELOCITY DATA

✗ Ensemble Averaging



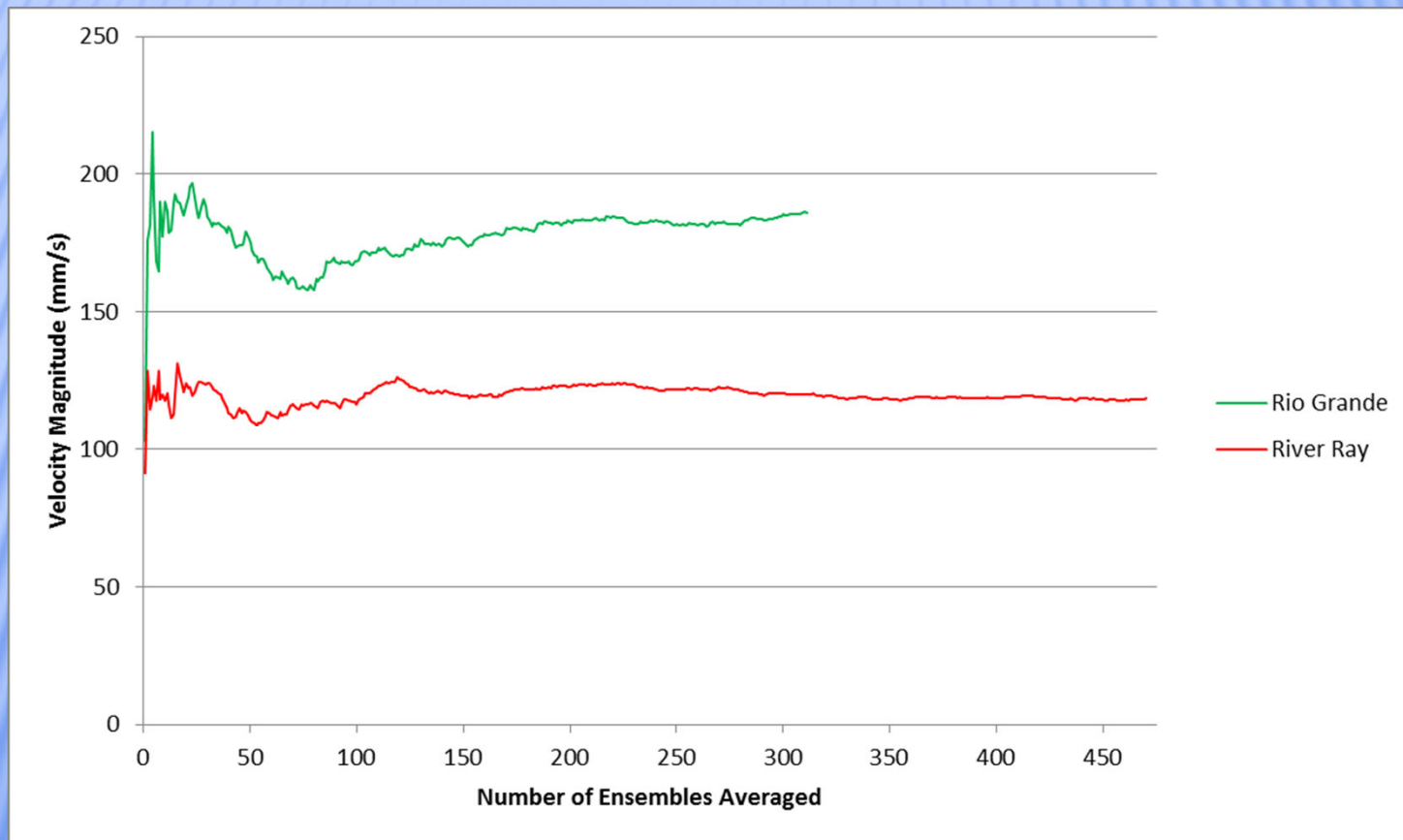
VELOCITY DATA

✗ Ensemble Averaging



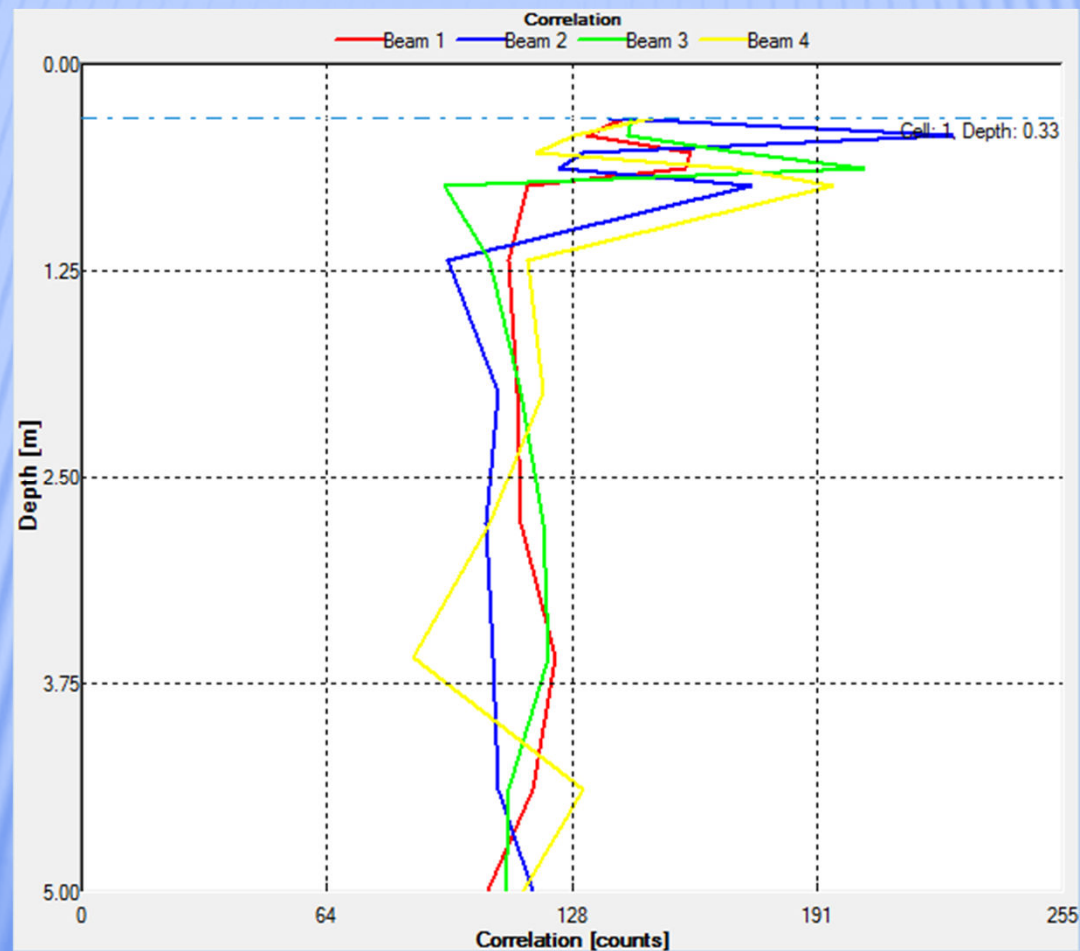
VELOCITY DATA

✗ Ensemble Averaging



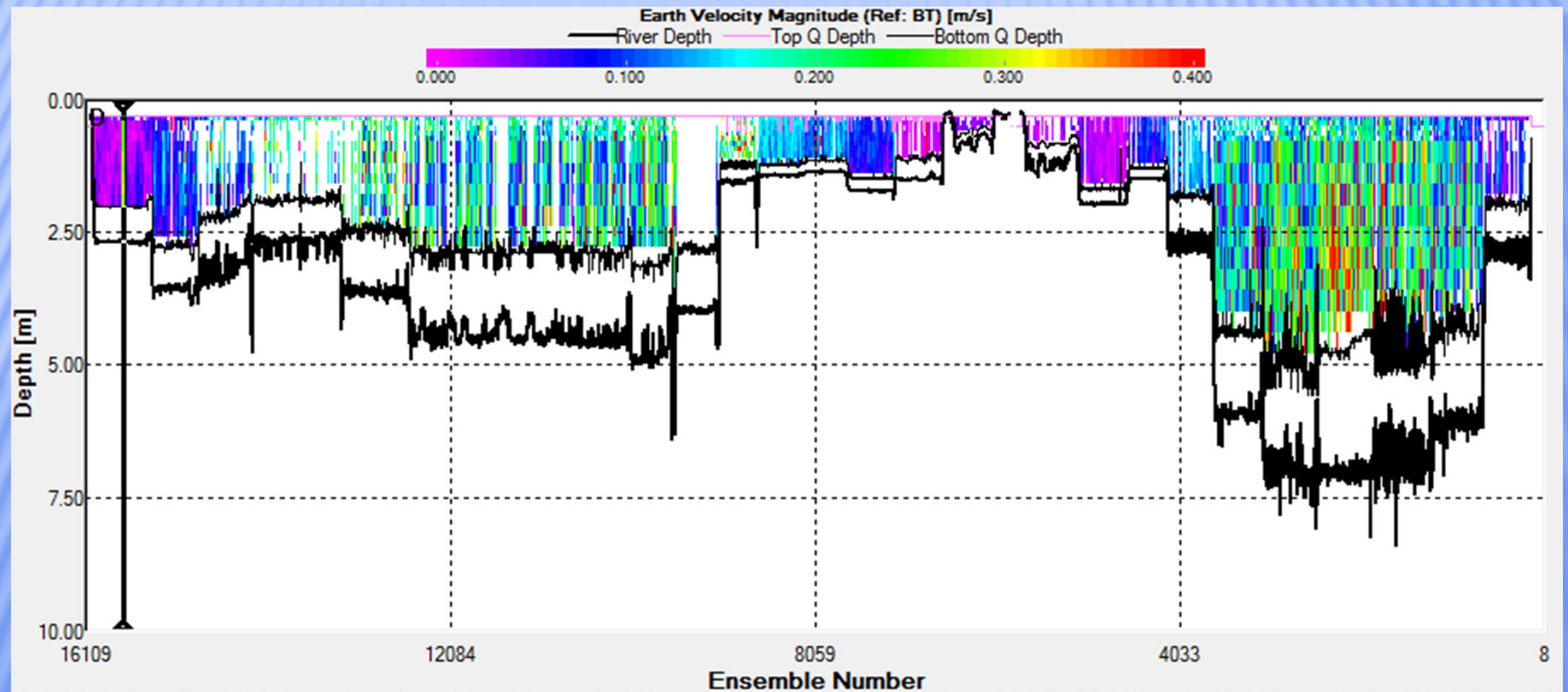
VELOCITY DATA

✖ Correlation



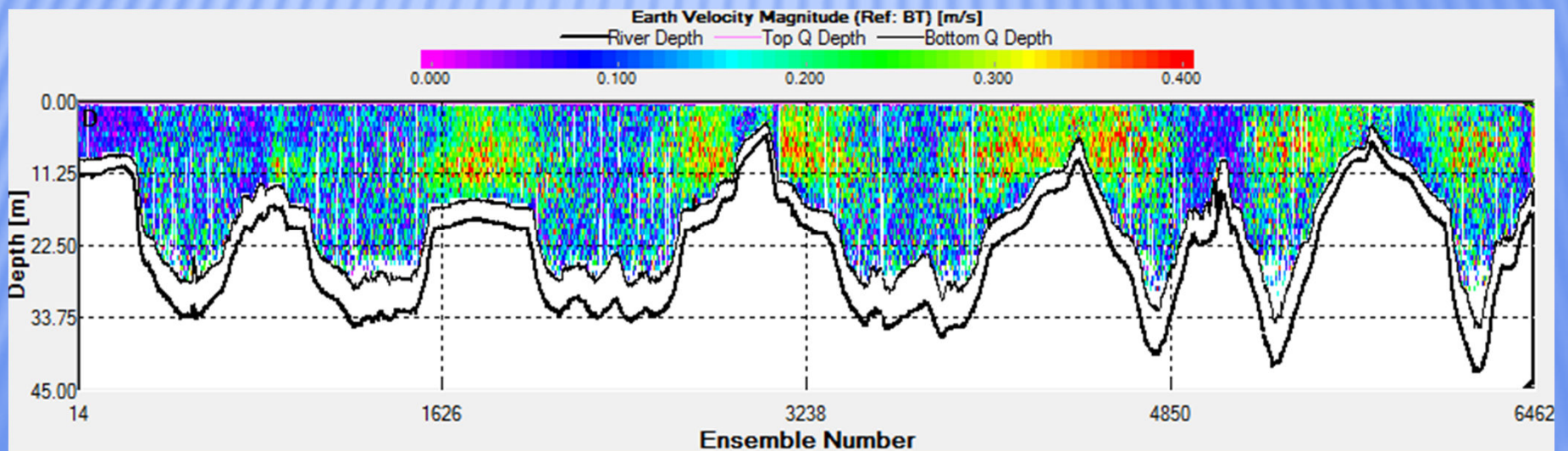
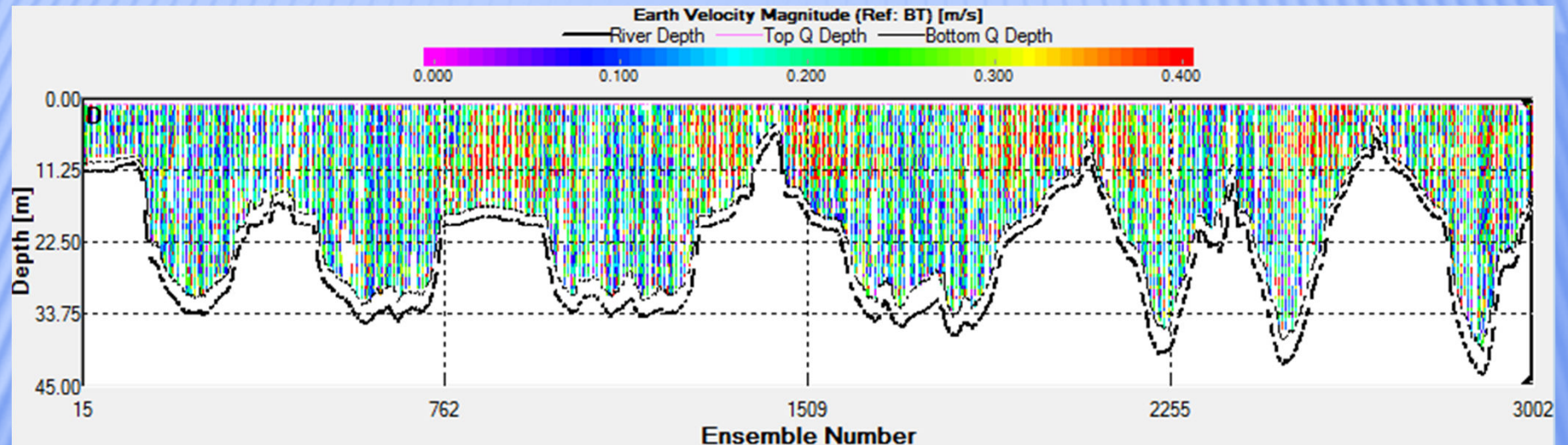
VELOCITY DATA

✗ Correlation

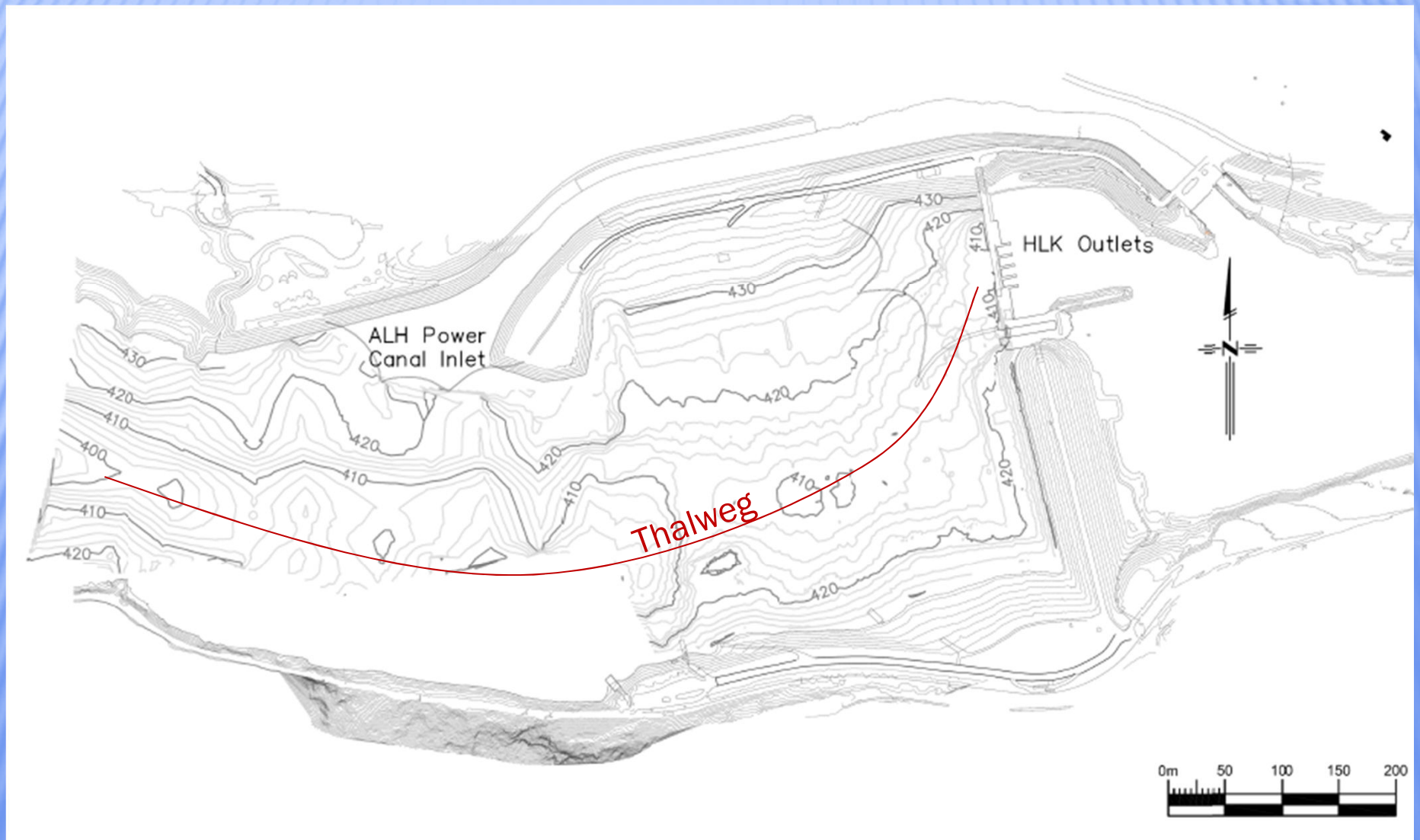


VELOCITY DATA

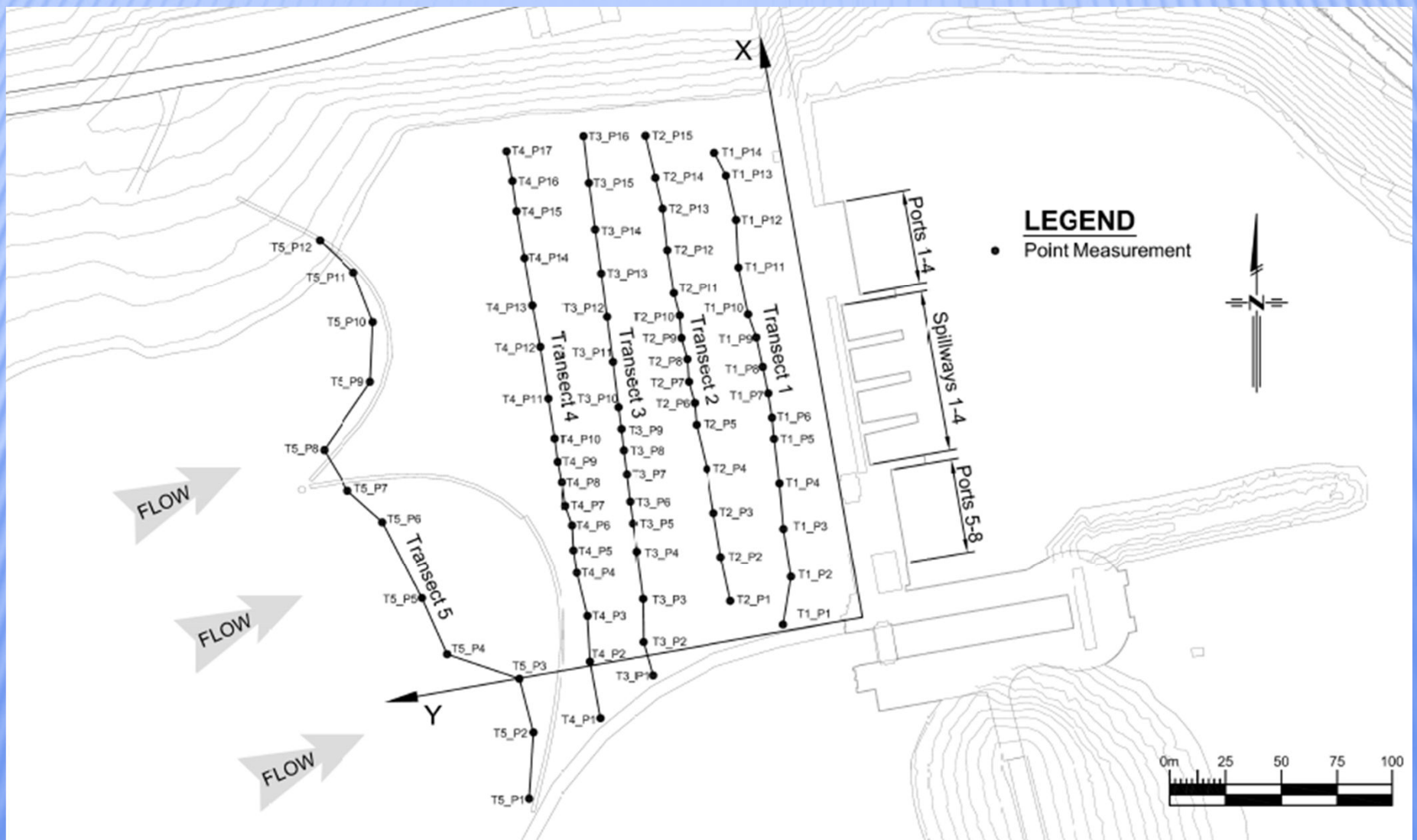
✗ Blanking Distance



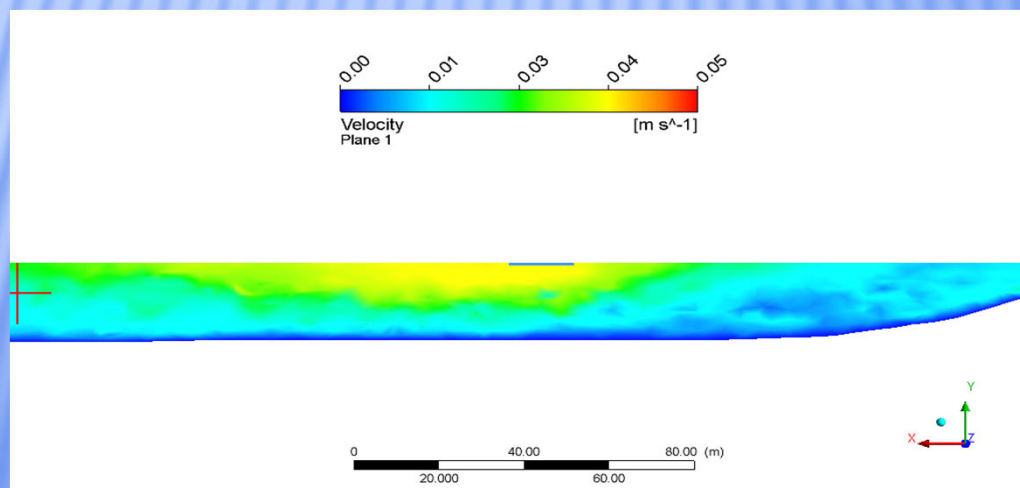
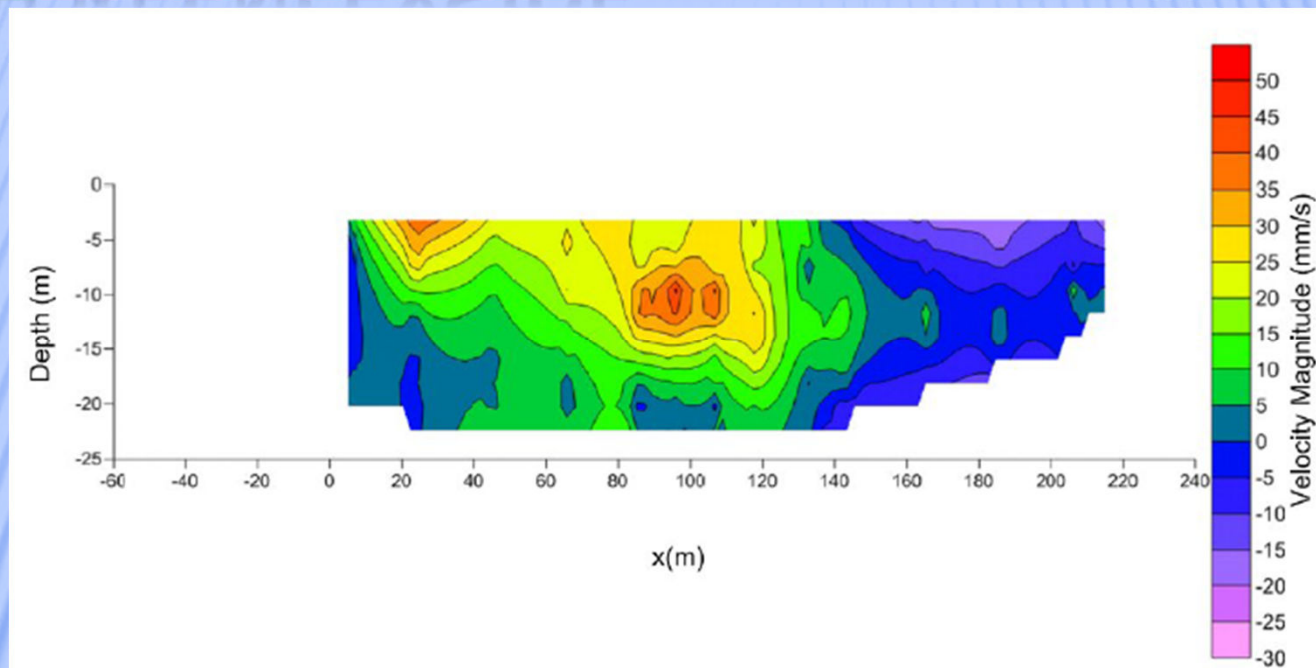
HUGH KEENLEYSIDE



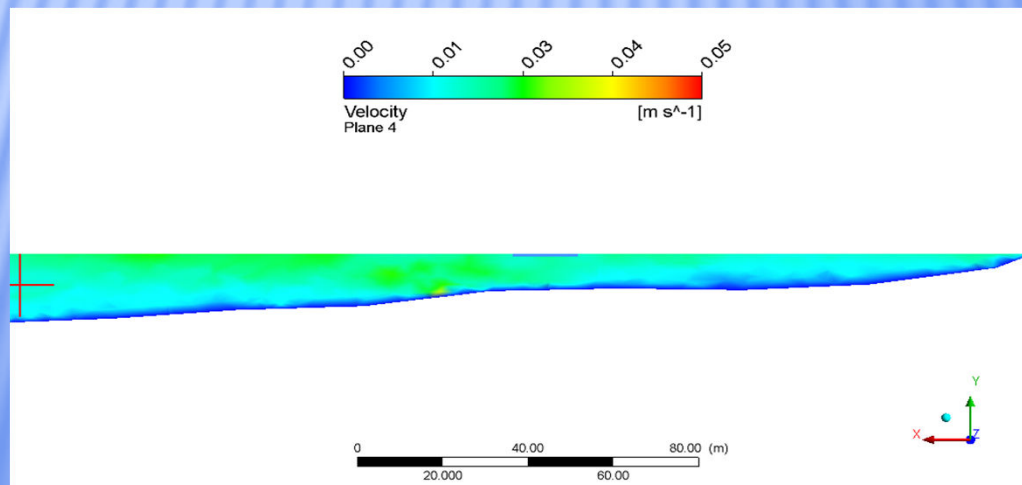
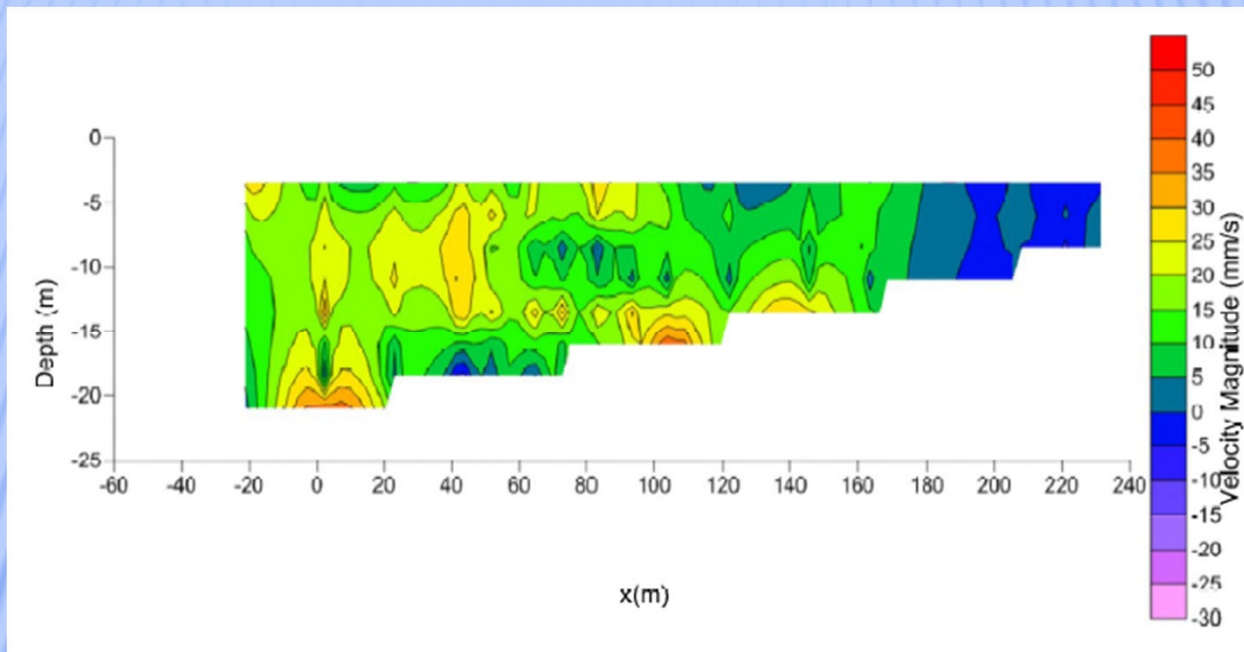
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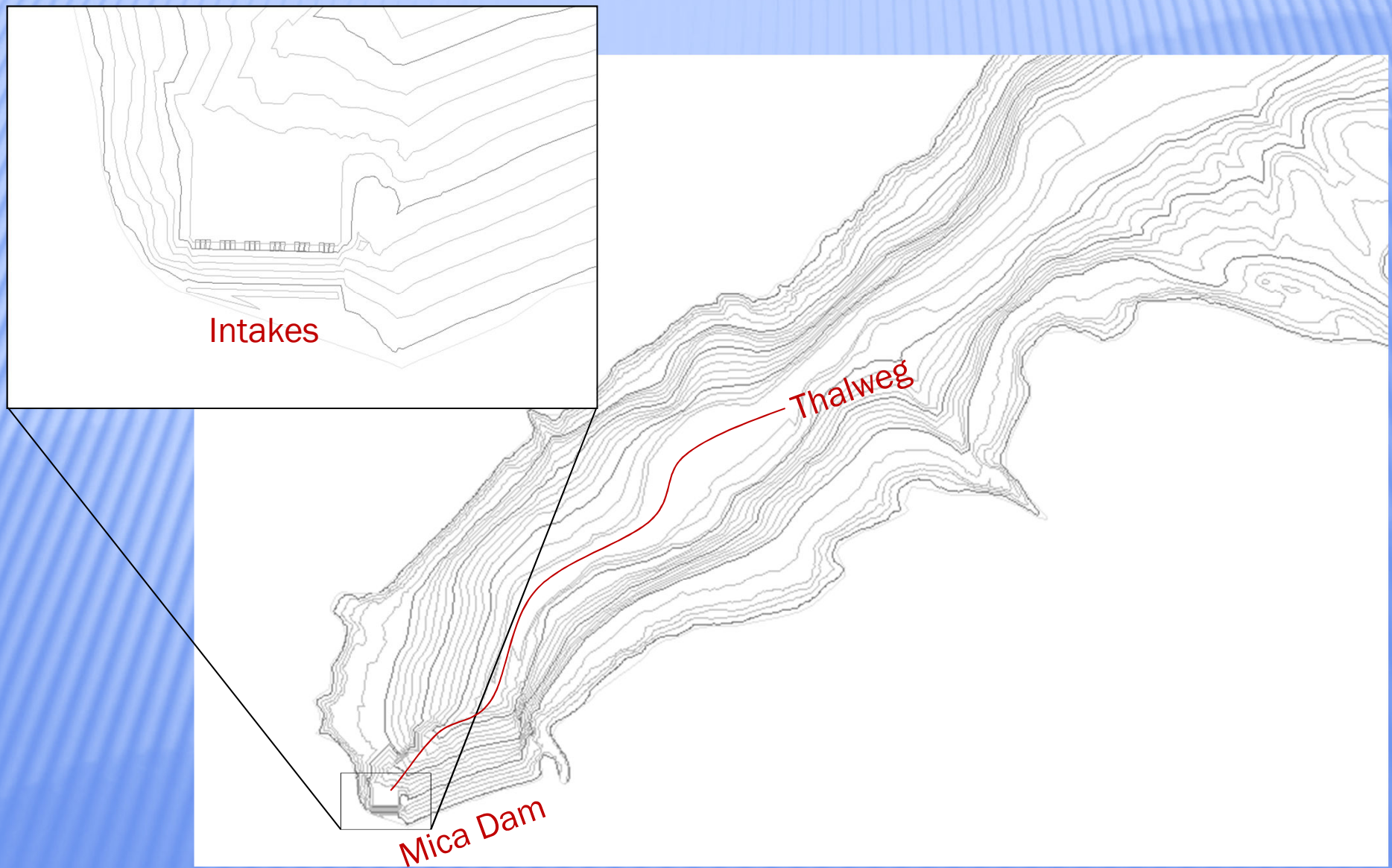
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HUGH KEENLEYSIDE

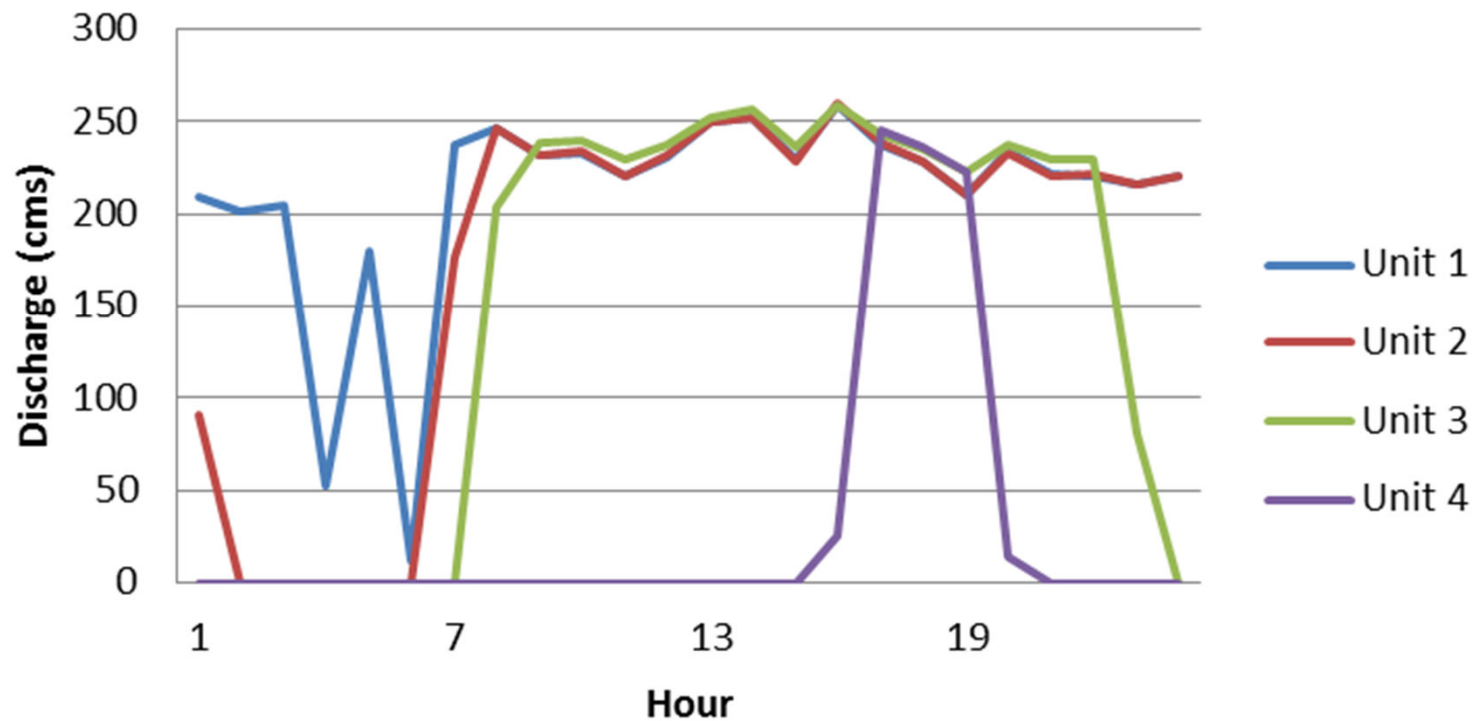


MICA



MICA

Operations Aug 13, 2010



ABERFELDIE



Aberfeldie Headpond



Aberfeldie Spillway

REVELSTOKE



Revelstoke Forebay (Upstream)



Revelstoke Forebay (East Bank)



QUESTIONS ?
