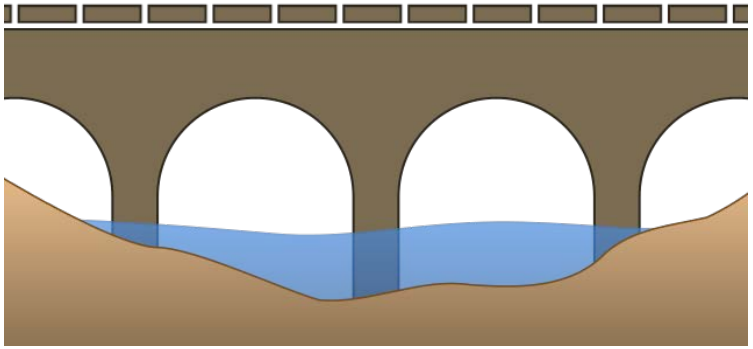
Chippewa River Bridge TDR Scour Instrumentation



2018 Midwest Geotechnical Conference

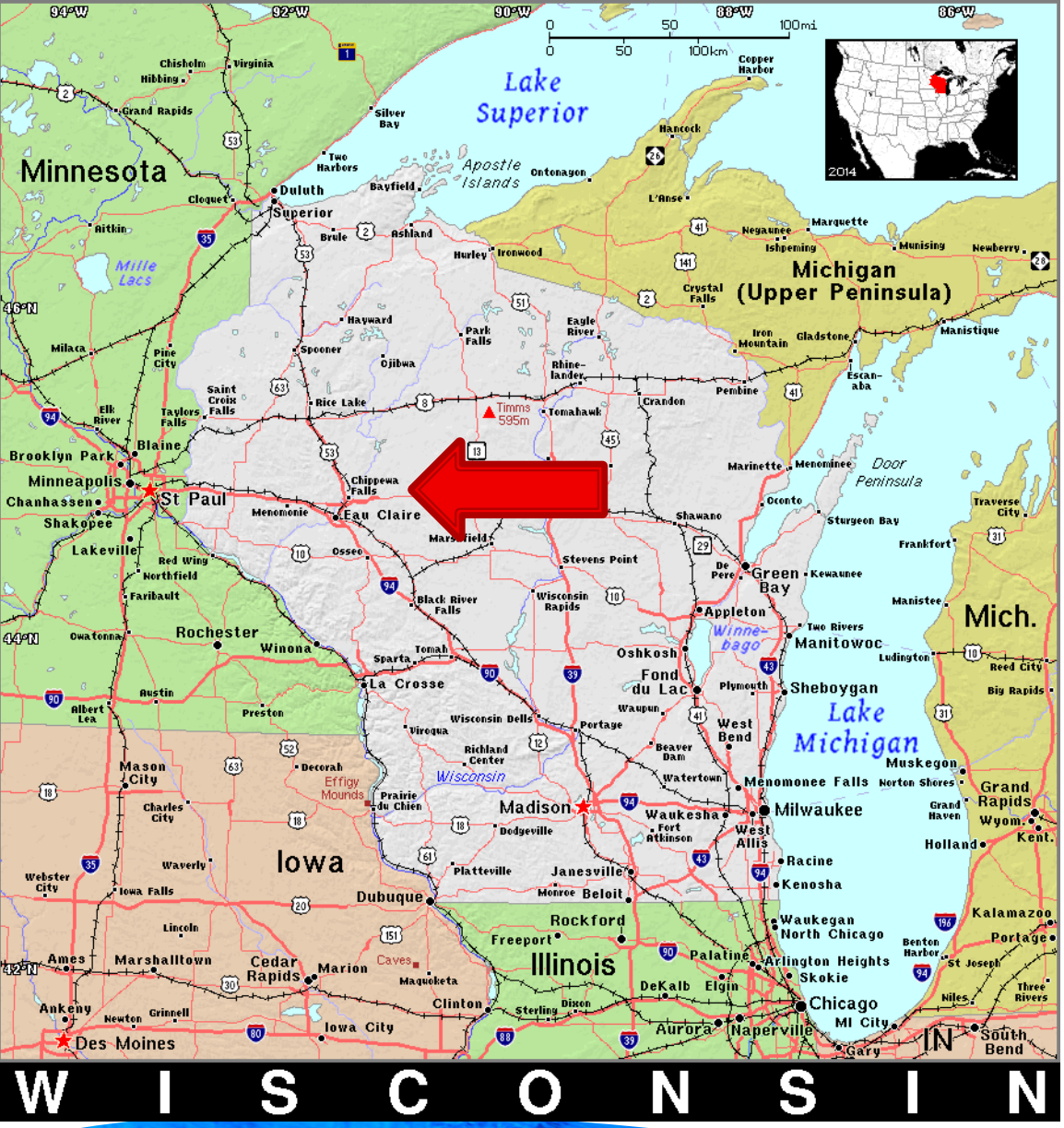
Moline, Illinois

Jeff Horsfall - Wisconsin DOT

Background

- 2017 Issues With a Project presented at last years conference

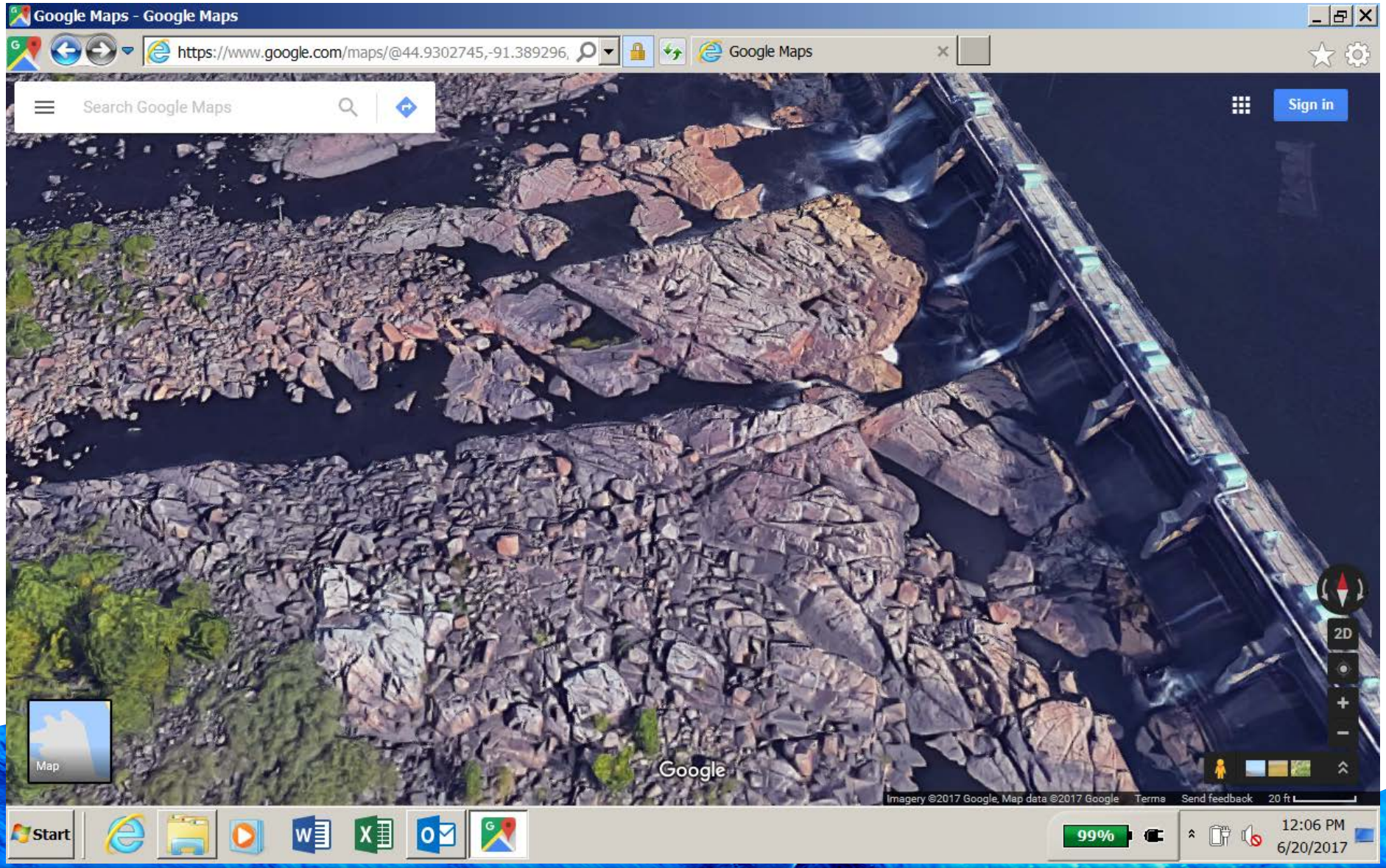
- Repairs (Micro-Piles) have been completed at Pier 3 and Pier 5. (Future Presentation)



Project Location Map

Plan View of Site

Bedrock Surface Below Dam



Background of Site

- Two Adjacent Bridges: NB [B-146] & SB [B-147]
- Carry STH 124 over Chippewa River, 1100’ Long
- Each Carries 2 Lanes Traffic, 25,000 ADT
- Just Upstream of Electric-Generating Dam
- In Area of Shallow Granite Bedrock
- Different Age Bridges – Constr. Sequence
  - Older (1932), Existing SB
  - Adjacent New NB Built 1992, Traffic Moved to NB
  - SB Reconstructed 1994, Traffic Moved to Both Bridges

TDR

Time-domain reflectometry or TDR is a measurement technique used to determine the characteristics of electrical lines by observing reflected waveforms.

TDR

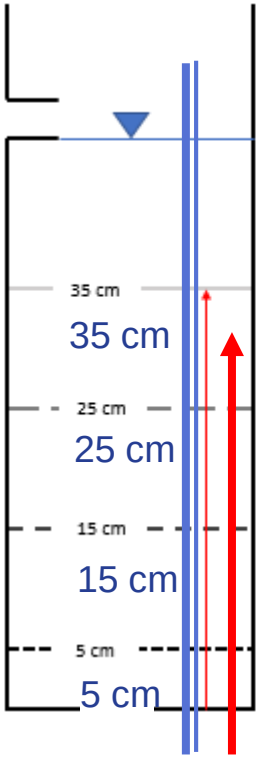
Schneider, J. and Fratta, D. Time-domain reflectometry — parametric study for the evaluation of physical properties in soils, Can. Geotech. J. 46: 753–767 (2009) doi:10.1139/T09-018.

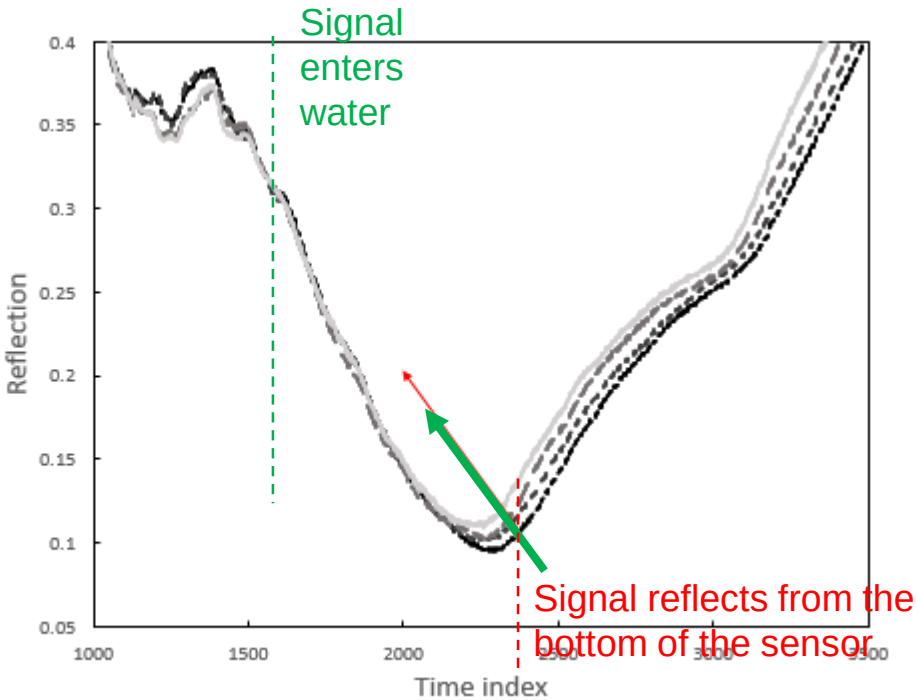
Lin, C.-P. et al., New types of time domain reflectometry sensing waveguides for bridge scour monitoring, Smart Mater. Struct. (2017) 26 075014.

Lab validation of TDR sensor cable

TDR cable probe

Tank filled with Water – The red arrow indicates the increase of sandy sediment layer in the tank while the water level remains constant



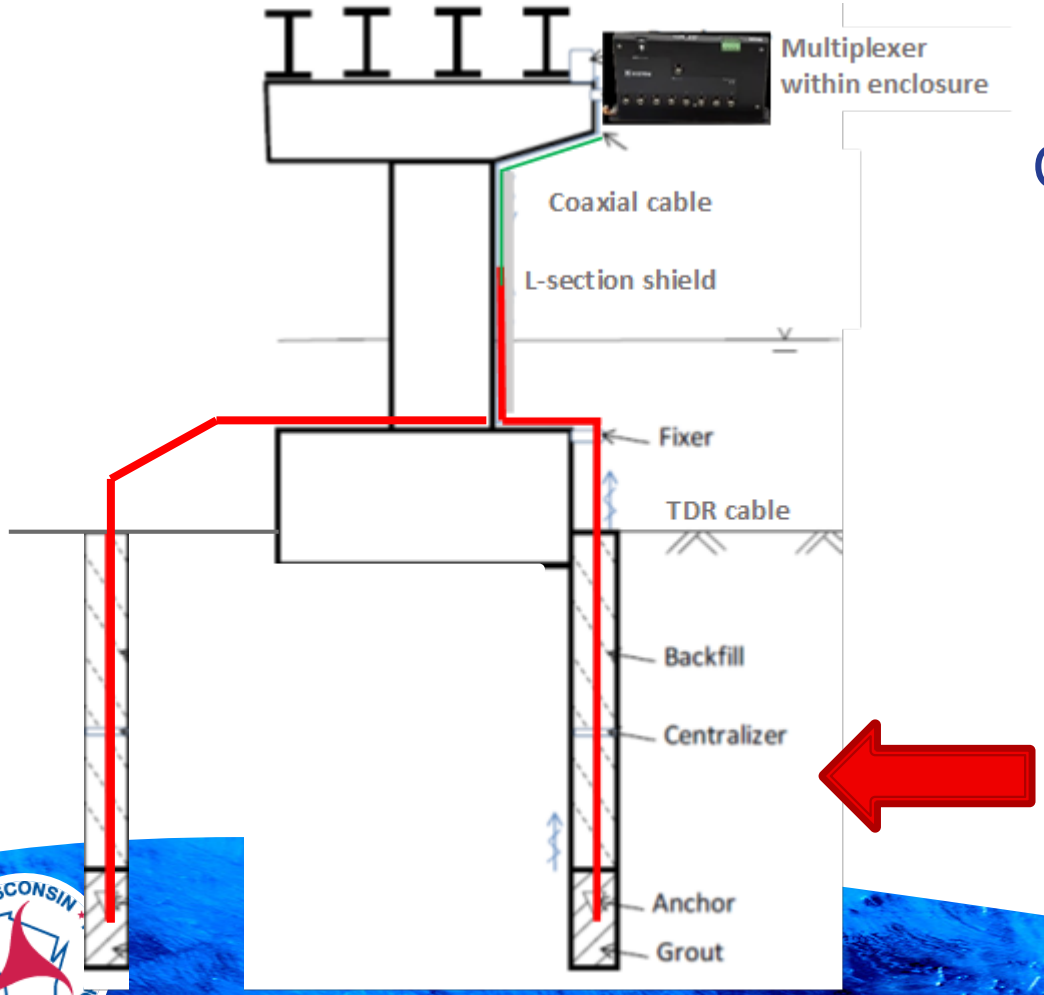


As the sediment level increases the travel time from the bottom the cable decreases (as indicated by the green arrow)

The Bridge

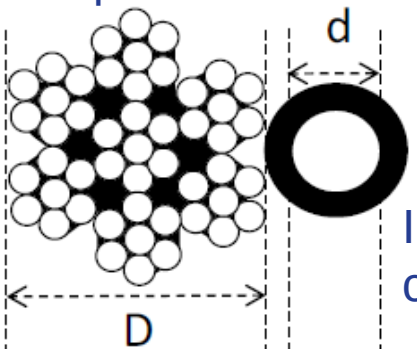
TDR Sensors and Configuration

- Sketch of deployment setup



Cable sensor configuration

Steel rope



Insulted
conductor

(after Lin et al. 2012)

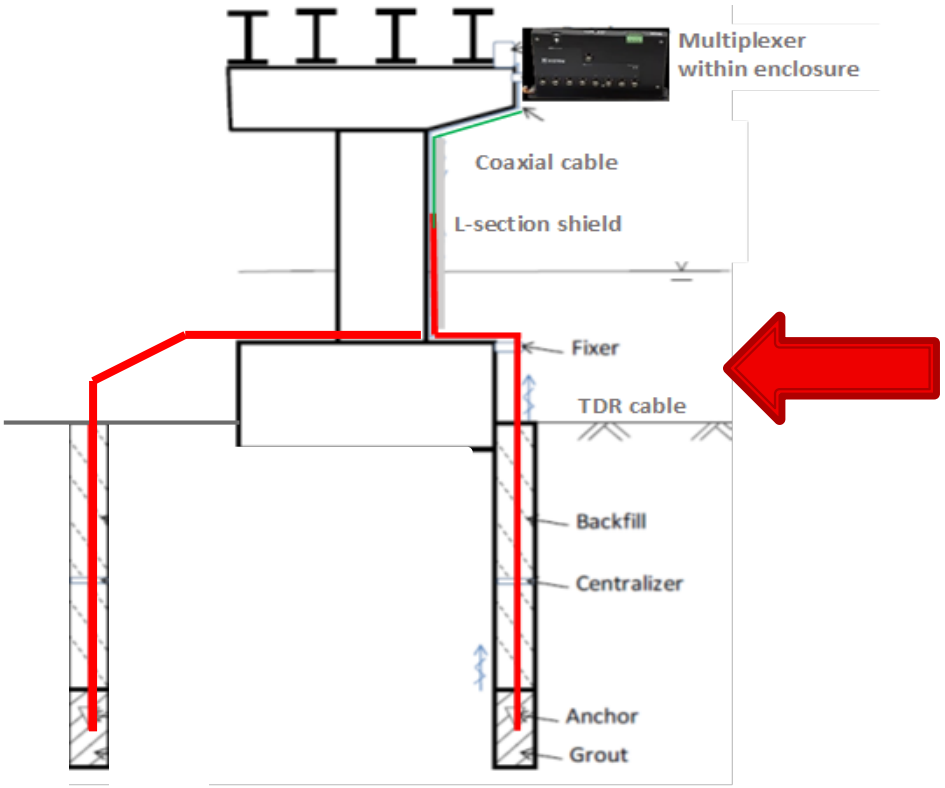
Drilling crew and setup

Difficult to hold the barge in place with shallow bedrock and little overburden.

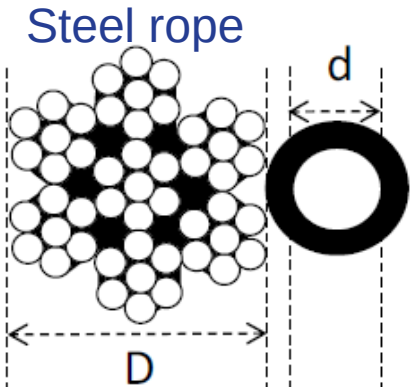
Rod and wire set up

TDR Sensors and Configuration

- Sketch of deployment setup



Cable sensor configuration



Insulted conductor

(after Lin et al. 2012)

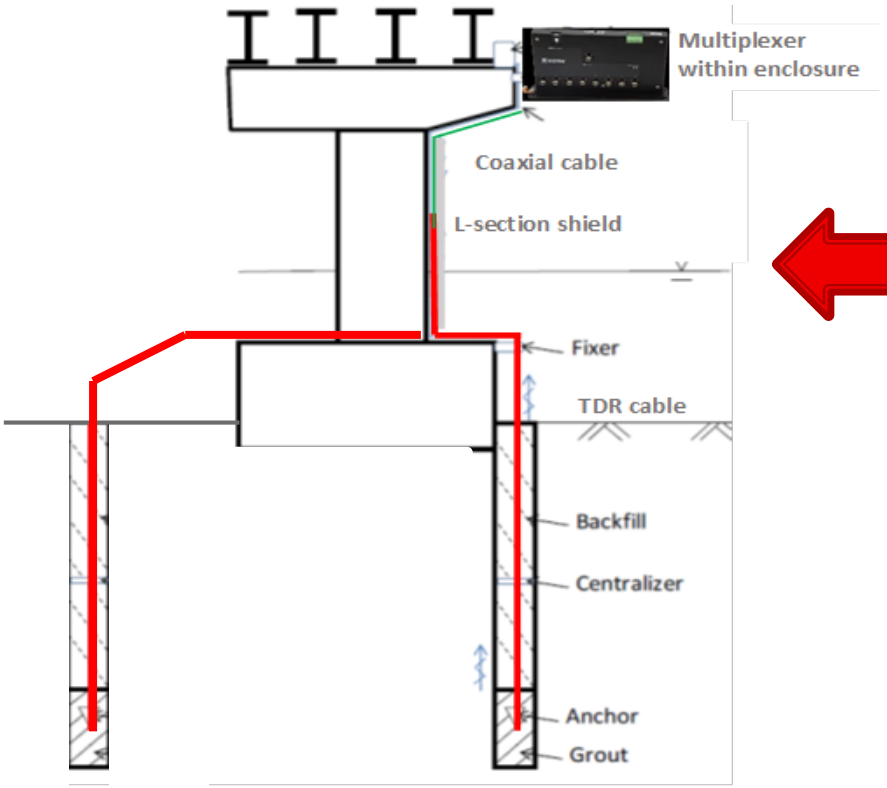
Installation of the wire and anchor into the borehole

Installation of the wires through the conduit

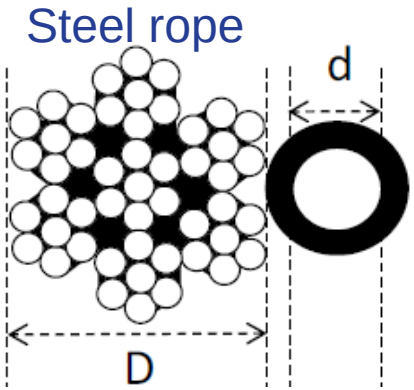
Installation of the wire through the conduit

TDR Sensors and Configuration

- Sketch of deployment setup



Cable sensor configuration

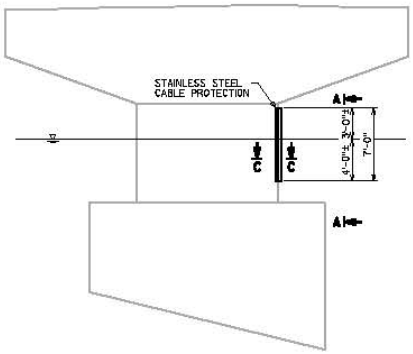


Insulted conductor

(after Lin et al. 2012)

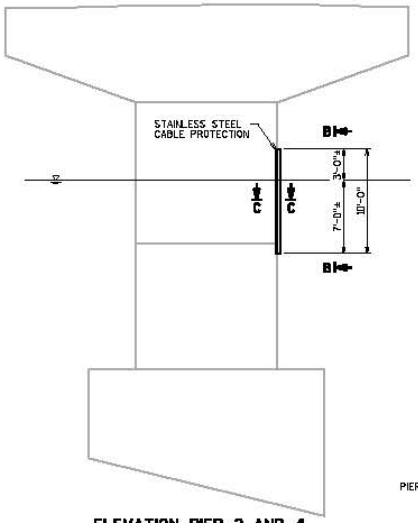
STATE PROJECT NUMBER

XXXX-XX-XX



ELEVATION PIER 1

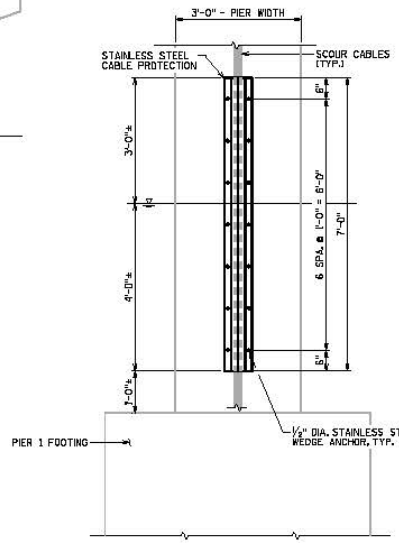
LOOKING SOUTH



ELEVATION PIER 2 AND 4

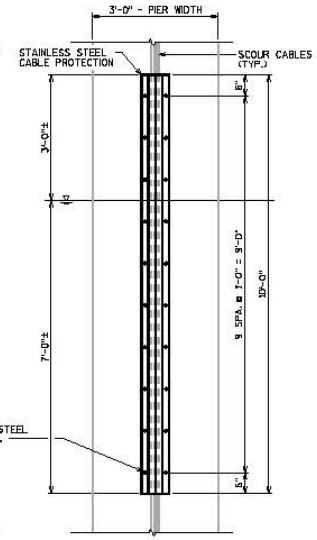
LOOKING SOUTH

PIER 2 SHOWN, PIER 4 SIMILAR



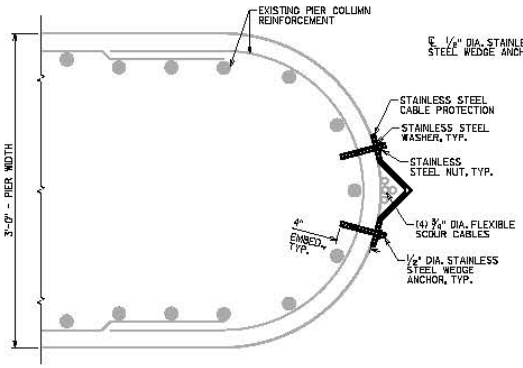
VIEW A-A

PIER 1

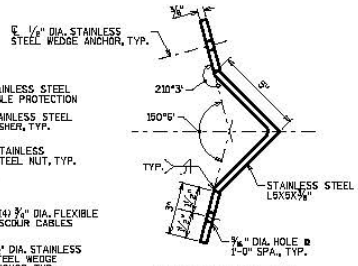


VIEW B-B

PIER 2 AND 4



SECTION C-C



STAINLESS STEEL CABLE PROTECTION DETAIL

DESIGN DATA

MATERIAL PROPERTIES:

STAINLESS STEEL A312 GRADE 304 ———— fy = 42,000 P.S.I.

TOTAL ESTIMATED QUANTITIES

BID ITEM NUMBER	BID ITEMS	UNIT	TOTAL
SPV.0105	CABLE PROTECTION B-9-146	LS	1

GENERAL NOTES

1/2" DIA. STAINLESS STEEL WEDGE ANCHORS TO BE EMBEDDED 4" INTO EXISTING CONCRETE PIERS

WATER LINE ELEVATION SHOWN ON THIS SHEET IS EL. 838.3

STRUCTURE DESIGN CONTACTS:

EMILY KUEHNE (608) 266-5089

AARON BONK (608) 261-0261

NO.	DATE	REVISION	BY

BUREAU OF STRUCTURES

ACCEPTED William C. Dreher 6/22/18

CHIEF STRUCTURES DESIGN ENGINEER DATE

STRUCTURE B-9-146

STH 124 NB OVER CHIPPEWA RIVER

COUNTY CHIPPEWA FALLS CITY CHIPPEWA FALLS

DESIGN SPEC. AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

DESIGNED BY EMK | DESIGNED CK'D. ABS | DRAWN BY EMK | PLANS CK'D.

SCOUR CABLES PROTECTION

SHEET 1 OF 1

SCALE = 5.00

I.D. 0656-22-09A DATE: JUNE 2018

8

8

Installation of the ice protection shield

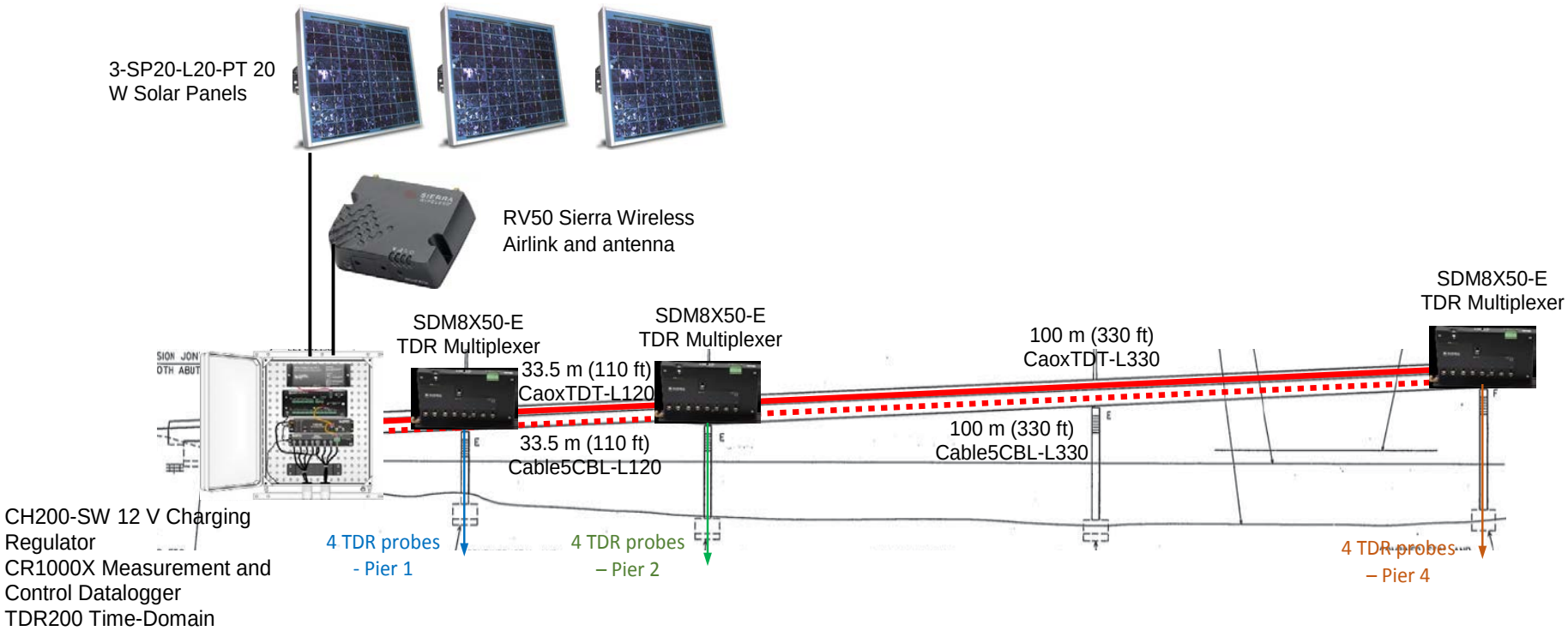
Installation of the ice protection shield

Ice Shield Installation, the float contains the wires.

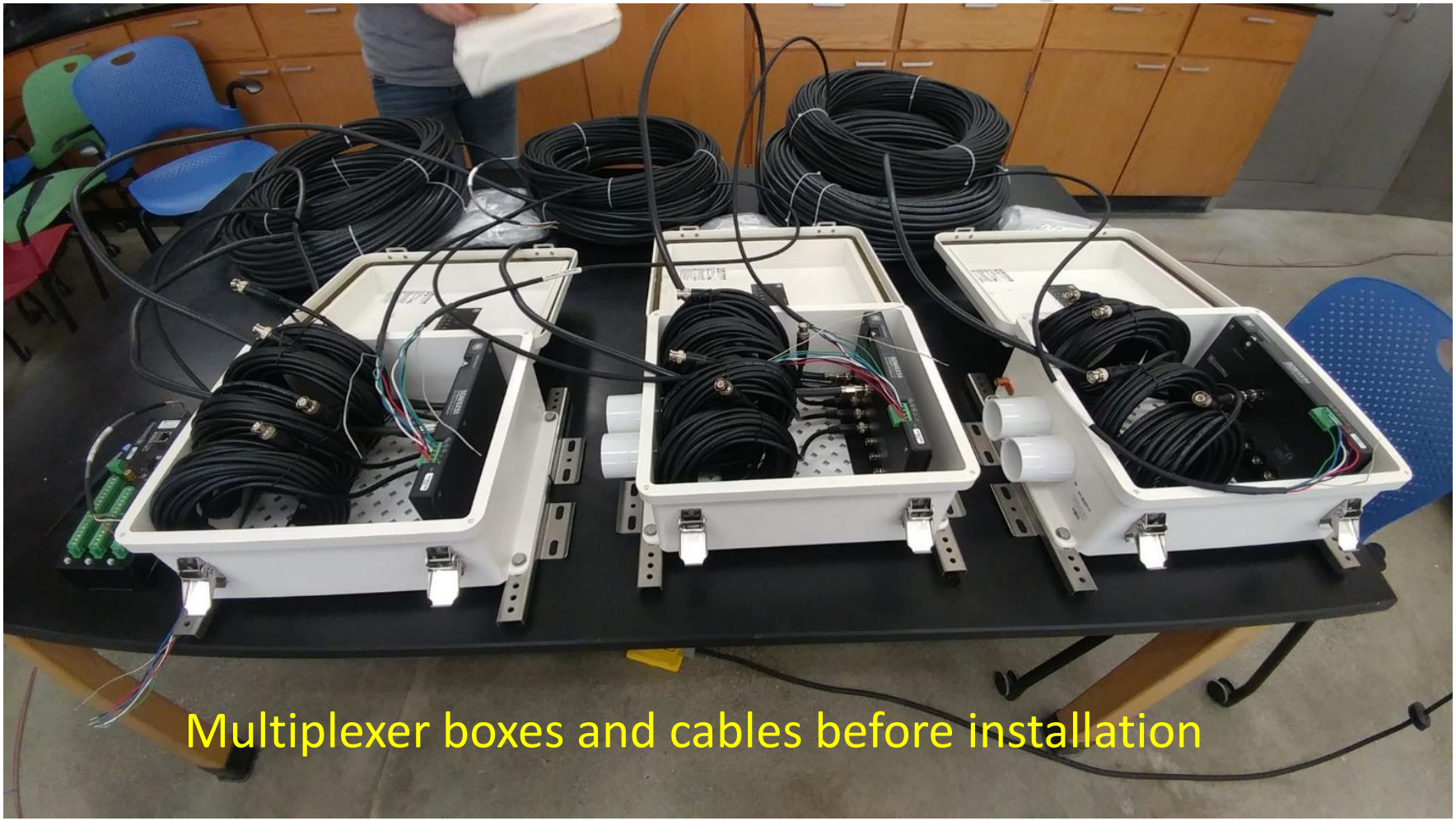
Deployed TDR Array and Communication System

- 12 Time Domain Reflectometer (TDR) sensors, controlled with three multiplexers, a TDR controller, data logger and wireless modem.
- The system is powered with three solar panels.
- Campbell Scientific provided the electronics for the system.

Deployed TDR Array and Communication System

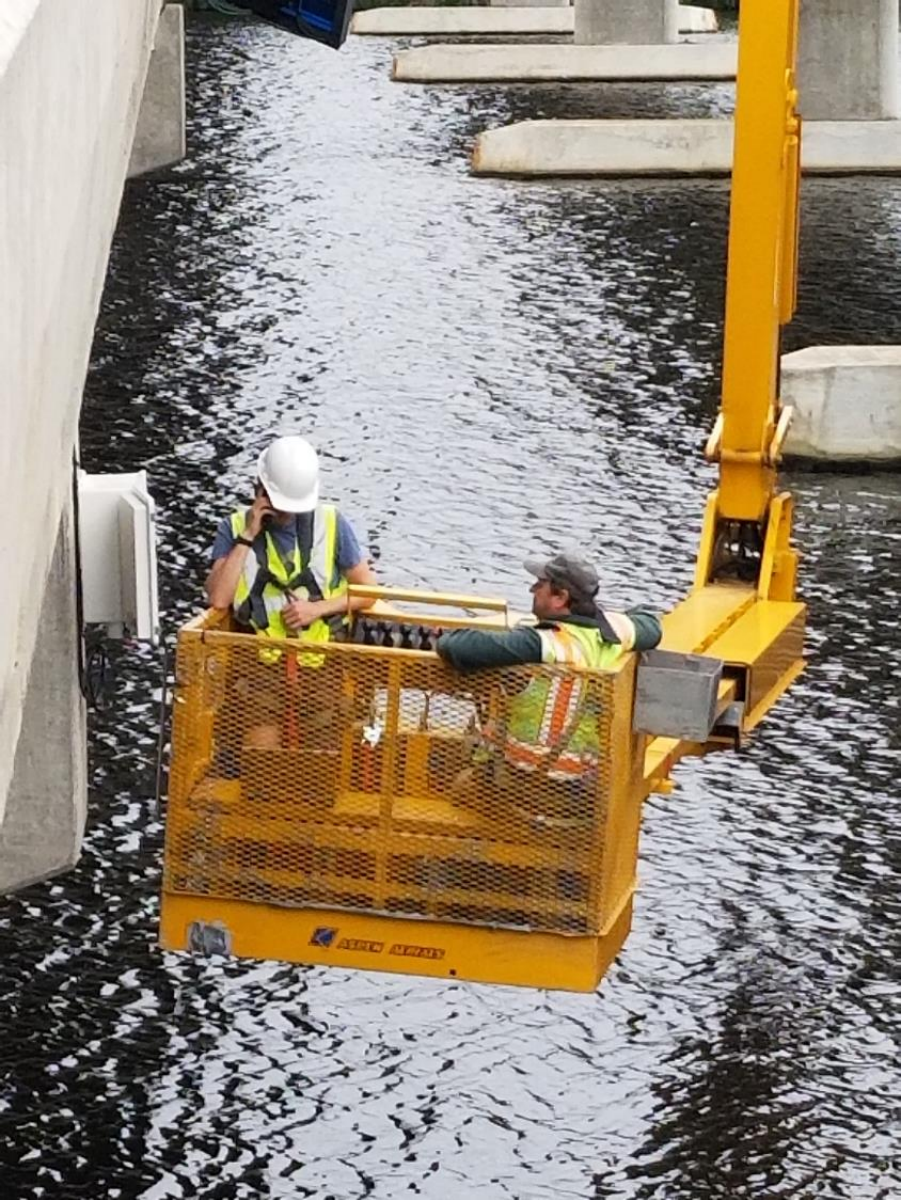


Instrumentation - Multiplexers



Multiplexer boxes and cables before installation

Installation



Installation and Troubleshooting the system

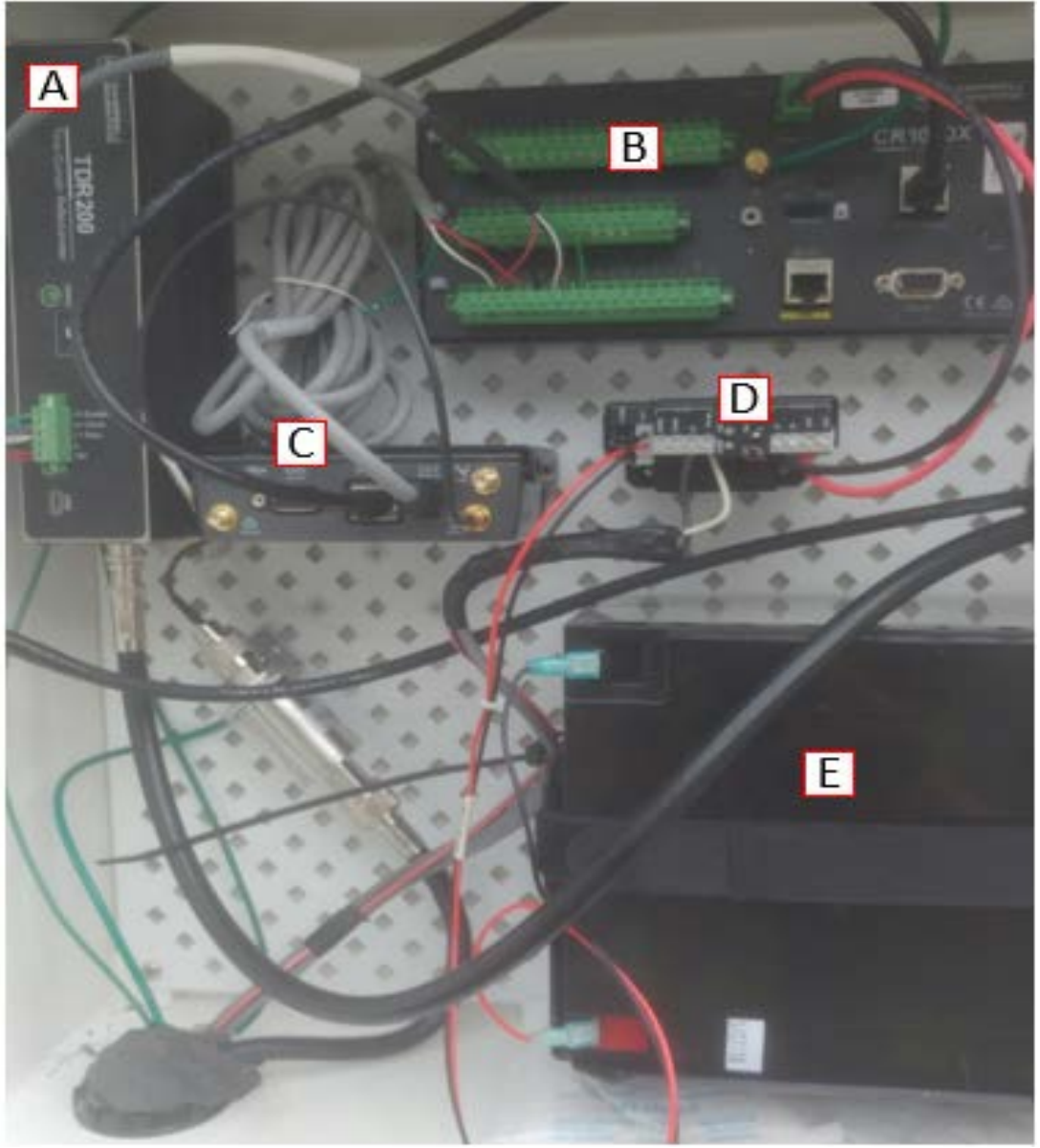
2

Installation

Sensor cable coming out of the water

Installed TDR cables and multiplexers

Installation



Installation

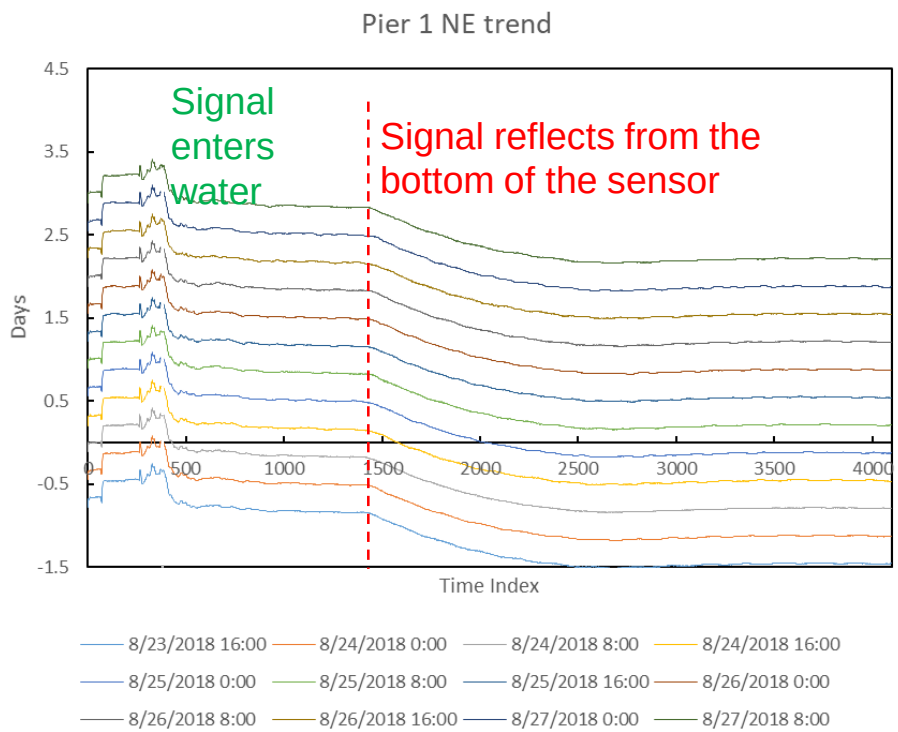
Main Sensor Box:

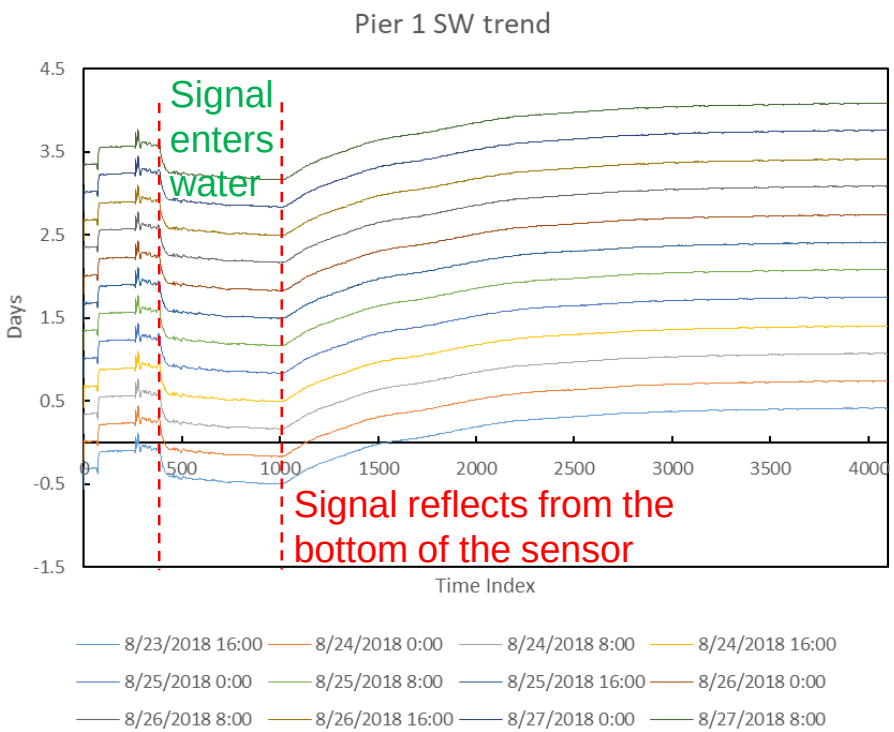
A: TDR200 control system.
B: CR1000X datalogger.
C: RV50 Sierra Wireless modem.
D: Charge regulator.
E: 12 volt battery.

Solar power setup

Wireless modem antenna

Preliminary Data





- NE and SW sensors show different responses after the reflecting from the bottom of the sensors, that is due to loss of dielectric insulation of the NE sensor.

- As the scour or deposit occurs, we expect to see changes in the time of the reflection from the bottom of the sensor: increase travel in time with scour and decrease in travel time with sediment deposition.

Questions

- Alternative Method for Real Time Scour Measurements