Use of Hydrology and Hydraulics to Support Environmental Response at a Derailment Site

RREC - October 2014

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CANADIAN PACIFIC

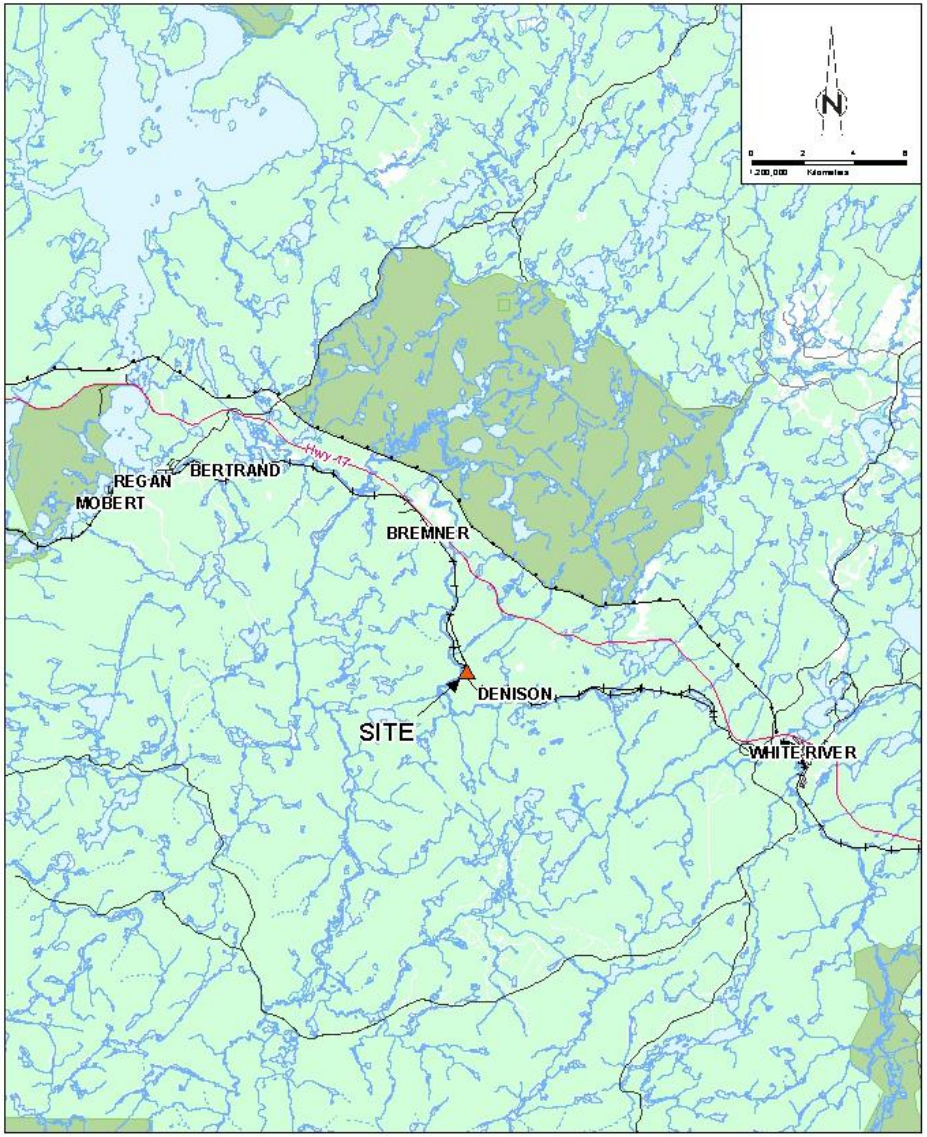
CRA CONESTOGA-ROVERS & ASSOCIATES

INTRODUCTION

- On April 3, 2013 a CP train derailed near the Town of White River, Ontario, Canada
- The rail line at the Site is a single track running geographic north-south on a 10 m (30 ft) high east embankment of the river White River
- A total of 22 rail cars derailed approximately 200 m (650 ft) from the water
- The derailment location is remote and surrounded by Crown (public) land
- The derailment occurred just before spring thaw and ice breakup (i.e. low river levels, just about to change)
- Personnel and equipment were mobilized immediately and emergency response and scene management were conducted

INTRODUCTION - DEFINITIONS

- Hydrology – the study of the movement of water. Usage for this application is to mean the quantification of surface water flow over time.
- Hydraulics – the study of the physical properties of liquids. Usage for this application is to mean determining the free surface flow in rivers.


N
REGAN
BERTRAND
MOBERT
HWY 17
BREMNER
DENISON
SITE
WHITE RIVER


Greenland
Pacific Ocean
Canada
SITE
United States
Atlantic Ocean


04/13/2013

WATER-RELATED CHALLENGES TO REMEDIATION

- Spilled contents within the river valley
- River flow and level anticipated to rise quickly due to spring thaw
- CP needed to quantify which zones of the river valley were safe for temporary management of impacted materials
- Equipment, personnel, and impacted soils may potentially be within the flood plain with imminent spring thaw (flood plain information was not available for this reach of the river)

WATER-RELATED INFORMATION REQUIREMENTS

- Information/data required for day to day Site management decisions - Daily predictions of river conditions, rain/snow, amount of runoff to be managed, freezing/non-freezing conditions
- Flood plain information to determine where impacted materials can be staged and processed without significant concerns of washout in the short to mid-term until a safe long-term solution could be implemented

DAY TO DAY SITE DECISION DATA

- Anticipated change in river water level for next few days
- Anticipated water to be handled on site

CONESTOGA-ROVERS & ASSOCIATES

White River Daily Hydrology Report

CRA: 71811

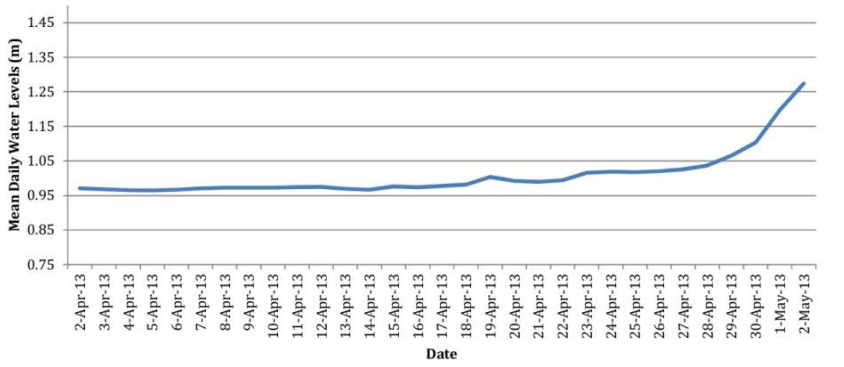
May 2, 2013

7 Day Weather Forecast

Date	Thursday May 2	Friday May 3	Saturday May 4	Sunday May 5	Monday May 6	Tuesday May 7	Wednesday May 8
Air Temperature - High	0 °C	6 °C	13 °C	13 °C	16 °C	17 °C	20 °C
Air Temperature - Low	-6 °C	-6 °C	2 °C	2 °C	2 °C	3 °C	4 °C
Precipitation – Rain (mm)	5-10 mm	Close to 5mm	Less than 1 mm	-	-	-	-
Probability of Precipitation	90%	90%	40%	30%	10%	10%	10%

Source: The Weather Network, www.weathernetwork.ca, Weather forecast for White River, Ontario

River Data



Site Observations:

Snow on Ground (cm): 17 (Wawa)

Site River Level (m amsl):

Source: Environment Canada Water Office, Real-Time Hydrometric Data, http://www.wateroffice.ec.gc.ca/index_e.html

Summary

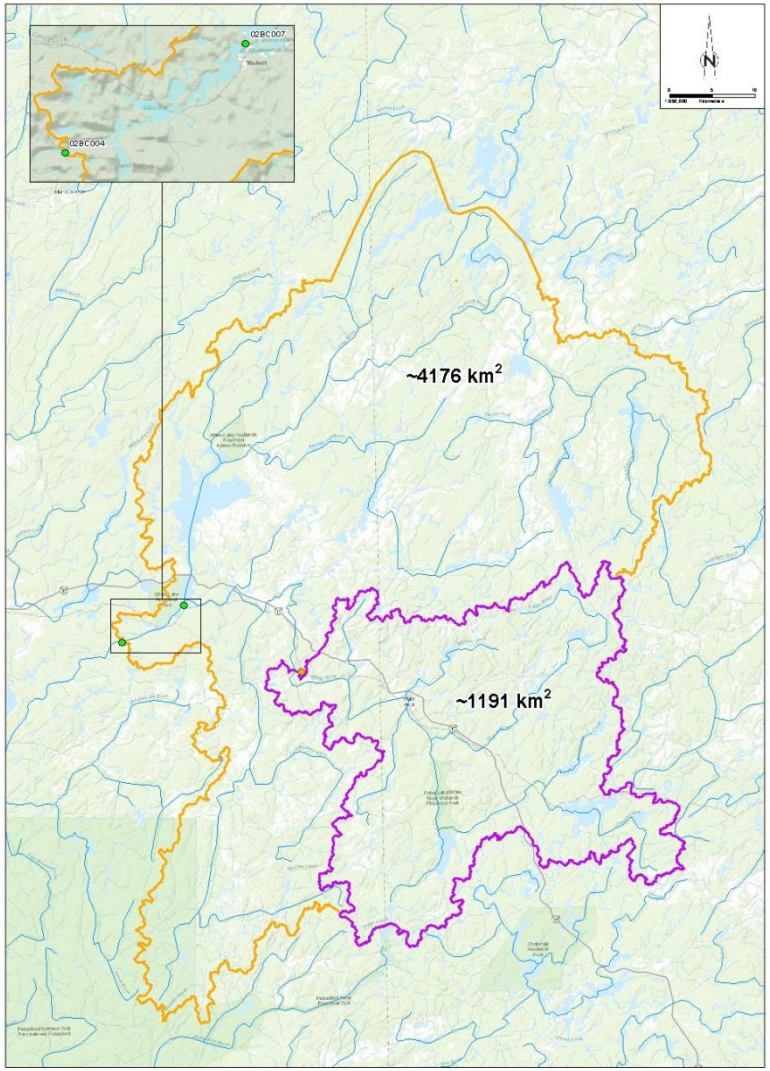
1. A freezing rain warning is in effect for today, continuing into Friday morning. Precipitation may fall as wet snow or ice pellets.
2. Precipitation today and tomorrow will likely result in an increase in the amount of runoff in the site area.
3. Forecast is for daily high temperatures above zero for the rest of the week and daily low temperatures above zero starting Saturday. River ice will continue to break up over the next week with the potential for corresponding ice jamming.
4. Increasingly warmer temperatures combined with precipitation today and tomorrow will likely expedite snowmelt within the watershed, resulting in a continuing increase in river water levels.

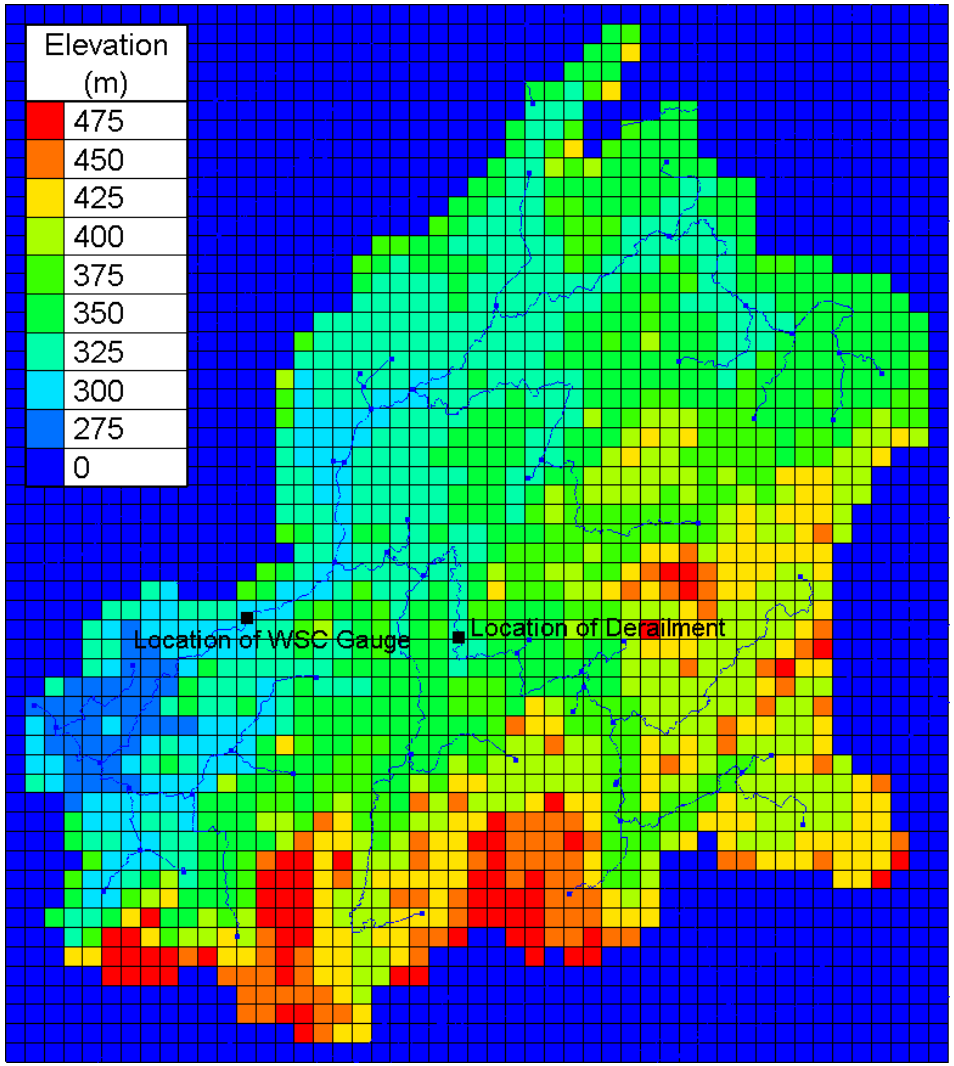
ESTIMATION OF FLOOD PLAIN ELEVATION

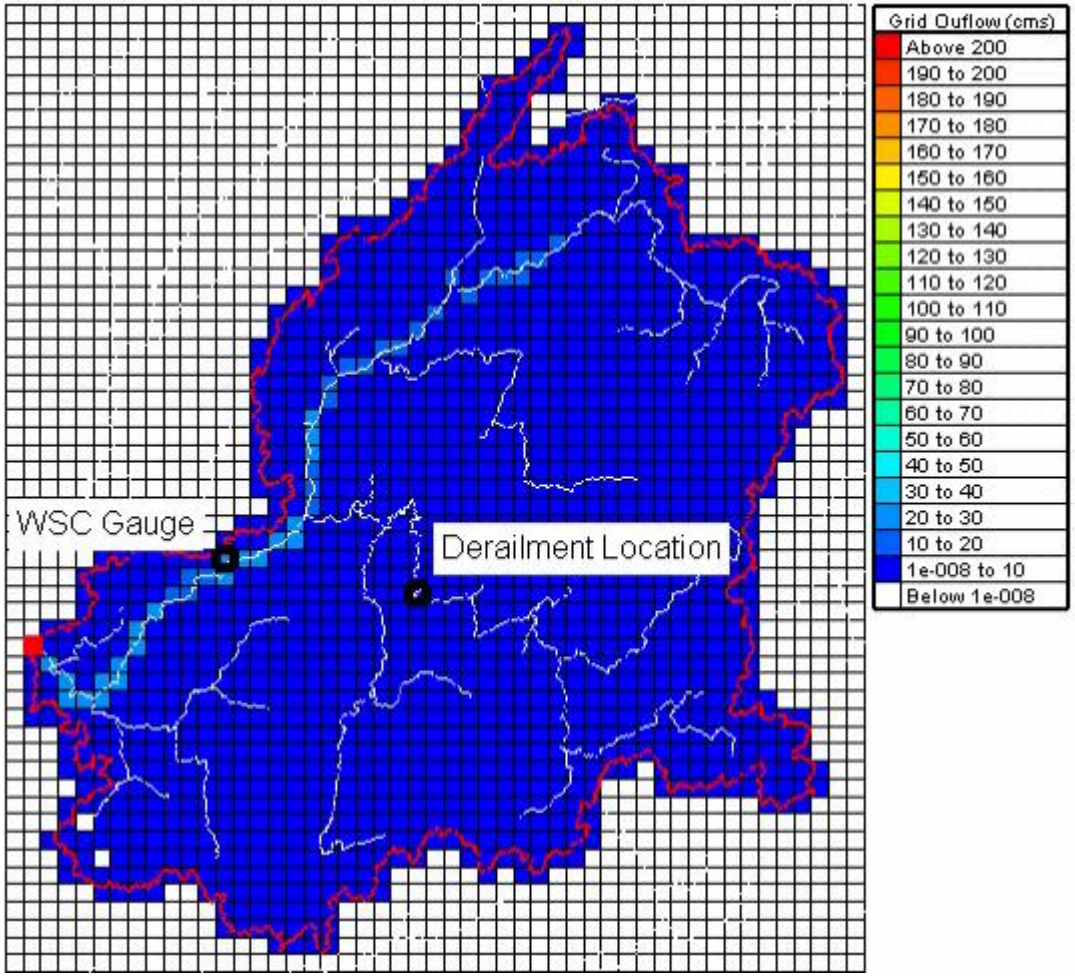
- Typically available for urbanized areas or high use rivers
- CP – not as fortunate with this location for a derailment (from a flood plain perspective)
- Regulators asked that we demonstrate what the 100-year flood plain elevation at the site was
- Broad scale steps:
  - Prepare hydrologic model to estimate river flow at points of interest
  - Conduct statistical analysis to determine 100-year flow
  - Prepare hydraulic model to estimate 100-year flood plain

ESTIMATION OF FLOOD PLAIN ELEVATION - HYDROLOGY

- Determine watershed at points of interest using DEM {~1,200 sq.km. at the site (~460 sq.miles)
- Obtain rainfall and temperature (for snow melt process) data for closest weather stations
- Assemble WATFLOOD model (cover types, soil, slopes, water bodies)
- Run model for period of record (1971 – 2012)
- Calibrate the model to the measured flows at the closest river gauging station {~35 km (22 miles) downstream}
- Conduct statistical analysis of flow data to determine 100-year flow {242 m^3/s (~8,500 cfs)}
- For comparison, average flow is ~17 m^3/s (~600 cfs)


02BC007
02BC004
~4176 km²
~1191 km²

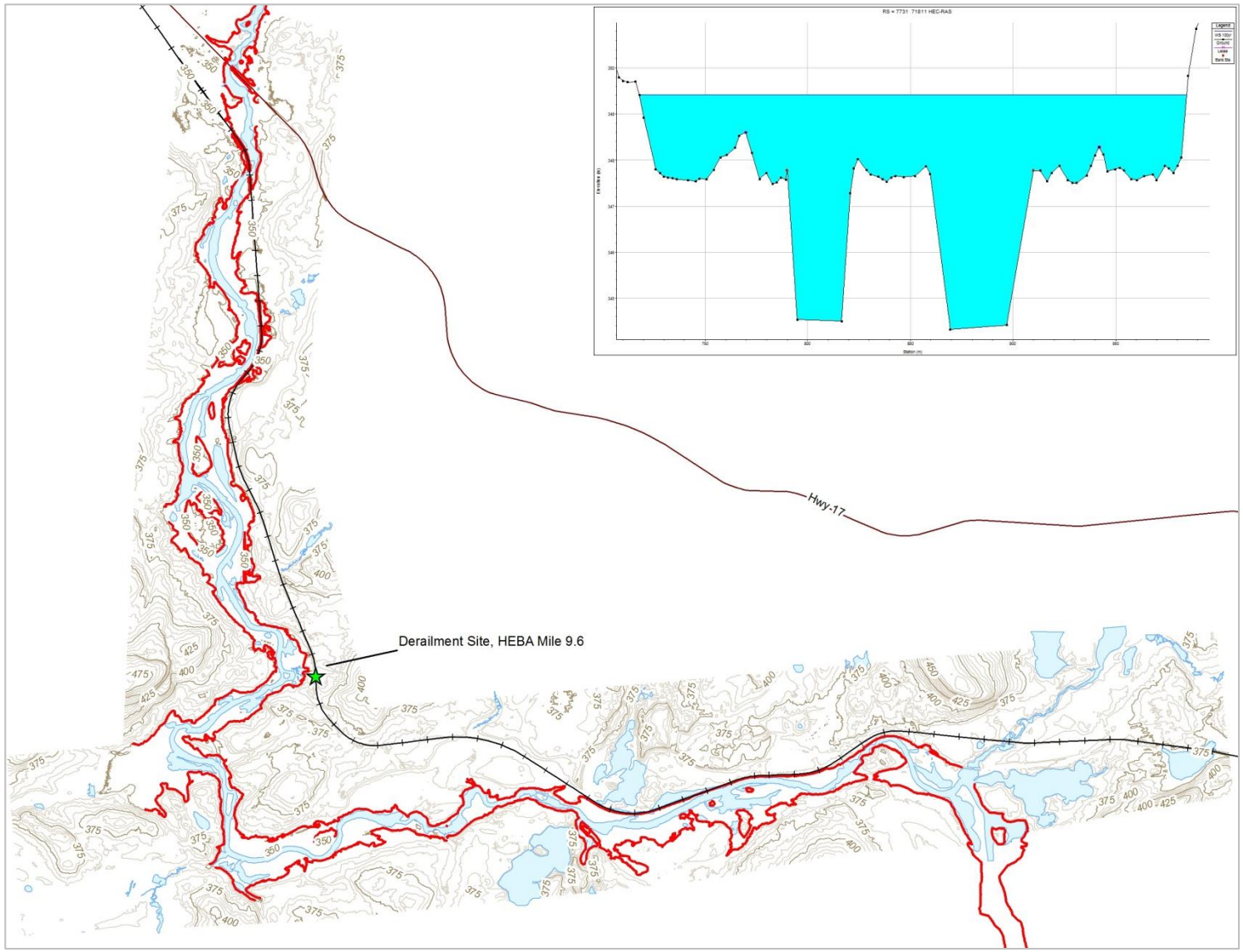

Elevation (m)
475
450
425
400
375
350
325
300
275
0
Location of WSC Gauge
Location of Derailment


WSC Gauge
Derailment Location
Grid Outflow (cms)
Above 200
190 to 200
180 to 190
170 to 180
160 to 170
150 to 160
140 to 150
130 to 140
120 to 130
110 to 120
100 to 110
90 to 100
80 to 90
70 to 80
60 to 70
50 to 60
40 to 50
30 to 40
20 to 30
10 to 20
1e-008 to 10
Below 1e-008

ESTIMATION OF FLOOD PLAIN ELEVATION - HYDRAULICS

- Available topographical data was very crude – not usable for level of accuracy required
- Obtained detailed topography using LiDAR from fixed wing aircraft {+/- 15 cm vertical accuracy (+/- 6 in.) with points on a 1 m (3 ft.) grid
- Use GIS software to convert the bare earth data files to TIN surface
- Use GeoRAS to prepare cross sections to bring into the HEC-RAS
- HEC-RAS is a 1-D hydraulic model that is used to estimate flood plain
- Model was prepared and run for the 100-year flow
- Resulting flood plain elevation was used to determine limits for site operations


Derailment Site, HEBA Mile 9.6
Hwy 17


Hwy-17
Derailment Site, HEBA Mile 9.6

AERIAL OF SITE

SUMMARY AND TAKE AWAY MESSAGE

- Hydrological and hydraulic assessments can be used to support a wide variety of activities associated with the rail industry
- This presentation focused on a derailment site that required critical water related information for proper emergency site management
- Also required water-related information for making decisions quickly on remediation options

QUESTIONS ?