# Overview of CN's Corridor Risk Assessment Process

## Risk Ranking Tool for Railway Transport of Dangerous Goods In Canada

***CSChE 2017 -- 24 October 2017***

# CN Corridor Risk Assessment - Background

- Launched August 2013 as a proactive CN initiative in the wake of the Lac-Mégantic incident:
  - Transport Canada (TC) establishes emergency order to conduct 'key route' assessments in 2014, finalizes regulation in 2015.
  - TC risk assessment requirements closely mirror CN's model and methodology.
  - TC regulation does not describe 'how' to conduct the assessment

- CN internal process used to assess numerous risk drivers along a given rail corridor:
  - Existing models inadequate to analyze CN network.
  - Analysis of both discrete and overall risks required.
  - Risk mitigation strategies identified and implemented following completion of the assessment.

# CN Corridor Risk Assessment – Key Route Scope

- What is a ‘key route’?
  - Any rail line segment handling more than 10,000 carloads of dangerous goods per year

- How many miles of ‘key route’ on CN in Canada?
  a) 1,000
  b) 6,000
  c) 9,000
  d) 12,000

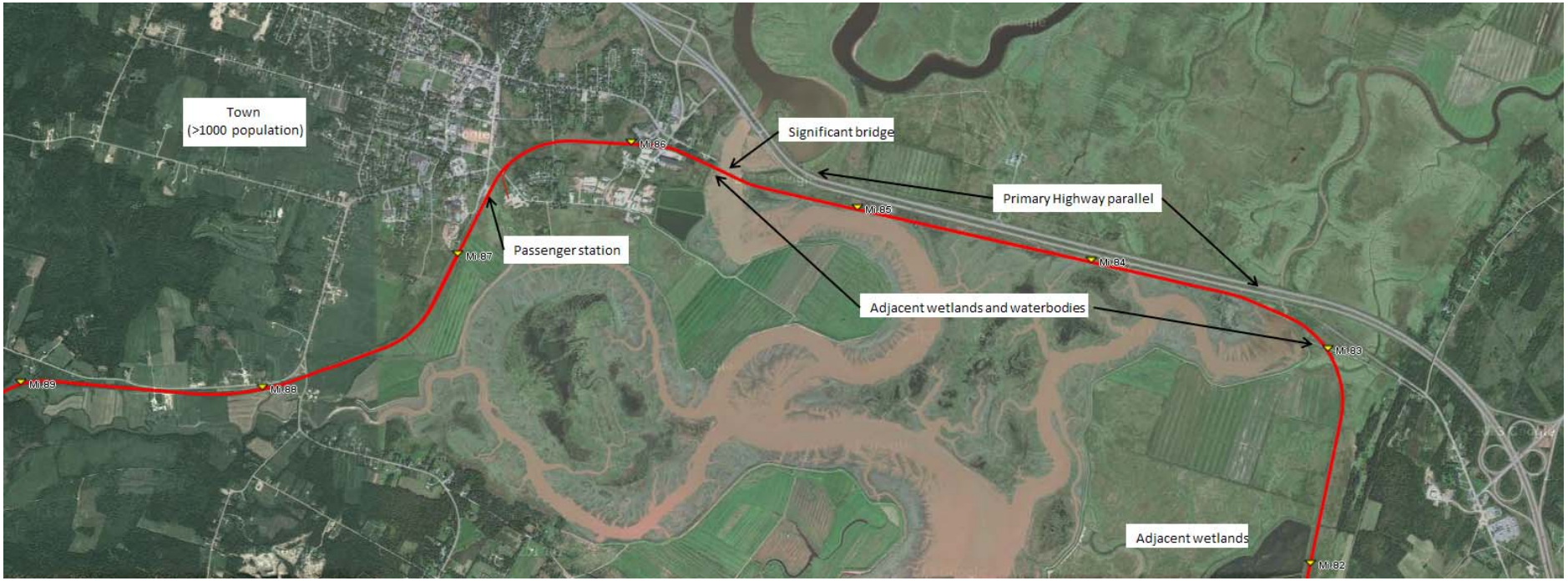
# CN Corridor Risk Assessment - Process

- Two stage process to undertake an assessment:
  - Initial work:
    - Collect information on the 28 elements of corridor characteristics and hazards as defined by TC.
    - Establish initial calculations of risk and vulnerability.
  - Team assessment working session:
    - Utilize the team's collective experience to review the initial findings, identify risk mitigations, propose plan to introduce technology or revised practices.

- Continued evolution of process and methods:
  - Engaged Canadian Rail Research Lab *(University of Alberta)* in 2015 to enhance the risk calculation process.
  - Application of new calculation methodology started August 2016.

# CN Corridor Risk Assessment – Initial Phase

- Detailed review of vulnerabilities and hazards:
  - Example from mapping review – what we are trying to quantify:



# CN Corridor Risk Assessment – Initial Phase

- Master inventory table (front-end) prepared to account for:
  - ✓ vulnerable features
  - ✓ infrastructure data
  - ✓ existing mitigating technologies developed to initiate the hazard, vulnerability and risk calculations.
- Portion of a sample vulnerability features table:

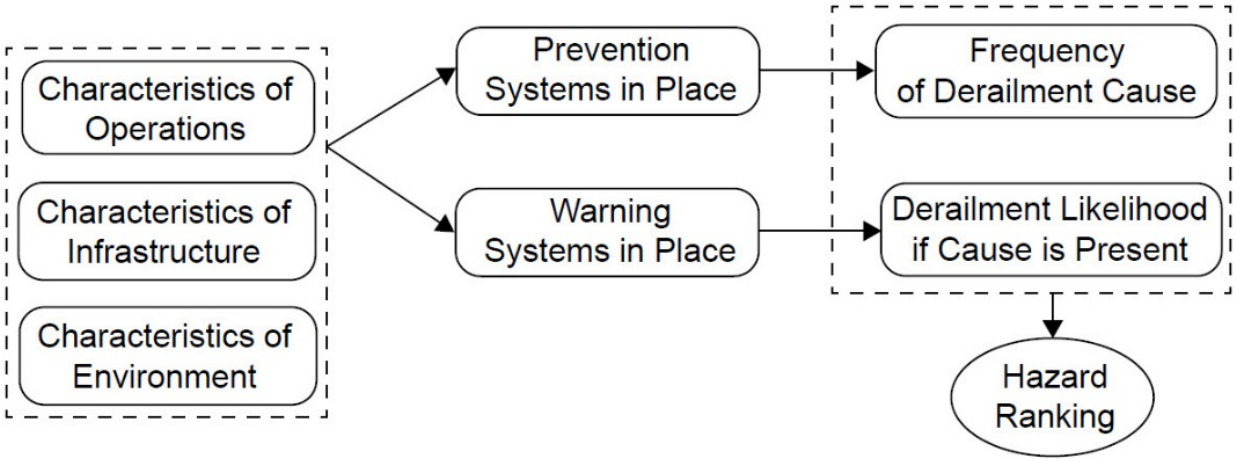
| Milepost | Significant Wetland or Waterway | Population 1000-10000 | Population 10000-100000 | Population 100000+ | Adjacent Highway | Adjacent Railway | No. of Significant Bridge Structure | Passenger Station | | Adjacent Parkland |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Yes/No | Usage ("High","Medium", "Low" or "Unknown") | |
| 0 | Yes | | | Yes | Yes | | 2 | Yes | Low | Yes |
| 1 | | | | Yes | | | | | | |
| 2 | | | | Yes | | | | | | |
| 3 | | | | Yes | | | | | | |
| 4 | | | | Yes | | Yes | | | | |
| 5 | | | | Yes | | | | | | |
| 6 | | | | Yes | Yes | | | | | Yes |
| 7 | | | | Yes | Yes | | | | | |
| 8 | | | | Yes | Yes | Yes | | | | Yes |
| 9 | | | | Yes | Yes | | | | | Yes |

# CN Corridor Risk Assessment – Risk Valuation

- Hazard, vulnerability and risk calculated using a mathematical approach developed with Canadian Rail Research Lab:
  - Hazard = likelihood for occurrence of derailment on a discrete mile segment:
    - based on incident history, infrastructure, operating practices
  - Vulnerability = valuation of exposure to physical elements
  - Risk = Hazard x Vulnerability

# CN Corridor Risk Assessment – Hazard Ranking

- Graphical representation of the hazard quantification methodology:




- Basic Hazard Ranking Equation:

$$H_R = \sum_1^{11}\left( h_i \times (n_i \, x \, f_i)\right) \; + \; (n_{12} \times f_{12})$$

# CN Corridor Risk Assessment – Hazard Ranking

- Multi-year data pool of accidents used to develop a potential for a derailment occurrence based on presence / absence of various factors:
  - Risk factors that influence derailment:
    - Trains per day, speed, track alignment, rail weight/type, public crossings, geotechnical features.
  - Mitigation (safety measure) factors:
    - Wayside inspection systems, hazard detectors, signal systems, inspection types / frequency.
  - 12 most frequent derailment causes evaluated against these factors *("i" in hazard equation)*

- Interactive – vary the safety measures to assess impact on hazard (and ultimately risk) valuation

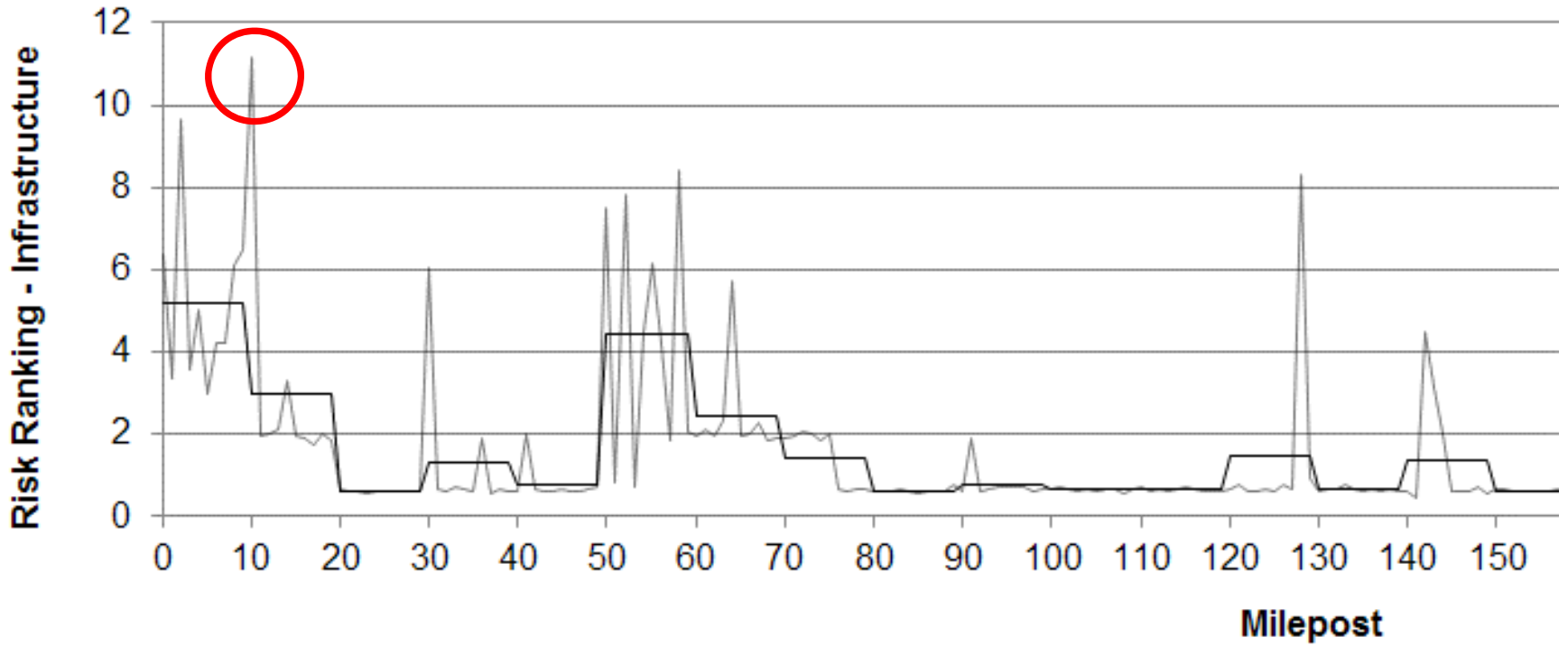
# CN Corridor Risk Assessment – Vulnerability Ranking

- Detailed inventory used to generate weighted vulnerability quantification for three main categories:
  - Public / workers:
    - Populated areas, passenger stations, parks, schools, etc.
    - Weight associated to usage levels.
  - Environment:
    - Waterways, parklands, other special features.
  - Infrastructure:
    - Roads, bridges, other railways, yard facilities, etc.

- Results normalized to a basis of 100

# CN Corridor Risk Assessment – Risk Ranking

- Numerical risk quantification generates tabular and graphical *(visual)* data presentation that pinpoints areas that may require focused mitigation efforts to reduce risk.
- Portion of a sample risk ranking chart:



# CN Corridor Risk Assessment – Team Review

- Risk assessment session where practices and risk features are reviewed and mitigations are proposed:
  - ➢ Multi-functional review with Transportation, Engineering, Mechanical and Environmental perspectives included
  - ➢ Issues of concern tabulated, mitigation strategies identified
  - ➢ Mitigation strategies ranked

| Sample Sub (Station A to Station E) | | CATEGORY |
|---|---|---|
| Issues of Concern | 1. DG volume:<br>- Station A to Station E = 10,001 loads in 2015 (various products)<br>2. Major population centres:<br>- City C<br>3. Major water resources in the vicinity:<br>- Big R. crossing<br>- numerous small ponds / lakes / wetlands in select areas<br>4. Branchline track conditions east of Station D | |
| Existing WIS Sites | 1. Existing DED sites = 2<br>2. Existing WILD sites = nil<br>3. Existing WIS sites = 6 | |
| Detection Enhancement | 1. Add One DED Mile x (west of Station E)<br>2. Add One WIS Mile y (east of City C) | 1 |
| Track/Structures Inspection Enhancement | 1. Rail Flaw Dectection - at least 10 inspections annually<br>2. Track Geometry - 1 - 2 track geometry passes each year | |
| Emergency Response | 1. Contractor in Station A (Static Liquids and low hazard gases)<br>2. Closest DGO in Station D<br>3. Industrial fire teams deployed from Station B<br>4. Foam availability - CN Station A, other carrier Station E<br>5. High hazard transfer equipment must come from US | |
| Environmental | 1. Equipment Caches: Existing at Station A (53' trailer); Station D (20' container)<br>2. E2MS mapping: complete<br>3. Contractor coverage being reviewed | 1 |

# CN Corridor Risk Assessment – Implementation

- Projects prioritized over a multi-year time horizon.
- Continuous project tracking by Safety Leadership Team:
  - ✓ proposal stage
  - ✓ approval with regional management
  - ✓ procurement
  - ✓ installation
  - ✓ commissioning
- Investments staged as the various CN corridor risk assessments are renewed on the mandated 3-year cycle.

# CN Corridor Risk Assessment – Results

- CN's corridor risk assessment process has proven to be highly valuable:
  - ✓ **High resolution:** assessment is discrete and location-specific
  - ✓ **Comprehensive:** assessment considers numerous risk drivers
  - ✓ **Mathematical basis**: linear risk valuation based on practice used in other high risk industrial activities
  - ✓ **Current:** connected with current traffic, municipalities and environment
  - ✓ **Accountable:** recognizes strengths and opportunities of current risk mitigations
  - ✓ **Pinpointed:** allow for specific risk reduction actions
  - ✓ **Proactive:** mitigate risk before it becomes a serious challenge

# CN Corridor Risk Assessment – Moving Forward

- Continuous improvement of the mathematical modeling for risk valuation:
  - Paper has been submitted for journal publication (Case Studies on Transport Policy) regarding the hazard calculation methodology for peer review.
  - Next step – integration with a corporate level risk management system.
- Opportunity to introduce new technologies to help mitigate risk as corridor characteristics change:
  - Assessment team has been challenged to consider new technologies as part of the review process.
  - Continued interaction with University of Alberta / Canadian Rail Research Laboratory.