



Development of a Risk Management Plan, Proposed Light Rail Transit (LRT) Corridor along Canadian Pacific ROW, Calgary, Alberta

A Case Study

2017 Railroad Environmental Conference

Joe Van Humbeck – System Manager, Environmental Assessment– Canadian Pacific
Dave Poole, M.Sc., P.Eng., CRM – Dillon Consulting Limited

October 24, 2017

Agenda

- **Background of Proposed LRT Corridor in Calgary**
- **Overview of Risk Management Principles**
- **Approach Taken to Assess the Risks**
- **Outcome – Risk Management Plan**

Overview of Proposed LRT Corridor

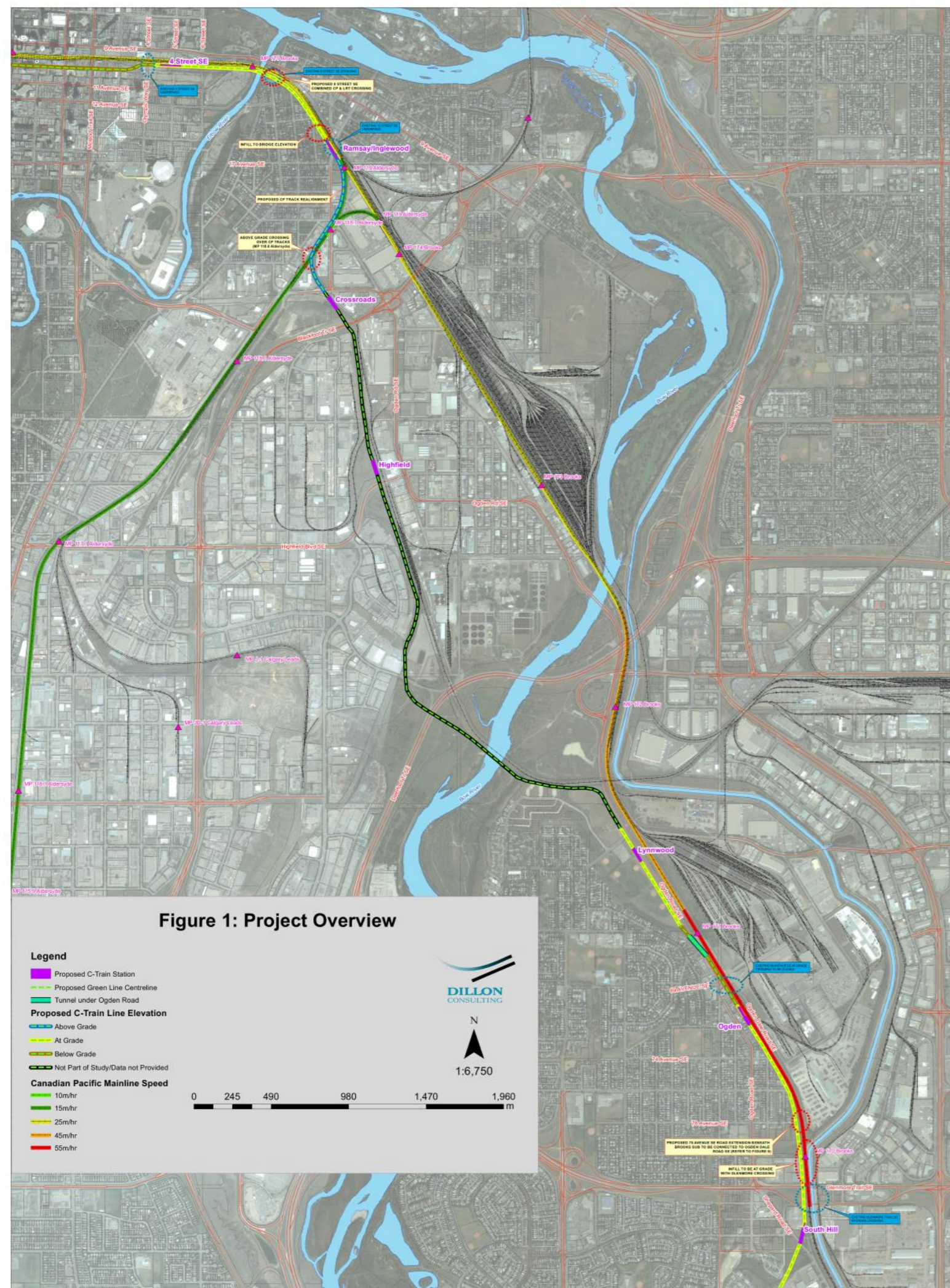
Overview of LRT Corridor

Video 1

Video 2

Called the Green Line

- 2.96 miles along CP ROW
- CP Track speeds vary between 10 – 55 mph
- Track both at grade and elevated guideway
- Pedestrian Tunnel
- 5 LRT Stations on CP ROW



Overview of LRT Corridor

Train Traffic

- 30 trains/hour or 180 trains/day

Hours of Operation

- 21 hours per day (0430 – 0130)

Service Frequency

- 3 – 6 minutes during rush hour
- 10 minutes during mid-day and early evening (until 2100 hrs)
- 15 minutes late evening (until 0130 hrs) and early morning (from 0430 hrs)

Overview of LRT Corridor

Train Speed

- 80 km/hour

Train Capacity

- 800 people at full capacity (4 car train)

Overview of Risk Management Principles

Risk Management Principles

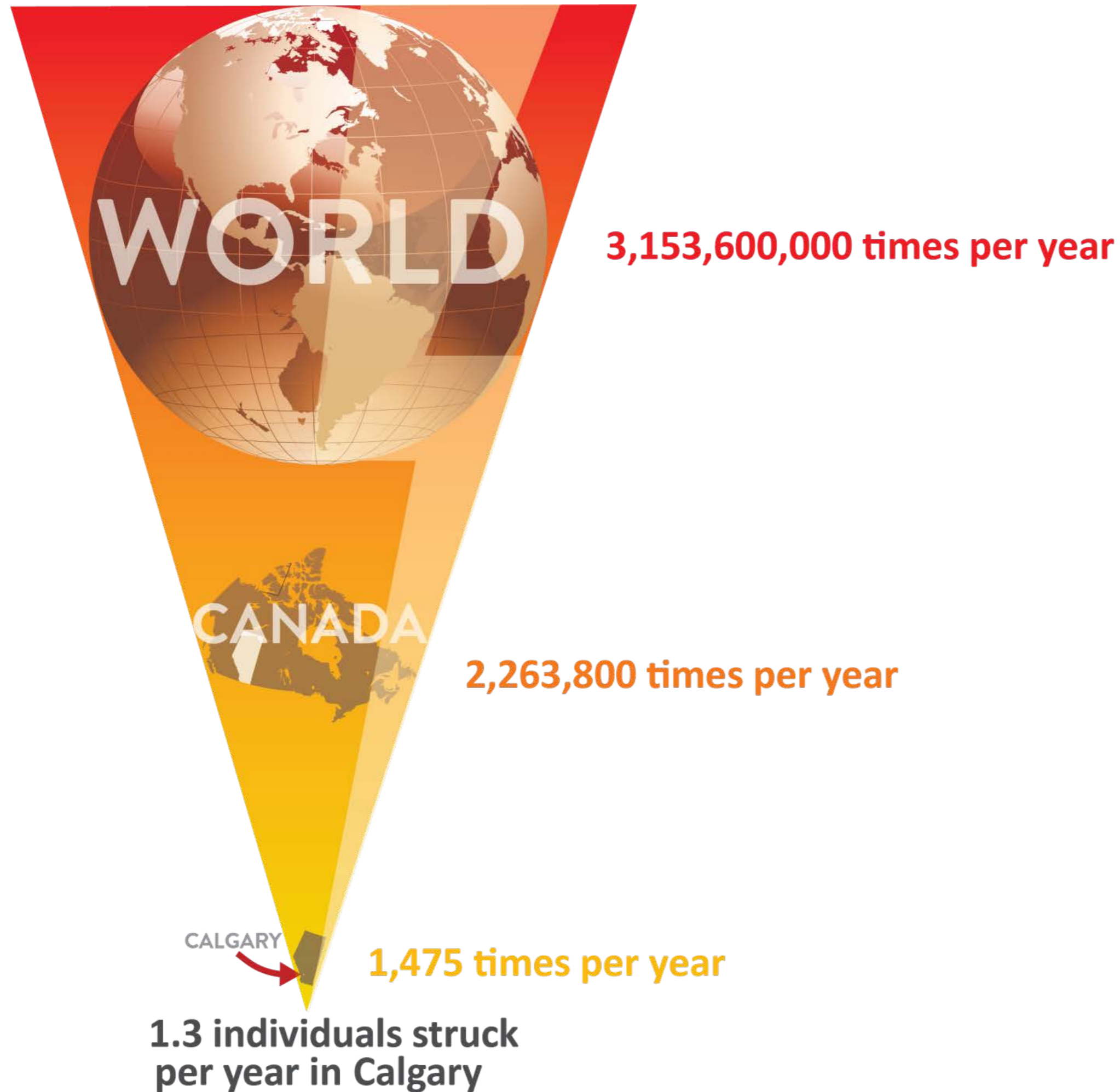
- **A common definition of “risk” is:**
 - A deviation from a desired outcome that can be either positive or negative
- **The "desired outcome" depends on your perspective - and perception becomes reality which defines the risk**

Risk Management Principles

- **The challenge is coming up with a common frame of reference in order to make informed decisions**
- **Given that perception drives risks, it is critical that the context is properly defined and easily understood**
 - How large (or small) do you define your perspective?

Perception of Risk

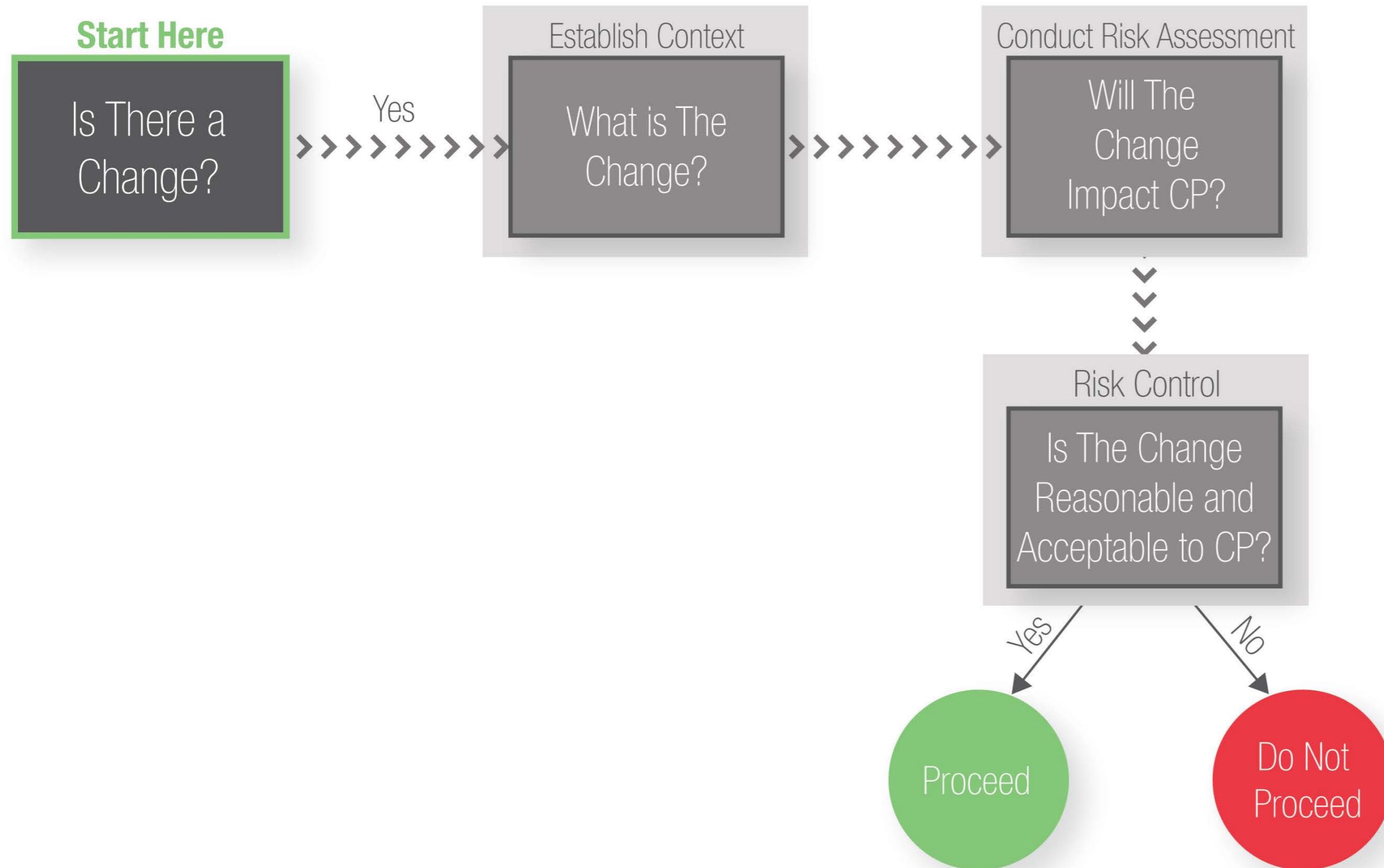
- Use lightning strikes as an example
- Lightning strikes the earth about 100 times second
- Frequency of strikes depends on your frame of reference
 - Goes up the larger your perspective



Approach Taken to Assess the Risks

Canadian Pacific Risk Management Framework

CANADIAN
PACIFIC



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CP Risk Management Framework

- Under paragraph 2(e) of the Railway Safety Management System Regulations, SOR/2001-37, CP is required to complete a risk assessment as part of its safety management system whenever there is a “significant change to railway operations”.

What was the “Change”?

- **City of Calgary will utilize existing CP lands along the ROW in several areas that are within proximity of rail operations**
- **Potentially higher than normal safety risk due to proximity of construction activities to active rail operations**
- **Alignment of Green Line will require re-configuration of existing track**

Conduct the Risk Assessment

- **CP determined a risk assessment was necessary to better understand the risks to:**
 - Safety (public, CP employee, City employee, contractors)
 - Environmental Protection
 - Level of Service and Operations
 - Regulatory

Conduct the Risk Assessment

- **Methodology Based on CAN/CSA ISO31000-10: Principles of Risk Management**

Establish Context

Articulate CP's objectives, define internal parameters to be taken into account and set the scope and risk criteria.

Risk Identification

Taking into consideration the design, construction and operation of the Green Line, what are the hazards that are being introduced?

Risk Analysis

What are the Undesired Events?
What are the chances of the Undesired Events occurring and how can CP and City be exposed?

Risk Evaluation

Do any of the risks exceed risk tolerance levels?
Are any of the risks considered acceptable?

Conduct the Risk Assessment

The following steps were completed:

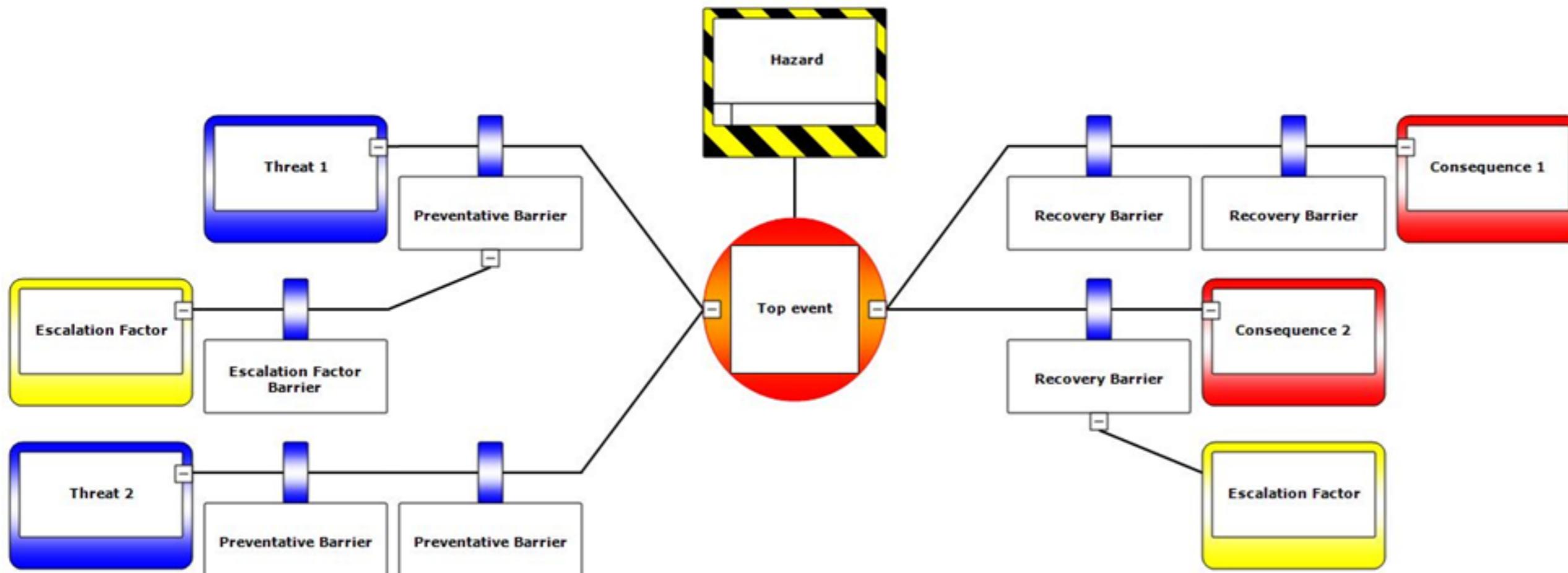
1. Identify key stakeholders – CP and City of Calgary
2. Identify Risk Assessment Triggers
3. Define Scope and Project Details
 - a) **Site Visit and Background Studies**
 - b) **Constraint Analysis**
4. Determine Risk Criteria – aligned with the Risk Drivers
5. Identify, analyze and evaluate the risks

PROJECT RISK MANAGEMENT PLAN														
RISK IDENTIFICATION				RISK ANALYSIS				RISK EVALUATION				RISK TREATMENT STRATEGY		
Hazard ID #	Hazard Identification	Risk Event ID #	Undesirable Event	SMART Column	Risk Trigger	Status of Existing Mitigation Plan/Circumstances	Likelihood of the Undesired Event	Risk Receptor	Consequences	Likelihood	Risk Score	Comments/Photos	Strategy	
1	Description of the Hazard that is introduced as a result of the Project.		Risk is an uncertain event or condition that, if it occurs, has a negative (harm) on a project.	Detailed description of the risk includes information on the risk that is Specific, Measurable, Attributable, Relevant and Timebound.	What is/are the underlying trigger(s) that would cause the undesired event to materialize?	What are the current circumstances (natural setting, existing mitigation plans, existing engineering features, operational procedures) that would reduce the inherent risk identified in preceding columns? What is remaining, the residual risk, is then evaluated to determine the risk score and the need for further management (if necessary).	What is the likelihood for the undesired event to occur?	Which "receptor" is impacted by the undesired event? (Receptors which have been crossed-out are not considered at risk.)	The consequences of the risk's effect on the project's objectives. Valid values - 1 to 5	Assessment of the likelihood of occurrence. Valid values - 1 to 5	Risk Score = Consequences x Likelihood		Avoid Transfer Mitigate Accept	
	Current CP train movements along Brooks Sub between MP172 and 169 Future CP train movements along Brooks Sub between MP172 and 169 Green Line LRT movements	U	CP Train derailment on the Brooks Sub between MP170.66 and MP170.	As shown on IWC NDF 33.129-TR-100-52-FRE-0031 and 0032, the Green Line will be located ~7 metres down slope and at close proximity (between 10 to 16 meters) to the CP ROW. In a derailment event, the elevation difference and type of derailment would increase the probability of derailed car(s) tumbling down slope towards the Green Line ROW and striking a traveling C-Train. Given that the CP train speed limit is 55 mph, it is likely that a jack-knife based derailment would take place, which can generate a lateral "footprint" up to one rail car length. An average rail car length is 75 feet (or 22.86 meter). A such event could be catastrophic, due to its potentially high consequence in terms of fatalities. For that reason we analyzed the following scenario: Scenario - CP train derailment between MP170 and 170.66, while a C-Train is traveling during off-peak hours. Taking into consideration the combined probability of a CP train derailment at the same time as a passing C-Train, the probability of the scenario = 1:2,002 years.	Derailment of CP train consisting with a C-Train movement along the Green Line. Green Line ROW located upwards of 7 m below the elevation of the Brooks Sub. Due to elevation difference between the Green Line and the Brooks Sub, a crash wall is not considered technically feasible.	CP has standard maintenance practices in place to conduct routine inspections and preventative repairs as required.	1	Employee Safety Third Party Safety Public Safety Regulatory Agency Environment Operations Costs Project Cost Project Schedule Productivity Level of Service Network Train Speed	4 5 5 5	1 1 1 1	4 5 5 5	These type of accidents would have an effect on the psychological health of the implicated CP employees. The employees would be examined for physical injuries and referred to expert in regards to psychological health. The C-train conductor could be killed or have serious injuries. The derailment could result in multiple fatalities, upwards of 800. A derailment will be investigated by CP police, local police and the Transportation Safety Board.	Mitigate Mitigate Mitigate Mitigate	M18 M19 M18 M19 M18 M19
	Current CP train movements along Brooks Sub between MP172 and 169 Future CP train movements along Brooks Sub between MP172 and 169 Green Line LRT movements	V	C-Train/Vehicle Collision @ 8th Street Crossing	A vehicle attempts to bypass warning system and struck by C-Train. This results in a 2 to 4 hour delay. Given that the Brooks Sub is part of the same crossing, no CP Train movements would occur until the accident is cleared (between 2 to 4 hours).	Human error - vehicle driver attempting to cross while C-Train is moving. Estimate of approximately 2 C-Train/Vehicle crossing accidents per year along the south leg of the Green Line. Peak hourly cross-product exceeds acceptable threshold for an at grade crossing (for only CP train traffic). Daily cross-product exceeds threshold when C-Train traffic taken into account.	The active warning system for the at grade crossing is integrated between the Green Line and Brooks Subdivision. Therefore, for the risk assessment, it is considered one crossing.	3	Employee Safety Third Party Safety Public Safety Regulatory Agency Environment Operations Costs	4 4 4 4 2	3 3 3 3 3	12 12 12 12 6	The vehicle collides with a C-Train (traveling at 80 km/hour) or by a CP train (traveling at 40 km/hour or 25 mph), the driver and occupants would suffer serious injuries (in the case of the 12 th Avenue and 36 th Street NE collision on December 19, 2015, there was one fatality), and the conductor of the train would require medical attention and treatment at a hospital. A crossing accident will trigger an operational shut down between 2 to 4 hours - average = 3 hours. Train delay cost to CP's operation is estimated at \$5,000/train/hr. On the Brooks Sub, a 3 hr. delay would affect 5 trains. Cumulative total of 7.5 hrs. of lost service time @ \$5,000/hr. = \$39,167.00 Change of Crew is estimated at \$3,000.00/hr. It will take ~2hrs to change the	Mitigate Mitigate	M21 M22 M21 M22

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Risk Assessment Tools

- Facilitated process
- Use workshop sessions with relevant stakeholders and SME
- Consensus building
- Transparency



Risk Management Plan

Process to Develop Risk Management Plan

- **Determine risk tolerance level**
- **Evaluate and implement existing risk management strategies**
- **Determine if the “residual risks” are tolerable**
- **If not tolerable, evaluate additional risk management strategies**
- **Repeat cycle as needed**

Objectives of Risk Management Strategies

When developing specific risk management strategies, there are several objectives to keep in mind:

- **Avoid the risk by deciding not to start**
- **Take on the increased risk without implementing additional measures**
- **Remove the risk source**
- **Reduce the likelihood/frequency and/or consequences**
- **Share the risk with the other parties (i.e. insurance, contractual agreements, etc)**

Risk Management Plan – Green Line

- **Design Modifications**
 - Closure of an at-grade crossing
 - Re-alignment of CP track
 - Increase elevation of guideway to prevent being struck by double-stack in the event of a derailment

Risk Management Plan – Green Line

- **22 specific Risk Management strategies grouped under the following:**
 - Construction Agreement
 - Maintenance & Access Agreement
 - Operating License
 - Communication Plan
 - Environmental Management Plan
 - Health, Safety & Security (HS&S) Plan
 - Emergency Preparedness Plan

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Thank You

Dave Poole, M.Sc., P.Eng., EP(CEA),
CRM – Dillon Consulting Limited
dpool@dillon.ca

Joe Van Humbeck, System Manager
Environmental Assessment, CP
Joe_VanHumbeck@cpr.ca