GOLDER

MEMBER OF WSP

Saskatchewan Mining Association

A GUIDE TO ASSESSING AND INCORPORATING CLIMATE CHANGE INTO DECISION MAKING FOR THE MINING SECTOR

Environmental Forum

October 20, 2021

What We Did

LOOKED FOR BEST PRACTICES IN THE SECTOR

Formed Steering Committee of MAC members

Consulted SME's on key technical issues

Held two workshops to obtain input

Liked to regulatory guidance (Impact Assessment Act, Yukon)

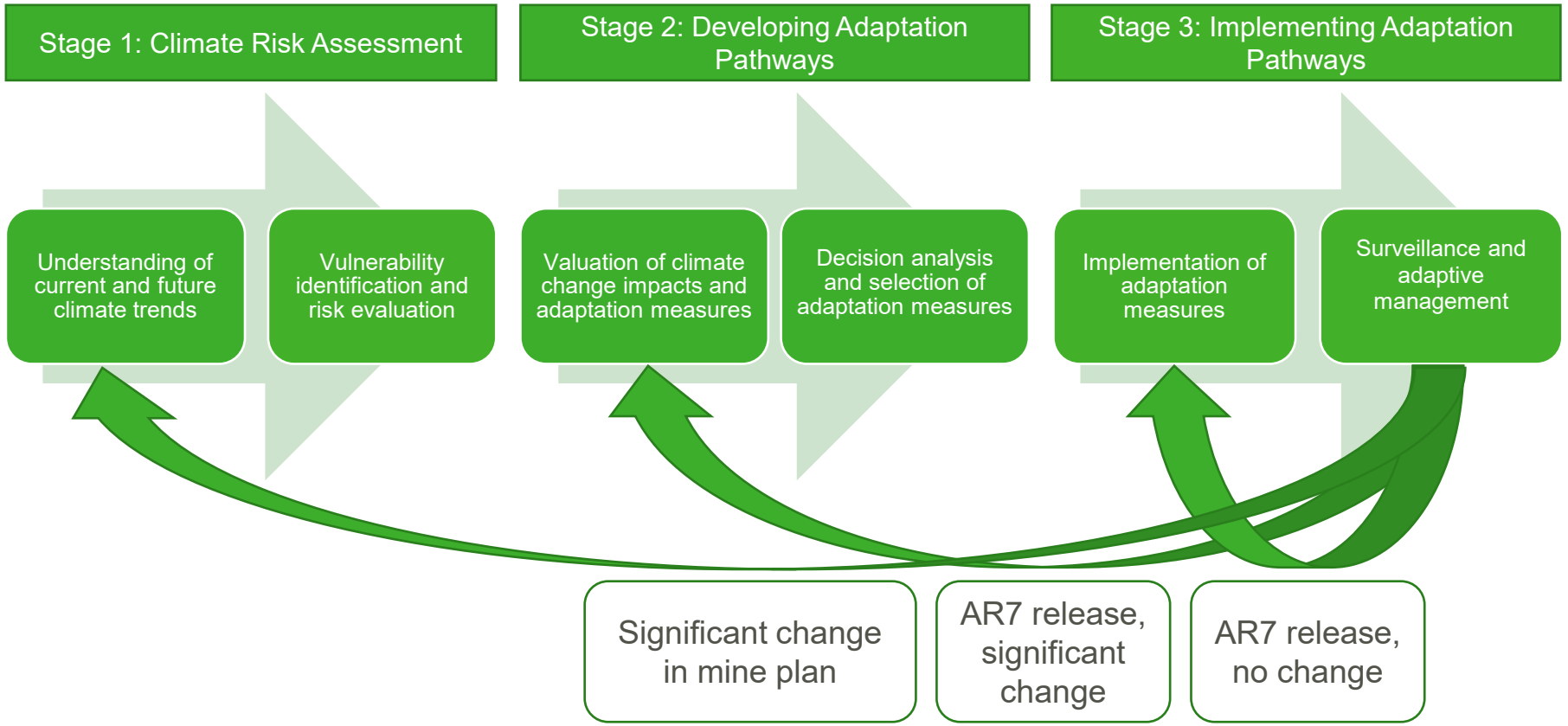
Incorporating Climate Change Adaptation for Mining

RESPONDING TO OTHER DRIVERS

1) Regulators
2) Professional practice
3) Stakeholder /Investor interest

Overall Process

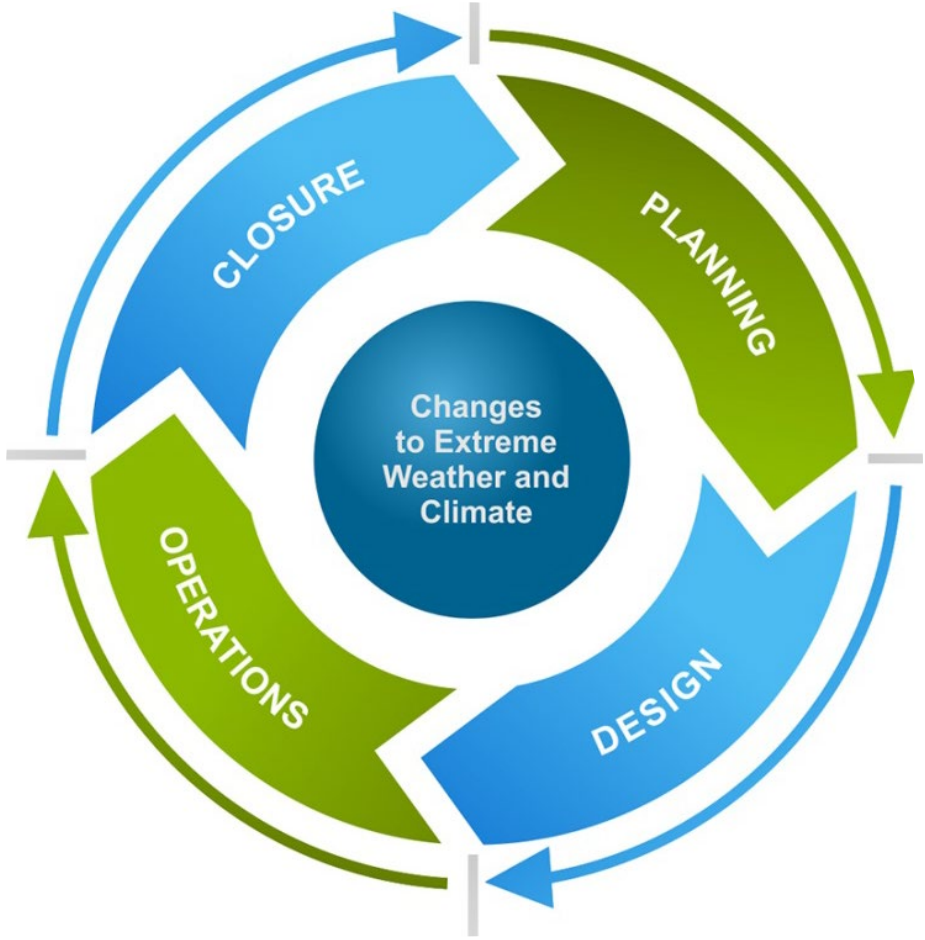
MAC CLIMATE ADAPTATION GUIDANCE



When to Consider a Changing Climate?

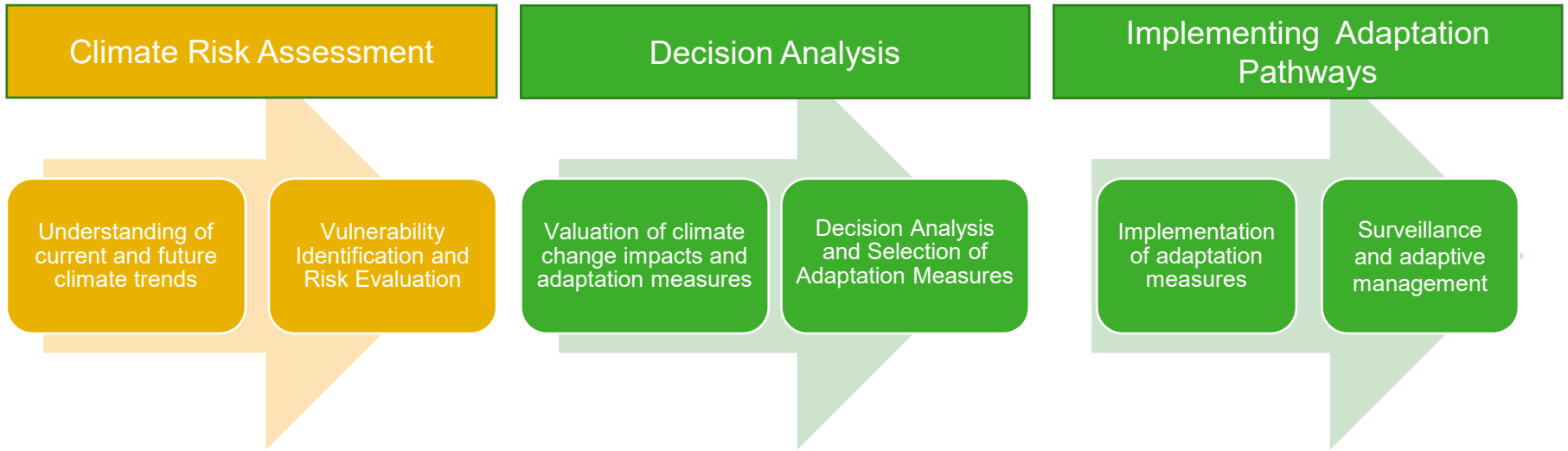
CLIMATE DECISIONS ARE REQUIRED AT EACH STAGE OF A PROJECT LIFE

The approach should be the same, however, the level of effort and available information varies with the project life cycle



Decision-Making Framework

CLIMATE RISK ASSESSMENT



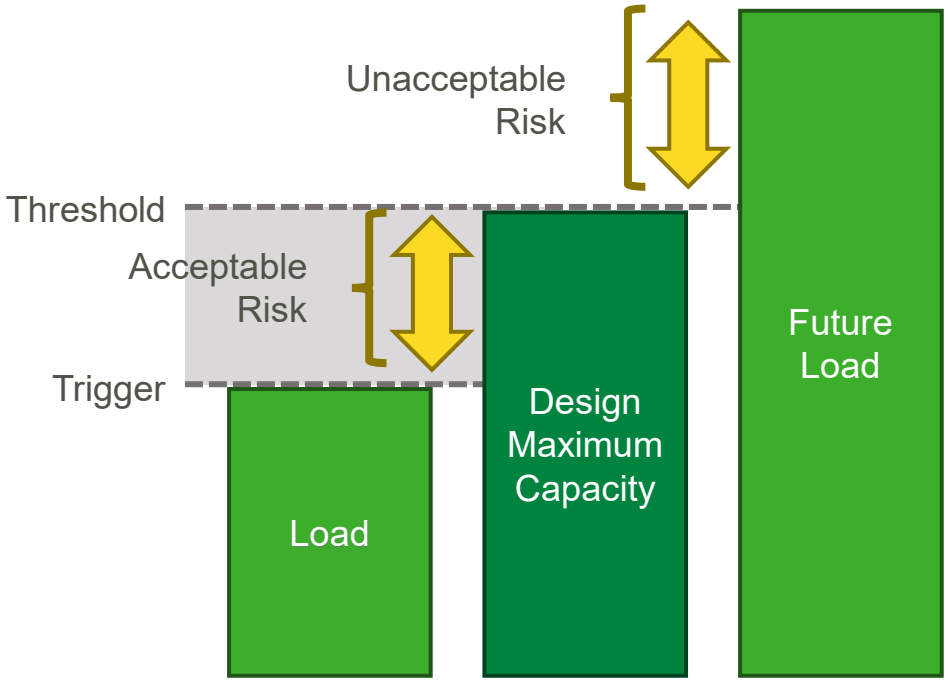
Future Climate

DATASET DEVELOPMENT CHECKLIST

- What future climate projections (covering periods following the most recent observations) were considered for the mine and how were they selected?
  - Which climate models are future climate projections from and how were they selected?
  - How were the climate projections obtained?
  - What future time periods (e.g. 2050s or mid-century) were considered?
  - Which scenarios were considered (e.g. RCPs)?
- How is uncertainty in the future climate projections addressed?
- What future climate variables were considered?
  - What variables are available directly from the climate models (e.g., total precipitation)?
  - What variables are based on analysis of the model projections (e.g. rainfall statistics)?
  - What variables are taken from literature?

Framing the Risk Assessment

TRIGGER AND THRESHOLD FOR ACTION



Adapted from Engineers Canada Climate Resilient Systems Training

Example: *spillway is designed for a 1:1000-year storm based on historical observations*

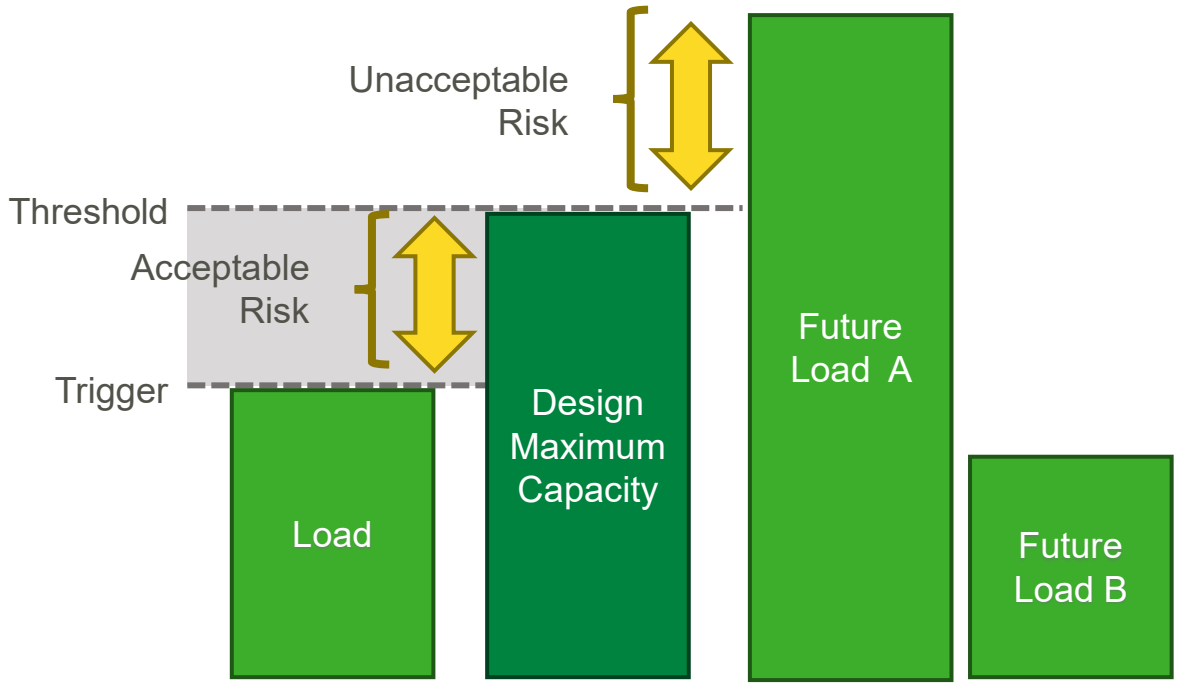
Threshold: *event with an equivalent magnitude to a 1:1000-year historical storm*

Trigger: *changes in frequency and intensity of future precipitation*

Action: *expand spillway before probability changes and an unacceptable risk is present*

Framing the Risk Assessment

TRIGGER AND THRESHOLD FOR ACTION



Adapted from Engineers Canada Climate Resilient Systems Training

Example: *Progressive rehabilitation slope contours based on historical observations*

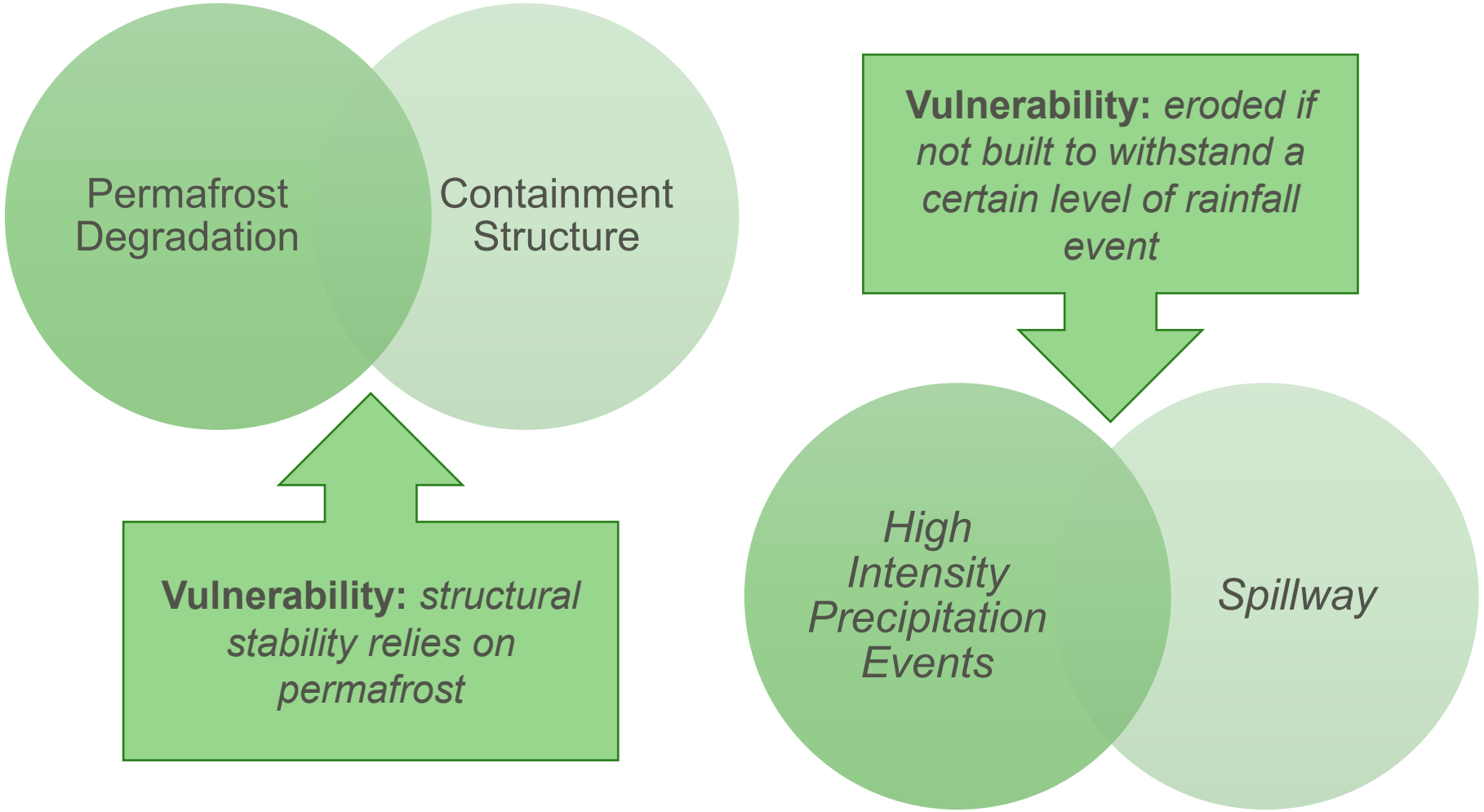
Threshold: *stability based on saturated conditions/vegetative cover*

Trigger: *changes in frequency and growing patterns can cause variability*

Action: *consider slope conditions under future range of conditions*

Climate Change Risk Assessment

ASSESSING CLIMATE CHANGE VULNERABILITY AND RISK



Climate Change Risk Assessment

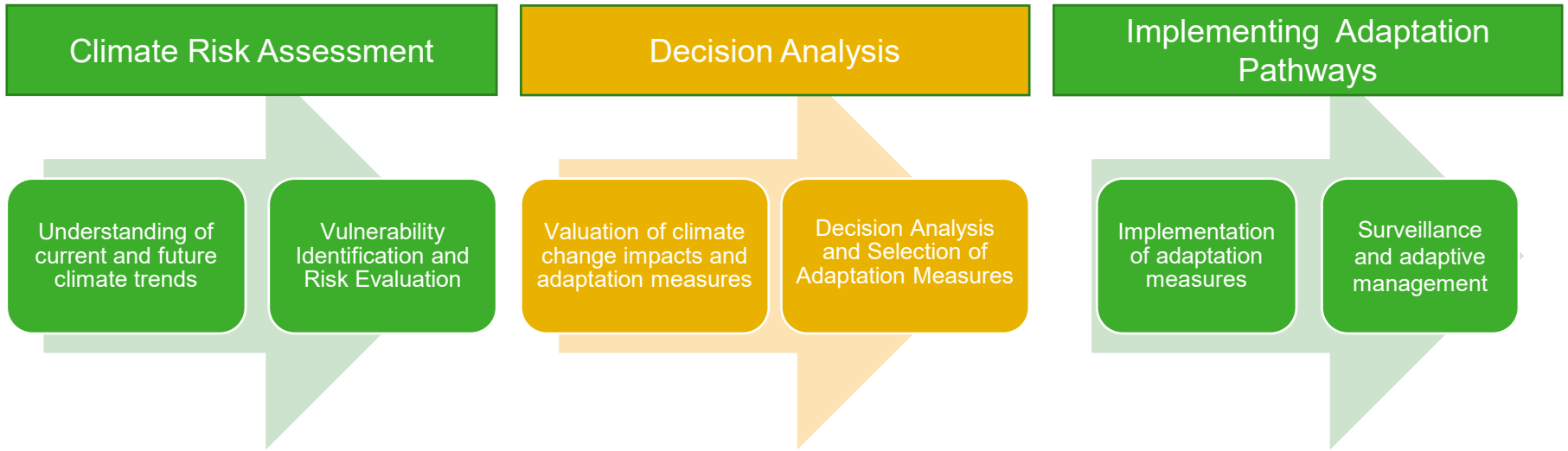
DEFINING PROBABILITY AND CONSEQUENCE

- A risk ranking system is required for both consequence and probability.
- The product of the risk criteria (for consequence and probability) is used to classify what is a low, moderate or high risk.

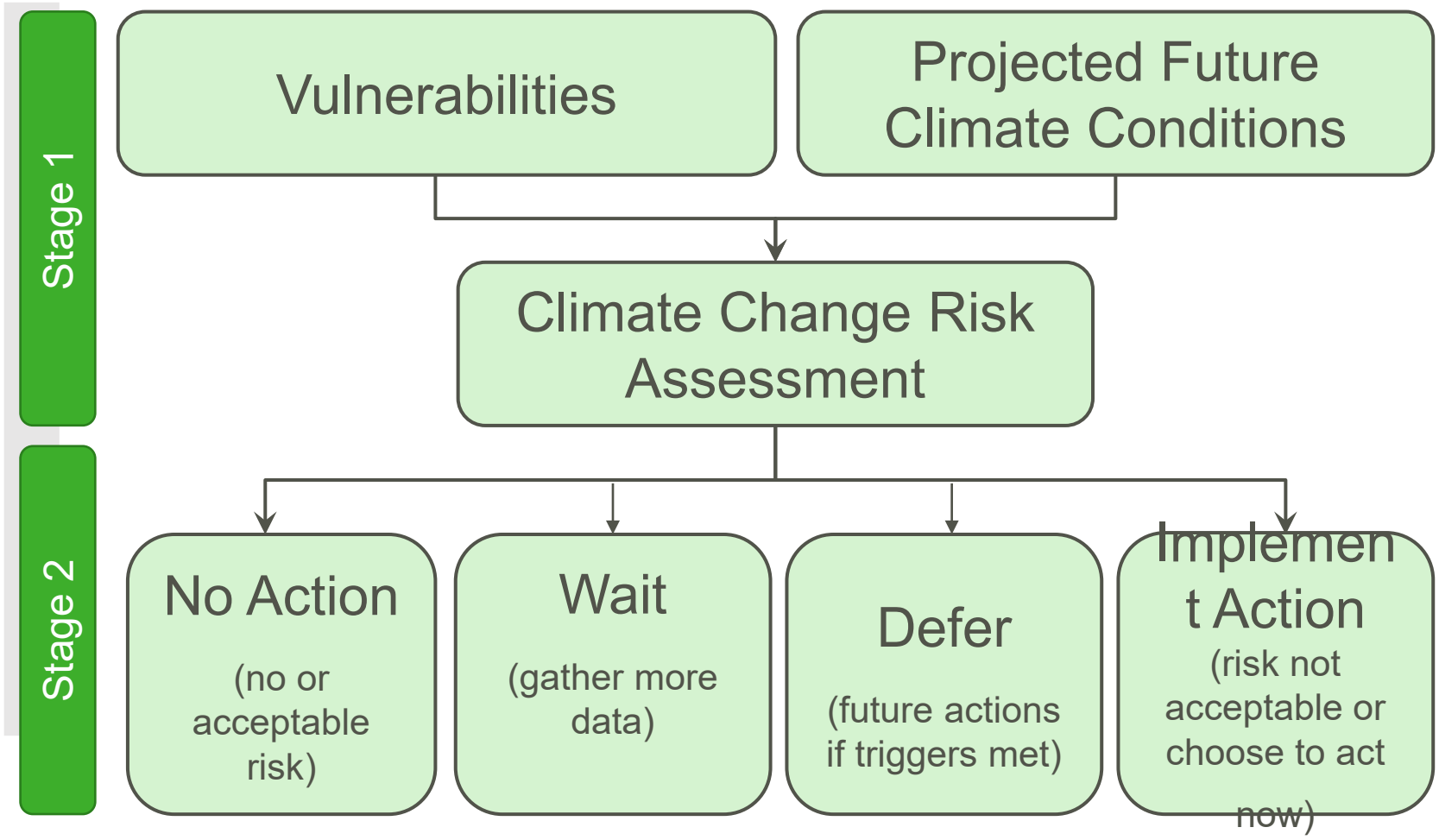
Many Owners have existing risk ranking systems that may be applied to climate change risks – with or without modification.

Decision-Making Framework

DECISION ANALYSIS

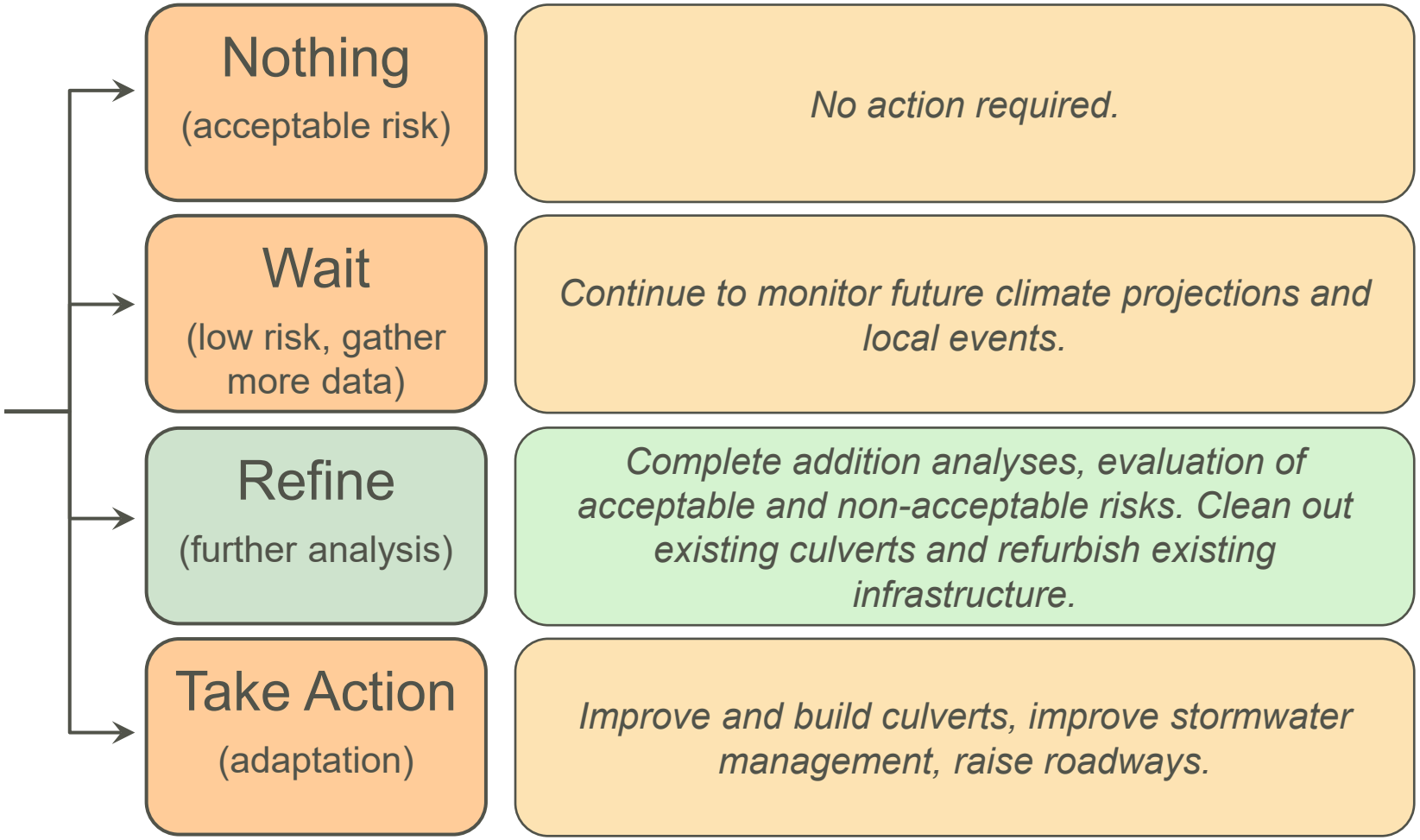


Decision Analysis



Decision Analysis

MULTIPLE OPTIONS/ PATHWAYS



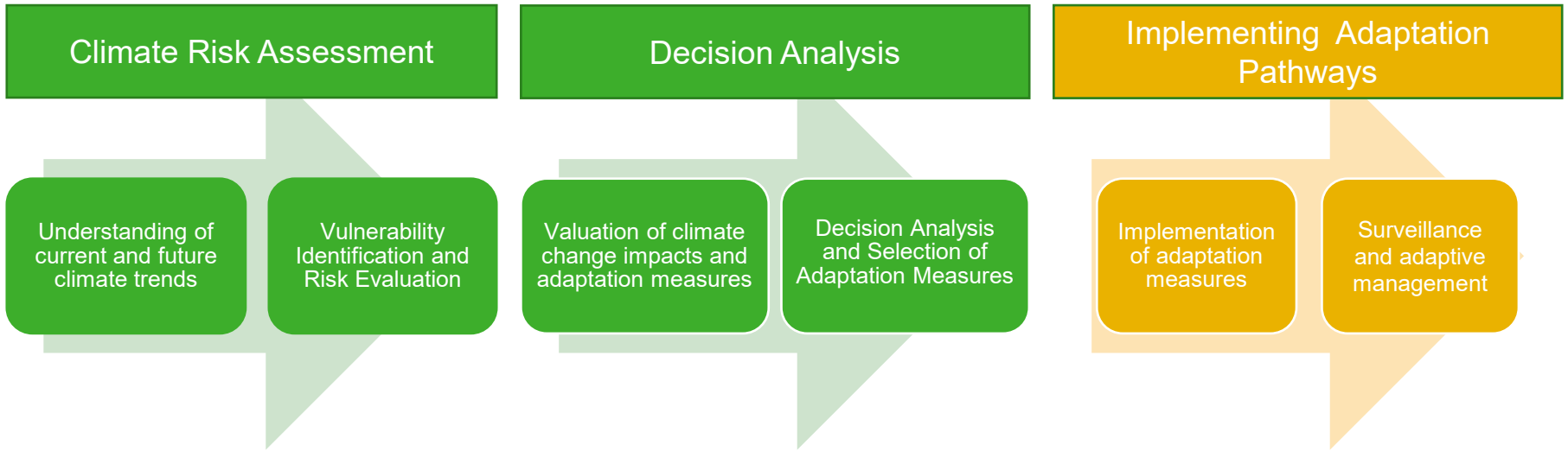
Decision Analysis

MULTIPLE PRIORITIES

- Must be location specific to consider local issues
- Cost Benefit Analysis vs Multiple Criteria Analysis
- Link to the consequence category that drove the priority setting
  - Health and Safety – low cost consideration
  - Environment – some cost consideration
  - Operational – more cost consideration

Decision-Making Framework

ADAPTIVE MANAGEMENT PLAN



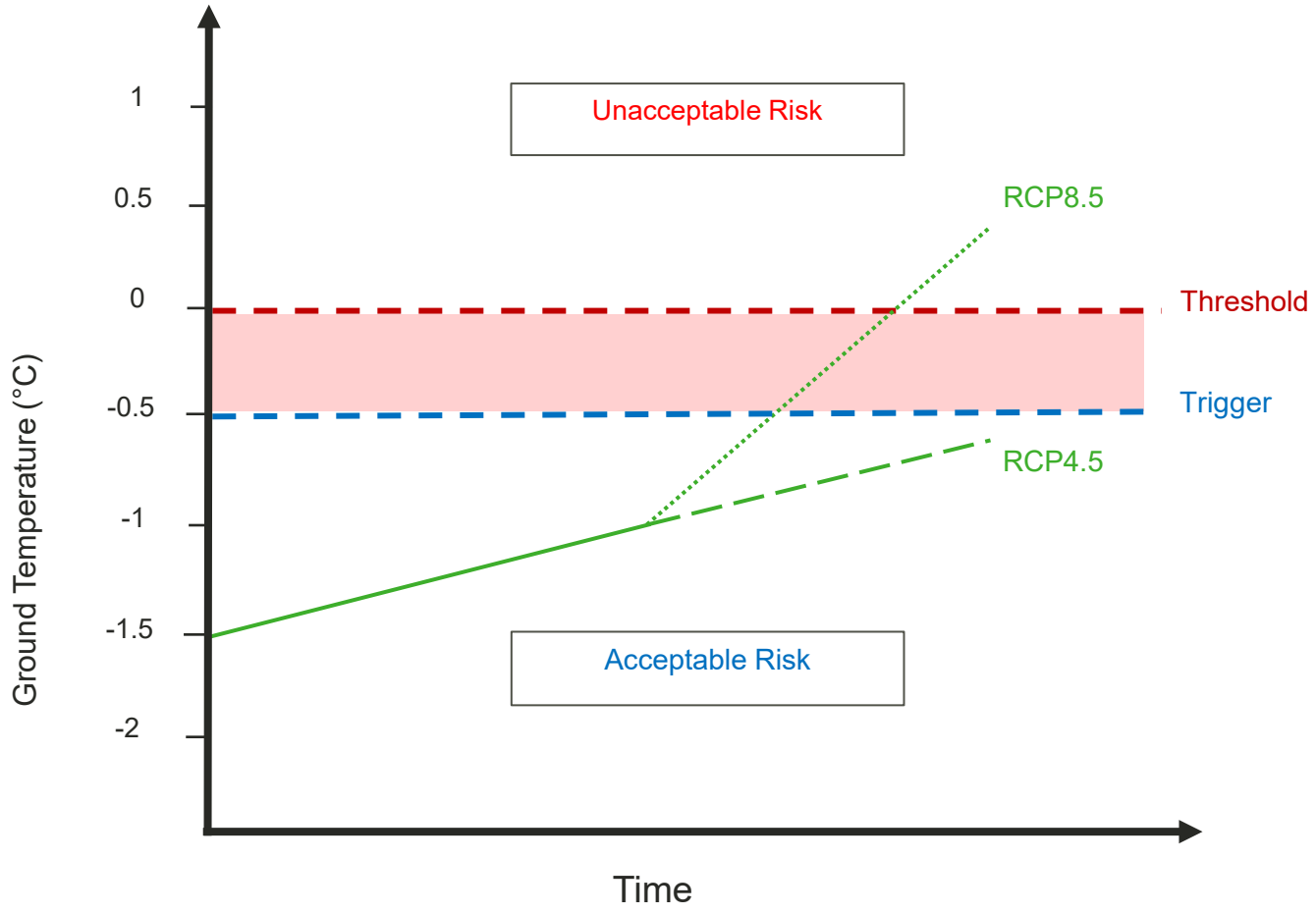
Time of Emergence Signals

WHEN SHOULD YOU RESPOND?

- Identifying ‘triggers’ or ‘time of emergence signals’ for climate change impacts
  - Knowing when things are likely to happen can help to address climate change uncertainty.
- Triggers will provide decision points, identifying when management action must occur
  - Timing of decisions is variable depending on the interaction
- Triggers should consider that climatic changes occur at different rates and are impacted by surrounding environment
  - No climate risk assessment is static

Trigger and Threshold for Action

PERMAFROST DEGRADATION



Case Studies

Examples – ESIA Component Assessment

COVER THICKNESS

Provided description of future projected climate (i.e. monthly mean temperature and precipitation)

- **Baker Lake Whale Tale**
  Results used to help inform cover design thickness, to account for changes in permafrost layers as climate changes

Example – ESIA Component Peer Review

INFORMATION RESPONCE

- Climate change modelling used to inform the initial planning of the tailings storage facilities and waste rock storage areas
- Introduction of an ongoing monitoring program that will determine whether freezing conditions are occurring during Operations and Closure
- Outlined additional mitigation strategies to be included as part of an adaptation management plan to overcome uncertainties of a changing climate

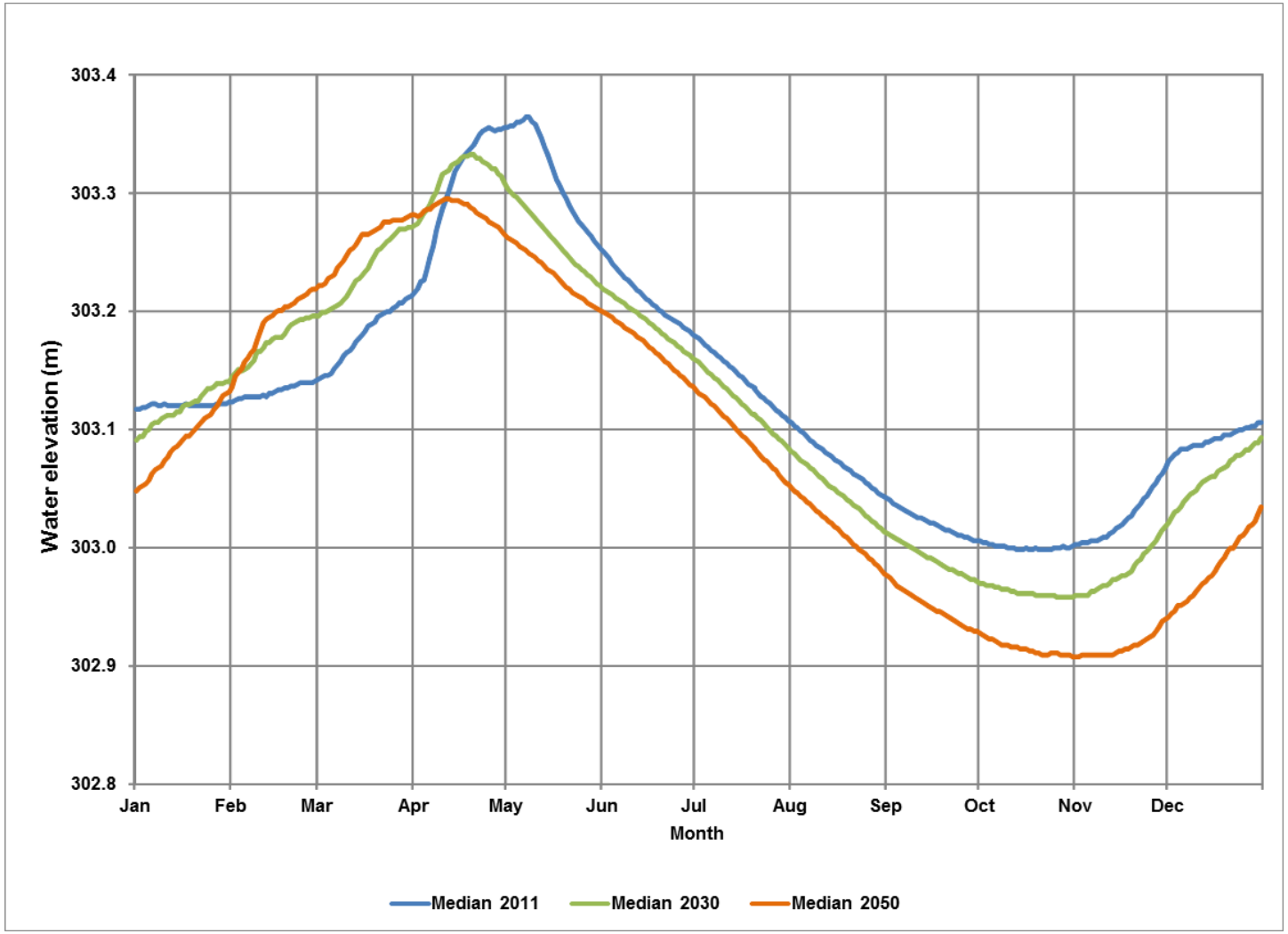
Sabina Gold & Silver, Retrieved from the Northern Miner News (2015) http://www.northernminer.com/news/sabina-focuses-on-optionality-at-back-river-project/1003637875/

Examples - Operations

SUDBURY INTEGRATED NICKEL OPERATIONS, GLENCORE

- Understand weather variability and long term climate change impacts on facilities
- Identify potential risks such as flooding, disruption to transportation, operations and worker health & safety, and how to adapt to each
- Analyze future water supplies, dam safety, flood control and requirements for water management
- Incorporate the assessment into the existing Risk Register and part of the Continuous Improvement Programs

Water Management

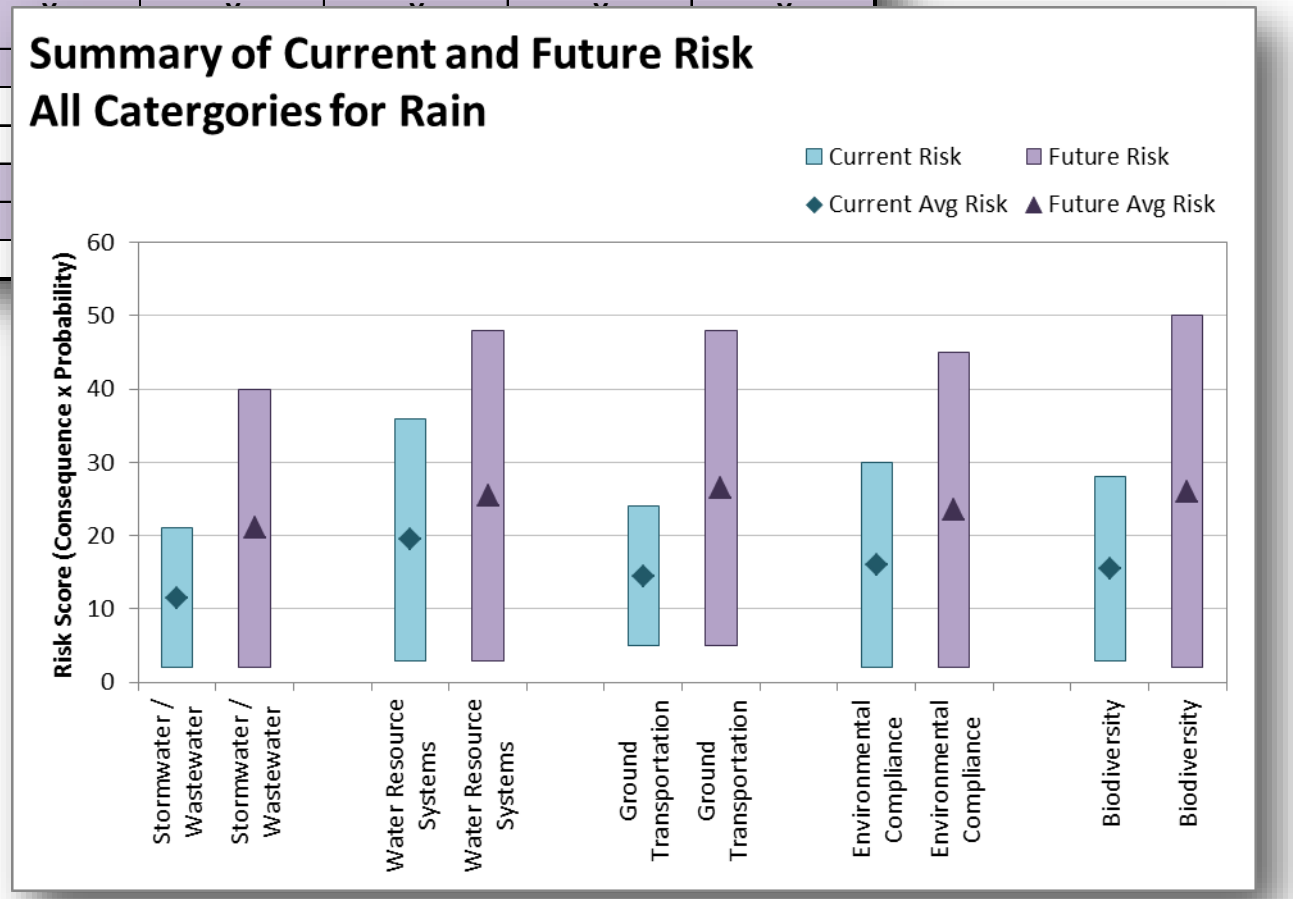


Vulnerability Assessment Studies

Infrastructure Component	Climate Factor				
	Temperature	Rain	Snow	Wind	Mixed Events
Stormwater, Wastewater Treatment and Collection Systems					
Water Resource Systems					
Ground Transportation					
Buildings and Infrastructure					
Environmental Compliance					
Biodiversity					
Public Infrastructure					

$$R = C \times P$$

R = Risk
C = Consequence
P = Probability



Questions

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