Environmental Consequence Classification of Mine Dam Failures: Updating the Canadian System

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(Ontario Ministry of Natural Resources and Forests)
Environmental Consequence Classification System

What the ECC is intended to be:

- A tool to inform design, operation, maintenance, and inspection of mining dams that is:
  - Reproducible
  - Broadly applicable across Canada’s varied environments
  - Based on high level (only 4(?) categories) gradation of potential impacts
Environmental Consequence Classification System

What the ECC is not intended to be:

- A statement about mine dam failure regarding:
  - level of societal or political concern
  - Statement of legal acceptability
  - A statement of a community’s values, sentiments, etc.

- Detailed statement of impact or a method for assessing the impact of an actual dam failure (requires detailed study)
# Why Do We Need to Change?

<table>
<thead>
<tr>
<th>Consequence Category</th>
<th>Pop’n at Risk</th>
<th>Incremental Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Loss of Life</td>
<td>Environmental &amp; Cultural Values</td>
</tr>
<tr>
<td>Extreme</td>
<td>Permanent</td>
<td>More than 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very High</td>
<td>Permanent</td>
<td>100 or fewer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Permanent</td>
<td>10 or fewer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significant</td>
<td>None</td>
<td>Unspecified</td>
</tr>
<tr>
<td>Low</td>
<td>Temporary Only</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
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</table>
## The Existing Consequence Classification System (CDA 2007)

### WHY DO WE NEED TO CHANGE?

<table>
<thead>
<tr>
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<tr>
<td>EXTREME</td>
<td>• Major loss of critical fish or wildlife habitat.</td>
<td></td>
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<tr>
<td></td>
<td>• Restoration or compensation in kind impossible.</td>
<td></td>
</tr>
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<td>VERY HIGH</td>
<td>• Significant loss or deterioration of critical fish or wildlife habitat.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Restoration or compensation in kind possible but impractical.</td>
<td></td>
</tr>
<tr>
<td>HIGH</td>
<td>• Significant loss or deterioration of important fish or wildlife habitat.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Restoration or compensation in kind highly possible.</td>
<td></td>
</tr>
<tr>
<td>SIGNIFICANT</td>
<td>• No significant loss or deterioration of fish or wildlife habitat.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Loss of marginal habitat only.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Restoration or compensation in kind highly possible.</td>
<td></td>
</tr>
<tr>
<td>LOW</td>
<td>• Minimal short-term loss</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No long term loss</td>
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<tr>
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<td></td>
</tr>
<tr>
<td>SIGNIFICANT</td>
<td>No <strong>significant loss</strong> or <strong>deterioration</strong> of fish or wildlife habitat. Loss of <strong>marginal</strong> habitat only. Restoration or compensation in kind highly possible.</td>
<td></td>
</tr>
<tr>
<td>LOW</td>
<td><strong>Minimal</strong> short-term loss No long term loss</td>
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WHY DO WE NEED TO CHANGE?

Is there a place for Judgment in Environmental decision-Making?

• Yes, but the nature of that judgment matters
• So does transparency
• Some guidance under which judgment is exercised also helps
• And a few other things…
The Existing Consequence Classification System (CDA 2007)

**WHY DO WE NEED TO CHANGE?**

**VALUE JUDGMENT**
- Opinion based on your principles and beliefs

**PROFESSIONAL JUDGMENT**
- Opinion originating from training and experience and relying on verifiable facts, data, scientific principles

Vs.
What do others do? CAN WE LEARN FROM THEM?

Absent:
- Clarity of definition;
- Impact of toxic substances;
- Consistency;
- Scientific basis

1999 Ontario Guidance
CDA 2007
Environmental Losses – Ontario (2011)
ANCOLD (2012)
Goals for a new system

- Clarity of definition;
- Impact of toxic substances;
- Consistency;
- Scientific basis
(Proposed) Environmental Consequence Classification Framework

DAM FAILURES IMPACT ON HABITATS OF LIVING THINGS

Three variables are used to classify environmental consequence:

Ecological Impact

Based on a **species of special interest**

Percent of **regional habitat** damaged from the physical effects of a breach

Intrinsic Hazard of Contents

Characteristics such as toxicity, metal-leaching, radionuclides

Increases environmental damage beyond physical

Duration of Impact

A modifying variable to reflect duration of effect

Enables consideration of ecosystem types and range in climate
The Proposed Environmental Consequence Classification Framework

1. Ecological Impact
   - Dam Break Analysis
   - Identify Species of Special Interest
   - Delineate Incremental Impact Zone
   - Define Region of Study
   - Quantify Amount of Habitat Damaged

2. Intrinsic Hazard of Contents
   - Stored Material Hazard
   - Classify: Stored Material Properties
     - Geochemistry
     - Toxicity
     - Radioactivity
   - Classification of Intrinsic Hazard Variable
     - Combine two main variables in the Matrix

3. Duration Of Impact
   - Duration of Impact
   - Quantify Amount of Habitat in Region
   - Stored Material
     - Hazard
     - Geochemistry
     - Toxicity
     - Radioactivity
     - Classify Variable

4. Environmental Consequence Classification
   - Modify Classification Based on impact duration

- Final Environmental Classification
The Proposed Environmental Consequence Classification Framework

Ecological Impact

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Intrinsic Hazard of Contents

- Stored Material Hazard
- Classify: Stored Material Properties
- Geochemistry
- Toxicity
- Radioactivity

Combine two main variables in the Matrix Classification of Intrinsic Hazard Variable

Final Environmental Classification

Environmental Consequence Classification

Modify Classification Based on impact duration X%
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Intrinsic Hazard of Contents

- Stored Material Hazard
- Classify: Stored Material Properties
- Geochemistry Toxicity Radioactivity
- Classification of Intrinsic Hazard Variable

Combine two main variables in the Matrix

Classification

Intrinsic Hazard of Contents

- Stored Material Hazard
- Classify: Stored Material Properties
- Geochemistry Toxicity Radioactivity
- Classification of Intrinsic Hazard Variable

Modify Classification Based on impact duration

Final Environmental Classification

-1 +1 0
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- **Duration Of Impact**
  - Duration of Impact
  - Modify Classification Based on impact duration

- **Environmental Consequence Classification**
  - Matrix: Intrinsic Hazard of Contents
  - Modify Classification Based on impact duration
  - Final Environmental Classification

- **Environmental Consequence Classification**
  - Matrix: Duration of Impact
  - Modify Classification Based on impact duration
  - Final Environmental Classification

- **Final Environmental Classification**
  - X%
BETA TEST:
MOUNT POLLEY TAILINGS DAM FAILURE
Good Candidate for a Beta Test

Mount Polley Was a “Positive Control”

- Thousands of pages of detailed physical, biological, chemical and geochemical studies – openly available on Imperials Metals’ website
- Countless Public Meetings, mail outs, progress videos
- Full transparency – data (including raw data) are on the internet
Mine Location
Inundation Map

AS IT OCCURRED

Ecological Impact

Dam Break Analysis

Delineate Incremental Impact Zone

Identify Species of Special Interest

Define Region of Study
Identifying Species of Special Concern

- Threatened race of Coho salmon
- Genetic structure of IFC: 5 distinct populations + subpopulations
- For Consequence Classification purposes, Quesnel Lake watershed is a suitable level of resolution as intermingling of that group would occur.
- Local habitat data available
## Ecological Impacts

STREAM SURVEY RESULTS: INTERIOR FRASER COHO HABITAT SURVEY 2007

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Habitat Amount</th>
<th>Spawning Adult Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length (m)</td>
<td>% total Length</td>
</tr>
<tr>
<td>Abbott Creek</td>
<td>900</td>
<td>5.4%</td>
</tr>
<tr>
<td>Clearbrook Creek</td>
<td>350</td>
<td>2.1%</td>
</tr>
<tr>
<td>Edney Creek</td>
<td>600</td>
<td>3.6%</td>
</tr>
<tr>
<td>Hazeltine Creek</td>
<td>650</td>
<td>3.9%</td>
</tr>
<tr>
<td>Mitchell River</td>
<td>6000</td>
<td>35.9%</td>
</tr>
<tr>
<td>Penfold Creek</td>
<td>3000</td>
<td>18.0%</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>16,700</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>

**Ecological Impact**

1. Dam Break Analysis
2. Delineate Incremental Impact Zone
3. Quantify Amount of Habitat Damaged
4. Identify Species of Special Interest
5. Define Region of Study
6. Quantify Amount of Habitat in Region

**TOTALS**

16,700 100.0% 530 100.0%
1. Ecological Impact

**CLASSIFICATION OF THE ECOLOGICAL IMPACT VARIABLE**

Of those creeks surveyed and containing IFC, 7.5% of available IFC habitat was impacted by the breach. Therefore: **Class B**

<table>
<thead>
<tr>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
<th>Class D</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5% of species of special concern habitat in the defined study area.</td>
<td>5-20% of species of special concern habitat in the defined study area.</td>
<td>20-50% of species of special concern habitat in the defined study area.</td>
<td>&gt; 50% of species of special concern habitat in the defined study area.</td>
</tr>
</tbody>
</table>

**IFC = Interior Fraser Coho**

**Population Level Effects Likely**
2. Intrinsic Hazard of Stored Material

**CLASSIFICATION OF WHAT IS INSIDE THE DAM**

- Fluid and solids **were released** in failure
- Supernatant was regularly tested → **non-toxic**
- Tailings: non-acid generating, non-metal leaching
- Therefore Class B

<table>
<thead>
<tr>
<th>Release of liquid contents</th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
<th>Class D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stored water/liquid transported outside the dam is non-acutely lethal</td>
<td>Stored water/liquid transported outside the dam is non-acutely lethal</td>
<td>Stored water/liquid transported outside the dam is acutely lethal</td>
<td>Stored water/liquid transported outside the dam is acutely lethal</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Release of solid contents</th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
<th>Class D</th>
</tr>
</thead>
<tbody>
<tr>
<td>No solids are released</td>
<td>Solids released not expected to leach metal(loid)s and/or produce acidity within the timeframe of reclamation activities</td>
<td>Solids released have the potential to leach metal(loid)s and/or produce acidity within the timeframe of reclamation activities.</td>
<td>Solids released are expected to leach metal(loid)s and/or produce acidity</td>
<td></td>
</tr>
</tbody>
</table>
### Classification Matrix – Mount Polley TSF Foundation Failure

<table>
<thead>
<tr>
<th>Intrinsic Hazard of Stored Contents</th>
<th>Ecological Impact</th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
<th>Class D</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLASS A</td>
<td></td>
<td>LOW</td>
<td>LOW</td>
<td>SIGNIFICANT</td>
<td>HIGH</td>
</tr>
<tr>
<td>transported water/liquid is non-acutely lethal and/or no solids are released</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLASS B</td>
<td></td>
<td>LOW</td>
<td>SIGNIFICANT</td>
<td>SIGNIFICANT</td>
<td>HIGH</td>
</tr>
<tr>
<td>transported water/liquid is non-acutely lethal and/or solids released not expected to leach metal(loid)s and/or produce acidity within the timeframe of reclamation activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLASS C</td>
<td></td>
<td>SIGNIFICANT</td>
<td>SIGNIFICANT</td>
<td>HIGH</td>
<td>VERY HIGH</td>
</tr>
<tr>
<td>transported water/liquid is acutely lethal and/or solids released have the potential to leach metal(loid)s and/or produce acidity within the timeframe of reclamation activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLASS D</td>
<td></td>
<td>HIGH</td>
<td>HIGH</td>
<td>VERY HIGH</td>
<td>VERY HIGH</td>
</tr>
<tr>
<td>transported water/liquid is acutely lethal and/or solids released are expected to leach metal(loid)s and/or produce acidity</td>
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- **Duration Of Impact**
  - Duration of Impact
  - Duration of Impact
  - Final Environmental Classification

**You are Here**

**Final Environmental Classification**

**Classification of Intrinsic Hazard**

**Matrix: Intrinsic Hazard**

**Matrix: Duration of Impact**

**Matrix: Final Environmental Classification**
3. Duration of Impact

- Active soil and revegetation work
- Active stream restoration work (Edney habitat constructed, Hazeltine Habitat in progress)
- IFC found in rebuilt sections of Edney Creek (excluded from Hazeltine during construction)
3. Duration of Impact

ENVIRONMENTAL CONSEQUENCE MODIFIER BASED ON ESTIMATED DURATION OF IMPACT

• Duration of impact estimated to be in range of 5 to 25 years

• No Change to ECC

<table>
<thead>
<tr>
<th>Reduce ECC</th>
<th>No Change</th>
<th>Increase ECC</th>
</tr>
</thead>
<tbody>
<tr>
<td>A return to acceptable restoration is feasible within a short (&lt; 5 years) timeframe</td>
<td>A return to acceptable restoration is feasible within a moderate timeframe (5 to 25 years)</td>
<td>A return to acceptable restoration is unlikely within an extended timeframe (&gt; 25 years).</td>
</tr>
</tbody>
</table>
Mount Polley Consequence Classification of “Significant”

REASONABLE?

Mount Polley

Meager Creek Slide
Goals for a new system

DID WE COME CLOSE?

- Clarity of definition;
- Impact of toxic substances;
- Consistency;
- Scientific basis
• Questions?
• Comments?
• Feedback?

...ARE WELCOME