Background to Workshop Development

- The Cariboo Adaptation Strategies planning process has brought together agricultural producers, dam owners, and government partners to evaluate climate change impacts on local agricultural production.
- The strategy to “maintain and enhance agriculturally significant dams” was prioritized.
- A collaborative process to identify challenges and resource gaps to dam ownership was conducted.
- This workshop and its resources have been developed to “strengthen the knowledge and capacity of agricultural dam owners to fulfill the Water Sustainability Act and Dam Safety Regulation.”

Purpose of this Workshop

- Focus of this workshop is knowledge transfer to agricultural dam owners via active participation and review of dam safety management resources.
- Workshop will cover:
  - regulatory requirements (Dam Safety related only)
  - dam failure consequence classification
  - dam owner responsibilities
  - operations and maintenance best practices
  - emergency planning
  - field surveillance and inspection
  - importance of record keeping
  - NOT licensing etc

Acknowledgements & Disclaimer

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- The Governments of Canada and of British Columbia are committed to working with industry partners. Opinions expressed in this document are those of Interior Dams Inc and the authors of included resources which are not necessarily those of the Governments of Canada and of British Columbia or the Investment Agriculture Foundation.

Agenda: Morning Session

9:00 Morning Session Start
- Regulatory requirements
- Regulated dams and dam failure consequence classification
10:30 Coffee Break
- Example – Dam failure consequence classification
- Small dam performance
12:00 Lunch Break
**Agenda: Afternoon Session**

12:30 Afternoon Session Start  
- Site surveillance and formal annual inspection  
- Dam failure modes and features to watch for  
- OMS (Operations, Maintenance & Surveillance)  
2:00 Coffee Break  
- DEP (Dam Emergency Plan)  
- Workshop evaluation

**Background**

- Government functions as a regulator and licensing body and oversees all water storage dams in the province  
- Dam owner is directly responsible for dam safety  
- Dam owner has a duty of care and this will mitigate risk  
- Today, dam safety includes a strong emphasis on a dam safety management system (DSMS)

**What is a DSMS?**

- A Dam Safety Management system goes beyond meeting regulations or dam inspection  
- It includes components that outline, document, plan and direct all decisions and activities during the life of the dam

**Canadian Dam Association – Principle 1d**  
"A dam safety management system, incorporating policies, responsibilities, plans and procedures, documentation, training, and review and correction of deficiencies and non-conformances, shall be in place."


**Typical Features of an Embankment Dam**

**Dam Safety Management System**

- The regulated approach for dams in BC requires dam owners to have knowledge of basic dam safety principles  
- Dam owner should develop and implement a Dam Safety Management System (DSMS)  
- Required complexity for an effective DSMS should match the size, type, and risks associated with the dam

**Dam Safety Management System (CDA 2007)**

- Reporting: Periodic reporting to management and regulator  
- Corrective Actions: Peer review and audits, incident investigations, respond to deficiencies and non-conformances identified during Dam Safety Reviews, responding to deficiencies and non-conformances identified during Dam Safety Reviews, responding to deficiencies and non-conformances identified during Dam Safety Reviews, responding to deficiencies and non-conformances identified during Dam Safety Reviews  
- Planning: Work program components, Execution responsibilities, Standards and procedures, Schedules  
- Implementation: Operation, Maintenance, Surveillance, Emergency preparedness  
- Supporting Processes: Dam surveillance and Dam Safety Reviews, Program peer reviews or review boards, Program audits, Incident investigations, Training of emergency preparedness, Equipment Testing  

TIP: Each section of your Binder is dedicated to parts of this process
**Binder Contents**

Binder is a Dam Safety Management System template

- Tab 1: Dam Safety Background & Regulations
- Tab 2: Dam Classification
- Tab 3: Operation, Maintenance & Surveillance Plan
- Tab 4: OMS Activities (Surveillance, Inspection, etc.)
- Tab 5: Emergency Response
- Tab 6: Regulatory Correspondence & Auditing
- Tab 7: Dam Safety Reviews
- Tab 8: Design Reports, Technical Memos, etc.
- Tab 9: Planned or Scheduled Works
- Tab 10: Supplementary Resource Links

**Regulatory Requirements**

- BC Dam Safety Regulation became effective in February 2000. Recently replaced by the Dam Safety Regulation under the new Water Sustainability Act
- Water Sustainability Act requires dam owners to have a water licence and comply with its terms and conditions
- Under the Act dam owners may be held liable for any damage and loss caused by the negligent construction, operation or failure of a dam

**Regulated Dams in BC**

<table>
<thead>
<tr>
<th>Dam Height</th>
<th>Live Storage Capacity</th>
<th>Dam Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5m (24.6ft)</td>
<td>30,000 m³ (24.3acft)</td>
<td>Entire Regulation applies</td>
</tr>
<tr>
<td>2.5m (8.2ft)</td>
<td>1,000,000 m³ (810.7acft)</td>
<td>LOW consequence dams exempt from Part 3 of the Regulation</td>
</tr>
<tr>
<td>1m (3ft)</td>
<td>10,000,000 m³</td>
<td>Minor dams exempt from the Regulation (see Part I Section 2 regulation)</td>
</tr>
</tbody>
</table>

**Regulation Part 2 Requirements**

- Owners of dams have obligations under the Regulation that are directly related to the dam’s failure consequence classification
- Ongoing regulatory requirements for all dams (except minor dams*) include:
  - determine the dam failure consequence classification; annually review and, if necessary, revise and submit to DSO
  - comply with applicable Parts of the Regulation
  - inspect, maintain, and repair dam to keep it in a good operating condition
  - prevent unauthorized operation of their dam

*Note: Minor dams <7.5 m high & <10,000 m³ and may be subject to the regulation if ordered by the Comptroller if it is hazardous [see Part 1, Section 2 – Application of Regulation to minor dam for more details]

**Regulation Part 3 Requirements**

- Prepare, review, and update the operation, maintenance and surveillance plan and Dam Emergency Plan
  - Not required for *low consequence dams
  - Must submit to DSO
- As part of a Dam Emergency Plan, submit a record of dam information to local emergency authorities
  - Helps them prepare their local emergency plans
- Must identify an emergency contact
- Erect signs at dams located on Crown Land
  - Not required for *low consequence dams
  - Notifies passersby to report problems to the dam owner and/or emergency response authorities

*Note: Low consequence dams must identify an emergency contact and submit a record to the Comptroller [see Part 3, Div. 2 - General Safety Requirements for more details]
Regulation Part 3 Requirements

- Obtain authorization under the Regulation when alterations or improvements to, or replacement of the dam are considered
- Obtain authorization from Water Manager or Comptroller of Water Rights before removing, decommissioning, deactivating or stopping normal operation of the dam
- Prepare a Dam Emergency Plan to address potential hazardous situations at the dam to minimize loss or damage downstream
- Respond to hazardous conditions or potentially safety hazards as prescribed in the Regulation (submit a notification, plan, and/or a record to the Comptroller)

[see Part 3, Div. 3 - Activities at or near Dam for more details]

Regulation Part 3 Requirements

- Conduct site surveillance of the dam on a regular basis
- Test outlet facilities, spillway gates, and other mechanical dam components
- Install instrumentation if needed to adequately monitor and record the dam performance
- Conduct dam safety reviews (except for low consequence and significant consequence dams)

NOTE: Contact your DSO prior to hiring contractor to discuss specific requirements for your dam safety review

[see Part 3, Div. 4 - Monitoring and Review of Dam Safety for more details]

Regulation Part 3 Requirements

- Report all findings resulting from inspections that reveal hazardous conditions
- Upon request, submit to your DSO records relating to inspections, tests, or reviews including recorded data on the dam, reservoir, downstream area, or upstream watershed
- Submit dam safety reviews to DSO

[see Part 3, Div. 5 - Information and Records to Be Submitted for more details]

Other Regulatory Information

Other definitions, clarifications, and additional information are given under the following sections:

- Part 4 – General
  - Division 1 – Dams with Multiple Owners
  - Division 2 – Records
  - Division 3 – Advise of Independent Expert
  - Division 4 – Offences
- Part 5 – Transition
  Gives clarification to dams undergoing transition (i.e. undergoing construction or change of dam classification)

[see Part 4 and Part 5 for more details]

Frequency of Activity

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency for each dam classification</th>
<th>Extreme</th>
<th>Very High</th>
<th>High</th>
<th>Significant</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-determine classification of dam and, if necessary submit to DSO written notice of proposed new classification</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td></td>
</tr>
<tr>
<td>Conduct site surveillance</td>
<td>weekly</td>
<td>weekly</td>
<td>weekly</td>
<td>monthly</td>
<td>quarterly</td>
<td></td>
</tr>
<tr>
<td>Conduct formal inspection</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td></td>
</tr>
<tr>
<td>Test operation of dam (a) mechanical components of dam; and (b) electrical and communication equipment</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td></td>
</tr>
<tr>
<td>Collect meetings from instrumentation and analyze and interpret the readings</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td></td>
</tr>
<tr>
<td>Review dam owner contact information in DEP; revise if necessary and report to DSO</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td></td>
</tr>
<tr>
<td>Review emergency contact information and, if necessary, revise and submit revision to DSO</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>annually</td>
<td></td>
</tr>
<tr>
<td>Review OMS manual and DEP; review if necessary and report to DSO</td>
<td>every 7 years</td>
<td>every 7 years</td>
<td>every 10 years</td>
<td>every 10 years</td>
<td>annually</td>
<td></td>
</tr>
<tr>
<td>Ensure dam safety review carried out and submit report to DSO</td>
<td>every 7 years</td>
<td>every 10 years</td>
<td>every 10 years</td>
<td>every 10 years</td>
<td>annually</td>
<td></td>
</tr>
</tbody>
</table>

[see Schedule 2 - Minimum Frequency of Dam Safety Activities for more details]
A requirement applicable to All Dams

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency for each dam classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-determine classification of dam and, if necessary submit to DSO written notice of proposed new classification</td>
<td>annually annually annually annually annually</td>
</tr>
</tbody>
</table>

- A new annual requirement as of 2016
- We will cover how to re-determine classification in a few slides

---

**Dam Classification**

**Loss of Life**

- Low: None
- Significant: Temporary only
- Extreme: Permanent

**Environmental and cultural values**

- Low: Minimal
- Significant: Minimal short-term to minor permanent
- Extreme: Minimal short-term to significant permanent

**Infrastructure and economics**

- Low: None
- Significant: Minimal to moderate
- Extreme: Significant to very severe

---

**Dam Classification**

**Loss of Life**

- Low: None
- Significant: Temporary only
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**Environmental and cultural values**

- Low: Minimal
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**Infrastructure and economics**

- Low: None
- Significant: Minimal to moderate
- Extreme: Significant to very severe

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**Dam Classification**

- A dam’s classification depends on the consequences of it failing
- Consequences are categorized as Loss of Life, Environmental and Cultural Losses, and Economic Losses
- Consequences for each category are determined based on estimates of loss based on the worst-case flood induced by a dam failure*
- The most severe potential consequence dictates the classification
*Estimating a flood that is induced by a dam failure is usually in the form of an inundation study

[Note: Inundation studies are typically outside of the scope of a Dam Safety Review]
Classification determination is the responsibility of the owner. A record of the dam’s inundation study (or similar) should be on file. If you require an inundation study, simplified estimation methods may apply that cost much less to perform.

See also:
- State of Washington Dam Safety Guidelines: Technical Note 1
- USBR RCEM – Guidelines for Estimating Life Loss for Dam Safety Risk Analysis

• Annual re-determination of Classification is often completed by owners but can be completed by consultants during Dam Safety Reviews
• Typically simple to perform
• This does not need to be submitted to a DSO unless requested or if there is a change in noted or new-construction
• A record of this re-determination must be kept on file
  – DSO can request a copy of this record

COFFEE BREAK

Video for Break

[Association of State Dam Safety Officials (ASDSO) – Hazard Creep .wmv]

Process to Re-determine Dam Classification

1) Review previous determination of classification and understand the flooded area (example: inundation study maps)
2) Understand if there are any downstream changes
   – new infrastructure, residential development, etc.
   – take investigation notes, photos, etc.
3) If significant changes have occurred, incrementally update “the most severe potential consequence” for each category
   – Ex. If 10 additional people at risk \( \rightarrow (\text{PAR}+10)(\text{DV}) = \text{new Loss of Life} \)
   – This detail typically only needed between HIGH & EXTREME
4) Using Section 2 Schedule 1 Table - Determine classifications
5) If a classification change is warranted, notify your DSO
6) Make a record of redetermination in your binder

Example 1 – Re-determine classification of your dam

• You are now required under the new regulation to re-determine the classification
• A record determining the classification is on file
• Your dam classification has been determined as LOW under the old regulation
• No changes to your dam’s height or volume of storage
• No changes downstream (no development, etc.)
• Re-determine the classification of your dam
Example 1 – Re-determine classification of your dam

Regulation says:
Dam failure consequences classification
(1) An owner of a newly constructed dam must, as soon as practicable and, in any event, no later than 60 days, after completion of the construction of the dam, (a) determine the classification of the dam in accordance with section 2 [determination of classification] of Schedule 1, and (b) submit to a dam safety officer, immediately after the determination is completed, a record setting out a proposed classification for the dam.

(2) An owner of a dam for which the classification has been determined under the former regulation or this regulation must, (a) no less frequently than is specified in item 1 of the table in Schedule 2 for the classification of the dam, redetermine the classification of the dam in accordance with section 2 of Schedule 1 to assess whether the classification of the dam has changed, and (b) if the classification of the dam has changed, submit to a dam safety officer, immediately after the redetermination is completed, a record setting out a proposed new classification for the dam.

Example 1 – Re-determine classification of your dam

Exercise 1 – Re-determine classification of your dam

1) Review previous determination of classification and understand the flooded area (example: inundation study maps)
   All consequence categories were determined to be LOW
   Flood mapping indicates estimated flood areas

2) Understand if there are any downstream changes
   No new development or infrastructure noted. Indicated flood areas unchanged. No significant changes have occurred.
   Date, time, and method and area of field review are recorded

3) If significant changes have occurred, incrementally update “the most severe potential consequence” for each category
   Not Applicable

4) Using Section 2 Schedule 1 Table - Determine classifications
   Classification was determined to still be LOW (see next slide)

Exercise 1 – Re-determine classification of your dam

5) If a classification change is warranted, notify your DSO - Not applicable

6) Make a record of redetermination in your binder

Exercise 2 – Re-determine classification of your dam

1) Review previous determination of classification and understand the flooded area (example: inundation study maps)
   All consequence categories were determined to be LOW
   Flood mapping indicates estimated flood areas

2) Understand if there are any downstream changes
   Date, time, and method and area of field review were recorded
   New development of 2 homes identified. Assuming 2.5 people per home, estimate additional population at risk (PAR = 2*2.5 = ~5 people)

3) If significant changes have occurred, incrementally update “the most severe potential consequence” for each category
   ***Assume worst case if an inundation study is not available
   Loss of Life: +5 lives estimated
   Environmental/Cultural values: No change
   Economic/Infrastructure: +2 homes estimated complete lost

Exercise 2 – Re-determine classification of your dam

- Your dam classification was determined as LOW under the former regulation
- The last 2 years your dam was re-determined as LOW and records are on file
- A new development of 2 homes was just completed directly in the path of your dam’s estimated flood area (if breached)
- Re-determine the classification of your dam
Exercise 2 – Re-determine classification of your dam

- Using the Schedule 1 table, the classification of HIGH most clearly describes 2 categories.
- Highest classification of all categories dictates.

4) Using Section 2 Schedule 1 Table - Determine classifications
   Two categories are now HIGH (see next slide).

5) If a classification change is warranted, notify your DSO
   DSO notified and proposed HIGH classification was accepted.

6) Make a record of redetermination in your binder.

Exercise 2 – Re-determine classification of your dam

- If re-determination cannot clearly define a classification, more detailed analysis is required.

Small Dam Performance

- A study of 23 dam failures from 1960 to 1998, demonstrated that the failure of dams between 6.1 and 15 m high represented 18 of the dam failures and caused 86% of deaths; 5 dams <6.1 m high failed and caused 2% of deaths.
- Average age of the dams that failed was 40 years.
- There is an average of 2 dam failures in BC each year.
- In 2015, there were 2 dam failures, 3 dam alerts and 3 dam incidents (not inclusive of similar structures covered under the Mines Act).
- Poorly managed small dams pose significant individual and cumulative threats that may cause catastrophic human, property, and environmental losses.

Recent BC Failures

- On March 15, 2015 an unauthorized 8 m high dam approximately 30 m long failed near Salmon Arm.
- Differential settlement of ~30 cm and heavy seepage were noted prior to failure.
- As a result, there was extensive damage to property including the complete loss of a barn and damage to the road.

- On March 27, 2015, a 3 m high dam holding approximately 135,000 m³ north of Prince George near Bear Lake failed due to a partial breach of its left bank.
- Failure was due to an inadequately sized spillway compounded by debris from beaver activity, instabilities to the berm from animal activity, overgrown vegetation and internal erosion.
- As a result, traffic had to be controlled downstream at Hwy 97 and at a railway crossing.

This is when inundation studies are usually required.

Loss of Life = PAR * Fatality Rate
Where: PAR = population at risk
DV = Depth x Velocity
FR = Graphical lookup using DV & PAR (~0.015)
Assume 2.5 people/home
LoL = (2.5 * 20) * 0.015
= 0.75 = ~ 1

RCEM (USBR, 2014)
Other Very Recent Failures
Flooding from breached Nevada dam affecting road and rail routes to Utah

Testalinden Dam Failure
June 13, 2010

Testalinden Dam Failure
Before Dam Breach

Testalinden Dam Failure
Dam Breach

Testalinden Dam Failure
Consequences
Overall losses and compensation to land owners estimated at ~$20 million
Could This Have Been Prevented?

High water mark prior to dam breach

Some Changes in BC

- Renewed emphasis to report/comply for all dam water license holders (owners)
  - Emphasis on compliance and tracking of compliance
- Dam classification changed to match Canadian Dam Association (2007) guidelines
  - Dam classification dictates required frequency and complexity of dam safety management activities required by owner
- New requirements for signs for dams classified as significant or higher located partially or entirely on Crown Land

LUNCH

Video for Lunch

[Montana Department of Natural Resources & Conservation (DNRC) – Perf2ImperfDam.wmv]

Small Dams

- Small earth dams are exposed to gradual deterioration; owners need to be aware of these changes
- Dams with incomplete safety management systems are more likely to fail
- Climate change is causing more precipitation extremes
  - Increased risk of extreme flood event (e.g. insufficient spillway capacity during extreme storm)
  - Increased risk of extreme drought (e.g. desiccation – extreme drying of the dam core resulting in cracking)
- Land use downstream of your dam may change over time thus potentially increasing the consequences of a dam failure

Critical Components for Dam Safety

- Owner commitment to dam safety
- Effective operations, maintenance, and surveillance practices (OMS)
- Effective dam emergency plan (DEP)
- Regular dam safety reviews, if needed
- These components are part of a Dam Safety Management System
  - a system your DSO would like to see you develop and use
Effective OMS Practices

- Effective Operations Maintenance & Surveillance (OMS) practices include
  - operating rules that do not compromise safety
  - maintenance schedules
  - multi-level surveillance and monitoring
  - complete life-cycle management
  - written records/documentation
- Dams can fail if allowed to deteriorate
- Regular surveillance can detect a deficiency prior to a catastrophic event

Operations Planning

- Dams need safe operating criteria:
  - maximum safe discharge rates
  - highest safe reservoir levels
  - seasonal constraints
- Dams need monitoring to verify safe operations
- For extreme inflow conditions
  - have procedures and equipment to ensure gates and spillways are operational as described in your OMS manual
  - have redundancies and back-up systems

Maintenance Planning

- Adequate financial resources are essential for an effective maintenance program
  - issue of relevance to some of you today
- Testing of flow control equipment should be part of inspection and maintenance
- Owners should have
  - accurate inventory of the dam components and their maintenance requirements
  - schedule of maintenance activities and a tracking system

Surveillance Planning

- Routine surveillance performed according to schedule
  - defined by the dam classification
  - tempered by issues of practicality (e.g. dam access and seasonal concerns)
- Special surveillance done after unusual or extreme events
- Maintain records/documentation of surveillance
  - instrumentation, if any, regularly monitored and results recorded

OMS Manual

- You should have an OMS manual
- Dams subject to Part 3 of the Regulation are required
Inspection and Testing

Reporting
- Periodic reporting to management and regulator

Corrective Actions
- Peer reviews and audits
- Incident investigations
- Responsive to deficiencies and non-conformances identified during Dam Safety Reviews
- Responsive to inspection, monitoring, equipment testing or emergency preparedness tests

Planning
- Work program components
- Executive responsibilities
- Standards and procedures
- Resources
- Schedules

Implementation
- Operational
- Maintenance
- Monitoring
- Emergency preparedness

Supporting Processes
- Staff training and qualification
- Program communication
- Record keeping and management

Checking and Reviewing
- Dam surveillance and Dam Safety Reviews
- Program peer reviews or review boards
- Program audits
- Incident Investigations
- Testing of emergency preparedness
- Equipment tests

Supporting Processes (OMS Activities)

Inspections and Equipment Tests

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency for each dam classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduct site surveillance</td>
<td>Extreme: weekly, High: weekly, Significant: monthly, Low: annually</td>
</tr>
<tr>
<td>Conduct formal inspection</td>
<td>High: annually, Significant: annually, Low: annually</td>
</tr>
<tr>
<td>Test operation of dam (a) mechanical components of dam, and (b) electrical and communication equipment</td>
<td>High: annually, Significant: annually, Low: annually</td>
</tr>
<tr>
<td>Collect readings from instrumentation and analyze and interpret the readings</td>
<td>High: annually, Significant: annually, Low: annually</td>
</tr>
</tbody>
</table>

Note: Dam Safety Review has a different purpose than the activities listed above even though it typically repeats all of these and more

Completion of Required Inspections for High – Extreme Dams (2011-2016)

 Majority of dam owners are complying

Checklist for Equipment Inspection

Note:
- Not required, but useful when checking equipment

Formal Annual Inspection

Note:
- Can be done by owner
- Often done by consultants
Causes of Dam Failures

Mode of Failure | %
---|---
Overtopping | 34
Spillway | 12
Piping | 49
Embankment | 12
Embankment-Foundation | 2
Foundation | 15
Slides | 4
Earthquakes | 1
Piping

A. Hole develops in conduit, ending embankment

B. Hole in conduit enlarges, conduit develops. Debris partially fills outlet

C. Sinkhole develops, complete failure in prodhuce.

[from: Dam Safety Guidelines: Inspection & Maintenance of Dams - FLNRIO]

Piping Around Cut-off Collar

[Image of Piping Around Cut-off Collar]

[Association of State Dam Safety Officials (ASDSO) – Piping.wmv]

BREAK

Video for Break

Sinkholes

A. Hole develops in conduit, ending embankment

B. Hole in conduit enlarges, conduit develops. Debris partially fills outlet

C. Sinkhole develops, complete failure of prodhuce.

[from: Dam Safety Guidelines: Inspection & Maintenance of Dams - FLNRIO]

Crest Problems

1. Excessive Vegetation

TIP: See Binder pg 118

2. Rodent Activity

3. Ruts Along Crest

[from: Dam Safety Guidelines: Inspection & Maintenance of Dams - FLNRIO]
Muskrat Burrows

Low Level Outlet

Spillway

Blocked or Under-Sized Spillways

Reservoir Problems

Problems Continued
Exercise 1 – Test your DEP

- While attending this workshop, you have been notified by phone that water is flowing over your dam
- The severity of the incident is unknown

What will you do?

Did the phone call come because a sign was on your dam?

Emergency Preparedness

- Dam Safety Policy
- Reporting
  - Periodic reporting to management and regulator
- Corrective Actions
  - Peer reviews and audits
  - Incident investigations
  - Response to deficiencies and non-conformances identified during Dam Safety Reviews
  - Response to inspection, monitoring, equipment testing or emergency preparedness tests
- Planning
  - Work program components
  - Execution responsibilities
  - Standards and procedures
  - Schedules
- Implementation
  - Operator
  - Maintenance
  - Emergency preparedness
- Supporting Processes
  - Staff training and qualification
  - Program communication
  - Record keeping and management
  - Checking and reviewing
    - Dam surveillance and Dam Safety Reviews
    - Program peer reviews or review boards
    - Incident investigations
    - Setup of emergency preparedness equipment tests

Multiple images of text and tables are presented, including:

- Table showing frequency of activity for each dam classification:
  - Review dam owner contact information in DEP, revise if necessary and report to DSO:
    - Extreme: annually
    - Very High: annually
    - High: annually
    - Significant: annually
    - Low: n/a
  - Review emergency contact information and, if necessary, revise and submit revision to DSO:
    - n/a
  - Review OMS manual and DEP, revise if necessary and report to DSO:
    - Every 7 years
  - Reminder – Regulatory Requirement:
  - Review emergency contact information and, if necessary, revise and submit revision to DSO:
  - Review OMS manual and DEP, revise if necessary and report to DSO:
  - Every 7 years

Exercise 2 – What Will You Do?

- Attempt to assess the potential severity of the event
- Activate your Dam Emergency Plan (DEP) (TIP: Located on pg 161)

No time to get into details... MUST BE PREPARED

Introduction to Dam Emergency Plan:

- DEP guides you through notification & communication procedures
- If applicable, it guides activation of protective actions
- A non-compliant emergency response may indicate an offence under the Regulation - this could lead to personal consequences...
- ...more on the DEP later
**Reminder - Regulatory Requirement**

- Prepare, review, and update the operation, maintenance and surveillance plan and Dam Emergency Plan (except for low consequence dams) and submit to DSO
- As part of a Dam Emergency Plan, submit a record of dam information to local emergency authorities to help them prepare their local emergency plans
- Erect signs at dams located on Crown Land (except for low consequence dams) notifying passersby to report problems to the dam owner and/or emergency response authorities

[see Part 3, Div. 2 - General Safety Requirements for more details]

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**Who is the Local Authority?**

- For a municipality, the municipal council
- For an electoral area in a regional district, the board of the regional district
- For a national park, the park superintendent or the park superintendent's delegate if an agreement has been entered into with the government of Canada under section 4 (2) (e) in which it is agreed that the park superintendent is a local authority for the purposes of the Emergency Program Act
- Not the RCMP – BUT the RCMP and others would be on your contact lists as part of your DEP

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**Effective Emergency Preparedness**

- Dam Emergency Plan (DEP) is a written plan in the event of an emergency situation
- DEP doesn’t need to be a long document
  - Template appropriate for small dams is available from the BC Dam Safety website (guideline in binder)
- Experience has shown that emergency plans save lives and money during dam failures
- Existing EPP’s may be acceptable as long as the Regulation requirement outlined is fulfilled

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**DEP Contents**

- Dam name
- Stream name
- Dam file number
- Location
- Local area map or photo of dam
- Dam owner
- DEP author
- Copy #, revision # and date
- Description of the dam
- Directions on how to get to the dam
- Access map to the dam
- Example emergency messages
- List of holders of copies of the DEP including:
  - local emergency authority
  - dam safety officer
- Record of revisions made to DEP

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**DEP Contents**

- DEP Overview / Purpose (Section 1)*
- Dam description, directions to dam & map (Section 2)*
- Roles and responsibilities (Section 3)
  - Dam Owner
  - Local Emergency Authorities
  - Emergency Management BC
  - Dam Owner’s Technical Representatives
  - FLNRO
- 5 Step Process (Section 4)*
- DEP Maintenance (Section 5)
- Record of Holders of Copies (Section 6)
- Record of Revisions & Updates (Section 7)

*Submit parts as required to Local Emergency Authority
**DEP Contents**

Appendix A*
- Emergency Contacts for Dam, Evacuation Map, Persons to Evacuate

Other Appendices:
- Notification Charts, Emergency Services Contacts,
- Other emergency service contacts
  - RCMP, Search and Rescue, etc.
- Emergency response resources
  - heavy equipment services, construction supplies, helicopter charter, boat, ATV & snowmobile rentals, etc.
- Plan drawing(s) of the dam showing pertinent design details and site map
  - refer to any additional plans or pertinent information in the dam’s Operation Maintenance & Surveillance (OMS) manual

*Submit parts as required to Local Emergency Authority

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**Potential Safety Hazard**

- Immediately notify DSO
- Activate appropriate component in your Dam Emergency Plan
- Prepare a plan for repairs or alterations and submit to DSO for acceptance
- Within 30 days, submit a report of what occurred

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**Exercise 3 – Due Diligence**

- Despite your dam being built to current standards, it has failed due to overtopping from an extreme storm event
- Fortunately, you activated your Dam Emergency Plan and no lives were lost, however, the economic losses are estimated to be in the millions of dollars

How do you demonstrate due diligence?

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**Exercise 3 – Due Diligence**

- How do you demonstrate due diligence?
  - Keeping a complete set of detailed records (incident reports, dam safety reviews, upgrades, etc)
  - Having a complete Dam Safety Management System (DSMS) with an updated Dam Emergency Plan (DEP)
**Dam Safety Review**

- For High, Very High, and Extreme dams
- Two types of review: audit or comprehensive
  - This is determined in discussion with your DSO before hiring engineering firm

**Reminder – Regulatory Requirement**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency for each dam classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensure dam safety review carried out and submit report to DSO</td>
<td>Every 7 years</td>
</tr>
</tbody>
</table>

**Dam Safety Review**

- A comprehensive dam safety review involves several components:
  - Review information provided
  - Design and construction
  - O&M practices
  - Emergency preparedness
  - Previous reports
  - Implementation of recommendations
  - Conduct consequence (classification) review
  - Site visit, dam inspection, and interviews
  - Identify functions and failure modes
  - Assess safety of dam

***Retaining complete and organized records may significantly reduce the effort and cost of Dam Safety Reviews***

**Review Engineer**

- Review engineer should be a registered professional engineer with appropriate experience
  - Review engineer cannot carry out two consecutive safety reviews of the same dam or be involved with its capital works
  - Review engineer must have at least 15 years of related experience for an individual qualified professional (10 years for lead qualified professional for a multidisciplinary team)
Audit Checklist (used by DSO)

- Open Binder to Tab 6 – pg 187

Audit Checklist (used by DSO)

- When a DSO uses this to audit, it is NOT an inspection
- Use this to internally audit your own dam activities
  - Consequence rating appropriate
  - Alterations or hazards occurred recently
  - Emergency plans prepared, submitted and updated
  - OMS manual prepared and submitted
  - Reservoir operations per OMS manual
  - Maintenance suitable
  - Annual inspection suitable
  - Sign posted on dam (Crown land only)
  - Dam Safety Review status suitable

Dam Status Reporting

- Dams having a HIGH, VERY HIGH, or EXTREME consequence are required under the regulation to submit a Dam Safety Status Form annually
- There may be legal consequences for not submitting
- Even if this is not required, it is a good way to check your status

Completion of Required Dam Status Report Form Returns (2011-2016)

- Majority of dam owners are complying

Summary of Documentation Requirements

All Dams
- Review consequence classification annually
- Update emergency contact information annually

Some Dams
- Submit Dam Status Report Form annually
- Have an OMS manual
- Update OMS manual as per table (7-10 yrs)
- Conduct a DSR as per table (7-10 yrs)
- Have a DEP and submit Part 2 to the local authority & DSO

Exercise 2 – Dam Status Report

- Complete your 2016 Dam Status Report Form
  - All Dam owners having a HIGH, VERY HIGH, or EXTREME consequence would have received one in the mail in November
  - If you are not required to submit one, complete the example form as an internal audit of your compliance to the Regulation
**Action Items For You**

- Be aware of the terms and conditions that come attached to your water licence
- Buy into the notion of being a responsible owner in an regulated environment
- Respond in a timely manner to the dam information requests from your DSO – this will help to confirm safe dam operation
  - keep copies of the information you assemble and submit
  - Use your binder or your computer to store the info so it is easier to submit subsequent documents

**Resource Links**

A few highlighted resources from Binder Tab 10:

- Plan Submission Guidelines for the Construction and Rehab of Dams
  - Gives guidance for planning upgrades or construction
  - Outlines minimum design requirements for many components
  - Gives instructions for log boom construction and other features
  - Aids owners in procuring a consultant
- Request for Proposals for Dam Safety Reviews
  - Sample RFP to use for hiring a consultant for DSRs
- Discrete Scope Directory
  - A directory on the Association of Professional Engineers and Geoscientists website to find qualified practitioners.

**Workshop Evaluation**

- Workshop covered the following items
  - regulatory requirements
  - dam owner responsibilities
  - operations and maintenance best practices
  - emergency planning
  - field surveillance and inspection
  - importance of record keeping
- Using the provided paper, please provide comments on the materials that were presented for each item and any suggestions for improvement – thanks!

**Training & Resources**

- Reporting
  - Periodic reporting to management and regulator
- Corrective Actions
  - Peer reviews and audit incident investigations
  - Respond to deficiencies and non-conformances identified during Dam Safety Reviews
  - Respond to inspection, testing, or emergency preparedness tests
- Implementation
  - Operations
  - Maintenance
  - Surveillance
  - Emergency preparedness
- Supporting Processes
  - Peer reviews and audit
  - Incident investigations
  - Testing of emergency preparedness Equipment tests

**Resource Links**

A few resources highlighted from Binder Tab 10:

- Environmental Farm Plan
  - A program that awards funding to farms
  - Funding is awarded for dam safety reviews (up to $20,000)
- Joint Works Agreement for Dams with Multiple Owners
  - A great template to adopt for multiple owners