

**BUILDING
PERFORMANCE**

Example of a Potential Impact Classification assessment report – Zeta Dam

Assessment under the Building (Dam Safety)
Regulations 2022

SEPTEMBER 2024



MINISTRY OF BUSINESS,
INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

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Preface

Document status

This resource is version 1 of MBIE’s Example of a Potential Impact Classification assessment report and takes effect from September 2024.

| Document history | | |
|------------------|-------------------|-------------|
| Status | Commencement date | Alterations |
| Version 1 | September 2024 | – |

The company, dam, property location and individual named in the example are purely fictional and have been created and used for example purposes only.

Purpose of this resource

The purpose of this resource is to provide technical practitioners and dam owners with an example of the level of detail which is appropriate as they prepare their own Potential Impact Classification (PIC) under the [Building \(Dam Safety\) Regulations 2022](#) (the Regulations).

The regulations require that a dam’s classification be determined as low, medium, or high based on criteria in Schedule 2 of the Regulations. This resource is provided for information, however there is no required format of a PIC assessment report.

The level of detail required in a potential impact classification to support a building consent may differ.

What is a Potential Impact Classification?

A Potential Impact Classification (PIC) assessment is a requirement for all dams impacted by the Regulations.

Under the Regulations, if a dam is 4 or more metres in height **and** stores 20,000 or more cubic metres volume of water, or other fluid, it is a *classifiable dam*, and is impacted by the Regulations.

The classification of a dam reflects the potential impact an uncontrolled release could have on the downstream community, historical or cultural places, critical or major infrastructure and the natural environment. The population at risk, and potential for loss of life are also key determinants.

A dam owner may undertake the classification of the dam themselves, although in many cases they may choose to engage a technical practitioner to determine the classification on their behalf.

Regardless of who prepares a classification it must be audited by a Recognised Engineer against the classification criteria in the regulations and, if they agree, provide the dam owner with a certificate ([Form 1](#)) confirming the dam’s PIC. It is the dam owner’s responsibility to supply this certificate to their Regional Authority.

1 For the purpose of the Building Act 2004 and the Regulations, the ‘dam owner’ is the person who legally owns the physical dam itself.

Example of a Potential Impact assessment

Introduction and Scope

The company, dam, property location and individual named in the below example are purely fictional and have been created and used for example purposes only.

Zeta Vineyard Ltd (Zeta) owns a property located on Hillcrest Road near the intersection of State Highway 2 in Inglewood. The property has historically been used for mixed grazing and cropping and is currently being developed into a vineyard.

John Locke² has been engaged by Zeta to estimate the downstream effects of a hypothetical dam breach of Zeta Vineyard Dam. The engagement includes the preparation of a Potential Impact Classification (PIC) assessment to meet the requirements of the [Building \(Dam Safety\) Regulations 2022](#) (the Regulations).

This PIC assessment will need to be audited and certified by a Recognised Engineer (PIC) before it is submitted to the relevant Regional Council. During that audit, clarifications may be requested by the Recognised Engineer before they certify the PIC. This PIC assessment report should be read in conjunction with those clarifications.

The PIC is determined by considering the potential effects of a hypothetical dam breach scenario. Three key inputs used to determine a dam's PIC are:

- the assessed damage level
- the Population at Risk (PAR)
- the potential loss of life.

The Zeta Vineyard Dam reservoir has a theoretical storage volume of approximately 100,000m³ to crest level. It is formed by an approximately triangular shaped earth dam, with a maximum retained height of 6 metres, as measured from the dam crest to the lowest point of the downstream toe.

The Regulations define a 'classifiable dam' as one that has a height of 4 or more metres, and which stores 20,000m³ of water or other fluid. The Zeta Vineyard Dam meets this definition.

² John Locke is an independent engineering technician with experience in dam break analysis and dam hazard classification assessments.

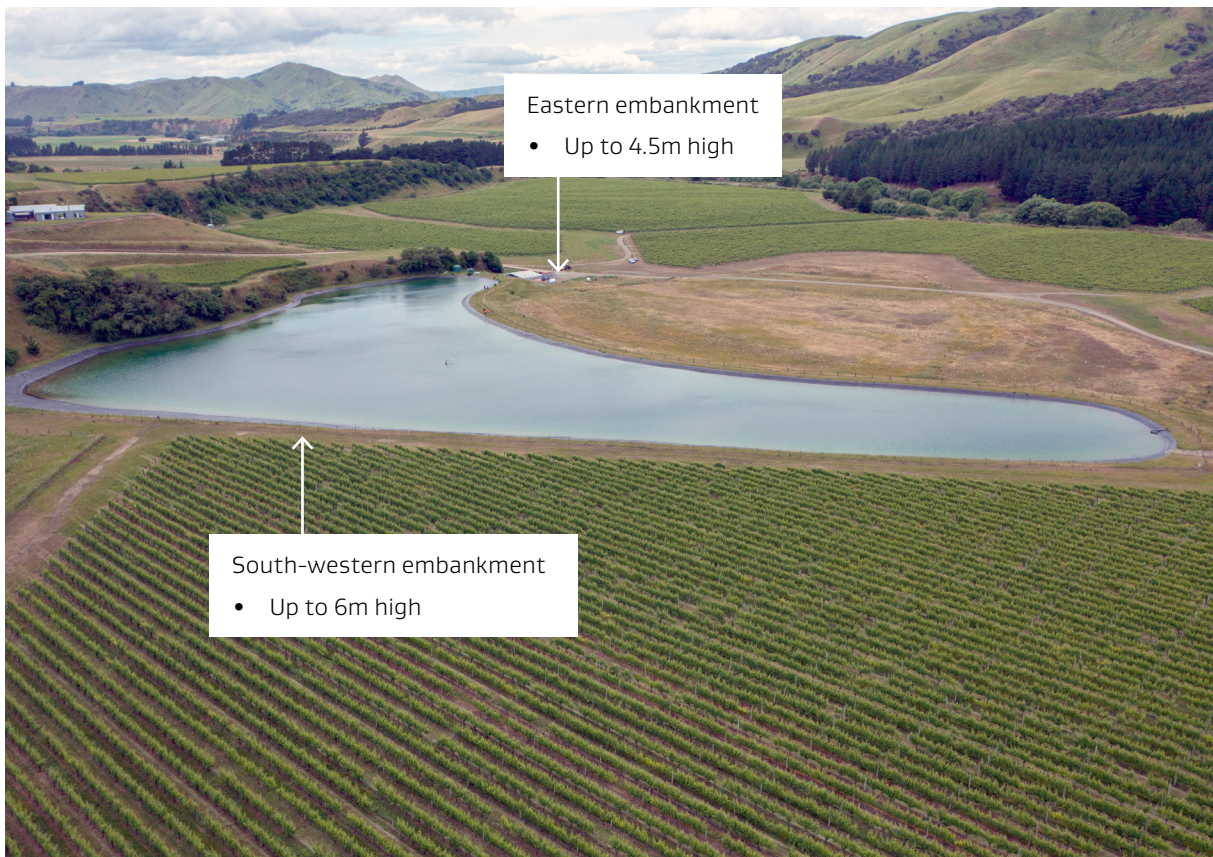


Figure 1: Zeta Vineyard Dam

Dam Break Assessment

For this dam break assessment, the dam is assumed to be full to the crest level. The breach is assumed to occur as a rapidly growing failure until it reaches the level of the surrounding ground at the downstream toe of the embankment.

- i. In the unlikely event of a breach, the released water will flow:
- ii. into the immediate surrounds of Zeta Vineyard,
- iii. continue east in the natural floodplain of Tau Creek to the State Highway, and then, breach waters will pond behind the rail embankment at the intersection of Tau Creek with the State Highway. The ponding of water will attenuate the flows in Tau Creek downstream of the rail embankment.

See figure 2 for a site sketch and illustration of the hypothetical breach.

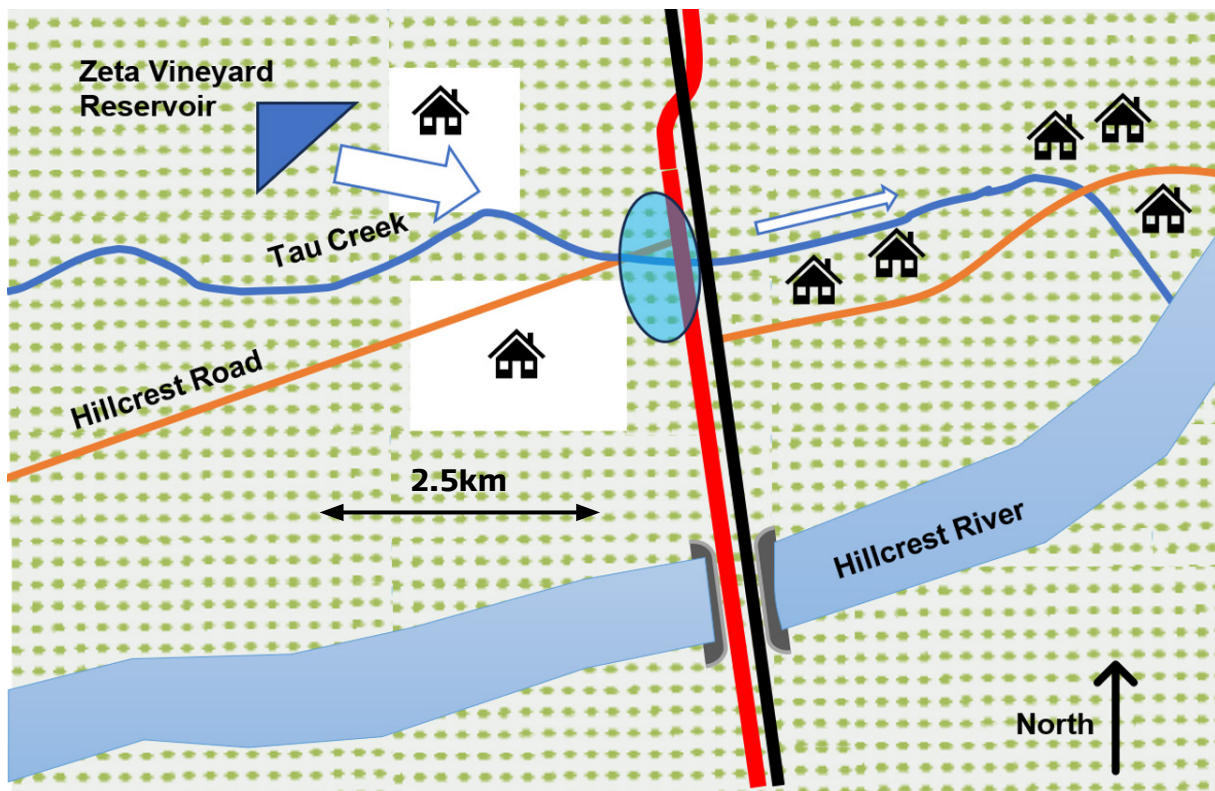







Figure 2: Site Sketch (note - this should be a marked-up NZTopo50 map in professional applications)

Key:

| | |
|---|---|
|  | Direction/flow of potential breach |
|  | State Highway 2 |
|  | Main North Line (train line) |
|  | Area of ponding expected to occur in the event of a hypothetical dam failure. |
|  | State Highway/Main North Line Bridge |

Mechanism of dam breach

Two scenarios of dam breach have been considered, being overtopping of:

- the south-western embankment, which is the highest part of the dam, or
- the eastern embankment, which is a shorter part of the dam, but is closer to affected buildings and infrastructure.

Breach flows have been estimated using methods of Froehlich (2008)³ and are summarised in Table 1. To meet the requirements of the regulations, the maximum retained water height has been taken as the embankment crest height, measured from the lowest point at the downstream toe.

Table 1: Summary of Peak Dam Breach Flows

| Scenario | Maximum Height (m) | Retained Volume (m ³) | Peak Outflow (m ³ /s) | Time to peak outflow |
|--|--------------------|-----------------------------------|----------------------------------|----------------------|
| Overtopping breach of south-western embankment | 6.0 | 100,000 | 85 | 30 minutes |
| Overtopping breach of eastern embankment | 4.5 | 85,000 | 45 | 18 minutes |

In the unlikely event of a breach, flood flows will discharge into the creek and surrounding vineyard before discharging into the floodplain of Tau Creek and flowing east in the direction of Hillcrest Road.

Approximately 2.5km downstream of the reservoir site the creek passes through a culvert beneath the road near the intersection with State Highway 2 (refer Figure 2). The flow will then reach a further culvert under the embankment of the Main North Line. By simple judgement, the capacity of this culvert is much less than the predicted breach flows and water is expected to back up behind the rail embankment and pond over State Highway 2.

Assessed Damage Level

The Regulations require that a dam's Potential Impact Classification be determined with reference to the potential damage to community, cultural sites, critical or major infrastructure, and the natural environment.

To estimate the effects of hypothetical breach, we have collected information based on the [checklist](#) from the Building Performance website. We have also checked the following sources of information about archaeological sites in Aotearoa/New Zealand:

- NZAA ArchSite (arcgis.com), and
- The [national register of heritage sites held by DOC](#), and
- [New Zealand Heritage List](#)

The criteria for assessing damage level are summarised in *Table 1* of the regulations, which is reproduced in the Appendices to this report (Appendix 1). A summary of the assessed impacts for the forementioned criteria are outlined as follows.

³ Froehlich, D. C. (2008). Embankment dam breach parameters and their uncertainties. *Journal of Hydraulic Engineering*, Vol 134, No.12. – *Note: This is an example. Other calculation methods could be used.*

Community

Based on a review of aerial photographs (and confirmed by the dam owner), two residences are located within 2km of the dam. The nearest residence is east of the dam, at 79 Hillcrest Road. The property comprises 1 house, 1 garage and 2 farm buildings. The house is situated approximately 1200m east of the dam's eastern side. The house is located on an alluvial fan which slopes gently to the south and originates from one of the northern tributaries of Tau Creek.

In the event of failure of the eastern embankment, attenuation and spreading of the breach flows are likely to occur in the 1200m between the dam site and house. The slope of the alluvial plain is likely to re-direct the flows to the south and away from the house and into the floodplain of Tau Creek. The potential for the house at 79 Hillcrest Road to be affected by breach floodwaters is very low.

In the event of failure of the south-western embankment the breach flows are expected to quickly reach Tau Creek, and then travel east following the floodplain of the creek towards the Hillcrest Road in the vicinity of the intersection of State Highway 2. On reaching the state highway, floodwaters are expected to overtop the road and backup behind the Main North Line railway embankment.

A further residence at 12 Hillcrest Road is located approximately 1000m west of the highway and 200m south of Hillcrest Road. The house is elevated from the floodplain of Tau Creek. The most probable mechanism of floodwaters reaching the house is the backup of floodwaters behind the main north line rail embankment. However, such a possibility is very unlikely, given the significant distance and gentle slope of the land between the house and the highway.

Overall, the effect on community is consistent with *Minor damage that does not materially affect the functionality of any household unit, commercial or industrial facility, or community facility (or no damage)*.

Cultural

A review of the Heritage New Zealand⁴ and Heathcote Regional Council Heritage Records indicates that only one heritage listed structure is located within 20 km of the dam site. This is a historic Cobb Cottage located near the Hillcrest settlement. It is not located within a potential breach flow path.

Based on this desktop assessment, the 'Cultural' assessed risk level is consistent with *no loss to any historical or cultural site*, and therefore meets the definition of 'Minimal' damage.

Critical and Major Infrastructure

Impacts on critical and major infrastructure must be considered in assessing a dam's potential impact. This includes energy (electricity, gas, petroleum), transport (road, rail, ports, and airports), water and telecommunications services.

A review of Heathcote Regional Council records indicates that an 11kv power line, which runs west-east is situated approximately 100m south of the dam's south-western embankment. In the event of a dam breach, it is possible that 1 or 2 supporting poles may be damaged by scour from released floodwaters. The time to recovery however is expected to be short, and unlikely to exceed one week. No gas or petrol infrastructure was identified within the potential breach flood path.

State Highway 2 is a major route between Inglewood and Heathcote. It could be affected by ponding of floodwaters behind the Main North Line. This ponding is likely to be up to 0.5m deep and may extend, at a

4 heritage.org.nz/places

reduced depth, for a 1.0 km distance. Short term ponding of water is consistent with a 'minimal' assessed damage level, and damage (if occurring), is likely to be relatively straightforward to remediate.

No rail, ports, airports, or water or telecommunications services (aside from individual private property connections) have been identified within the hypothetical dam breach path.

Based on this desktop assessment, the 'infrastructure' assessed risk level is 'Minimal', i.e., *Minor damage to 1 or more critical or major infrastructure facilities (or no damage)*.

Natural Environment

In the unlikely event of a dam breach, flood flows are expected to reach Tau Creek before travelling east in the broader floodplain of the creek before discharging into Hillcrest River. It is likely that damage, including erosion and scouring of land, may occur within the immediate vicinity of the dam failure. However, such effects are likely to be limited to a small area of private land in the immediate surrounds of the dam and relatively straightforward to clean up.

Based on this desktop assessment, the 'natural environment' assessed risk level is 'Minimal' i.e., *Only minor rehabilitation or restoration may be required, or recovery is possible without intervention (or no damage)*.

Assessed Damage Level Summary

Based on the assessed damage level resultant from the dam-break flooding of the downstream categories, a **damage level of 'minimal'** has been determined in this assessment, as shown in Appendix 1.

Population at Risk and potential loss of life

The hypothetical breach of the reservoir has the potential to affect various communities (ie the PAR) along the flood path. These are broadly grouped as:

- vineyard staff
- local residents
- vehicles on local roads (Hillcrest Road)
- vehicles on State Highway 2
- trains on the Main North Line.

The area in which the reservoir is located is designated as a 'Rural Zone' within Heathcote Regional Council's Resource Management Plan. The predominant use of the site and neighbouring properties is viticulture and low- density farming operations. The location of the reservoir in relation to the features listed above is indicated on Figure 1.

Vineyard Staff

Within the immediate downstream proximity of the reservoir, the population most likely affected in the event of dam breach would be vineyard workers.

During summer/warmer months (October through to March), approximately six workers are typically present on the vineyard. The land downstream of the proposed reservoir is a small fraction of the total vineyard, being approximately 10 per cent. The nature of their duties is week-on, week off, and limited to a total of two months over the October to March period. The workers will be itinerant (ie they will move from place to place in the course of their work), and their presence on-site will be generally limited to daylight hours.

On this basis, the likelihood of a single staff member being present in affected areas at any given time is estimated to have an annual probability of around 0.2 per cent⁵.

Even if a worker was present in the inundation area, it is considered unlikely that a life would be lost as work mainly occurs outdoors, during daylight hours, and workers would have opportunity to observe and respond to a developing dam failure event. The PAR associated with vineyard workers is in the range 0 to 1.

The effects of a breach on the natural and built environment (such as vineyard infrastructure, or existing ephemeral streams) would be considered minimal and short-term.

Local Residents

A review of the potential breach paths with reference to the nearest houses suggests that no houses will be affected. The likelihood for occupants to be a PAR is deemed negligible and has been discounted.

Other Downstream Dwellings

A further five dwellings have been identified adjacent to the lower reaches of Tau Creek, downstream of SH2 and the railway embankment. Within this reach, breach flows will be attenuated to be no larger than the annual flood flows. In all cases, the dwellings are situated outside the floodplain of the creek, and risk to the residences is considered remote.

Local Roads - Hillcrest Road

Hillcrest Road is a local east-west road and is situated approximately 1000m south of Zeta Vineyard Dam. The most likely scenario of floodwaters reaching the road is via the floodplain of Tau Creek (approximately 2km downstream of Zeta Vineyard Dam). Under normal conditions, flows in Tau Creek pass within a culvert under the road.

A breach of the dam is likely to release flows that will rapidly exceed the capacity of the culvert and overtop the road (refer Figure 3). The gradient of the stream at this location is approximately 1-in-100, however, it is still possible that the flow would wash out or damage the road.



Figure 3: Hillcrest Road at Tau Creek culvert. (Source: Heathcote Regional Council)

⁵ Estimated as 6 people x 2 months / 12 months per year x 12 hours / 24 hour day.

There is a low likelihood of vehicles encountering the inundation zone on Hillcrest Road. The probability of a vehicle encountering the developed dam breach flow and failing to stop is considered 'unlikely' as good sight lines are available from both directions. In hours of darkness, the likelihood of a vehicle failing to observe the hazard is increased, although traffic counts during hours of darkness is also likely to be very low.

The expected duration of a dam breach event is in the order of 20-30 minutes⁶. There will be some attenuation of floodwaters between the breach and Hillcrest Road, which will reduce peak flows. The depth of water overtopping the road is expected to be up to 2m, although it may be deeper over short distances.

Although the depth of water is significant, the duration of the breach is relatively brief, which reduces the likelihood of a vehicle encountering the breach, particularly at times of low traffic volume, such as at night. Overall, the PAR associated with a user of Hillcrest Road is estimated to be low, and in the range 0 to 1 people.

It is also a reasonable amount of time for road users to see and respond to a developing breach and to move along the road to higher ground. On this basis it is considered very unlikely that a life would be lost on Hillcrest Road.

State Highway 2

State Highway 2 (SH2), a major arterial route between Inglewood and Heathcote, is situated approximately 2km east (2.2km downstream) of the Zeta Vineyard Dam. In the unlikely event of a dam breach, flood flows would attenuate before reaching the SH2 and ponding on the road behind the Main North Line rail embankment.

The ponding of water could present a hazard to the road users; however, the risk of a road accident is mitigated by the following considerations:

- From the north, traffic will have slowed for a level crossing with the Main North Line
- From the south, traffic will have slowed for a narrow bridge crossing of Hillcrest River for both the Main North Line and SH2.

In both instances, it is unlikely that a driver on SH2 would have accelerated before encountering the floodwaters. Given the probability of a driver encountering the floodwaters and failing to stop is low, a death on SH2 is also deemed to be very unlikely.

Trains on Main North Line

The rail embankment in the vicinity of the Main North Line is approximately 2m high. In the event of a breach, floodwaters are expected to back up behind the rail embankment with an attenuated flow discharged through the culvert beneath it.

The volume of water retained within the reservoir is unlikely to be sufficient to overtop the Main North Line rail embankment. The effect on trains on the main north line is expected to be minimal.

⁶ Froehlich, D. C. (2008). Embankment dam breach parameters and their uncertainties. *Journal of Hydraulic Engineering*, Vol 134, No.12. – *Note: This is an example. Other calculation methods could be used.*

Summary of Population at Risk and potential loss of life

Based on this qualitative assessment of population at risk for fixed locations (eg houses), designated routes (eg local roads, SH2), and other areas (eg agricultural land), no permanent population has been identified to be affected within the likely path of a dam breach flow.

Given the seasonal nature of the temporary populations, such as vineyard workers and the limited effect on road users, the PAR is conservatively assessed to be in the range 0 to 1.

Given the mitigating factors, including visibility of the approaching flood waters in relatively flat topography; the potential for loss of life during a dam-break flood is estimated to be **'minimal'**.

Summary of Potential Impact Classification

This assessment has followed the requirements of the Building (Dam Safety) Regulations 2022.

- The 'population at risk' due to a hypothetical dam-break flood is estimated to be 0-1 people during the day and night.
- An assessed damage level of 'minor' has been determined in this assessment.

In terms of *Table 2* of the regulations (Appendix 2), for a dam with minimal damage level and PAR less than one, where loss of life is not likely, the appropriate classification is **"Low Potential Impact (Low PIC)"**.

Appendices

Appendix 1: Table 1 – Determination of assessed damage level

| Specified categories | | | | | |
|----------------------|---|--|---|--|--|
| Damage level | Community | Cultural | Critical or major infrastructure | | Natural environment |
| | | | <i>Damage</i> | <i>Time to restore critical or major infrastructure to pre-dam failure operations</i> <i>(see Note one)</i> | |
| Catastrophic | One or more of the following apply: <ul style="list-style-type: none"> • 50 or more household units rendered uninhabitable • 20 or more commercial or industrial facilities rendered inoperable • two or more community facilities rendered inoperable or uninhabitable. | Irreparable loss to two or more historical or cultural sites | Two or more critical or major infrastructure facilities rendered inoperable | One year or more | Extensive and widespread damage, with permanent, irreparable effects on the natural environment |
| Major | One or more of the following apply: <ul style="list-style-type: none"> • four or more but less than 50 household units rendered uninhabitable • five or more but less than 20 commercial or industrial facilities rendered inoperable • one community facility rendered inoperable or uninhabitable. | One or more of the following apply: <ul style="list-style-type: none"> • Irreparable loss to one historical or cultural site • loss to one or more historical or cultural sites where it is possible, but impracticable, to fully restore the site | One critical or major infrastructure facility is rendered inoperable | Three months or more but less than one year | Extensive and widespread damage where it is possible, but impracticable, to fully restore or repair the damage |

| Specified categories | | | | | |
|----------------------|--|---|--|--|--|
| Damage level | Community | Cultural | Critical or major infrastructure | | Natural environment |
| | | | <i>Damage</i> | <i>Time to restore critical or major infrastructure to pre-dam failure operations</i> <i>(see Note one)</i> | |
| Moderate | One or more of the following apply: <ul style="list-style-type: none"> • one or more but less than four household units rendered uninhabitable • one or more but less than five commercial or industrial facilities rendered inoperable • loss of some functionality of one or more community facilities. | Significant loss to one or more sites of historical or cultural significance where it is practicable to restore the site | One or more critical or major infrastructure facilities are affected by the loss of some functionality | Less than three months | Significant damage that is practicable to restore or repair |
| Minimal | Minor damage that does not materially affect the functionality of any household unit, commercial or industrial facility, or community facility (or no damage) | Loss to one or more historical or cultural sites that will require minor restoration only (or no loss to any historical or cultural site) | Minor damage to one or more critical or major infrastructure facilities (or no damage) | One week or less | Only minor rehabilitation or restoration may be required or recovery is possible without intervention (or no damage) |

Note

1. The estimated time required to repair the damage sufficiently to return the critical or major infrastructure to the normal operation that the infrastructure had immediately before the failure of the dam.

Appendix 2 - Table 2 - Determination of dam's Potential Impact Classification

| Assessed damage level | Population at risk (number of persons) | | | | Potential loss of life |
|-----------------------|--|--------|--------|---------------|------------------------|
| | 0 | 1-10 | 11-100 | more than 100 | |
| Catastrophic | High | High | High | High | No persons |
| | N/A (see Note 1) | High | High | High | One person |
| | N/A (see Note 1) | High | High | High | Two or more persons |
| Major | Medium | Medium | High | High | No persons |
| | N/A (see Note 1) | Medium | High | High | One person |
| | N/A (see Note 1) | High | High | High | Two or more persons |
| Moderate | Low | Low | Medium | Medium | No persons |
| | N/A (see Note 1) | Medium | Medium | Medium | One person |
| | N/A (see Note 1) | High | High | High | Two or more persons |
| Minimal | Low | Low | Low | Low | No persons |
| | N/A (see Note 1) | Medium | Medium | Medium | One person |
| | N/A (see Note 1) | High | High | High | Two or more persons |

Note

1. Not applicable. Population at risk is zero, therefore there is no potential loss of life.

Population at risk (PAR) means the number of people likely to be affected by an uncontrolled release of all or part of the stored water or other fluid due to a failure of the dam (assuming that no person takes any action to evacuate).



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