



**FLOOD DETENTION DAMS - 2023
INTERMEDIATE DAM SAFETY REVIEW**

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Flood Detention Dams - 2023 Intermediate Dam Safety Review

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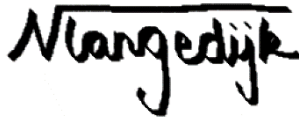


Flood Detention Dams - 2023 Intermediate Dam Safety Review

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Executive Summary

Hastings District Council (HDC) operates a stormwater management service to a number of areas within the Hastings District by utilising flood detention dams to attenuate flood flows from upstream catchment areas. These include four small dams in the coastal area of Clifton above a camping ground, two small dams in the Te Awanga catchment, and five larger, High Potential Impact Classification (PIC) dams in adjacent catchments in Havelock North. Only Lower Te Awanga and the five Havelock North dams have consent conditions that require annual inspections to be submitted to Hawkes Bay Regional Council (HBRC).

Since 2000, HDC has engaged Stantec New Zealand to perform annual Intermediate Dam Safety Reviews (IDSR), which include dam inspections and assessment and identification of dam safety issues. The latest Comprehensive Dam Safety Review (CDSR) was carried out in 2020. CDSRs are completed every 5 years.

The intent of the intermediate inspections and reporting is to detail the current conditions at each dam for dam safety deficiencies and review the operations information of the dams to assess the current safety performance. Relevant Dam Safety Issues and dam maintenance recommendations are made. The status of previous Dam Safety Issues from the 2022 IDSR have been reviewed and updated, as have the status of the 2020 CDSR Dam Safety Issues.

The performance of the dams during Cyclone Gabrielle was reviewed by Stantec in a separate study.

Based on visual inspection, the flood detention dams appeared to be functioning adequately and satisfactory performance is expected under normal (non-flood) operating conditions.

To ensure performance during small to medium flood events, the culverts, in particular the upstream channels, screens, and inlet structures, should be maintained clear of vegetation. To ensure safe discharge of larger floods via the spillways, the spillway channels should be maintained clear of obstructions including fences, gates, and vegetation.

Operation, Maintenance, and Surveillance documentation for the detention dams was prepared in 2020 by Stantec, to cover aspects of dam safety management across HDC's portfolio of dams.

The New Zealand Dam Safety Regulations to be introduced in 2024 will require the HDC detention dams to be reviewed to confirm their PIC, and the Medium and High PIC dams will require ongoing dam safety management.



Acronyms / Abbreviations

| | |
|--------|---|
| AEP | Annual Exceedance Probability |
| CDSR | Comprehensive Dam Safety Review |
| DSAP | Dam Safety Assurance Programme |
| DSI | Dam Safety Issue |
| DSMS | Dam Safety Management System |
| EAP | Emergency Action Plan |
| FSL | Full Supply Level |
| HBRC | Hawke's Bay Regional Council |
| HDC | Hastings District Council |
| IDF | Inflow Design Flood |
| IDSR | Intermediate Dam Safety Review |
| NZSOLD | New Zealand Society on Large Dams |
| OMS | Operation, Maintenance and Surveillance |
| PAR | Population at Risk |
| PFM | Potential Failure Mode |
| PIC | Potential Impact Classification |
| PMF | Probable Maximum Flood |
| PMP | Probable Maximum Precipitation |



1 Background Information

Hastings District Council (HDC) operates flood detention dams to protect Havelock North and the coastal area of Te Awanga. There are two dams in the Te Awanga catchment, several small dams above Clifton Camping Ground and five larger, High Potential Impact Classification (PIC) dams in adjacent catchments in Havelock North (see Figure 1-1). The location of all the dams can be seen in Appendix A.

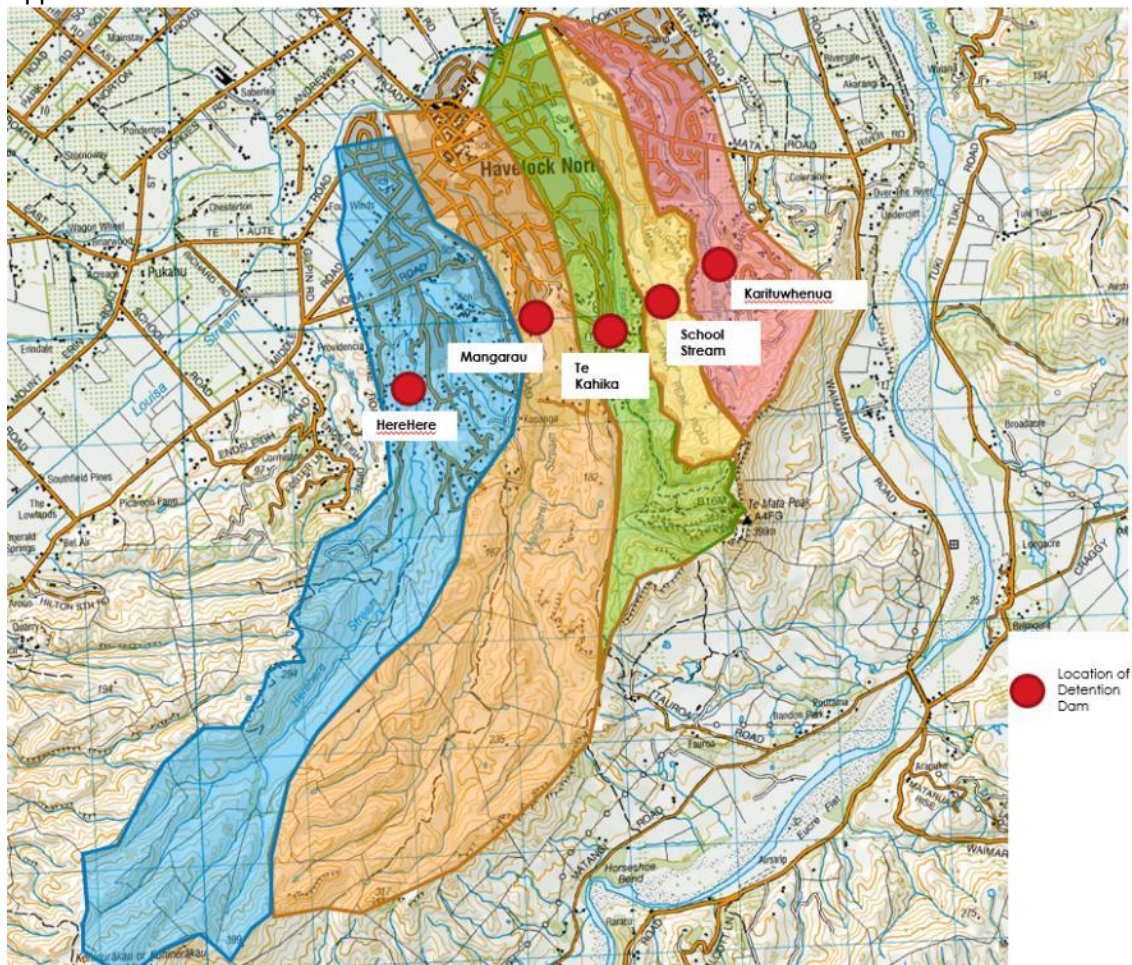


Figure 1-1. Havelock North Dams along with the upstream catchment area and downstream areas.

In February 2023, Cyclone Gabrielle passed through and all the Havelock North dams operated to some extent. The Stantec 2023 Report on Cyclone Gabrielle focused on the Havelock North dams which all performed satisfactorily but note there was still flooding in Havelock North due to the magnitude of the flood event. Mangarau was the only dam where the spillway operated, and witness reports suggest that most dams' main culvert inlets were at least partially blocked by vegetation debris generated by the cyclone.

1.1 Intermediate Dam Safety Review (IDSR)

The intent of the IDSRs is to complete inspections and reporting to detail the current conditions at each dam for Dam Safety Issues and review the operations information of the dams to assess the



Flood Detention Dams - 2023 Intermediate Dam Safety Review

2 Methodology

current safety performance. Since 2000, HDC has engaged Stantec New Zealand to perform annual Intermediate Dam Safety Reviews.

An IDSR is intermediate in the sense that it fits between Routine Surveillance by HDC and the Comprehensive Dam Safety Review (CDSR) in frequency and in its level of detail. The last CDSR was performed by Stantec in 2020 and the next CDSR is due in 2025.

An IDSR is largely based on:

- A visual inspection by a Technical Adviser (Stantec).
- A close examination of surveillance, operation, maintenance, and testing records.
- For High and Medium Potential Impact Classification (PIC) dams IDSRs should be completed annually by a Technical Adviser external to HDC. For Low PIC dams, IDSRs should be completed every 1 to 2 years. HDC arrange for an annual inspection and IDSR report for all their dams, together in one report (this report), regardless of the dams' PIC.
- A review of the performance of the dam during any events within the applicable timeframe. Note that Stantec have reported the performance of the Havelock North dams during Cyclone Gabrielle in a separate report.

This IDSR covers an inspection that was completed on 1st and 2nd of August 2023 and the relevant Dam Safety Issues and dam maintenance recommendations made. The status of previous Dam Safety Issues have also been reviewed and updated (Section 7).

1.2 Scheme Details

The Havelock North Flood Protection Scheme was originally developed to alleviate flooding problems associated with five major streams in the area (Figure 1-1). Constructed during the early 1980's by the Hawke's Bay Catchment Board in response to a significant flood event in the 1970's, a series of detention embankment dams (Karituwhenua, School Stream, Te Kahika, Mangarau, and Here Here) were designed to reduce peak flood flows and overflow of the stream banks.

There are also two dams in the Te Awanga catchment upstream of Te Awanga, and a group of four small dams in the Clifton area in the catchment of the Clifton Motor Camp.

Each dam in the scheme operates as an on-line impounding structure with a throttle pipe that is sized to allow the passing of average, daily flows but then chokes during flood and causes flood water to temporarily impound behind the dams, thus reducing the high magnitude flows that would otherwise be experienced downstream. Refer also to the 2020 CDSR and OMS Manual for more information on the dams and how they operate.

2 Methodology

Our inspection methodology and dam safety evaluation is based on the requirements of the current NZSOLD Dam Safety Guidelines for Medium to High PIC dams. The 2023 inspection and review consisted of the following activities:

- Walkover inspection of dam embankments and abutment areas. Inspections looked for evidence of instability, seepage, possible signs of piping, historic flood levels, vegetation and maintenance requirements, and anything unusual.
- Walkover inspection of the areas immediately upstream and downstream of the dam. Inspections looked for evidence of subsidence, instability, seepage, vegetation, and other materials in or adjacent to the channels, assessment of likely debris deposited during/after flood events, and any unusual features that could affect the safety of the dam.



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3 New Regulations

- Limited visual inspections were made of the low-level culverts for evidence of structural distress, settlement, faulty joints, seepage, or piping issues. No culverts were entered. One of the previous recommendations was to perform CCTV reviews for all these culverts and this has started.
- Walkover inspection of overflow spillways, with emphasis on assessing the ability of the spillway to effectively discharge design flood flows.
- Photographs were taken during each inspection to document the current conditions at each site.
- Water level and rainfall data for the last year (focus period for this IDSR) has been provided by HDC, which has been summarised for each Havelock North dam.
- Summary of the routine inspections and maintenance that is undertaken.
- An assessment of previous IDSR and CDSR Dam Safety Issues was considered for each dam, with the updated status of these presented in Section 7.
- The preparation of this report which outlines background information, the inspection observations, dam safety information, Dam Safety Issues, and a selection of photographs.

3 New Regulations

In May 2024, new Dam Safety Regulations are due to come into force for which HDC will need to confirm the PIC for each of the classifiable dams¹ (all HDC dams except Clifton and Lower Te Awanga Dams). A Dam Safety Assurance Programme (DSAP) will then be required to be implemented for those dams with Medium or High PIC. The HDC dams have previously had PIC assessments, but these will need to be reviewed, and some updated, to align with the requirements of the Regulations.

¹ 4 m or greater in height, and 20,000 m³ and greater in volume, or 1 m or greater in higher, and 40,000 m³ and greater in volume.



4 Observations from the Site Inspections

4.1 General Observations

Site specific observations from the inspections are summarised in Table 4-1 to Table 4-8. Additional photographs are included in the appendices for each dam (Appendix B to I). Left (LHS) and right (RHS) within the context of this report are based on the observer looking in a downstream direction.


4.2 Clifton Dams

The Clifton Dams were inspected by Nathan Fletcher & Nicole Langedijk (Stantec) with guidance from Tony Dench (HDC) from 9:30am to 11am on Tuesday 1 August 2023.




Access was gained to the Clifton Motor Camp via Clifton Road to inspect the outfall. Access to the Clifton Dams was via foot from halfway up the 4WD track (starting at Forestry Road turn off) due to vehicle access issues on the muddy track.

Inspection comments, dam safety issues, and key photographs are included in Table 4-1.


Table 4-1: Summary of Clifton Dams Site Inspection

| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|---|--|---|--|
| <p>Clifton Motor Camp Stormwater Gully</p> | <p>Flood flows from the catchment and detention dams flow down the stormwater gully through the Clifton Motor Camp. There is no control over these flows, but the channel is defined through the motor camp to reduce flooding of campsites.</p> <p>The stormwater gully has been scoured out since last year due to heavy rainfall events. The scour has deepened the channel and exposed an unknown concrete pipe section upstream of the road (see top image). The concrete box channel still has some sediment but less than 2022 and is in about the same condition. There is now a picket fence protecting the public from falling into the channel downstream of the concrete box channel which has also been scoured deeper. There is no longer an earth plug at the bottom of the channel where it meets the beach and the boulders placed on the beach as erosion protection from waves have been displaced.</p> <p>The gully was not easily inspected due to fallen trees, overgrown vegetation and wet slippery slopes. Conditions were similar to previous inspections, albeit from limited inspection at the lower section of the slope.</p> | <p>The capacity, make up and remediation of the gully or other stormwater control options should be investigated (previous DSI).</p> <p>Clear the downstream gully stormwater channel upstream of the concrete box section, and within the concrete box section (previous DSI).</p> |  |

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| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|----------------------------------|---|--|---|
| <p>West Dam</p> | <p>The West Dam was in satisfactory condition. There was a pond of water on the RHS and the ground was muddy.</p> <p>The inlet is clearly marked by 4 waratahs that also help prevent any large debris from blocking the pipe. The pipe inlet was clear of debris as was the outlet.</p> <p>The upstream stock ponds, which are historically in poor condition, were not inspected and landowner of Clifton Station was not home.</p> <p>Flows from the West Dam may flow down a different gully to the motor park below. It was not clear which gully the flood flows travel down and there were water troughs in the downstream area which could be carried by flood flows.</p> | <p>Discuss the stock ponds with the landowner and manage the potential issues and impacts on the flood detention dams (previous DSI).</p> <p>Mark the pipe outlet location for easier maintenance and inspection practices (previous DSI).</p> |  |
| <p>Lower (Middle) Dam</p> | <p>The Lower Dam was in satisfactory condition.</p> <p>The inlet is clearly marked by 4 waratahs that also help prevent any large debris from blocking the pipe. There was vegetation growing around the inlet but the pipe itself was clear as was the outlet.</p> <p>The lowered crest section in the centre of the embankment (spillway) was clear and stable.</p> | <p>Mark the pipe outlet location for easier maintenance and inspection practices.</p> |  |
| <p>East Dam</p> | <p>The East Dam was in satisfactory condition.</p> <p>The inlet is a capped pipe with holes to allow water through.</p> <p>The pipe outlet could not be located due to the high grass covering the downstream embankment. The outlet should be maintained with vegetation cleared to ensure unobstructed flows through the pipe.</p> <p>The sea outlet channel was clear and stable, with minor bank erosion visible.</p> | <p>Mark the pipe outlet location so this can be inspected and maintained.</p> |  |

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| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|----------------------------------|--|------------------|---|
| <p>Upper (Middle) Dam</p> | <p>The Upper Dam was in satisfactory condition.</p> <p>The inlet is clearly marked by 3 waratahs that also help prevent any large debris from blocking the pipe. There was vegetation growing around the inlet but the pipe itself was clear.</p> <p>The pipe outlet could not be located due to the high grass covering the downstream embankment. The outlet should be maintained with vegetation cleared to ensure unobstructed flows through the pipe.</p> | |  |





4.3 Lower Te Awanga Dam

The Lower Te Awanga Dam was inspected by Nathan Fletcher & Nicole Langedijk (Stantec) with guidance from Tony Dench (HDC) from 11am to 12pm on Tuesday 1 August 2023.



Access was gained via Clifton Road. The outlet is at the bottom of the field for 367 Clifton Road. The dam is accessed through the field opposite 365 Clifton Road.

Inspection comments, dam safety issues, and key photographs are included in Table 4-2.

Table 4-2: Summary of Lower Te Awanga Dam Site Inspection


| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|---------------------------------|---|--|---|
| <p>Pipe & Outlet</p> | <p>During Cyclone Gabrielle, a manhole lid along Clifton Road lifted due to high flows/pressure in the culvert (at a 90 degree bend). The manhole in front of 365 Clifton Road had steel plates to hold the manhole cover down but these had rusted so the manhole cover had limited effect against the ~10 m head of pressure within the pipe at this location. This manhole cover has since been replaced with a stainless steel cover. The other manhole cover in front of 367 Clifton Road still had plates holding the cover on. The pressure in the pipe was enough to lift the concrete manhole cover at the back of 367 Clifton Road property. This concrete manhole was covered in vegetation over the years and the flooding scoured the surrounding earth when the water pressure lifted the manhole, leaving depressions and holes which pose a risk to the public and livestock.</p> <p>The pipe outlet (see image), ~40 m upstream of where discharges into the Maraetotara River, appeared in satisfactory condition. The vegetation was becoming overgrown which hindered inspection and the riprap was partly disturbed.</p> | <p>Clear the vegetation from the concrete manhole at the back of 367 Clifton Road. Raise the manhole so that the manhole lid sits above the ground. Backfill the holes around the manhole.</p> <p>Clear the vegetation from the outlet to inspect rip rap and determine if repairs are needed.</p> |  |
| <p>Spillway Channel</p> | <p>There are two gabion check dams at 20 m intervals downstream of the dam. These were generally stable even though there were clear bulges and holes at the base of the lower one.</p> <p>The gabion wall on the main spillway structure was in similar condition to 2022 but was covered in debris and large branches. The right side is still bulging and the left side now has a large dent.</p> <p>The upper concrete spillway structure was in satisfactory condition.</p> <p>The vertical inlet was in satisfactory condition. There was a small base flow passing through the culvert.</p> | <p>Repair the hole at the base of the lower gabion wall.</p> <p>Monitor the bulges in the gabion walls for movement / further disfigurement. Consider adding a second row of gabions for improved stability.</p> <p>Remove debris.</p> |  |

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| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|---|---|-------------------------------------|---|
| | | |  |
| <p>Culvert & Inlet</p> | <p>The culvert looked clear from the auxiliary inlet but cannot be confirmed without CCTV of the whole pipe. There was some sediment build up near the inlet.</p> <p>The inlet debris screen had some debris and vegetation so that the wing walls were not entirely visible for inspection. The previously cleared vegetation has not returned to the channel in front of the inlet.</p> <p>The gabion wall to the left of the inlet was in in satisfactory condition but was partly covered by vegetation which makes inspection difficult.</p> | <p>Remove screen debris.</p> |  |
| <p>Reservoir Area & Upstream Channel</p> | <p>The reservoir area showed no signs of landslides from the heavy rainfall.</p> <p>Animal bones indicated their presence, but no burrows were identified in the reservoir area or on the dam slope.</p> | <p>None.</p> | |



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| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|------------------------------|---|---------------------|---|
| <p>Dam Embankment</p> | <p>The embankment area was in satisfactory condition with stable slopes and clear crest area.</p> | <p>None.</p> |  |



4.4 Upper Te Awanga Dam

The Upper Te Awanga Dam was inspected by Nathan Fletcher & Nicole Langedijk (Stantec) with guidance from Tony Dench (HDC) from 12pm to 1pm on Tuesday 1 August 2023.


Access was gained on foot through the Nilsson property to the dam (see Figure 4-1).





Figure 4-1. Access route to Upper Te Awanga Dam and flow paths.

Inspection comments, dam safety issues, and key photographs are included in Table 4-3.

Table 4-3: Summary of Upper Te Awanga Dam Site Inspection



| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|------------------------------|--|--|---|
| <p>Left Abutment</p> | <p>The left abutment embankment appeared stable and in satisfactory condition.</p> <p>The pipe through this section was in poor condition where visible and this inlet was not functioning well and was partly blocked by vegetation across the grate.</p> | <p>Previous Dam Safety Issues noted for maintenance of this outlet.</p> |  |

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| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|--|--|---|--|
| <p>Spillway and Outlet Culvert</p> | <p>The spillway channel was clear and in satisfactory condition.</p> <p>The inlet structure appeared stable and the debris screen only had minor debris present. The debris included some grass and a couple of cardboard boxes. There was ponded water which prevented an inspection of the invert.</p> <p>The outlet structure was partially obscured by the turbid water flowing through and ponding at the downstream end. The rip rap was scattered, presumably by high flows, so that it no longer performs as intended, and is probably undersized. The rip rap placement should be reviewed and replaced with larger graded stone where it looks light or vulnerable. The structure itself appeared to be in a stable condition.</p> <p>The culvert has previously been recommended to be inspected for movement and current condition. The dams are undergoing CCTV inspection to check on the condition of the culverts, but a quick visual inspection showed no obvious signs of deterioration or settlement of the culvert. Note that CCTV is still recommended due to the low spots on the crest that suggest settlement or internal erosion.</p> | <p>Review and improve the rip rap protection to the area downstream of the culvert and outlet structure (previous DSI).</p> <p>Complete a culvert inspection (CCTV) for current condition and identifying issues (previous DSI).</p> |  |
| <p>Embankment, Reservoir and Right Abutment</p> | <p>The main embankment dam was in satisfactory condition with consistent short grass coverage. The previously identified low spot of the crest could indicate settlement or internal erosion around the culvert.</p> <p>The right abutment pipe was overgrown at the outlet and had ponded water. This should be cleared by rodding for improved functionality. The inlet was relatively clear but requires some maintenance and vegetation clearance. The grate covering the inlet was raised to allow small flows through without getting blocked.</p> <p>The reservoir area was clear.</p> | <p>Conduct a detailed dam topographic survey to identify and monitor any low spots (previous DSI).</p> <p>Complete maintenance on the right abutment pipe at the inlet and outlet to ensure this will function adequately (previous DSI).</p> |  |



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| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|--|--|---|--|
| <p>Downstream Outlet (to Charlton Stream)</p> | <p>The culvert inlet structure was covered in debris. This was removed during the inspection to allow more flow and stop the ponding. Maintenance should be completed around the structure with review of adequacy of inlet structure and replacement of rip rap.</p> <p>The outlet culvert structure was in similar condition to the previous inspections, with the placement of rock protection around the structure (completed previously by HBRC Works Group). Leakage appeared to be exiting outlet near the base and trickling through the rip rap. This is not a significant problem, as flow can be managed through here, but should be monitored for any issues or changes in future.</p> | <p>Complete maintenance at the inlet and outlet of the downstream outlet (Charlton Stream). Previous DSI.</p> <p>Review the adequacy of rip rap around the downstream culvert outlet. Previous DSI.</p> |   |




4.5 Karituwhenua Dam

The Karituwhenua Dam was inspected by Nathan Fletcher & Nicole Langedijk (Stantec) from 11am to 12pm on Wednesday 2 August 2023.




Access was gained via Fulford Road.

Inspection comments, dam safety issues, and key photographs are included in Table 4-4.

Table 4-4: Summary of Karituwhenua Dam Site Inspection


| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|------------------------------|--|--|--|
| <p>Embankment</p> | <p>The dam crest and slope in general were in satisfactory condition. There were no obvious issues with slope movement or crest settlement.</p> <p>The trees and vegetation on the downstream left abutment should be removed, as some have already fallen over and should be cleared. This would assist in providing a clear area for inspection and lessen risks of root infiltration into the embankment. As viewed in the previous inspection, this has also caused some surface erosion from runoff.</p> <p>Pine trees identified as becoming established on the upstream right side of the embankment should be removed. Although unclear where the dam turns into the right abutment, there are pine trees on the dam that could cause similar issues as those mentioned above for the trees on left abutment.</p> <p>Sheep were present in the valley, helping to maintain appropriate grass length. Use of sheep to control vegetation is an acceptable practice. There was also a dead sheep on the downstream embankment which should be removed.</p> | <p>Clear trees and vegetation from the downstream left abutment (between the dam and spillway) (previous DSI).</p> <p>Clear the pine trees on the upstream slope and crest near the right abutment (previous DSI).</p> |  |

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4 Observations from the Site Inspections

| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|---|--|---|---|
| <p>Upstream Channel and Inlet Structure</p> | <p>The upstream channel from the culvert inlet had large trees that have fallen. The trees were not blocking the low flow during the inspection but would be a problem for larger flows and should be removed.</p> <p>The inlet also had debris blocking the screen which impedes flow and should be cleared. Karituwhenua is the only Havelock North dam without an auxiliary inlet that can be used if the inlet gets blocked. Options to install an auxiliary inlet should be investigated.</p> <p>Keeping debris clear will also help prevent damage to the instrument (RHS of inlet) that monitors the reservoir level.</p> <p>A side channel feeds into the inlet from the RHS. There is a culvert at the property boundary fence that drops the water to the inlet channel. The culvert was in poor condition, and most of the flow was bypassing it. The culvert inlet was surrounded by a wooden fence but the hole where most of the water flows is in open field and the outlet, just upstream of the dam's inlet, was overgrown.</p> | <p>Remove trees from upstream channel (including those that have fallen over) (previous DSI).</p> <p>Clear debris from inlet screen.</p> <p>Repair side channel culvert to control inflows.</p> <p>Investigate the installation of an auxiliary inlet (previous DSI).</p> |  |
| <p>Spillway Channel</p> | <p>The spillway channel was wet during the inspection from recent rainfall. Otherwise, the spillway channel was in satisfactory condition.</p> <p>Fencing within part of the spillway channel about halfway down has the potential to be a restriction during flood operation of the spillway. This should be removed or at the very least pushed back out of the trapezoidal spillway channel.</p> <p>Downstream of the spillway channel there is an open corrugated half pipe with timber headboards to direct flows. This is ineffective as the flow travels underneath this pipe and has scoured large areas under it. This structure is far enough away from the dam to not cause concern but will continue to erode and may wash away in a large flood.</p> | <p>Remove or adjust all fencing from within the spillway channel (previous DSI).</p> <p>Re-design the spillway outlet structure and restore the eroded slope (previous DSI).</p> |  |
| <p>Outlet Structure and Downstream Channel</p> | <p>The culvert outlet structure was partially obscured by a fallen tree on the LHS. This tree (and the rest on the LHS of downstream face mentioned under embankment) should be removed to allow a clear view. A fence should be installed around the outlet structure to prevent people/stock falling in.</p> <p>The water in the outlet was turbid so a clear view of the dissipators and outlet structure floor was not possible. The concrete walls looked to be in satisfactory condition with some minor damage to the end of the LHS wall. Immediately downstream of the outlet structure had a lot of scour, especially of the left bank. Surface drainage from the trees on the LHS of downstream face was entering the stream in the same area and likely contributed to the scour on the left bank.</p> <p>The downstream channel was mostly clear. There were signs of slips along the downstream valley. There is a fence across the stream which had a lot of small debris and was damaged by a fallen tree. The debris and tree should be removed so that flow is not impeded. If possible, the fence should also be removed. The tree narrowly missed falling on the borehole/ gauge. HDC should check which resident owns this instrument and what data they collect.</p> | <p>Remove trees that have fallen over outlet & downstream channel (previous DSI).</p> <p>Reinstate the bank from scour damage and protect further scour at outlet structure (LHS in particular).</p> |  |



**Flood Detention Dams - 2023 Intermediate Dam Safety Review
4 Observations from the Site Inspections**

| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|------------------------------|----------------------------------|------------------|---|
| | | |  |


4.6 School Stream Dam

The School Stream Dam was inspected by Nathan Fletcher & Nicole Langedijk (Stantec) from 9am to 10am on Wednesday 2 August 2023.




Access was gained via Te Mata Peak Road.

Inspection comments, dam safety issues, and key photographs are included in Table 4-5.

Table 4-5: Summary of School Stream Dam Site Inspection



| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|---|--|--|---|
| <p>Reservoir Area, Upstream Channel, and Inlet Culvert</p> | <p>There was evidence of channel erosion in the upstream channel as well as several dead sheep. A patch of bushes and most of the trees in the upstream channel area have withstood the cyclone event. There were some trees that came down and lost their branches, but these were mainly at the abutments. All vegetation and trees near the channel should be removed as they can impact flow and the trees that have fallen should also be removed to prevent them blocking the inlet.</p> <p>The inlet culvert was blocked with debris, including a dead sheep. There was still a small flow passing through the culvert but signs of ponding upstream. The telemetry system that records reservoir level sits on the right of the inlet.</p> | <p>Remove trees from upstream channel (especially those that have fallen over) – previous DSI.</p> <p>Remove vegetation, debris, and dead sheep from upstream channel & culvert inlet.</p> |  |

Flood Detention Dams - 2023 Intermediate Dam Safety Review
 4 Observations from the Site Inspections

| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|------------------------------|---|---|--|
| | | |  |
| <p>Embankment</p> | <p>The dam crest and slopes appeared stable with no signs of instability. The abutments showed signs of slips with material seen on the LHS of the upstream face. Since the ground was wet, the tracks where the owner had traversed to the paddocks were clearly visible and muddy.</p> <p>A cable (most likely pressure sensor cable for depth measurement) had been exposed between the inlet and auxiliary inlet. Measures should be taken to ensure this does not get damaged (e.g., bury it again).</p> <p>The pond upstream of the spillway on the right abutment was high and so a small amount of water was flowing across the toe of the dam towards the inlet. This means that until the pond level goes down, the toe of the dam will remain saturated.</p> <p>The downstream face was in satisfactory condition with large branches and cut up trees scattered at the bottom. These should be removed to prevent damage to the outlet structure.</p> | <p>Monitor the slips on the upstream left abutment for further movement.</p> <p>Protect the exposed telemetry cable below the auxiliary inlet.</p> <p>Remove debris.</p> |   |



Flood Detention Dams - 2023 Intermediate Dam Safety Review
4 Observations from the Site Inspections

| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|---|---|--|---|
| <p>Spillway</p> | <p>A large tree had fallen and was blocking the spillway entrance channel. The large trees around the spillway entrance need to be removed to restore spillway capacity. There were also trees lining the spillway channel that should be removed before their roots do more damage to the spillway structure.</p> <p>The concrete spillway appeared in satisfactory condition but tree roots were starting to lift the panels out of place on the left. The fence with swing gate across the start of the spillway structure is a dam safety issue in large floods, as it will constrict flows. Significant blockage is also likely. Currently the fence/gate does not open easily due to the stiff hinges and grass/debris.</p> <p>The long grass and vegetation around and within the wooden spillway structure obscures the timber which made inspection difficult. The surrounding long grass should be trimmed, and the channel invert cleared out as part of maintenance to allow for visual inspections. From the timber cross supports that could be inspected, a number were cracked or missing and should be replaced.</p> <p>There is a culvert with a small headwall that feeds a side channel into the spillway structure. During the inspection there was only a small amount of water coming through, but there was evidence on the left wall of the spillway structure that more water has passed through. There was some debris and vegetation around the culvert inlet that should be cleared.</p> <p>At the bottom of the wooden spillway structure there was a lot of wood from fallen trees that had been chopped up. This should be removed so that it does not obstruct the flow and become hazards downstream.</p> | <p>Clear trees and vegetation from upstream of, within, and along the sides of the spillway.</p> <p>Clear debris from and monitor the entrance to the side culvert (right side of spillway).</p> |  |
| <p>Outlet Culvert and Downstream Channel</p> | <p>The downstream channel area was flowing and clear, however above the channel flow there were numerous trees, branches, and logs. These represent significant debris and blockage potential and hazards downstream so should be removed. There was also an old trampoline that should be removed.</p> <p>The outlet structure was in satisfactory condition. The invert of the structure was not visible for inspection due to the depth of turbid water.</p> | <p>Remove the trees, large branches, and logs from within the downstream channel area in the vicinity of the dam (previous DSI).</p> <p>Remove the trampoline.</p> |  |




4.7 Te Kahika Dam

The Te Kahika Dam was inspected by Nathan Fletcher & Nicole Langedijk (Stantec) from 4pm to 5pm on Tuesday 1 August 2023.

Access was gained via Tauroa Road.

Inspection comments, dam safety issues, and key photographs are included in Table 4-6.

Table 4-6: Summary of Te Kahika Dam Site Inspection



| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|---|---|--|--|
| <p>Reservoir Area, Upstream Channel, and Inlet Structure</p> | <p>The upstream channel was in a satisfactory condition. There was some erosion damage to the channel from the cyclone. The footbridge has been previously identified in poor condition and should not be used.</p> <p>The reservoir area incorporates a driveway for one of the properties which will be impacted during an extreme flood event (it would have been under a few metres of reservoir for a few hours during the cyclone). There was a large landslide that had washed away the deck of the house in the immediate reservoir area upstream of the dam. The ground should be monitored for further signs of landslides. There were sheep grazing in the upper reservoir area.</p> <p>The vertical auxiliary inlet structure was in satisfactory condition. There was some vegetation around the inlet and concrete channel that should be removed to keep the capacity of the inlet.</p> <p>No issues were identified with water previously appearing to be seeping in various places (mainly at joints) on the right concrete slope of the upstream channel. But with wetter conditions on the day this would have been harder to detect. This should be monitored in future inspections for any issues.</p> | <p>Clear the upstream channel and inlet of vegetation and remove the branch across the inlet (previous DSI).</p> <p>Remove trees from upstream channel (previous DSI).</p> |  |

Flood Detention Dams - 2023 Intermediate Dam Safety Review
4 Observations from the Site Inspections

| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|------------------------------|--|--|---|
| <p>Embankment</p> | <p>The crest was in satisfactory condition, with the road and kerb showing no signs of erosion or displacement.</p> <p>The upstream slope was covered in short grass and was in satisfactory condition, with no obvious movement or settlement but the downstream slope was covered in long grass that obstructed inspection.</p> <p>Two of the standpipes at the downstream toe were inspected but the rest were not located in the long grass. These standpipes are not monitored and a previous recommendation was for reinstatement and monitoring of the standpipes to determine groundwater level. If the standpipes are blocked then some work may need to be done to reinstate them.</p> <p>There was a wet patch on the right abutment behind the spillway. The cause was not determined but most likely a hose left on or pipe leak from one of the hose connections. This is likely far enough away from the spillway/dam to not be a concern, but it was near a transformer which poses a potential risk to the residents and public.</p> <p>On the downstream left abutment was debris from a slip from across the road. This should be monitored for changes and impacts on the embankment.</p> | <p>Investigate the purpose of and consider reinstatement of the downstream toe standpipes and plan future monitoring as part of the Dam Safety Management System (previous DSI).</p> <p>Review and monitor changes to the slip material that has flowed down the downstream left abutment of the embankment.</p> |  |
| <p>Spillway</p> | <p>The concrete section of the spillway was in similar condition to previous inspections and was satisfactory. There was a lot of grass growing on the concrete spillway which could be hiding damage/issues. The invert of the spillway should be cleared of vegetation.</p> <p>The gate across the top of the spillway (under the bridge) has been modified to swing in the direction of flow, but functionality in an extreme flood is uncertain. Significant established trees and plants are located along both sides of the timber spillway channel. These have caused issues for the structure such as the buckling of members and sides, and deterioration of the structure as well as making inspections difficult. The remaining recommendations to replace and strengthen elements of the wooden structure (2018 Stantec structural assessment) should be re-assessed (hydraulic and structural capacity) given the time that has passed since that review and any repairs or upgrades completed, as well as removal of the rest of the trees along each side of the spillway which have contributed to maintenance issues. Note that a timber spillway is not a particularly robust means of conveyance, and it is likely to be damaged during operation. This needs to be considered in the re-assessment.</p> <p>The side inlet culvert (RHS spillway) that runs under the driveway upstream of the bridge had a number of holes and the outlet was covered in overgrown vegetation. The vegetation should be cleared and pipe checked for any obstructions or damage.</p> | <p>Remove or relocate the gate from across the start of the spillway structure (previous DSI).</p> <p>Re-assess spillway condition and its appropriateness (previous DSI).</p> <p>Clear remaining trees/vegetation from the sides of the spillway and vegetation from the invert (previous DSI).</p> |  |



Flood Detention Dams - 2023 Intermediate Dam Safety Review
 4 Observations from the Site Inspections

| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|---|--|--|--|
| | | |  |
| <p>Outlet Culvert and Downstream Channel</p> | <p>The outlet culvert structure was in satisfactory condition and was clear at the outlet and within the stilling basin. The view of the outlet structure was partially obscured by vegetation growing on the right side of the outlet structure. There is already a small fence/barrier above the outlet structure which could be improved to prevent falls into the outlet.</p> <p>The flow was low enough to allow view of the dissipation blocks which seemed in satisfactory condition. There was some sediment sitting in the stilling basin.</p> <p>The downstream channel has been landscaped into a picnic area with new trees planted. As long as the new trees are not planted in an area that will impact large flows, this is acceptable. The public should be aware of the dam and any potential consequences from heavy rainfall and floods.</p> <p>The vegetation around the confluence of spillway with outlet should be cleared to improve the outflow capacity. There were signs of some erosion in the downstream channel, especially at the spillway outlet. The channel should be monitored for further erosion and may require rip rap if more damage occurs.</p> | <p>Clear the vegetation from the RHS of the outlet structure to allow better view for inspections (previous DSI).</p> |  |


4.8 Mangarau Dam

The Mangarau Dam was inspected by Nathan Fletcher & Nicole Langedijk (Stantec) with guidance from Tony Dench (HDC) from 3pm to 4pm on Tuesday 1 August 2023.



Access was gained via 21A Toop Street.

Inspection comments, dam safety issues, and key photographs are included in Table 4-7.

Table 4-7: Summary of Mangarau Dam Site Inspection



| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|--------------------------------|---|--|--|
| <p>Spillway Channel</p> | <p>The spillway channel was being used as an access road by the developer of the adjacent subdivision and the plans seem to show the spillway channel acting as a driveway for the completed development. This should be discussed with the developer as it would affect access during flood events and spillway operation.</p> <p>The developer had installed temporary silt fences along the right side of the spillway channel which were damaged due to flow from the spillway operation in the cyclone. There was also a silt curtain across the channel which will block flow down the spillway and should be removed.</p> <p>The spillway channel was lined with trees and fences which will reduce flow capacity. Some of the obstructions are still within the roughly trapezoidal channel where the majority of the flow passes through. These should be removed or at least pushed back out of the main channel.</p> <p>Some scour was evident at the top of the channel where the stream flows under the spillway (in a culvert) which suggests this stream overtopped and flowed down the spillway channel. The developer has already made efforts to restore the spillway channel as the access road, but if this is used as a driveway in the future, the residents should be aware of this and the possible operation of this channel in flood events which may prevent them access during and after the event.</p> <p>The concrete sill at the spillway crest was in satisfactory condition. The surrounding grass should be maintained shorter and the electric fence across the channel removed.</p> | <p>Remove the electric fence from across the spillway structure and silt curtains across the spillway channel.</p> <p>Remove the vegetation, trees, and adjust fences from within the spillway channel (previous DSI).</p> <p>Remove silt fences and silt from along the side of the spillway channel once development is completed (previous DSI).</p> |  |

Flood Detention Dams - 2023 Intermediate Dam Safety Review
 4 Observations from the Site Inspections

| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|---------------------------------|---|---|--|
| <p>Upstream Channels</p> | <p>The side channel culvert that runs under the spillway (downstream to upstream) to the dam's upstream channel has undergone upstream works since the last inspection. The culvert inlet now has a concrete pad (~1m long) with waratahs at the upstream end to catch large debris and horizontal bars across the inlet for any debris the waratahs do not capture. The developer may have completed these improvements, without consulting the council, after the Cyclone Gabrielle event where water from this stream overtopped and flowed down the spillway channel. There is still a chance for overtopping if the loose fencing in the upstream channel were to catch on the waratahs and block the culvert. The scruffy dome of the outlet has not been fixed since the last inspection, but the surrounding rock channel does not seem worse. The condition of the flap gate is unknown.</p> <p>The main upstream channel, just upstream of the inlet, was scoured in places and had a few large branches and trees lying on the banks. Some of the fallen trees in the reservoir area have been chopped into smaller pieces, but not yet removed. Vegetation is still a concern and should still be monitored. There is a build-up of silt on the channel banks and sand in the stream bed.</p> | <p>Maintenance of the side channel outlet and restore the scruffy dome to correct position. Investigate the flap gate (previous DSI).</p> <p>Discuss improvements with developer and investigate rip rap for spillway above side channel inlet.</p> <p>Clear sediment build up in the channel just upstream of the inlet.</p> <p>Remove trees from upstream channel especially those that have fallen over.</p> |  <p>The top photograph shows a person in an orange safety vest standing on a grassy slope next to a culvert outlet. A blue corrugated metal structure is visible in the background. The bottom photograph is a close-up of a circular, wire-mesh dome structure partially buried in a rocky channel.</p> |
| <p>Embankment</p> | <p>The downstream embankment area was generally in satisfactory condition. The grass was overgrown which made it difficult to spot any issues like animal burrows. There was no stock present and various fences ranging from fair to poor condition run across the dam embankments. Some areas of the crest were in poor condition from previous stock use and these areas should be repaired (i.e., backfilled and grassed over).</p> <p>There was a slight line (~1 m) on the downstream face that suggests a slump but no indication of further movement and appeared stable at the time of inspection. There were stringlines set up down the left abutment along the garden edge. It is worth keeping communication with the residents to understand future development of the land.</p> <p>The upstream embankment had a patch of scorched earth. This is not a significant issue but is a good reminder of the public's access and misuse of the dam.</p> <p>Some evidence was still visible as to the level of storage during the cyclone, with vegetation/debris on the upstream slope and fence lines.</p> | <p>Remove fences and clear vegetation across the dam area. Repair damaged areas such as erosion across the crest (previous DSI).</p> <p>Monitor for changes to the slump on the downstream slope.</p> |  <p>The photograph shows a wide view of the dam embankment. In the foreground, there is a grassy slope with a visible line of slump. Fences run across the embankment. In the background, there are trees and a blue sky with some clouds.</p> |



Flood Detention Dams - 2023 Intermediate Dam Safety Review
4 Observations from the Site Inspections

| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|---|---|---|--|
| <p>Inlet Structure</p> | <p>The inlet had a lot of debris built up on the screen. This debris is blocking the inlet so needs to be removed. The inlet should also be monitored for any significant sediment build up that could also block flow.</p> <p>The vertical auxiliary inlet structure appeared in satisfactory condition.</p> | <p>Clear debris from the inlet screen.</p> |  |
| <p>Outlet Structure and Downstream Channel</p> | <p>The outlet structure appeared in reasonable condition with some sediment deposits in the stilling basin. The trees at the end of the stilling basin had managed to survive even though scour had exposed their roots. These trees are at great risk of falling and should be removed to prevent damage.</p> <p>The downstream channel showed signs of scour but has had significant upgrades to make a public pathway and bank repairs following the cyclone. There were a couple of fences and picnic tables on the left bank as well as an eel feeding shelter. The planting and regeneration along the left bank are acceptable but will require ongoing maintenance.</p> <p>On the right bank, the developer had installed a silt curtain across the lower spillway channel where it would flow back into the stream. This silt curtain will hinder flow and so should be removed, and an alternative solution found that will not block flow.</p> | <p>Remove trees from the ends of the outlet structure (stilling basin) (previous DSI).</p> <p>Remove silt curtain blocking the spillway channel where it flows back into the stream. Discuss alternatives with the developer.</p> |  |




4.9 Here Here Dam

The Here Here Dam was inspected by Nathan Fletcher & Nicole Langedijk (Stantec) with guidance from Tony Dench (HDC) at 1pm to 2pm on Tuesday 1 August 2023.



Access was gained via Margaret Avenue.

Inspection comments, dam safety issues, and key photographs are included in Table 4-8. Refer to Appendix H for additional photographs.

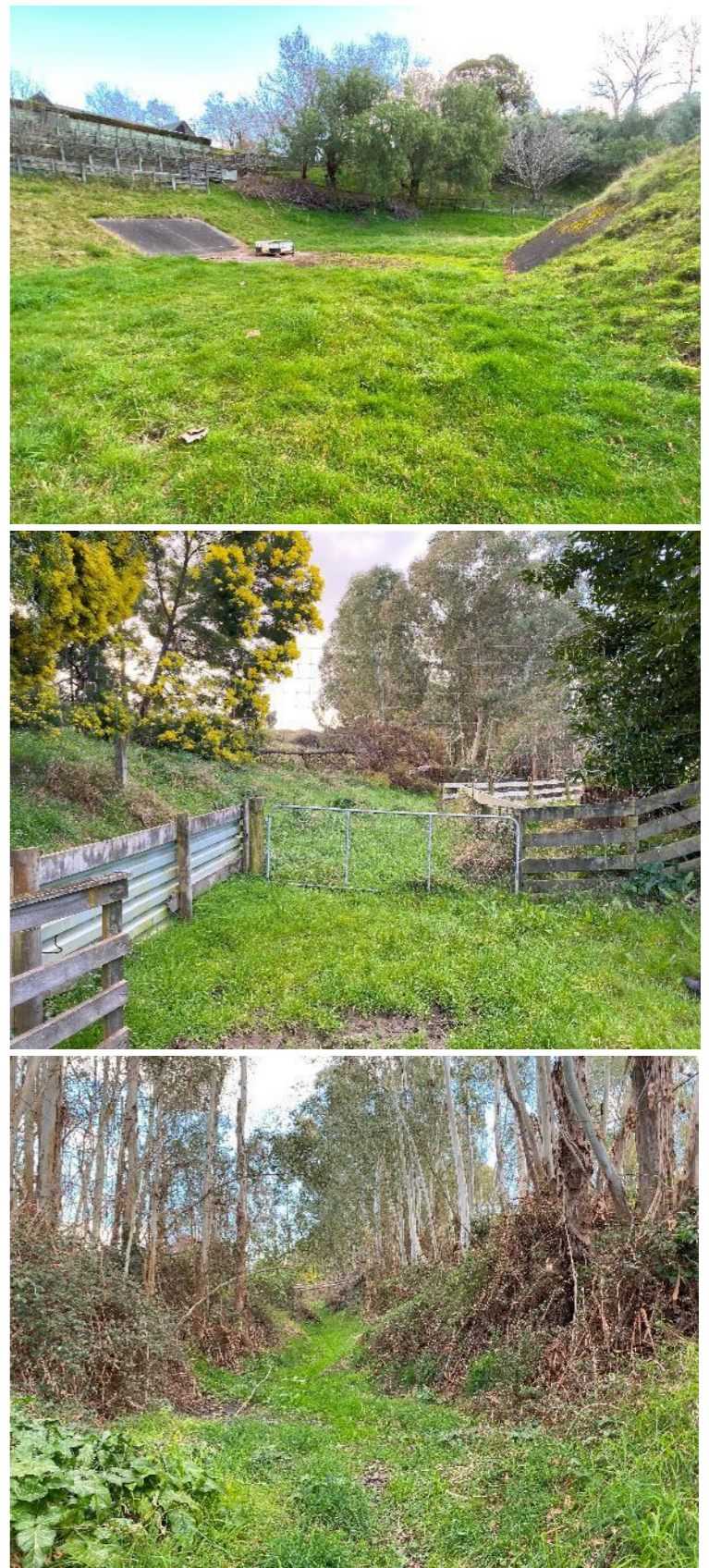
Table 4-8: Summary of Here Here Dam Site Inspection

| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|---|---|---|--|
| <p>Reservoir Area and Upstream Channel</p> | <p>The reservoir area was clear and open and contains mostly open pasture, surrounded by trees. There was a noticeable layer of silt in the reservoir area. Some large fallen trees had been chopped into smaller pieces but not yet removed and others have just been left. These are potential debris that could block the inlet.</p> <p>The boundary fence had a lot of debris caught in the wire and the left side fence looked new so was likely replaced. Upstream of the fence, a power line pole appeared to have fallen.</p> <p>The culvert/bridge upstream of the inlet structure was still stable. The timber supports were in similar condition to previous inspection in that some of them are broken or damaged and could deteriorate quickly. There was evidence of scour behind the timber supports on the left downstream corner. The vegetation, especially upstream, had mostly been cleared by scour and slumping of the channel banks. The flap gate was still hanging loose on the left side. The reason for this access bridge is unknown.</p> | <p>Remove trees and branches from around the upstream channel, especially those that have already fallen and may block the inlet (previous DSI).</p> |  |

Flood Detention Dams - 2023 Intermediate Dam Safety Review
4 Observations from the Site Inspections


| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|-------------------------------|---|---|--|
| <p>Inlet Structure</p> | <p>The culvert appeared in satisfactory condition as could be viewed from the upstream end with a torch. A CCTV review of the culvert should be done to check if there is any damage or misalignment. The auxiliary inlet needs repair and strapped down as the top section had lifted and been knocked out of alignment. The inlet was partially blocked by debris on the screen which has also allowed some sediment to build up in front of the inlet. The debris should be cleared.</p> <p>The large trees upstream of the inlet structure should be removed before they start causing issues at the inlet structure.</p> | <p>Complete wider tree clearance around the inlet, especially the left abutment (previous DSI).</p> <p>Repair the auxiliary inlet and secure so that pipe section cannot be displaced again. Investigate all auxiliary inlets on the other dams for similar design flaws.</p> <p>Clear debris from inlet screen.</p> |  |
| <p>Embankment</p> | <p>The upstream face was in satisfactory condition with stable slopes. There were no obvious signs of movement or settlement across the dam crest.</p> <p>The downstream face was similar to the upstream face and crest. The trees on the downstream left and right abutments were close to encroaching on the embankment which could lead to penetrating roots. These trees should be removed.</p> | <p>Remove the trees from the downstream left and right abutment areas (previous DSI).</p> |  |

Flood Detention Dams - 2023 Intermediate Dam Safety Review
4 Observations from the Site Inspections

| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|------------------------------|---|--|--|
| <p>Spillway</p> | <p>The concrete sill was in satisfactory condition. There were animal troughs (large buckets) left around the spillway channel that should be removed.</p> <p>The wooden fence and trees along the left side of the channel should be removed, as they have encroached on the trapezoidal channel and will impact on flow capacity during operation. The fence can just be moved a few meters up the hill and out of the channel if the purpose is still important. The trees outside of the channel should be removed or at least well maintained so that they cannot fall into the spillway.</p> <p>At the downstream end of the trapezoidal spillway channel, a gate was located across the spillway (as per previous inspections). This gate and the surrounding fencing should be removed to keep the full capacity of the spillway available. The little shed/ hen house had been moved up to the left bank since the last inspection.</p> <p>The house on the right side of the spillway should be checked against flood levels when the spillway is in use (previous CDSR DSI). At the very least, the house may be cut off so residents should be prepared.</p> <p>The downstream spillway channel drops down steeply from the house and the channel is narrower. There was a small trickle of water during the inspection, likely due to wet ground. There was a lot of vegetation in this area which could be removed or at least maintained to prevent more fallen trees and tree stumps blocking the channel.</p> <p>There is more fencing where the spillway meets back with the stream that was covered in debris. Since the spillway was operating during the Cyclone Gabrielle event, the debris must have come from the stream itself which suggests a large flow or that the stream was blocked.</p> | <p>Complete maintenance in the spillway channel (clear trees and vegetation and move wooden fence on left side) (previous DSI).</p> <p>Remove/alter the fence and gate at the downstream end of the trapezoidal channel (previous DSI).</p> <p>Remove vegetation & fallen trees in the downstream spillway channel.</p> |  |



Flood Detention Dams - 2023 Intermediate Dam Safety Review
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| Dam or Appurtenant Structure | Key Site Inspection Observations | Dam safety issue | Photograph |
|---|---|---|---|
| <p>Outlet Structure and Downstream Channel</p> | <p>The downstream channel was scoured in a few places but generally in satisfactory condition. There was some fencing and a small bridge that had a build-up of debris and should be removed to allow flow downstream.</p> <p>The stilling basin was generally in satisfactory condition but one of the dissipators had been sheared off and there was some build-up of sediment on the right side of the stilling basin. The vegetation seen in the previous inspection has been washed away. The reverse-flap gate (corrugated iron sheet) was in poor condition but still serves its purpose (presumably for stock exclusion).</p> <p>There were some small vertical holes behind the left wall of the outlet structure that cannot be explained. They were too uniform for animals, and it was difficult to determine the depth. Downstream of the outlet structure there was some scour of the stream banks.</p> | <p>Repair the dissipation block that had been damaged.</p> |  |

5 Routine Inspections and Maintenance

Routine inspection and maintenance is carried out on a regular basis by contractors engaged by HDC. Ongoing maintenance relates to the removal of vegetation growth and accumulated sediments upstream and downstream of the throttle culverts and maintaining a clear spillway channel for the safe passage of flood flows. The presence of accumulated sediments, debris, vegetation, and potentially unstable slopes in the approach channels relate to a higher likelihood that the culverts may become blocked during flood events. The removal and maintenance of vegetation also assists visual inspection during the routine and annual inspections.

The ground had been too wet since Cyclone Gabrielle to get the contractors machinery in to clear debris and sediment from the inlets. Also, the frequency of contractors for maintenance has been unpredictable due to the contractors generally being resource constrained and repairing damage from the Cyclone.

The maintenance aspects across all the dams are outlined in the OMS Manual. The maintenance contractor currently completes a visual checklist at the various dam inspections undertaken during maintenance visits.

HDC should consider fences/barriers around inlet/outlet structures to prevent falls (to protect livestock and people that may be in the area, during dam inspections).

Special inspections should be completed as per the OMS Manual (i.e., after rainfall of greater than 100 mm in a 24-hour period or after an earthquake with Modified Mercalli Intensity 5 or greater, although typically earthquakes will be a lower priority as the likelihood of this coinciding with a large flood are very low). There were no earthquakes above Magnitude 5 recorded in the Hawkes Bay region in the period between the 2022 IDSR and 2023 dam inspections. Some consulting engineers (T+T) looked at the Havelock North dams after Cyclone Gabrielle while they were in the area and found no major issues other than blocked inlets, but the auxiliary inlets were still operational. This IDSR forms a more complete record of the inspections and data following the cyclone, along with the 2023 report on the performance of the Havelock North dams from the cyclone event.

Data is collected for the Havelock North dams. The summary of water levels and rainfall for the Havelock North dams is outlined and discussed in the Section 6. The Cyclone Gabrielle event was assessed and summarised in the Cyclone Gabrielle HDC Havelock North Dams Flow Analysis Summary Report.



6 Reservoir Level & Rainfall Data (Havelock North Dams)

HDC record water levels and rainfall at each of the Havelock North flood detention dams. Water levels are recorded hourly and records extend back to June 2007. Table 6-1 and the figures in this section show the (10-minute) rainfall and water levels for the past year – the focus period of this IDSR.

Table 6-1: Summary of Maximum Dam Water Levels (July 2022 – August 2023)

| Dam | Maximum Water Level (m) [^] | Maximum Water Level (m) during Cyclone Gabrielle | Approximate Dam Height (m)* (and % height filled during cyclone) |
|---------------|--------------------------------------|--|---|
| Karituwhenua | 1.0 | 5.6 | 8.8 (64) |
| School Stream | 2.1 | 7.9 | 12.1 (65) |
| Te Kahika | 1.3 | 8.1 | 12.0 (68) |
| Mangarau | 2.0 | 11.3 | 12.5 (90) |
| Herehere | 1.2 | 10.7 | 12.5 (86) |

[^]In the period since the last Dam Safety Review (IDSR, August 2022), excluding Cyclone Gabrielle.

*Difference between dam crest level and invert of culvert inlet (from 2015 survey).

As can be seen in Table 6-1, Cyclone Gabrielle brought the reservoir levels to approximately 64-86% of the dam heights for the Havelock North dams, and in the case of Mangarau exceeded the spillway level.

For more detailed assessment of the dams during the cyclone, reference can be made to the 2023 summary report.

The gauges and telemetry systems have not been checked for a long time and should be recalibrated. At School Stream there is an exposed cable that is suspected to be part of the telemetry system and should be protected. There is a chance that the cable is already damaged and could be from the rainfall gauge which recorded as zero for the whole year. The HDC data recording system is undergoing an upgrade. As part of this, HDC are going to investigate if it is possible to increase the frequency of readings when a certain reservoir level is reached as well as set alarm points.

This system seems to be performing well but has not been calibrated in a long time. If possible, increase the frequency of readings to say 15 minutes for more accurate data in floods. The system should also have alarms where notification is given for set rainfall and reservoir levels.

**Flood Detention Dams - 2023 Intermediate Dam Safety Review
6 Reservoir Level & Rainfall Data (Havelock North Dams)**

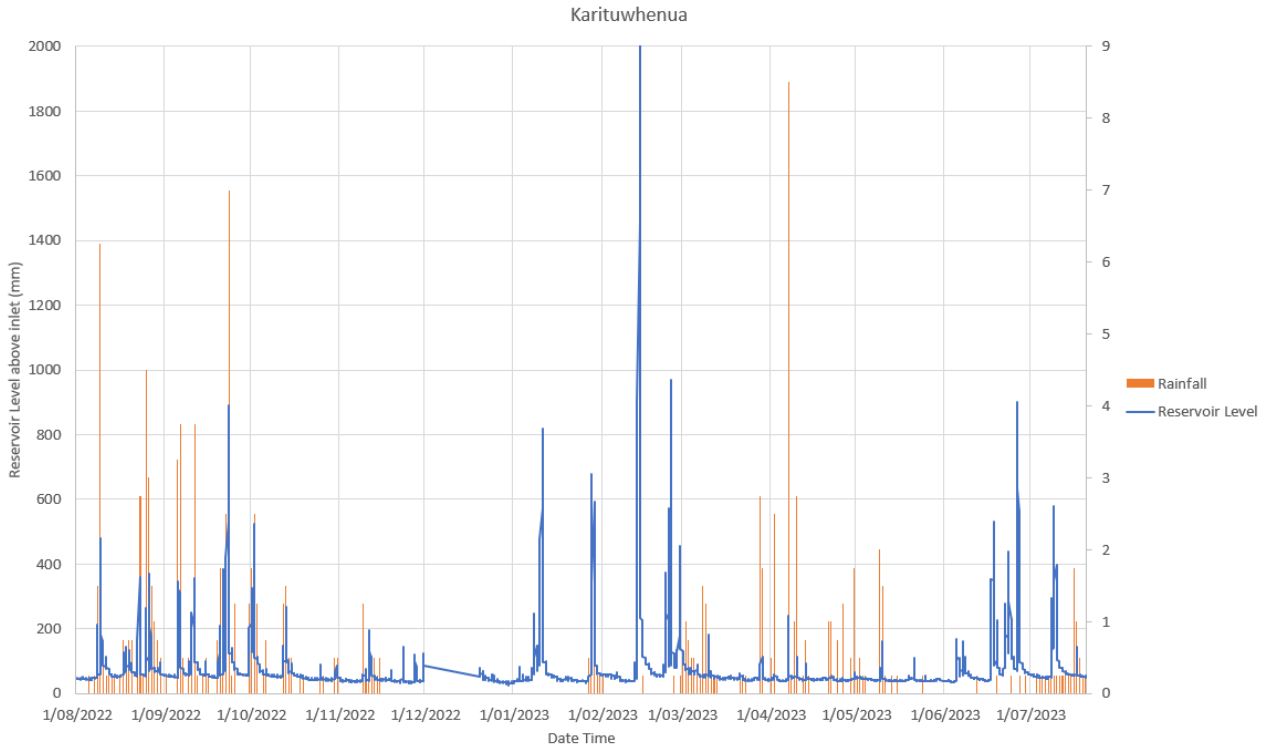


Figure 6-1: Karituwhenua Dam Water Levels and Rainfall (July 2022 – August 2023)

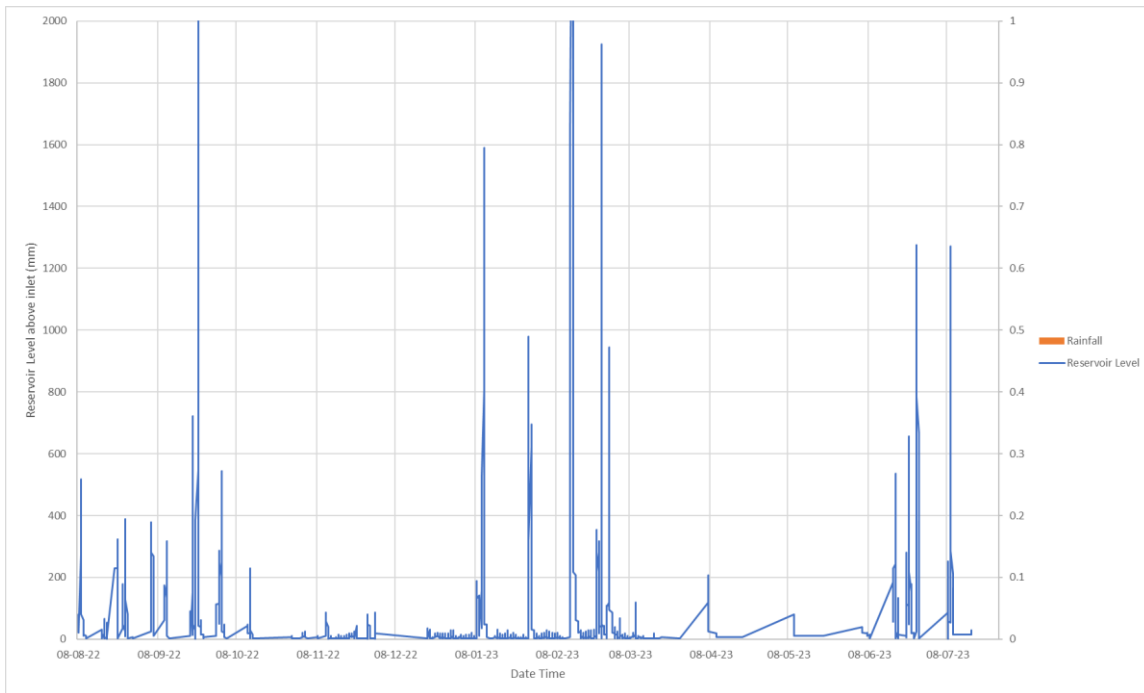


Figure 6-2: School Stream Dam Water Levels (July 2022 – August 2023)



**Flood Detention Dams - 2023 Intermediate Dam Safety Review
6 Reservoir Level & Rainfall Data (Havelock North Dams)**

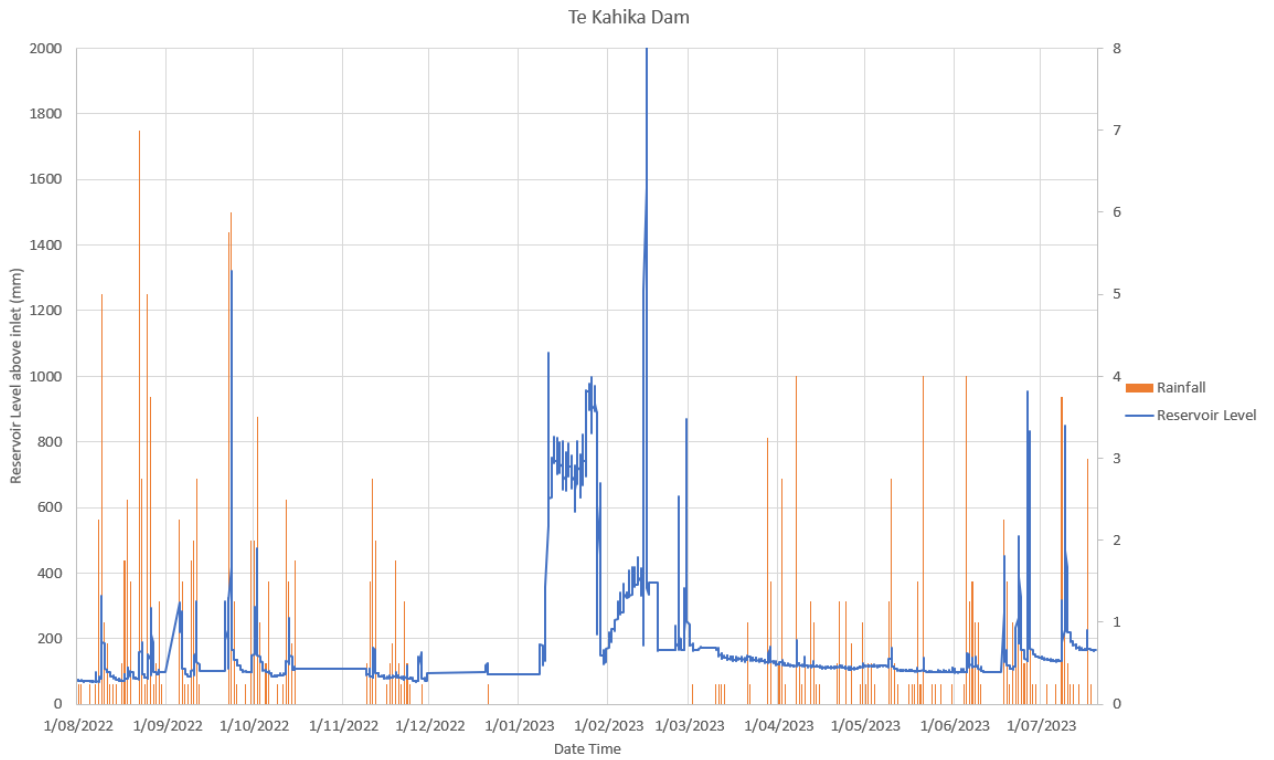


Figure 6-3: Te Kahika Dam Water Levels and Rainfall (July 2022 – August 2023)

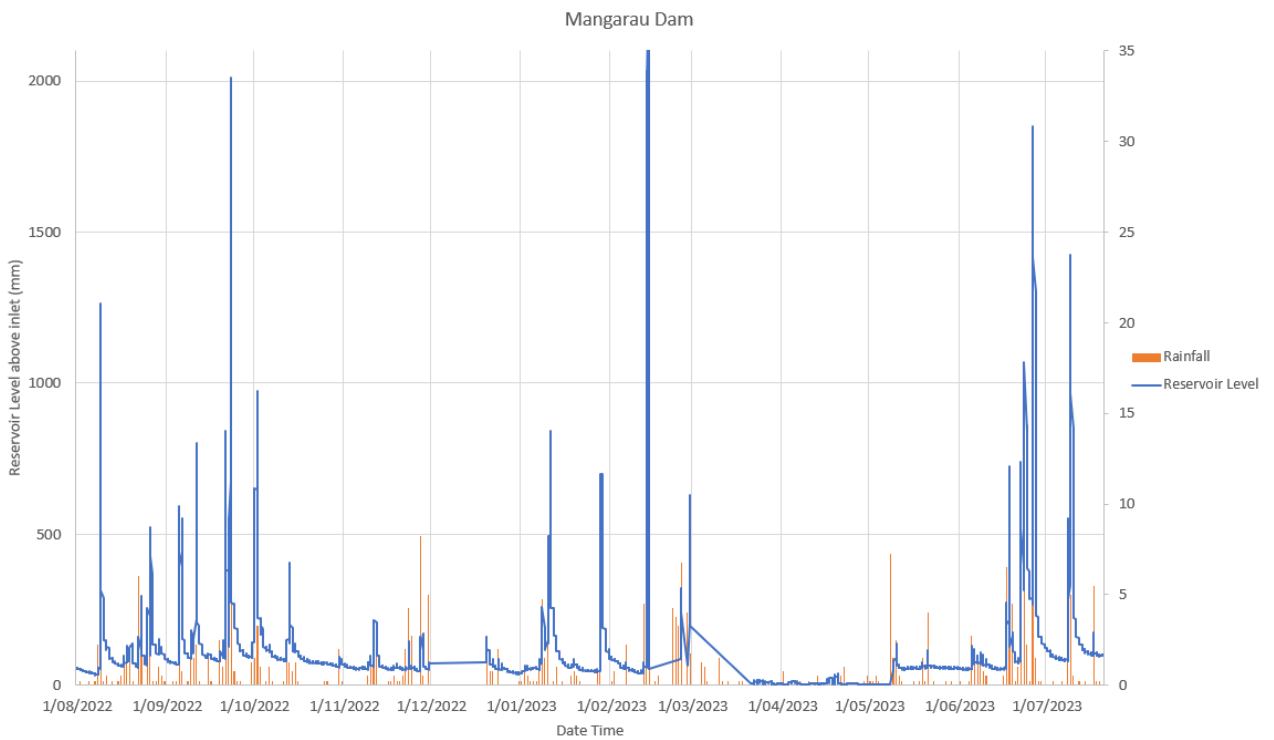


Figure 6-4: Mangarau Dam Water Levels and Rainfall (July 2022 – August 2023)



**Flood Detention Dams - 2023 Intermediate Dam Safety Review
6 Reservoir Level & Rainfall Data (Havelock North Dams)**

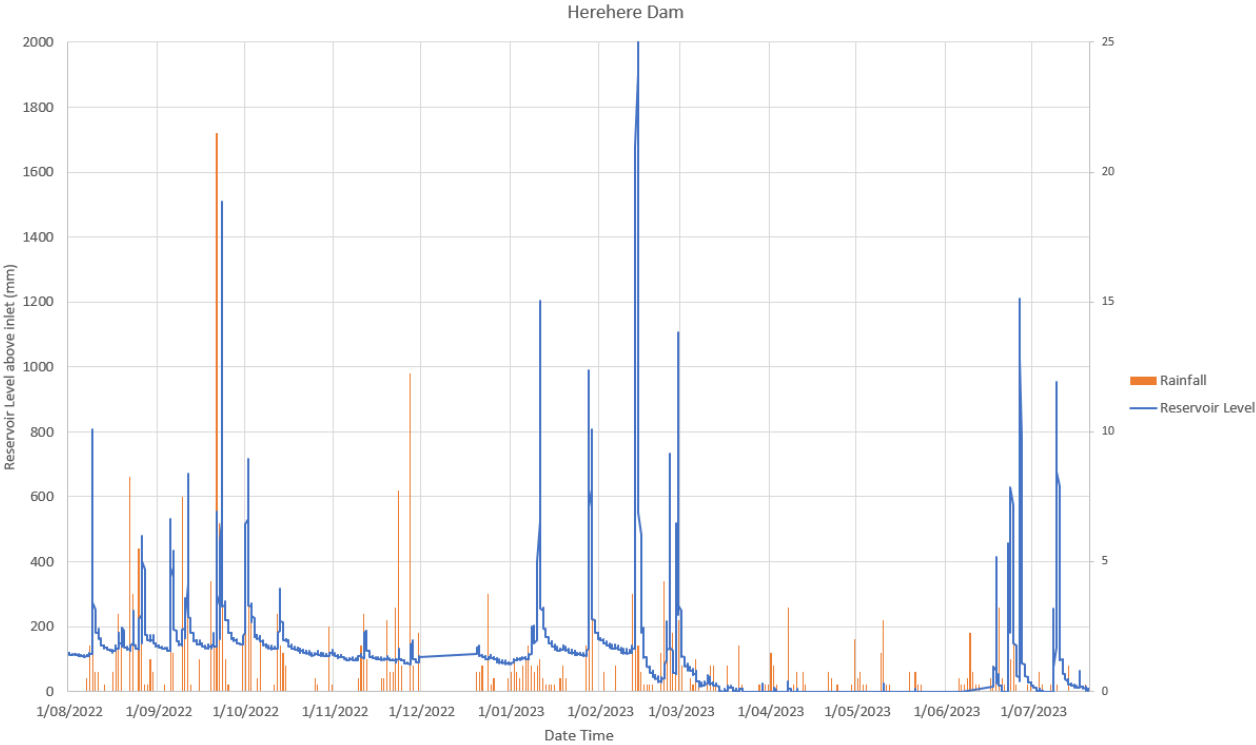


Figure 6-5: Herehere Dam Water Levels and Rainfall (July 2022 – August 2023)



7 Dam Safety Issues

7.1 Resource Consent Conditions

The following Resource Consents (Water Permit), from Hawke's Bay Regional Council (HBRC) are in place for the dams:

Table 7-1: HDC Dams – Resource Consents Summary

| Resource Consent No. | Dam/Location | Details | Conditions | Comments |
|-----------------------|---|---|--|-----------------------------------|
| WP990304M & DP990305W | Mangarau Pufflett Road Havelock North. | Dam the Mangarau Stream. Dam Height = 14 m. Volume of reservoir = 450,000 m ³ . Discharge water from the dam into the original water course. Consent duration = expiring 31 May 2034 (dated 9 July 1999). | <p>All works and structures relating to this resource consent shall be designed and constructed to conform to the best engineering practices and at all times maintained to a safe and serviceable standard.</p> <p>The consent holder shall undertake all operations in accordance with any drawings, specifications, statements of intent and other information supplied as part of the application for this resource consent. In the event that there is conflict between the information supplied with the application and any consent condition(s), the conditions(s) shall prevail.</p> <p>The consent holder shall carry out an annual inspection of the dam and forward a copy of the inspection report to the Regional Council (Environmental Regulation section), within a month of the inspection taking place.</p> <p>Review of Consent Conditions by the Council during the months of June 2009, June 2019, and June 2029.</p> | Consent conditions are being met. |
| WP990306M & DP990307W | Here Here Lane Road and Margaret Avenue Havelock North | Dam the Herehere Stream. Dam Height = 13 m. Volume of reservoir = 250,000 m ³ . Discharge water from the dam through a 1,600 mm diameter pipe into the original water course. Consent duration = expiring 31 May 2034 (dated 9 July 1999). | | Consent conditions are being met. |
| WP990310M & DP990311W | Te Kahika Tauroa Road Havelock North. | Dam the Te Kahika Stream. Dam Height = 14 m. Volume of reservoir = 194,200 m ³ . Discharge water from the dam through a 900 mm diameter pipe into the original water course. Consent duration = expiring 31 May 2034 (dated 9 July 1999). | | Consent conditions are being met. |
| WP990312M & DP990313 | Karituwhenua Durham Drive Havelock North. | Dam the Karituwhenua Stream. Dam Height = 9 m. Volume of reservoir = 41,750 m ³ . Discharge water from the dam through a 900 mm diameter pipe into the original water course. Consent duration = expiring 31 May 2034 (dated 9 July 1999). | | Consent conditions are being met. |

Flood Detention Dams - 2023 Intermediate Dam Safety Review
7 Dam Safety Issues

| Resource Consent No. | Dam/Location | Details | Conditions | Comments |
|-----------------------|---|---|---|-----------------------------------|
| WP990554M & DP990566W | School Stream Te Mata Peak Road Havelock North. | Dam the School Stream. Dam Height = 10.5 m. Volume of reservoir = 150,000 m ³ . Discharge water from the dam through a 750 mm diameter pipe into the original water course. Consent duration = expiring 31 May 2034 (dated 31 January 2000). | <p>All works and structures relating to this resource consent shall be designed and constructed to conform to the best engineering practices and at all times maintained to a safe and serviceable standard.</p> <p>The consent holder shall undertake all operations in accordance with any drawings, specifications, statements of intent and other information supplied as part of the application for this resource consent. Specially this includes. In the event that there is conflict between the information supplied with the application and any consent condition(s), the conditions(s) shall prevail.</p> <p>The consent holder shall give the Council's Environmental Regulation section at least two working days notice of the intention to commence the works, and shall advise the Council of having finished the works immediately following their completion.</p> <p>The consent holder shall take all practical measure to limit the amount of sediment entering the water during construction. This includes minimising the use of machinery in the stream.</p> <p>Exposed surfaces shall be grassed or planted upon completion of the works and disturbed areas restored to a similar or better state than existed prior to commencement of the works.</p> <p>Machinery operating in the stream shall be adequately maintained so as to avoid the leaking of oil or any other contaminant, and the refuelling of that machinery shall not take place in the bed or in any position where spills may enter the stream.</p> <p>At the completion of any works all debris and rubbish shall be removed.</p> <p>The consent holder shall carry out an annual inspection of the dam and forward a copy of the inspection report to the Regional Council (Environmental Regulation section), within a month of the inspection taking place.</p> <p>Review of Consent Conditions by the Council = during the months of June 2009, June 2019, and June 2029.</p> | Consent conditions are being met. |



Flood Detention Dams - 2023 Intermediate Dam Safety Review
7 Dam Safety Issues

| Resource Consent No. | Dam/Location | Details | Conditions | Comments |
|---|--|--|---|--|
| WP100264M, WP100265D, LU100306C, LU1003070V and DP100308W | Lower Te Awanga 252 Clifton Road Te Awanga | Dam structure, culvert and a pipe in the bed of an unnamed tributary of the Maraetotara River (known as the Te Awanga Stream). Divert Te Awanga Stream into a 1,050 mm pipeline. Discharge water from a reservoir, via a pipe, to the Maraetotara River. Consent duration (WPs/DP) = expiring 31 May 2045 (dated 16 November 2010). | Post Construction: On completion of the works, the bed of the waterbody shall be restored to no lesser state than it was before the works commenced. The consent holder shall ensure that at the completion of the works, any newly established surfaces and any grassed or vegetated areas that were cleared or damaged as a result of the activity, excluding the reservoir area, are re-vegetated in order to prevent sediment from entering the stream. Upon completion of the works, the consent holder shall submit a dam monitoring and maintenance plan to the satisfaction of Council (Manager Compliance), see advice note. The plan shall include but not limited to: a). An outlined of the methodology of the annual inspection and inspection report as required by Condition 20 below; b). The guidelines of the Auckland Regional Council Technical Publication entitled 'TP109'. The consent holder shall carry out an annual inspection of the dam and a copy of the inspection report shall be sent to the Council (Manager Compliance) within one month of the date of the inspection. Any maintenance issues identified in the inspection report shall be addressed within three months of the date of the inspection and be to the satisfaction of the Council (Manager Compliance). Review of Consent Conditions by the Council = during the month of May, of any year. | This is the annual inspection report.. |



Flood Detention Dams - 2023 Intermediate Dam Safety Review

7 Dam Safety Issues

7.3 IDSR Dam Safety Issues

Listed in Table 7-2 is the new (2023) Dam Safety Issues for each dam. Previous issues which are still valid are included in Table 7-3.

The Dam Safety Issues are separated into the following categories:

1. Physical infrastructure issues (PI).
2. Potential dam safety deficiency (PDSD).
3. Confirmed dam safety deficiency (CDSD).
4. Non-conformances (NC). These are where dam safety management system processes and procedures have not been followed or established dam safety practices have not been implemented.

Table 7-2. 2023 IDSR Dam Safety Issues

| Reference Number | Report Reference | Description | Category | Comments |
|------------------|------------------|---|----------|--|
| 2023-ALL-1 | S4 | Calibrate telemetry system. Increase the number of reservoir level readings taken, especially during flood events. | PDSD | HDC to investigate while system undergoing upgrades. |
| 2023-UTA-1 | S4.3 | Clear the vegetation from the concrete manhole at the back of 367 Clifton Road. Raise the manhole so that the manhole lid sits above the ground. Backfill the holes around the manhole. | PI | |
| 2023-UTA-2 | S4.3 | Clear the vegetation from the outlet to inspect rip rap and determine if repairs are needed. | PI | |
| 2023-UTA-3 | S4.3 | Repair the hole at the base of the lower gabion wall. | PI | |
| 2023-UTA-4 | S4.3 | Monitor the bulges in the gabion walls for movement / further disfigurement. Consider adding a second row of gabions for improved stability. | PI | |
| 2023-KW-1 | S4.5 | Investigate repair of the side channel culvert. | PI | |
| 2023-KW-2 | S4.5 | Reinstate the bank from scour damage and protect further scour at outlet structure (LHS in particular). | PI | |
| 2023-SS-1 | S4.6 | Remove vegetation, debris, and dead sheep from upstream channel & culvert inlet. | PI | |
| 2023-SS-2 | S4.6 | Monitor the slips to see if there is any movement. | PI | |
| 2023-SS-3 | S4.6 | Protect the exposed cable below the auxiliary inlet. | PI | |
| 2023-SS-4 | S4.6 | Clear trees and vegetation from upstream of, within, and along the sides of the spillway. | PI | |
| 2023-SS-5 | S4.6 | Clear debris from and monitor the entrance to the side culvert (right side of spillway). | PI | |
| 2023-SS-6 | S4.6 | Remove or relocate the trampoline. | PI | |



Flood Detention Dams - 2023 Intermediate Dam Safety Review

7 Dam Safety Issues

| Reference Number | Report Reference | Description | Category | Comments |
|------------------|------------------|---|----------|----------|
| 2023-TK-1 | S4.7 | Review and monitor changes to the slip material that has flowed down the downstream left abutment of the embankment. | PI | |
| 2023-M-1 | S4.8 | Remove the electric fence from across the spillway structure and silt curtains across the spillway channel. | PI | |
| 2023-M-2 | S4.8 | Discuss improvements with developer and investigate rip rap for spillway above side channel inlet. | PI | |
| 2023-M-3 | S4.8 | Monitor sediment build up in the channel just upstream of the inlet. | PI | |
| 2023-M-4 | S4.8 | Remove trees from upstream channel especially those that have fallen over. | PI | |
| 2023-M-5 | S4.8 | Monitor for changes to the slump on downstream slope. | PI | |
| 2023-M-6 | S4.8 | Clear debris from the inlet screen | PI | |
| 2023-M-7 | S4.8 | Remove silt curtain blocking the spillway channel where it flows back into the stream. Discuss alternatives with the developer. | PI | |
| 2023-HH-1 | S4.8 | Repair the auxiliary inlet. | PI | |
| 2023-HH-2 | S4.8 | Clear debris from inlet screen. | PI | |
| 2023-HH-3 | S4.8 | Remove vegetation and fallen trees from the downstream spillway channel. | PI | |
| 2023-HH-4 | S4.8 | Repair dissipation block in stilling basin. | PI | |

where ALL = all Havelock North dams, KW = Karitwhenua, SS= School Stream, TK = Te Kahika, M = Mangarau and HH = Herehere.

Table 7-3: Previous IDSR Dam Safety Issues

| Reference Number | 2022 Report Reference | Description | Category | Status |
|------------------|-----------------------|---|----------|---|
| 2022-CD-1 | S3.2 | The remediation of the gully or other stormwater control options should be investigated. | PI | Motorcamp stormwater gully still needs work. |
| 2022-CD-2 | S3.2 | Clear the downstream gully stormwater channel upstream of the concrete box section, and within the concrete box section. | PI | Motorcamp stormwater channel was cleared by high flows. |
| 2022-CD-3 | S3.2 | The main outlet channel at the Camp was dry and blocked at the downstream end, partly due to earthworks recently undertaken to restore/protect the eroded coastline. This channel should be opened up to allow the passing of flood flows through to the beach. | PI | Motorcamp stormwater channel was opened to the beach again. |
| 2022-CD-4 | S3.2 | Discuss the stock ponds with the landowner and manage the potential issues and impacts on the flood detention dams. | PI | Close, refer to CDSR 2020-49. |



Flood Detention Dams - 2023 Intermediate Dam Safety Review

7 Dam Safety Issues

| Reference Number | 2022 Report Reference | Description | Category | Status |
|------------------|-----------------------|---|----------|---|
| 2022-CD-5 | S3.2 | Clear the pipe outlet area so this can be viewed and can discharge flows effectively. | PI | Lower Middle Dam. No progress. |
| 2022-CD-6 | S3.2 | Investigate the outlet location and mark out the outlet of the pipe through the East Dam. Pegging out of all outlets would be useful. | PI | East Dam. No progress. |
| 2022-UTA-1 | S3.4 | Complete maintenance on the left abutment pipe at the inlet and outlet to ensure this will function adequately. | PI | Ongoing maintenance to keep inlet clear of vegetation and debris. |
| 2022-UTA-2 | S3.4 | Review and improve the rip rap protection to the area downstream of the culvert and outlet structure. | PI | No progress. |
| 2022-UTA-3 | S3.4 | Complete a culvert inspection (CCTV) for current condition and identifying issues. | PI | Planned. |
| 2022-UTA-4 | S3.4 | Conduct a detailed dam topographic survey to identify and monitor any low spots. | PI | No progress. |
| 2022-UTA-5 | S3.4 | Complete maintenance on the right abutment pipe at the inlet and outlet to ensure this will function adequately. | PI | Ongoing maintenance to keep inlet clear of vegetation and debris. |
| 2022-UTA-6 | S3.4 | Complete maintenance at the downstream outlet (Charlton Stream) inlet utility access hole (review adequacy of scruff dome and replacement rip rap). | | Ongoing maintenance to keep screen clear of debris and assess rip rap coverage. |
| 2022-K-1 | S3.5 | Clear trees and vegetation from the downstream left abutment (between the dam and spillway). | PI | Close, refer to CDSR 2020-18. |
| 2022-K-2 | S3.5 | Clear the pine trees on the upstream slope and crest near the right abutment. | PI | Close, refer to CDSR 2020-16. |
| 2022-K-3 | S3.5 | Upstream channel vegetation maintenance including removal of some larger trees. | PI | Some of these trees are down but still require removal. |
| 2022-K-4 | S3.5 | Remove all fencing from within the spillway channel. | PI/PDSD | Close, refer to CDSR 2020-19. |
| 2022-K-5 | S3.5 | Remove the spillway outlet structure and re-design the erosion protection works (e.g., rip rap or gabion mattress). | PI | Close, refer to CDSR 2020-21. |
| 2022-SS-1 | S3.6 | Clear the spillway approach channel from trees and vegetation. | PI | Some of these trees are down but still require removal. |
| 2022-SS-2 | S3.6 | Remove the fence and gate from across the start of the spillway structure. | PI+PDSD | Close, refer to CDSR 2020-27. |
| 2022-SS-3 | S3.6 | Clear debris from and monitor the entrance to the side culvert (right side of spillway) | PI | Ongoing maintenance to keep clear of debris. |



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7 Dam Safety Issues

| Reference Number | 2022 Report Reference | Description | Category | Status |
|------------------|-----------------------|--|----------|---|
| 2022-SS-4 | S3.6 | Clear out and maintain the invert of the wooden spillway structure, remove fallen trees, and repair broken spillway cross members. | PI | Close, refer to CDSR 2020-26. |
| 2022-SS-5 | S3.6 | Complete the recommendations from the Spillway Structural Condition Assessment (Stantec 2018). | PI | No Progress. Note that this report is now likely out of date. |
| 2022-SS-6 | S3.6 | Remove the trees, large branches, and logs from within the downstream channel area in the vicinity of the dam. | PI | No Progress. |
| 2022-TK-1 | S3.7 | Clear the upstream channel of vegetation (upstream of concrete lined section) and clear vegetation from within and around the concrete lined section. | PI | No Progress. |
| 2022-TK-2 | S3.7 | Investigate the purpose of and consider reinstatement of the downstream toe standpipes and plan future monitoring as part of the Dam Safety Management System. | PI+NC | No Progress. |
| 2022-TK-3 | S3.7 | Remove the gate from across the start of the spillway structure. Consider fencing below the expected overflow level. | PI+PDSD | Close, refer to CDSR 2020-31. |
| 2022-TK-4 | S3.7 | Complete the recommendations from the Spillway Structural Condition Assessment (Stantec 2018). | PI+PDSD | No Progress. Note that this report is now likely out of date. |
| 2022-TK-5 | S3.7 | Clear remaining trees/vegetation from the sides of the spillway and vegetation from the invert. | PI | No Progress. |
| 2022-TK-6 | S3.7 | Clear the stilling basin and downstream channel of all vegetation. | PI | No Progress. |
| 2022-M-1 | S3.8 | Remove vegetation, trees, and fences from within the spillway channel. Remove silt fences and silt once development is completed. | PI+PDSD | No Progress. Silt fences damaged and extra one blocking flow. |
| 2022-M-2 | S3.8 | Maintenance of the side channel outlet (upstream right side) utility access hole scruffy dome (attach correctly) and investigate functionality of the flap gate. | PI | No Progress. |
| 2022-M-3 | S3.8 | Remove fences and clear vegetation across the dam area. Repair damaged areas such as erosion across the crest. | PI | No Progress. |
| 2022-M-4 | S3.8 | Remove trees on the sides and ends of the outlet structure (stilling basin) and in the downstream channel. | PI | No Progress. Tree roots exposed so need removal. |
| 2022-HH-1 | S3.9 | Continue to monitor the trees and their potential impact on the channel, flows, and the debris potential to block the inlet. | PI | Remove trees as they contributed to cyclone debris. |
| 2022-HH-2 | S3.9 | Complete wider tree clearance around the upstream left abutment where some large trees are present (proactive maintenance). | PI | |
| 2022-HH-3 | S3.9 | Remove the trees from the downstream left and right abutment areas. | | |



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7 Dam Safety Issues

| Reference Number | 2022 Report Reference | Description | Category | Status |
|------------------|-----------------------|---|----------|---|
| 2022-HH-4 | S3.9 | Complete maintenance in the spillway channel (clear trees and vegetation and remove wooden fence on left side). | PI | No Progress. |
| 2022-HH-5 | S3.9 | Remove/alter the fence and gate at the mid section of the spillway channel. | PI | No Progress. |
| 2022-HH-6 | S3.9 | Remove hen house, rubbish pile, and associated fencing in the downstream spillway channel. | PI | Ongoing. Shed moved out of flow path by owner. |
| 2022-HH-7 | S3.9 | Clear the invert of the stilling basin outlet structure. | PI | Naturally cleared but stilling basin needs more work. |
| 2022-HH-8 | Previous IDSRs | Clean out RHS toe drain pipe (exits into the outlet structure). Confirm whether blockage noted (0.7 m from wall) is related to pipe collapse (surface depression) previously noted. | PI | Not seen. |
| 2022-HH-9 | Previous IDSRs | Confirm whether embankment toe drain outlet pipes are free of sediment and functional. | PI | No Progress. |
| 2022-ALL-1 | S3 | Review tree health (arborist) within dam reservoir areas, and remove trees at risk. | PI | No Progress. |

where ALL = all Havelock North dams, KW = Karituwhenua, SS= School Stream, TK = Te Kahika, M = Mangarau and HH = Herehere.



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7 Dam Safety Issues

7.4 CDSR Dam Safety Issues

The 2020 CDSR listed a number of Dam Safety Issues relating to the flood detention dams. Table 7-4 provides a summary of these and the current understood status of these.

Table 7-4: 2020 Outstanding CDSR Dam Safety Issues and Current Status

| Ref. / Report Ref. | Recommendation | Category | Priority | Timescale | Status |
|---------------------------|--|-----------------|-----------------|------------------|--|
| 2020-1 /1.1 | It is recommended that the next inspection for a CDSR is on or before 10 November 2025. | - | - | 5 yr | N/A – future CDSR inspection note |
| 2020-2 /2.1 | A search through HDC, Hawkes Bay Regional Council, and local library archives is recommended to better understand the history and construction of the dams, especially on the details of the embankment materials. | A | Medium | 2 yr | No update/progress. HDC should plan for this. |
| 2020-3 /2.2 | It is recommended that a factual report on each dam is prepared that includes the most recent topographic survey information and as-built dimensions and key levels, storage information and discharge performance for baseline records on which to base all dam safety management. Any gaps found should be filled by way of additional study and survey. Any gaps found in more complex information (hydraulics) should be filled. | B | High | 1 yr | No update/progress. HDC should plan for this. |
| 2020-4 /2.3 | It is recommended that a Data Book is prepared for the dams. | C | Medium | 2 yr | No update/progress. HDC should plan for this. This can be developed from existing information. |
| 2020-5 /3.1 | It is recommended that an assessment is made of the fitness of all the inundation maps on record and confirm what gaps are present and if necessary a new updated set of dam break inundation maps should be prepared to ensure consistency across all of HDCs detention dams. | B | High | 1 yr | No progress. HDC are planning for this. This is higher priority for the Havelock North dams. Planning for the PIC assessment review for the Havelock North dams is underway. |
| 2020-6 /3.2 | Review the historical Havelock North Dam break studies to determine if an update is required to confirm Population at Risk and Potential Loss of Life. | B | High | 1 yr | No update/progress. HDC are currently planning for this, to complete the PIC reviews and updates to the new Regulations. |



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| | | | | | |
|-------------------|--|---|--------|--------|---|
| 2020-7 /3.3 | A PIC study is recommended for the Clifton Dams that should consider Population at Risk and Potential Loss of Life. | B | High | 1 yr | HDC should plan for this, even though these will not be required under the new Regulations (dams are not classifiable). |
| 2020-8 /3.4 | The PIC study for the Upper and Lower Te Awanga Dams is recommended to be updated to consider downstream concurrent flooding, incremental Population at Risk and Potential Loss of Life. | B | High | 1.5 yr | Completed. Final report was issued in December 2021. |
| 2020-9 /3.5 | Existing flood studies should be checked and updated with any new hydraulic capacity information from 2.2 if required. | B | High | 1.5 yr | No update/progress. HDC should plan for this. This is for the Havelock North Dams. |
| 2020-10 /3.6 | A wind-wave assessment, if not already complete should be carried out for each dam either as a standalone report or as part of any flood study updates to determine the minimum required wave freeboard. | B | High | 1.5 yr | Completed for the Te Awanga Dams flood study. HDC should continue with the others with updated flood assessments. |
| 2020-11 /3.7 | For flood prone structures identified following 2.2, 3.5 and 3.6, carry out high level optioneering for hazard reduction measures. | B | High | 2 yr | No update/progress. HDC should plan for this but follows other assessments. |
| 2020-12 /4.1 | Carry out CCTV surveys of all dams' throttle pipework to record gradient, length, and any areas of damage (open joints, cracking etc.), and any such damage repaired. The CCTV survey specification and outputs should be reviewed by a Dam Engineer for comment. Complete future CCTV inspections 5 yearly to be available for review with CDSRs. | B | High | 0.5 yr | Some progress. This is especially important after all the cyclone. The Havelock North dams are being done when crew available. Te Kahika completed and reviewed by Stantec. |
| 2020-13 /4.2 | A specific Failure Modes and Effects Analysis has not been completed for HDC's dams and this is recommended following flood study updates. | B | Low | 3 yr | No update/progress. HDC should plan for this, and develop as part of the DSAP. |
| 2020-14 /5.1 | Update the contact details of all residents and landowners who own all or parts of the land on which the flood detention structures are located. The responsibilities of HDC and residents in terms of maintenance and operation should be clarified (such as the opening of spillway livestock gates in a flood warning). | - | Medium | 2 yr | No update/progress. |
| 2020-15 /5.2.1 | Karituwhenua - it is recommended that gates or stiles are installed to enable safer crossing for inspection and maintenance purposes. Location to suit landowners and HDC. | A | Medium | 3 yr | Outstanding. |
| 2020-16 /5.2.2 | Karituwhenua - the right-hand side of the dam was very overgrown and needs better maintenance, grass cut (machine or sheep) and small trees completely removed. | B | Medium | 2 yr | Outstanding. Trees on RHS have grown a lot bigger in meantime. |



Flood Detention Dams - 2023 Intermediate Dam Safety Review

7 Dam Safety Issues

| | | | | | |
|-------------------|---|-----|--------|------|--|
| 2020-17 /5.2.3 | Karituwhenua - the crest fence was in poor condition and needs replaced. Right hand side was very overgrown and needs improved or more frequent maintenance; grass cut (machine or sheep) and small trees on the dam completely removed. | A&B | Medium | 1 yr | HDC to review and confirm with landowner |
| 2020-18 /5.2.4 | Karituwhenua - trees in the vicinity of the dam footprint should be removed. | C | Medium | 2 yr | Outstanding |
| 2020-19 /5.2.5 | Karituwhenua - Farm management practices should be confirmed (temporary fencing etc) and no obstructions must be allowed across the spillway structure. If a fence or gate is necessary, then responsibilities for opening if there is a flood warning should be confirmed. | B | High | 1 yr | Outstanding |
| 2020-20 /5.2.6 | Karituwhenua - The hydraulic capacity of the overflow should be checked (see also 2.2). | B | High | 1 yr | Outstanding |
| 2020-21 /5.2.7 | Karituwhenua - Replace end of spillway conduit with a small trap/gully and buried pipe arrangement with an outlet to the downstream channel and reinstate the slope damage. In an extreme flood, significant damage would be expected at this steep drop off at the end of spillway, however it is far enough (80m or so) from the dam to not present significant risk. | A | Low | 5 yr | Outstanding |
| 2020-22 /5.2.8 | Install a vertical auxiliary inlet pipe to the existing throttle to improve effectiveness of the system and provide greater assurance over blockage risk. | A | Medium | 5 yr | Outstanding |
| 2020-23 /5.3.1 | School Stream - It is recommended that gates or stiles are installed to enable safer crossing for inspection and maintenance purposes. Location to suit landowners and HDC. | A | Medium | 3 yr | Outstanding |
| 2020-24 /5.3.2 | School Stream - the dam needs improved vegetation maintenance, grass cut more frequently (machine or sheep) and bushes on the dam completely removed. | A&B | Medium | 2 yr | Outstanding |
| 2020-25 /5.3.3 | School Stream - There is a fall hazard at the outlet which could be improved by a new fence. | - | Medium | 2 yr | Outstanding. HDC should consider this fall hazard across all dams. |
| 2020-26 /5.3.4 | School Stream - Several rotten timbers were noted on the spillway and these should be replaced. The hinged overflow gates across the sill of the emergency overflow were operable but should be checked during routine surveillance visits. | B | Medium | 2 yr | Outstanding |



Flood Detention Dams - 2023 Intermediate Dam Safety Review

7 Dam Safety Issues

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|-------------------|---|-----|--------|--------|--|
| 2020-27 /5.3.5 | School Stream - The need for the spillway gates should be confirmed and it is recommended they should be removed or replaced by a fixed fence set well upstream of the overflow and below the level of the overflow sill. | B | Medium | 2 yr | Outstanding |
| 2020-28 /5.3.6 | School Stream - The hydraulic capacity of the overflow should be checked (see also 2.2). | B | High | 1 yr | Outstanding |
| 2020-29 /5.4.1 | Te Kahika - It is recommended that gates or stiles are installed to enable safer access for inspection and maintenance purposes. Location to suit landowners and HDC. | A | Medium | 3 yr | Outstanding |
| 2020-30 /5.4.2 | Te Kahika - Developing potholes and damage noted on the crest (road surface) should be repaired. | A | Medium | 2 yr | Complete. No potholes seen during 2023 IDSR inspection. |
| 2020-31 /5.4.3 | Te Kahika - The need for the spillway gate should be confirmed and it is recommended it should be removed or replaced by a fixed fence set well upstream of the overflow and below the level of the overflow sill | B | Medium | 2 yr | Outstanding |
| 2020-32 /5.4.4 | Te Kahika - The hydraulic capacity of the overflow and stepped timber channel should be confirmed by calculation and if it is shown to be under capacity then the spillway should be considered for improvement (See also 2.2). | B | High | 1 yr | Outstanding |
| 2020-33 /5.4.5 | Te Kahika - A new bridge deck and parapet system is recommended along with an assessment of structural capacity and appropriate bridge weight limits provided on road signs. | A | Low | 5 yr | Outstanding |
| 2020-34 /5.5.1 | Mangarau - It is recommended that gates or stiles are installed to enable safer crossing for inspection and maintenance purposes. Location to suit landowners and HDC. | A | Medium | 3 yr | Outstanding |
| 2020-35 /5.5.2 | Mangarau - Some bare patches and livestock damage noted at the true dam and the natural dam crest and downstream slope which should be repaired. Grass maintenance needs improved. It is not consistent along the full length of the dam. Trees on the dam must be removed. | A&B | High | 1 yr | Outstanding |
| 2020-36 /5.5.3 | Mangarau - The make-up of the natural dam is apparently unknown and should be investigated (archive search followed by ground investigation) to confirm its make-up and ability to safely impound water. | B | Medium | 3 yr | Outstanding |
| 2020-38 /5.5.5 | Mangarau - It is recommended that the CCTV survey at Mangarau is prioritised over the other dams due to turbulence heard at the outlet suggesting something is disturbing the flows. (See also 4.1) | B | High | 0.5 yr | Outstanding. Planned for this year, as with other HDC dams following Cyclone Gabrielle (Te Kahika complete). |



Flood Detention Dams - 2023 Intermediate Dam Safety Review

7 Dam Safety Issues

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|-------------------|---|-----|--------|------|--|
| 2020-40 /5.5.7 | Mangarau - The hydraulic capacity of the overflow and channel should be confirmed by calculation and if it is shown to be under capacity or to present a risk to the natural dam abutment, then the spillway should be considered for improvement. | B | High | 1 yr | Completed as part of review of performance of the Havelock North dams from Cyclone Gabrielle. |
| 2020-41 /5.6.1 | Here Here - It is recommended that gates or stiles are installed to enable safer crossing for inspection and maintenance purposes. Location to suit landowners and HDC. | A | Medium | 3 yr | Outstanding |
| 2020-42 /5.6.2 | Here Here - Grass on the dam was very long and needs improved maintenance, (machine or sheep). | A&B | Medium | 2 yr | Ongoing |
| 2020-44 /5.6.4 | Here Here - The hydraulic capacity of the overflow and channel (including consideration of the closed gate downstream and the fence / vegetation) should be confirmed by calculation and if it is shown to be under capacity or to present a risk to the dam, then the spillway should be considered for improvement. The bend and tapering at the start of the channel should be considered within this calculation to confirm the location of the hydraulic control which may be downstream of the concrete sill. (See also 2.2). | B | High | 1 yr | Outstanding |
| 2020-45 /5.7.1 | Clifton - Some improvements are recommended with respect to periodically cutting back vegetation at the sides of the 4x4 vehicle access track over the initial few hundred metres of track. | A&B | Medium | 2 yr | Outstanding |
| 2020-46 /5.7.2 | Clifton - Cattle damaged areas on the dams should be repaired. It is recommended that cattle are prevented from accessing the dams by installing fencing. | A&B | High | 1 yr | Outstanding |
| 2020-47 /5.7.3 | Clifton - Small box sized trash screens are recommended to be installed to prevent blockage. | B | Medium | 3 yr | Progressed. Waratahs have been installed around the inlets to capture large debris. |
| 2020-48 /5.7.4 | Clifton - The outlet channel at the Motor Camp should be continued through the earthworks to the beach. | A | Medium | 3 yr | Ongoing. The shape of outlet channel is constantly changing with erosion protection works. Cleared to beach. |
| 2020-49 /5.7.5 | Clifton - A cattle drinking pond perched at the top of the hill above the Western Dam is in a state of gradual failure and this should be monitored for worsening condition and repairs or demolition works carried out as required to reduce the risk to the Western Dam i.e. if the pond fails and materials slip down and inundate and damage the Western Dam. | B | Medium | 2 yr | Ongoing |
| 2020-50 /5.7.6 | Clifton - The hydraulic capacity of the overflows and channels should be checked. The resilience (erosion resistance) of the Lower Central dam overflow should be appraised. (See also 2.2). | B | High | 1 yr | Outstanding |



Flood Detention Dams - 2023 Intermediate Dam Safety Review

7 Dam Safety Issues

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|-------------------|---|---|--------|--------|---|
| 2020-51 /5.7.7 | Clifton - A webcam or similar means of remote surveillance is recommended if PIC study shows that the dams present a significant risk to the Clifton Motor Camp. | - | Low | 5 yr | Outstanding |
| 2020-52 /5.9.1 | Te Awanga Upper - A preferred access route to the dam should be agreed with the landowner and defined accurately on a plan of the area. | A | Medium | 3 yr | Outstanding |
| 2020-54 /5.9.3 | Te Awanga Upper - conduct a CCTV survey of the downstream culvert drop shaft structure. This also requires a portable pump. (See also 4.1). Install a safety screen to the Outlet to Charlton Stream. | A | High | 0.5 yr | Ongoing. Screen over outlet to Charlton Stream. |
| 2020-55 /5.9.4 | Te Awanga Upper - The hydraulic capacity of the overflow should be confirmed and if it is shown to be under capacity or to present a risk to the dam (erodibility), then should be considered for improvement. | B | High | 1 yr | Outstanding |
| 2020-56 /5.9.5 | Te Awanga Upper - Given the remoteness of the site and the current perceived flood risk, a similar water level / rainfall measurement system as used at the Havelock North Dams is recommended. Such a system is not considered to be required for Te Awanga Lower given it is on the same catchment. | A | Medium | 2 yr | Outstanding |
| 2020-57 /6.1 | Update Surveillance and Monitoring as follows; a) set up trigger warning systems for rainfall (>100mm in 24hrs) and water level (>1.5m) b) set up a system to receive earthquake alerts from GeoNet, and a system to trigger an inspection depending on severity of the shaking (MMI 5 and above felt at the dam based on interpolation of felt reports). c) Install permanent settlement monitoring pins on the Havelock North and Te Awanga dams' crests. Carry out a baseline survey, then again after 1 year, then every 5 years after that. d) carry out CCTV surveys at 5 yearly intervals or sooner if there is suspected damage or after an impounding event. | - | n/a | 2 yr | Outstanding |
| 2020-58 /6.2 | Download all monitoring data (rainfall and water depth) monthly to a spreadsheet and review this data monthly. | - | n/a | 1 yr | Outstanding |
| 2020-59 /6.3 | Download monthly records from Kopanga rain gauge (HBRC) to compare with HDC data. | - | n/a | 2 yr | Outstanding |
| 2020-60 /6.4 | It is recommended that all rain gauges are location verified, checked, and calibrated to ensure accurate data capture. Certificates of calibration should then be maintained with the rest of the dam data in the Data Book. | A | Medium | 2 yr | Outstanding |



Flood Detention Dams - 2023 Intermediate Dam Safety Review

7 Dam Safety Issues

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| 2020-61 /7.1 | Review the OMS manual for the dams annually and update as required. | - | n/a | 1 yr | Ongoing |
| 2020-62 /7.2 | It is recommended that an Emergency Action Plans (EAP) should be prepared for each dam. | C | High | 1.5 yr | Outstanding. Planning underway to complete these for the Havelock North dams with the PIC assessments. |



8 Conclusions

On the basis of the visual inspections, the flood detention dams are expected to perform as intended under normal (non-flood) operating conditions. The flood detention dams were recently tested during Cyclone Gabrielle, and this has generally reinforced the following areas of vulnerability.

The culvert inlets and approaches need to be maintained clear of debris before the next flood event (which may or may not come with warning time) and fallen trees cleared so that the debris does not damage and/or block the structures. Such a review of debris and potential debris needs to be extended to the wider catchment, including a review of trees that are likely to be at risk of falling over. Screening arrangements should be reviewed for fitness for purpose and improvements made if necessary.

The spillway channels need to be maintained clear of debris and fences and screens and the more potentially vulnerable channels (timber spillways of Te Kahika and School Stream) re-assessed (hydraulic and structural capacity) for fitness of purpose.

A CCTV survey of all throttle pipework is required to confirm effectiveness and fitness of purpose following any damage through flood operation.

The successful performance of the auxiliary overflows is paramount (and one is required at Karituwhenua, which is the only flood detention dam without one). The risk of buoyancy of the auxiliary overflows (based on the uplift failure of Here Here auxiliary inlet) needs to be assessed and any preventative works carried out to ensure performance during flood.

Monitoring and Surveillance, especially the recording of water levels is crucial, and all monitoring instrumentation should be checked / calibrated annually, and the frequency of water level recording changed to a more frequent interval (currently ~1 hour but should be every 15 minutes). Alarm levels and a notification system also should be established.

There are outstanding Dam Safety Issues to be resolved. A programme of studies, investigations and works as well as the preparation of key dam safety documentation (Emergency Action Plans (EAP)) needs to be developed by HDC without delay to safely maintain and manage the dams and appurtenant structures going forward. The reassessment of the PIC for the Havelock North dams and EAP development is currently being scoped by HDC.

The Dam Safety Regulations will require formalisation of PICs for the HDC dams (the 5 Havelock North dams and possibly Upper Te Awanga Dam) from May 2024, then a Dam Safety Management Programme (DSAP) of the Medium and High PIC dams. Many aspects of the DSAP are already in place (e.g. the OMS, IDSRs, CDSRs), and with the EAP aspect in development.



9 References

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Stantec (2023), Cyclone Gabrielle HDC Havelock North Dams Flow Analysis Summary Report.



APPENDICES



Appendix A HDC Flood Detention Dams Location Map



Appendix B Clifton Dams



Figure 9-1. Channel through the motor camp (upstream and downstream).



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Figure 9-2. Examples of the inlets and outlets.



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Figure 9-3. Erosion of sea outlet channel for overflow from Eastern Dam.



Appendix C Te Awanga (Upper and Lower Dams)



Figure 9-4. Lower: Manhole lid that lifted from culvert water pressure.



Figure 9-5. Lower: Outlet structure and channel to Maraetotara River.



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Figure 9-6. Lower: Spillway downstream channel below gabion walls.



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Figure 9-7. Upper: Settlement of crest



Appendix D Karituwhenua



Figure 9-8. Side Channel (RHS of inlet) culvert inlet and outlet.



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Figure 9-9. Spillway Downstream Structure



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Figure 9-10. Landslides along the valley slopes (downstream of Spillway Downstream Structure).



Appendix E School Stream



Figure 9-11. Drains under access path.



Figure 9-12. Landslide on Upstream Left Abutment.





Figure 9-13. Pond in front of Right Abutment and Spillway.

Appendix F Te Kahika



Figure 9-14. Dam Crest driveway.



Figure 9-15. Wet patch on Downstream Right Abutment.



Appendix G Mangarau



Figure 9-16. Downstream slope.



Figure 9-17. Side Channel Culvert Inlet.





Figure 9-18. Tree that fell on house on Upstream Left Abutment.

Appendix H Herehere



Figure 9-19. Trees fallen over Upstream Channel



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Figure 9-20. Upstream Channel Culvert for access track

