Kaeo WWTP Flood Hazard Assessment

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1. Introduction

Jacobs has been engaged by Far North District Council (FNDC) to undertake a flood risk assessment of the Kaeo Waste Water Treatment Plant (WWTP) as part of the resource consent renewal process. This assessment includes consideration of the effects of flooding in the Kaeo River on the hydraulic performance of the pipe that discharges from the WWTP to the Kaeo River.

For the Kaeo WWTP consent renewal FNDC is required to demonstrate:

- The Kaeo WWTP will not be inundated by a 1% AEP (with climate change) flood event, and
- The Kaeo WWTP does not cause excessive flooding due to displacement in the floodplain directly adjacent to the WWTP

2. Background

The Kaeo WWTP sits in the floodplain of the Kaeo River about 760 m from the river. The outfall from the treatment ponds is piped to the river in a diameter 200 mm pipe. The treatment plant lies between two areas of higher ground and a small open channel flows around the western side of the treatment plant. The Northland Regional Council (NRC) have developed a flood model of the Kaeo River that covers the WWTP. We have used this existing model to assess the flooding at the treatment plant.

The treatment plant consists of an oxidation pond, an emergency storage pond, a vermifilter system and a constructed wetland. In June 2012 what was previously the maturation pond was divided to create the emergency storage pond and a vermifilter system with a new bund separating the two halves. The oxidation and emergency storage ponds and the vermifilter system are protected by bunds that have an elevation of 5.4m or higher, further discussion of bund heights will be provided the next section. The constructed wetland also has a bund however this is lower and likely to be from 4.0- 4.4m high. Figure 1 shows the location of the site and the bunds.

2.1 Data Used

We obtained the following information which we have used in this study:

- Kaeo River Mike Flood model (supplied by NRC)
- Kaeo River Mike Flood model results (supplied by NRC) for the 1% AEP (100-year) flood event with climate change allowance of 2.1°C and the 10% AEP for current climate.
- Kaeo Model Build Report (GHD, August 2013)
- NRC LiDAR (2019)
- As built drawings of the treatment system, vermifilter system, the constructed wetland and the related pipe infrastructure and outfall:
  - 1.3 796131 - Kaeo WWTP 1996 Wetland Treatment System – As-builts

- 1.3 702499_VO1425_Vermifilter - 2012 Vermifilter – As-builts
- 1.3 KaeoSewTmt_1 - 2006 Modifications to inlet and outlet structures

The model of the Kaeo River was developed in 2010 using 2008 LiDAR by GHD. The model was updated to include a wider 2d extent in 2012.

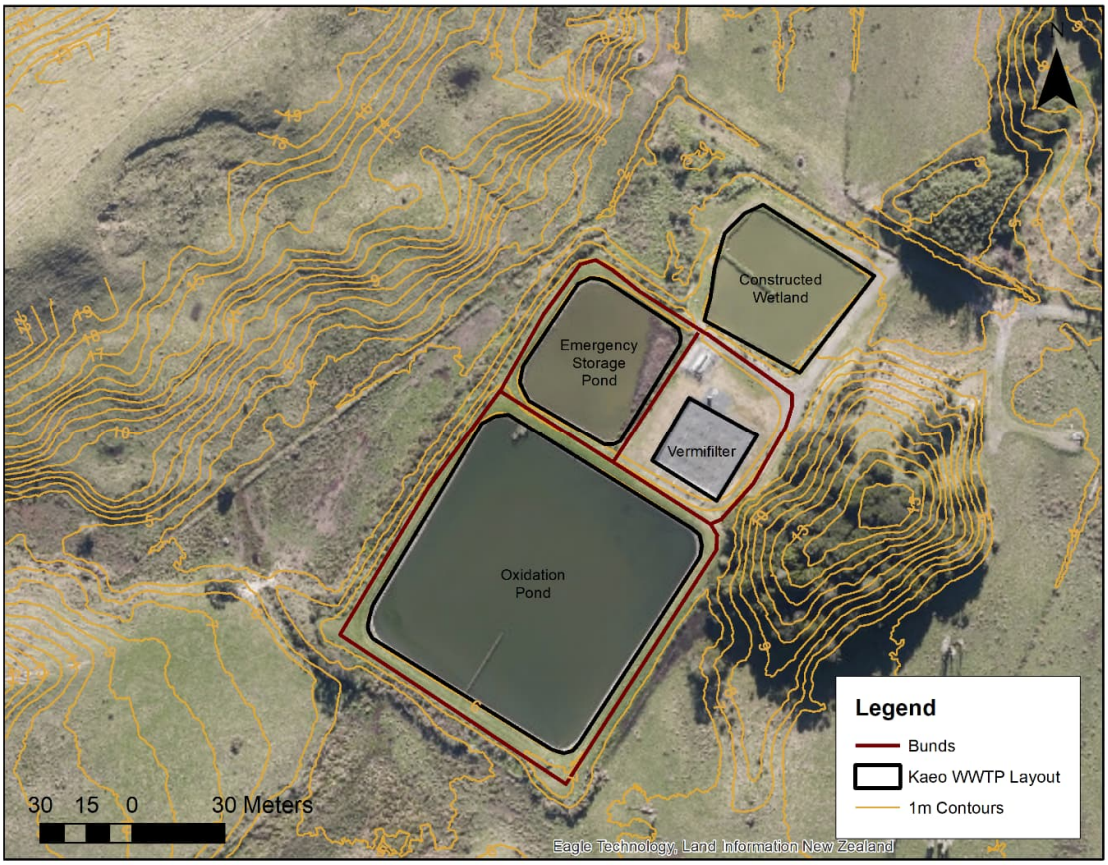

Figure 1. Indicative site layout map

2.2 Flood assessment of treatment ponds and plant site

We reviewed the as-built drawings, and LiDAR contours to ascertain the bund elevations as no recent survey of the bunds was available. Although the LiDAR contours were flown prior to construction of the vermifilter system, the outside bunds were not altered during creation of the vermifilter system this does not invalidate the modelling that has been done.

- The bund height from the as-built drawings from the MWH feasibility study (2006) are shown as 5.4m (One Tree Point, msl) at the southern edge of the secondary pond (prior to the vermifilter upgrade)
- 1m LiDAR contours indicate the bund around the oxidation pond is higher, above 6m
- 1m LiDAR contours indicate that most of the bund around the storage pond is above 5m, however they indicate there may be a point lower than 5m in the centre of the northern side of the bund around the storage pond and vermifilter
- The as-built drawing for the vermifilter and the additional bund between the vermifilter and the emergency storage pond show the bund height as 5.56m
- The model bathymetry has the bund height varying from 5.06 to 5.5m along the southern (downstream) side (refer to Figure 2).

The modelled maximum water level for the 1% AEP event with climate change is 5.43m. This level means it is likely the Emergency Storage Pond will be flooded as the lowest points in the bund may be around 5m elevation. Survey of the bund level would be required to confirm this. If the Emergency Storage Pond is

flooded it will not be available for emergency storage during the event. The vermifilter is likely to be flood free as the bund between the storage pond and vermifilter and the eastern side of the bund are both higher than 5.5m modelled depth of 5.43m, although there is only a freeboard allowance of 0.07m. the constructed wetland will be flooded however the

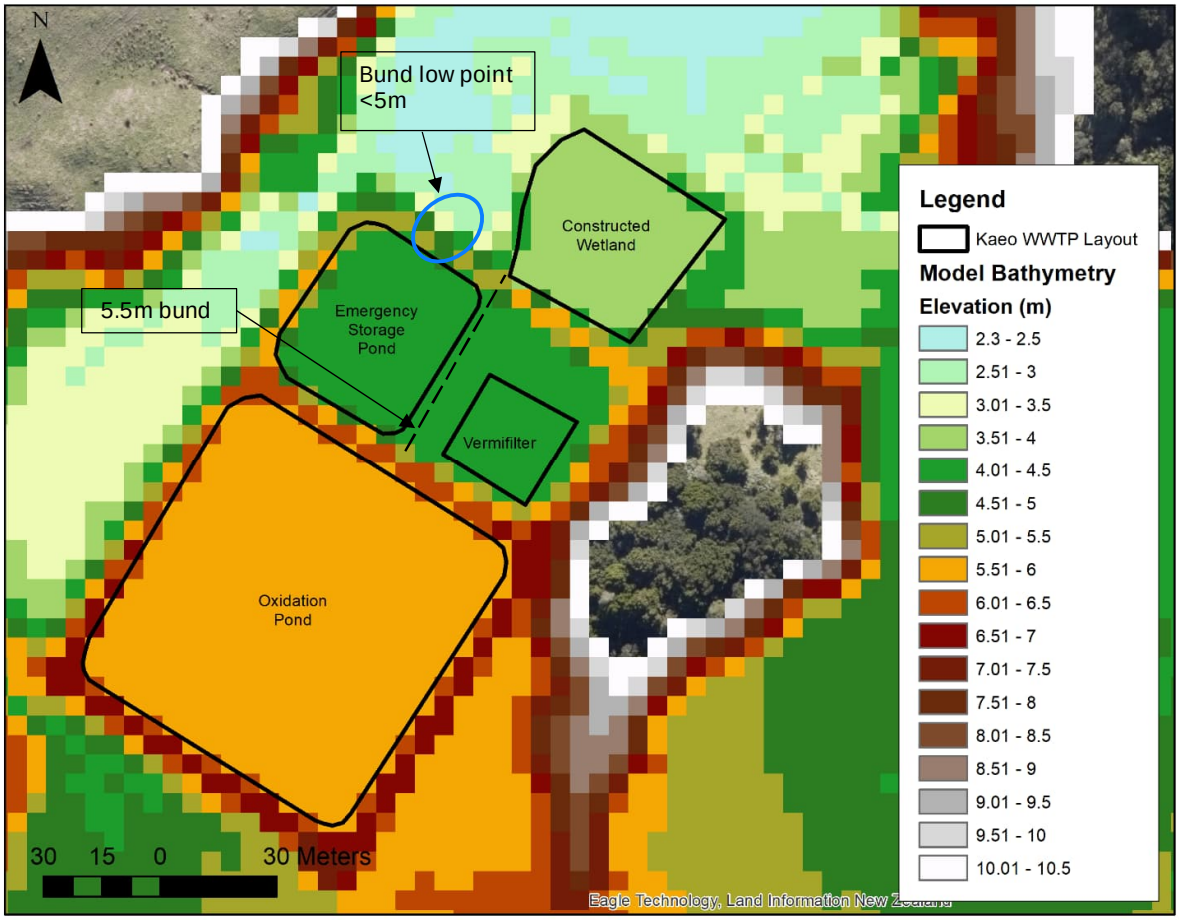

Figure 2. Model Bathymetry showing lower bund adjacent to the emergency storage pond

NZTA are planning to upgrade the State Highway 10 bridge across the Kaeo River. The bridge is 1.65 km downstream of the treatment plan outlet on the Kaeo River and a further 700m from the WWTP, so it is not likely to be affected by the bridge upgrade. Aurecon prepared a report on the effects of the upgrade on flooding in Kaeo (*Northland Bridges – Kaeo. Hydraulic Modelling Technical Specialist Report, 2019*) and we have used this report and the model results from this to check if there are any effects of the bridge upgrade on the flood hazard at the WWTP. Effects of the bridge (increases of 0.05-.1m), even with the existing abutments remaining only extend to 600-700mm upstream of the, so the WWTP is outside the area that may be affected by the bridge upgrade.

2.3 Outlet pipe hydraulic performance

Treated effluent from the vermifilter is currently discharged directly to the Kaeo River after UV disinfection, bypassing the constructed wetland. At present, the wetland planting is in poor condition. The outlet pipe is an approximately 750m long 200mm diameter gravity pipe. The invert at the pipe inlet is assumed to be 3.215m (from manhole detail in drawing 796131 KaeoWWTP Wetland). No survey of the pipe outlet into the Kaeo River was available; however, the LiDAR contours indicate a bank level of just below 1m and photos of the outlet indicates that it is below bank level and submerged during normal flows, so the pipe outlet invert is likely well below 1m.

During the 1% AEP +CC event the river levels at the outlet reach a maximum of 5.5m so the pipe is likely to be operating under a negative head with no gravity drainage from the plant for several hours. In the 10% AEP event the river level at the outlet reaches 3.8m and so the operation of the pipe is also likely to be affected during more frequent floods. There is a risk of backflow into the vermifilter bunded area through the pipe if backflow prevention is not in place. The environmental risk is low as this is effectively final treated effluent at this point. However, there is a risk to site operation in that sediment could blind the vermifilter and the UV treatment would require cleaning and removal of sediment.

3. Conclusions and Recommendations

- There is a risk at the bund low point that the flood water could enter the emergency storage pond in the 1% AEP event
- We recommend site measurements / survey of the bund crest to confirm if this low point exists
- If survey confirms the bund crest levels are below the 1% AEP + CC flood level the bunds, raising of the bund to allow 500mm freeboard for the entire site is recommended, this would likely only be required in the north-western corner of the site adjacent to the emergency storage pond
- The constructed wetland would be flooded in the 1% AEP +CC event, although discharge currently bypasses the wetland
- There is a risk of backflow of water from the Kaeo River via the outlet pipe in both the 10% and 1% AEP +CC events into the vermifilter bunded site
- We recommend taking measurements at the manholes to confirm the pipe inverts and whether back flow into the WWTP is truly a risk
- If surveyed pipe inverts confirm that there is a risk of backflow, to avoid this risk a non-return flap or valve could be installed on the discharge pipe.

Appendix A. Flood Level Map Kaeo WWTP 1% AEP +CC