Waipawa Solar Farm
Flood Risk Assessment – Part 1

Prepared for Helios Energy New Zealand Ltd
Prepared by Beca Limited

12 May 2023

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Revision History

Revision Nº	Prepared By	Description	Date
A	Roisin Blundell-Dorey	First Issue – Client Review	12 May 2023

Document Acceptance

Action	Name	Signed	Date
Prepared by	Roisin Blundell-Dorey		12 May 2023
Reviewed by	Cameron Oliver Justin Kirkman		12 May 2023
Approved by	Mark Jacob	pp:	12 May 2023
on behalf of	Beca Limited		

Executive Summary

This report summarises a high-level flood risk assessment (FRA) of parcels of land in Central Hawke's Bay region, for a proposed solar farm. A screening assessment of the existing 1D flood model was undertaken to determine its suitability for understanding the flood risk at the site.

The digital elevation model (DEM) indicates that the Tukituki River has historically flowed through the site as evidenced by the river bed contouring of the land. Stopbanks offer flood protection and act to constrain flow within the main Tukituki River channel. However, if the stopbank is overtopped or fails for any reason, water would likely flood the site through the paleochannles (historical channels). While the Tukituki River represents the greatest flood risk to the site, the unnamed stream and Ongaonga Streams north of the site could both cause flooding, albeit to a more limited extent.

The assessment of the DEM and existing 1D flood model shows the southwest of the site is situated in the Tukituki River flood plain and **is subject to flooding** in a 100-year event. No terrace or stopbank overtopping was modelled in this event. However, the existing flood model does not account for climate change and does not illustrate the effects to the site of any stopbank failure (e.g. due to internal erosion) or overtopping.

In summary:

- The southwestern corner of the site is expected to be inundated in a 100 year event, and
- The eastern side of the site would be inundated if stopbanks fail or were overtopped.

The depth of inundation is unknown but could be in the order of 1 to 2 meters. In both scenarios flow velocity would be high, meaning a significant risk of scour (erosion) around support poles.

The viability of a solar development on this site will depend on the balance between risk appetite and cost. Mitigation against flooding would involve raising the panels above water levels and ensuring support poles were sunk deep enough to provide support under scour conditions.

We recommend that if the client would like to progress plans for the site, further modelling is undertaken. We recommend that this modelling includes:

- Revision of rainfall assumptions and inclusion of allowance for climate change
- Development of a 2D site specific flood model that fully captures behaviour of flood plain surrounding site
- Test stopbank failure and overtopping scenarios to determine the effect of flooding through the eastern side of the site.

1 Introduction

Helios Energy NZ (Helios) is investigating the feasibility of a solar farm on parcels adjacent to Tukituki River, west of the Waipawa Township, in the Central Hawke's Bay region of the North Island. Beca Ltd (Beca) has been commissioned by Helios to undertake a high-level flood risk assessment to address the following issues:

- Review existing information, including flood modelling developed by Hawkes Bay Regional Council.
- Assess the suitability of the site for the development based on the information collected and the project information provided by Helios.
- Provide advice on the reliability of this information and recommendations for further work / next steps.

2 Site Description

The site lies within the Ruataniwha Plain, an inter-montane basin between the Ruahine range in the west and the Ruakawa Range in the east (Ballinger, 2011). The Ruataniwha Plain is an important horticultural region for the Hawkes Bay. It supports four main rivers, the Waipawa, Tukituki, Makaretu, and Tukipo Rivers (Figure 1). The proposed development is situated on the north (left) bank of the Tukituki River with an unnamed stream running through the north of the site.

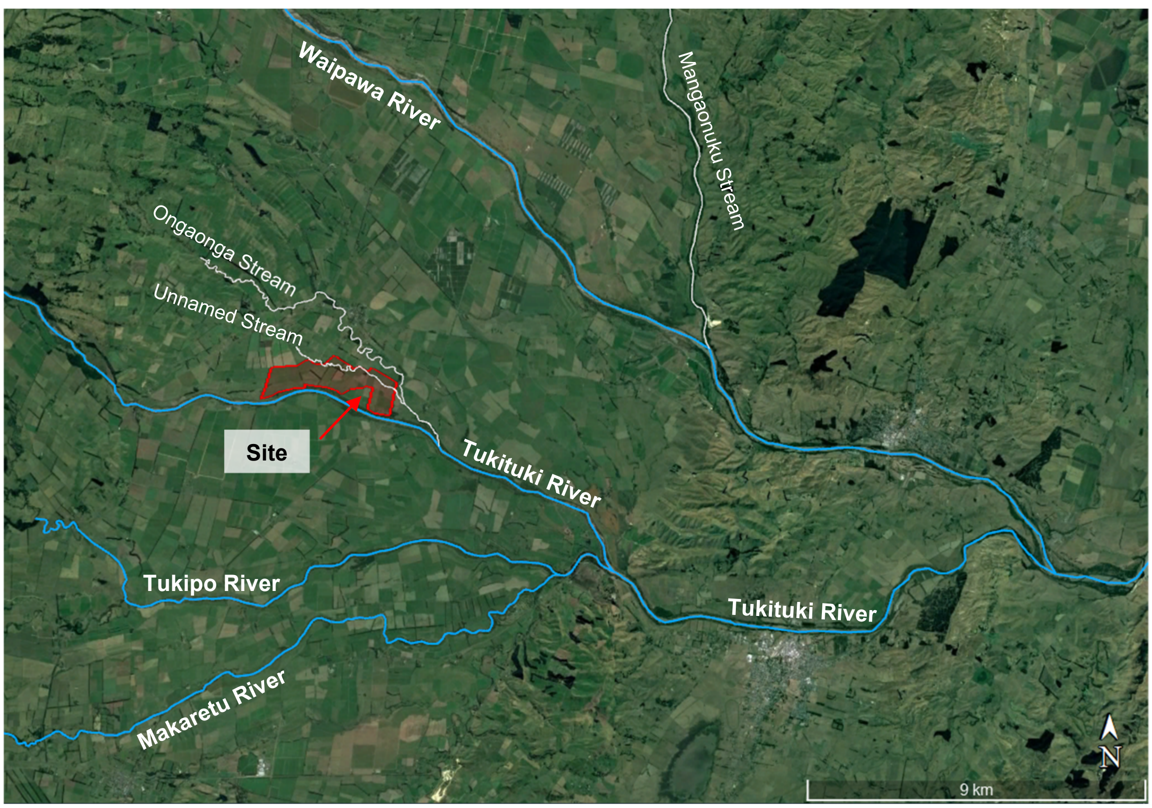

Figure 1: Ruataniwha Plains rivers in relation to the proposed site.

Figure 2 plots terrain elevation surrounding the site based on 2021 LiDAR[1], while Figure 3 annotates various features of this terrain. Several observations can be made:

- Terraces mark historical edges of the Tukituki River and by extension, the width of the floodplain. These terraces suggest that it is possible for water to reach this extent.
- The terrain indicates that the Tukituki River used to flow through the site itself, along the path marked as "historical channel" in Figure 3. The width and the braided nature of this terrain is consistent with the main river.
- Stopbanks offer flood protection and act to constrain flow within the main Tukituki River channel. However if the stopbank is overtopped or fails for some reason, water would likely flow through the site, either along a the historical channel or otherwise through farmland.
- On the downstream (eastern) side of the site, the Tukituki River is elevated above the surrounding farmland. The importance of the stopbanks is even more critical here.
- While the Tukituki River represents the greatest flood risk to the site, the unnamed stream and Ongaonga Stream could both cause flooding, albeit to a more limited extent.

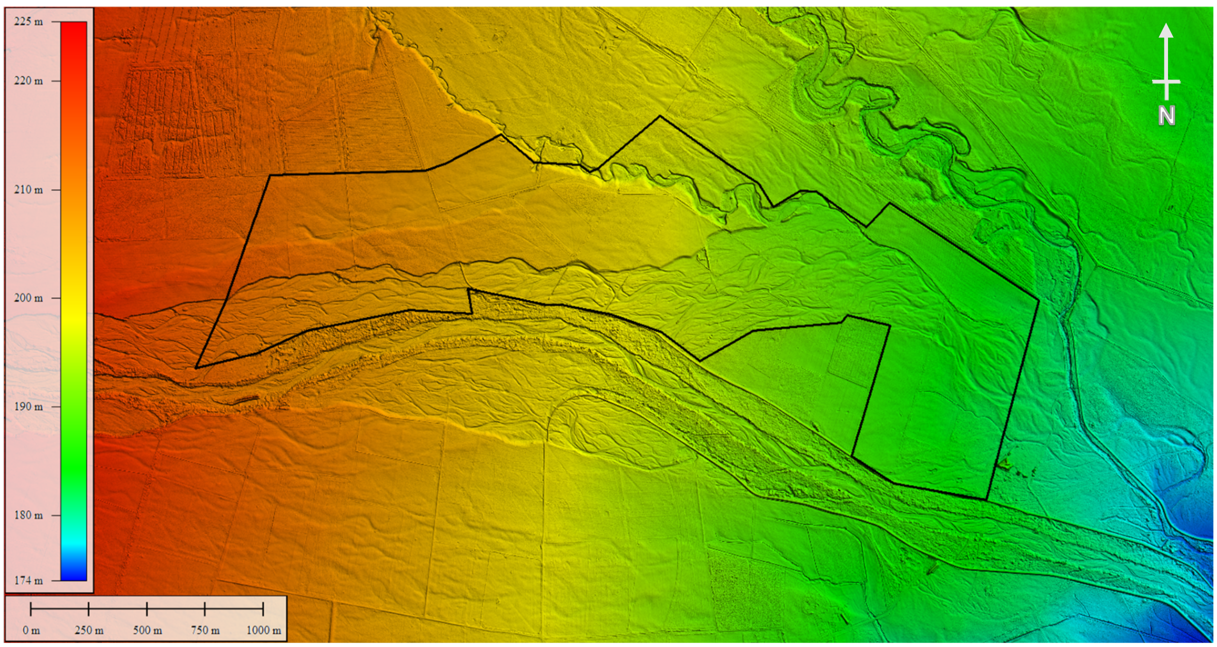

Figure 2: Digital elevation model of the proposed site.

[1] https://data.linz.govt.nz/layer/112889-hawkes-bay-lidar-1m-dem-2020-2021/

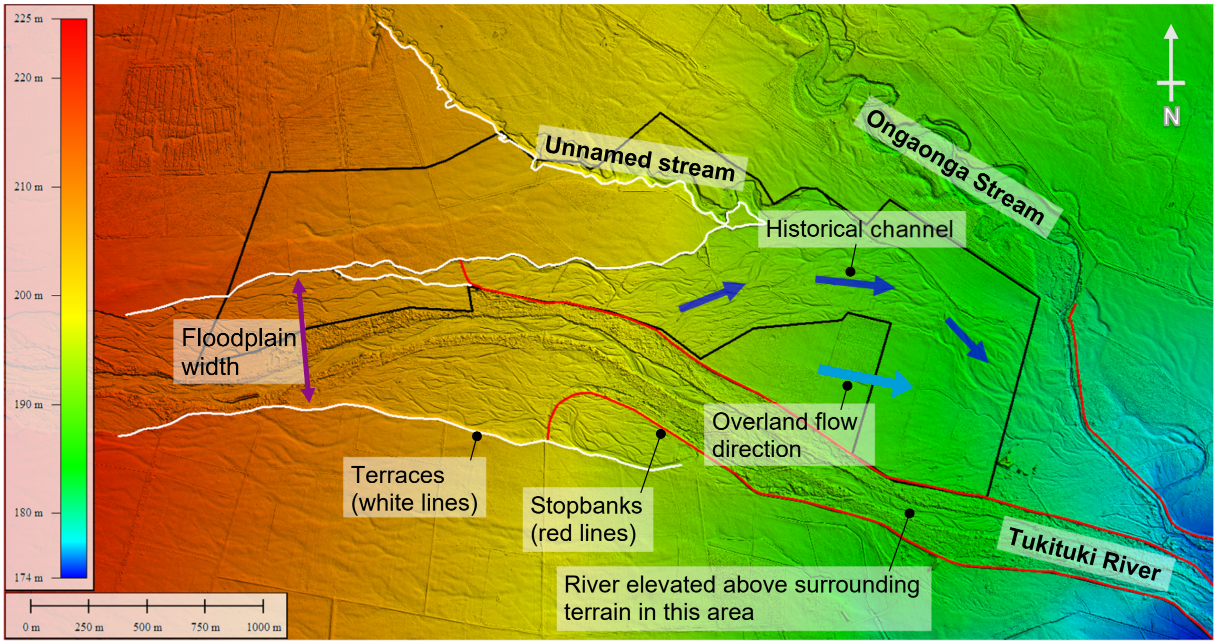

Figure 3: Annotated terrain.

3 Flood Modelling

Hawkes Bay Regional Council (HBRC) have a one-dimensional (1D) flood model of the Tukituki River and its tributaries, developed circa 2008 using the MIKE11 hydraulic modelling software. Catchment runoff was modelled using the lumped MIKE11-NAM model[2], based on nested storm design rainfall hyetographs.

Limited documentation is available for this model, but the following observations can be made:

- 100-year rainfall estimates were taken from a 1980 document[3] (much more recent estimates are now available)
- No adjustment was made for anticipated climate change
- The 100-year flood event was the only event modelled
- No information was available regarding roughness assumptions made

The cross-sections of the 1D flood model span between the terraces and/or stopbanks, as seen in Figure 4. Ongaonga Stream was included in this model, however its cross-sections are not plotted in Figure 4.

[2] We were unable to verify the parameters used in this runoff model

[3] Tomlinson, A. I. 1980. The Frequency of High Intensity Rainfalls in New Zealand, Part 1. Water and Soil Technical Publication No. 19

Figure 4: Cross-sections (green lines) from HBRC 1D model.

The stopbank or terrace heights and the corresponding modelled water level for each cross section are summarised in Table 1. The model clearly indicates that in the 100-year event *the south-western part of the site will be subject to inundation*. This floodable area is highlighted in yellow in Figure 4.

Table 1 Cross-section information (elevations in mRL)

Number	Water level	Stopbank or terrace elevation		Glass walling	Would water overtop left side?
		Left (north)	Right (south)		
68	222.5	225.7	223.8	no	no
67	217.3	unknown	217.6	yes (minor)	no (based on inspection of LIDAR)
66	211	212.5	unknown	no	no
65	207.3	208.2	207.9	no	no
64	203.2	204.3	203.9	no	no
63	199.2	200.4	200.2	no	no
62	195	196.1	195.7	no	no

Figure 6 illustrates cross section 68, an example where terraces on both sides are included in the cross section. Cross section 67 is truncated on the left (north) side and does not include the terrace, as shown in Figure 5, therefore, a vertical 'glass wall' is assumed by the model. However, the terrace is well above the water level at this location and there is no risk of water spilling further into the site. The left terrace or stopbank is visible in all other cross-sections, and is at least 0.9 m higher than the modelled 100 year water level, meaning *no overtopping was modelled* in this event.

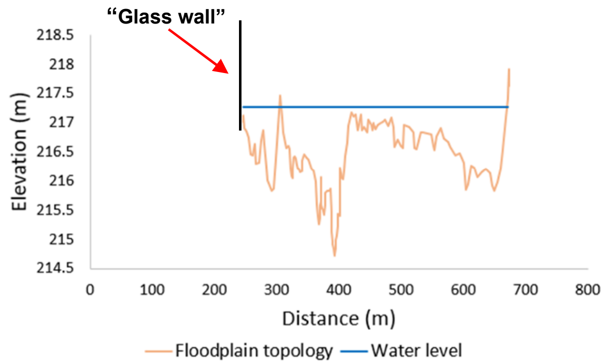

Figure 5: Cross section 67 topology and modelled water level.

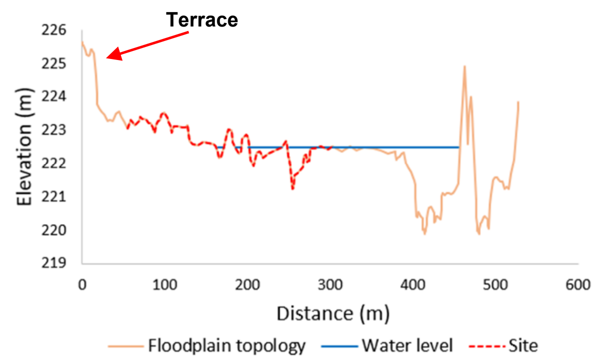

Figure 6: Cross-section 68 topology and water level.

4 Conclusion and Recommendations

The site is adjacent to Tukituki River, within the Ruataniwha Plains. Terraces mark historical edges of the Tukituki River and by extension, the width of the floodplain. The LiDAR terrain indicates that the Tukituki River used to flow through the site itself.

Stopbanks offer flood protection and act to constrain flow within the main Tukituki River channel. However, if the stopbank is overtopped or fails for some reason, water would likely flow through the site, either along a historical channel or otherwise through farmland. The importance of the stopbanks is most critical on the downstream (eastern) side of the site, as the Tukituki River is elevated above the surrounding farmland. While the Tukituki River represents the greatest flood risk to the site, the unnamed stream and Ongaonga Stream could both cause flooding, albeit to a more limited extent.

Hawkes Bay Regional Council developed a simple flood model of Tukituki River and its tributaries in approximately 2008. This model used now-superseded rainfall estimates and did not allow for anticipated climate change effects.

The DEM and the existing 1D flood model show the southwest of the site is situated in the flood plain and is subject to flooding in a 100-year event. No terrace or stopbank overtopping was modelled in this event.

The existing flood model does not account for climate change and does not illustrate the effects to the site of any stopbank failure (e.g. due to internal erosion) or overtopping. Limited information was available regarding the assumptions made in the model. In our opinion, this model is useful to inform the present day flood risk to the site from the Tukituki River only and does not account for the full flood risk profile to the site, such as from the unnamed stream.

The flood risk is therefore in the southwest of the site due to flooding in the channel and in the eastern side of the site due to stopbank failure or overtopping. The depth of inundation is unknown but could be in the order of 1 to 2 meters. In both scenarios flow velocity would be high, meaning a significant risk of scour (erosion) around support poles.

The viability of a solar development on this site will depend on the balance between risk appetite and cost. Mitigation against flooding would involve raising the panels above water levels and ensuring support poles were sunk deep enough to provide support under scour conditions.

We recommend that if the client would like to progress plans for the site, further modelling is undertaken to assess the effects of flood inundation on the eastern side, including within the historical channel alignment.

Specifically, our recommendations are:

- Revise rainfall assumptions and include allowance for climate change
- Develop a 2D site specific flood model that fully captures behaviour of flood plain surrounding site
- Test the effect of flooding through the site due to:
  - stopbank failure at the 100-year with climate change level, and
  - stopbank overtopping in larger events

5 Bibliography

Ballinger, J. (2011). *Natural buffer placement and downstream flood mitigation in rural Hawkes Bay, NZ.* Wellington. Retrieved from https://researcharchive.vuw.ac.nz/bitstream/handle/10063/1960/thesis.pdf?sequence=2