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Memorandum

To:	Keri Davis-Miller		
Company:	Waikato District Council		
From:	James Armitage		
Date	20 July 2023	Project No:	146685.32
Subject:	WDC Small Works - Variation 3 - Stormwater Model Methodology Review		

1 BACKGROUND

1.1 Purpose

The purpose of this memorandum is to assess the modelling methodology used in the "Variation 3 Technical Review: Stormwater" report by Te Miro Water (the Report), dated May 2023 against the Regional Infrastructure Technical Specifications (RITS) and the Waikato Regional Council Guidelines for Stormwater Modelling.

This memorandum does not review of any scope outside the methodology used to provide rapid flood modelling for the refinement of flood risk/overland flow path areas in Tuakau, Pookeno, Huntly, and Ngaaruawaahia.

1.2 Limitations

The review is being provided in an extremely short period in order to provide feedback for the Waikato District Council, however due to the limited timeframe, this review has not covered in detail all of the standard areas a full peer review would. This memorandum evaluates if the standards and guidelines have been met, what variations there are, their applicability to the project, and any recommendations to correct the model and/or Report.

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2 MODELLING STANDARDS AND GUIDELINES

2.1 Waikato Regional Infrastructure Technical Specification

The Waikato RITS is a specification which covers the design of infrastructure in the Waikato Region. The RITS states:

"For catchments less than 8 hectares, surface water runoff using the Rational Method will be accepted. For larger catchments, or where significant storage elements (such as stormwater detention and treatment devices) are incorporated, surface water runoff should be determined using an appropriate hydrological or hydraulic computerised model. All modelling shall be carried out in accordance with the WRC's Waikato Stormwater Runoff Modelling Guideline (May 2018) and the relevant (or HCC) SW Modelling Methodology and software."

The Waikato Stormwater Runoff Modelling Guide has been updated since the issue of the RIITS and the most current version is referred to here.

2.2 Waikato Stormwater Modelling Guideline May 2020

The stormwater modelling guideline (the Guideline) provides instruction for determining runoff for catchments in the Waikato using the US SCS (TR55) method. This method is tailored to the Waikato Region typical rainfall, and includes direction for climate change assumptions, but has not been validated for the Waikato Region.

The guidelines are appropriate for assessing the effects of land use change, modelling extreme events, and simulating natural and engineered systems. The guidelines state that HEC HMS is an appropriate software to use for running the hydrological model.

The Guideline describes various model constraints which may apply to different projects. The following constraints for models are applicable on this project:

- Flows are assumed to be in open channels or in unconfined flows. Further modelling is required for flows divided between reticulated and overland to better determine the time of concentration.
- Rainfall data should utilise the most up to date NIWA HIRDS information available at the time.
- Soil types should be based on site soils testing.
- The model is applicable to both rural and urban catchments, and parameters for land cover are provided for these.
- The accuracy of the model will be dependent on the antecedent ground conditions and spatial rainfall variation. If required, curve numbers should be refined to represent local testing on gauged catchments to calibrate the system.

3 HYDROLOGIC RUNOFF

3.1 Modelling Software

The hydrologic rainfall runoff was calculated using HEC HMS to model the temporal runoff from the 24 hour rainfall pattern provided in the Guideline. This software is stated as acceptable in the Guideline.

3.2 Soils and Land Use Curve Numbers

Soil groups were determined and applied, including assumed initial and constant losses. The curve numbers were developed for each sub catchment using a weighted method which is standard industry practice for larger catchments, using the HCC GIS Curve number dataset (HCC 2017). Further assumptions were made to delineate the impervious and pervious areas based on existing and maximum developed states based on permitted plan values.

3.2.1 Variations from Modelling Guideline

The curve numbers are taken from the HCC dataset which is based on the NRCS methodology and includes the geologic factors of the soil types. The weighted values used will not line up exactly with standard NRCS values, however have been better developed for local application. We recommend using the curve values as determined by TMW.

3.3 Climate Change Adjustments

The Guideline states that a 2.1° change by 2090 is the minimum value, and the most current guidance on projected temperature rise shall be used. The model was adjusted for climate change in the proposed scenario based on the Guideline and the most current guidance at that time, which was to use HIRDs RCP 6.0 with the 2081-2100 period as advised by Waikato Regional Council. The Waikato Climate Change Guideline (2017) also provides indicative changes in temperature for the region in which the RCP 6.0 most closely aligns with the 2.1° change in the Guideline for 2100.

3.4 Existing and Proposed Rainfall

The historical values for the rainfall depths taken from HIRDS v4 are based on May 2020 values as documented in the report. These values are updated by NIWA on occasion and are currently different to the values indicated in the report. The table below shows the differences in value.

Town	Duration	10% AEP 2020 Rainfall Depth (mm)	10% AEP 2023 Rainfall Depth (mm)	10% AEP Change in rainfall depth (mm)	1% AEP 2020 Rainfall Depth (mm)	10% AEP 2023 Rainfall Depth (mm)	1% AEP Change in rainfall depth (mm)
Tuakau	24 hr	112	112	0	179	178	-1
Pookeno	24 hr	119	118	-1	190	189	-1
Huntly	24 hr	111	112	+1	175	176	+1
Ngaaruawaahia	24 hr	127	126	-1	198	197	-1

The rainfall values used in the model generally match the current HIRDS values. Therefore, the model has the appropriate values for the current rainfall guidance from NIWA.

3.4.1 Variations from Modelling Guideline

The values expected for stormwater runoff match the calculations defined in the Guideline. The values from the HIRDs V4 website are within <1% of the 2020 values used in the report, and therefore we don't recommend re-running the model for updated flow values.

3.5 Manning's Values

Manning's roughness coefficients used for calculations are listed in the report, and generally match the Guideline. The Grass and Roads values do not show enough decimal places to indicate their value – these have been confirmed with discussion with the team and verified in the model to be the values proposed by the Guideline.

3.5.1 Variations from Modelling Guideline

The values are not shown completely. We recommend the full values to be shown in the documentation for clarity.

3.6 Summary and Recommendations

There are no additional calculations required for the hydrologic model. We recommend clarifications on Manning's values to be included in a revised report.

4 HYDRAULIC MODEL

The hydraulic calculations are provided by a 1D and 2D model in TuFlow to determine rapid flooding levels in the regions discussed.

4.1 Provided Data

The model uses rainfall runoff as determined by HEC HMS (see Section 3), as well as public reticulation data to develop the 1d pipe system response serving the regions. The manhole and pipe data was incomplete in some areas. The Guideline does not state specific assumptions to make when data is missing, therefore assumptions were made based on standard engineering first principles:

- pipes were similar diameter to those upstream
- missing inverts were assumed to match adjoining pipes
- where depth was missing, minimum depth of cover was assumed
- where pipe data seemed incorrect, the pipes were updated based on interpretation of assumed errors.
- any missing manhole diameters were assumed based on the largest connecting pipe.
- any missing manhole depths were taken from the invert of the lowest connecting pipe.

Culverts were incorporated in the model where significant waterways occurred.

The DEM was based on the 2022 Lidar of the Waikato provided to Te Miro Water, with a resolution of 1m x 1m. Some areas of the DEM were noted to be higher based on dense vegetation and lowered based on break lines provided from survey.

4.1.1 Variations from Modelling Guideline

The assumptions made for missing pipe and manhole data are not covered in the Guideline. The assumptions are reasonable for engineering first principles.

4.1.2 Recommendations

We do not have additional recommendations for the provided data.

4.2 Reviewed Files

The following files were reviewed to verify that the outlined parameters were input correctly into the model:

- Model Control Files
  - Geographic
  - Boundary
  - Materials
  - Main Control file
- CSV files for time series flows from HEC HMS
- Error logs
- Check files

4.2.1 Recommendations

The Guideline does not specify what files should be reviewed as it allows for various accepted software. We do not have additional recommendations for the reviewed files as the information provided was sufficient to verify parameters throughout the models.

4.3 Model Set Up

The model results utilised a 2m x 2m grid, and incorporated Sub Grid Sampling (SGS). This methodology uses sampling at a finer resolution in the appropriate areas to better define the flood extents (0.5m x 0.5m grid size). Generally, this method provides a faster model run with more accurate results, and based on the discussion of Quadtree and SGS applicability to models, the resolution of the DEM and grid size means this is an appropriate situation to apply this feature of TuFlow modelling.

The catchments and other features are defined in QGIS, with the majority of layers having been provided for review. There were no exceptions or concerns with the delineation of the catchments or 1d reticulation network.

Boundary conditions were reviewed and discussed with the modeller. The main assumption was that the downstream boundary was unconstrained with a normal depth of 0.5%, consistent with the area's slope. This is feasible in that the outlets to the Waikato River for overland flows are not constrained by river heights in the considered floods (due to stop banks, etc), and that any primary system failures are included in the hydraulic model as blockages meeting the above guidelines and WRC direction for flow modelling.

4.3.1 Variations from Modelling Guideline

There are no variations from the Guideline in the model set up with regard to hydraulic modelling. The Guideline does not provide specific guidance for GIS or TuFlow specific 2D model set up, however the 1D pipe and manhole parameters meet the standards and guidelines.

4.3.2 Recommendations

We do not recommend any changes to the model set up. We recommend further detail about the Waikato River being excluded from boundary conditions in the report as this is a significant water body in several of the areas considered.

4.4 Model Variations and Testing

The Lidar data provided contained multiple depressions that were artifacts of roof areas being changed in post processing which were resulting in ponding areas that were deemed not realistic and affecting the overall storage volumes and flood levels. In order to remove these depressions without editing the surface data significantly, the storm analysis was run typically over a 72 hour period with a prior storm allowing the depressions to fill, runoff to fully drain, and then the standard nested storm to occur. This allowed normal runoff from the catchment and gave the full volume of runoff expected as the depression volumes were already full. This generally would result in reasonable approximation of the runoff as roof and surface water have very similar curve numbers.

The model has not been calibrated with real world data as there are no major flood records comparable to the model to calibrate to.

Sensitivity of the system has been undertaken in previous runs of the model, and will be clarified in an updated report.

4.4.1 Variations to Model Guidelines

The Guideline requires a 24 hour storm to be run for the rainfall runoff. In order to manage topographic issues, the 72 hour event was run with enough time between storms to allow for the standard 24 hour nested storm to run off the catchment as described above.

4.4.2 Recommendations

We recommend accepting the variation as described above, as it ensures the correct runoff is modelled in the catchment.

We recommend a section discussing model calibration and sensitivity is added to the report to outline why calibration is not realistic, and results of previous runs identifying any critical/sensitive aspects of the model.

5 SUMMARY

The model provided meets the Guideline and RITS methodology requirements where applicable. The above changes represent what is happening on site, in order to best indicate the full extent of flooding in the areas considered. Deviations and exceptions have a basis for application and are therefore not a concern.

Updated runs using the most recent NIWA HIRDS values are unlikely to affect the extents of the flood areas, however constant updates of the model should be undertaken with care as climate change information and science is constantly changing.

There is no additional information from Te Miro Water that is required for review of the report, and the recommended points that require updating in the report have been passed back to Te Miro Water to incorporate.

6 RECOMMENDATIONS

Model changes:

- No model changes suggested. Current variations from the guidelines are acceptable.

Report changes:

- Correct Manning's values in the Report.
- Add clarification on boundary conditions for Waikato River and stop banks.
- Add clarification on calibration of the model.
- Add information on sensitivity checks performed previously.

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