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Planning | Surveying | Engineering | Environmental

Sunfield Development
FTA Flood Model Peer Review

Sunfield Developments Limited

Document Information

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1 Executive Summary

1.1 Purpose of the peer review

The purpose of this document is to provide a technical peer review of the Flood Modelling prepared by Maven Associates to support the Fast Track Application for the proposed Sunfield development in Takanini, Auckland. The review was undertaken by CKL, who were engaged by Winton Land Limited. This assessment covers two separate models: the Eastern TUFLOW model and the Western TUFLOW model. The review focuses on the appropriateness of technical inputs, modelling methods, and validity of results against industry best practice and relevant engineering principles. The overall objective of the originating flood modelling was to manage the increased stormwater runoff resulting from the development and eliminate any flood hazards and adverse effects on upstream and downstream properties

1.2 Summary of findings for both Eastern and Western TUFLOW models

The peer review found that most aspects of the models were appropriate.

Positive and Conservative Findings:

- **Terrain Representation:** Modifications made for roads, LiDAR fixes, and other elevation changes were deemed appropriate. The representation of buildings by applying increased roughness, rather than modifying the Digital Elevation Model (DEM), was considered appropriate.
- **Infiltration/Soils:** The base Curve Number (CN) value of 74 was accepted as appropriate for this level of modelling, as the site's organic peat soils could behave anywhere between Hydrological Soil Group (HSG) B and HSG D soils. Initial abstraction ratios and infiltration layer coverage were also appropriate.
- **Stability:** Mass balances and volumetric errors in both the Eastern and Western TUFLOW models were within acceptable tolerances (all within ±1%) for all computational runs.
- **Roadway Roughness:** The Manning's n value used for roadways (0.05) is considered high compared to the recommended value of 0.02. This high value is likely to result in a conservative (overpredicted) estimate of flood depths in roadways, but its consistent use across baseline and proposed scenarios minimizes its effect on the relative difference between pre- and post-development flood depths.
- **Resolved Data Issues:** A critical data discrepancy was identified in the Western TUFLOW model where the 5yrCC rainfall boundary appeared duplicated from the 2yrCC rainfall data. The modeller has since rectified this issue by re-running the scenarios with the correct updated RF boundary and log files, which the reviewers confirmed were satisfactory.

1.3 Overall compliance with Relevant standards

Following the initial review and subsequent incorporation of responses from the originating engineers, all major issues concerning compliance and data use were addressed and accepted by the reviewers:

- **Climate Change Factors:** The modeller confirmed that climate change factors were applied in accordance with the Stormwater Code of Practice (SWCoP) v4, using a 2.1°C factor for 2-, 5-, 10-, 20-, and 50-year Annual Recurrence Interval (ARI) events, and a 3.8°C factor for the 100-year ARI.
- **Grid Resolution Compliance:** Although Auckland Council's Modelling Specification requires a maximum 2m x 2m grid, the reviewers accepted the current configuration (using 10m/5m/2.5m grids with Sub-Grid Sampling (SGS) enabled and quadtree refinement down to 1.25m in channels) as **fit-for-purpose**. The reviewers agreed that reducing the grid size was unlikely to materially affect the results.
- **Model Warnings:** Explanations regarding Warning 1100 (culvert inverts below channel bed) and Warning 2934 (merge polygon vertex outside sub-domain) were accepted, as they accurately represent the intended design/process and do not materially affect the modelling results.
- **Sensitivity Analysis:** Sensitivity checks for Curve Number, storm duration, and spatial rainfall distribution were confirmed to have been performed and documented in the flood modelling report.

1.4 Model suitability

The input data, model schematisation, and build were generally considered **suitable and/or conservative**. All required refinements and confirmations identified during the initial review, including the correction of the duplicated rainfall data in the Western TUFLOW model, have been addressed by the originating engineers and accepted by the reviewers.

1.5 Key recommendations

All required refinements and confirmations outlined in the initial findings (including grid refinement, rainfall verification, climate change factors, sensitivity analysis reporting, and model warnings checks) have been addressed by the originating engineers.

The reviewers have checked the updated files and justifications and found the responses reasonable and acceptable, concluding that **no further action is required**.

2 Introduction

2.1 Background

CKL was engaged by Winton Land Limited to undertake a technical peer review of the Flood Modelling undertaken by Maven Associates (Maven) to support the Fast Track Application for the proposed Sunfield development in Takanini, Auckland.

The subject site has a total site area of 244.5 Ha and is located within two stormwater catchments as shown in Figure 1, namely;

- The northern portion with an area of 188 Ha (Eastern Catchment) is located within the lower part of the Papakura Stream catchment and discharges to the Papakura Stream via existing farm drainage networks
- The southern portion, with an area of 56.5 Ha (Western Catchment) is located within the upper reaches of the Pahurehure Inlet Catchment and discharges via the existing Awakeri Wetlands/Takanini Stormwater Conveyance Corridor.

Both catchments discharge into the Manukau Harbour.

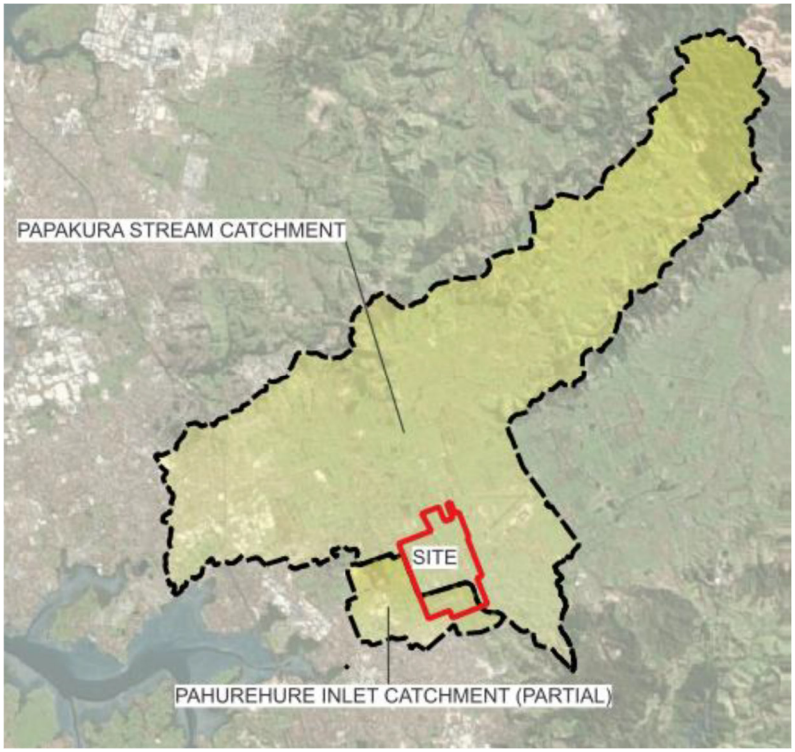

Figure 1: Site location and context (from Maven Stormwater Modelling Report January 2025)

The site is located within the Papakura Flood plain and, as such, has the potential to be affected by or cause effects to the flood behaviour within the wider flood plain.

2.2 Objectives of the flood modelling

The proposed development of the site will result in increased runoff and changes to the behaviour of the surrounding floodplain. Overall, the stormwater management strategy for the development aims to manage the effects of the development within the site and eliminate any increase in flood hazards within the surrounding area which could result from the development of the site. Peak flows, water levels and entry and exit locations of overland flow paths are proposed to be maintained to ensure upstream and downstream properties of the site are not adversely affected by the development. The flood modelling undertaken aims to demonstrate the effectiveness of the proposed mitigation measures in mitigating the effects of the development on flood risk within the upstream and downstream environment.

2.3 Scope of the peer review

The peer review covers two separate models developed by Maven, namely:

- **Eastern TUFLOW model** – covering the northern part of the development area receiving flows from the east and discharging north to the main Papakura Stream catchment
- **Western TUFLOW model** – covering the southern part of the development area receiving flows from the south and discharging to west to the Awakeri Wetland/Takanini Stormwater Conveyance Channel.

This peer review focusses on the appropriateness of the technical inputs, modelling methods and validity of results against industry best practice and relevant engineering principles. No interpretation of the results or modelling outputs has been undertaken as part of the peer review, with respect to the conclusions reached by the originating engineer based on the results of the flood modelling.

2.4 Reviewer credentials and methodology

This peer review has been undertaken by Zeb Worth and Dorcas Adjei-Sasu.

Zeb Worth is a Chartered Professional Engineer (CPEng) and Chartered member of Engineering New Zealand (CMEngNZ) with a bachelor's degree in civil and environmental engineering. He has over 25 years of New Zealand and Australian experience in civil and environmental engineering with over 18 years specialising in Stormwater and Flood Risk Management. He has held technical leadership roles on several stormwater and flood risk management projects including large scale public infrastructure and land development projects. This includes development and review of flood models in both TUFLOW and HEC-RAS.

Dorcas Adjei-Sasu is a Chartered Civil and Environmental Engineer (CMEngNZ) with over 16 years of international experience across New Zealand, South Africa, Ghana, and beyond. She specialises in stormwater management, catchment planning, and 1D–2D hydraulic modelling using tools such as InfoWorks ICM, TUFLOW, DHI MIKE, and HEC-RAS. Dorcas has extensive experience in technical peer review and quality assurance of hydraulic and stormwater models for local councils and government agencies. Her peer review portfolio includes:

- Wellington Water Limited – Peer reviewer of stormwater catchment models across Porirua, Wellington, Lower Hutt, and Upper Hutt, challenging assumptions, inputs, and outputs to ensure robust, defendable results.
- Tauranga City Council (Wairoa and Bethlehem projects) – Reviewed model conversions and stormwater management concepts, assessing compliance with consented base models and comparing Low Impact Design vs conventional approaches.
- Ōpōtiki District Council – Reviewed TUFLOW to ICM stormwater model conversion, verifying results consistency and updating with latest infrastructure.
- Timaru District Council (Grey Street model) – Reviewed hydraulic models to support development planning and confirm habitable floor levels.
- Waka Kotahi (Cambridge–Piarere SH1 improvements) – Reviewed hydrological calculations and stormwater models for major highway upgrades.

2.5 Review methodology

This peer review has been undertaken in accordance with Engineering New Zealand Practice Note 2: Peer Review Version 2 – April 2018 and generally following the process outlined below:

- CKL contact originating Engineers (Maven) and request for model files
- CKL Receipt of model and initial review
- Comment register issued to Maven and follow up meeting to discuss key issues raised
- Maven incorporates comments/feedback (including updating model where necessary) and issue revised model
- CKL review updated models and complete review

2.6 Information Reviewed

CKL have reviewed the following as provided by Maven via file sharing:

- **Eastern TUFLOW model files including:**
  - bc_dbase files including: inflow boundary files for the various modelled events (.csv), tidal boundaries (.csv), soil/infiltration files for CN39, CN61, CN74 and CN98 land use (.tsoilf)
  - Model check files for each event/scenario
  - Base model files including: materials .csv files (Manning's), TUFLOW control files(.tbc, .tgc, .ecf, .qcf)
  - Depth discharge tables for proposed outlet structures (Northern outflow, Pond 2 and Pond 3)
  - GIS shapefiles for various scenarios (1d_nwk, 2d_bc, 2d_bg, 2d_code, 2d_mat, 2d_oz, 2d_po, 2d_qnl, 2d_rf, 2d_sa, 2d_soil, 2d_zsh)
  - Grid files (DEM terrain) for each scenario based on LIDAR and site design surfaces
  - Pit inlet curves and database for inlet characteristics
  - TUFLOW run files (.bat, .tef, .tcf)
  - TUFLOW log files
- **Western TUFLOW model files including:**
  - bc_dbase files including: inflow boundary files for the various modelled events (.csv), tidal boundaries (.csv), soil/infiltration files for CN39, CN61, CN74 and CN98 land use (.tsoilf)
  - Model check files for each event/scenario
  - Base model files including: materials .csv files (Manning's), TUFLOW control files(.tbc, .tgc, .ecf, .qcf)
  - Depth discharge tables for proposed outlet structures (Northern outflow, Pond 2 and Pond 3)
  - GIS shapefiles for various scenarios (1d_nwk, 2d_bc, 2d_bg, 2d_code, 2d_mat, 2d_oz, 2d_po, 2d_qnl, 2d_rf, 2d_sa, 2d_soil, 2d_zsh)
  - Grid files (DEM terrain) for each scenario based on LIDAR and site design surfaces
  - Pit inlet curves and database for inlet characteristics
  - TUFLOW run files (.bat, .tef, .tcf)
  - TUFLOW log files

2.7 Relevant reference documents and information

- Auckland Council Stormwater Code of Practice version 4 (2025)
- Water New Zealand National Stormwater Modelling Guide version 1 (2024)
- Auckland Council Stormwater Flood Modelling Specification version 4 (2011)
- Auckland Council Stormwater Runoff Modelling Guidelines TP108 (1999)

3 Model Overview

3.1 Grid and Quadtree Resolution

- Base grid set at 10 m resolution, with quadtree refinement down nested to 2.5 m in key areas and alignments.
- Cell size transitions assumed not to cause instability or artificial head loss

3.2 Hydraulic Roughness (Manning's n)

- Standard TUFLOW recommended ranges used in conjunction with recommended values from the Auckland Council Modelling Specification
- Assumed constant within each land-cover type (no sub-grid variability).

3.3 Structures Representation

- Culverts and bridges represented using TUFLOW 1D structures linked to 2D cells (ESTRY engine).

3.4 Boundary Conditions

- Upstream inflow hydrographs applied at delineated catchments using RF (rainfall-runoff) or QT (flow-time) boundaries.
- Downstream boundary set as a stage–time series tied to tidal levels at Pahurehure Inlet.

3.5 Energy Losses

- Applied via Manning's n, plus culvert/bridge coefficients as above.
- No additional local head loss coefficients applied to bends or junctions unless explicitly surveyed.

3.6 Rainfall Application

- Applied as areal hyetographs (RAINFALL events distributed uniformly over catchments).
- Temporal patterns based on Auckland Council guidance

4 Initial Input Data Review

4.1 Topography: LiDAR, DEM, and contour data

The review confirms several aspects related to the Digital Elevation Model (DEM) and elevation modifications:

- **Roads:** Changes related to roads were applied globally and are considered appropriate.
- **LiDAR Fixes:** All modifications implemented based on LiDAR fixes were found to be appropriate relative to the model schematisation.
- **Other Elevation Changes:** Any other elevation changes made were also deemed appropriate based on the model schematisation.
- **Building Representation:** The approach used to represent buildings is applying **increased roughness** rather than modifying the terrain itself (i.e. lifting the building footprint above the surrounding ground), which the reviewer considers appropriate.

4.2 Rainfall

Specific comments regarding the rainfall data used for the various Annual Recurrence Interval (ARI) events:

- In the **Western TUFLOW** model, the **5yrCC rainfall boundary** appeared to be an exact copy of the **2yrCC rainfall** data for both pre- and post-development scenarios.
- The reviewer recommended that the modeller confirm the **correct 24hr rainfall depth** and climate change factors were used.

4.3 Soil and Land Use

The base parameters related to ground cover and infiltration characteristics were reviewed with the following observations:

- **Soil Type and Runoff:** The base Curve Number (CN) value of 74 utilised in the model may be too high for the typical Hydrological Soil Group (HSG) B alluvial soils present in the area. However, as the soils are likely to be predominantly organic peat soils (as is common in the Takanini plains) which can change hydrological response depending on water content/groundwater to behave anywhere between HSG B and HSG D soils, adopting a value representative of HSG C is considered appropriate for this level of modelling. It should be noted that for the Eastern TUFLOW model, the reporting states that **CN74** was used as per the HEC-RAS model. However, the documentation also notes that **varying CN based on soil types is used**, but the specific regions where these varying CN values are applied could **not be identified** by the reviewer.
- **Infiltration Layer Coverage:** The coverage of both the Mannings and Infiltration layers across the model domain is considered appropriate.
- **Initial Abstraction:** The initial abstraction ratios used are appropriate for the assumed soil type and impervious coverage.

4.4 Hydrology

Observations from the modelling on the computational aspects, flow boundaries, and model duration related to the calculation of flood flows are discussed:

- **Inflow Boundaries:** Inflow boundaries are correctly set up.
- **Outflow Boundaries:** Outflow boundaries are generally appropriate.
- **Model Duration:** A duration of **24-hours** was used for **both the Eastern and Western TUFLOW** simulations which is also considered sufficient, as the maximum depth is reached and the flood successfully subsides within this period
- **Time Steps:** for **both the Eastern and Western TUFLOW models**, an HPC adaptive timestep (minimum of 1 second maximum of 2.5 seconds)

  The timesteps used are considered acceptable, dependent on the stability of the results.
- **Output settings:** The default result settings, including output settings, are appropriate for all runs.
- **Mass Balance/Stability:** mass balances and excess iterations in **both the Eastern and Western TUFLOW** models are **within acceptable tolerances**.

5 Initial Model Configuration and Build Review

5.1 Mesh/grid resolution and alignment with flow paths

The review identified a number of observations relating to the configuration, resolution and orientation of the 2D grid used in the model received as summarised below;

- **Resolution:** both models use a **10m grid** for the wider floodplain, a **2.5m grid** for main channels, and a **5m grid** for the Sunfield development area. This resolution is considered appropriate, particularly because buildings are not explicitly modelled.
- **Council Specification:** The reviewer notes that Auckland Council's Modelling Specification requires a **maximum 2m x 2m grid**. It was suggested that the modeller may want to reduce the grid size in areas of interest and refinement regions to meet this specification. However, this was not considered a critical aspect by the reviewer.
- **Orientation:** The current orientation of the grid cells **does not align with the flow direction** in the main Awakeri Wetland Channel or some of the proposed channels. It was suggested by the reviewer that the modeller may want to align the grid in the relevant region to improve stability. However, this was considered a minor issue by the review and not critical to the performance of the model.
- **Model Extent:** Minor "glass walling" (model results hitting the boundary) are noted at 2d domain boundaries surrounding the development area. However, these are considered by the reviewer to be shallow depth artifacts of the rain on grid approach for the 2D region and are not considered to materially affect the results as inflow boundaries dominate flood behaviour.
- **Building Representation:** Buildings are represented by increasing the roughness value rather than modifying the underlying DEM. This is considered appropriate for the modelling objectives

5.2 Representation of overland flow paths

Overland flow paths are generally represented appropriately in both the HEC-RAS and TUFLOW models. The only observation noted relates to the choice of Manning's roughness coefficient for overland flow on roadways.

- **Roadway Roughness:** The Manning's *n* value used for roadways (0.05) is considered high. The SWCoP recommends a lower value of **0.02** for overland flow along roadways. However, the adopted value is likely to overpredict flood depths within roadways and is therefore considered likely to result in a conservative estimate. In any case, the same roughness coefficient has been adopted in both the baseline and proposed scenarios so is unlike to have any significant effect on the relative difference between pre and post development flood depths

5.3 Hydraulic connectivity and floodplain interaction

Comments related to how flow interacts with the model boundaries and the floodplain:

- **Model Extent:** refer comments in Section 5.1 above

5.4 Climate change adjustments

The model's incorporation of climate change factors needs verification:

- **Rainfall Data Discrepancy:** in the **Western TUFLOW** model the **2yrCC rainfall boundary appeared to be an identical copy of the 5yrCC** rainfall boundary. It was recommended that the modeller immediately check the rainfall boundaries for these runs and re-run as required.
- **Factor Confirmation:** it was recommended that the modeller confirm the correct climate change factor and the specific scenario (i.e., **2.1 degrees or 3.8 degrees**) used for each ARI event.
- **Temporal Distribution:** Confirmation that the temporal distributions used comply with the standards set in **SWCoP v4 Table 2** for each climate change scenario is recommended.

5.5 Energy Losses

The parameters used to account for friction and infiltration losses were reviewed:

- **Friction Losses (Roughness):** The Manning's n values used across the model are appropriate, except for the roadways, where the value of 0.05 is high. The SWCoP standard recommends an n value of **0.02** for overland flow along roadways.
- **Infiltration Losses (CN):** The base Curve Number (CN) of **74** may be high for Group B alluvial soils, but this is accepted as a **conservative assumption** and is likely to more closely represent the peat soils likely to be present on the site.
- **Initial Abstraction:** The initial abstraction ratios used are considered appropriate for the soil type and level of impervious coverage assumed.

6 Calibration and Validation Review

6.1 Validation against Historic Floods or current Auckland Council Flood Modelling

No information regarding comparison with historical flood data or traditional validation metrics is present in the sources.

6.2 Sensitivity analysis of key parameters

Results and data for sensitivity analysis scenarios to varying parameters (e.g. CN, Manning's, duration) was not provided. However, it is noted from the reporting that this may have been undertaken as part of the model build. If this has been undertaken, it is recommended by the reviewers that the outcome of the sensitivity analysis be included in the reporting to give further confidence in the validity of the assumptions used and results obtained from the modelling.

6.3 Model stability and convergence

The reviewers have made the following observations related to computational stability:

- **TUFLOW model**
    - **Stability:** checks, including WSE errors and maximum iterations for both the **Western TUFLOW and Eastern TUFLOW** models were within acceptable tolerances.
    - **Mass Balance:** 1D and 2D Cumulative Mass and Volumetric Errors are within acceptable limits for all computational runs (all within ±1%) for **both Eastern and Western TUFLOW models**
    - **Warning Messages: No critical warnings** were reported during the computational runs for the **Eastern TUFLOW model**.

      However, **warnings relating to the geometry** were noted for the **Western TUFLOW model**. These related to the application of zshape modifications and invert levels of a number of 1D structures/culverts:

        - BattalionRdCvt crest/invert (11.592) is below bed (15.960) of primary upstream channel MHCR1318773
        - Structure 3000023254 crest/invert (25.780) is below bed (26.121) of primary upstream channel 3000023255
        - Structure 3000018207 crest/invert (25.050) is below bed (25.970) of primary upstream channel 30000180302

      It was recommended that the 1D levels in these structures be reviewed and checked to ensure that they represent the intended 1D network configuration. It was also recommended that the zhape modifications be checked to ensure they are appropriately applied and that the noted warning does not affect results.

7 Summary of initial findings and recommendations

The section below provides a summary of the findings and recommended actions from the initial review of the models. A summary of the findings along with the recommended actions outlined in Section 7.3 were provided to the originating engineers for consideration and incorporation into the modelling where appropriate. A record of the review findings, responses and actions is provided in Appendix 1.

7.1 Summary of findings

Generally, most aspects of the models were found to be appropriate:

- **Terrain Representation:** The modifications implemented based on LiDAR fixes, roads, and other elevation changes were deemed appropriate relative to the model schematisation. The approach of representing buildings by increasing roughness, rather than modifying the Digital Elevation Model (DEM), is considered appropriate.
- **Infiltration/Soils:** The use of a base Curve Number (CN) value of 74, while possibly high for typical Hydrological Soil Group (HSG) B alluvial soils, is considered appropriate for this level of modelling because the site likely contains organic peat soils which can change hydrological response, behaving anywhere between HSG B and HSG D soils. Initial abstraction ratios and infiltration layer coverage are also appropriate.
- **Stability:** Mass balances and volumetric errors in both the Eastern and Western TUFLOW models were within acceptable limits (all within ±1%) for all computational runs. Checks, including WSE errors and maximum iterations for both the Eastern and Western TUFLOW models, were within acceptable tolerances.
- **Roadway Roughness (Conservative):** The high Manning's n value used for roadways (0.05), compared to the Auckland Council Stormwater Code of Practice (SWCoP) recommendation of 0.02, is likely to result in a conservative (overpredicted) estimate of flood depths within roadways. Since this same coefficient was used for both baseline and proposed scenarios, it is unlikely to have a significant effect on the relative difference between pre- and post-development flood depths.

7.2 Model adequacy and compliance

While most parameters were appropriately configured or adopted conservatively, specific issues regarding compliance and configuration necessitate further checking and refinement:

- **Grid Resolution Compliance:** Both models utilize a 10m grid for the wider floodplain, a 2.5m grid for main channels, and a 5m grid for the Sunfield development area. However, **Auckland Council's Modelling Specification requires a maximum 2m x 2m grid**.
- **Data Discrepancy (Rainfall/Climate Change):** A significant issue was noted in the **Western TUFLOW** model where the 5yrCC rainfall boundary appears to be an identical copy of the 2yrCC rainfall data for both pre- and post-development scenarios. The documentation does not provide the rainfall derivation, making it impossible to confirm the correct rainfall and climate change factor (2.1 degrees or 3.8 degrees) used for each Annual Recurrence Interval (ARI) event.
- **Model Orientation:** The current orientation of the grid cells does not align with the flow direction in the main Awakeri Wetland Channel or some of the proposed channels.

7.3 Required refinements or additional modelling

1. **Grid Refinement:** The modeller should consider **reducing the grid size** in areas of interest and refinement regions to meet the Auckland Council Modelling Specification requirement of a maximum 2m x 2m grid.

2. **Rainfall Data Verification:** The modeller **should immediately confirm** that the correct 24-hour rainfall depth and climate change factors were used, especially in the Western TUFLOW model where the 5yrCC and 2yrCC rainfall boundaries appear duplicated. The model should be re-run with the correct rainfall boundary for the relevant scenario(s).

3. **Climate Change Factor Confirmation:** The modeller **must confirm** the specific climate change factor and scenario (2.1 degrees or 3.8 degrees) used for each ARI event, as well as confirming that the temporal distributions comply with the standards set in SWCoP v4 Table 2 for each scenario.

4. **Sensitivity Analysis Reporting:** If a sensitivity analysis of key parameters (e.g., CN, Manning's, duration) has been undertaken as part of the model build, it is recommended that the **outcome of this analysis be included in the reporting** to give further confidence in the validity of the assumptions and results.

5. **Warning 1100** was noted in the **Western TUFLOW** log files at 3 locations relating to culvert invert levels and zshape modifications:

    a. BattalionRdCvt crest/invert (11.592) is below bed (15.960) of primary upstream channel MHCR1318773

    b. Structure 3000023254 crest/invert (25.780) is below bed (26.121) of primary upstream channel 3000023255

    c. Structure 3000018207 crest/invert (25.050) is below bed (25.970) of primary upstream channel 30000180302

    review of the 1D topography and structure invert/dimensions is recommended

6. **Warning 2934** relating to topography zshape modifications:

    a. At least one merge polygon vertex is outside quadtree sub-domain

    check that the appropriate topography modifications have been applied

8 Modeller responses

Following circulation and discussion with the originating Engineers of the findings and recommendations outlined in Section 7, the responses shown were received. The responses below are numbered corresponding to the action items listed in Section 7.3 above in normal text with reviewer comments included below each item in ***bold italics***.

1. **Grid Refinement:**

   Sub-Grid Sampling (SGS) is enabled with a Sample Target Distance of 1m, which provides an effective sub-cell representation of terrain features and hydraulic controls significantly finer than the base cell size. This allows narrow features (embankments, local ground undulations, berms) and wet-dry interfaces to be captured within each cell without necessitating a 2 m base grid across broad areas. The current grid resolution is considered fit-for-purpose and captures the necessary hydraulic complexity, enabling broader scenario testing and sensitivity analyses. We propose to retain the current configuration, with optional localised mesh sensitivity tests if requested.

   Additionally, a quadtree grid refinement of level 3 (1.25m grid) is applied to farm drain to the north of Airfield Road, to better capture the terrain of these small open channels.

   Running the hydraulic model at a 2m x 2m grid resolution significantly increases computational time. Given the number of scenarios assessed, completing all runs at this resolution would take several weeks. Importantly, this refinement is unlikely to materially change the outcomes or influence key decisions. We recommend maintaining the current configuration and only providing 2m x 2m grid outputs if specifically requested by Council, and for the scenarios they identify.

   The reviewers agree that reducing the grid size is unlikely to materially affect the results given the inclusion of sub grid sampling and quadtree within the model set-up. Retaining the current model configuration is considered appropriate and no further action is considered necessary.

2. **Rainfall Data Verification (Western TUFLOW Model):**

   We re-ran the model overnight to address Point 2. The pre- to post-development results for the 5-year critical duration storm event are satisfactory [Updated model files for 5yrcc scenario provided for review].

   The reviewers have checked the updated RF boundary and log files and confirm the updated values used are now correct. No further action is considered necessary.

3. **Climate Change Factor Confirmation:**

   Climate change factors have been applied in accordance with SWCoP v4, with a 2.1°C factor used for the 2-, 5-, 10-, 20-, and 50-year ARI events, and a 3.8°C factor applied to the 100-year ARI. These inputs are documented in Tables 2.1 and 4.1 of the stormwater modelling report.

   Rainfall factors are appropriate and in line with accepted standards. Note that the reviewers have not sighted the updated Stormwater Modelling Report referenced but it is assumed that this has been adequately documented in the report. No further action required.

4. **Sensitivity Analysis Reporting:**

   Sensitivity checks have been included for Curve Number (CN 61 and CN 74), storm duration (30 minutes, 60 minutes, and 24 hours), and spatial rainfall distribution. These details are documented in the latest version of the flood modelling report.

   Sensitivity tests are considered appropriate. Note that the reviewers have not sighted the updated Stormwater Modelling Report referenced but it is assumed that this has been adequately documented in the report. No further action required.

5. **Warning 1100:**

   The WARNING 1100 messages for structures 3000023254, 3000018207, and BattalionRdCvt are expected and acceptable in this case. These structures are connected to upstream manholes, which are designed to have invert levels lower than the bed elevation of the primary upstream channel. No changes are proposed, and the configuration is consistent with the intended drainage design.

   This is considered reasonable and, based on further information provided, accurately represents the 1D pipe network configuration for these assets. No further action required.

6. **Warning 2934:**

   The warning message: “WARNING 2934 – At least one merge polygon vertex is outside quadtree sub-domain.” has been reviewed and is not considered an error in this context.

   This warning occurs when a ZShape polygon used for topographic modification extends slightly beyond the active model domain or quadtree sub-domain. In this case, the "NO MERGE" option was applied to each culvert inlet/outlet area to ensure complete modification of the elevation. Additionally, the relevant 2d_zsh file was imported using “Read GIS Z Shape” at the end of the topography input sequence. This ensures that the intended elevation modifications are correctly applied and overwrite any previous elevation data, including those affected by earlier merge operations. The warning is informational and does not impact results. No further action is required.

   This explanation is accepted and, based on location and context provided, is not considered by the reviewers to materially affect the results of the modelling. No further action required.

9 Summary and conclusions

Based on the initial findings and the subsequent responses provided by the originating modellers, Section 9 Summary and Conclusions can be populated as follows:

9.1 Summary of findings

The peer review found that most aspects of the Eastern and Western TUFLOW models prepared for the Sunfield Development were appropriate.

Positive Findings Confirmed by Review:

- **Terrain Representation:** Modifications based on LiDAR fixes, roads, and other elevation changes were appropriate. The approach of representing buildings by applying increased roughness instead of modifying the Digital Elevation Model (DEM) was considered appropriate.
- **Infiltration/Soils:** The base Curve Number (CN) value of 74 was deemed appropriate for this level of modelling, even though it may be high for typical Hydrological Soil Group (HSG) B alluvial soils, because the site likely contains organic peat soils which can behave between HSG B and HSG D soils. Initial abstraction ratios and infiltration layer coverage were also appropriate.
- **Stability: Mass balances and volumetric errors were within acceptable tolerances (all within ±1%)** for all computational runs in both the Eastern and Western TUFLOW models.
- **Roadway Roughness:** The high Manning's n value used for roadways (0.05) is considered conservative, likely overpredicting flood depths in roads, but its consistent use in both baseline and proposed scenarios minimizes its effect on relative flood depth differences.
- **Resolved Data Issues:** The critical data discrepancy in the Western TUFLOW model, where the 5yrCC rainfall boundary appeared to be an identical copy of the 2yrCC rainfall data, was rectified by the modeller who re-ran the scenarios with the correct updated RF boundary and log files.

9.2 Model adequacy and compliance

While overall the input data, model schematisation, and build were considered suitable and/or conservative, several key issues were identified during the initial review, all of which have since been addressed by the originating Engineers and accepted by the reviewers:

Table 1: Summary of recommendations and actions

Initial Issue	Compliance Requirement / Finding	Modeller Response / Reviewer Acceptance
Rainfall Data Verification	Needed to confirm correct 24-hour rainfall depth and climate change factors, especially the duplicated 2yrCC/5yrCC boundaries in the Western model.	The model was re-run with the correct updated values, which the reviewers confirmed were satisfactory.
Climate Change Factors	Needed confirmation of the specific factor (2.1°C or 3.8°C) and compliance of temporal distributions with SWCoP v4 Table 2.	Factors were confirmed: 2.1°C for 2-, 5-, 10-, 20-, and 50-year ARI events, and 3.8°C for the 100-year ARI, aligning with SWCoP v4 and accepted by the reviewers.
Grid Resolution	Auckland Council's Modelling Specification requires a maximum 2m x 2m grid. Models used 10m/5m/2.5m grids.	The use of Sub-Grid Sampling (SGS) and quadtree refinement (down to 1.25m in some channels) was confirmed. The reviewers agreed that the current configuration is fit-for-purpose and that reducing the grid size is unlikely to materially affect the results. The current configuration is considered appropriate.
Model Warnings (1100)	Warnings relating to 1D structure crest/invert levels being below the upstream channel bed.	The modeller confirmed these warnings were expected and acceptable as they accurately represent the intended design of manholes connected to the 1D pipe network. This was accepted and agreed by the reviewers
Model Warnings (2934)	Warning about zshape modifications where a merge polygon vertex was outside the quadtree sub-domain.	The modeller explained this warning is informational, occurs when using the "NO MERGE" option to ensure elevation modification, and does not impact results. The explanation was accepted by the reviewers.
Sensitivity Analysis	Recommendation to report outcomes of sensitivity analyses (CN, Manning's, duration) if undertaken.	The modeller confirmed sensitivity checks were performed for Curve Number (CN 61 and CN 74), storm duration (30 minutes, 60 minutes, and 24 hours), and spatial rainfall distribution, and were documented in the flood modelling report.

9.3 Outstanding Actions

All required refinements and confirmations outlined in the initial findings have been addressed by the originating engineers. The reviewers have checked the updated files and justifications and found the responses reasonable and acceptable, concluding that **no further action is required** regarding grid refinement, rainfall verification, climate change factors, sensitivity analysis reporting, or model warnings.

10 Limitations

This report has been prepared solely for the benefit of our client with respect to the particular brief and it may not be relied upon in other contexts for any other purpose without the express approval by CKL. Neither CKL nor any employee or sub-consultant accepts any responsibility with respect to its use, either in full or in part, by any other person or entity. This disclaimer shall apply notwithstanding that the memo/report may be made available to other persons including Council for an application for consent, approval or to fulfil a legal requirement.

Appendix 1 Comments Schedules

Flood Model Peer Review
Comment Schedule

Project:	**Sunfield Development, Takanini**	**File:**	**A24151-EV- -Sunfield Flood Model Peer Review Comments v1_CKL20251015.xlsx**
Model Name/ID:	**Western TUFLOW**	**Revision:**	**2**
Reviewer:	**Zeb Worth**	**Date:**	**15/10/2025**

Item	Topic	Review Comment	Modeller Response	Final Action Completed	Reviewer Comments		importance	Status	Date closed
1	2D Grid & Model Domain								
1.1	*Resolution appropriate*	*10m grid for wider floodplain with 2.5m grid for main channels. and 5m grid for Sunfield development. Considered appropriate, as buildings are not modelled. . However, note that Auckland Council specify a 2m x 2m grid in their Modelling Specification so it may be worth reducing grid size within refinement regions and areas of interest to maximum 2m x 2m or smaller if there is significant hydraulic complexity*	*see Eastern TUFLOW comment sheet for modeller response*	*see Eastern TUFLOW comment sheet for modeller response*	*accepted and closed*		*Low*	*Closed*	*10/10/2025*
1.2	*Orientation appropriate*	*Orientation of grid cells does not align with flow direction in main Awakeri Wetland Channel or some of the proposed channels. Consider using breaklines to align cells to match flow direction for improved stability*	*see Eastern TUFLOW comment sheet for modeller response*	*see Eastern TUFLOW comment sheet for modeller response*	*accepted and closed*		*Low*	*Closed*	*10/10/2025*
1.3	Extent appropriate	*Extent considered appropriate*	N/A	N/A	N/A		Comment (no action required)	N/A	N/A
2	Hydrology								
2.1	*Rainfall*	*2yr and 5yr CC rf boundaries appear to be duplicates. Confirm correct rainfall is applied for these scenarios*	*Model re-run with corrected rainfall boundary data*	*Updated TUFLOW model files provided*	*Updated model files reviewed and checked correct rainfall applied. Updated RF boundaries are appropriate and item closed*		*High*	*Closed*	*14/10/2025*
2.2	*Losses*	*Base CN value of 74 used may be too high for soil types (generally Group B alluvial soils) however, this is a conservative assumption so will overpredict runoff. Initial abstraction ratios are appropriate for assumed soil type and impervious coverage.*	*see Eastern TUFLOW comment sheet for modeller response*	*see Eastern TUFLOW comment sheet for modeller response*	*accepted and closed*		*Low*	*Closed*	*10/10/2025*
3	2D Boundary Conditions								
3.1	Outflow Boundaries	*Outflow boundaries generally appropriate.*	N/A	N/A	N/A		Comment (no action required)	N/A	N/A
2.4	Inflow Boundaries	*Inflow boundaries are correctly set and called from bc database for each event*	N/A	N/A	N/A		Comment (no action required)	N/A	N/A
4	2D Landuse								
4.1	*Roughness*	*Manning's n for roadways is high (0.05). SWCoP recommends 0.02 for overland flow along roadways. Consider adopting lower n value for roadways. Remainder of n values are appropriate*	*see Eastern TUFLOW comment sheet for modeller response*	*see Eastern TUFLOW comment sheet for modeller response*	*justification is reasonable and in line with local guidance*		*Low*	*Closed*	*10/10/2025*
4.2	*Initial & Continuing Losses*	*varying CN based on soil types is used Initial abstraction ratios are appropriate for assumed soil type and impervious coverage.*	*see Eastern TUFLOW comment sheet for modeller response*	*see Eastern TUFLOW comment sheet for modeller response*	*based on information provided CN=74 is considered appropriate. Comparative results from both CN61 and CN74 scenarios show minimal difference in overall results*		*Low*	*Closed*	*10/10/2025*
4.3	Coverage of layers	*Mannings and Infiltration layer coverages are appropriate*	N/A	N/A	N/A		Comment (no action required)	N/A	
5	Elevation Shapes / Initial Water Levels								
5.1	Roads - Appropriate changes applied globally	*Not applicable*	N/A	N/A	N/A		Comment (no action required)	N/A	
5.2	LiDAR fixes - Check if appropriate	*All modifications are appropriate based on model schematisation*	N/A	N/A	N/A		Comment (no action required)	N/A	
5.3	Other elevation changes - Check if appropriate	*All modifications are appropriate based on model schematisation*	N/A	N/A	N/A		Comment (no action required)	N/A	
5.4	Review DTM used (addition of buildings etc)	*Buildings are represented by increased roughness rather than terrain modification/DTM which is considered appropriate*	N/A	N/A	N/A		Comment (no action required)	N/A	
6	Computational Setup								
6.1	Appropriate timesteps applied	*HPC adaptive timesteps used. All timestep setup is considered appropriate Base timestep of 1sec with 2.5sec maximum 0.5 second base timestep used for 1D computation*	N/A	N/A	N/A		Comment (no action required)	N/A	
6.2	Correct durations (maximum depth is reached - approx. 2x rainfall duration)	*24hr duration with 24hr rainfall Maximum depth reached by 14hrs in most areas. Duration considered appropriate*	N/A	N/A	N/A		Comment (no action required)	N/A	
6.3	*Check stability - Maximum iterations and WSE errors*	*cannot review stability as no tlf or log files provided*	*TLF and log files to be provided*	*TUFLOW log files uploaded to file share*	*log files reviewed WSE errors and iterations within acceptable tolerances for all runs*		*High*	*Closed*	*14/10/2025*
6.4	Check stability - continuity and mass balances	*All mass errors within tolerances (less than +/- 0.5%)*	N/A	N/A	N/A		Comment (no action required)	N/A	
6.5	Default result settings (e.g. cutoff depths, mapping increments, output timesteps)	*Output settings are appropriate for all runs*	N/A	N/A	N/A		Comment (no action required)	N/A	
6.6	*Review warning messages*	*cannot review messages as no tlf and log files are supplied and*	*TLF and log files to be provided*	*TUFLOW log files uploaded to file share*	*log files reviewed Warnings noted relating to culvert invert levels at BattalionRdCvt crest/invert (11.592) is below bed (15.960) of primary upstream channel MHCR1318773 Structure 3000023254 crest/invert (25.780) is below bed (26.121) of primary upstream channel 3000023255 Structure 3000018207 crest/invert (25.050) is below bed (25.970) of primary upstream channel 30000180302 review of the 1D topography and structure invert/dimensions is recommended Warning relating to topography zshape modifications: At least one merge polygon vertex is outside quadtree sub-domain check that the appropriate topography modifications have been applied*	*The WARNING 1100 messages for structures 3000023254, 3000018207, and BattalionRdCvt are expected and acceptable in this case. These structures are connected to upstream manholes, which are designed to have invert levels lower than the bed elevation of the primary upstream channel. No changes are proposed, and the configuration is consistent with the intended drainage design. The warning message: "WARNING 2934 – At least one merge polygon vertex is outside quadtree sub-domain." has been reviewed and is not considered an error in this context. This warning occurs when a ZShape polygon used for topographic modification extends slightly beyond the active model domain or quadtree sub-domain. In this case, the "NO MERGE" option was applied to each culvert inlet/outlet area to ensure complete modification of the elevation. Additionally, the relevant 2d_zsh file was imported using "Read GIS Z Shape" at the end of the topography input sequence. This ensures that the intended elevation modifications are correctly applied and overwrite any previous elevation data, including those affected by earlier merge operations. The warning is informational and does not impact results. No further action is required.*	*Low*	*Closed*	*15/10/2025*

Flood Model Peer Review
Comment Schedule

Project:	**Sunfield Development, Takanini**	**File:**	**A24151-EV- -Sunfield Flood Model Peer Review Comments v1_CKL20251015.xlsx**
Model Name/ID:	**Eastern TUFLOW**	**Revision:**	**1**
Reviewer:	**Dorcas Adjei-Sasu**	**Date:**	**15/10/2025**

Item	Topic	Review Comment	Modeller Response	Final Action Completed	Reviewer Final Comments	Importance	Status	Date closed
1	2D Grid & Model Domain							
1.1	*Resolution appropriate*	*10m grid for wider floodplain with 2.5m grid for main channels. and 5m grid for Sunfield development. Considered appropriate, as buildings are not modelled. . However, note that Auckland Council specify a 2m x 2m grid in their Modelling Specification so it may be worth reducing grid size within refinement regions and areas of interest to maximum 2m x 2m or smaller if there is significant hydraulic complexity*	*Sub-Grid Sampling (SGS) is enabled with a Sample Target Distance of 1 m, which provides an effective sub-cell representation of terrain features and hydraulic controls significantly finer than the base cell size. This allows narrow features (embankments, local ground undulations, berms) and wet-dry interfaces to be captured within each cell without necessitating a 2 m base grid across broad areas. The current grid resolution is considered fit-for-purpose and captures the necessary hydraulic complexity, enabling broader scenario testing and sensitivity analyses. We propose to retain the current configuration, with optional localised mesh sensitivity tests if requested.*	*retain the current configuration* *Additionally, a quadtree grid refinement of level 3 (1.25m grid) is applied to farm drain to the north of Airfield Road, to better capture the terrain of these small open channel.*	*accepted and closed*	*Low*	*Closed*	*10/10/2025*
1.2	*Orientation appropriate*	*Orientation of grid cells does not align with flow direction in main Awakeri Wetland Channel or some of the proposed channels. Consider using breaklines to align cells to match flow direction for improved stability*	*TUFLOW's results are largely insensitive to mesh orientation due to its finite-volume solver and Sub-Grid Sampling (SGS) technology, which virtually eliminates orientation dependence even with coarse fixed-grid resolutions. In addition, Breaklines have been used to maintain terrain integrity and hydraulic realism.*	*No changes are proposed*	*accepted and closed*	*Low*	*Closed*	*10/10/2025*
1.3	Extent appropriate	*Extent of model domain considered appropriate*	N/A	N/A	N/A	Comment (no action required)	N/A	N/A
2	Hydrology							
2.1	*Rainfall*	*Confirm climate change scenario is correct for each ARI (i.e. 2.1degrees or 3.8degrees). Check that temporal distributions used are appropriate for each climate change scenario as per SWCoP v4 Table 2*	*Climate change scenarios including 2.1 and 3.8 degrees factors been applied correctly for each ARI and in accordance with Auckland Council SWCoP v4. Details refer to flood report.*	*No changes are proposed*	*accepted and closed*	*Low*	*Closed*	*10/10/2025*
2.2	*Losses*	*varing CN based on soild types is used. Could not identify where these regions are from as the reporting says CN74 used as per hecmodel* *Intial abstraction ratios are appropriate for assumed soil type and impervious coverage.*	*Variable CN values have been correctly applied based on soil and land-use mapping. Initial abstraction ratios are appropriate and consistent with HEC-HMS and SWCoP v4 guidance. Refer to flood report for detailed statements.*	*Both of CN 61 and 74 for peat soil are applied in the updated TUFLOW model*	*accepted and closed*	*Low*	*Closed*	*10/10/2025*
3	2D Boundary Conditions							
3.1	Outflow Boundaries	*Outflow boundaries generally appropriate.*	N/A	N/A	N/A	Comment (no action required)	N/A	N/A
2.4	Inflow Boundaries	*Inflow boundaries are correctly set*	N/A	N/A	N/A	Comment (no action required)	N/A	N/A
4	2D Landuse							
4.1	*Roughness*	*Manning's n for roadways is high (0.05). SWCoP recommends 0.02 for overland flow along roadways. Consider adopting lower n value for roadways. Reminder of n values are appropriate*	*The applied Manning's n value of 0.05 for roads/impervious areas is consistent with Auckland Council Stormwater Modelling Specifications (December 2023, Issue 1), Table A6-4, which recommends 0.05 for 2D surfaces representing roads and impervious areas. Sensitivity tests with n = 0.02 showed negligible change in flood extents but introduced unrealistic velocities and reduced attenuation along road corridors. Using n = 0.05 provides conservative and physically representative results.*	*No changes are proposed*	*justification is resonable and in line with local guidance*	*Low*	*Closed*	
4.2	*Initial & Continuing Losses*	*varing CN based on soild types is used. Could not identify where these regions are from as the reporting says CN74 used as per hecmodel* *Intial abstraction ratios are appropriate for assumed soil type and impervious coverage.*	*Variable CN values have been correctly applied based on soil and land-use mapping. Initial abstraction ratios are appropriate and consistent with HEC-HMS and SWCoP v4 guidance. Refer to flood report for detailed statements.*	*Both of CN 61 and 74 for peat soil are applied in the updated TUFLOW model*	*based on information provided CN=74 is considered appropriate. Comparitive results from both CN61 and CN74 scenarios show minimal difference in overall results*	*Low*	*Closed*	
4.3	Coverage of layers	*Mannings and Infiltration layer coverages are appropriate*	*N/A*	N/A	N/A	Comment (no action required)	N/A	N/A
5	Elevation Shapes / Initial Water Levels							
5.1	Roads - Appropriate changes applied globally	*Not applicable*	*N/A*	N/A	N/A	Comment (no action required)	N/A	N/A
5.2	LiDAR fixes - Check if appropriate	*All modifications are appropriate based on model schematisation*	*N/A*	N/A	N/A	Comment (no action required)	N/A	N/A
5.3	Other elevation changes - Check if appropriate	*All modifications are appropriate based on model schematisation*	*N/A*	N/A	N/A	Comment (no action required)	N/A	N/A
5.4	Review DTM used (addition of buildings etc)	*Buildings are represented by increased roughness rather than terrain modification/DTM which is considered appropraite*	*N/A*	N/A	N/A	Comment (no action required)	N/A	N/A
6	Computational Setup							
6.1	Appropriate timesteps applied	*HPC adaptive timestepping used*	*N/A*	N/A	N/A	Comment (no action required)	N/A	N/A
6.2	*Correct durations (maximum depth is reached - approx. 2x rainfall duration)*	*24hr duration.*	*A completed TUFLOW model is re-uploaded*	*A completed TUFLOW model is re-uploaded*	*24hr duration with 24hr rainfall* *Maximum depth reached during simulation.* *Duration considered appropriate*	*Low*	*Closed*	*10/10/2025*
6.3	*Check stability - Maximum iterations and WSE errors*	*unable to check as xmdf files are corrupted*	*A completed TUFLOW model is re-uploaded*	*A completed TUFLOW model is re-uploaded*	*WSE errors and maximum iterations in re-uploaded model within acceptable tolerances*	*High*	*Closed*	*10/10/2025*
6.4	*Check stability - continuity and mass balances*	*cant review messages as no tlf files are supplied and unable to intiate a run*	*A completed TUFLOW model is re-uploaded*	*A completed TUFLOW model is re-uploaded*	*All mass errors in updated model within tolerances (less than +/- 0.5%)*	*Low*	*Closed*	*10/10/2025*
6.5	Default result settings (e.g. cutoff depths, mapping increments, output timesteps)	*Output settings are appropriate for all runs*	*A completed TUFLOW model is re-uploaded*	A completed TUFLOW model is re-uploaded	N/A	Comment (no action required)	N/A	N/A
6.6	*Review warning messages*	*cant review messages as no tlf and log files are supplied and*	*A completed TUFLOW model is re-uploaded*	*A completed TUFLOW model is re-uploaded*	*no critical warning messages noted in tlf files or messages layers*	*Low*	*Closed*	*10/10/2025*