



BMT Commercial Australia Pty Ltd
6/20 Byron Street
Bangalow NSW 2479
Australia

Our Ref: : L.B23632.004.docx

Tel: +61 2 6687 0466
Fax: +61 2 6687 0422

ABN 54 010 830 421

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www.bmt.org

General Manager
Byron Shire Council
PO Box 219
Mullumbimby NSW 2482

Attention: Mark Arnold

Dear Mark

RE: UPDATE OF THE BELONGIL CREEK HYDRAULIC MODEL

Context

BMT have been working with the owners of a large land holding in Byron Bay (Denis and John Cornell through their company Hammock Investments Pty Ltd), located between the North Coast Railway, Kendall Street, Ewingsdale Road and Belongil Creek for several years.

This project is aiming to realise a long-held ambition of the landowners to achieve a high-quality 'Byron compatible' development on their land. While some of their land has development potential, much of it is designated as 'flood way' (and other environmental values) in Council's planning studies, which imposes some development restrictions. The owners realise that much of the land is not developable and would like to retain the majority of the land in its natural form, or even an enhanced environmental condition. However, to achieve a realistic development outcome more land is required. Council has agreed to engage in a Planning Proposal for the development of the site which will establish a planning pathway for development of the land and ultimately facilitate rezoning of the land by Council. Ideally, assessments forming the Planning Proposal will be finalised by September 2021, but it is recognised that this timeline is not fixed and can be extended if required.

The potential to upgrade the Belongil set of flood models was raised by Council as BMT were commencing a flooding assessment for the site to improve development outcomes. BMT agree with the need to upgrade the flood models and have participated in subsequent discussions and meetings with Council and the landowners separately, to outline a pathway under which this may occur. The possibility of a joint flood investigation funded by the landowners and Council was raised by Council. The landowners do not seek to influence outcomes, they simply wish to complete a definitive assessment using the latest tools (if possible) to fully understand development opportunities and constraints on their land and to enable them to 'move on' after many decades of deliberation.

Key considerations to progress the model upgrade study include: the scope of model upgrades, project funding and project timelines. This letter focusses on the technical scope of the model upgrade. Other key considerations will need to be resolved by Council and the landowner to establish a mutually agreeable pathway forward. The study will be overseen by a flood risk management committee, which will include representatives from the local community and DPIE and will enable formal adoption of the updated flood model and flood levels.

Technical Considerations

The Belongil Creek hydraulic model was originally developed by SMEC for the Belongil Creek Flood Study (2009) using TUFLOW. The model was based on a digital elevation model (DEM) of terrain captured from aerial photogrammetry that was available at the time. During the subsequent floodplain risk management study, BMT reviewed and revised the model. Model revisions did not include an update to the underlying model terrain. The revised model was adopted by Council in 2015, and, to date, has been used as the basis for development assessments in the catchment.

Over the last few years, BMT has been involved in assessing several proposed developments in the catchment. Through this work, additional topographic data has been collected. This data includes:

- A 1m resolution DEM based on LiDAR survey captured in 2010 (collected by LPI); and
- Surveys of drains in the regional wetland surrounding Union Drain (collected by BMT/AWC as part of a project for Council that assessed an alternative outflow arrangement for the Byron STP).

BMT updated the adopted model by including the 2010 LiDAR and refining the grid resolution to 5 m during a detailed, local catchment, flood assessment for a proposed development near Ewingsdale Road. Results from the updated model showed a significant reduction in flood levels, with peak 1% AEP flood levels typically 200mm lower in the regional wetland compared to the adopted model. This reduction has been attributed to differences between the photogrammetry and LiDAR terrain elevations. It is suspected that the LiDAR data has captured the ground levels more accurately, and that the photogrammetry data is more representative of the vegetation canopy elevation. This demonstrates how sensitive the model is to adopted ground levels. Improvements to the underlying software used to simulate floods (TUFLOW) will also improve the efficiency, utility and accuracy of the model (discussed in more detail in the next section).

Proposed Scope of Work

It is proposed that the following updates are made:

- Data collection tasks include:
 - Council to collate the most contemporary LiDAR survey data available (if other than the LPI 2010 dataset available on ELVIS);
 - Council to provide other topographic or survey data that may be suitable for use, such as existing site surveys for West Byron lands, Ewingsdale Road, Byron Bay Bypass, Byron CBD, Butler Street drain, etc. Accessing these data will be a key consideration and a discussion point in the inception meeting;
 - Council to provide as-built surveys for key infrastructure such as Ewingsdale Road roundabouts, Cavanbah centre, Byron Bay Bypass and other selected developments. Final confirmation of key infrastructure to be included in the model will be required before commencing the development of the design event flood models;
 - Council to provide key hydraulic structure data (excluding urban stormwater pipe data) as may be available from as-built drawings or from surveys that Council are willing to collect as part of the study;
 - Council to provide downstream boundary assumptions (ocean levels during floods). Our fee does not include the undertaking of a joint probability analysis, but such an analysis can be undertaken as a fee variation if deemed necessary – to be discussed at the inception meeting; and

- Council to collect flood mark data for two historic events for model calibration. The adopted events will be confirmed with the committee at the inception meeting. Floods in May 2016 and March 2017 are two candidates, and some data has already been collected for these events through other studies undertaken by BMT for Council. It may be prudent to seek additional flood mark data from the community before embarking on model calibration. It is assumed that Council will manage the collection and survey of additional flood marks.
- Proposed hydrologic modelling updates include:
 - Changing software from XP-RAFTS to either WBNM or URBS (The vendor of XP-RAFTS no longer support this software);
 - Refine the resolution of sub-catchment boundaries (i.e. use smaller sub-catchment areas) to facilitate future development assessments;
 - Review the hydrologic model and update the design storms to Australian Rainfall and Runoff (ARR 2019) guidelines;
 - Undertake a rainfall frequency analysis for up to four rainfall gauges in the catchment;
 - Compare intensity-duration-frequency curves between ARR 2019, ARR 1987 and the rainfall frequency analysis at the selected rainfall gauges; and
 - Compare flows from the modelling to that estimated by the ARR 2019 regional flood frequency estimation model.
 - It has been assumed that there are no suitable gauges for undertaking a flood frequency analysis due to the tidal influence on gauge levels.
- Proposed hydraulic model updates include:
 - Utilise the latest version of TUFLOW's fixed grid solver. This includes the HPC solver (which reduces simulation times), the QPC solver (which enables a finer spatial resolution to be used where needed) and the SGS solver (which can improve model accuracy when there are narrow drains and channels);
 - A revision of the spatial resolution of the model. The current resolution is 10m, and this may be reduced where needed to improve the model resolution surrounding narrow flow areas, such as drains or in the river channel, or in areas where future developments are likely to be investigated;
 - Removing 1D channels from the model (provided a small enough spatial resolution is utilised);
 - Update the model terrain data to utilise the most contemporary LiDAR data available and other survey data identified from the data collection tasks;
 - Council to confirm what development has been built since the LiDAR survey or will be built soon and should be included in the model. It is assumed that Council will provide ground elevation models of new or approved development;
 - Update the model to include an upgraded Ewingsdale Road scenario, if available. The model will be set up with a scenario to run the existing road or the upgraded road case. The road upgrade will be based on the latest design information available at the time of the model update.
 - Up to two calibration events will be simulated in versions of the hydraulic model that estimate the development footprint at the time of the historic flood. We have allowed for up to five model revisions to improve the calibration. BMT may seek a fee variation if further improvements are requested by Council.

- Note that our proposed scope excludes inclusion of trunk and street drainage that is additional to that already in the current model. Additional trunk drainage can be added to the model at a later date, in a separate project, if required.
- Some flow crosses between the Simpson Creek and Belongil Creek catchment along the coastal dunes. It is assumed that these cross-catchment flows are negligible for the purposes of this study.
- Proposed flood simulations include:
 - Calibrate the model to one or two events, to be confirmed by the committee at the inception meeting. Candidate floods include May 2016 and March 2017. The choice of events may be dependent on availability and suitability of data to assist in the calibration;
 - Simulate eight event magnitudes using ARR 2019 (39%, 18%, 10%, 5%, 2%, 1%, 0.05% AEP and PMF); and
 - Simulate the 2050 and 2100 climate for the 1% AEP change scenarios including rainfall increase and increase in sea level rises (as adopted by Council).
- Proposed reporting and mapping are as follows:
 - A technical memo outlining the calibration results to be submitted to Council before the Calibration committee meeting.
 - Provision of a single draft report after completing the design flood event modelling in PDF format for review by Council and the committee. We have allowed for one round of collated feedback in our fee. Collation of responses is important to weed out duplicates and frivolous comments.
 - Provision of a single final report in PDF format, in which we will include our responses to any comments received from Council and committee on the draft report.
 - Provide updated maps that depict the flood risk management layers: Floodway, Flood Storage and Flood Fringe; and
 - Mapping of flood levels, depth, velocities, velocity depth and hazard (i.e. ZAEM) for a range of events. This data is more easily managed and viewed in digital format using a GIS and will be provided as such to Council. Flood mapping requirements for the reporting will be discussed with Council, as it is anticipated that maps may not be required for all events and metrics.
- The three proposed meetings and review stages include (to be hosted and chaired by Council):
 - Inception meeting for introductions and to discuss the project scope, including which events to adopt for calibration, the approach for the catchment/ocean joint probability and whether any additional survey is needed.
 - Model calibration meeting to present the model calibration results; and
 - Design event modelling meeting to present the final model results.
- Provision of all model input and model results in GIS format to Council.

Funding

The land-owners willingness to contribute has been established in-principle, and they have agreed for BMT to draft a potential technical scope for the model update (this letter), with a motivation to finalise the definition of flood levels and development constraints across the site.

Process and Timing

On Council's advice, we understand that this project would be run through Council's Floodplain Management Committee with involvement of DPIE to ensure due process has been applied. The involvement of the Floodplain Management Committee and DPIE will have consequences on timelines and the review process but will ultimately pave the way for model adoption.

BMT have proven experience and capacity to update the Belongil Creek Flood Study. We expect that the technical model updates could be completed in over several months following either the provision of all required data or following contract signing (whichever is later). The full study timeline could take longer due to the need to secure funding (determined by Council internally), arrange meetings and to receive reviews and acceptance at the review stages.

Fee

It is understood that DPIE funds all flood studies in NSW to the ratio of 2 to 1. As such it is not in Council's interests to fund a study to more than this ratio whether supported by private interest or State Government. As a guideline for budgeting purposes only, BMT estimates that the scope of work to update the Belongil Creek Flood Model/Study to best practice including coverage of key catchment developments is approximately \$90,000 excluding GST. A breakdown of the costs is found in Table-1.

This would provide a fee of around \$60,000 for private funding and \$30,000 for Council. It is our understanding that Council can direct procure this project through existing panels for this amount.

Table-1 Approximate Cost for the Scope of Works

Item	Approximate Cost (ex GST)
Data collation and review	\$7,500
Hydrologic modelling	\$22,000
Hydraulic modelling	\$31,000
Data Processing and Reporting	\$12,000
Preparation for and attendance at three meetings	\$10,000
Handover to Council	\$2,500
Project Management	\$5,000
Total	\$90,000

Council can engage BMT through the local government procurement panel (current) subject to Council's own internal procurement practice. Please note that these panels are being reassessed currently and BMT are expected to remain on the panel (submission provided for assessment). Regardless of the form of procurement, BMT will require confirmation of the contractual conditions that the project is intended to be completed under.

Please contact the undersigned on 0447 172 123 if you have any questions.

Yours Faithfully
BMT

A handwritten signature in black ink, appearing to read "Damion Cavanagh". The signature is fluid and cursive, with a long horizontal stroke at the end.

Damion Cavanagh
Principal