BMT WBM Pty Ltd
Level 8, 200 Creek Street
Brisbane Qld 4000
Australia
PO Box 203, Spring Hill 4004

Tel: +61 7 3831 6744
Fax: + 61 7 3832 3627

ABN 54 010 830 421

www.bmtwbm.com.au

Our Ref: L.B18330.001.FIA.docx

21 November 2013

Byron Shire Council
70-90 Station Street
Mullumbimby
NSW 2482

Attention: James Flockton

Dear James

RE: SPORTS FIELD FLOOD ASSESSMENT

Byron Shire Council (Council) is considering purchasing lot 5/880917 in North Ocean Shores adjacent to the Old Pacific Highway and Shara Boulevard for the purpose of developing two sports fields. As such, BMT WBM were commissioned by Council to use the TUFLOW model developed for the *Tweed-Byron Coastal Creeks Flood Study* (BMT WBM, 2010) to estimate the impact of the proposed development on peak flood levels. This letter documents our preliminary flood impact assessment of the two sports fields. The site locality is shown in Figure 1.

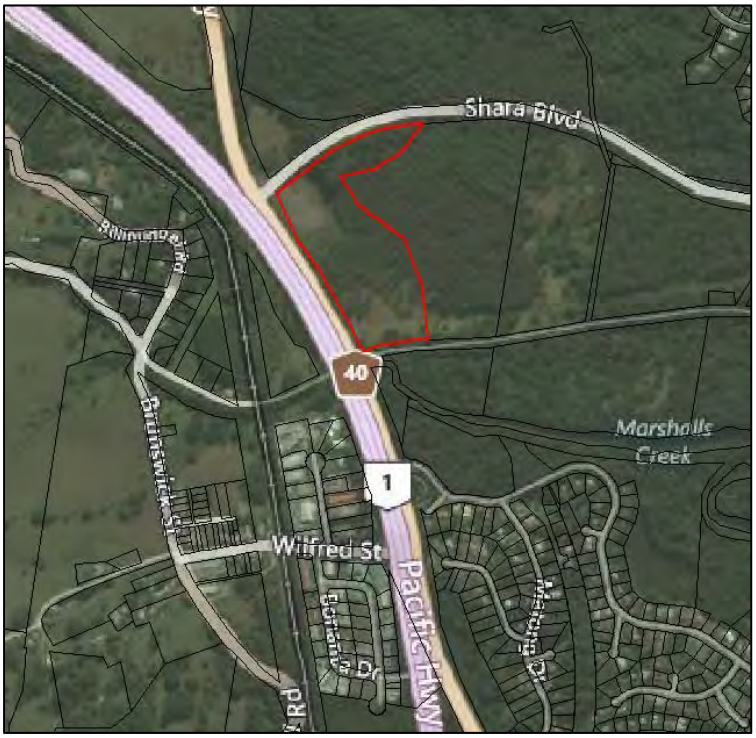

Figure 1: Site Location (shown with red outline)

Existing Flood Behaviour

The site lies on the Marshalls Creek floodplain, immediately downstream of a floodway through the Pacific Highway. Floodwaters exiting this floodway generally continue in a uniform north easterly trajectory (see Figure 2). Marshalls Creek is located near the southern boundary of the site, and high ground bounds the northern edge of the site. There is a fill pad in the north west corner of the lot. This fill pad is flood immune in the 100 year Annual Recurrence Interval (ARI) flood.

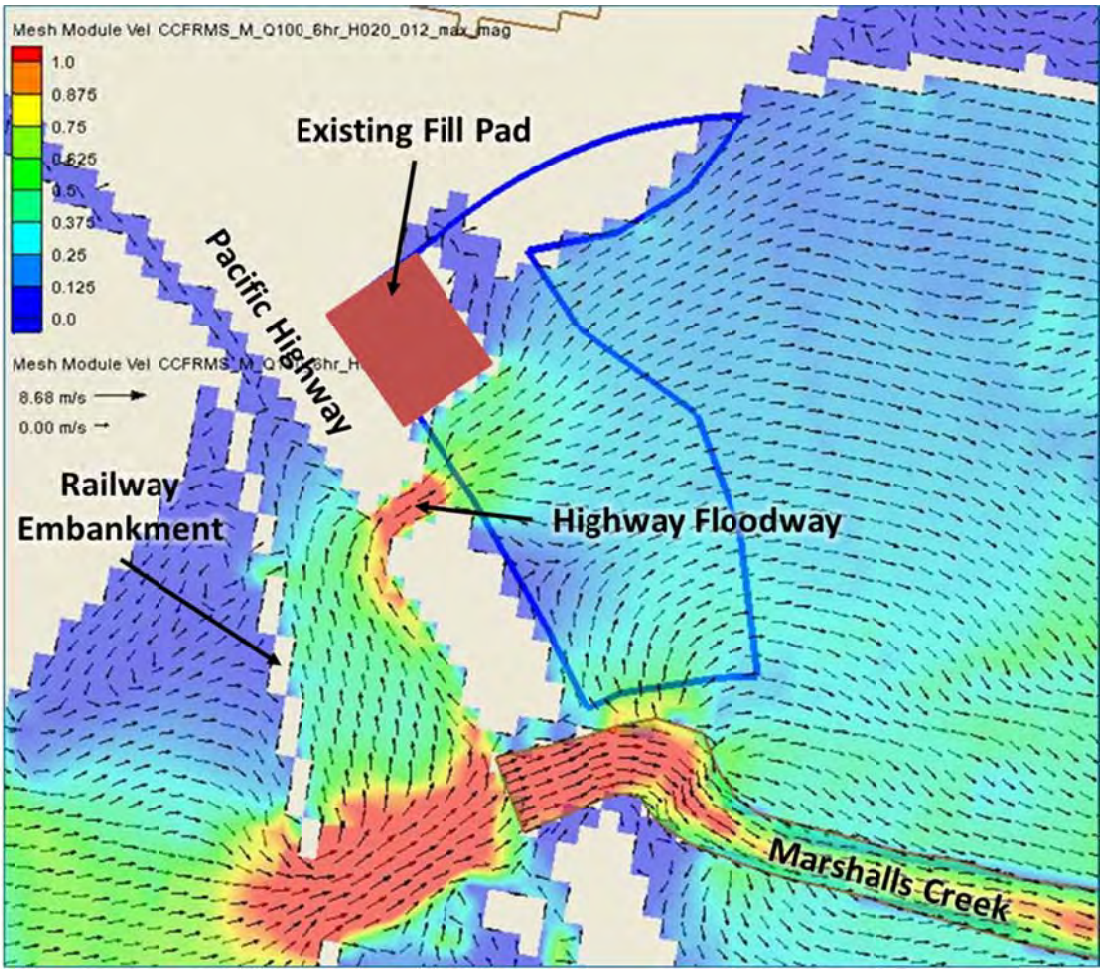

Figure 2: Existing Flood Behaviour

The flood behaviour across the northern portion of the site is mainly influenced by flow exiting the floodway under the highway. Upstream of the highway, flood flows are constrained by a disused railway embankment. Thus, flow through the highway floodway is derived from a breakout of flood waters from the left bank of Marshalls Creek between the railway and highway and floodwaters that overtop the railway embankment. Flood waters accelerate to around 1m/s through the 30m wide floodway and then decelerate to around 0.5m/s on exit from the floodway before entering the site.

The flood behaviour in the southern portion of the site is mainly influenced by a breakout from the left bank of Marshalls Creek downstream of the highway.

Proposed Development Considerations

The following design considerations were put forward by Council:

- Two sports field of 130m x 90m required;
- Sports field levels should be set at around the 5 year ARI flood level;
- A road is required for access to these fields. This road can be at a lower level than the sports field, as they are not intended to be used during a flood – the flood immunity requirement is to facilitate\expedite use of the fields after a flood;
- Batter slopes of 1m in 4m should be used;
- The fill material will be sourced from the site. Therefore, a cut/fill balance should be undertaken;
- Fill material can be obtained from lowering of the existing fill pad and high ground within the site;
- The proposed development should not increase peak flood levels external to the site for the considered design flood events; and
- Consider the 5, 10, 20, 50 and 100 year ARI flood events.

Site Layout Trial 1

An initial site layout trial was developed whereby the fields were concentrated towards the northern portion of the site (see Figure 3). The fields where offset from the highway to provide a floodway adjacent to the highway between the highway floodway and Marshalls Creek.

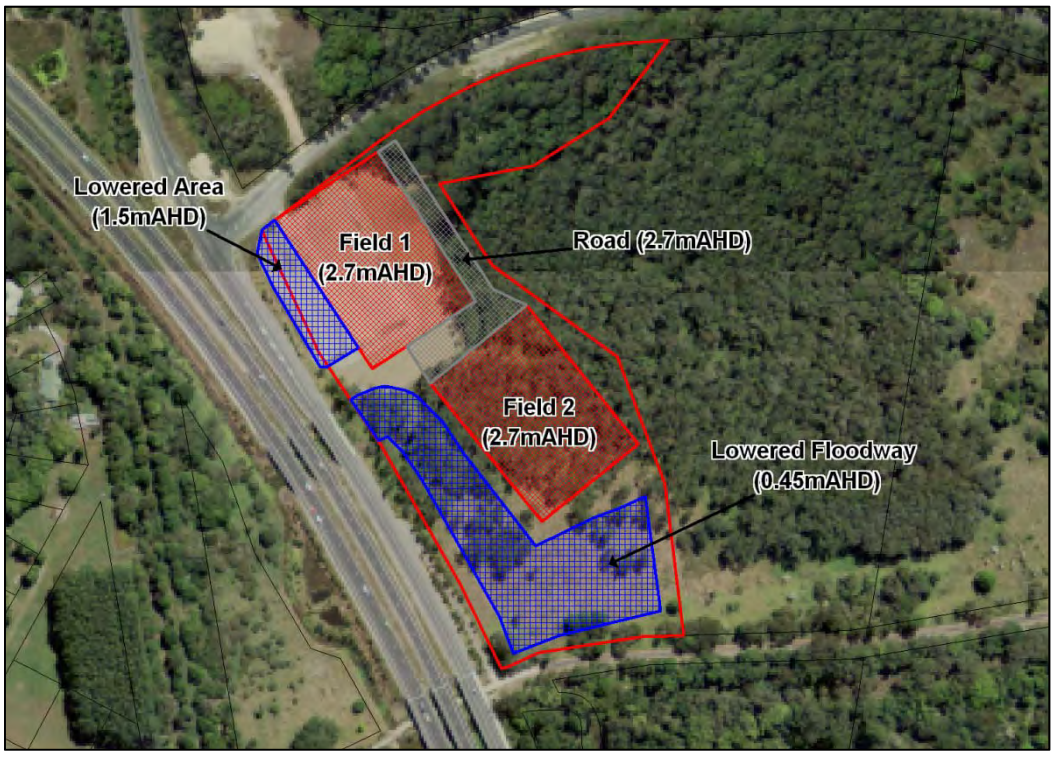

Figure 3: Proposed Site Layout – Trial 1

This layout was inserted into the flood model and a 100 year ARI flood event simulated. The results showed that the proposed fill constrained the flow exiting the highway floodway, and that the lowered floodway was insufficient in mitigating this constraint. The resultant increase in flood level upstream of the site, between the railway embankment and highway, was approximately 0.015m. There were no flood impacts downstream of the site.

Site Layout Trial 2

A second site layout was trialled in order to mitigate the 0.015m flood impact upstream of the site in trial 1. This second layout aligned the two fields relatively close to the highway and on either side of the highway floodway (see Figure 4). The concept behind this alignment was to:

i. Locate the fields in the 'shadow' of the highway embankment:

ii. To maintain a clear flow path for flows exiting the highway floodway; and

iii. Ensure the floodway through the site followed a similar alignment as the existing flood flow trajectory.

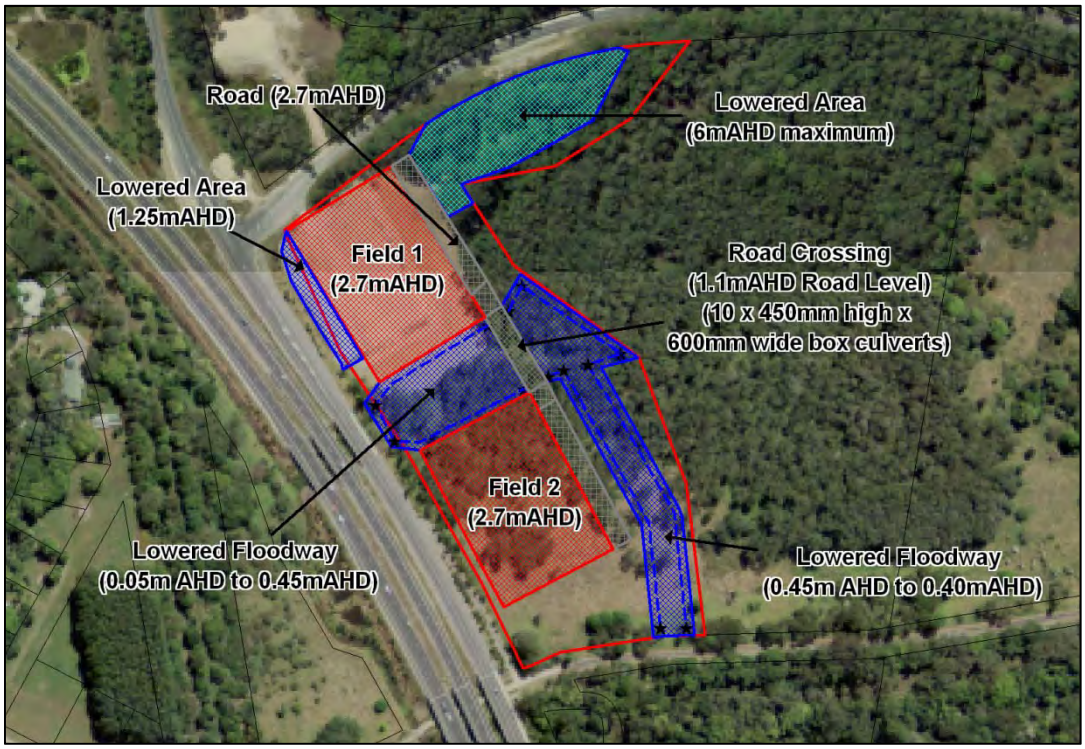

Figure 4: Proposed Site Layout – Trial 2

The layout produced an excess of cut material of 2,845m³.

The results from this second trial are as follows:

- For the 100, 50 and 20 year ARI flood events, the results indicate that there are negligible increases in flood levels external to the site (i.e. less than 0.01m change in flood level).

- For the 10 and 5 year ARI flood events marginal increases (of about 0.01m) in flood levels occur upstream of the development adjacent to the highway.

Flood impacts are illustrated in the figures attached to this letter.

Other Considerations

The following limitations and considerations are noted:

- This assessment has used an existing TUFLOW model. The model was originally developed and calibrated as part of the *Tweed-Byron Coastal Creeks Flood Study*. The model has subsequently been adapted to enable it to be run with more recent versions of TUFLOW as part of the *Tweed Coastal Creeks Floodplain Risk Management Study*. There is negligible difference in flood levels between these two model versions in the vicinity of the study area. Thus, the more contemporary model has been used for this assessment.
- The TUFLOW model covers a broad area, as it was designed for a catchment scale flood study. The model computational grid resolution in the vicinity of the study area is 15m. This is relatively coarse , however is considered adequate for the purposes of this assessment. This relative coarseness should be borne in mind when interpreting the model results.
- Only flooding sourced from Marshalls Creek have been represented in the model within the study area. It is uncertain at this stage whether there is a local catchment north of the site that drains through the site. If a local flooding mechanism does exist, the impact of the proposed development on local flooding has not been considered.
- A critical storm duration assessment has not been undertaken. The existing model has been developed for a 6, 24 and 36 hour storm duration. Of these three storm durations, the 6 hour storm duration produced the highest water levels in the vicinity of the site. Therefore, a 6 hour storm duration was adopted for this assessment.
- Headwater dominated design events were simulated in the model. This approach was adopted on consideration that the flood impacts would be most pronounced for such events, as higher tail water conditions would reduce velocities across the site (due to a shallower water level gradient). The adopted correlating headwater and tail water magnitudes are listed in Table 1 (as per the existing model design event arrangement).

Table 1: Design Event Arrangement

Design Event	Headwater	Tail Water
5 year	5 year	5 year
10 year	10 year	10 year
20 year	20 year	10 year
50 year	50 year	10 year
100 year	100 year	20 year

- For the purpose of this assessment, a difference in pre and post development peak flood levels of less than 0.01m has been reported as negligible.
- The proposed layout has been developed considering large floods. However, it is likely that ponding would occur in the floodway during frequent storm events (due to local rainfall). The practicality of the design with regards to drainage after a flood or for local rainwater has not been considered. Additional drainage elements may need to be appended to the indicative layout to drain the proposed floodway (pump or drains under New Brighton Road). Drainage infrastructure will be included during detailed design.

This is a preliminary assessment. Further refinement of the design during detailed design stage may reduce the flood impacts further (e.g. making the floodway wider and/or deeper). I trust that this letter covers the flood assessment scope requested by Council. If you wish to discuss the contents of this letter further please contact the undersigned on 07 3831 6744.

Yours Faithfully
BMT WBM

Richard Sharpe
Senior Flood Engineer

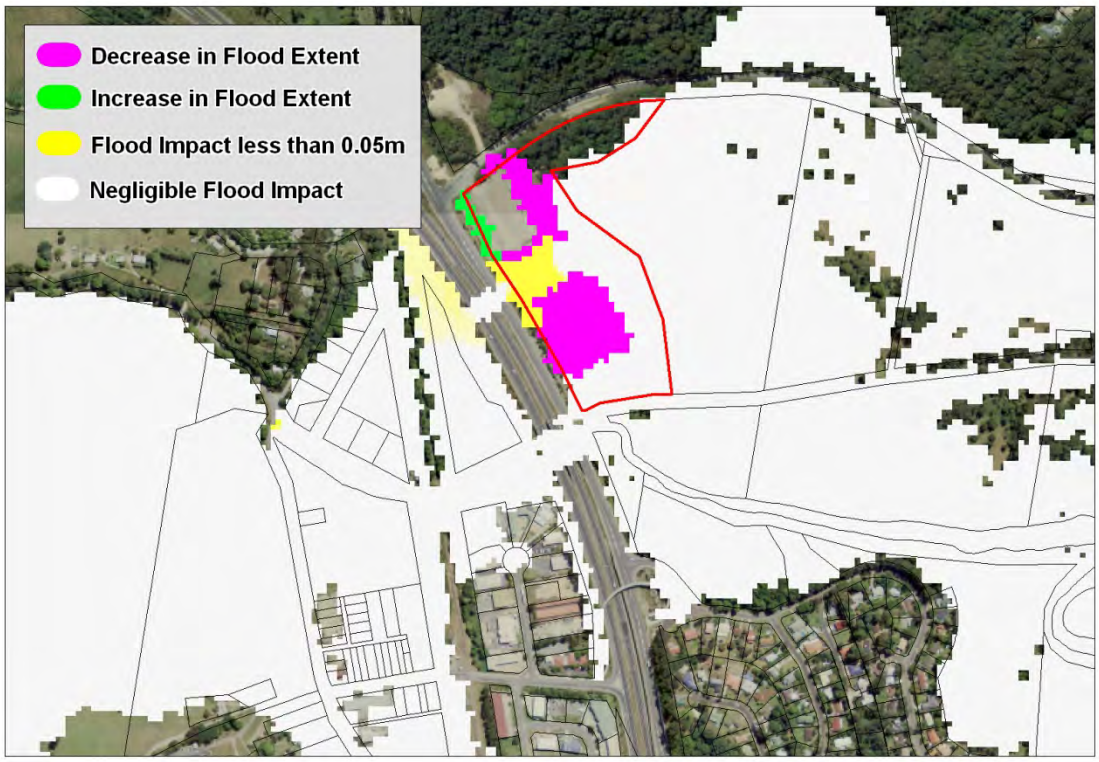

Figure 5: 5 Year ARI Flood Impacts

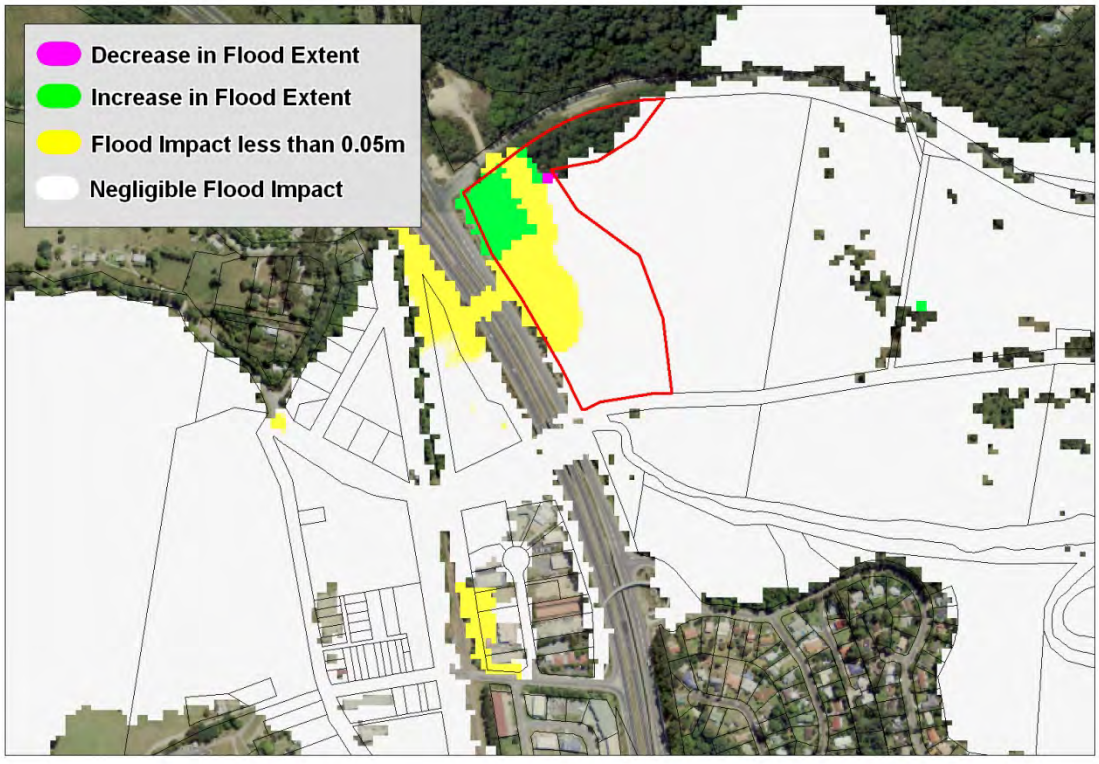

Figure 6: 10 Year ARI Flood Impacts

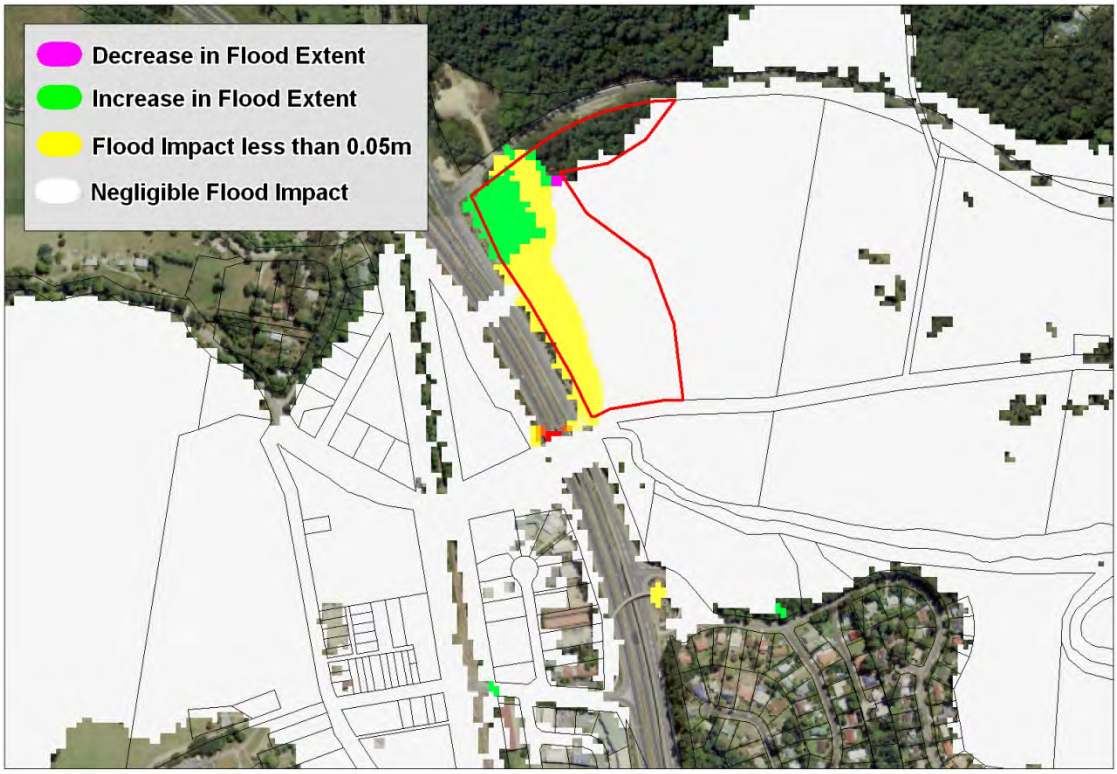

Figure 7: 20 Year ARI Flood Impacts

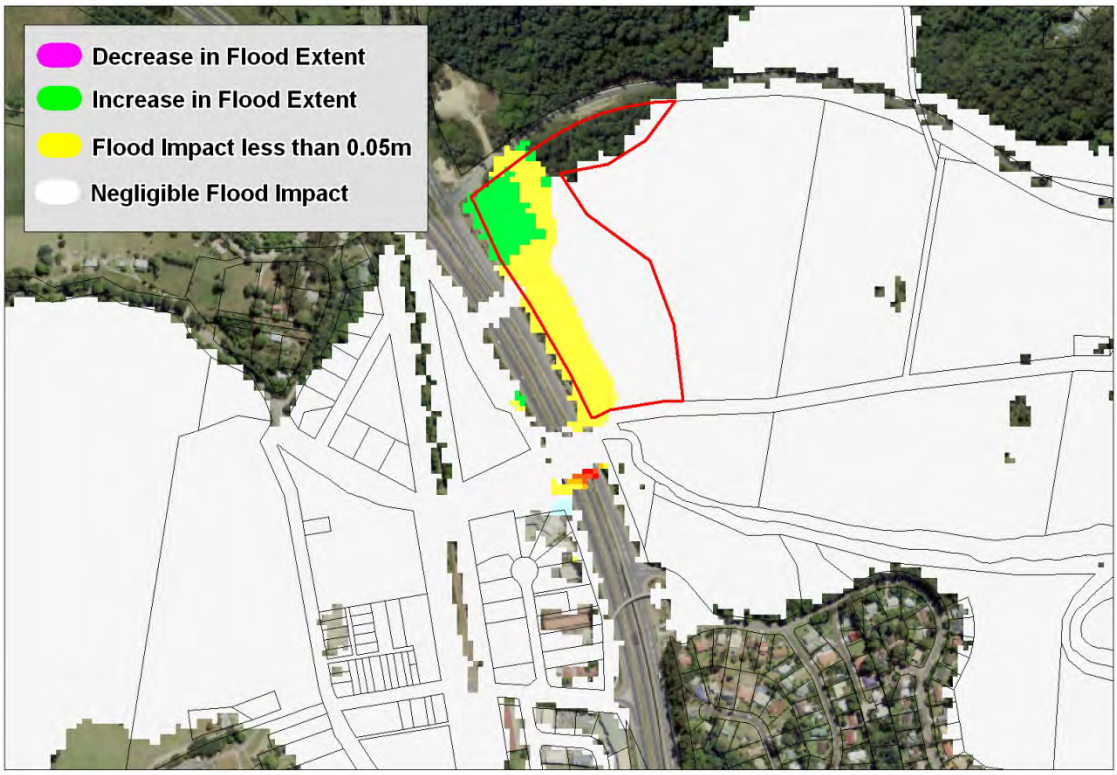

Figure 8: 50 Year ARI Flood Impacts

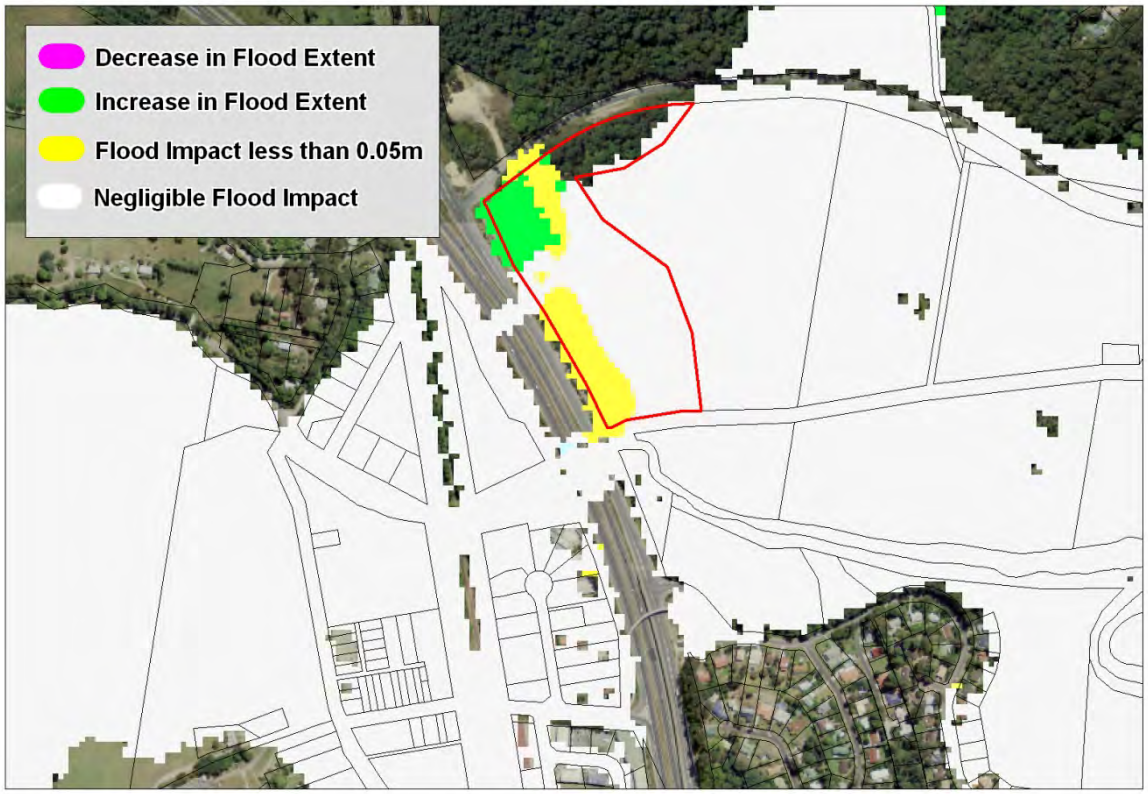

Figure 9: 100 Year ARI Flood Impacts

BMT WBM Pty Ltd
Level 8, 200 Creek Street
Brisbane Qld 4000
Australia
PO Box 203, Spring Hill 4004

Tel: +61 7 3831 6744
Fax: + 61 7 3832 3627

ABN 54 010 830 421

www.bmtwbm.com.au

Our Ref: L.B18330.002.FIA.docx

3 November 2014

Byron Shire Council
70-90 Station Street
Mullumbimby
NSW 2482

Attention: Nikki Bourke

Dear Nikki

RE: SPORTS FIELD FLOOD ASSESSMENT

Byron Shire Council (Council) is considering purchasing lot 5/880917 in North Ocean Shores adjacent to the Old Pacific Highway and Shara Boulevard for the purpose of developing a sports field. As such, BMT WBM were commissioned by Council to use the TUFLOW model developed for the *Tweed-Byron Coastal Creeks Flood Study* (BMT WBM, 2010) to estimate the impact of the proposed development on peak flood levels. This letter documents our flood impact assessment of the sports field. The site locality is shown in Figure 1.

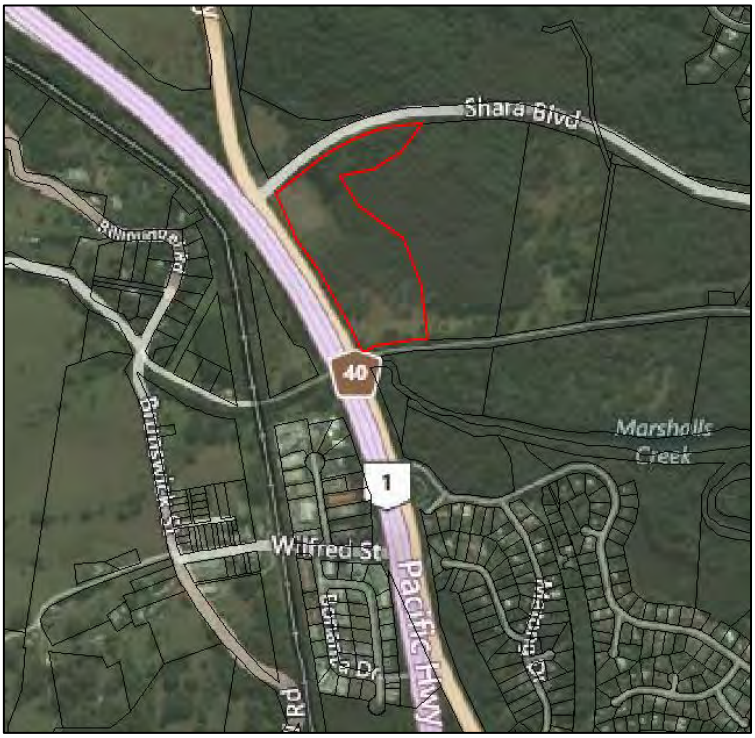

Figure 1: Site Location (shown with red outline)

Existing Flood Behaviour

The site lies on the Marshalls Creek floodplain, immediately downstream of a floodway through the Pacific Highway. Floodwaters exiting this floodway generally continue in a uniform north easterly trajectory (see Figure 2). Marshalls Creek is located near the southern boundary of the site, and high ground bounds the northern edge of the site. There is a fill pad in the north-west corner of the lot. This fill pad is flood immune in the 100 year Annual Recurrence Interval (ARI) flood.

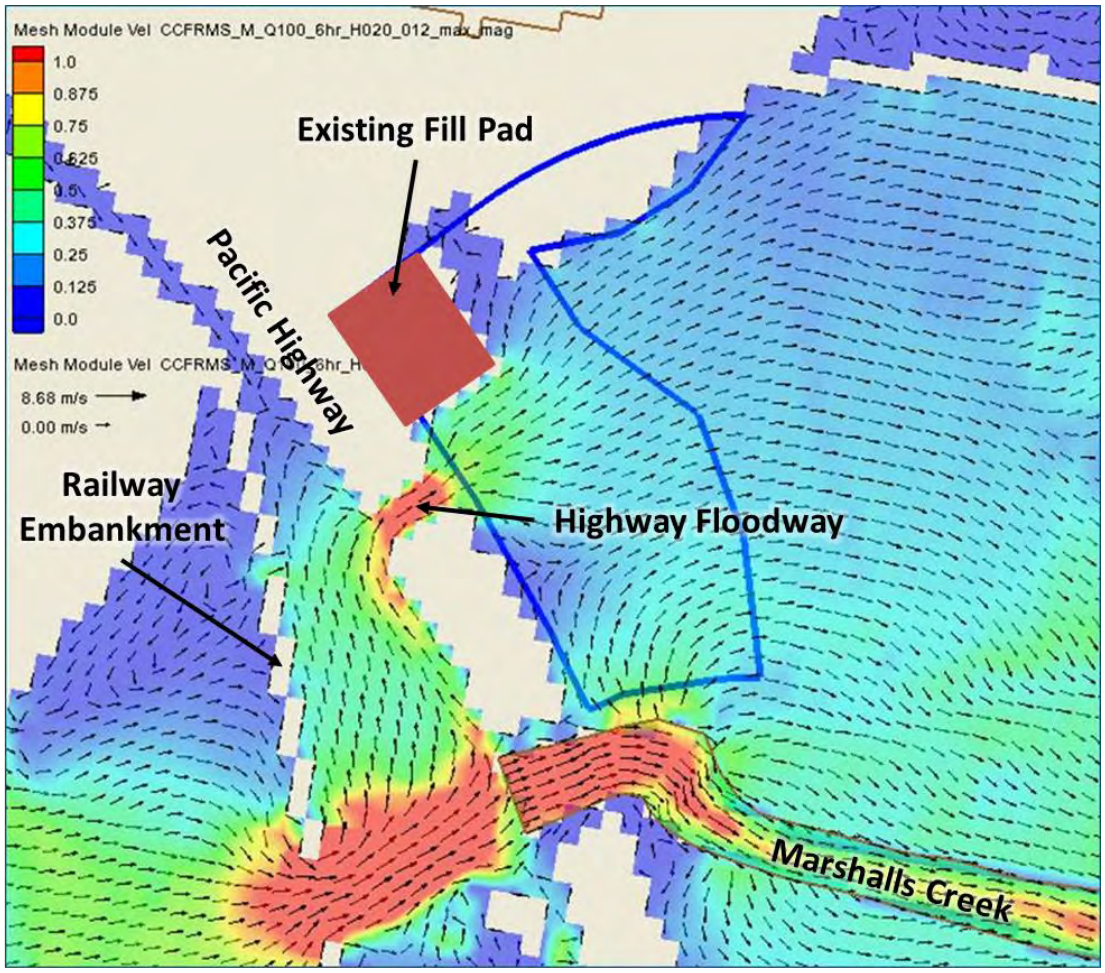

Figure 2: Existing Flood Behaviour

The flood behaviour across the northern portion of the site is mainly influenced by flow exiting the floodway under the highway. Upstream of the highway, flood flows are constrained by a disused railway embankment. Thus, flow through the highway floodway is derived from a breakout of flood waters from the left bank of Marshalls Creek between the railway and highway and floodwaters that overtop the railway embankment. Flood waters accelerate to approximately 1m/s through the 30m wide floodway and then decelerate to approximately 0.5m/s on exit from the floodway before entering the site.

The flood behaviour in the southern portion of the site is mainly influenced by a breakout from the left bank of Marshalls Creek downstream of the highway.

Site Layout and Peak Flood Level Impacts

Council provided a draft concept plan for development of the northern part of the site into a sports field, provided as both a drawing file and as a pdf. The key features of this layout are shown in Figure 3, and include:

- One playing field with the following dimensions 100m x 50m (fill levels between 2.92 and 3.77mAHD). The edge of the field has batter slopes of 1m in 4m;
- Car park and bus parking bays to the north of the playing fields (along Shara Boulevard);
- Provision of an area for a future access road to the 'southern' playing field area (level between 1.06 and 2.27mAHD);
- Amenities block / club house to the west of the playing field (FFL 3.92mAHD); and
- Drainage in the form of grass lined swales to direct discharge into the existing open drain to the west of the playing field. The performance of these swales has not been assessed.

The drawing file of this layout was converted into a Digital Elevation Model (DEM) which was updated and run through the existing TUFLOW model for the 5, 10, 20, 50 and 100 year ARI events.

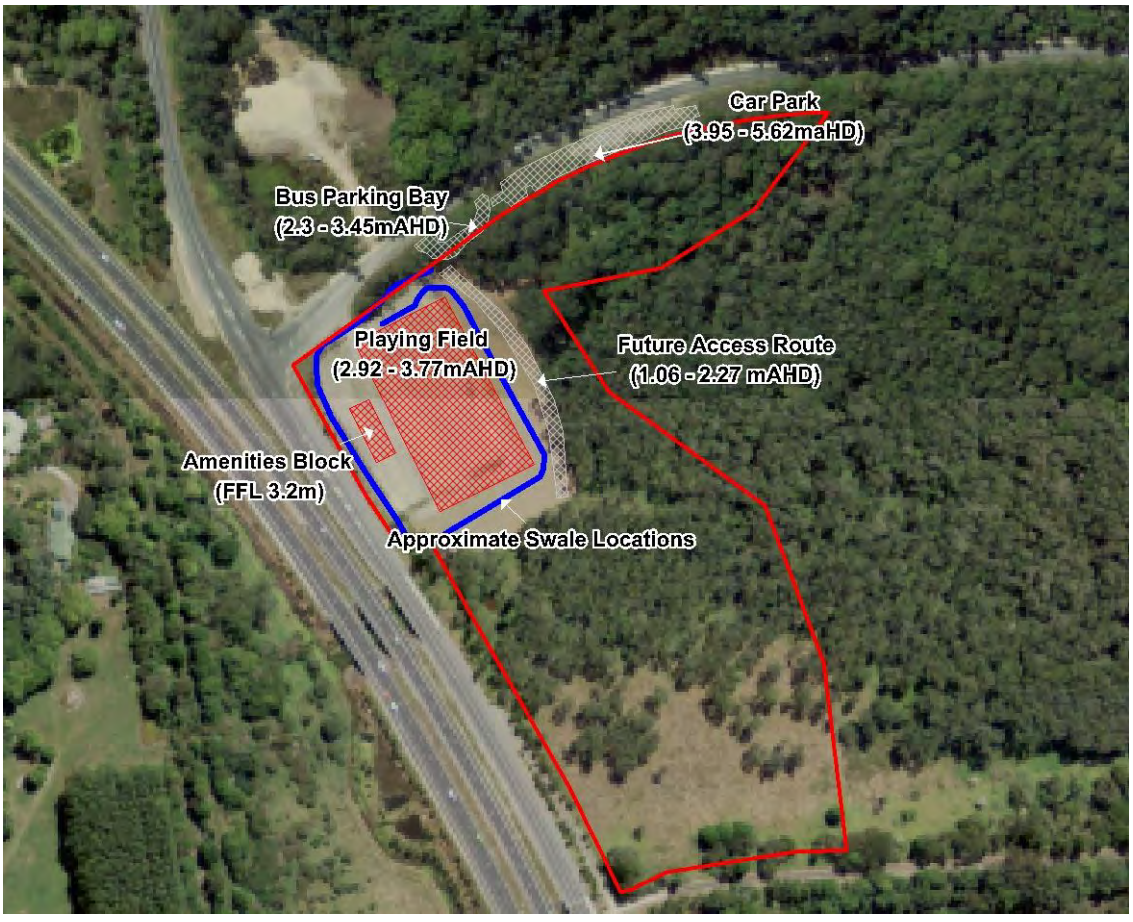

Figure 3 Key Layout Features

The results from the proposed layout are as follows:

- For the 100, 50 and 20 year ARI flood events; the modelled results indicate that there is minimal change to peak flood level external to the site (i.e. less than 0.01m change in flood level). The 50 and 20 year ARI flood events show a localised increase in flood levels at the bridge crossing Marshall's creek. Within the site boundary there is an increase in peak flood level of up to 0.02m.
- For the 10 year ARI flood event, the modelled results indicate there is minimal impact to peak flood level, both on and external to the site, as a result of the proposed layout (i.e. less than 0.01m change in flood level).
- For the 5 year ARI flood event, across most of the area there is minimal impact to peak flood levels. There is an isolated increase in peak flood levels by up to 0.04m to the east of Brunswick Road. This is downstream of a culvert.

Peak flood impacts are illustrated in the figures attached to this letter.

Other Considerations

The following limitations and considerations are noted:

- This assessment has used an existing TUFLOW model. The model was originally developed and calibrated as part of the *Tweed-Byron Coastal Creeks Flood Study*. The model has subsequently been adapted to enable it to be run with more recent versions of TUFLOW as part of the *Tweed Coastal Creeks Floodplain Risk Management Study*. There is negligible difference in flood levels between these two model versions in the vicinity of the study area. Thus, the more contemporary model has been used for this assessment.
- The TUFLOW model covers a broad area, as it was designed for a catchment scale flood study. The model computational grid resolution in the vicinity of the study area is 15m. This is relatively coarse, however is considered adequate for the purposes of this assessment. This relative coarseness should be borne in mind when interpreting the model results.
- Only flooding sourced from Marshalls Creek have been represented in the model within the study area. It is uncertain at this stage whether there is a local catchment north of the site that drains through the site. If a local flooding mechanism does exist, the impact of the proposed development on local flooding has not been considered.
- A full critical storm duration assessment has not been undertaken. The existing model has been developed for 6, 24 and 36 hour storm durations. Of these three storm durations, the 6 hour storm duration produced the highest water levels in the vicinity of the site. Therefore, a 6 hour storm duration was adopted for this assessment.
- Headwater dominated design events were simulated in the model. This approach was adopted on consideration that the flood level impacts would be most pronounced for such events, as higher tail water conditions would reduce velocities across the site (due to a shallower water level gradient). The adopted correlating headwater and tail water magnitudes are listed in Table 1 (as per the design event arrangement adopted for the *Tweed-Byron Coastal Creeks Flood Study*).

Table 1: Design Event Arrangement

Design Event	Headwater	Tail Water
5 year	5 year	5 year
10 year	10 year	10 year
20 year	20 year	10 year
50 year	50 year	10 year
100 year	100 year	20 year

- For the purpose of this assessment, a difference in pre and post development peak flood levels of less than 0.01m has been reported as minimal.
- The practicality of the design with regards to drainage after a flood or for local rainwater has not been considered.

I trust that this letter covers the flood assessment scope requested by Council. If you wish to discuss the contents of this letter further please contact the undersigned on 07 3831 6744.

Yours Faithfully
BMT WBM

Melissa Blum
Environmental Engineer

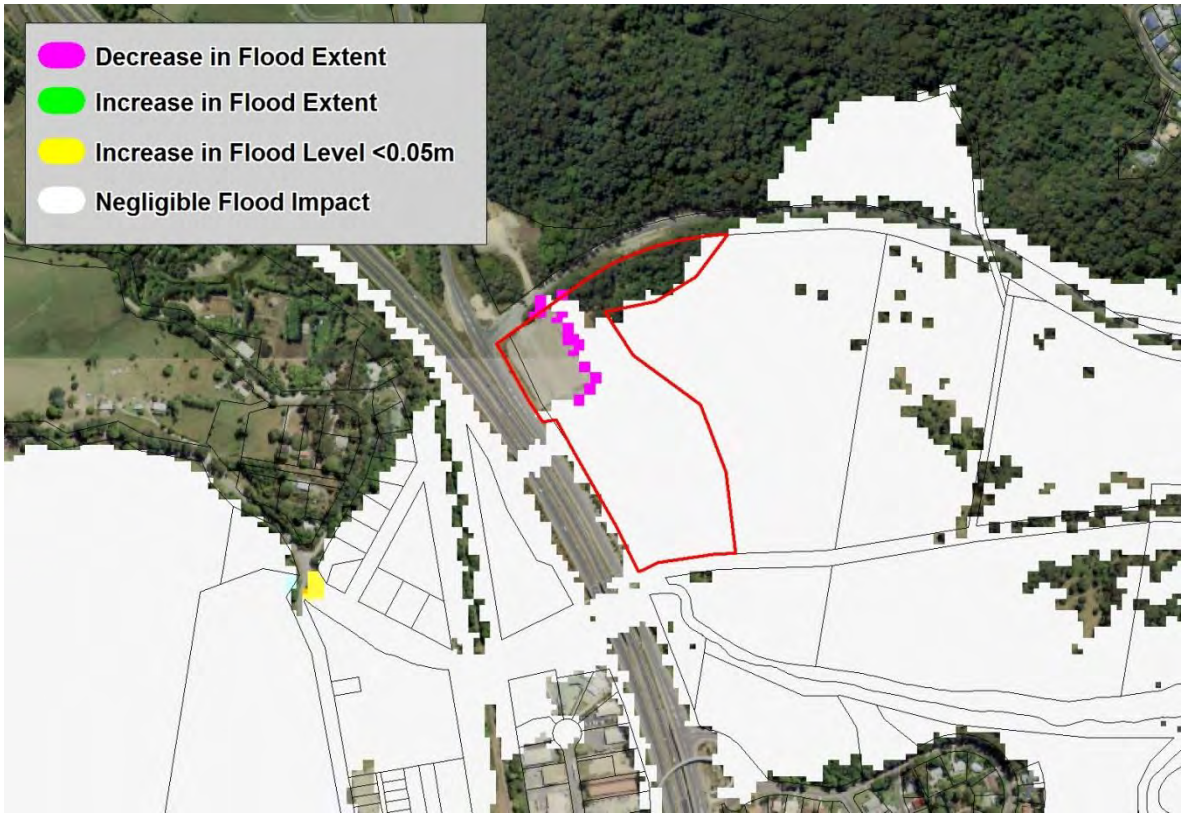

Figure 4: 5 Year ARI Flood Impacts

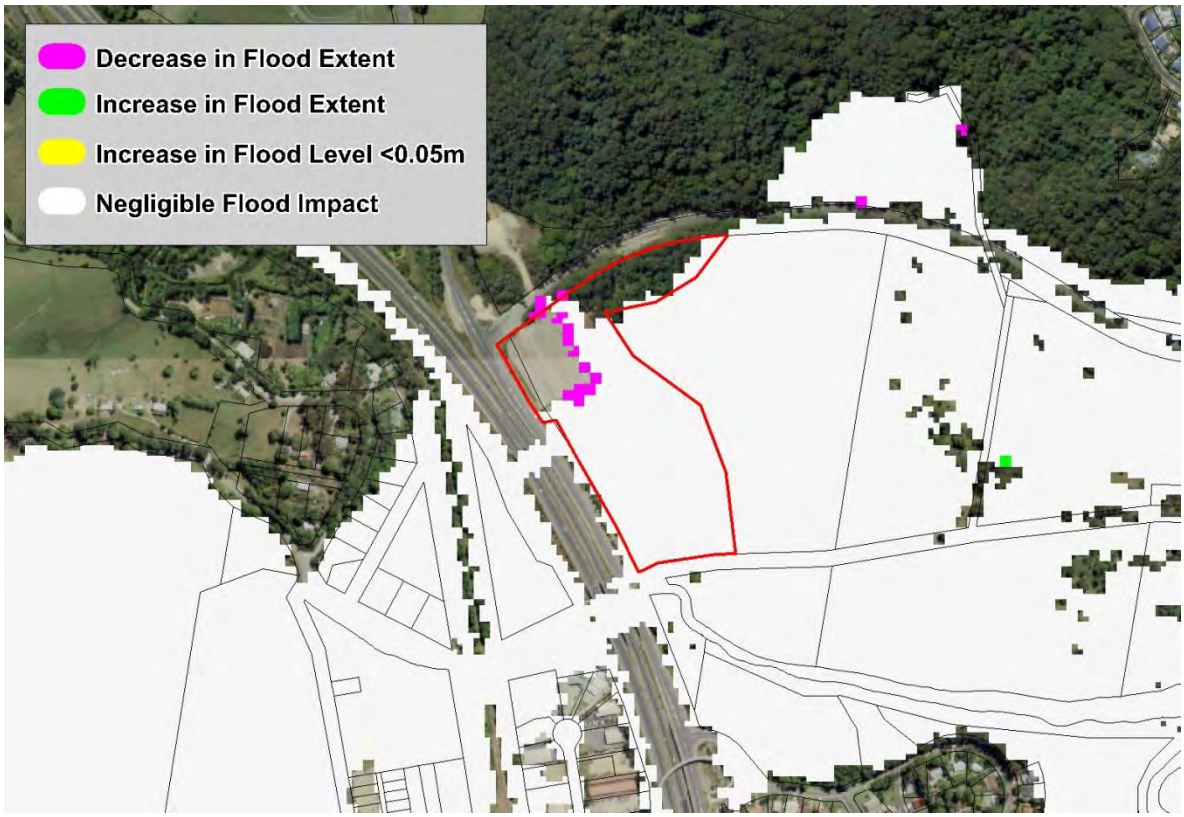

Figure 5: 10 Year ARI Flood Impacts

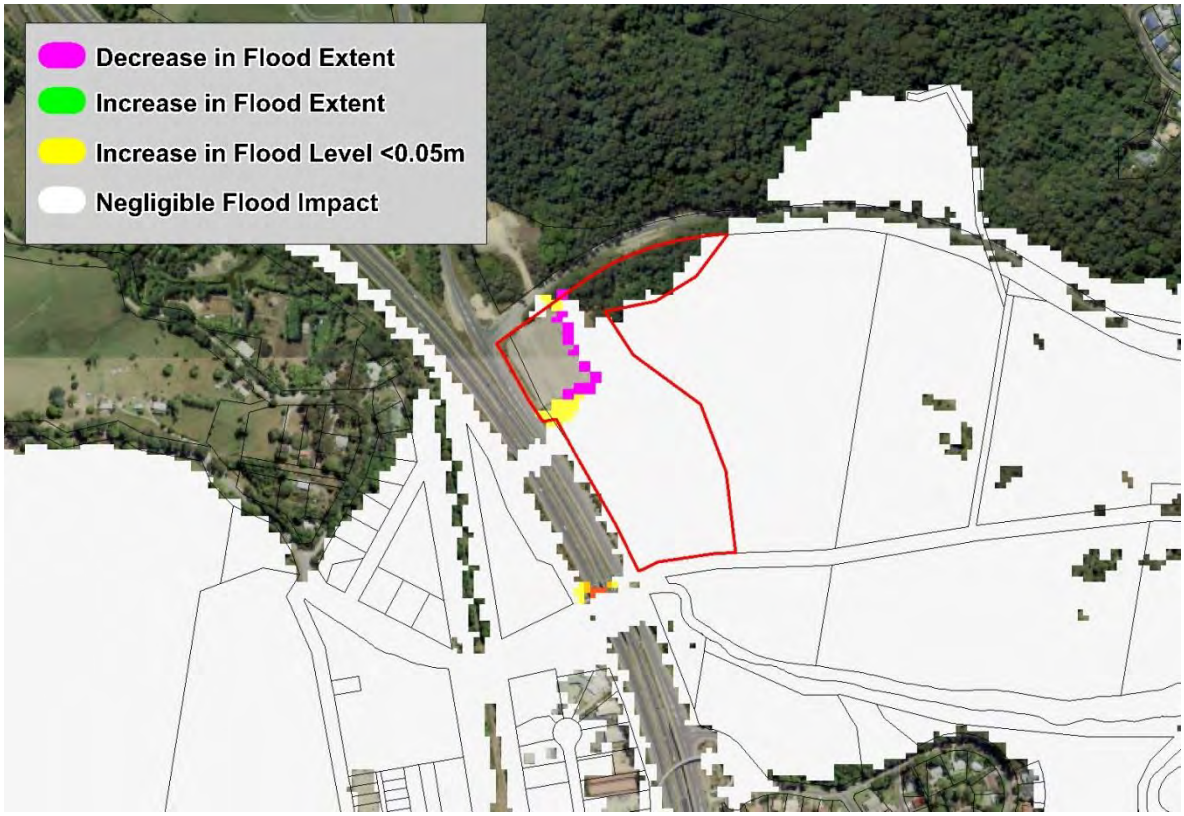

Figure 6: 20 Year ARI Flood Impacts

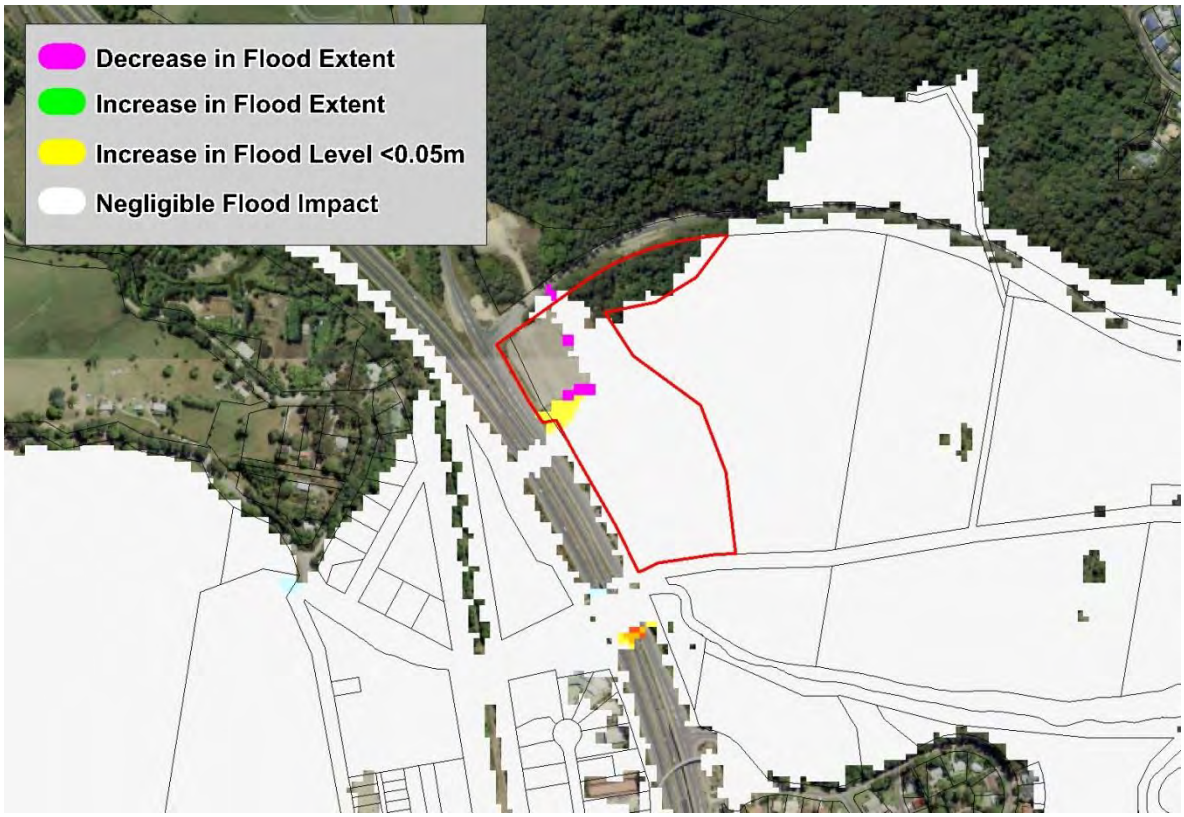

Figure 7: 50 Year ARI Flood Impacts

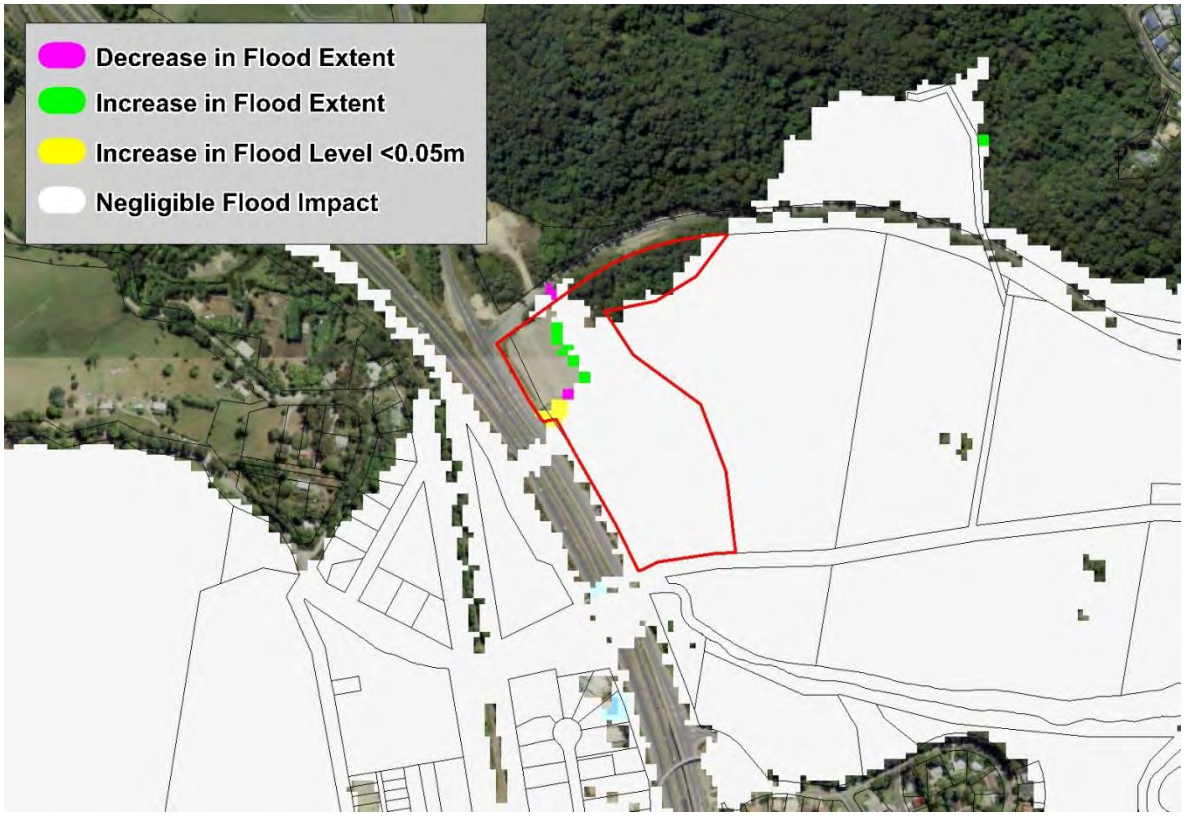

Figure 8: 100 Year ARI Flood Impacts