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Our Ref: PP: L.M20391.002.BarrageAssessment

10th October 2014

Tamar Lake Inc.
101 Cameron Street,
Launceston,
Tasmania 7250

Attention: Robin Frith

Dear Robin

RE: LAKE TAMAR FLOOD MODELLING

This letter provides the results and findings of the flood impact assessment modelling of the Lake Tamar proposal as outlined in the document "The Tamar Valley – A Strategic Plan and Vision for its Development" (Frith, 2011). This assessment has been commissioned by the not-for-profit organisation, Tamar Lake Inc. in order to investigate the flooding impacts of the proposed Lake Tamar development.

Specifically the aims of this assessment were to:

- Calculate the drawdown time of the lake from 0.9m AHD to 0m AHD.
- Undertake a flood impact assessment under a number of scenarios, namely:
  - The barrage in place being operated to provide flood buffering; and
  - The barrage in place with the gates fully closed (the worst case scenario).

The details of the barrage configurations were provided by Tamar Lake Inc and based on the preliminary assessment undertaken by BMT WBM (2012). The scenarios above were assessed for the 1 in 100 year and 1 in 200 year ARI events[1] under both the current sea level conditions and a sea level rise assessment whereby sea levels were increased by 0.8m.

1 Background

The South and North Esk Rivers combine at Launceston to form the River Tamar. Together the two rivers drain approximately 9,550 km^2 or some 14% of the state of Tasmania. The larger of the catchments is the South Esk River and significant flooding in the River Tamar is predominantly a result of rainfall events in the South Esk. Small catchments along the Tamar Valley do not contribute significantly to flooding in the River Tamar.

A number of flood studies of the River Tamar have been undertaken. One of the early studies was in the late 1950's and early 1960's by the University of New South Wales (UNSW). A physical model of the Upper Tamar River was developed for that study. The UNSW study recommended the construction of a levee system to protect the low lying areas of Launceston, which were devastated by flooding in 1929. The levee system was constructed, but is now undergoing significant maintenance and upgrade works.

[1] The 95% 200 year ARI flow hydrograph will be used in this analysis as was adopted for the design of the levees systems in Launceston (BMT WBM, 2008)

In preparation for these works the Launceston City Council commissioned BMT WBM to undertake detailed numerical flood modelling of the River Tamar. Findings from this study are presented in the River Tamar & North Esk River Flood Study (BMT WBM, 2008). For the 2008 study, BMT WBM developed and calibrated a two-dimensional (2D) TUFLOW model of the full length of the River Tamar and the lower reaches of the North and South Esk Rivers. The model calibration was in the upper reaches only. Launceston City Council designated flood levels are derived from BMT WBM (2008).

Since the development of the River Tamar TUFLOW model, Launceston City Council has continued to develop the model incorporating new developments and changes to the floodplain in and around Launceston. This model is therefore considered to be the to be the best available information at the location of the proposed barrage and was adopted for this assessment.

2 Flooding

2.1 Existing Conditions

For this assessment the modelling was undertaken using the most recent version of the Tamar River flood model[2]. This model was developed for the Launceston Flood Authority to assess impacts of the Town Point levee and includes a number of minor enhancements within the Launceston area. For the current assessment. the model was updated to run in the 2013 release (Build: 2013-12-AC-iDP-w64) of TUFLOW.

The 100 year and 200 year ARI flood events were run with the spring tide boundaries previously developed as part of BMT WBM (2008)..

2.2 Barrage Configuration

The construction of a barrage would separate the Tamar River into a tidal section on the downstream side and a freshwater lake on the upstream side. During non-flood conditions, the barrage would maintain an upstream lake level of approximately 0.9m AHD.

The existing TUFLOW model was modified to incorporate a barrage near the township of Rowella with the following characteristics:

- Lake level of 0.9m AHD;
- Spillway crest of -3.0m AHD;
- Spillway width of 350m; and
- Crest level at 2.2m AHD.

The barrage opening was modelled as a 1D weir in the TUFLOW with the details above. The weir flow was reduced by 20% to approximate the losses through the floodgates. The barrage opening (flood gates) was set-up as unidirectional to only allow flow in one direction (allowing water to flow from the lake into the tidal section). This configuration stops tidal flows backing-up into the proposed lake and mimics the assumed operations of the flood gate during a flood event.

[2] This is the TUFLOW hydraulic model that has been developed by BMT WBM on behalf of the Launceston Flood Authority and is based on the orginal Tamar River TUFLOW hydraulic model (BMT WBM, 2008)

2.3 Lake Tamar drawdown

The drawdown time from an initial lake level of 0.9m AHD to a water level of 0.0m AHD was calculated using the TUFLOW model for both the current conditions and sea level rise conditions. The start of the drawdown was set to occur on the ebb tide so the tail water level would be decreasing with tide levels. For the current conditions, the drawdown was approximately 4 hours and for the climate change conditions the drawdown was approximately 14 hours. In this analysis a spring tide was assumed.

The upstream and downstream water levels and flow rate through the barrage for the current conditions are shown in Figure 2-1 and for the climate change conditions in Figure 2-2. The initial increase in downstream water levels is due to the release of water from behind the barrage and is not the influence of the tidal boundary.

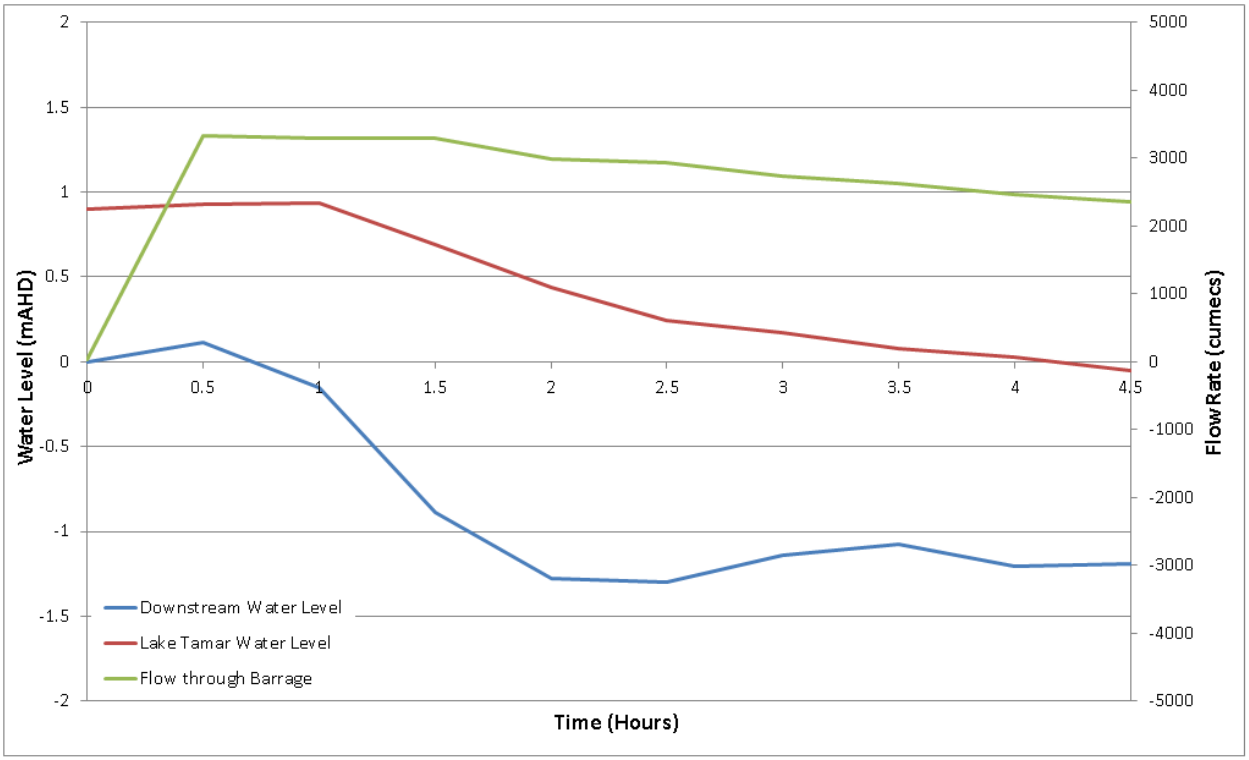


Figure 2-1 Current conditions lake level drawdown

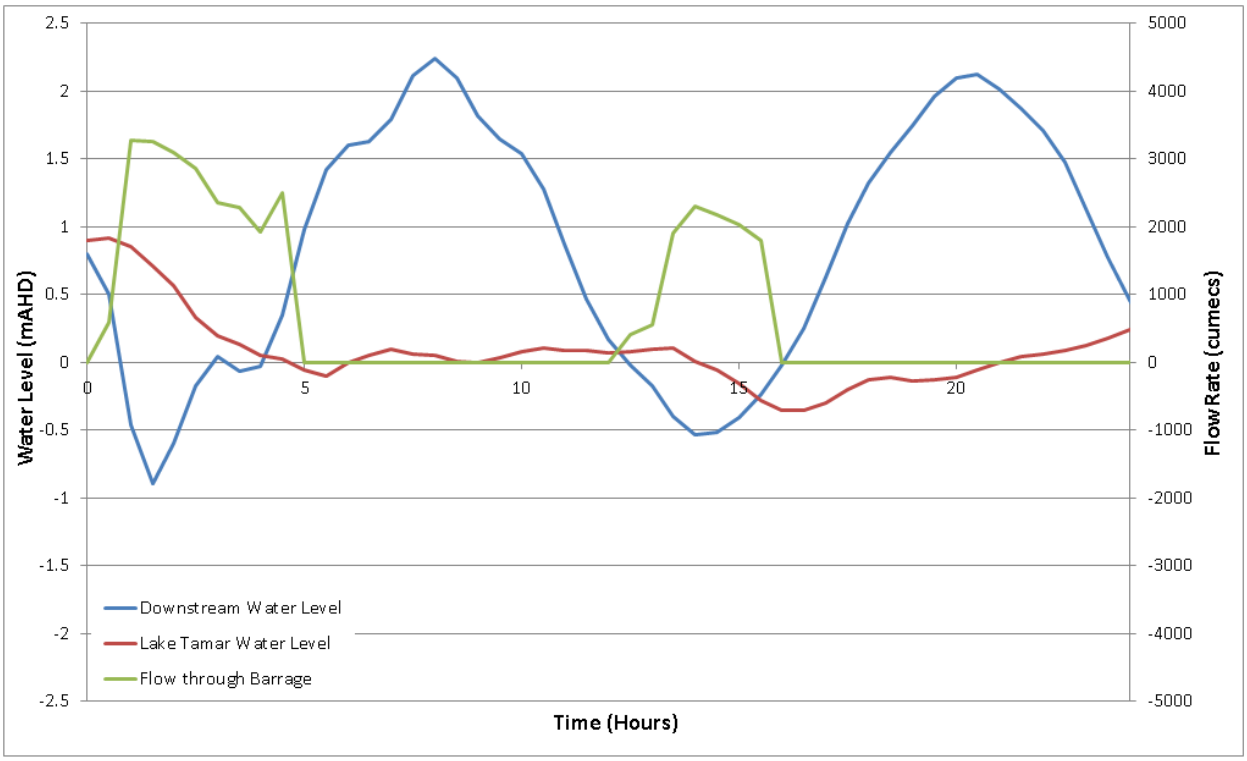


Figure 2-2 Climate change conditions lake level drawdown

2.4 Barrage Normal Operations

For this assessment the barrage was set to operate normally, that is, during times of flood, the flood gates would be opened when upstream water levels exceed downstream water levels to provide flood buffering. Initial results demonstrated that only allowing the lake level to fall to 0m AHD (and not below) would not provide sufficient flood buffering, therefore, the lake was allowed to fall below 0m AHD. The resulting flood height differences for the 100 year and 200 year ARI events are shown in Figures A-1 and A-2 respectively.

Figure 2-3 shows a timeseries of the upstream and downstream water levels during the 100 year ARI event. This figure shows the water levels upstream of the barrage falling when water levels downstream of the barrage (tidal levels) are below the upstream water levels. The water levels upstream of the barrage rise when the downstream water level is greater than the lake level. This effect mimics the assumed operation of the barrage during flood events. The increase in water levels upstream of the barrage is due to inflow from the North Esk and South Esk. This plot shows that if a flood warning is issued 24 hours prior to the flood event arriving at the barrage there will be sufficient flood buffering attenuate the flood.

Similarly, Figure 2-4 shows the water levels upstream and downstream of the barrage for the 200 year ARI event. This figure shows a similar trend to the 100 year ARI event, although the peak flood height in the lake leads to some overtopping of the barrage.

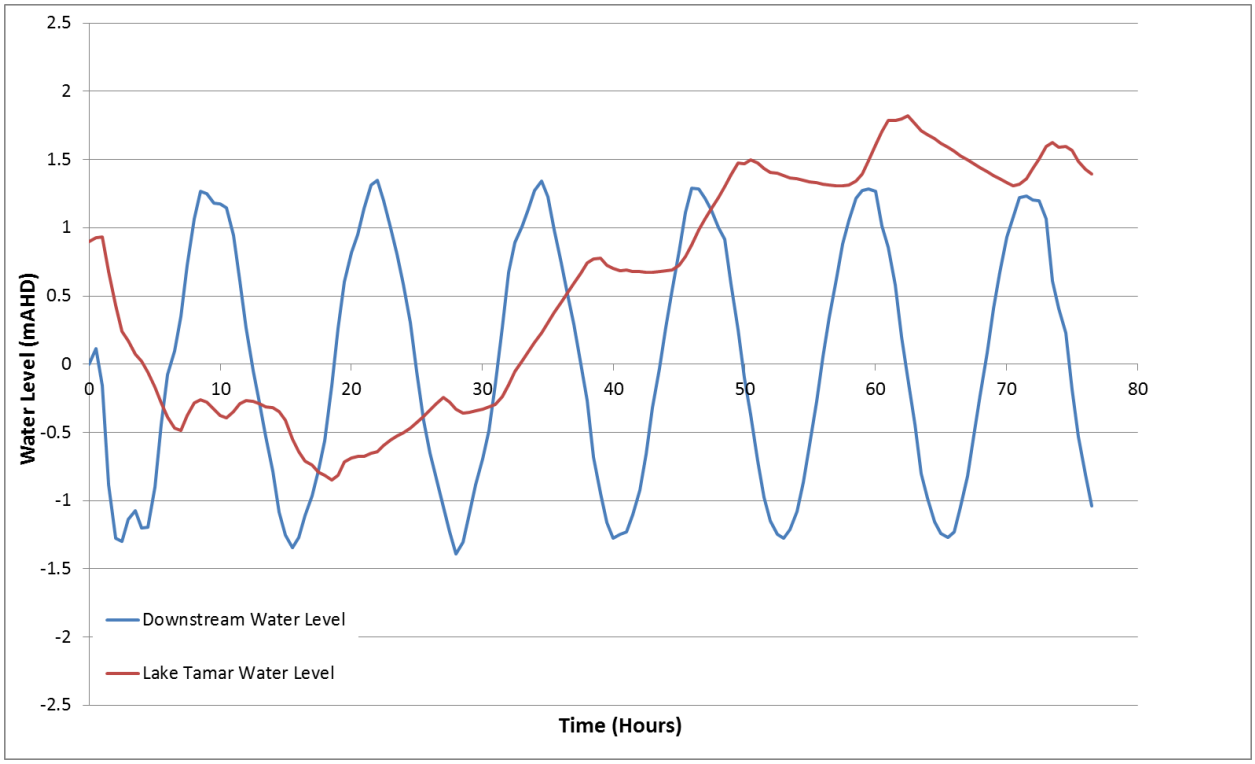


Figure 2-3 Water level upstream and downstream of the barrage – 100 Year ARI

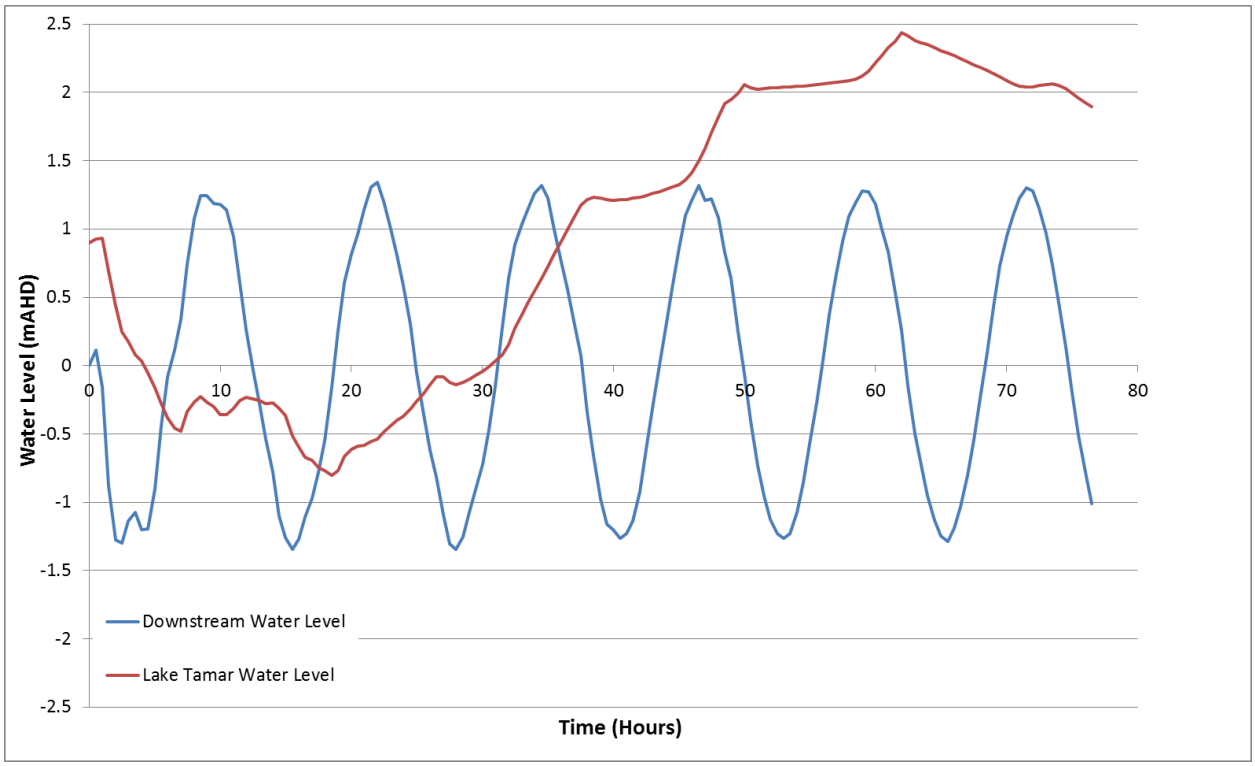


Figure 2-4 Water level upstream and downstream of the barrage – 200 Year ARI

Under the 100 year ARI flood event, there was a reduction in water levels upstream of the barrage. Water levels along the Tamar River are heavily influenced by the tidal level, with the tidal influences removed from the system the peak water levels were lower than the existing levels. These levels should be

considered as the '*best case'*, given the levels behind the barrage were allowed to reduce below 0m AHD. Further, the operation of the floodgates is perfect, that is, there is no lag time in opening or closing the gates so the full range of the water level difference is available for flow.

During the 200 year ARI event flood height impacts were found to occur with elevated flood levels upstream of the barrage. These increases in water level are within 0.25m and extend as far as Swan Bay and with no significant increases in water in Launceston.

2.5 Barrage Fully Closed

This assessment investigated the effect on flood levels caused by a failure of the flood gates rendering them fully closed during a flood event; the worst case scenario. The top of the barrage was set to 2.2m AHD and the initial water level within the lake was set to 0.9m AHD. The resulting flood height differences for the 100 year and 200 year ARI events are shown in Figures A-3 and A-4 respectively.

In both cases, there were significant increases in flood levels upstream of the barrage, as expected. Water levels increased by more than 2m in some locations in both cases and by up to 2m in and around Launceston. In both cases, the Launceston levee system was over topped leading to extensive inundation. This overtopping in Launceston, was found to increase flooding, including the inundation of properties that were previously not flood prone.

2.6 Tidal Climate Change – Flood Conditions

Under the sea level rise scenario only the tidal boundary was altered. For this assessment the tidal cycle boundary was raised by 0.8m. Both the barrage under normal operations and fully closed conditions were investigated. The resulting flood height difference in the 100 year and 200 year ARI events are shown in Figures A-5 and A-6 under normal operations and in Figures A-7 and A-8 with the barrage fully closed.

The Tamar River is heavily influenced by tidal levels, this influence increases in the sea level rise scenario. As such, when the barrage is operating normally both flood events were found to reduce flood levels upstream of the barrage. This reduction is due to the removal of the increased water levels of the climate change condition.

With the barrage closed during the modelled flood events there are still increases water levels within the lake, however, the magnitude of the impacts has reduced. As mentioned above, this reduction in impacts is due to the increased water levels in the existing case from the tidal boundary under climate change. Despite this, there remains a significant increased risk of flooding to many properties within Launceston.

2.7 Conclusions and Findings

An assessment of the flood impact of the proposed Lake Tamar barrage has been undertaken using the Tamar River TUFLOW hydraulic model. This assessment has found that:

- The approximate drawdown time from 0.9m AHD to 0m AHD is 4 hours for the current conditions and 14 hours for the climate change conditions.
- With 24 hours warning of a flood event on the Tamar River and there is sufficient time to create enough storage upstream of the barrage to provide sufficient flood buffering for the 100 year ARI

event under the current tidal conditions. In the 200 year ARI event, there is an increase in water levels upstream of the barrage to Swan Bay, but no significant increases in Launceston.

- Under the sea level rise conditions there was a reduction in flood levels upstream of the barrage. This reduction in both cases is due to the barrage stopping the influence of the sea level propagate upstream.
- The barrage closed scenario shows significant impacts upstream of the barrage, as expected. These increases represent a significant increase in flood risk in and around Launceston. It is recommended that a failsafe is investigated such as a secondary spillway or fuseplug arrangement.

It is of note that the assessment presented here does not take into account storm surge. Given the proximity of the proposed barrage to Bass Strait, assessment of the impact of storm surge should be undertaken. This could affect design parameters of the barrage as well as the flood risk.

3 Disclaimer

It is noted that consent to use the existing River Tamar & North Esk River TUFLOW Hydraulic model has been provided by the Launceston Flood Authority. This consent does not imply or otherwise endorse the Tamar Lake Barrage Proposal by the Launceston Flood Authority. This assessment is independently being undertaken for Tamar Lake Inc.

Yours faithfully
BMT WBM

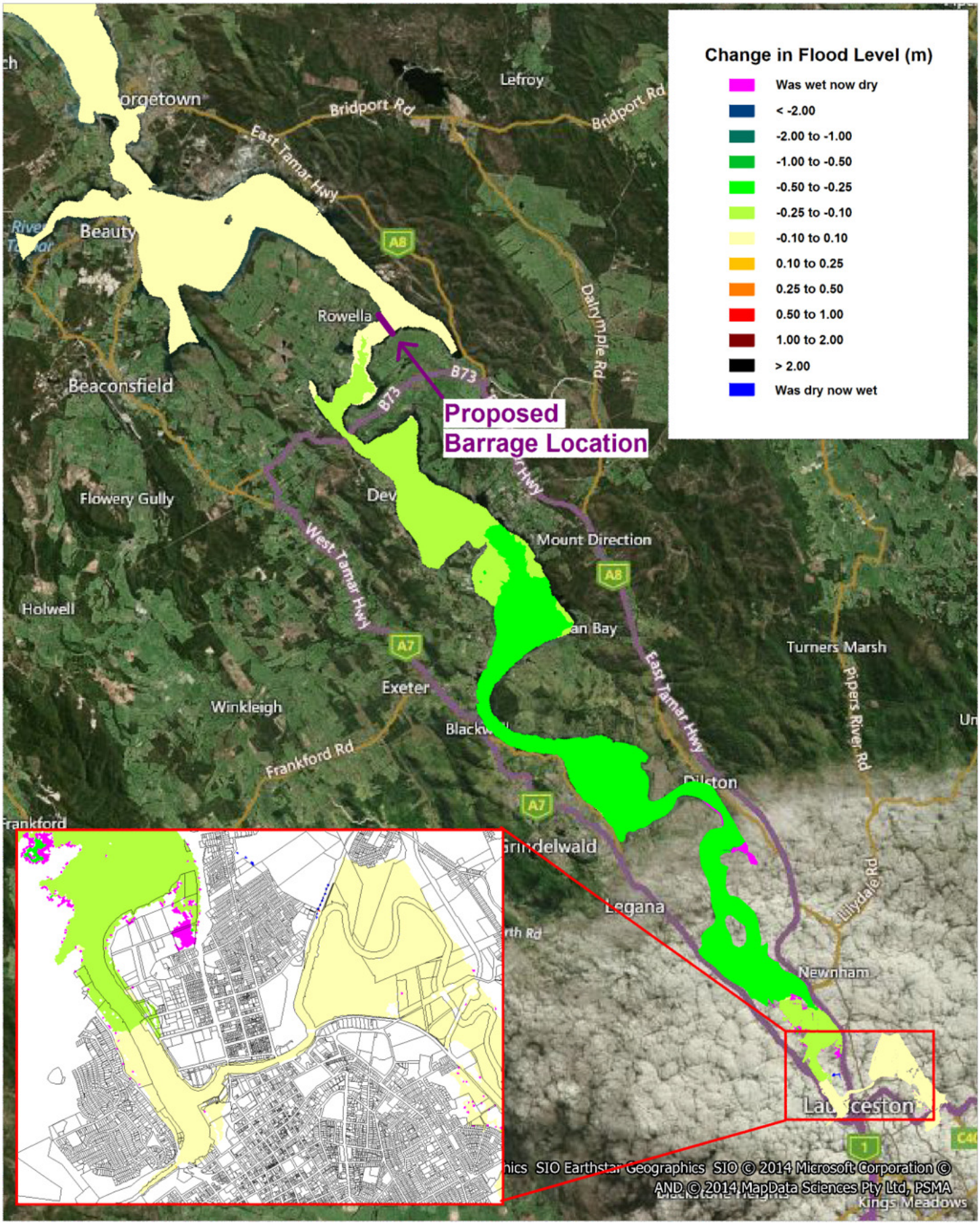
Philip Pedruco

4 References

BMT WBM (2008), River Tamar & North Esk River Flood Study, Report for Launceston City Council, Report No. R.M7246.002.01, November 2008.

BMT WBM (2012). Tamar Lake Preliminary Technical Assessment, Report for Tamar Lake Inc., Report No. R.B18703.001.02.TamarLake.doc, February 2012.

Frith, R. (2011), The Tamar Valley - A Strategic Plan and Vision for its Development, Robin Smith, 11 June 2011.



Title:

Lake Tamar Barrage - 100y Flood Height Impact Barrage in Operation

Figure:	Rev:
A-1	A

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N

0 3.75 7.5km

Approx. Scale

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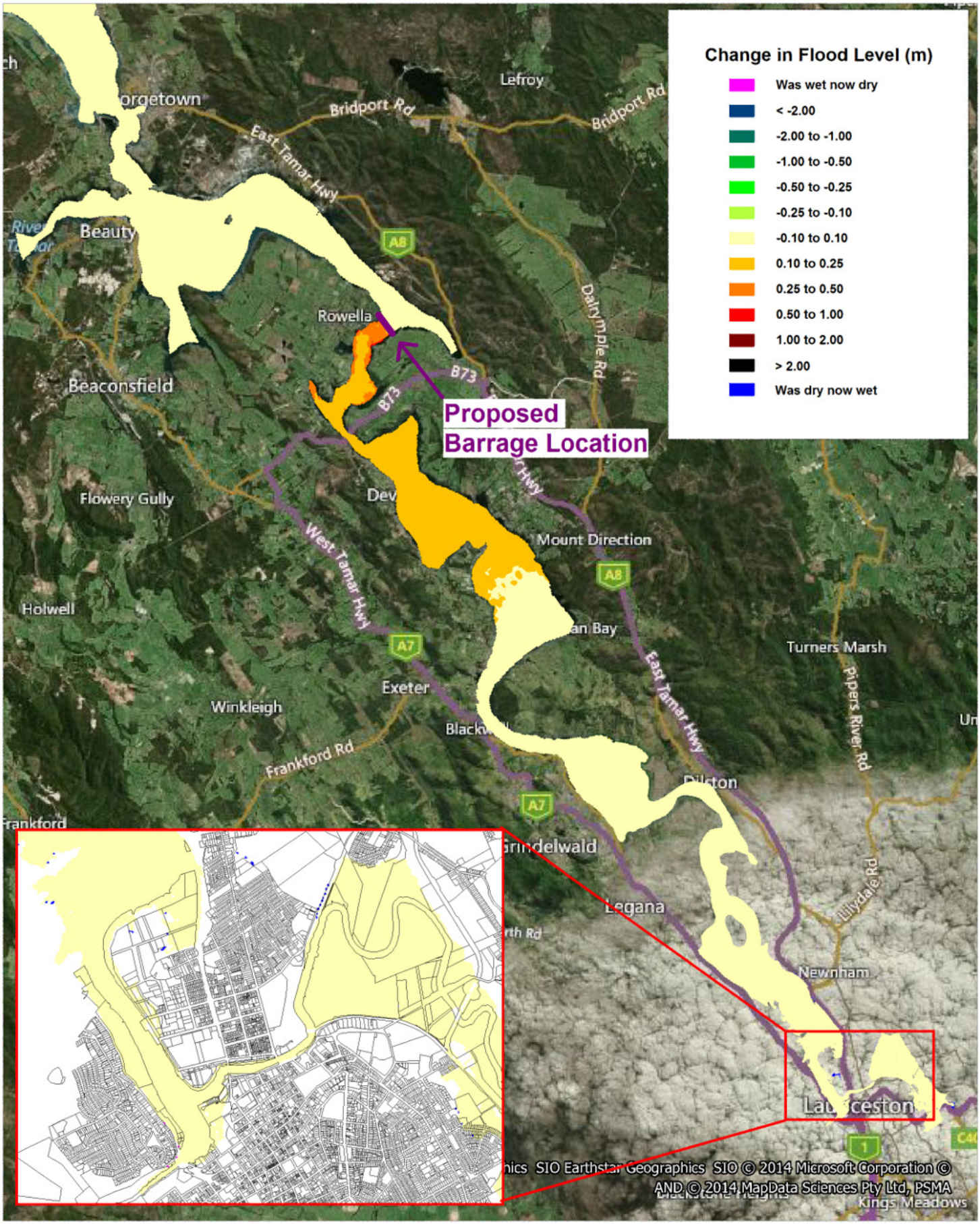

Title:

Lake Tamar Barrage - 95% 200y Flood Height Impact Barrage in Operation

Figure:	Rev:
A-2	A

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Approx. Scale

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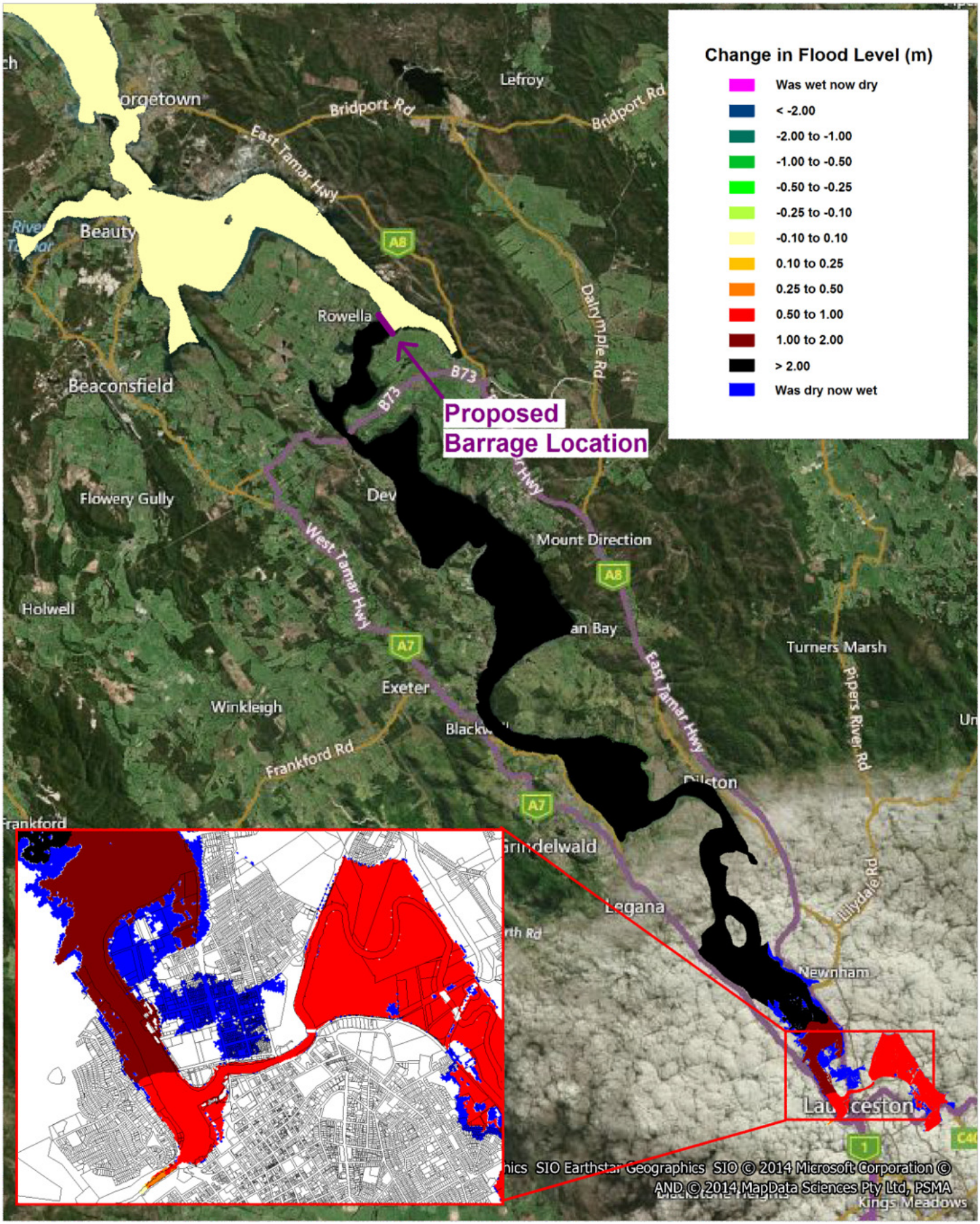

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Lake Tamar Barrage - 100y Flood Height Impact Barrage Closed

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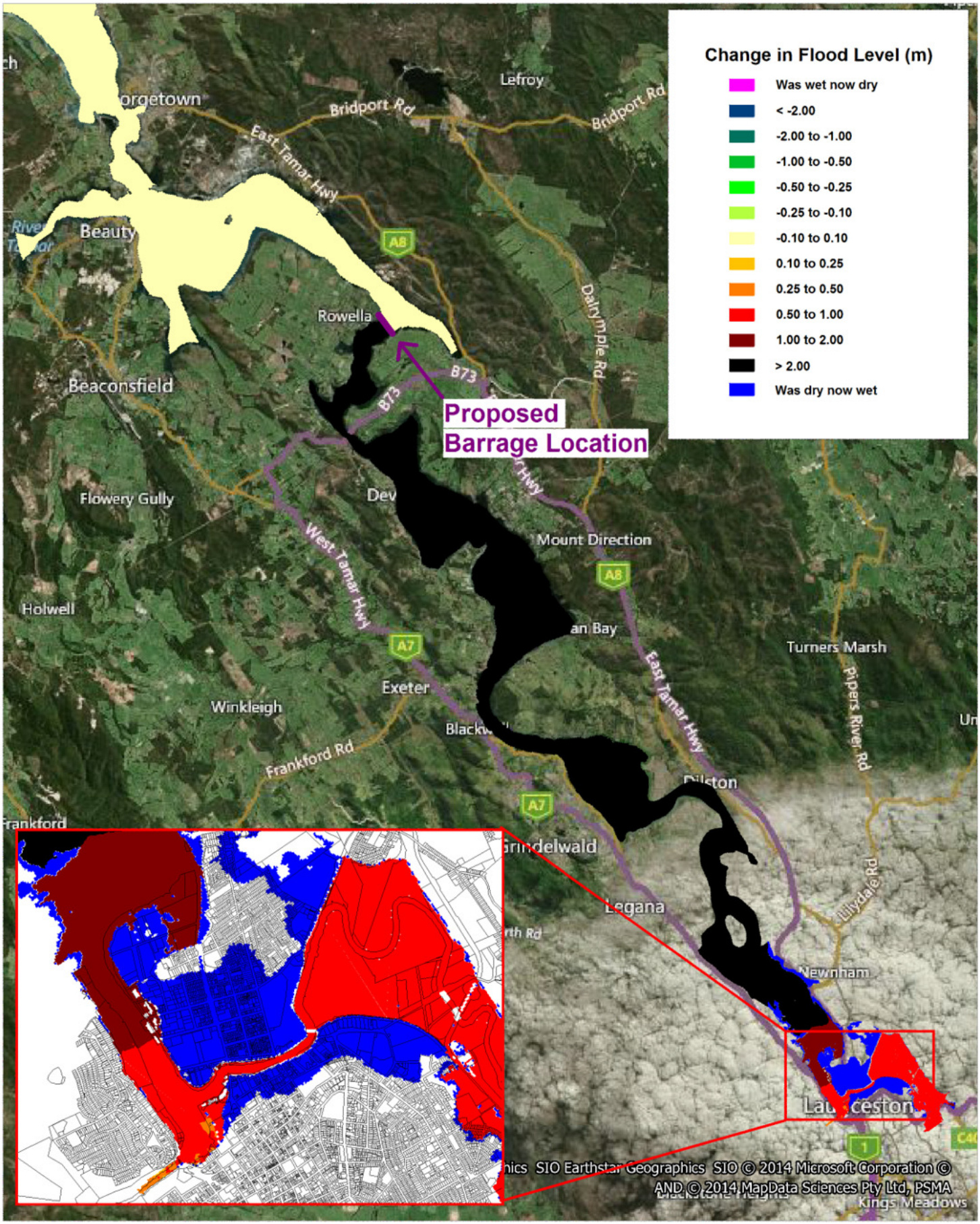

Title:

Lake Tamar Barrage - 95% 200y Flood Height Impact Barrage Closed

Figure:	Rev:
A-4	A

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0 3.75 7.5km

Approx. Scale

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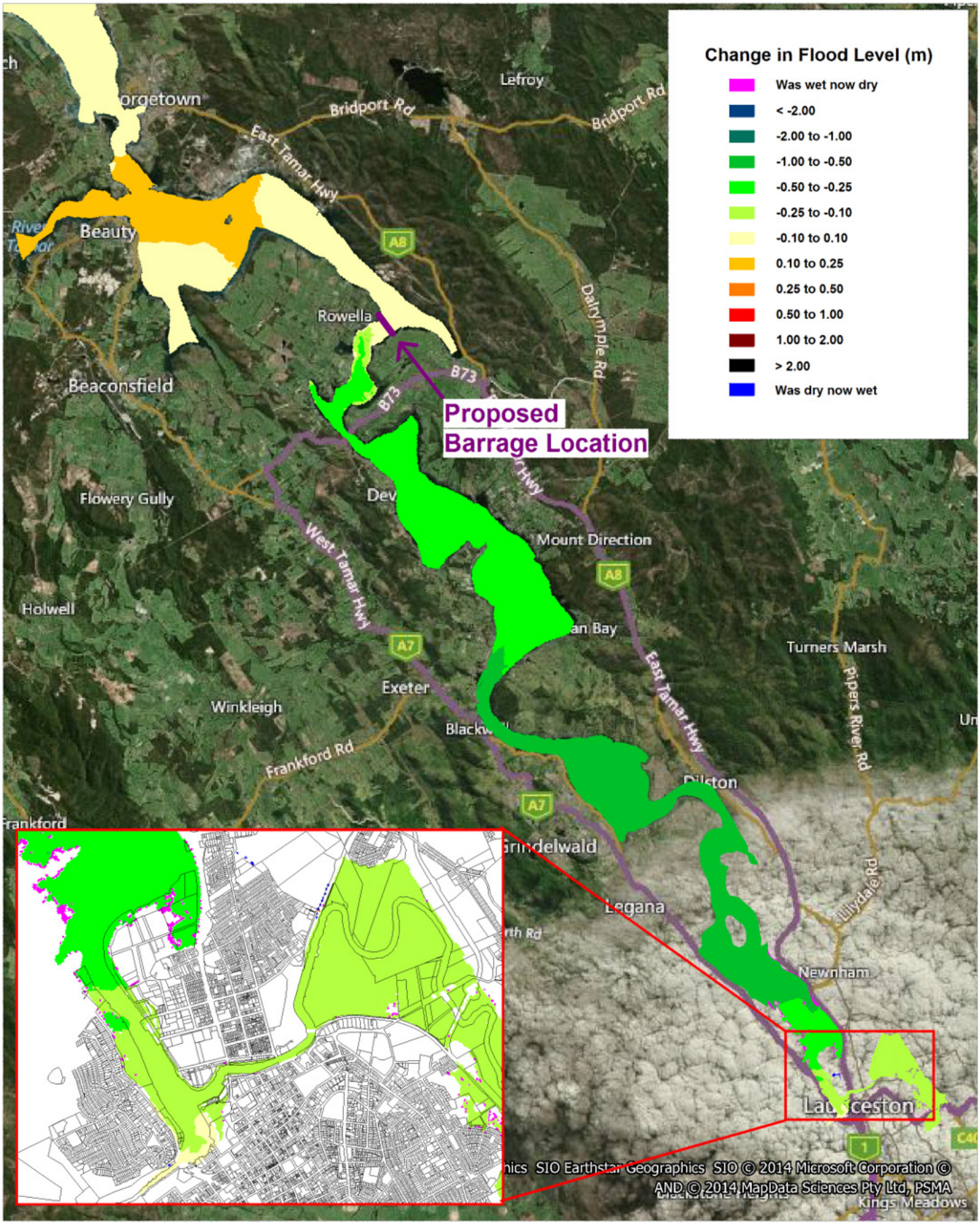

Title:

Lake Tamar Barrage - 100y Flood Height Impact
Barrage in Operation - Sea Level Rise

Figure:	Rev:
A-5	A

N

0 3.75 7.5km

Approx. Scale

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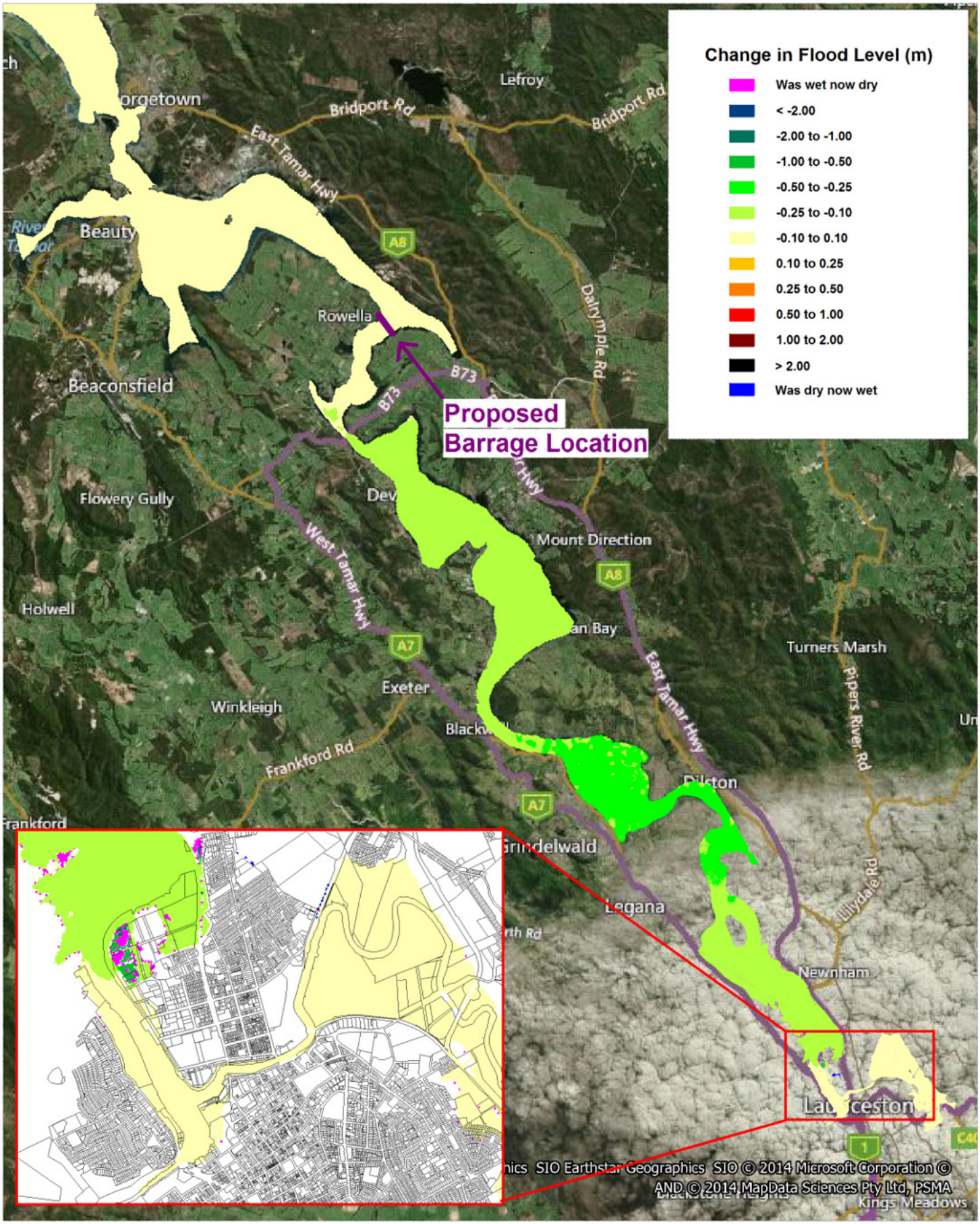

Title:

Lake Tamar Barrage - 95% 200y Flood Height Impact Barrage in Operation - Sea Level Rise

Figure: **A-6**

Rev: **A**

N

0 3.75 7.5km

Approx. Scale

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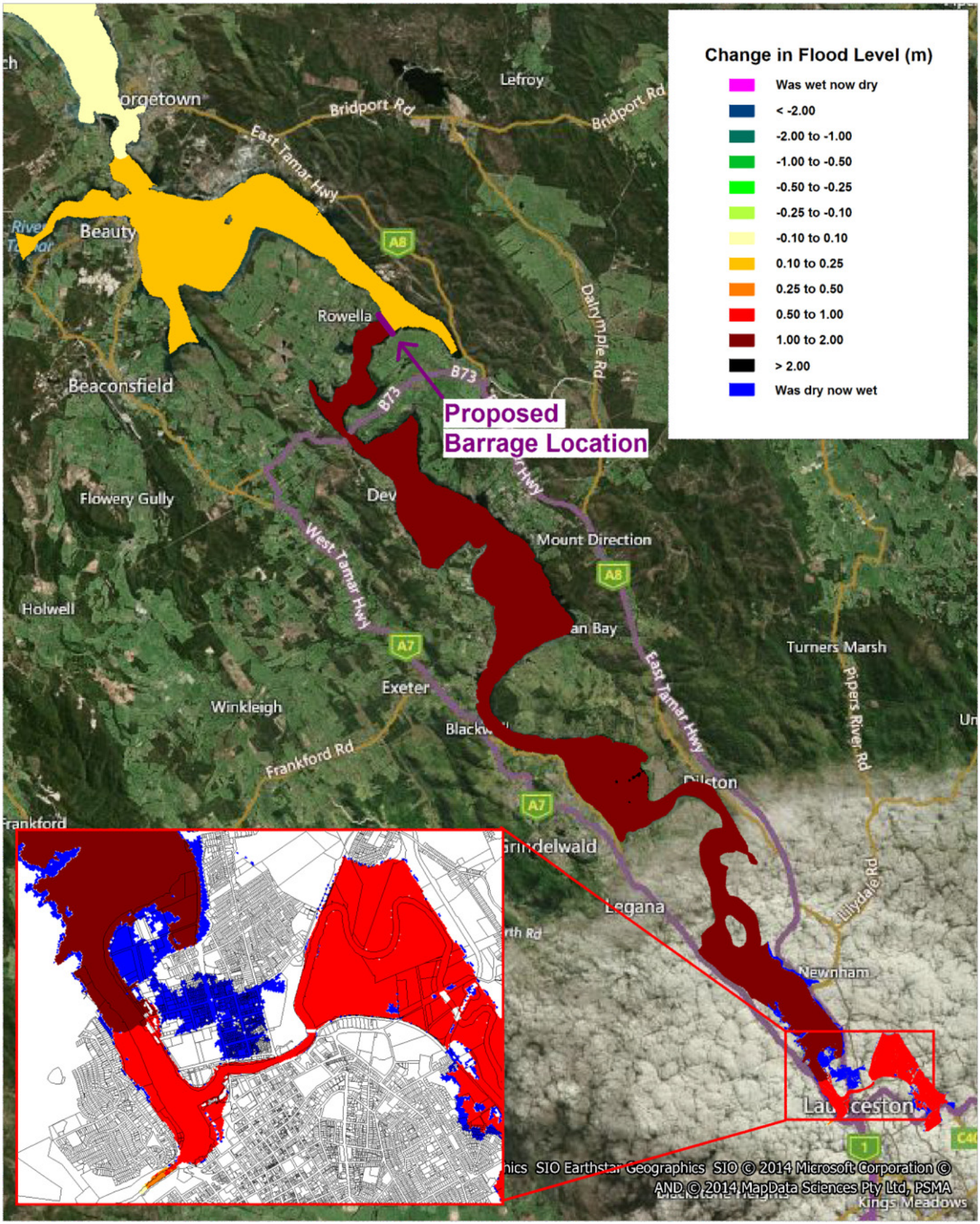

Title:

Lake Tamar Barrage - 100y Flood Height Impact
Barrage Closed - Sea Level Rise

Figure: **A-7**

Rev: **A**

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Approx. Scale

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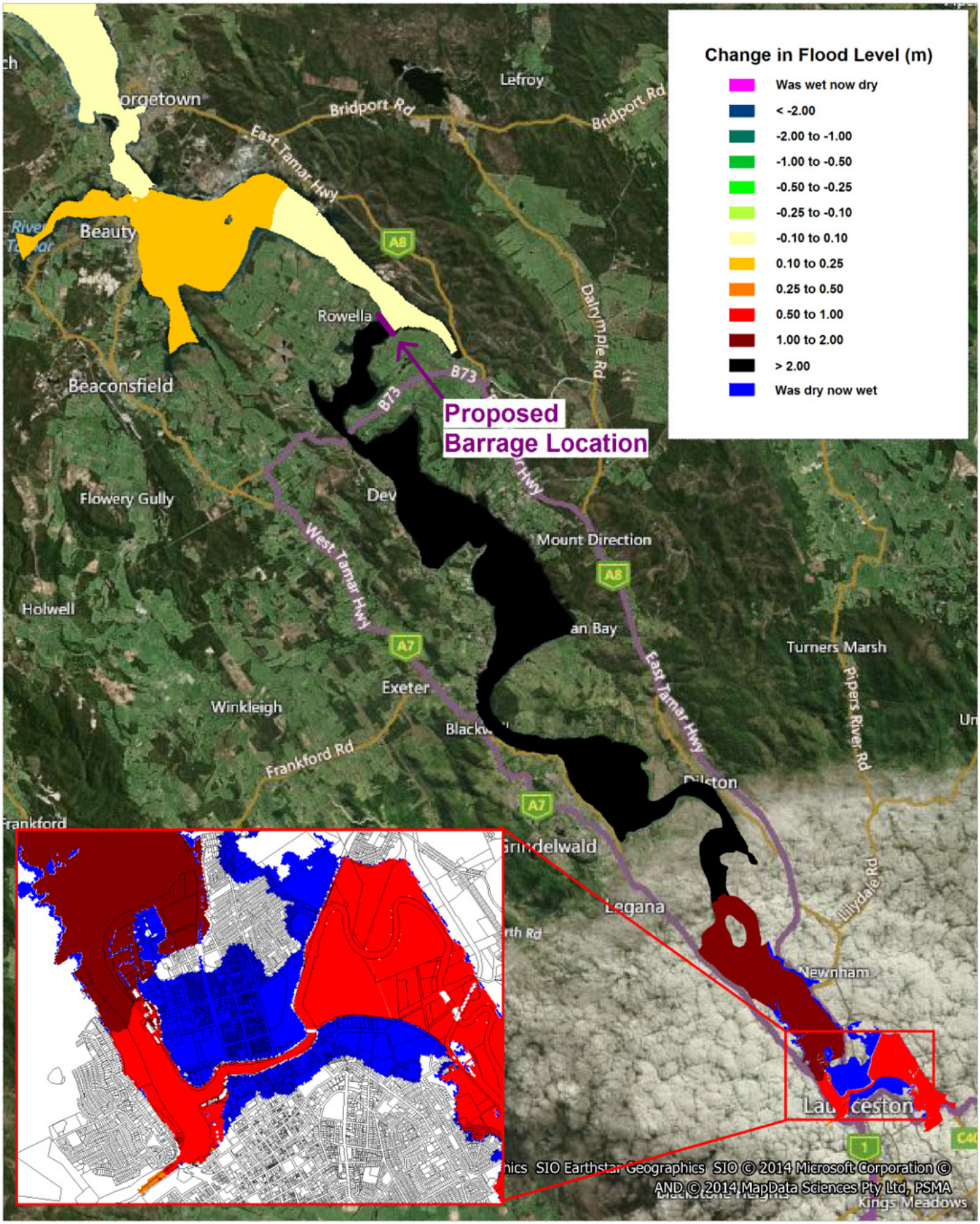

Title:

Lake Tamar Barrage - 95% 200y Flood Height Impact Barrage Closed - Sea Level Rise

Figure:	Rev:
A-8	A

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Approx. Scale

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