Transport for NSW

M1 Pacific Motorway extension to Raymond Terrace

Submissions Report - Appendix F

June 2022

Australian Government

BUILDING OUR FUTURE

NSW GOVERNMENT

M1 Pacific Motorway extension to Raymond Terrace

Appendix F

Supplementary report - hydrology and flooding

June 2022

Executive summary

Transport for New South Wales (Transport) proposes to construct the M1 Pacific Motorway extension to Raymond Terrace (the project). Approval is sought under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* and Part 9, Division 1 of the *Environment Protection and Biodiversity Conservation Act 19*99.

In accordance with the Secretary's Environmental Assessment Requirements (SEARs), an environmental impact statement (EIS) was prepared by Transport in July 2021 *M1 Pacific Motorway extension to Raymond Terrace Environmental Impact Statement* (Transport for NSW 2021a) to assess the potential impacts of the project. The EIS was exhibited by the Department of Planning, Industry and Environment (DPIE) for 28 days from 28 July 2021 to 24 August 2021.

The *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) was prepared in support of the EIS for the project. The purpose of the assessment was to assess potential hydrology and flooding impacts from the projects operation and construction, and where required, identify management measures. The assessment was also prepared to address the SEARs issued by DPIE for the project.

Following exhibition of the EIS, receipt of submissions and further consultation with stakeholders a number of refinements have been made to the project. The main design refinements that potentially influence hydrology and flooding include:

- Reduction of construction footprint at Tarro on the flood plain
- Minor increase to construction footprint near drain at Heatherbrae to enable any works at existing headwall
- Reduction in size at ancillary sites, AS5, AS6, AS7 and AS9
- Drainage design change near horse training facility, Heatherbrae
- Reduced height of access tracks on the floodplain.

Updates were made to the flood hydraulic modelling to assess these design changes. Additional updates were made to the assessment methodology based on newly obtained floor level data for existing residential buildings and with respect to amended flood management objectives and assessment criteria.

This supplementary hydrology and flooding assessment has been prepared in accordance with the SEARs to assess the potential impacts of the design refinements made to the project following public exhibition of the EIS. The following points summarise the findings of this supplementary assessment:

- The supplementary flooding assessment identified that flood impacts during construction and operation are generally negligible to minor across the large majority of the study area with regards to afflux at residential buildings and on properties. Afflux (change in flood level from existing case as a result of the project) is generally up to 0.03 metres during construction and up to 0.02 metres during operation across most of the study area. Changes in flood hazard from existing are minimised and changes in duration of inundation from existing are generally negligible. Flood impacts are generally within acceptable limits
- Identified impacts to residential buildings during construction in the 20%, 10% and 5% AEP events include:

  - 62 residential buildings with above floor afflux exceeding 0.01 metres
  - Three individual residential buildings with new above-floor flooding
  - 25 individual residential buildings with change in duration of inundation of above floor flooding greater than one hour.

- Identified impacts to residential buildings during operation include:
  - 134 residential buildings with above floor afflux exceeding 0.01 metre in the 1% AEP event
  - One residential building with new above-floor flooding in the 1% AEP event
  - Six individual residential buildings with change in duration of inundation of above floor flooding greater than one hour in the 10%, 5% and 1% AEP events.
- The refinements to the ancillary facilities and temporary and permanent access tracks generally reduce the flood impacts during construction and operation compared to the EIS. Afflux upstream of the project is generally reduced compared to the EIS. There are minor increases in afflux compared to the EIS downstream of the project, but these do not result in flood levels being higher than the existing case
- There are increased flood impacts to a 900 metre section of the Main North Rail Line during construction as a result of the proposed design changes to ancillary site AS 6. Further design refinement may be considered at detailed design
- There would be a negligible change to the overtopping flood event AEP of existing levees of the Hunter Valley Flood Mitigation Scheme since the afflux due to the project would be negligible. There is potential for localised scouring due to localised increases in flow velocities around access tracks and ancillary sites. Other potential impacts to the Hunter Valley Flood Mitigation Scheme are as per the EIS. The amended project would be designed and constructed to ensure there are no changes to flow capacity, and as such are not expected to impact operation, function or structural integrity of the scheme (including the floodgates). Transport will continue to consult with the operators of the scheme during detailed design to minimise impacts on the scheme
- Further refinements to the hydraulic modelling will be considered at detailed design including expanding the model to capture the full spatial extent of afflux impacts, refinement of road design model on Pacific Highway at Tomago Road and/or representation in the flood hydraulic model to remove anomalous model results and adoption of finer model grid to improve the accuracy of flood impact estimates at selected locations around the project works
- There are no material impacts to hydrology and drainage conditions as a result of the proposed design refinements during construction and operation.

The refinements explored in this assessment are expected to produce outcomes for the project that are generally better or consistent with the impacts described in the EIS. The construction and operation impacts of the refinements have been assessed, and the environmental management measures have been updated and further elaborated as a result of these refinements.

Clarifications and additional information are also presented in response to EIS submissions and agency consultation, which has resulted in refinements to the flood impact assessment methodology and criteria. A number of the project design refinements themselves were initiated in response to the clarifications and submissions.

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Glossary of terms and abbreviations

Term/ Acronym	Description
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARTC	Australian Rail Track Corporation
DPE	Department of Planning and Environment (formerly DPIE)
DPIE	Department of Planning, Industry and Environment (now DPE)
EIS	Environmental Impact Statement
FMO	Flood Management Objective
FMP	Flood Management Plan
LGA	Local Government Area
NSW	New South Wales
PMF	Probable Maximum Flood
POI	Point of Interest
SSI	State Significant Infrastructure

1 Introduction and background

1.1 The project

Transport for New South Wales (Transport) proposes to construct the M1 Pacific Motorway extension to Raymond Terrace (the project). The project would connect the existing M1 Pacific Motorway at Black Hill and the Pacific Highway at Raymond Terrace within the City of Newcastle and Port Stephens Council local government areas (LGAs). The project location is shown in **Figure 1-1**.

The project would include the following key features (see **Figure 1-2**):

- A 15 kilometre motorway comprised of a four lane divided road (two lanes in each direction)
- Motorway access from the existing road network via four new interchanges at:
  - Black Hill: connection to the M1 Pacific Motorway
  - Tarro: connection and upgrade (six lanes) to the New England Highway between John Renshaw Drive and the existing Tarro interchange at Anderson Drive
  - Tomago: connection to the Pacific Highway and Old Punt Road
  - Raymond Terrace: connection to the Pacific Highway.
- A 2.6 kilometre viaduct over the Hunter River flood plain including new bridge crossings over the Hunter River, the Main North Rail Line, and the New England Highway
- Bridge structures over local waterways at Tarro and Raymond Terrace, and an overpass for Masonite Road in Heatherbrae
- Connections and modifications to the adjoining local road network
- Traffic management facilities and features
- Roadside furniture including safety barriers, signage, fauna fencing and crossings and street lighting
- Adjustment of waterways, including Purgatory Creek at Tarro and a tributary of Viney Creek
- Environmental management measures including surface water quality control measures
- Adjustment, protection and/or relocation of existing utilities
- Walking and cycling considerations, allowing for existing and proposed cycleway route access
- Permanent and temporary property adjustments and property access refinements
- Construction activities, including establishment and use of temporary ancillary facilities, temporary access tracks, haul roads, batching plants, temporary wharves, soil treatment and environmental controls.

A more detailed description of the project incorporating the refinements identified in **Section 1.2** is presented in Appendix A of the *M1 Pacific Motorway extension to Raymond Terrace Submissions Report* (Transport for NSW, 2022).

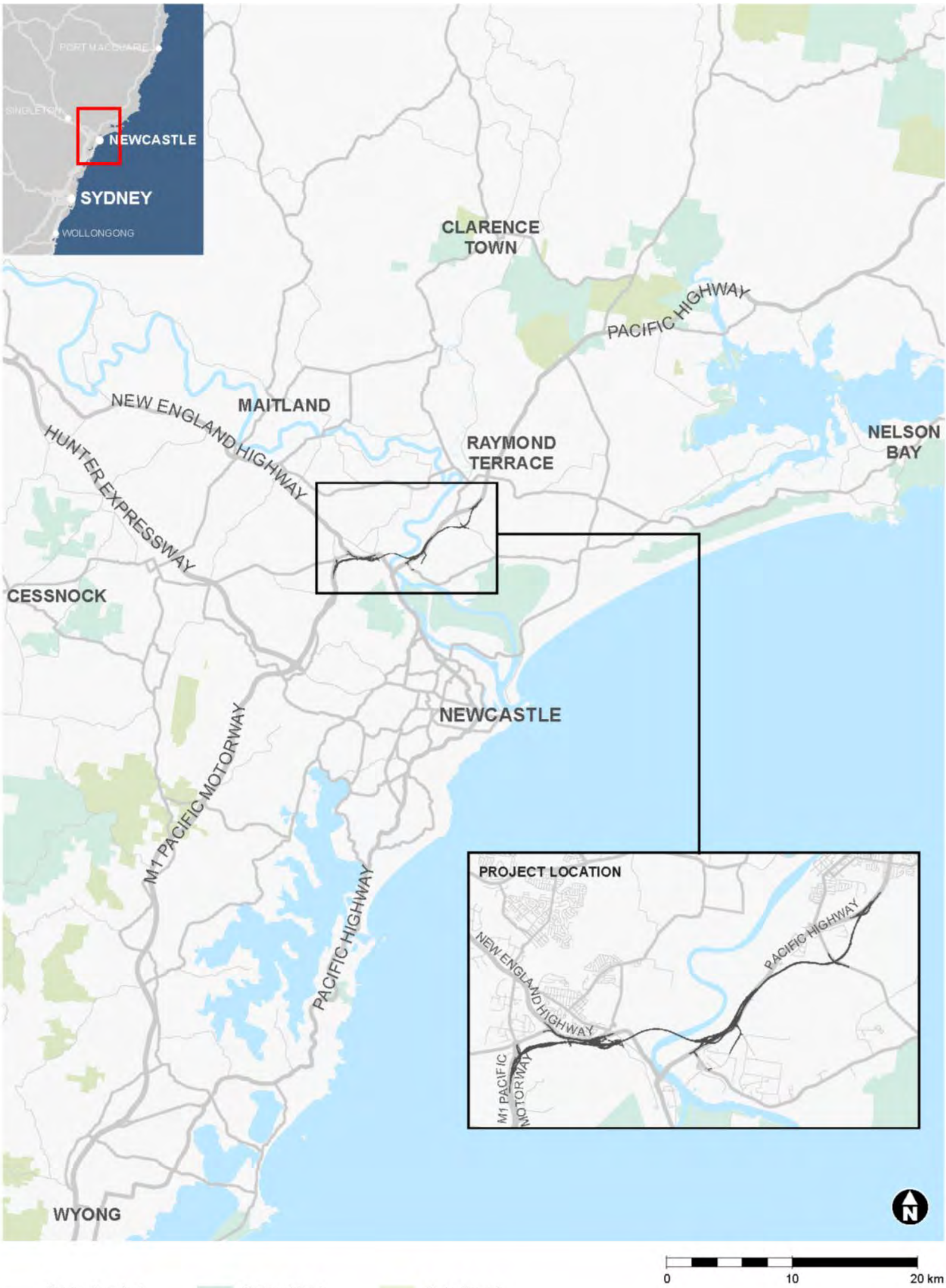

Figure 1-1 Regional context of the project

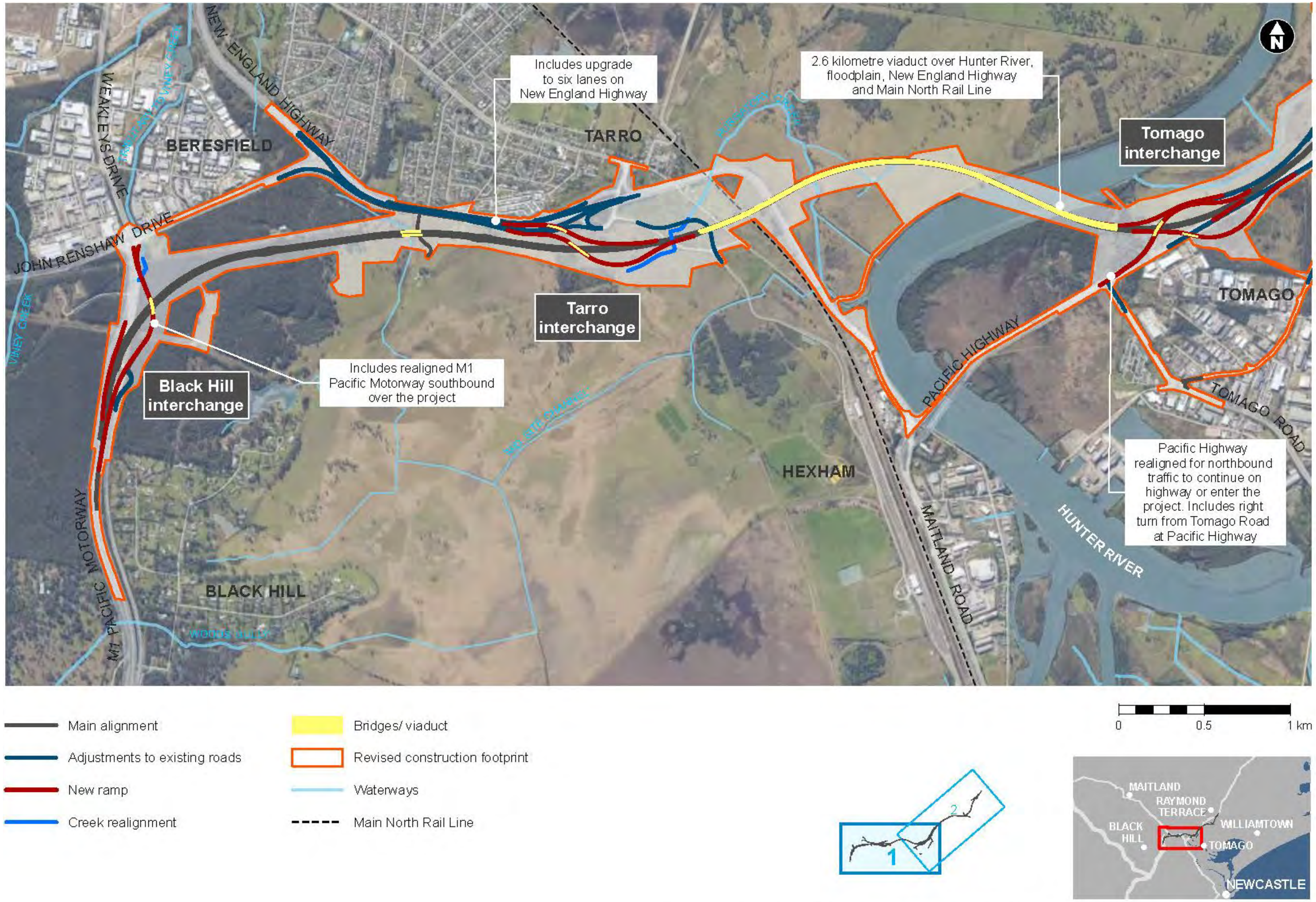

Figure 1-2 Project key features (map 1 of 2)

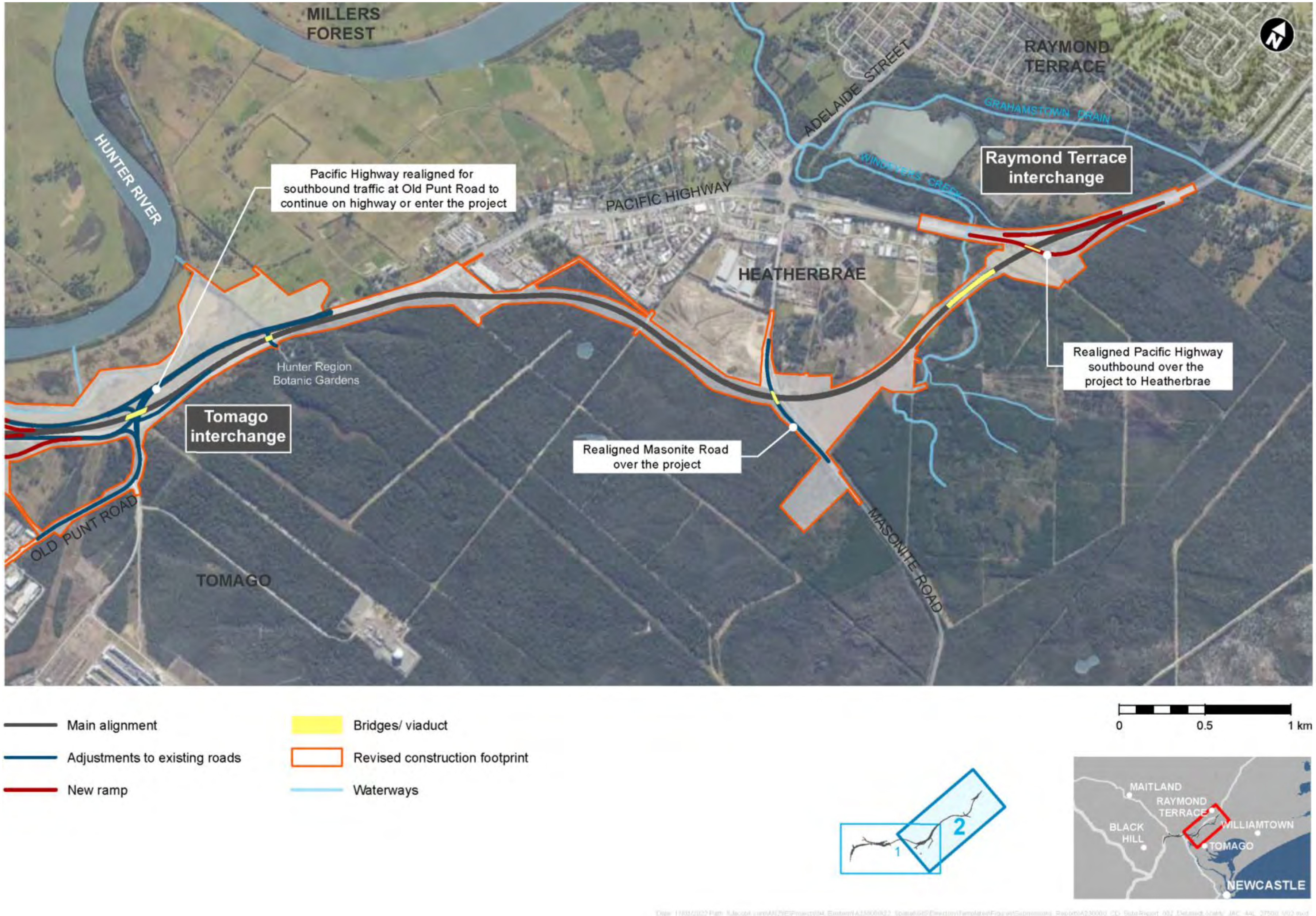

Figure 1-2 Project key features (Map 2 of 2)

1.2 Project refinements

Transport has refined a number of aspects of the project as exhibited in the environmental impact statement (EIS). These refinements have arisen through the ongoing review of the concept design and construction methodology, identification of opportunities to reduce environmental impact, consultation with landowners and government agencies, and in response to issues raised during the EIS exhibition period. The project refinements are described below.

Design refinements

- Southbound M1 Pacific Motorway merge – a 200 metre extension of the merge lane for southbound traffic from the John Renshaw Drive/Weakleys Drive intersection to allow for improved capacity and safety
- Utilities strategy – key changes include grouping of utilities at Tarro and Tomago into utility corridors and extension of the construction footprint at Beresfield and Hexham to accommodate utility relocations
- Cycleway strategy – improvements to facilitate incorporation with the Richmond Vale Rail Trail and removal of shared use path on the new Masonite Road bridge (bridge at Heatherbrae
- Drainage design at Heatherbrae – minor changes to basin locations and extension of drainage lines to minimise property and drainage impacts on adjacent properties
- Water quality basins – lining of temporary and permanent water quality basins which interface with ground water.

Construction refinements

- Ancillary facilities and site access – minor changes to the size, location and access arrangements of some ancillary facilities
- Earthworks management – identification of a borrow pit and sites for beneficial reuse of materials within the construction footprint.

Construction staging

- Staged project opening - the project would be delivered via two packages of work, the Southern (Black Hill to Tomago) and Northern (Heatherbrae bypass) works. The Northern section would likely have a shorter construction duration and could potentially be opened to traffic before the Southern section.

Project footprint refinements

- Consultation with landowners and the design and construction refinements to reduce property and biodiversity impacts have resulted in minor changes to the construction and operational project footprints.

1.3 Purpose of the document

The *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) was prepared in support of the EIS for the project. The purpose of the working paper was to provide an assessment of the potential impacts and benefits from the construction and operation of the project on hydrology and flooding.

This assessment was prepared to address the Secretary's Environmental Assessment Requirements (SEARs) and Supplementary SEARs as described in Section 1.4 of the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b).

During the exhibition of the EIS several submissions were made in relation to hydrology and flooding matters. These submissions have been addressed in the *M1 Pacific Motorway extension to Raymond Terrace Submissions Report (*Transport for NSW, 2022).

This supplementary hydrology and flooding assessment has been prepared to assess the potential impacts of the project refinements identified in **Section 1.2.** Where further clarification or additional information is required to provide a detailed response to the submission, these matters have been included in this supplementary report and an overview is presented in **Chapter 3**. The assessment of potential hydrology and flooding impacts resulting from these project refinements are presented in **Chapter 5** (assessment of potential construction impacts) and **Chapter 6** (assessment of potential operational impacts).

This supplementary assessment only includes information that has changed since the EIS and should be read in conjunction with the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) included in the EIS.

2 Existing environment

2.1 Overview

Information presented regarding the existing environment in Chapter 4 of the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) for the EIS included:

- Catchment overview
- Geology and soil landscapes
- Surface water features
- Groundwater features
- Flooding conditions
- Sensitive receiving environments.

A summary of the existing flood behaviour and existing case impacts to buildings are presented below.

2.2 Summary of existing flood behaviour

Flooding in the Hunter River at and upstream of the project is generally contained within the river banks by existing Hunter Valley Flood Mitigation Scheme levees in up to and including the 20% annual exceedance probability (AEP) flood event. Inundation on the floodplain during this event is due to direct rainfall and local catchment runoff. In the 10% AEP event and larger, floodwaters from the River overtop the levees and inundate the floodplain. When the western side levee bank of the Hunter River is overtopped, a substantially larger area is inundated. This broad and wide floodplain extends to Thornton, Woodberry and Heatherbrae. On the eastern side of the Hunter River, the floodplain encroaches on the urban fringe at Heatherbrae and Raymond Terrace. Flood flows are conveyed within the Hunter River as well as on the floodplain in larger events.

The project's crossing location of the Hunter River is located at a flow constriction point caused by natural topography at Tarro and Tomago and by existing infrastructure including the New England Highway embankment and Main North Rail Line. During the 10% AEP event and larger, the Hunter River floodwaters overtop the New England Highway and spill into Hexham Swamp, a large flood storage area to the west of the Hunter River. In smaller flood events, flooding in Hexham Swamp is caused by local catchment flooding.

Downstream of the project, the Hunter River drains towards the south and discharges to the Tasman Sea to the east of Newcastle.

Local watercourses including Windeyers Creek, which is a prominent tributary on the Hunter River floodplain, are crossed by the project at its eastern extent. During flood events, the Windeyers Creek catchment experiences flooding in low lying areas from the local catchment and/or from backwater from the Hunter River. Other unnamed watercourses cross the project on the eastern side of the Hunter River. On the western side of the Hunter River, Hexham Swamp is drained by Purgatory Creek and Mid Site Channel through the Main North Rail Line and New England Highway to the Hunter River.

There are a number of rural properties located in the floodplain which are subject to existing flooding. Typically, dwellings on these properties are impacted by existing flooding in the 1% AEP event to depths of two to three metres. Properties located in residential subdivisions located around the project are generally not affected by flooding in the 1% AEP event.

2.3 Existing flooding impacts to residential buildings

An analysis of existing flood impacts on buildings was undertaken based on building spatial and floor level survey information provided by Newcastle City Council, Port Stephens Council and Transport. This formed a basis for assessing flood impacts to buildings resulting from the project. A focus is placed on residential buildings and above-floor flooding, because of the higher vulnerability of residential buildings (e.g. risk to life, financial impacts) compared to commercial or industrial buildings.

Table B-1 in **Appendix B** presents a count of the residential buildings affected by different depths of flooding above floor level in the 20%, 10%, 5% and 1% AEP events. In summary:

- In the 20% AEP event, there are 37 residential buildings with above floor flooding. About a quarter of buildings have up to 0.1 metres depth above floor, and 84 per cent experience depth above floor of up to 0.5 metres. There are five buildings with depth above floor between 0.5 and one metre and there is one building with depth above floor of between 1.5 and two metres
- In the 10% AEP event, there are 72 residential buildings with above floor flooding. A third of buildings have up to 0.1 metres depth above floor and 79 per cent experience depth above floor of up to 0.5 metres. There are 14 buildings with depth above floor between 0.5 and one metre and there is one building with depth above floor of between 1.5 and two metres
- In the 5% AEP event, there are 111 residential buildings with above floor flooding. About 22 per cent of buildings have up to 0.1 metres depth above floor and 71 per cent experience depth above floor of up to 0.5 metres. There are 26 buildings with depth above floor between 0.5 and one metre, 5 with depth between one and 1.5 metres and there is one building with depth above floor of between 1.5 and two metres
- In the 1% AEP event, there are 371 residential buildings with above floor flooding. Between 18 and 26 per cent of buildings fall in each of the 0 to 0.5 metre, 0.5 to one metre, one to 1.5 metre and 1.5 to two metre categories of depth above floor. Ten per cent of buildings experience above floor depths greater than two metres.

3 Clarifications and additional information

3.1 Submissions

Three submissions received during the exhibition of the EIS required further review on hydrology and flooding matters. A summary of those issues requiring additional information or assessment are presented in **Table 3-1**.

Table 3-1 Response to EIS submissions

Stakeholder	Issue	How addressed in this report
Public	Concerns were raised regarding flood impacts to landowner's property, increased runoff from the project and reduced drainage capacity.	Increased runoff and drainage capacity at this property and is discussed in **Section 3.1.2**.
Newcastle City Council	Council sought clarification on flooding assessment, adopted assessment criteria and impacts to properties in the LGA. Concern raised whether properties impacted by an increased flooding risk can be suitably addressed with management measures and what these management measures would be.	Flood impacts to residential buildings are discussed in **Section 5.3.2** and **Section 6.3.2** for construction and operation respectively. Flood impacts to properties are discussed in **Section 5.3.3** and **Section 6.3.3** for construction and operation respectively. Changes to flood hazard are discussed in **Section 5.2.2** and **Section 6.2.2** for construction and operation respectively. The assessments are based on the amended project design and updated flood assessment which result in reduced impacts compared to the EIS. The flood assessment criteria have been revised and this is discussed in **Section 4.4**. Updated environmental management measures are outlined in **Chapter 7**.
DPE – Biodiversity and Conservation Division	Queries raised regarding: • Clarification of flood assessment methodology for hydrologic modelling and climate change analysis • Basis for the adopted assessment criteria • Clarification of detailed flooding impacts to buildings and properties • Management measures for impacted properties. • Further details requested on flooding assessment methodology and impacts.	Clarifications on the flood assessment methodology for hydrologic and hydraulic modelling and climate change analysis are provided in **Section 5.2.3**. The flood assessment criteria have been revised and this is discussed in **Section 4.4**. Impacts to buildings and properties have been revised based on the revised criteria, new building floor level data, amended project design and updated flood assessment which has resulted in reduced impacts compared to the EIS. Flood impacts to residential buildings are discussed in **Section 5.3.2** and **Section 6.3.2** for construction and operation respectively. Flood impacts to properties are discussed in **Section 5.3.3** and **Section 6.3.3** for construction and operation respectively. Updated environmental management measures are outlined in **Chapter 7**.

3.1.1 Management measures

The impacts of potential flooding have been assessed for the amended design and on the basis of revised flood management design objectives. The revised objectives and criteria are discussed in **Section 4.4** and the assessment outcomes discussed in **Chapter 5** and **Chapter 6** for the construction and operational phases, respectively. Buildings and properties where residual impacts exceed the adopted criteria have been identified for consideration of further management measures (refer to **Chapter 7**).

Specific measures for each building or property have not been confirmed as these are subject to consultation with individual property owners, however, appropriate measures would be identified for each eligible property on a merit-based approach with consideration of the degree of flood impact to the property.

3.1.2 Increased runoff to properties and drainage capacity

Additional issues were raised in the public submissions about the potential for increased runoff directed to properties as a result of the project, particularly around Hexham Swamp and Tarro. Tables J-2 to J-4 in Appendix J of the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) present findings from stormwater modelling for the project, which indicate an average increase in runoff volume from the project of about five per cent, which were considered unlikely to pose a significant impact. Maximum increases in runoff volumes of 10 per cent to 17 per cent would occur at discharge locations in Tomago and at Windeyers Creek which, based on their locations and the absence of nearby development, were also unlikely to pose a risk of drainage and flooding impacts.

A public submission raised concerns about where runoff from the project, including the viaduct and road, would be directed in relation to the correspondent's property. In general, the existing drainage patterns and catchment areas around the submitter's property at Tarro would be maintained and runoff would drain to the existing discharge points and waterways as per the existing case. The Project would involve about 200 metres of the proposed viaduct which would drain from outside the existing catchment area to a watercourse adjacent to the submitter's property, representing an increase in catchment area of about 0.5 hectares. While this represents a minor increase in the total watercourse catchment area, it may result in localised flooding and drainage impacts. A potential mitigation measure has been included in the revised environmental management measures in **Chapter 7**, which would involve investigating options to minimise any increase in catchment area draining to Purgatory Creek and for improving the drainage capacity of existing drainage channels and culverts along Purgatory Creek during frequent rainfall storm events.

A public submission raised concerns about increased runoff from the project affecting the correspondent's property. Review of the project drainage design confirms that runoff from the project would be discharged to existing drainage lines which discharge away from the resident's property.

3.1.3 Assessment of property impacts

Residential and industrial lots reported in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) with increased maximum depths on a lot of up to 0.3 metres are due mainly to a relatively coarse model grid and coarse representation of topography on the lot.

The flood modelling from the EIS has been updated with the refined project design, which generally reduces the flood afflux resulting from the project. Reporting of the flood impacts to lots has been updated and presented in **Section 5.3.3** and **Section 6.3.3** for construction and operation respectively.

The updated impact reporting includes manual validation of the modelled impacts to screen for and identify anomalous impacts. The screening considers the magnitude of the flood afflux in the broader area and any local topographic features to filter out anomalous and localised impacts. A register of remaining lots with flood impacts exceeding the adopted criteria has been developed to facilitate consultation with landowners on appropriate management measures. Refer to Table E-13 in **Appendix E** and Table F-13 in **Appendix F** for lists of lots with afflux criteria exceeded during construction and operation, respectively.

The change in flood hazard has also been reassessed based on revised project design and updated hydraulic modelling. This is discussed in **Section 5.2.2** and **Section 6.2.2** for construction and operation respectively.

3.2 Additional information

3.2.1 Flooding impacts to the Pacific Highway

A query was raised about the flooding impacts to the Pacific Highway reported in the Section 5.2.7 and Section 5.3.8 of the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b), for construction and operation, respectively. While improvements are reported for the 5% and 10% AEP events, increases in the length of the Pacific Highway which are subject to flooding within the study area are reported for the 20% AEP event. This result for the 20% AEP event is an anomaly in the modelling, with a discontinuity in the road levels between the project road design terrain and the existing road levels at the project interface with the existing road on the Pacific Highway at Tomago Road. The designed road was modelled as slightly lower than the existing road causing a localised area of ponding during modelling of the operation and construction phases. It is expected this minor issue would be resolved at detailed design. The flood model inputs would be refined to reflect actual road levels at this location which will remove the discontinuity between the designed road levels and adjoining existing road levels. This would result in this anomalous model result being eliminated and there would not be an increase in the length of the Pacific Highway that is affected by flooding in the 20% AEP event.

3.2.2 Assessment criteria for duration of inundation

A comment was received that the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) did not provide justification regarding whether the predicted increases in duration of inundation are acceptable.

The hydrology and flooding assessment for the EIS mapped the change in duration with a +/- five per cent increment, and identified that increases in duration were less than five per cent across the large majority of the study area. The change in duration of inundation mapping in this supplementary report, which is based on the amended project design, has been refined to display the change in duration of inundation with a +/- one per cent increment bracket.

The refined mapping indicates that the change in duration of inundation is less than a one per cent increase across the majority of the study area. With durations of inundation of up to 90 hours typically, this translates to less than a one hour increase, which is considered acceptable given the long duration of flooding on the floodplain.

Higher percentage increases are present along the fringes of the flood extents which are proportional with the relative increase in depths along the fringes. The absolute duration of inundation would be similar to the adjacent existing inundated areas. **Section 5.2.3** and **Section 6.2.3** provide updated duration of inundation assessment for construction and operation, respectively.

The supplementary flood assessment includes assessment of above floor flood duration at buildings based on new building data. Increases in the duration of above floor flooding of more than one hour from the existing case are reported. **Section 5.3.2** and **Section 6.3.2** provide the updated duration of inundation above floor level at buildings in the study area, for construction and operation respectively.

3.2.3 Additional clarification that the project design minimises potential flood impacts

Additional information was sought to confirm that the project has been designed to minimise impacts caused by flooding and provide justification for why afflux of less than 10 millimetres could not be achieved through design.

Various route alignments and options were considered during the development of the project. These project alternatives are outlined in Chapter 4 of the EIS. The adopted road alignment was chosen because it best met the project objectives, had less environmental impacts, provided better opportunities to connect to the regional road network, improved the interface and constructability across existing rail and road infrastructure and had the best allowance for future urban development. There were no practical design alternatives to the adopted route alignment that avoided crossings of floodplain areas or the Hunter River.

The project design includes a 2.6 kilometre viaduct across the main part of the Hunter River and its floodplain, to minimise flooding impacts from the project. However, any infrastructure constructed on a floodplain has the potential to cause minor changes to flooding behaviour (i.e. afflux, increase duration of inundation and flood risk changes). Factors that contribute to changes in flooding behaviour (such as afflux) include:

- The location of the viaduct abutments
- Bridge design alignment, span and pier shape
- Operational maintenance facilities such as access tracks to maintain the viaduct
- Temporary construction accesses, ancillary facilities and wharfs.

Bridge abutments

The bridge length, and therefore abutment locations, are limited by several factors.

The western abutment of the viaduct is located on a low-lying portion of land at Tarro, about 240 metres west of the Main North Rail Line. This abutment contributes to afflux due to its location on flood-prone land and proximity to Purgatory Creek. However, extending the bridge to the west and shifting the abutment and approach embankment to minimise these impacts is not practical due to the proximity of the Tarro interchange and associated southbound exit ramp.

In order to mitigate the impacts from the western abutment, the project proposed a significant widening and realignment of Purgatory Creek (including box culverts beneath the embankment) to maintain drainage connectivity.

The eastern abutment is located at the edge of the 1% AEP flood area on higher land at Tomago and does not contribute significantly to afflux or other flood impacts.

The bridge has an overall length of 2,578 metres and is the maximum length bridge practical, noting the constraints outlined above.

Bridge design

The bridge piers contribute to afflux however sensitivity testing of different span lengths shows that changes to span arrangements do not significantly improve or worsen afflux. Additionally, the alignment of the viaduct results in a complex structure due to changing radius horizontal and vertical curves, as well as changing cross-section width. This limits the type of bridge that can be adopted.

Constraints on the horizontal and vertical alignment of the viaduct include crossing the realigned Aurizon access road, Main North Rail Line, New England Highway, future allowance for the Lower Hunter Freight Corridor, 330 kilovolt transmission lines and the Hunter River.

The project has adopted 1.5 metre super-T girders with a maximum span between each pier of about 32 metres across the floodplain. The Hunter River crossing has a different superstructure design to accommodate navigation channel requirements.

The shape of piers would be further reviewed during detailed design to ensure that impacts from the piers are minimised.

Operational maintenance facilities

A minor access track is required along the viaduct in order to undertake performance inspections and carry out maintenance activities such as bearing replacements, and cleaning out of drainage pipes and expansion joints.

This access track contributes to afflux and therefore has been designed to at the lowest height practical and includes sections of causeway where the track would be constructed at natural ground level (i.e. dug into the ground). This results in the access track being more expensive to construct and less flood-immune, however minimises flood afflux impacts from the project. **Section 5.1** and **Section 6.1** outlines the design refinements during construction and operation, respectively, compared to the EIS and the effect these refinements have had on minimising afflux and other flood impacts. Operational access tracks proposed are now similar to existing farming access roads.

3.2.4 Assessment criteria for afflux

A comment was received that the adopted Flood Management Objectives (FMOs) were not supported and did not align with recent project approvals, particularly for afflux (the change in peak flood level from the existing case as a result of the project, and often referring to an increase in flood level).

In developing the FMOs proposed in the EIS for the project consideration was made of industry technical guidance and recent project planning approval conditions. Development on floodplains in NSW does not provide specific guidance for establishing FMOs for large infrastructure projects. The core guidance document for various levels of government is the NSW Floodplain Development Manual (2005). While the document does not prescribe numerical objectives, it does set out general objectives including that a "*merit based approach shall be adopted for all development decisions in the floodplain to take into account social, economic and ecological factors, as well as flooding considerations*". It goes on to "*recognize the following important facts…if all development applications and proposals for flood prone land are assessed according to rigid and prescriptive criteria, some appropriate proposals may be unreasonably disallowed or restricted.*"

In response to the SEARs for the project, Transport considered and were informed by various factors. These included DPIE's standard conditions of approval for linear infrastructure in place at the time of assessment and other transport projects located within a comparably large floodplain environment. At the time of assessment, the DPIE standard conditions of approval stated "…*a maximum increase in inundation levels upstream of the SSI of 50 mm in a 1% AEP rainfall event*". On this basis, Transport considered and the EIS stated that "*A 50 mm afflux threshold is considered reasonable in relation to the magnitude of flooding in the Hunter River and the overall susceptibility of urban development in the floodplain (large majority is above the 1% AEP; most of the impacted area is rural)*."

The FMOs and assessment criteria have been revised following ongoing consultation with stakeholders and agencies. The adopted revised criteria are discussed in **Section 4.4**.

3.2.5 Flood impacts extending outside flood modelling domain

A comment was received that the hydraulic model extent presented in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) was not sufficiently large to locate where the flood impacts resulting from the project would dissipate to acceptable levels. For example, the afflux reported in the hydrology and flooding assessment for the EIS for the 1% AEP event during operation was predicted to be 0.02 metres at the upstream boundaries of the hydraulic model. The hydraulic modelling undertaken for the project flood impact assessment was in response to the adoption of flood afflux objectives noted above and the Port Stephens Council catchment flood model that extended well beyond a predicted afflux of 50mm attributable to the project. This approach was considered conservative noting that predicted afflux from the project during operation did not exceed the flood afflux objectives at the upstream boundary of the model for a 1% AEP event.

Since submission of the EIS and in response to clarifications by DPE, a review of topographic data and other previous flood studies has been undertaken to identify the likely absolute upstream limits of afflux.

Flood mapping for the 1% AEP event in the *Hunter River Branxton to Green Rocks Flood Study* (WMAwater, 2010) for Maitland City Council is shown on **Figure 3-1**. The mapping indicates a relatively steep flood surface gradient between the six and seven metres above height datum (AHD) around Morpeth which suggests a hydraulic control on flooding at this location. This is likely to be the upstream extent of afflux on the Hunter River resulting from the project. Hence, flood impacts resulting from the project are unlikely to extend further upstream than Morpeth.

Supplementary flood modelling has also been undertaken by Transport on the Hunter River in the Green Rocks to Branxton reach to confirm the effects and extent of afflux. Outcomes of this modelling are included in the *M1 Pacific Motorway extension to Raymond Terrace Submissions Report* (Transport for NSW, 2022). Detailed design flood modelling for the project would include extension of the current model domain to identify the absolute upstream extent of afflux as a result of the project.

Review of aerial photography of the Williams River shows that Seaham Weir is the first hydraulic control upstream of the Hunter River after Raymond Terrace. The weir is expected to be the upstream limit of afflux and flood impacts resulting from the project. The *Williams River Flood Study* (BMT WBM, 2009) describes that “there is considerable head gradient in the vicinity of Seaham Weir. This is due to a number of factors; constriction of flow, the sharp bend in river upstream of weir and losses across weir”. Long sections of the flood surface along the Williams River from upstream to downstream of the weir show at least a 0.5 metre drop in water level across the weir in all flood events up to and including the probable maximum flood (PMF), which supports the assertion that Seaham Weir is the likely upstream extent of flood impacts resulting from the project. **Figure** 3-2 shows the flood surface long section for the 1% AEP event from Raymond Terrace to Seaham.

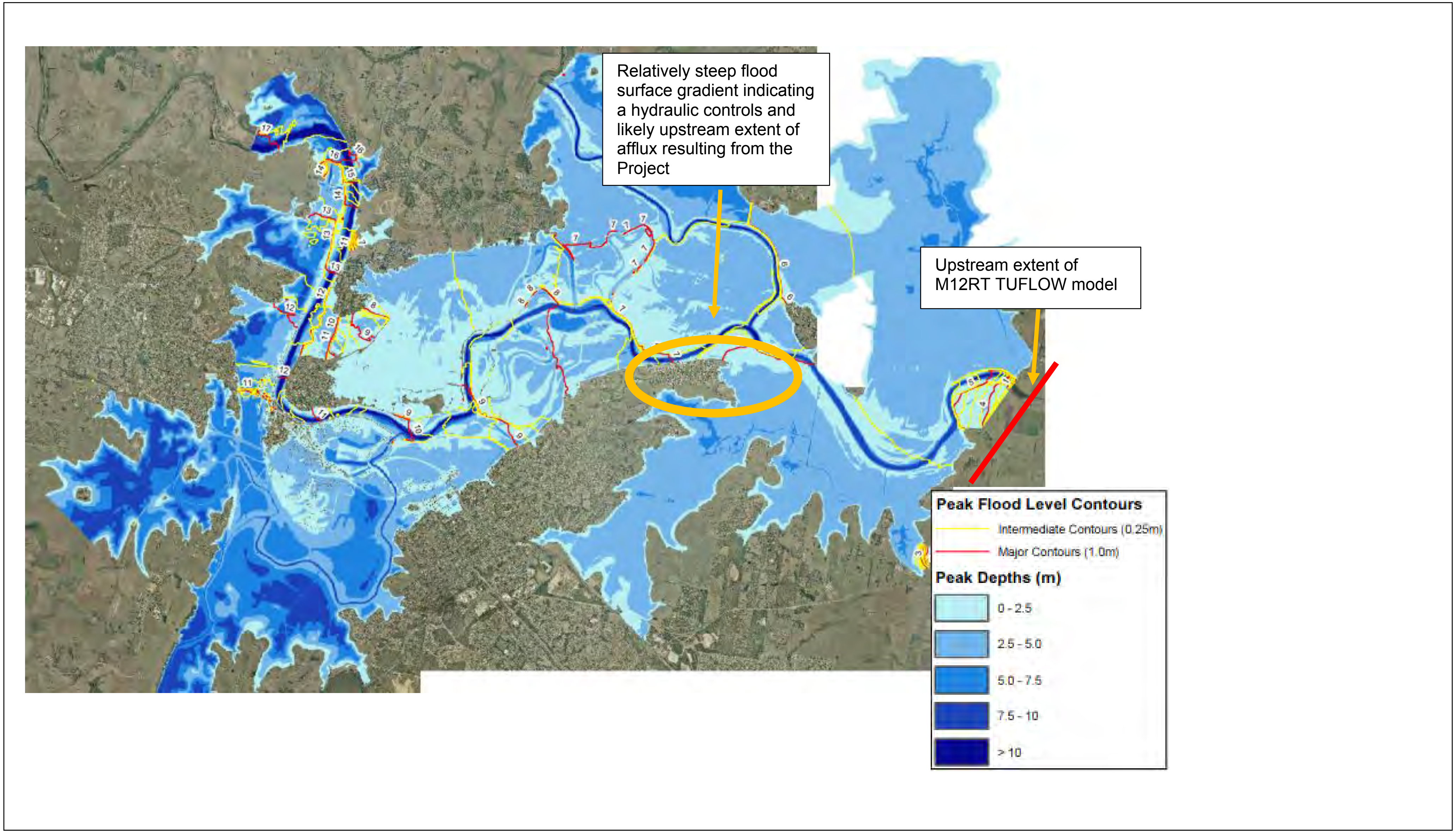

Figure 3-1 Location of likely upstream extent of afflux on Hunter River. Source: *Hunter River Branxton to Green Rocks Flood Study* (WMAwater, 2010).

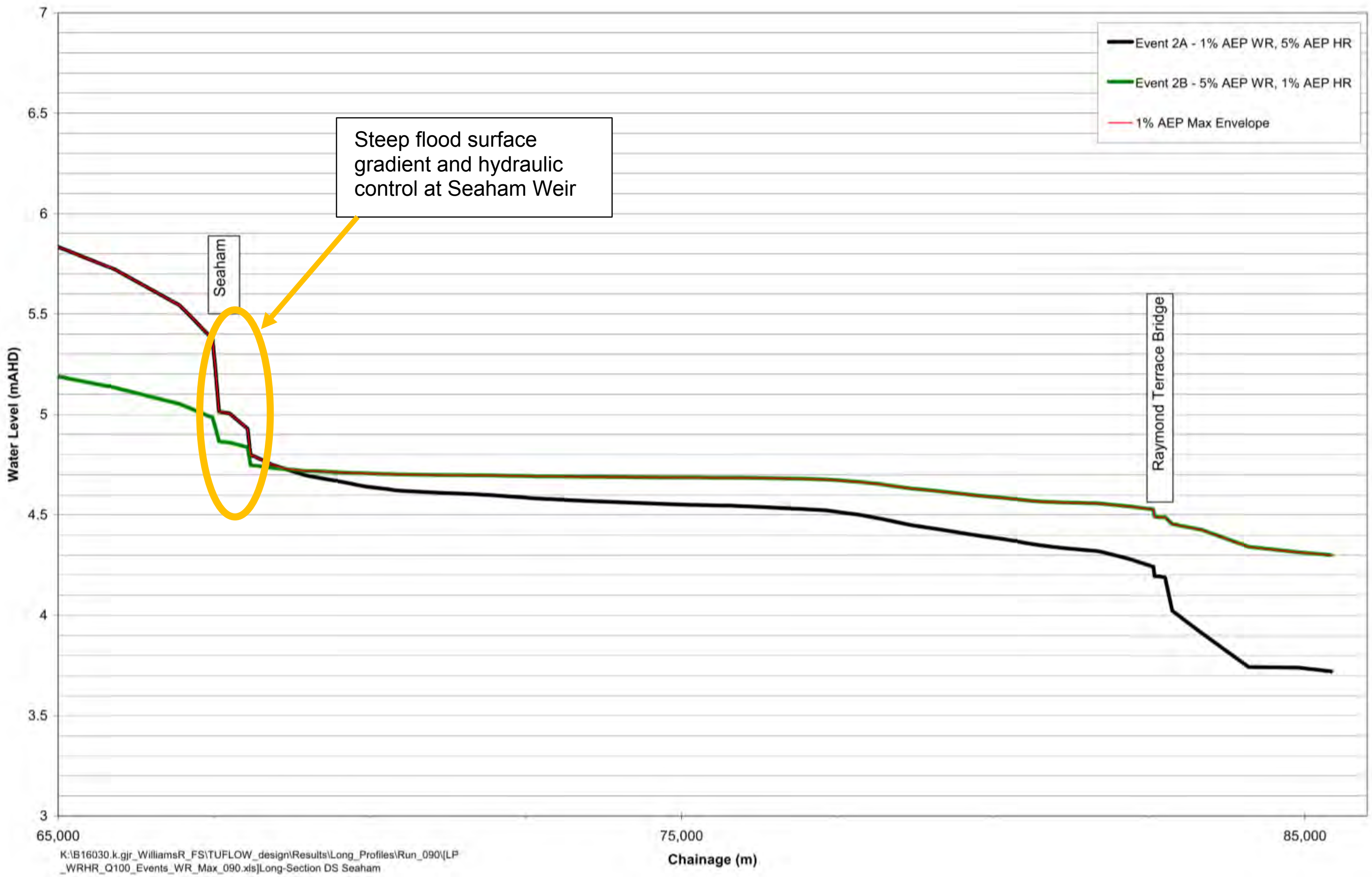

Figure 3-2 Design flood surface long sections, Williams River from Raymond Terrace to Seaham (source: Drawing 72 in *Williams River Flood Study* (BMT WBM, 2009).

3.2.6 Scour and bank stability risk

A comment was received regarding the potential of increased risk of scour and risk to stability of river and watercourse banks resulting from the project. Further assessment of changes to flow velocities resulting from the project during flood events has been undertaken and is discussed in **Section 5.2.4** and **Section 6.2.4**, for construction and operation respectively, in *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b). The environmental management measures have been revised in **Chapter 7** to include monitoring for flood flow scouring as a result of the project and remedial works, if required. Management measures related to scouring and bank instability due to stormwater and drainage flows from the project are already included in the EIS.

4 Methodology

4.1 Overview

The flooding assessment presented in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) for the project has been updated in response to public submissions and agency comments. Updates include:

- Refinements to the project design
- Update to the flood modelling of the project during construction and operation to reassess the hydraulic effects of the amended project design on flood behaviour
- Revised criteria for assessment of potential flood impacts
- Assessment of flooding impacts to existing buildings in the flooding study area based on recently obtained information on buildings, including floor level data.

These updated aspects of the assessment methodology are discussed in the sections below.

4.2 Amended project design

Project features which have the potential to influence hydrology and flooding during construction and operation, include:

- Earthworks for permanent road embankments
- Bridge works including construction of piers, temporary crane pads, temporary wharves
- Temporary and permanent access roads
- A total of 21 ancillary facilities during construction are located along the project alignment. Low lying areas within ancillary facilities are filled up to provide flood immunity. The ancillary facilities would seek to maintain existing drainage lines where feasible and reasonable however some redirection may be necessary.
- Temporary stockpiles
- Culverts and other drainage works, including temporary waterway crossings.
- Ancillary facilities, temporary access tracks and waterway crossings and other temporary construction stage features would be removed post-construction for the operation stage and construction sites rehabilitated to pre-existing site conditions.

The project design was amended with a range of refinements as outlined in **Section 1.2**. One of the objectives for project refinements was to reduce the flooding impacts which were described in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b). This has been achieved in most locations as a result of the amendments. The design refinements relevant to flooding are summarised in **Section 5.1** and **Section 6.1**, respectively.

Further, many of the design refinements which are relevant to the hydrology and flooding assessment were also made in response to the public submissions and clarifications.

4.3 Flood modelling update

The flood modelling was updated to reassess potential flooding impacts with the project design refinements. The updated flood impacts were determined for the 20%, 10% and 5% AEP events for construction, and 20%, 10%, 5% and 1% AEP events for operation with respect to the revised assessment criteria described in **Section 4.4**.

4.4 Assessment criteria

In response to queries relating to the flood management objectives and assessment criteria adopted in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b), the assessment criteria was updated for this supplementary assessment in consultation with DPE to provide details on any additional afflux caused by the project with a focus on residential building impacts where afflux is greater than 10 millimetres. The criteria summarised in **Table 4-1** were adopted for assessment of flooding impacts to buildings.

Where assessment criteria are exceeded, additional mitigation would be considered as outlined in **Chapter 7** and would depend on a range of factors such as the nature of existing impacts, the magnitude of the project impacts, whether the impacts are a result of construction or operation, and other factors.

The AEP events outlined in **Section 4.3** were modelled in accordance with the project SEARs, and the assessment of impacts against the below criteria were carried out for these representative events only.

Table 4-1 Comparison of current assessment criteria and EIS-adopted flood management objectives and criteria

Parameter	Location or land use	EIS objective	Current assessment criteria	Change
Afflux i.e. increase in flood level resulting from implementation of the project	Above floor flooding of habitable floors [1]	50 mm	10 mm	Reduction in threshold of 40mm
	Other urban and residential property	100 mm	50 mm	Reduction in threshold of 50mm
	Sensitive infrastructure, assumed to include: Emergency services (e.g. hospitals, ambulance, fire, police stations) Electricity substations Water treatment plants.	50 mm	50 mm	No change
	Rural, forest and recreation	100 mm	100 mm	No change
	Named roads and railways	Less than 100 mm. Less than 10% change in length of overtopping.	Less than 100 mm. Less than 10% change in length of overtopping.	No change
Flood hazard i.e. increase in flood hazard resulting from	All areas outside the project	Minimise changes based on an assessment of risk with a focus on land	Minimise changes based on an assessment of risk with a focus on land	No change

Parameter	Location or land use	EIS objective	Current assessment criteria	Change
implementation of the project		use and flood sensitive receptors	use and flood sensitive receptors	
Flood duration i.e. increase in duration of inundation resulting from implementation of the project	All areas outside the project	Less than 10% change in duration of inundation for flood depths above 0.5 metres	Less than 10% change in duration of inundation for flood depths above 0.5 metres	No change
	Above-floor flooding of residential buildings	No criterion	Less than one hour increase	Additional criterion

1 Refer to **Section 4.6** for details of the methodology implemented to identify habitable floors adopted in this assessment.

4.5 Buildings floor level information

Supplementary data on building floor levels was obtained to determine flooding impacts to buildings at a higher level of detail. Building databases, sourced from City of Newcastle and Port Stephens Council, contains surveyed floor levels of buildings located within the flooding study area. Additional building floor survey was collected or otherwise estimated by Transport, mainly in the Maitland City Council LGA. The buildings were classified as residential and other buildings following visual review of aerial photography and zoning data. Residential buildings are the primary focus of the detailed flood impact assessment. No floor level information was available for commercial or industrial zoned properties, or non-residential buildings in other areas. However, lots where afflux criteria (as outlined in **Table 4-1**) have been assessed.

In total:

- 3,210 residential buildings were identified for the building flood impact assessment
- 1,940 buildings had surveyed floor level information available
- 1,270 buildings had floor levels estimated by LiDAR and visual estimation of floor height above ground.

4.6 Identification of habitable floors

For the purposes of this supplementary assessment, habitable floors were identified based on the following conditions:

- In a residential situation this comprises "*a living or working area such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom"* in accordance with the residential definition of habitable room in the NSW Floodplain Development Manual (NSW Government,2005). All residential buildings identified in available building databases and by field survey were assumed to have one floor that was habitable. For buildings greater than one storey (and where that data was available), the higher floor level was the assumed habitable floor.
- Garages and sheds located in a residential situation were not considered to be habitable, including where these may have been subsequently converted to living spaces including bedrooms without approval. The non-habitable space purpose may have been approved as appropriate for the existing flood risk to that space, while the unapproved habitable purpose is unlikely to be appropriate for the given flood risk. Similarly on rural properties, there are numerous shed structures in the study area which are used to store equipment and materials which are susceptible to flood damage. Such buildings and floor spaces on rural properties

were not considered to be habitable because they do not protect valuables against existing flood impacts.

- The NSW Floodplain Development Manual (NSW Government, 2005) provides in their definition of habitable spaces areas "*in an industrial or commercial situation … [areas] used for an office or to store valuable possessions, goods or equipment susceptible to flood damage in the event of a flood*". In most locations in the project study area, such spaces are comprised of industrial and commercial workshops and storage facilities and would not be considered habitable. It is noted that some commercial buildings would have floors meeting the definition of being "habitable", however this would require detailed investigation of each commercial building as well as floor level survey. Industrial and commercial buildings containing valuables were not considered to be habitable where that building was not designed for the purpose of protecting those valuables from flooding. However, each commercial and industrial lot potentially affected has been identified and further investigations during detailed design would be carried out to confirm if they contain a habitable floor.

5 Assessment of potential construction impacts

This chapter includes an assessment of the construction impacts of the project refinements.

5.1 Specific impacts resulting from project refinements

A range of design refinements were made to address concerns raised in the public submissions and clarifications on the EIS in relation to potential flood impacts resulting from the project. The effects on hydrology and flooding are discussed in the sections below for the refinements that relate to construction of the project.

5.1.1 Reduction of size at ancillary facilities and construction footprint

Refinement description

The proposed design refinement includes reductions in the construction footprint of ancillary facilities, AS 5, AS 6, AS 7 and AS 9 in Tarro. Likely effects of the design refinements on flooding are identified from the flood impact mapping discussed in **Section 5.2**.

The extent of AS 5 was reduced in the western half only (shown in **Figure 5-1**) and ground levels within the site were raised to 2.35 metres AHD to achieve flood immunity in a 5% AEP event, an increase in height of 0.1 metres from the EIS.

The extent of AS 6 was reduced to the north as shown in **Figure 5-1**. Ground levels within AS 6 were raised to elevation 2.4 metres AHD to achieve flood immunity in a 5% AEP event, an increase in height of 0.15 metres from the EIS.

AS 7 was reduced to almost half (refer to **Figure 5-1**) of the size adopted in the EIS and the footprint was extended to the New England Highway boundary at south-western side. Ground levels within AS 7 were raised to level 2.8 metres AHD to achieve flood immunity in a 5% AEP event, an increase in height of 0.55 metres from the EIS.

The extent of AS 9 was reduced as shown in **Figure 5-1**. A small area, about 4,000 square metres, located at south-eastern corner of AS 9 was raised to 2.9 metres AHD to provide flood immunity in a 5% AEP event, an increase in height of 0.65 metres from the EIS. Ground levels for the remaining areas within AS 9 were raised to 0.8 metres AHD, a decrease in height of 1.45 metres from the EIS.

Impacts from refinement

The direct impact of the design refinement to AS 5 to flood afflux within the construction footprint is a reduction in the afflux from EIS of 1.3 metres, 0.7 metres and 0.5 metres in the 20%, 10% and 5% AEP events, respectively, affecting the previous eastern area of AS 5. The resultant afflux from the existing case is 0.15 to 0.35 metres in the 20% AEP event in localised areas, and 0.07 metres in the 10% AEP event and 0.03 metres in the 5% AEP event. Afflux levels in excess of the adopted criteria are contained within the construction footprint and do not affect existing adjacent buildings. Negligible changes in afflux from the EIS are expected outside of the construction footprint from this refinement. Negligible changes to the reported impacts to surface water hydrology and drainage are expected from this refinement.

The direct impact of the design refinement to AS 6 to flood afflux is an increase in the afflux of 0.05 metres from the EIS in the 5% AEP event in the area of land between the Main North Rail Line and the New England Highway, with a resultant afflux of 0.15 metres increase from existing case. Refer to **Section 5.3.7** for further details of the impact to railways. Negligible changes to the reported impacts to surface water hydrology and drainage are expected from this refinement.

The direct impact of the design refinement to AS 7 to flood afflux are not discernible from the overall reductions in afflux from the EIS, which are due to modifications to other project construction features such as access track heights. Negligible changes to the reported impacts to surface water hydrology and drainage are expected from this refinement.

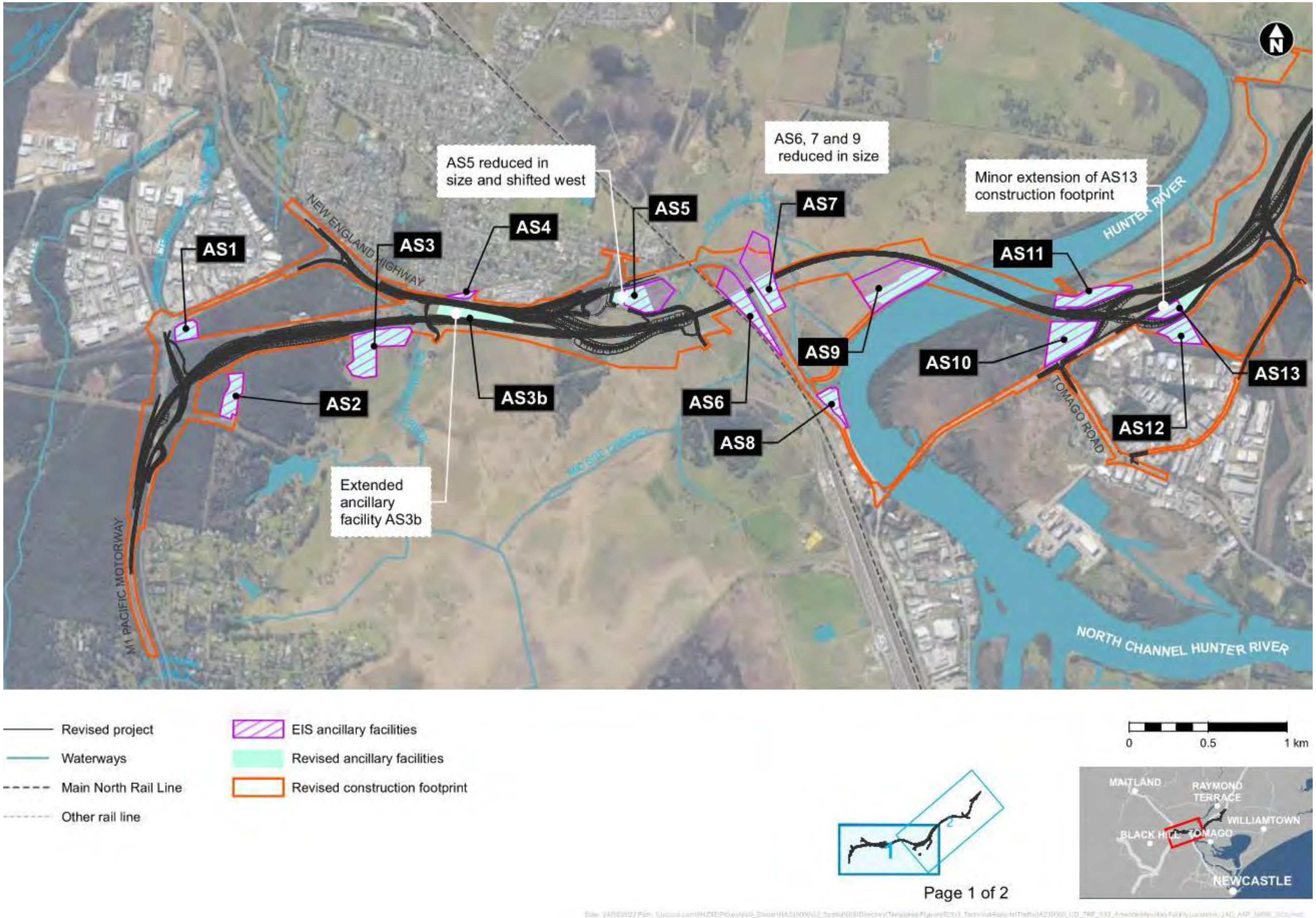

Figure 5-1 Amended ancillary facilities (map 1 of 2)

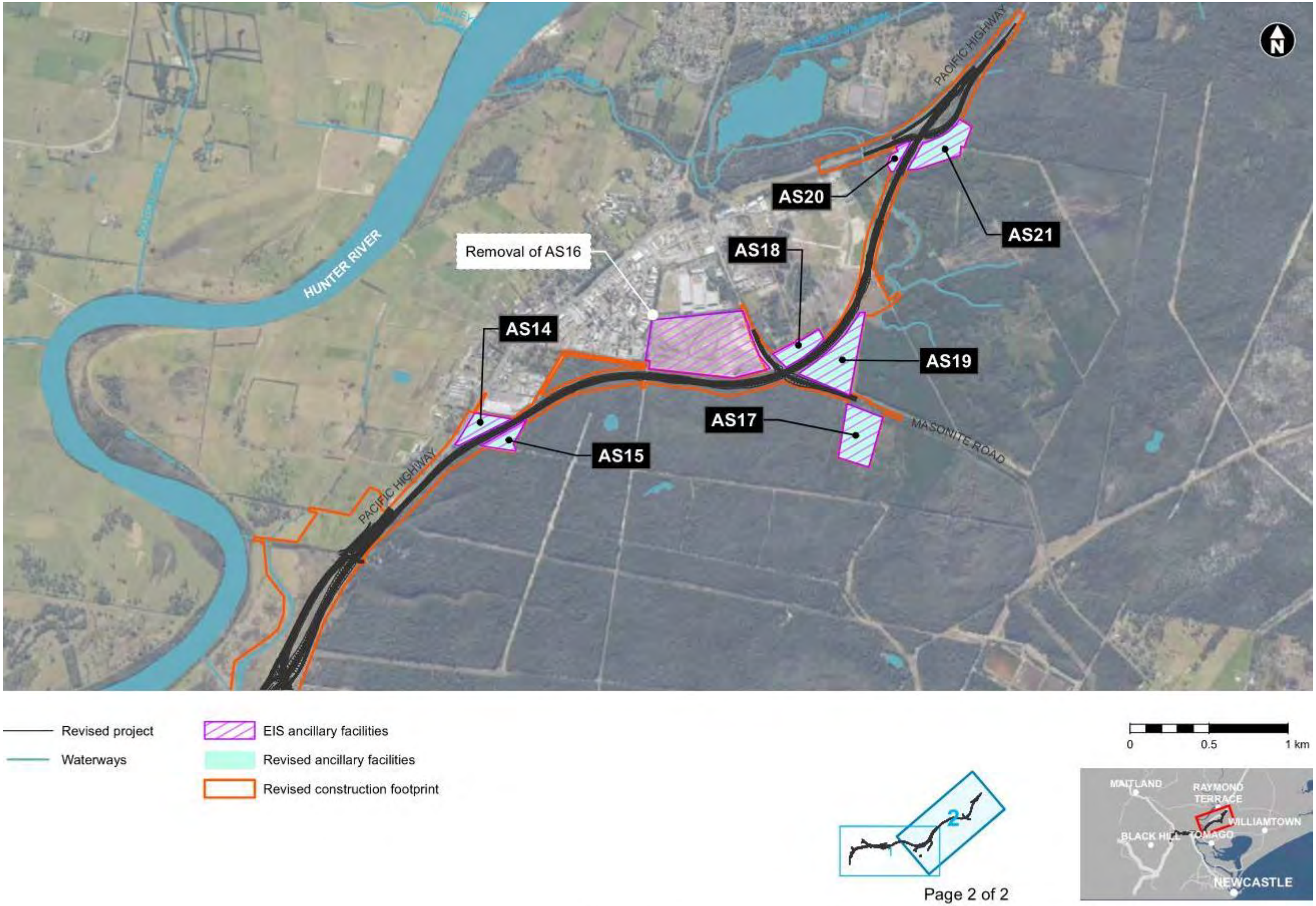

Figure 5-1 Amended ancillary facilities (Map 2 of 2)

The direct impact of design refinement to AS 9 is a reduction in afflux from the EIS of 0.07 metres in the 20%, 10% and 5% AEP events for the area immediately to the north of the AS 9 site, and increase in afflux from the EIS of 0.06 metres and 0.11 metres in the 10% and 5% AEP events, respectively. Negligible changes to the reported impacts to surface water hydrology and drainage are expected from this refinement. There is expected to be reduced interface with the existing Hunter Valley Flood Mitigation Scheme flood level adjacent to the site as a result of the overall reduced height of the AS 9 site level.

Additional mitigation

Options for further refinement of the design of ancillary site AS 6 will be investigated in detailed design to minimise the potential afflux impacts to the Main North Rail Line.

5.1.2 Reduced height of access tracks on floodplain

Refinement description

Access tracks were typically designed 1.45 metres above existing ground to achieve flood immunity in a 20% AEP flood event. Adequate culverts and causeways at watercourses and flow paths were included to provide flow conveyance across and through the access tracks to manage afflux. The construction stage access tracks which are located between the New England Highway on the western side of the Hunter River and the proposed Tomago Interchange on the eastern side of the Hunter River are 0.3 to 0.9 metres lower compared to the EIS. An access track which was up to one metre high above existing ground levels and situated on the eastern bank of the Hunter River at the viaduct construction site was deleted.

Impacts from refinement

The direct impact of this design refinement is a reduction in afflux from the EIS during construction of up to 0.06 metres in the 20%, 10% and 5% AEP events, respectively, for the areas upstream of the project, and increase in afflux from the EIS of 0.06 metres and 0.11 metres in the 10% and 5% AEP events, respectively, for areas downstream of the project. Resultant afflux from existing case are 0.01 to 0.04 metres increases in flood levels upstream of the project in the 5% AEP event and decreases of up to 0.04 metres downstream of the project.

Negligible changes to the reported impacts to surface water hydrology and drainage are expected from this refinement. There is expected to be reduced interface with the existing Hunter Valley Flood Mitigation Scheme flood level as a result of the overall reduced height of the access tracks.

Additional mitigation

No additional management measures are required to address this proposed design refinement.

5.1.3 Minor increase to construction footprint near drain at Heatherbrae to enable any works at existing headwall

Refinement description

The proposed design refinement includes a very minor increase (0.1 hectares) to the construction footprint at Heatherbrae to enable works at the existing headwall near the horse racing facility (**Figure 5-2**).

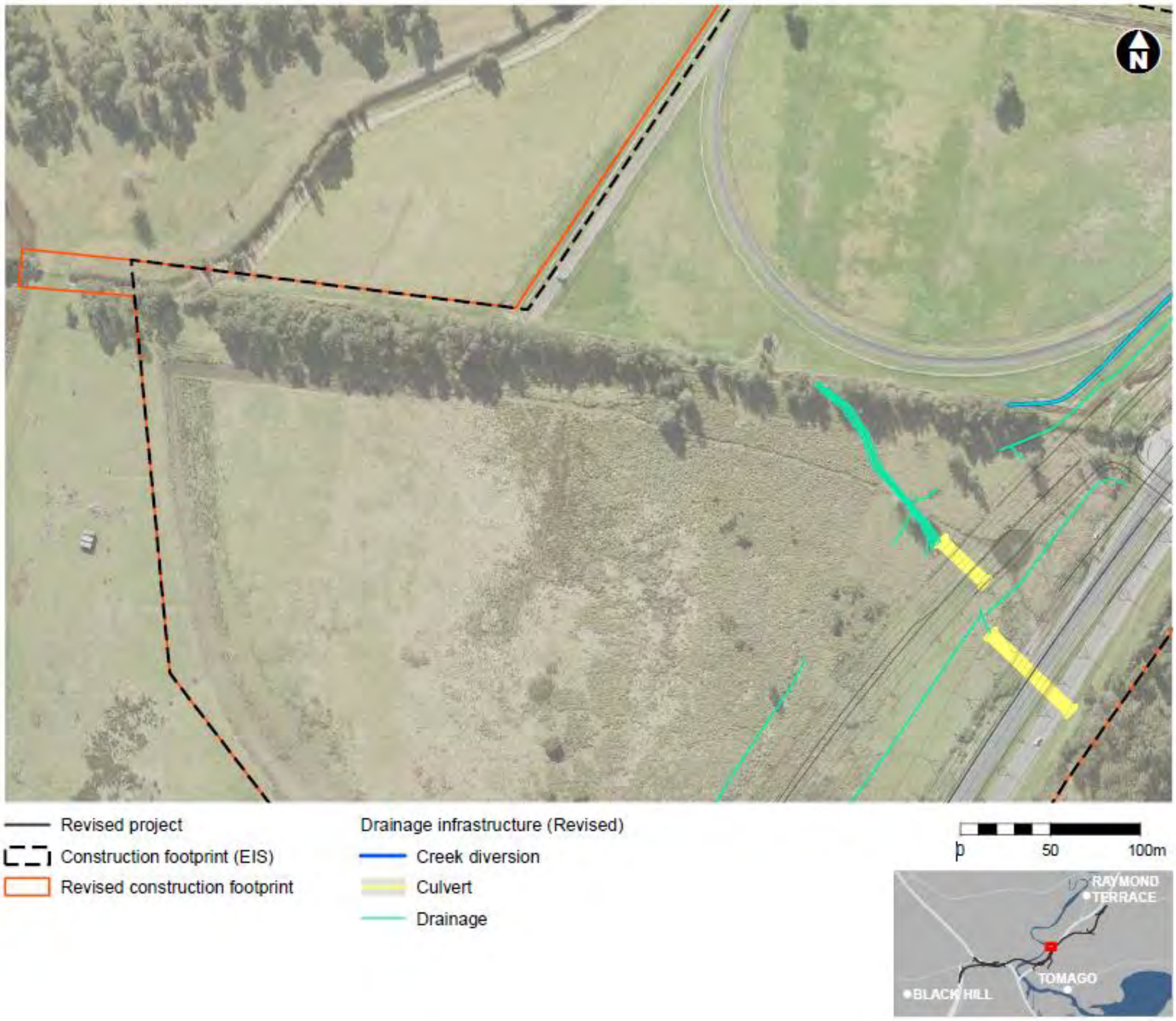

Figure 5-2 Minor increase to construction footprint at existing headwall, Heatherbrae

Impacts from refinement

The minor increase in the construction footprint is expected to pose a negligible risk to flooding and hydrology. It may be assumed that the existing drainage capacity of the drainage channel and culvert would be maintained. The construction of the headwall constitutes localised works and would not result in an obstruction to flood flows.

Additional mitigation

No additional management measures are required to address this proposed design refinements.

5.2 Overview of flood impacts

5.2.1 Afflux

Flood afflux mapping for construction phase is presented in Figures B-1 to B-3 in **Appendix B**, which represents the change in peak flood levels from existing to construction. The afflux is typically less than 0.03 metres in the 20%, 10% and 5% AEP events for areas outside the construction footprint. There is an area in the 20% AEP event on the floodplain east of the Hunter River, between the Hunter River and the Pacific Highway in Tomago and Heatherbrae, and upstream of the project where afflux is above 0.05 metres as a result of increased highway cross drainage capacity.

There are localised areas with afflux of 0.14 metres in the 20% AEP event and 0.19 metres in the 10% AEP event, affecting low-lying vegetated areas in Heatherbrae. There is an area with afflux of 0.19 metres and 0.15 metres in the 20% and 5% AEP events, respectively, between the Main North Rail Line and New England Highway in Tarro.

There are areas of afflux of 0.14 metres and 0.24 metres in the 20% and 5% AEP events, respectively, affecting trapped low points in the flood model at the northern extent of the flood study area on the SUEZ Raymond Terrace Resource Recovery Park property.

Change in afflux compared to EIS

Change in afflux mapping is presented in Figures B-4 to B-6 in **Appendix B**, which represents the change in the afflux from the EIS to the updated flood assessment results, for construction. The change in afflux is due to the project design refinements following the EIS.

The mapping indicates that the afflux has reduced from the EIS by up to 0.06 metres in the 10% and 5% AEP events in the area immediately upstream of the project. In the wetland areas to the west of the Hunter River and downstream of the project in the vicinity of Beresfield and Tarro, including in Hexham Swamp, the afflux reduces by 0.01 metres in the 10% AEP event and up to 0.07 metres in the 5% AEP event.

Downstream of the project, in the Hunter River and floodplain areas to the east of the Hunter River, the afflux increases by up to 0.1 metres from the EIS, although it should be noted that the afflux itself (flood level increase from existing case) remains at or less than zero. This is confirmed by the afflux mapping as discussed in **Section 5.2.1**.

5.2.2 Change in flood hazard

Figures B-7 to B-9 of **Appendix B** show the change in flood hazard for the 20%, 10% and 5% AEP events, respectively, for the construction phase. For the purposes of the assessment, H1 and H2 flood hazard are referred to a “low” hazard and H3 to H6 referred to as “high” hazard. Refer to Section 2.3.12 in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) for the definition of the flood hazard categories. The changes in hazard are expressed in terms of changes between dry, low hazard and high hazard condition, or no change.

The increases in flood hazard in particular to high hazard are localised and in rural and forest areas. In the 5% AEP event, there are areas of increased flood hazard to high hazard on the fringes of the urban area in Tarro, Beresfield, Thornton and Woodberry. These changes are due to flood depth increases of less than 0.02 metres. Hence while there is a change in flood hazard category from low to high, the incremental increase in the flood hazard is minor, due to the minor change in flood depth.

In the 20% AEP event, localised increases in flood hazard to high hazard are generally on rural areas and resulting from depth increases of between 0.01 metres and 0.05 metres. The incremental increase in the flood hazard is minor, due to the minor change in flood depth.

The areas of increase to high flood hazard are predominantly on rural and open space lands. There are no large increases in extent of the high hazard areas, which would indicate a new floodway or flow path being formed as a result of the construction phase. There are some minor areas of new high hazard flooding on the fringe of the urban areas in Raymond Terrace and Tarro, which are localised extensions of existing high flood hazard areas.

While there are localised increases in flood hazard with the amended project design, since the afflux has generally decreased from the EIS, the increase in flood hazard has also reduced from the EIS.

The change in flood hazard, and change from the EIS, is discussed at key points of interest in **Section 5.3.1**.

5.2.3 Change in duration of inundation

Figures B-10 to B-12 of **Appendix B** show the change in the duration of inundation for the 20%, 10% and 5% AEP events, respectively, for the construction phase. The durations and the change in durations are assessed for flood depths greater than 0.5 metres. The change is expressed as the percentage change from the existing case. Total durations of inundation on the floodplain are typically up to 70 hours. Areas around Tarro, Hexham Swamp and Nelsons Plains experience durations of up to 90 hours in the 5% AEP event

The mapping shows that the change in duration of inundation is less than one per cent for the majority of the flood study area. In the 5% AEP event, the change in remaining areas is generally less than five per cent, and mainly around two per cent. A two per cent increase on a duration of up to 90 hours is less than two hours, which is considered acceptable when compared to the long 90 hour duration of inundation.

In the 20% AEP event, some low-lying wetland areas on rural lands experience more than ten per cent increase in duration of inundation. Areas downstream of the project experience reductions in duration of inundation.

The change in duration of inundation, and the change from the EIS, is discussed at key points of interest in **Section 5.3.1**.

The absolute change in duration of inundation is discussed in terms of hours change at buildings within the study area in **Section 5.3.2**.

Given that the afflux has generally decreased from the EIS, the change in duration of inundation has also reduced from the EIS.

5.2.4 Change in velocity

Figures B-13 to B-15 of **Appendix B** show the change in flow velocity for the 20%, 10% and 5% AEP events, respectively, for the construction phase. Increases in velocities occur as a result of localised changes in flow patterns around the project at embankments, access tracks and ancillary facilities.

Changes in velocities include increases and decreases of up to 0.3 metres per second in the 10% AEP and up to 0.5 metres per second in the 5% AEP event around the bridge construction site due to increased interaction of flood flows with access roads, temporary wharves and other features. There is also increased interaction with the New England Highway and ancillary facilities around the western end of the viaduct crossing with increased velocities of 1.5 metres per second. These changes are similar to those described in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b).

In the 5% AEP event, there are increase velocities of up to 1.7 metres per second over the Main North Rail Line embankment due to increased overtopping depths of 0.1 metres. These changes are lower than those discussed in the Hydrology and Flooding Working Paper.

Around the viaduct and along the Hunter River banks, localised increases in velocity of up to 0.3 metres per second are predicted in the 5% AEP event, with velocities during construction of up to 1.3 to 1.8 metres per second. These generally occur at the ends of the access tracks.

On and around access tracks, increases in velocity of 0.3 to 0.5 metres per second are predicted in the 5% AEP event, with velocities during construction of up to 1.3 to 1.8 metres per second.

In Windeyers Creek localised changes in velocity are +/- 0.2 metres per second in the 5% AEP event. Velocities are up to 0.5 metres per second.

In Purgatory Creek localised changes in velocity are 0.1 to 0.5 metres per second in the 5% AEP event, generally around access tracks and culvert crossings. Velocities are up to 1 metre per second.

Impacts of changes in flow velocity are generally localised. There is not expected to be widespread scouring of riverbanks based on the predicted changes in velocities. Revised potential management measures are discussed in **Chapter 7** and include riprap scour protection in appropriate locations including culvert outlets, monitoring of scouring and remedial works.

With regards to scouring at bridge abutments and piers, assessment of scouring depths and scour protection requirements is to be undertaken based on industry standard bridge hydraulic design guidelines.

Flow velocity impacts during construction are similar to those reported in the EIS.

5.2.5 Flood mapping for construction

Mapping is provided in **Appendix B** to illustrate the flooding conditions during construction:

- Flood levels and depths in 20%, 10% and 5% AEP events: Figures B-16 to B-18
- Flood hazard in 20%, 10% and 5% AEP events: Figures B-19 to B-21
- Duration of inundation in 20%, 10% and 5% AEP events: Figures B-22 to B-24
- Flow velocity in 20%, 10% and 5% AEP events: Figures B-25 to B-27.

5.3 Flood impacts to property and infrastructure

5.3.1 Points of interest

The flood impacts are assessed at key points of interest in the flood study area, which have been defined based on representative locations for a holistic assessment of flood impacts across the study area and at selected locations relevant to the public submissions. The locations of the points of interest are shown in **Figure 5-3**.

Table 5-1 summarises and compares the flooding conditions at the assessment points of interest for depth, flood hazard category and duration of inundation for existing case and for construction with the amended project.

Tables E-1 to E-3 in **Appendix E** describe the afflux, change in flood hazard category and change in duration of inundation during construction for the amended project. The impacts predicted in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) and the change in impacts from the original EIS assessment are also outlined.

The points of interest assessment indicates that the afflux is minor and changes in flood hazard and duration of inundation are generally minor during construction. There is increase in flood hazard category in a limited number of locations resulting from minor incremental increases in flood depths, hence the incremental increase in the flood hazard is also minor. Impacts are generally within the revised afflux criteria for below-floor flooding for the land use at those locations. The afflux and impacts are generally reduced from the original EIS assessment.

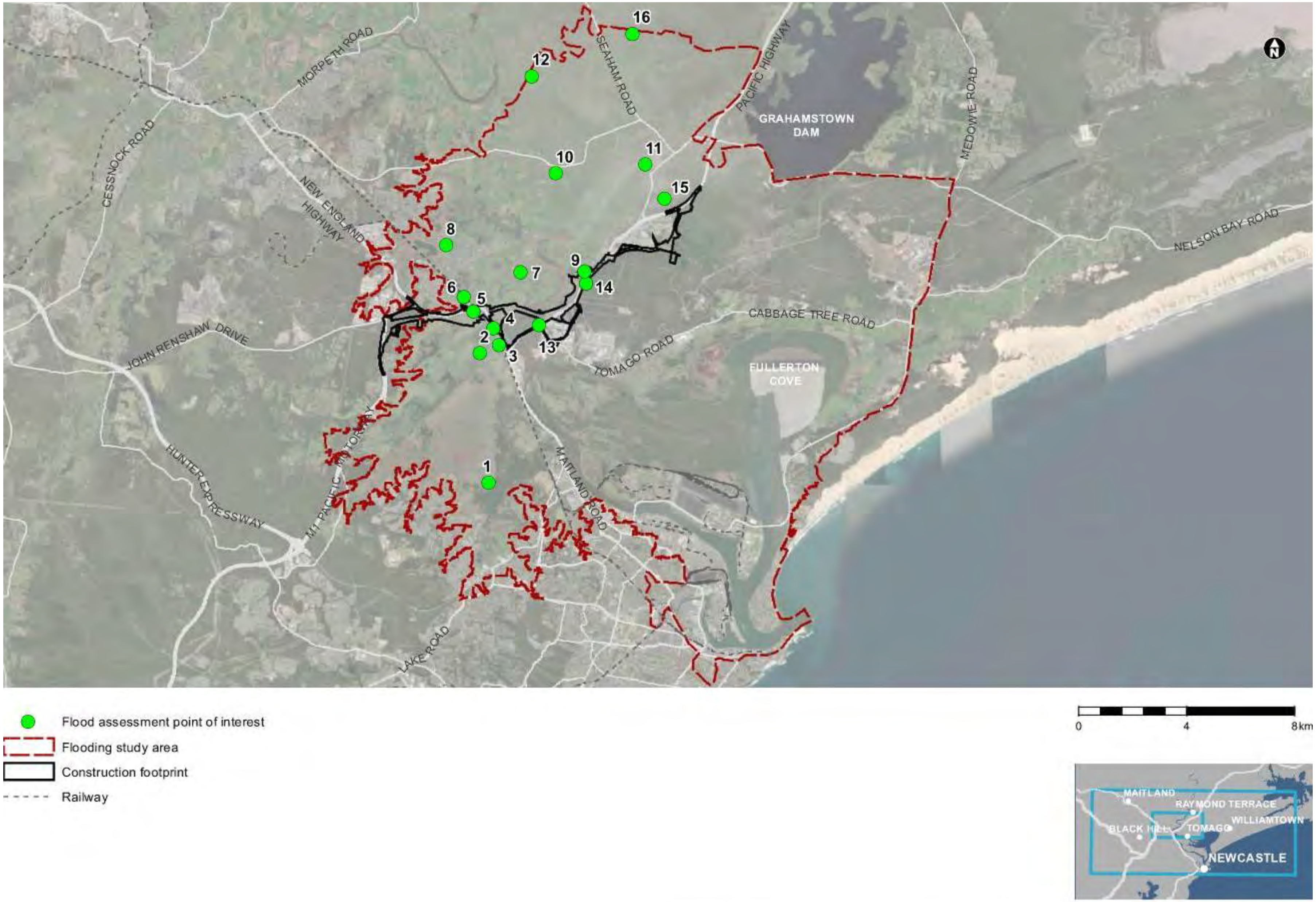

Figure 5-3 Point of interest locations

Table 5-1 Comparison of predicted flood level impacts to existing case at points of interest – Construction (up to % AEP event only assessed for construction)

POI	Existing case flood impact	Amended project potential flood impact
1	Existing flooding is caused by overflows of floodwater from the Hunter River into Hexham Swamp over the New England Highway and Main North Rail Line in the 10% AEP event and larger in addition to local runoff from the Hexham Swamp catchment area. Flood depths are 0.5 m in the 20% AEP event, 0.8 m in the 10% AEP event and 1.2 m in the 5% AEP event. Flood hazard category is H3 in the 20%, 10% and 5% AEP events. Durations of inundation are 43 hours in the 20% AEP event, 67 hours in the 10% AEP event and 73 hours in the 5% AEP event.	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp in events larger than the 10% AEP event and minor reductions in floodplain storage due to the new road embankments. Zero afflux is predicted in the 10% AEP event and afflux of 0.03 m in the 5% AEP event. Afflux is within acceptable limit of 0.05 m for rural land use. No change to flood hazard category. In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.
2	Existing flooding is caused by overflows of floodwater from the Hunter River into Hexham Swamp over the New England Highway and Main North Rail Line in the 10% AEP event and larger in addition to local runoff from the Hexham Swamp catchment area. Flood depths are 0.01 m in the 20% AEP event, 0.2 m in the 10% AEP event and 0.4 m in the 5% AEP event. Flood hazard category is H1 in the 20%, H2 in the 10% AEP event and H3 in the 5% AEP event. Durations of inundation are up to 53 hours in the 5% AEP event. There is an existing dwelling at this location. Flooding is below floor level in up to and including the 5% AEP.	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp in events larger than the 10% AEP event and minor reductions in floodplain storage due to the new road embankments. Zero afflux is predicted in the 10% AEP event and afflux of 0.02 m in the 5% AEP event. Afflux is within acceptable limit of 0.1 m for rural and environmental living land use. No change to flood hazard category. In the 5% AEP event the change in duration of inundation from existing case is less than +/- 1%.
3	Existing flooding is caused by overflows of floodwater from the Hunter River into Hexham Swamp over the New England Highway and Main North Rail Line in the 10% AEP event and larger in addition to local runoff from the Hexham Swamp catchment area. Flood depths are 0.03 m in the 10% AEP event and 0.4 m in the 5% AEP event. POI 3 is outside the 20% AEP flood. Flood hazard category is H1 in the 10% and H3 in the 5% AEP event. Durations of inundation are up to 15 hours in the 5% AEP event. There are existing maintenance buildings at this location at Hexham Train Support Facility. Flooding is below floor level in up to and including the 5% AEP.	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp and the area adjacent to the northern end of the Aurizon train support facility in the 10% AEP event and larger and minor reductions in floodplain storage due to the new road embankments. Zero afflux is predicted in the 10% AEP event and afflux of 0.02 m in the 5% AEP event. No change to flood hazard category. In the 5% AEP event the change in duration of inundation from existing case is less than 1%.

POI	Existing case flood impact	Amended project potential flood impact
4	Existing flooding is caused by overflows of floodwater from the Hunter River into Hexham Swamp over the New England Highway and Main North Rail Line in the 10% AEP event and larger in addition to local runoff from the Hexham Swamp and Purgatory Creek catchment areas. Flood depths on the railway at POI 4 are 0.04 m in the 10% AEP event and 0.14 m in the 5% AEP event. POI 4 is above the 20% AEP flood. Flood hazard category is H2 in the 10% and H4 in the 5% AEP event. Durations of inundation are up to 28 hours in the 5% AEP event.	The project causes increased overflows of floodwater from the Hunter River, over the New England Highway in the 10% AEP event and larger, causing increases in flood depths over the Main Northern Rail Line near Mid Site Creek. The project also results in reductions in floodplain storage due to filling of ancillary site AS 6. Afflux of up to 0.13 m is predicted in the 10% AEP event and 0.03 m in the 5% AEP event on the railway line in the vicinity of POI 4. No change to flood hazard category. In the 5% AEP event the change in duration of inundation from existing case is 5%, or less than 1 hour.
5	Flooding at POI 5 is a result of floodwaters backflowing through the existing Purgatory Creek culvert under the New England Highway and overtopping of the New England Highway in the 10% AEP event and larger. Flood depths at POI 5 are 0.3 m in the 10% AEP event and 0.4 m in the 5% AEP event. POI 5 is above the 20% AEP flood. Flood hazard category is H1 in the 10% and H2 in the 5% AEP event. Durations of inundation are around 30 hours in the 5% AEP event in the vicinity of POI 5. There is an existing dwelling at this location. Flooding is below the habitable floor level in up to and including the 5% AEP.	The project causes increases in these flows due to the increased flood levels upstream of the viaduct, ancillary sites and access tracks. Afflux of up to 0.01 m is predicted in the 10% AEP event and 0.06 m in the 5% AEP event. Afflux is within acceptable limit of 0.1 m for rural and environmental living land use. No change to flood hazard category. In the 5% AEP event the change in duration of inundation from existing case is 7%, or about 2 hours.
6	Flooding of the Main North Rail Line at POI 6 occurs in the existing case in the 10% AEP event and larger. Flood depths on the railway at POI 6 are 0.2 m in the 10% AEP event and 0.7 m in the 5% AEP event. POI 5 is above the 20% AEP flood. Flood hazard category is H2 in the 10% and H3 in the 5% AEP event. Durations of inundation are up to 30 hours in the 5% AEP event on the railway at POI 6.	The project causes increased flood levels at POI 6 as a result of the viaduct, ancillary sites and access tracks. Afflux on the floodplain adjacent to the railway is 0.01 m in the 20% AEP event, which does not overtop the railway. Afflux is 0.02 m in the 10% AEP event and 0.04 m in the 5% AEP event. Increase in hazard category from H2 to H3 for 10% AEP event. No change to flood hazard category for other events. In the 5% AEP event the change in duration of inundation from existing case is 3%, or about 1 hour.

POI	Existing case flood impact	Amended project potential flood impact
7	Flooding at POI 7 occurs in the existing case in the 10% AEP event and larger. Flood depths are 1.6 m in the 10% AEP event and 2.1 m in the 5% AEP event. POI 5 is above the 20% AEP flood. Flood hazard category is H4 in the 10% and H5 in the 5% AEP event. Durations of inundation are around 60 hours in the 10% AEP event and 67 hours in the 5% AEP event. There is an existing dwelling at this location. Flooding is below the habitable floor level in up to and including the 5% AEP.	The project causes increased flood levels as a result of the viaduct, ancillary sites and access tracks. Afflux is 0.02 m in the 10% AEP event and 0.03 m in the 5% AEP event. Not flooded in 20% AEP event. No change to flood hazard category. In the 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.
8	Flooding at POI 8 occurs in a wetland area on Francis Greenway Creek, at western Woodbury Park in the 20% AEP event and larger. Flood depths are 0.4 m in the 20% AEP event, 1.6 m in the 10% AEP event and 2.1 m in the 5% AEP event. Flood hazard category is H2 in the 20% AEP event, H4 in the 10% AEP event and H5 in the 5% AEP event. Durations of inundation are 63 hours in the 10% AEP event and 67 hours in the 5% AEP event.	The project causes increased flood levels as a result of the viaduct, ancillary sites and access tracks. Afflux is 0.02 m in the 10% AEP event and 0.03 m in the 5% AEP event. The afflux is zero in the 20% AEP event. No change to flood hazard category. In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.
9	Flooding at POI 9 occurs on low-lying rural land, on the eastern bank of the Hunter River at Heatherbrae, in the 20% AEP event and larger. Flood depths are 0.3 m in the 20% AEP event, 1.7 m in the 10% AEP event and 2.1 m in the 5% AEP event. Flood hazard category is H2 in the 20% AEP event, H4 in the 10% AEP event and H5 in the 5% AEP event. Durations of inundation are 33 hours in the 20% AEP event, 72 hours in the 10% AEP event and 73 hours in the 5% AEP event.	The project causes increased flood levels as a result of the viaduct, ancillary sites and access tracks, in addition to increased cross-drainage flows from local catchment on the eastern side of the M1 Motorway. Afflux is 0.05 m in the 20% AEP event, 0.02 m in the 10% AEP event and 0.03 m in the 5% AEP event. No change to flood hazard category. In the 20% AEP event, the change in duration of inundation from existing case is 41%, increasing from 33 hours to 47 hours. In the 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.

POI	Existing case flood impact	Amended project potential flood impact
10	Flooding at POI 10 occurs in a low-lying drainage ponding area on the western floodplain of the Hunter River in Millers Forest in the 20% AEP event and larger. Flood depths are 1.0 m in the 20% AEP event, 2.2 m in the 10% AEP event and 2.7 m in the 5% AEP event. Flood hazard category is H2 in the 20% AEP event, H4 in the 10% AEP event and H5 in the 5% AEP event. Durations of inundation are 86 hours in the 20% AEP event, 75 hours in the 10% AEP event and 77 hours in the 5% AEP event.	The project causes increased flood levels as a result of the viaduct, ancillary sites and access tracks. Afflux is 0.02 m in the 10% AEP and 5% AEP events. The afflux is zero in the 20% AEP event. No change to flood hazard category. In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.
11	Flooding at POI 10 occurs at the southern end of Port Stephens Street in Raymond Terrace in the 20% AEP event and larger. Flood depths are 0.05 m in the 20% AEP event, 0.6 m in the 10% AEP event and 1.0 m in the 5% AEP event. Flood hazard category is H1 in the 20% AEP event and H3 in the 10% and 5% AEP events. Durations of inundation are 15 hours in the 10% AEP event and 37 hours in the 5% AEP event.	The project causes increased flood levels as a result of the viaduct, ancillary sites and access tracks. Afflux is 0.01 m in the 20% AEP and 10% AEP events and 0.02 m in the 5% AEP event. No change to flood hazard category. In the 10% AEP event the change in duration of inundation from existing case is 7% (1 hour) and in the 5% AEP the change is 2% (less than 1 hour).
12	Flooding at POI 12 occurs in the existing case in the 10% AEP event and larger. Flood depths are 0.2 m in the 10% AEP event and 1.6 m in the 5% AEP event. POI 12 is above the 20% AEP flood. Flood hazard category is H1 in the 10% and H3 in the 5% AEP event. Durations of inundation are up to 17 hours in the 5% AEP event.	The project causes increased flood levels as a result of the viaduct, ancillary sites and access tracks. Afflux is zero in the 10% and 5% AEP events. No change to flood hazard category. In the 5% AEP event the change in duration of inundation from existing case is 3% (less than 0.5 hours).
13	Flooding at POI 13 occurs at the Tomago Road intersection with the Pacific Highway in the 20% AEP event and larger. Flood depths are 0.4 m in the 20% AEP event, 0.5 m in the 10% AEP event and 0.9 m in the 5% AEP event. Depths are highest on the southbound carriageway of the Pacific Highway, while the northbound carriageway is not flooded in the 20% AEP event at this location. Flood hazard category is H2 in the 20% and 10% AEP events and H3 in the 5% AEP event. Durations of inundation are 15 hours in the 10% AEP event and 37 hours in the 5% AEP event.	The project causes reduced flood levels at this location. Afflux is -0.02 m to -0.03 m in the 20% AEP and 10% AEP events and -0.11 m in the 5% AEP event. No change to flood hazard category. In the 10% AEP event the change in duration of inundation from existing case is about -50% in the vicinity of POI 13. In the 5% AEP event the change in duration of inundation from existing case is -13%.

POI	Existing case flood impact	Amended project potential flood impact
14	Flooding at POI 14 occurs in wetlands at the Hunter Regional Botanic Gardens in the 20% AEP event and larger. Flood depths are 0.9 m in the 20% AEP event, 1.2 m in the 10% AEP event and 1.3 m in the 5% AEP event. Flood hazard category is H3 in the 20% AEP event and H4 in the 10% and 5% AEP events. Durations of inundation are 81 hours in the 20% AEP event, 90 hours in the 10% AEP event and 91 hours in the 5% AEP event.	The project causes reduced flood levels due to increased cross-drainage capacity under the M1 Pacific Motorway in smaller events, and increased flood levels in larger events as a result of the viaduct, ancillary sites and access tracks. Afflux is -0.48 m in the 20% AEP event and -0.37 m in the 10% AEP event. The afflux is zero in the 5% AEP event. Reduction in hazard category from H4 to H3 for 10% AEP event. No change to flood hazard category for other events. Change in duration of inundation from existing case for -49% in the 20% AEP, -29% in the 10% AEP and -22% in the 5% AEP.
15	Flooding at POI 15 occurs in watercourses and ponds adjacent to the Raymond Terrace wastewater treatment plant. Flooding does not inundate the treatment plant itself in up to the 5% AEP event in the existing case. Flood depths are 0.8 m in the 20% AEP event, 1.6 m in the 10% AEP event and 2.0 m in the 5% AEP event. Flood hazard category is H3 in the 20% AEP event and H4 in the 10%AEP event and H5 in the 5% AEP event. Durations of inundation are 52 hours in the 20% AEP event, 63 hours in the 10% AEP event and 70 hours in the 5% AEP event.	The project causes increased flood levels, backing up from the Hunter River, as a result of the viaduct, ancillary sites and access tracks. Afflux is 0.02 m in the 20%, 10% and 5% AEP events. No change to flood hazard category. In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.
16	Flooding at POI 16 occurs on the floodplain located between the Hunter River and Williams River at Nelsons Plains. Flood depths are 1.7 m in the 20% AEP event, 2.6 m in the 10% AEP event and 2.8 m in the 5% AEP event. Flood hazard category is H4 in the 20% AEP event and H5 in the 10%AEP event and H5 in the 5% AEP event. Durations of inundation are 54 hours in the 20% AEP event, 76 hours in the 10% AEP event and 81 hours in the 5% AEP event.	The project causes increased flood levels, backing up from the Hunter River, as a result of the viaduct, ancillary sites and access tracks. Afflux is 0.01 m in the 20% AEP and 5% AEP events. The afflux is zero in the 10% AEP event. No change to flood hazard category. In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.

5.3.2 Buildings flood impacts

Analysis of flood impacts to buildings during construction was undertaken based on building data discussed in **Section 4.5**, with a focus on above-flood flooding at residential buildings. A count of buildings with varying above-floor afflux is provided in Table E-4 in **Appendix E**. A 0.01 metre afflux criterion applies to above-floor flooding. In summary:

- There are 14 residential buildings with above-floor afflux greater than 0.01 metres in the 10% AEP event, of which there are eight buildings with 0.01 to 0.02 metres afflux, and six with 0.02 to 0.03 metres afflux. There are no residential buildings with above-floor afflux greater than 0.03 metres
- There are 48 residential buildings with above-floor afflux greater than 0.01 metres in the 5% AEP event, of which there are 7 buildings with 0.01 to 0.02 metres afflux, and 41 with 0.02 to 0.03 metres afflux. There are no residential buildings with above-floor afflux greater than 0.03 metres
- There are no buildings with above-floor afflux greater than 0.01 metres in the 20% AEP event.

Buildings which are denoted with above-floor afflux are already affected by above-floor flooding during the 10% and 5% AEP events before the project and exclude those with new above-floor flooding during these AEP events.

A count of residential buildings with new above-floor flooding during construction in the 10% and 5% AEP events is provided in Table E-5 in **Appendix E**. There is one residential building with new above-floor flooding in the 10% AEP event and two residential buildings with new above-floor flooding in the 5% AEP event. There are three individual residential buildings in the 10% and 5% AEP events with new above-floor flooding.

A count of residential buildings with above-floor flooding duration increasing by more than one hour during construction is provided in Table E-6 in **Appendix E**. There are eight residential buildings with duration of above-floor inundation increasing by more than one hour in the 10% AEP event and 17 residential buildings with duration of above-floor inundation increasing by more than one hour in the 5% AEP event. There are 25 individual residential buildings across the 20%, 10% and 5% AEP events with change in duration of inundation of above floor flooding greater than one hour.

While **Section 5.2.3** describes that the majority of the floodplain would experience less than one per cent increase in duration of inundation from the existing case, the increase in duration of inundation is generally higher and may exceed an increase of one hour on the fringes of the flooding, which is where the residential buildings are typically located.

The detailed building flood impact assessment based on floor level survey focusses on residential buildings given their relative sensitivity to flooding impacts compared to commercial and industrial building types, and given that occupants of these premises can more readily vacate and return to their places of residence (if these are not flood-affected themselves).

5.3.3 Properties flood impacts

Table E-10 to E-12 in **Appendix E** summarises the number of cadastral lots within residential, commercial and industrial land use zones, respectively, during construction according to the change in peak flood depth on each lot. The estimate of the number of lots, which was initially based on automated spatial analysis procedures, also involves a manual validation of the impacts to denote lots where an anomalous impact due to modelled resolution of the terrain and other factors could be identified. In summary:

- The large majority of flood-affected residential, commercial and industrial lots in the existing case experience negligible change in flood depth (+/- 0.01 metres change) during construction
- In the 5% AEP event, 131 residential lots, 79 commercial lots and 102 industrial lots are affected by an increase in flood depths of over 0.01 metres
- In the 5% AEP event, one residential lot, no commercial lots and one industrial lot is affected by an increase in flood depths of over 0.05 metres. This includes one large residential lot with a

change in maximum flood depth of greater than 0.3 metres, on low-lying land on the lot immediately adjacent to the project road embankment. This increase in flood depth does not affect any existing buildings on the lot.

Table E-13 in **Appendix E** lists the lots affected by afflux exceeding the adopted criteria. The lots include residential, commercial and industrial land use zonings in addition to other land use zones. In summary, there are 14 lots identified and comprised of:

- One zoned residential
- Two zoned industrial
- Two zoned environmental living/environmental conservation
- Two zoned special uses
- Seven zoned rural.

This is a reduction from the 19 lots identified in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b).

Potential management measures are outlined in **Chapter 7**. Specific measures for each building or property will be identified for each eligible property on a merit-based approach with consideration of the degree of flood impact to the property.

5.3.4 Impacts to sensitive properties

The flood management objectives in **Section 4.4** adopt an acceptable afflux limit of 0.05 metres on sensitive properties such as emergency services (hospitals, ambulance, fire, police stations) electricity substations, and water treatment plants for below-floor flooding. A 0.01 metre afflux criterion applies to above-floor flooding.

The areas of afflux exceeding 0.05 metres during construction are limited in area and generally affect rural, vegetated and open space areas. There are no sensitive properties identified in areas affected by greater than 0.05 metres afflux.

No sensitive property buildings were identified with above-floor flood afflux greater than 0.01 metres. This outcome is consistent with the flooding impacts in the EIS assessment.

5.3.5 Land use flood impacts

An acceptable afflux limit of 0.1 metres on rural, forest and recreational land use areas is adopted. Several locations are mapped with afflux over 0.1 metres during construction, including:

- There are localised afflux areas of up to 400 square metres of up to 0.18 metres in the 5% AEP event during construction on forest areas to the east of Raymond Terrace. These localised areas are surrounded by broad areas of afflux of 0.02 to 0.05 metres, which are within the acceptable range
- A pond within a recreational open space area in Raymond Terrace, with afflux of 0.27 metres in the 5% AEP event. This is surrounded by broad areas of afflux of 0.01 metres, which is within the acceptable range
- A refuse pit in the SUEZ Raymond Terrace Resource Recovery Park, with afflux of 0.24 metres in the 5% AEP event. This is surrounded by broad areas of afflux of 0.01 metres, which is within the acceptable range
- A low-lying marsh area in Nelsons Plains in the north-west extent of the study area is mapped with afflux of 0.14 metres in the 20% AEP event. A trapped drainage point is created in this area by a road, with the overtopping of the road accentuating the surrounding broad afflux of 0.01 metres. This is an anomalous area of afflux predicted by the modelling, as there is an existing culvert under the road which would balance out the afflux with the surrounding areas down to the background afflux levels of 0.01 metres. The afflux in the 10% and 5% AEP events are under 0.01 metres.

These impacts are similar to the flooding impacts in the EIS assessment.

The afflux identified at these locations in the construction phase are localised in extent and no significant impacts to land uses are expected. Given these are predicted for the construction phase, the time frame during which these construction impacts may occur is temporary.

5.3.6 Flood impacts to roads

An acceptable afflux limit of 0.1 metres on roads and a maximum increase of 10 per cent of total road length being flooded is adopted. Table 5-4 and Table 5-5 in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021) indicated that the change in length of roads affected is predominantly less than 10 per cent on highways, major roads and other named roads in the study area. The large majority of major roads experience no or minor change (up to six per cent increase) in the length of road affected by flooding. This is maintained or reduced in this supplementary flood assessment since the afflux is generally reduced from the EIS.

An exception includes the section of the New England Highway within the study area, where there is a 23 per cent increase in the length of road affected by flooding in the 10% AEP event, due to a new four metre section being affected by H2 flood hazard. This affects the start of a minor entry ramp lane and not the main alignment. Overall trafficability is not substantially affected in this location.

There are no major roads which become newly-affected by flooding during construction as a result of the project.

In terms of afflux impacts to roads, Figures B-1 to B-3 in **Appendix B** show that the large majority of the flood study area is affected by afflux less than 0.05 metres and hence the increases in flood levels on existing roads is within the acceptable limit of 0.1 metres. There is a 400 metre section of the New England Highway in Tarro which would be subject to a 0.14 metre increase in flood level in the 5% AEP event. This is attributed to the configuration of ancillary facility AS 6 located between the Highway and the Main North Rail Line. It is noted that this section of the New England Highway is already subject to flood depths of 0.4 to 0.8 metres in the existing 5% AEP event which is above safe limits, hence there is no material impact to trafficability of the road. road affected Given the existing depths of flooding of the road at this location, no mitigation is proposed.

5.3.7 Flood impacts to railways

An acceptable afflux limit of 0.1 metres on railways and a maximum increase of 10 per cent of total railway length being flooded is adopted. Table 5-6 in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021) indicated that the change in length of railway affected is up to 0.1 per cent in the study area. This is maintained or reduced in this supplementary flood assessment since the afflux is generally reduced from the EIS.

In terms of afflux impacts to railways, Figures B-1 to B-3 in **Appendix B** show that the large majority of the flood study area is affected by afflux less than 0.05 metres and hence the increases in flood levels on existing railways is within the acceptable limit of 0.1 metres. There is a 900 metre section of the Main North Rail Line in Tarro which would be subject to up to a 0.14 metre increase in flood level in the 5% AEP event. This is attributed to the configuration of ancillary site AS 6 located between the Highway and the Main North Rail Line. It is noted that part of this section of the railway is already subject to flood depths of over one metre in the existing 5% AEP, hence there is no material impact to trafficability of the railway at this location. The increase in the length of the railway affected by flooding at this location is a minor incremental extension of the length of railway already affected in the existing case without the project. The location, size and height of AS 6 would be reviewed to minimise potential short-term impacts to the Main North Rail Line.

5.3.8 Impacts to Hunter Valley Flood Mitigation Scheme

Flood levees which are a part of the Hunter Valley Flood Mitigation Scheme have the purpose of reducing overflows of floodwater from the Hunter River onto the floodplain during flood events. The levees in the study area begin to overtop in about a 20% AEP event.

The afflux in the Hunter River would be up to 0.03 metres during construction. Given that the difference between the 20% and 10% AEP peak flood level in the River is 0.7 metres, the 0.03 metres afflux translates to a negligible reduction in the overtopping flood event AEP.

As discussed in **Section 5.2.4**, around the viaduct and along the Hunter River banks, localised increases in velocity of up to 0.3 metres per second are predicted in the 5% AEP event, with velocities during construction of up to 1.3 to 1.8 metres per second. These generally occur in the vicinity of new access tracks and may affect the existing flood levee on the western bank of the Hunter River around the viaduct and access tracks. Revised potential management measures are discussed in **Chapter 7** and include monitoring of scouring and erosion of levee banks and remedial works if required.

Bridge piers will be built during the construction phase and may impact on the existing levees. This may require localised realignment of the levee at the pier location. Any modification would be designed to not impact on the flood protection function of the levee system.

Other potential impacts to the Hunter Valley Flood Mitigation Scheme are as per the EIS. For example, a number of ancillary facilities, temporary wharves and access roads would be situated immediately adjacent to or on the levees, channels and drainage infrastructure which are part of the Hunter Valley Flood Mitigation Scheme. Access roads for the project would be constructed immediately next to Hunter Valley Flood Mitigation infrastructure, namely existing flood levees on the western Hunter River Floodplain. While these access roads may modify the structure and maintenance of the levees, the amended project would be designed and constructed to ensure there are no changes to flows or capacity, and as such are not expected to impact operation, function or structural integrity of the scheme (including the floodgates). Transport will continue to consult with the operators of the scheme during detailed design to minimise impacts on the scheme.

5.4 Summary of construction impacts to flooding

A supplementary flood impact assessment has been completed for the project, with the construction impacts discussed in this report section. Note that construction impacts are short term and therefore mitigation for over-criteria impacts would be focussed on addressing any short-term impacts. Additionally, the representation of the construction phase in the flood modelling is a worst-case scenario that includes all ancillary sites, access tracks and piers in place concurrently. Construction staging is likely to mean that not all of these elements would be in place at the same time and hence it is unlikely that impacts would be as severe as those outlined here.

The outcomes of the flood impact assessment for construction are summarised below:

- The afflux resulting from the amended project design is within the adopted acceptable limits across the large majority of the study area for land uses and below-floor flooding. There are a limited number of locations where afflux exceeds acceptable limits
- Afflux for the amended project design is generally reduced compared to the afflux predicted for the EIS. Where afflux is increased from the EIS, the flood levels during construction generally remain below the existing case flood levels
- Changes in flood hazard are minimised. The increases in flood hazard to high hazard category are localised and predominantly in rural and forest areas. In the 5% AEP event, there are localised areas increasing to high hazard on the fringes of the urban areas due to flood depth increases of less than 0.02 metres. Hence while there is a change in flood hazard category from low to high, the incremental increase in the flood hazard is minor, due to the minor change in flood depth. There are no large or widespread areas of new high flood hazard zones which would have indicated new flood flow paths being created
- Changes in duration of inundation in the study area are generally negligible, less than one per cent from existing, across the large majority of the study area. Given durations of inundation typically up to 90 hours, these represent changes of less than one hour in the duration of inundation. Higher per cent increases in duration occur along the fringes of the flood extent due

to shallow flood depths. The durations in these areas simply rise to the same duration of inundation in the adjoining main body of flooding

- There are 48 residential buildings with above-floor afflux greater than 0.01 metres in the 5% AEP event. There are no residential buildings with above-floor afflux greater than 0.03 metres. There are three individual residential buildings in the 10% and 5% AEP events with new above-floor flooding, and 25 residential buildings with duration of inundation above floor level greater than one hour. Those buildings denoted with above-floor afflux are already affected by above-floor flooding before the project. Residential buildings are typically located on the fringes of the floodplain where increases in duration of inundation tend to be higher than on the main body of the floodplain
- There are no sensitive properties identified in areas affected by greater than 0.05 metres afflux in up to the 5% AEP event during construction. The buildings flood impact analysis did not identify any sensitive property buildings with above-floor flood afflux greater than 0.01 metres
- The large majority of major roads experience no or minor change (up to six per cent increase) in the length of road affected by flooding. This is maintained or reduced in this supplementary flood assessment since the afflux is generally reduced from the EIS
- The large majority of the flood study area is affected by afflux less than 0.05 metres and hence the increases in flood levels on existing railways is within the acceptable limit of 0.1 metres
- Given that the afflux is reduced from the EIS, so too the increases in flood hazard, duration of inundation and impacts to buildings, properties, roads and rail are similarly reduced from the EIS
- The afflux of up to 0.03 metres would result in a negligible change to the AEP of the flood event overtopping the Hunter Valley Flood Mitigation Scheme levees. The levees may be subject to increases in flow velocities of up to 0.3 metres per second in the 5% AEP event and monitoring for potential scour should be considered.

Identified non-compliances to the adopted flood management objectives during construction are summarised in **Table** 5-2 below. Management measures are outlined in **Chapter 7**.

Table 5-2 Flood management objective non-compliances – Construction

Flood management objective	Description of non-compliance
Afflux – Above floor flooding of habitable floors	Across all assessed flood events up to and including 5% AEP during construction: • 48 residential buildings with above floor afflux exceeding 0.01 m • Three individual residential buildings with new above-floor flooding.
Afflux – Other urban and residential land	In the 5% AEP event, one residential lot and one industrial lot is affected by an increase in flood depths of over 0.05 metres. This includes one large residential lot with a change in maximum flood depth of greater than 0.3 metres, on low-lying land on the lot immediately adjacent to the project road embankment. This increase in flood depth does not affect any existing buildings on the lot.
Afflux – Rural, forest and recreation land	Several locations are mapped with afflux over 0.1 metres during construction: • There are localised afflux areas of up to 400 square metres of up to 0.18 metres in the 5% AEP event during construction on forest areas to the east of Raymond Terrace. These localised areas are surrounded by broad areas of afflux of 0.02 to 0.05 metres, which are within the acceptable range. • A pond within a recreational open space area in Raymond Terrace, with afflux of 0.27 metres in the 5% AEP event. This is surrounded by broad areas of afflux of 0.01 metres, which is within the acceptable range.

Flood management objective	Description of non-compliance
	• A refuse pit in the SUEZ Raymond Terrace Resource Recovery Park, with afflux of 0.24 metres in the 5% AEP event. This is surrounded by broad areas of afflux of 0.01 metres, which is within the acceptable range. A low-lying rural area in Nelsons Plains in the north-west extent of the study area is mapped with afflux of 0.14 metres in the 20% AEP event. Noted as a likely modelling anomaly.
Afflux and inundation of named roads	On the New England Highway in the 10% AEP event there is a 23 per cent increase in the length of road affected by flooding, due to an additional four metre section being affected by H2 category flood hazard. This affects the start of a minor entry ramp lane and not the main alignment. Overall trafficability is not substantially affected in this location.
Afflux and inundation of railways	There is a 900 metre section of the Main North Rail Line in Tarro which would be subject to up to a 0.14 metre increase in flood level in the 5% AEP event. This is attributed to the configuration of ancillary site AS 6 located between the Highway and the Main North Rail Line. This section of railway is already affected by flood depths of up to 0.6 metres in the 5% AEP event. The increase in the length of the railway affected by flooding at this location is a minor incremental extension of the length of railway already affected in the existing case without the project.
Change in duration of inundation	25 individual residential buildings with change in duration of inundation of above floor flooding greater than one hour. These buildings are already affected by above-floor flooding in the 5% AEP event.

5.5 Construction flood and hydrology impact management measures

Responses were received in the public submissions regarding typical flooding and hydrology management measures for properties identified as being impacted above the adopted assessment criteria.

This section presents information on management measures that would be considered during detailed design and construction of the project, for the construction phase hydrology and flooding impacts of the project. Revisions to the environmental management measures identified in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021) are discussed in **Chapter 7**.

Table 5-3 Management measures to be considered for impacts above the flood assessment criteria during construction for 5%, 10% and 20% AEP events

Action for consideration	Applies to	Details
Community consultation	• Afflux – Above floor flooding of habitable floors • Afflux – Other urban and residential land • Change in duration of inundation	Community engagement and consultation would occur prior to and during construction of the project to inform affected residents about the project. The project would work with councils, floodplain managers and emergency services to ensure that property owners have access to resources required to implement effective flood management plans / procedures. The project would ensure that affected property owners are provided with advanced warning of incoming major flood events.
Refinements to staging of	• Afflux – Above floor flooding of habitable floors	The project construction impacts have been modelled assuming that all identified ancillary facilities and access

Action for consideration	Applies to	Details
construction work	• Afflux – Other urban and residential land • Change in duration of inundation	tracks are in place, as well as the project being fully constructed. The project would confirm the construction staging and use of temporary construction facilities to identify whether potential flood impacts during construction can be minimised. Where a flood event is expected to occur, the project will identify measures to minimise the impact of flooding. This may include removing plant and equipment from the construction site, and removing temporary works such as sections of access track to provide better hydraulic conductivity across the site.
Assistance with flood event responses	• Afflux – Above floor flooding of habitable floors • Afflux – Other urban and residential land • Change in duration of inundation	During construction, the project would have resources on site that may assist in flood preparedness and emergency response. This could include provision of available plant and equipment to support emergency services and for specific support tasks such as sand bag deployment. Where afflux impacts from the project during construction are considered materially significant, temporary flood mitigation would be considered. This includes provision of sandbags or flood barriers at doorways to minimise impacts. The assessment of whether impacts are considered materially significant would be a merits-based assessment and take into consideration a range of factors including: • The nature of the impacts and whether they result in new above-floor inundation caused by afflux greater than 10mm, • The vulnerability of the building (e.g. residential building), • The type of structure (e.g. single storey without any other flood-free floors or evacuation areas), • Existing flood immunity and depth of existing flooding in each rainfall event, • The feasibility and reasonableness of the physical management measures. For example, an impact may be considered materially significant where a residential habitable floor is affected by new above-floor inundation caused by afflux greater than 10mm, or where afflux of greater than 30mm occurs and worsens existing above-floor inundation. The above measures would be carried out in consultation with the affected property owner.

6 Assessment of potential operational impacts

This chapter contains an assessment of impacts on hydrology and flooding from proposed project refinements during operation.

6.1 Specific impacts resulting from project refinements

6.1.1 Drainage design refinements, Heatherbrae

Refinement description

Transport proposes drainage design refinements near the horse training facility to reduce the impacts to the horse track and the Hunter River Botanic Gardens (refer to **Figure 6-1**). Design refinements relevant to the hydrology and flooding assessment include:

- Relocation and reshaping of the permanent water quality basin B09440L such that it would be five metres from the open channel that discharges to Hunter River drain
- Modification of the road pavement drainage so that runoff from two catchments draining to two separate basins; PB26 (B09160M) and PB27 (B09360L), was optimised so that all discharge is now into a combined new basin PB26 (B09200L) resized accordingly to maintain previous water quality treatment levels
- A new clean water channel within the horse track property to replace an existing channel that is impacted by realignment of Pacific Highway. The realigned clean water channel conveys flows from the outlet of transverse drainage culvert C9380 along the western side of realigned Pacific Highway connecting to the existing channel at southeast corner of horse track. To limit the footprint of the new channel a trapezoidal profile with concrete lining was adopted.

Impacts from refinement

There are no changes to the hydrologic and stormwater impacts from those reported in the EIS. The road drainage catchment areas for the proposed stormwater discharge points remain consistent. Any changes to peak runoff rates and volumes to be discharged to receiving drainage lines are also expected to be minor. The design changes would not influence flooding behaviour. Flooding impacts from those identified in the EIS would remain unchanged.

Additional mitigation

No additional management measures are required to address this proposed design refinements.

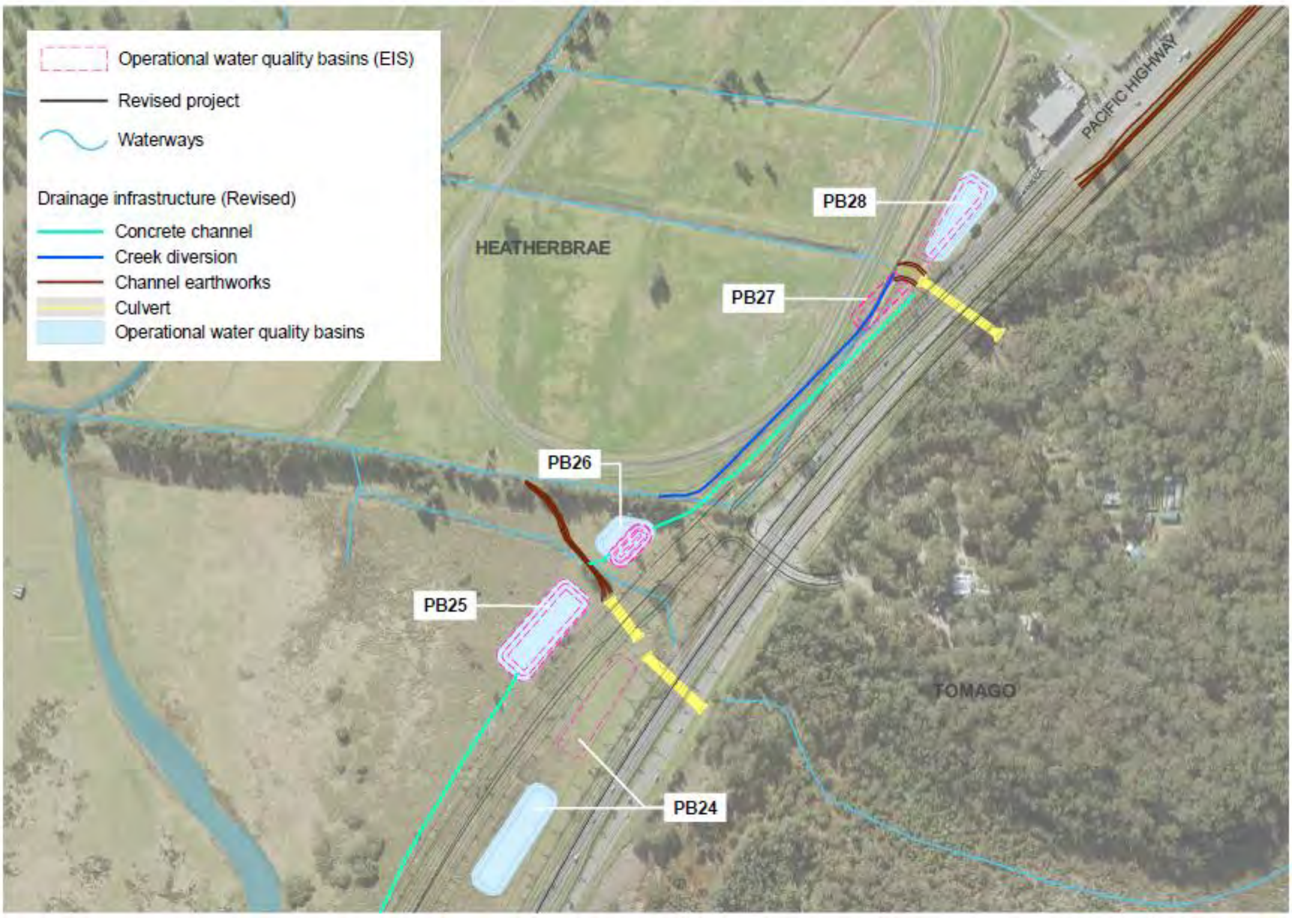

Figure 6-1 Drainage design refinement near horse training facility, Heatherbrae

6.1.2 Reduced height of operational maintenance access tracks on floodplain

Refinement description

Typically, 0.5 metre high access tracks would be provided during operation in order to maintain the bridge (e.g. conduct inspections, replace bearings, clean expansion joints and drainage pipes). Crest levels along access tracks across Purgatory Creek would be set at elevation 0.9 metres AHD to ensure that new access tracks are not higher than existing tracks and informal levees located on the floodplain. In addition, culverts and causeways would be provided at waterway crossings to mitigate potential afflux. The operational maintenance access tracks which are located between the New England Highway on the western side of the Hunter River and the proposed Tomago Interchange on the eastern side of the Hunter River are 0.3 to 0.9 metres lower compared to the EIS. An access track which was up to one metre high above existing ground levels and situated on the eastern bank of the Hunter River at the viaduct construction site was deleted.

Impacts from refinement

The direct impact of this design refinement would be a reduction in afflux from the EIS during operation of up to 0.03 metres in the 20%, 10%, 5% and 1% AEP events, respectively, for areas upstream of the project. An increase in afflux from the EIS of up to 0.03 metres in the 20%, 10% and 5% AEP events would be predicted for areas downstream of the project.

Afflux was predicted to be between 0.01 to 0.02 metres increases from existing in flood levels upstream of the project in up to and including the 1% AEP event. There were predicted to be localised increases in flood levels from the existing case of 0.05 metres in the 20% AEP event on the floodplain on the western Hunter River bank at the viaduct crossing. It was also predicted that there would be decreases in flood levels from the existing case of up to 0.02 metres downstream of the project in up to and including the 1% AEP event. Figures C-1 to C-4 in **Appendix C** show predicted afflux mapping for the design refinement in the 20%, 10%, 5% and 1% AEP events, respectively.

Negligible changes to the reported impacts to surface water hydrology and drainage are expected from this refinement. There would be expected to be reduced interface with the existing Hunter Valley Flood Mitigation Scheme flood levee as a result of the overall reduced height of the access tracks.

Additional mitigation

No additional management measures are required to address this proposed design refinement.

6.2 Overview of flood impacts

6.2.1 Afflux

The flood afflux for operation is presented in Figures C-1 to C-4 in **Appendix C**, which represents the change in peak flood levels from existing to operation. The afflux is typically up to 0.02 metres in the 20%, 10%, 5% and 1% AEP events for areas outside the operational footprint. There is an area in the 20% AEP event on the floodplain east of the Hunter River and upstream of the project where afflux is above 0.05 metres as a result of increased highway cross drainage capacity. There are areas of up to 0.03 metres afflux in Hexham Swamp in the 5% AEP event.

Around the Tarro Interchange, there are areas of increased ponding with afflux of up to 0.06 metres in the 10%, 5% and 1% AEP events. The afflux is up to 0.35 metres in the 20% AEP event. The affected areas are zoned E2 Environmental Conservation.

There are localised areas with afflux of 0.1 metres in the 20% AEP event and 0.06 metres in the 10% and 5% AEP events, affecting low-lying vegetated areas in Heatherbrae. There is an area with afflux of 0.04 metres 15% AEP event in the and between the Main North Rail Line and New England Highway in Tarro.

There is an area of afflux of 0.08 metres in the 5% AEP event affecting a trapped low point in the flood model at the northern extent of the flood study area on the SUEZ Raymond Terrace Resource Recovery Park property. There is an area of afflux of 0.06 metres in the 20% AEP event affecting a trapped low point in the flood model at the north-western extent of the flood study area on low-lying rural land.

Change in afflux compared to EIS

The project refinements outlined in **Section 6.1** have reduced the afflux impacts of the project compared to that presented in the EIS.

The change in afflux is presented in Figures C-5 to C-8 in **Appendix C**, which represents the change in the afflux from the EIS to the updated flood assessment results, during operation. The change in afflux is due to the project design refinements following submission of the EIS.

The mapping indicates that the afflux has reduced from the EIS by up to 0.03 metres in the 10% event and up to 0.02 metres in the 5% AEP event in the area immediately upstream of the project. The reduction is 0.01 metres in the 1% AEP event. There is minimal change in the 20% AEP event.

In the wetland areas to the west of the Hunter River and downstream of the project, including in Hexham Swamp, the afflux reduces by 0.02 metres in the 10% AEP event and up to 0.01 metres in the 5% AEP event. There is minimal change in the 20% and 1% AEP events.

Downstream of the project, in the Hunter River and floodplain areas to the east of the River, the afflux increases by up to 0.02 metres from the EIS in localised areas, although it should be noted that the afflux itself (flood level increase from existing case) remains at or less than zero. This is confirmed by the afflux mapping as discussed in **Section 6.2.1**.

6.2.2 Change in flood hazard

Figures C-9 to C-12 of **Appendix C** show the change in flood hazard from the existing case for the 20%, 10%, 5% and 1% AEP events, respectively, during operation. For the purposes of the assessment, H1 and H2 flood hazard are referred to a “low” hazard and H3 to H6 referred to as “high” hazard. Refer to Section 2.3.12 in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) for the definition of the flood hazard categories. The changes in hazard are expressed in terms of changes between dry, low hazard and high hazard condition, or no change.

The increases in flood hazard in particular to high hazard are localised and in rural and forest areas. The largest increases to high flood hazard category, in terms of area, occur in the 20% AEP event. The mapping for the 10%, 5% and 1% AEP events shows generally limited increases to high flood hazard category in terms of total area.

Similar to during construction, in the 5% and 1% AEP events, there are areas of increased flood hazard to high hazard on the fringes of the urban area in Tarro, Beresfield, Thornton and Woodberry. These changes are due to typical flood depth increases of less than 0.02 metres. Hence while there is a change in flood hazard category from low to high, the incremental increase in the flood hazard is minor, due to the minor change in flood depth.

There are some minor areas of new high hazard flooding on the fringe of the urban areas in Raymond Terrace and Tarro in addition to within Raymond Terrace CBD in the 1% AEP event. These new high hazard areas are incremental and localised extensions of existing high flood hazard areas.

There are no large increases in extent of the high hazard areas, which would indicate a new floodway or flow path being formed from operation of the project. While there are localised increases in flood hazard with the amended project design, since the afflux has generally decreased from the EIS, the increase in flood hazard has also reduced from the EIS.

The change in flood hazard, and change from the EIS, is discussed at key points of interest in **Section 6.3.1** for operation.

6.2.3 Change in duration of inundation

Figures C-13 to C-16 of **Appendix C** show the change in the duration of inundation from the existing case for the 20%, 10%, 5% and 1% AEP events, respectively, for operation of the project. The durations and the change in durations are assessed for flood depths greater than 0.5 metres. The change is expressed as the percentage change from the existing case without the project. Total durations of inundation on the floodplain are typically up to 70 hours. Areas around Tarro, Hexham Swamp and Nelsons Plains experience durations of inundation up to 90 hours in the 5% AEP event and 95 hours in the 1% AEP event.

Similar to during construction, the mapping shows that the change in duration of inundation is less than one per cent for the majority (over 95 per cent) of the flood extent within study area in each flood event. In the 5% AEP event, the change in remaining areas is generally less than five per cent, and in most instance around two per cent. In the 20% AEP event, some low-lying wetland areas on rural lands experience more than ten per cent increase in duration of inundation. Areas downstream of the project experience reductions in duration of inundation.

Higher per cent increases in duration exceeding 50 per cent occur along the fringes of the flood extent due to shallow flood depths. The durations in these areas simply rise to the same duration of inundation in the adjoining main body of flooding.

The change in duration of inundation, and the change from the EIS, is discussed at key points of interest in **Section 6.3.1**.

The absolute change in duration of inundation is discussed in terms of hours change at buildings within the study area in **Section 6.3.2**.

Given that the afflux has generally decreased from the EIS, the change in duration of inundation has also reduced from the EIS.

6.2.4 Change in velocity

Figures C-17 to C-20 of **Appendix C** show the change in flow velocity from the existing case for the 20%, 10%, 5% and 1% AEP events, respectively, during operation. Increases in velocities occur as a result of localised changes in flow patterns around the project at embankments, access tracks and transverse drainage outlets.

Changes in velocities include increases and decreases of up to 0.3 metres per second in the 10% AEP and up to 0.4 metres per second in the 5% and 1% AEP event around the viaduct due to increased interaction of flood flows with permanent access tracks.

There are increases in velocities of 0.3 metres per second in some drains to the west of the project in Tomago and Heatherbrae downstream of transverse drainage outlets in the 20% AEP event. There are localised velocity increases of up to 1.2 metres per second at a drainage channel outlet to the Hunter River upstream of the eastern end of the viaduct in up to the 5% AEP events.

Around the viaduct and along the Hunter River banks, localised increases in velocity of up to 0.7 metres per second are predicted in the 10% AEP event, 0.5 metres per second in the 5% AEP event and 0.3 metres per second in the 1% AEP event, with velocities during operation of up to 1.3 to 1.6 metres per second. These generally occur at the ends of the access tracks.

On and around access tracks, increases in velocity of 0.3 to 0.6 metres per second are predicted in the 5% AEP event, with velocities during operation of up to 1.3 to 1.6 metres per second. In the 1% AEP event, velocities increase by up to 0.3 metres per second and velocities are also up to 1.6 metres per second.

In Windeyers Creek localised changes in velocity are less than 0.1 metres per second in the 5% and 1% AEP event.

In Purgatory Creek localised changes in velocity are 0.1 to 0.5 metres per second in the 5% and 1% AEP events, generally around access tracks and culvert crossings. Velocities are up to one metre per second in the 5% AEP event and 1.4 metres per second in the 1% AEP event.

Impacts of changes in flow velocity are generally localised. There is not expected to be widespread scouring of river banks based on the predicted changes in velocities. Revised potential management measures are discussed in **Chapter 7** and include riprap scour protection at appropriate locations including culvert outlets, monitoring of scouring and remedial works.

With regards to scouring at bridge abutments and piers, assessment of scouring depths and scour protection requirements is to be undertaken based on industry standard bridge hydraulic design guidelines.

6.2.5 Flood mapping for operation

Mapping is provided in **Appendix C** to illustrate the flooding conditions during operation:

- Flood levels and depths in 20%, 10%, 5% and 1% AEP events: Figures C-21 to C-24
- Flood hazard in 20%, 10%, 5% and 1% AEP events: Figures C-25 to C-28
- Duration of inundation in 20%, 10%, 5% and 1% AEP events: Figures C-29 to C-32
- Flow velocity in 20%, 10%, 5% and 1% AEP events: Figures C-33 to C-36.

6.3 Flood impacts to property and infrastructure

6.3.1 Points of interest

The flood impacts are assessed at key points of interest in the flood study area, which have been defined based on representative locations for a holistic assessment of flood impacts across the study area, and at selected locations relevant to the public submissions. The locations of the points of interest are shown on **Figure 5-3**.

Table 5-1 summarises and compares the flooding conditions for depth, flood hazard category and duration of inundation for existing case and during operation with the amended project.

Tables F-1 to F-3 in **Appendix F** describe the afflux, change in flood hazard category and change in duration of inundation including proposed refinements during operation. The impacts predicted by the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) and the change in impacts from the refinements documented in this supplementary report are also outlined.

The points of interest assessment indicates that the afflux is minor and changes in flood hazard and duration of inundation are generally minor during operation. There is increase in flood hazard category in a limited number of locations resulting from minor incremental increases in flood depths, hence the incremental increase in the flood hazard is also minor. Impacts are generally within the revised afflux criteria for below-floor flooding for the land use at those locations. The afflux and impacts are generally reduced from the original EIS assessment.

Table 6-1 Comparison of predicted flood level impacts to existing case at points of interest – Operation

POI	Existing case flood impact	Amended project potential flood impact
1	Existing flooding is caused by overflows of floodwater from the Hunter River into Hexham Swamp over the New England Highway and Main North Rail Line in the 10% AEP event and larger in addition to local runoff from the Hexham Swamp catchment area. Flood depths are 0.5 m in the 20% AEP event, 0.8 m in the 10% AEP event, 1.2 m in the 5% AEP event and 3.4 m in the 1% AEP event. Flood hazard category is H3 in the 20%, 10% and 5% AEP events and H5 in the 1% AEP event. Durations of inundation are 43 hours in the 20% AEP event, 67 hours in the 10% AEP event, 73 hours in the 5% AEP event and 82 hours in the 1% AEP event.	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp in events larger than the 10% AEP event and minor reductions in floodplain storage due to the new road embankments. Afflux of 0.00 m in the 20% and 10% AEP events, 0.03 m in the 5% AEP event and -0.01 m in the 1% AEP event is predicted. No change to flood hazard category. In the 20% AEP event, the change in duration of inundation from existing case is 1.7%. In the 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 1%.
2	Existing flooding is caused by overflows of floodwater from the Hunter River into Hexham Swamp over the New England Highway and Main North Rail Line in the 10% AEP event and larger in addition to local runoff from the Hexham Swamp catchment area. Flood depths are 0.01 m in the 20% AEP event, 0.2 m in the 10% AEP event, 0.4 m in the 5% AEP event and 2.5 m in the 1% AEP event. Flood hazard category is H1 in the 20%, H2 in the 10% AEP event, H3 in the 5% AEP event and H5 in the 1% AEP event. Durations of inundation are up to 53 hours in the 5% AEP event and 67 hours in the 1% AEP event. There is an existing dwelling at this location. Flooding is below floor level in up to and including the 5% AEP.	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp in events larger than the 10% AEP event and minor reductions in floodplain storage due to the new road embankments. Afflux of 0.00 m in the 20% and 10% AEP events, 0.02 m in the 5% AEP event and -0.01 m in the 1% AEP event is predicted. Afflux is within acceptable limit of 0.1 m for rural and environmental living land use. Afflux is within acceptable limits for above-floor flooding in the 1% AEP event, with no above-floor flooding in the 5% AEP event and lower. No change to flood hazard category. In the 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 2%.
3	Existing flooding is caused by overflows of floodwater from the Hunter River into Hexham Swamp over the New England Highway and Main North Rail Line in the 10% AEP event and larger in addition to local runoff from the Hexham Swamp catchment area. Flood depths are 0.03 m in the 10% AEP event, 0.4 m in the 5% AEP event and 1.1 m in the 1% AEP event. POI 3 is outside the 20% AEP flood. Flood hazard category is H1 in the 10%, H3 in the 5% AEP event and H5 in the 1% AEP event.	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp and the area adjacent to the northern end of the Hexham Train Support Facility in the 10% AEP event and larger and minor reductions in floodplain storage due to the new road embankments. Afflux of 0.00 m in the 10% AEP events, 0.02 m in the 5% AEP event and 0.00 m in the 1% AEP event is predicted. There are existing maintenance buildings at this location at Hexham Train Support Facility. No above-floor afflux impacts in up to and including the 5% AEP. Afflux is within acceptable limits.

POI	Existing case flood impact	Amended project potential flood impact
	Durations of inundation are up to 15 hours in the 5% AEP event and 66 hours in the 1% AEP event. There are existing maintenance buildings at this location at Hexham Train Support Facility. Flooding is below floor level in up to and including the 5% AEP.	No change to flood hazard category. In the 5% and 1% AEP events the change in duration of inundation from existing case is less than 2%.
4	Existing flooding is caused by overflows of floodwater from the Hunter River into Hexham Swamp over the New England Highway and Main North Rail Line in the 10% AEP event and larger in addition to local runoff from the Hexham Swamp and Purgatory Creek catchment areas. Flood depths on the railway at POI 4 are 0.04 m in the 10% AEP event, 0.14 m in the 5% AEP event and 2.0 m in the 1% AEP event. POI 4 is above the 20% AEP flood. Flood hazard category is H2 in the 10%, H4 in the 5% AEP event and H6 in the 1% AEP event. Durations of inundation are up to 28 hours in the 5% AEP event and 69 hours in the 1% AEP event.	The project causes increased overflows of floodwater from the Hunter River, over the New England Highway in the 10% AEP event and larger, causing increases in flood depths over the Main Northern Rail Line near Mid Site Creek. Afflux of 0.00 m is predicted in the 10% AEP event, 0.02 m in the 5% AEP event and 0.01 m in the 1% AEP event on the railway line in the vicinity of POI 4. No change to flood hazard category. In the 5% AEP event the change in duration of inundation from existing case is 3%. In the 1% AEP event the change in duration of inundation from existing case is less than 1%.
5	Flooding at POI 5 is a result of floodwaters backflowing through the existing Purgatory Creek culvert under the New England Highway and overtopping of the New England Highway in the 10% AEP event and larger. Flood depths at POI 5 are 0.3 m in the 10% AEP event, 0.4 m in the 5% AEP event and 2.5 m in the 1% AEP event. POI 5 is above the 20% AEP flood. Flood hazard category is H1 in the 10%, H2 in the 5% AEP event and H5 in the 1% AEP event. Durations of inundation are around 30 hours in the 5% AEP event in the vicinity of POI 5 and 68 hours in the 1% AEP event. There is an existing dwelling at this location. Flooding is below the habitable floor level in up to and including the 5% AEP.	The project causes increases in these flows due to the increased flood levels upstream of the viaduct and access tracks. Afflux is predicted up to 0.01 m in the 10% AEP event, 0.05 m in the 5% AEP event and 0.04 m in the 1% AEP event. Afflux in up to and including the 5% AEP event is within acceptable limit of 0.1 m for rural and environmental living land use. Afflux is non-compliant for above-floor flooding of dwelling in the 1% AEP event. No above-floor afflux impacts in up to and including the 5% AEP. No change to flood hazard category. In the 5% AEP event the change in duration of inundation from existing case in the vicinity of POI 5 is 9%, or about three hours. In the 1% AEP event the change in duration of inundation from existing case is less than 1%.

POI	Existing case flood impact	Amended project potential flood impact
6	Flooding of the Main North Rail Line at POI 6 occurs in the existing case in the 10% AEP event and larger. Flood depths on the railway at POI 6 are 0.2 m in the 10% AEP event, 0.7 m in the 5% AEP event and 2.3 m in the 1% AEP event. POI 5 is above the 20% AEP flood. Flood hazard category is H2 in the 10%, H3 in the 5% AEP event and H5 in the 1% AEP event. Durations of inundation are up to 30 hours in the 5% AEP event and 59 hours in the 1% AEP event on the railway at POI 6.	The project causes increased flood levels at POI 6 as a result of the viaduct and access tracks. Afflux on the floodplain adjacent to the railway is 0.01 m in the 20%, 10% and 5% AEP events. The railway is not overtopped in the 20% AEP event. Afflux is 0.02 m in the 1% AEP event. Increase in hazard category from H2 to H3 for 10% AEP event as a result of minor incremental increase in depth of 0.01 m. No change to flood hazard category for other events. In the 5% AEP event the change in duration of inundation from existing case is 1%. In the 1% AEP event the change in duration of inundation from existing case is less than 1%.
7	Flooding at POI 7 occurs in the existing case in the 10% AEP event and larger. Flood depths are 1.6 m in the 10% AEP event, 2.1 m in the 5% AEP event and 3.6 m in the 1% AEP event. POI 5 is above the 20% AEP flood. Flood hazard category is H4 in the 10% and H5 in the 5% and 1% AEP events. Durations of inundation are around 60 hours in the 10% AEP event, 67 hours in the 5% AEP event and 72 hours in the 1% AEP event. There is an existing dwelling at this location. Flooding is below the habitable floor level in up to and including the 5% AEP.	The project causes increased flood levels as a result of the viaduct and access tracks. Afflux is predicted up to 0.01 m in the 10% AEP event, 0.01 m in the 5% AEP event and 0.02 m in the 1% AEP event. Not flooded in 20% AEP event. Afflux in up to and including the 5% AEP event is within acceptable limit of 0.1 m for rural and environmental living land use. Afflux is non-compliant for above-floor flooding of dwelling in the 1% AEP event. No change to flood hazard category. In the 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 1%.
8	Flooding at POI 8 occurs in a wetland area on Francis Greenway Creek, at western Woodbury Park in the 20% AEP event and larger. Flood depths are 0.4 m in the 20% AEP event, 1.6 m in the 10% AEP event, 2.1 m in the 5% AEP event and 3.8 m in the 1% AEP event. Flood hazard category is H2 in the 20% AEP event, H4 in the 10% AEP event and H5 in the 5% and 1% AEP events. Durations of inundation are 63 hours in the 10% AEP event, 67 hours in the 5% AEP event and 75 hours in the 1% AEP event.	The project causes increased flood levels as a result of the viaduct and access tracks. Afflux of 0.00 m in the 20% event, 0.01 m in the 10% AEP event, 0.01 in the 5% AEP event and 0.02 m in the 1% AEP event is predicted. No change to flood hazard category. In the 20%, 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 1%.

POI	Existing case flood impact	Amended project potential flood impact
9	Flooding at POI 9 occurs on low-lying rural land, on the eastern bank of the Hunter River at Heatherbrae, in the 20% AEP event and larger. Flood depths are 0.3 m in the 20% AEP event, 1.7 m in the 10% AEP event, 2.1 m in the 5% AEP event and 3.7 m in the 1% AEP event. Flood hazard category is H2 in the 20% AEP event, H4 in the 10% AEP event and H5 in the 5% and 1% AEP events. Durations of inundation are 33 hours in the 20% AEP event, 72 hours in the 10% AEP event, 73 hours in the 5% AEP event and 76 hours in the 1% AEP event.	The project causes increased flood levels as a result of the viaduct and access tracks, in addition to increased cross-drainage flows from local catchment on the eastern side of the M1 Motorway. Afflux of 0.05 m in the 20% event, 0.01 m in the 10% AEP event, 0.01 m in the 5% AEP event and 0.02 m in the 1% AEP event is predicted. No change to flood hazard category. In the 20% AEP event, the change in duration of inundation from existing case is 41%, increasing from 33 hours to 47 hours. In the 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 1%.
10	Flooding at POI 10 occurs in a low-lying drainage ponding area on the western floodplain of the Hunter River in Millers Forest in the 20% AEP event and larger. Flood depths are 1.0 m in the 20% AEP event, 2.2 m in the 10% AEP event, 2.7 m in the 5% AEP event and 4.3 m in the 1% AEP event. Flood hazard category is H2 in the 20% AEP event, H4 in the 10% AEP event and H5 in the 5% and 1% AEP event. Durations of inundation are 86 hours in the 20% AEP event, 75 hours in the 10% AEP event, 77 hours in the 5% AEP event and 82 hours in the 1% AEP event.	The project causes increased flood levels as a result of the viaduct and access tracks. Afflux of 0.00 m in the 20% event, 0.01 m in the 10% AEP event, 0.01 m in the 5% AEP event and 0.02 m in the 1% AEP event is predicted. No change to flood hazard category. In the 20%, 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 1%.
11	Flooding at POI 10 occurs at the southern end of Port Stephens Street in Raymond Terrace in the 20% AEP event and larger. Flood depths are 0.05 m in the 20% AEP event, 0.6 m in the 10% AEP event, 1.0 m in the 5% AEP event and 2.6 m in the 1% AEP event. Flood hazard category is H1 in the 20% AEP event and H3 in the 10% and 5% AEP events and H5 in the 1% AEP event. Durations of inundation are 15 hours in the 10% AEP event, 37 hours in the 5% AEP event and 61 hours in the 1% AEP event.	The project causes increased flood levels as a result of the viaduct and access tracks. Afflux of 0.00 m in the 20% event, 0.00 m in the 10% AEP event, 0.01 m in the 5% AEP event and 0.02 m in the 1% AEP event is predicted. No change to flood hazard category. In the 10% AEP event the change in duration of inundation from existing case is 3%, in the 5% AEP the change is less than 1% and in the 1% AEP the change is less than 1%.

POI	Existing case flood impact	Amended project potential flood impact
12	Flooding at POI 12 occurs in the existing case in the 10% AEP event and larger. Flood depths are 0.2 m in the 10% AEP event, 1.6 m in the 5% AEP event and 2.1 m in the 1% AEP event. POI 12 is above the 20% AEP flood. Flood hazard category is H1 in the 20% AEP event and H3 in the 10% and 5% AEP events and H5 in the 1% AEP event. Durations of inundation are up to 17 hours in the 5% AEP event and 51 hours in the 1% AEP event.	The project causes increased flood levels as a result of the viaduct and access tracks. Afflux of 0.00 m in the 10% AEP event, 0.00 m in the 5% AEP event and 0.01 m in the 1% AEP event is predicted. Not flooded in 20% AEP event. No change to flood hazard category. In the 5% AEP event the change in duration of inundation from existing case is 1%. In the 1% AEP event the change in duration of inundation from existing case is less than 1%.
13	Flooding at POI 13 occurs at the Tomago Road intersection with the Pacific Highway in the 20% AEP event and larger. Flood depths are 0.4 m in the 20% AEP event, 0.5 m in the 10% AEP event, 0.9 m in the 5% AEP event and 2.5 m in the 1% AEP event. Depths are highest on the southbound carriageway of the Pacific Highway, while the northbound carriageway is not flooded in the 20% AEP event at this location. Flood hazard category is H2 in the 20% and 10% AEP events, H3 in the 5% AEP event and H5 in the 1% AEP event. Durations of inundation are 15 hours in the 10% AEP event, 37 hours in the 5% AEP event and 56 hours in the 1% AEP event.	The project causes reduced flood levels at this location. Afflux is -0.03 m in the 20% AEP, -0.05 m in the 10% AEP event1 and -0.01 m in the 5% AEP event. Zero afflux in the 1% AEP event. No change to flood hazard category. In the 10%, 5% and 1% AEP event the change in duration of inundation from existing case is +/-1%.
14	Flooding at POI 14 occurs in wetlands at the Hunter Regional Botanic Gardens in the 20% AEP event and larger. Flood depths are 0.9 m in the 20% AEP event, 1.2 m in the 10% AEP event, 1.3 m in the 5% AEP event 2.8 m in the 1% AEP event. Flood hazard category is H3 in the 20% AEP event, H4 in the 10% and 5% AEP events and H5 in the 1% AEP event. Durations of inundation are 81 hours in the 20% AEP event, 90 hours in the 10% AEP event, 91 hours in the 5% AEP event and 92 hours in the 1% AEP event.	The project causes reduced flood levels due to increased cross-drainage capacity under the M1 Pacific Motorway in smaller events, and increased flood levels in larger events as a result of the viaduct and access tracks. Afflux is -0.48 m in the 20% AEP event, -0.37 m in the 10% AEP event, -0.02 m in the 5% AEP event and -0.03 m in the 1% AEP event. Reduction in hazard category from H4 to H3 for 10% AEP event. No change to flood hazard category for other events. Change in duration of inundation from existing case for -83% in the 20% AEP, -44% in the 10% AEP, -35% in the 5% AEP and -16% in the 1% AEP event.

POI	Existing case flood impact	Amended project potential flood impact
15	Flooding at POI 15 occurs in watercourses and ponds adjacent to the Raymond Terrace wastewater treatment plant. Flooding does not inundate the treatment plant itself in up to the 5% AEP event in the existing case. Flood depths are 0.8 m in the 20% AEP event, 1.6 m in the 10% AEP event, 2.0 m in the 5% AEP event and 3.6 m in the 1% AEP event. Flood hazard category is H3 in the 20% AEP event and H4 in the 10% AEP event and H5 in the 5% and 1% AEP events. Durations of inundation are 52 hours in the 20% AEP event, 63 hours in the 10% AEP event, 70 hours in the 5% AEP event and 80 hours in the 1% AEP event.	The project causes increased flood levels, backing up from the Hunter River, as a result of the viaduct and access tracks. Afflux is 0.02 m in the 20%, 0.01 m in the 10% AEP event, 0.01 m in the 5% AEP event and 0.02 m in the 1% AEP event. No change to flood hazard category. In the 20%, 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than 1%.
16	Flooding at POI 16 occurs on the floodplain located between the Hunter River and Williams River at Nelsons Plains. Flood depths are 1.7 m in the 20% AEP event, 2.6 m in the 10% AEP event, 2.8 m in the 5% AEP event and 4.2 m in the 1% AEP event. Flood hazard category is H4 in the 20% AEP event and H5 in the 10% AEP event, H5 in the 5% AEP event and H6 in the 1% AEP event. Durations of inundation are 54 hours in the 20% AEP event, 76 hours in the 10% AEP event, 81 hours in the 5% AEP event and 91 hours in the 1% AEP event.	The project causes increased flood levels, backing up from the Hunter River, as a result of the viaduct and access tracks. Afflux is 0.01 m in the 20% AEP event, 0.00 m in the 10% AEP event, 0.00 m in the 5% AEP event and 0.01 m in the 1% AEP event. No change to flood hazard category. In the 20%, 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than 1%.

6.3.2 Buildings flood impacts

Analysis of flood impacts to buildings during operation was undertaken based on building data discussed in **Section 4.5**, with a focus on above-flood flooding at residential buildings. A count of buildings with varying above-floor afflux is provided in Table F-4 in **Appendix F**. In summary:

- 134 residential buildings have above-floor afflux greater than 0.01 metres in the 1% AEP event, which are all affected by 0.01 to 0.02 metres afflux. Existing depths of flooding above-floor in the 1% AEP event are 0.5 metres to over two metres at affected residential buildings, refer to **Section 2.3** and Table D-1 in **Appendix D**
- No buildings have above-floor afflux greater than 0.01 metres in the 20%, 10% and 5% AEP event.

A count of residential buildings with new above-floor flooding during operation in the 20%, 10%, 5% and 1% AEP events is provided in Table F-5 in **Appendix F**. One residential building would have new above-floor flooding in the 1% AEP event. This building is separate from the buildings identified above with above-floor afflux. Review of the flood impact to the identified building indicates that it is likely to be a modelling anomaly and further detailed investigation at detailed design would be undertaken to refine the flood impact estimate at this building.

A count of residential buildings predicted to have above-floor flooding duration increasing by more than one hour during operation is provided in Table F-6 in **Appendix F**. One residential building with duration of above-floor inundation increasing by more than one hour has been predicted in the 10% AEP event, three residential buildings in the 5% AEP event and two residential buildings in the 1% AEP event. A total of six individual residential buildings across the 10%, 5% and 1% AEP events with change in duration of inundation of above floor flooding greater than one hour has been predicted during operation of the project.

While **Section 6.2.3** describes that the majority of the floodplain would experience less than one per cent increase in duration of inundation from the existing case, the increase in duration of inundation is generally higher and may exceed an increase of one hour on the fringes of the flooding. This area is where the residential buildings are typically located.

Tables F-7, F-8 and F-9 list the lot and DP for residential buildings during operation with the criteria exceeded for afflux, new above- floor flooding and change in duration of inundation.

6.3.3 Property flood impacts

Table F-10 to F-12 in **Appendix F** summarises the number of cadastral lots within residential, commercial and industrial land use zones, respectively, during operation according to the change in peak flood depth on each lot. The estimate of the number of lots, which was initially based on automated spatial analysis procedures, also involves a manual validation of the impacts to demote lots where an anomalous impact due to modelled resolution of the terrain and other factors could be identified. In summary:

- The large majority of flood-affected residential, commercial and industrial lots without the project would experience negligible change in flood depth (+/- 0.01 metres change) during operation of the project
- In the 5% AEP event, 46 residential lots, zero commercial lots and 13 industrial lots are affected by an increase in flood depths of over 0.01 metres from the project
- In the 1% AEP event, 309 residential lots, 95 commercial lots and 145 industrial lots are affected by an increase in flood depths of over 0.01 metres form the project
- One individual residential lot would be affected by a change in flood depth over 0.05 metres in the 20%, 10% and 5% AEP events. This is a large residential lot with a change in maximum flood depth of 0.1 metres, on low-lying land on the lot immediately adjacent to the project road embankment. This predicted increase in flood depth would not affect any existing buildings on the lot.

Table F-13 in **Appendix F** lists the lots that are predicted to be affected by afflux exceeding the adopted criteria. The lots include residential, commercial and industrial land use zonings in addition to other land use zones. In summary, there are four lots identified and comprised of:

- One zoned residential
- Three zoned environmental living/environmental conservation.

This would be a reduction from the ten lots identified in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b).

6.3.4 Impacts to sensitive properties

The flood management objectives in **Section 4.4** adopt an assessment criterion of 0.05 metres on sensitive properties such as emergency services (hospitals, ambulance, fire, police stations) electricity substations, and water treatment plants for below-floor flooding. A 0.01 metre afflux limit applies to above-floor flooding.

The areas of afflux exceeding 0.05 metres during operation are limited in area and generally affect rural, vegetated and open space areas. There are no sensitive properties identified in areas predicted to be affected by greater than 0.05 metres afflux.

The buildings flood impact analysis did not identify any sensitive property buildings with above-floor flood afflux greater than 0.01 metres.

6.3.5 Land use flood impacts

An afflux assessment criterion of 0.1 metres on rural, forest and recreational land use areas has been adopted. There are no significant areas of afflux exceeding 0.1 metres outside the operational footprint. Several locations are mapped with afflux predictions over 0.1 metres during operation. These include:

- Localised afflux areas of about 1000 square metres of up to 0.24 metres in the 5% AEP event during operation on forest areas to the east of Raymond Terrace. These localised areas are surrounded by broad areas of afflux of 0.02 to 0.05 metres, which are below the adopted assessment criterion
- Areas of increased ponding around the Tarro interchange with afflux of 0.15 to 0.36 metres in the 20% AEP event affecting rural land
- Increased water levels exceeding 0.1 metres in the 20% AEP event along the crest of the existing flood levee on the western bank of the Hunter River. Adjoining areas have afflux of less than 0.02 metres
- A number of localised and isolated areas about 1000 square metres of afflux in the 20% AEP event on various parts of the rural floodplain. These do not affect any existing development.

The afflux identified at these locations in the operation phase are localised in extent and would have no significant impacts on existing land uses.

6.3.6 Flood impacts to roads

An afflux assessment criterion of 0.1 metres on roads and a maximum increase of 10 per cent of total road length being flooded has been adopted. Table 5-11 and Table 5-12 in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) outlined a change in length of roads affected is predominantly less than 10 per cent on highways, major roads and other named roads in the study area. The large majority of major roads would experience no change or a minor change (up to eight per cent increase) in the length of road affected by flooding. This would be maintained or slightly reduced by implementation of the proposed refinements as a reduction in afflux has been predicted when compared to the EIS.

Similar to the construction phase flooding assessment, an exception includes the section of the New England Highway within the study area, where there is a 23 per cent increase in the length of road affected by flooding in the 10% AEP event, due to an additional four metre section being affected by H2 flood hazard. This affects the start of a minor entry ramp lane and not the main alignment. Overall trafficability is not substantially affected in this location.

These are the same conditions as reported in the EIS. It should be noted that the project does not result in any new flooding of roads during operation which were not previously affected by flooding.

In terms of afflux impacts to roads, Figures C-1 to C-4 in **Appendix C** show that the large majority of the flood study area is affected by afflux less than 0.05 metres and hence the increases in flood levels on existing roads is within the assessment criterion of 0.1 metres.

6.3.7 Flood impacts to railways

An afflux assessment criterion of 0.1 metres on railways and a maximum increase of 10 per cent of total railway length being flooded has been adopted. Section 5.3.8 in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021b) discusses that the change in length of railway affected by flooding in the study area would be up to 0.1 per cent for events up to the 1% AEP flood. This would be represent no change or a small reduction as afflux would generally be reduced compared to the EIS.

Figures C-1 to C-4 in **Appendix C** show that the large majority of the flood study area would be affected by afflux less than 0.05 metres. The figures show that there would be no sections of railway with increases in flood levels on existing that exceed the assessment criterion of 0.1 metres, and that there would be no new railways affected by flooding. Increases in flooding would be limited to minor extensions of the sections of railway already affected by flooding without the project.

6.3.8 Impacts to Hunter Valley Flood Mitigation Scheme

The afflux in the Hunter River would be 0.01 to 0.02 metres in the 20% and 10% AEP events during operation. Given that the difference between the 20% and 10% AEP peak flood level in the River is 0.7 metres, the afflux of 0.01 to 0.02 metres translates to a negligible reduction in the overtopping flood event AEP, which is currently around a 20% AEP event. The afflux during operation is less than during construction.

As discussed in **Section 6.2.4**, localised increases in velocity of up to 0.7 metres per second are predicted in the 10% AEP event, 0.5 metres per second in the 5% AEP event and 0.3 metres per second in the 1% AEP event, with velocities during operation of up to 1.3 to 1.6 metres per second. These generally occur in the vicinity of new permanent access tracks and may affect the existing flood levee on the western bank of the Hunter River around the viaduct and access tracks. Revised potential management measures are discussed in **Chapter 7** and include monitoring of scouring and erosion of levee banks and remedial works if required.

Other potential impacts are as per the EIS. The project including the proposed design refinements would be designed, constructed and operated to ensure there is no changes to flow capacity of culverts and drains, and no impacts to the operation, function or structural integrity of the scheme (including the floodgates and levees).

6.4 Summary of operational impacts to flooding

The outcomes of the flood impact assessment for operation following project refinements are summarised below:

- The afflux resulting from project design refinements are within the adopted assessment criteria across the large majority of the study area for land uses and below-floor flooding. There are a limited number of locations where afflux exceeds the adopted criteria
- Afflux for the project including design refinements would generally be reduced compared to the afflux predicted for the EIS. Where afflux is increased from the EIS, the flood levels during operation remain below the existing flood levels without the project
- Changes in flood hazard are minimised. The increases in flood hazard to high hazard category are localised and predominantly in rural and forest areas. There are some minor areas of new

high hazard flooding on the fringe of the urban areas in Raymond Terrace and Tarro in the 5% and 1% AEP events in addition to the Raymond Terrace CBD in the 1% AEP event. These new high hazard areas are incremental and localised extensions of existing high flood hazard areas and are a result of flood depth increases of less than 0.02 metres. Hence while there is a change in flood hazard category from low to high, the incremental increase in the flood hazard is minor, due to the minor change in flood depth. There are no large or widespread areas of new high flood hazard zones which would have indicated new flood flow paths being created
- Changes in duration of inundation in the study area are generally negligible, less than one per cent from existing, across the large majority of the study area. Given durations of inundation typically up to 70 hours with some areas up to 90 hours, these represent changes of less than one hour in the duration of inundation. Higher per cent increases in duration occur along the fringes of the flood extent due to shallow flood depths. The durations in these areas simply rise to the same duration of inundation in the adjoining main body of flooding
- There are a total 134 residential buildings with above-floor afflux greater than 0.01 metres in the 1% AEP event, which are all affected by 0.01 to 0.02 metres afflux. Over 70 per cent of these buildings are already affected by above floor level flood depths of 0.5 metres to over two metres in the existing case without the project. There are no buildings with above-floor afflux in the 20%, 10% and 5% AEP event
- There is one residential building with new above-floor flooding in the 1% AEP event. This building is separate from the buildings identified above with above-floor afflux. Review of the flood impact to the identified building indicates that it is likely to be a modelling anomaly and further detailed investigation at detailed design would be undertaken to refine the flood impact estimate at this building
- There is one residential building with duration of above-floor inundation increasing by more than one hour in the 10% AEP event, three residential buildings with duration of above-floor inundation increasing by more than one hour in the 5% AEP event and two residential buildings with duration of above-floor inundation increasing by more than one hour in the 1% AEP event. There are six individual residential buildings across the 10%, 5% and 1% AEP events with change in duration of inundation of above floor flooding greater than one hour during operation. Residential buildings are typically located on the fringes of the floodplain where increases in duration of inundation tend to be higher than on the main body of the floodplain where a one per cent increase in duration typically occurs
- There are no sensitive properties identified in areas affected by greater than 0.05 metres afflux in up to the 1% AEP event during operation. The buildings flood impact analysis did not identify any sensitive property buildings with above-floor flood afflux greater than 0.01 metres
- The EIS reported that the large majority of major roads experience no or minor change (up to eight per cent increase) in the length of road affected by flooding This would be maintained or slightly reduced by implementation of the proposed refinements as a reduction in afflux has been predicted when compared to the EIS
- The large majority of the flood study area is affected by afflux less than 0.05 metres and hence the increases in flood levels on existing railways is within the acceptable limit of 0.1 metres
- Given that the afflux is reduced from the EIS, so too the increases in flood hazard, duration of inundation and impacts to buildings, properties, roads and rail are similarly reduced from the EIS during operation
- The afflux of 0.01 to 0.02 metres in the 20% and 10% AEP events would result in a negligible change to the AEP of the flood event overtopping the Hunter Valley Flood Mitigation Scheme levees. The levees may be subject to localised increases in flow velocities of up to 0.7 metres per second in the 10% AEP event, 0.5 metres per second in the 5% AEP event and 0.3 metres per second in the 1% AEP event and monitoring for potential scour should be considered.

Identified non-compliances to the adopted flood management objectives during operation are summarised in **Table** 6-2. Management measures are outlined in **Chapter 7**.

Table 6-2 Flood management objective non-compliances – Operation

Flood assessment criteria	Description of non-compliance
Afflux – Above floor flooding of habitable floors	During operation: • 134 residential buildings with above floor afflux exceeding 0.01 m in the 1% AEP event • One residential building with new above-floor flooding in the 1% AEP event. Review of the flood impact to this building indicates that it is likely to be a modelling anomaly and further detailed investigation at detailed design would be undertaken to refine the flood impact estimate at this building.
Afflux – Other urban and residential land	• One residential lot is affected by change in flood depth over 0.05 metres in the 20%, 10% and 5% AEP events. This is a large residential lot with a change in maximum flood depth of 0.1 metres, on low-lying land on the lot immediately adjacent to the project road embankment. This increase in flood depth does not affect any existing buildings on the lot.
Afflux – Rural, forest and recreation land	• There are localised afflux areas of up to 1000 square metres of up to 0.24 metres in the 5% AEP event during operation on forest areas to the east of Raymond Terrace. These localised areas are surrounded by broad areas of afflux of 0.02 to 0.05 metres, which are within the acceptable range. • There are areas of increased ponding around the Tarro interchange with afflux of 0.15 to 0.36 metres in the 20% AEP event affecting rural land. • Increased water levels exceeding 0.1 metres in the 20% AEP event along the crest of the existing flood levee on the western bank of the Hunter River. Adjoining areas have afflux of less than 0.02 metres. • There are a number of localised and isolated areas up to 1000 square metres of afflux in the 20% AEP event on various parts of the rural floodplain. These do not affect any existing development. The afflux identified at these locations in the operation phase are localised in extent and no significant impacts to land uses are expected
Afflux and inundation of named roads	Two main roads in the study area with more than 10 per cent increase in flood affected length: • An increase of 91 per cent from existing inundated length is experienced on the Pacific Highway at Tomago Road in the 20% AEP event only, where the total length affected increases from 51 metres to 97 metres. This is due to minor inconsistency in modelled road levels between existing road levels and the design road levels and is expected to be resolved during detailed design. • On the New England Highway there is a 23 per cent increase in the length of road affected, due to an additional four metre section being affected. This affects the start of a minor entry ramp lane and not the main alignment. Overall trafficability is not substantially affected in this location.
Change in duration of inundation	Six individual residential buildings with change in duration of inundation of above floor flooding greater than one hour across the 10%, 5% and 1% AEP events.

6.5 Operational flood and hydrology impact management measures

Responses were received in the public submissions regarding typical flooding and hydrology management measures for properties identified as being impacted above the adopted assessment criteria.

This section presents information on management measures that would be considered during detailed design and construction of the project, for the operational hydrology and flooding impacts of the project. Revisions to the environmental management measures identified in the *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper* (Transport for NSW, 2021) are discussed in **Chapter 7**.

Table 6-3 Management measures to be considered for impacts above the flood assessment criteria during operation for 1%, 5%, 10% and 20% AEP events

Action for consideration	Applies to	Details
Detailed investigation of impacts	• Afflux – Above floor flooding of habitable floors • Afflux – Other urban and residential land • Change in duration of inundation	Further detailed investigation of properties where the flood assessment criteria are exceeded would occur, including field survey of ground and floor levels, and identification of habitable floors.
Community consultation, and access to flood information	• Afflux – Above floor flooding of habitable floors • Afflux – Other urban and residential land • Change in duration of inundation	Community engagement and consultation would occur prior to and during construction of the project. This would include providing property owners with details of existing and future flood impacts such as their floor levels, existing level of flood immunity, emergency access routes and procedures. The project would work with councils, floodplain managers and emergency services to ensure that property owners have access to resources required to implement effective flood management plans and procedures. The project would provide updated flood models, floor levels and ground surveys to councils to ensure development control plans are updated as appropriate (if required). Providing details of flooding levels and floor levels would provide property owners with an improved understanding of their current level of impacts so that they could potentially source more cost effective and appropriate flood insurance.
Physical management measures, e.g. • Raising access roads • Providing levees or diversion barriers • Cleaning out or widening of existing drainage channels • Localised flood-proofing such as flood barriers at doorways • Relocation of minor structures or	Afflux – Above floor flooding of habitable floors	Where afflux impacts from the project are considered materially significant in comparison to existing flood levels, physical management measures may be considered. The assessment of whether impacts are considered materially significant would be a merits-based assessment and take into consideration a range of factors including: • The nature of the impacts and whether they result in new above-floor inundation caused by afflux greater than 10mm • The vulnerability of the building (e.g. residential building) • The type of structure (e.g. single storey without any other flood-free floors or evacuation areas) • Existing flood immunity and depth of existing flooding in each rainfall event • The feasibility and reasonableness of the physical management measures For example, an impact may be considered materially significant where a residential habitable floor is affected by new above-floor inundation caused by afflux greater than 10mm, or where afflux of greater than 30mm occurs and worsens existing above-floor inundation.

Action for consideration	Applies to	Details
raising of floor levels		The above measures would be carried out in consultation with the affected property owner.
Financial settlement	Afflux – Above floor flooding of habitable floors	Where afflux impacts from the project are considered materially significant as outlined above, and physical mitigation is not practical or appropriate, financial settlement of the incremental impact of the project may be considered.

7 Revised environmental management measures

The *M1 Pacific Motorway extension to Raymond Terrace Environmental Impact Statement* (Transport for NSW 2021) identified a range of environmental outcomes and management measures that would be required to avoid or reduce the environmental impacts.

After consideration of the issues raised in the public submissions and the changes to the project, the environmental management measures for the project (refer to Chapter 24 of the EIS) have been revised.

Additional and/or modified environmental management measures to those presented in the environmental impact statement are in ***italics*** and deleted measures, or parts of measures, have been struck out.

The following **Table 7-1** presents the proposed changes to the hydrology and flooding environmental management measures.

Table 7-1 Summary of revised environmental management measures – Hydrology and flooding

Impact	Reference	Management measure	Responsibility	Timing
Flooding impacts during construction	FH01	A Flood Management Plan (FMP) will be prepared for the project and will detail the processes for flood preparedness, materials management, weather monitoring, site management and flood incident management. The FMP will also address procedures and responsibilities for flood response (preparation of site upon receipt of flood warning, evacuation of site personnel) during and recovery following a flood event. The FMP will also include: • Consideration of temporary traffic arrangements to minimise impact on flood evacuation route traffic capacity. • Appropriate measures to manage potential flood impact associated with temporary ancillary facilities subject to flooding within 20% AEP flood level • Where feasible, the size of the ancillary facilities and the height and extent of temporary access tracks will be reduced to minimise flood impacts • Ancillary facilities will also be designed to provide for conveyance of flood flows in order to minimise flooding impacts to adjacent properties and environment	Transport / Contractor	Prior to construction
Potential changes to flood impacts resulting from detailed design	FH02	Any changes to the design described in this Supplementary Report would be further investigated during detailed design, including further flood investigations and hydrological and hydraulic modelling to ensure the flood immunity objectives and performance criteria for the project are met ***where reasonable and feasible*.** The detailed design will consider refinement to ~~temporary and permanent access roads and~~ ***ancillary facilities*** to further reduce flood afflux with impacts to drainage capacity, where reasonable and feasible. ***The detailed design will also consider additional refinements including:*** • ***Investigation of options to minimise any increase in road catchment area draining to Purgatory Creek, such as refinements to drainage design.*** • ***Improving the drainage capacity of existing drainage channels and culverts along Purgatory Creek for servicing frequent rainfall storm events. Consultation with affected property owners would be undertaken in relation to drainage capacity upgrades and physical works.*** • ***Amendment of road design model on Pacific Highway at Tomago Road and/or representation in the flood hydraulic model to eliminate anomalous modelled increases in flood extent at the interface of the design and the existing road levels***	Transport/ Contractor	Detailed design

Impact	Reference	Management measure	Responsibility	Timing
		• ***Extension of flood hydraulic model in the upstream direction along the Hunter River, Paterson River and Williams River to define the full extent of afflux and other impacts resulting from the project*** • ***Refinement to a finer model grid size at selected locations in the hydraulic model for improved representation of model terrain in existing and design cases and improved assessment of potential flood impacts. Locations in the immediate vicinity of the project (road embankments etc.) should be considered as a focus for these refinements.*** • ***Additional building floor survey to improve the accuracy of the flood impact assessment.***		
Flooding impacts on property	FH03	Consultation will be carried out with landowners impacted by flood affects from the project which exceed the flood ***assessment criteria*** ~~management objectives~~ (afflux, change in flood hazard, change in time of inundation) about reasonable and feasible management measures. ***The applicability of these measures to each affected property would be determined with a merit-based approach with consideration of the degree of impact, temporary (during construction) versus permanent (during operation) impacts, and other factors.*** Further modelling may be carried out at detailed design to assess impacts to property.	Transport / Contractor	Detailed design
Impacts on existing drainage systems	FH04	Existing hydraulic capacity of drainage systems will be maintained during construction where practicable.	Contractor	Construction
	FH05	The requirement to provide further upgrades to existing drainage systems will be considered at detailed design where there is: • An increase of more than 20 per cent in the peak discharge rate during operation • An increase in drainage system capacity within the project boundary but where downstream infrastructure has not been upgraded.	Contractor	Detailed design
Impacts to flood mitigation schemes	FH06	The design of temporary and permanent works will ensure there is minimal impact to the function and flow capacity of the Hunter Valley Flood Mitigation Scheme or as otherwise agreed during consultation with operators of the scheme.	Transport / Contractor	Detailed design

Impact	Reference	Management measure	Responsibility	Timing
Impacts to river banks immediately downstream of project discharge locations during construction	FH07	Monitoring of temporary construction phase stormwater discharge locations to minimise downstream geomorphological impacts from the project will be included in the Construction Soils and Water Management Plan. ***Monitoring will also be undertaken following a flood event for scour resulting from the project to river banks, watercourses, floodplain areas and other areas adjacent to ancillary sites and temporary and permanent access tracks. Riprap scour protection will be provided in appropriate locations including culvert outlets.***	Contractor	Construction
Impacts to river banks immediately downstream of project discharge locations during operation	FH08	The project design aims to ensure that stormwater discharge velocities are controlled at the project outlet to ensure minimal downstream impacts occur immediately downstream of the project. ***Riprap scour protection will be provided in appropriate locations including culvert outlets.*** A geomorphological survey will be completed of the waterways downstream of the discharge points where there is greater than 20 per cent increase in stormwater discharge from the project. Waterways (channels and banks) immediately downstream of these project discharge locations will be monitored for a minimum period of twelve months or until establishment and stabilisation. Monitoring will look for evidence of initiation of erosion and scour and, if required, carry out appropriate remediation measures. ***Monitoring will also be undertaken following a flood event for erosion and scour resulting from the project to river banks, watercourses, floodplain areas and other areas adjacent to ancillary sites and temporary and permanent access tracks.***	Transport	Operation
Impact to surface water and groundwater hydrology	FH09	Baseline monitoring of hydrological attributes would be carried out prior to the commencement of construction, with ongoing monitoring during construction and the initial stages of operation (refer to Hydrology and Flooding Working Paper (Appendix J of the EIS).	Transport/ Contractor	Prior to construction/ construction/ operation
Flood impacts to railways during construction	***FH10***	***The location, size and height of AS6 would be reviewed to minimise potential short-term flood afflux impacts to the Main North Rail Line.***	***Contractor***	***Detailed design***

8 Conclusion

This supplementary assessment has been prepared for the M1 Pacific Motorway extension to Raymond Terrace (the project). It considers project design refinements and amendments including updated flood hydraulic modelling, revised flood management objectives and assessment criteria and new assessment of flooding impacts at residential buildings based on newly acquired building data. Potential impacts of the project during construction and operation are assessed. While the main focus of the supplementary report is on an updated flood impact assessment, several design refinements have potential hydrologic and drainage impacts and these are briefly discussed.

This supplementary report also provides clarifications to queries and responses to submissions received on the EIS, with respect to the hydrology and flooding outcomes. A number of the design and assessment refinements which are relevant to the hydrology and flooding assessment were developed in response to the public submissions and agency clarifications.

The supplementary assessment identified that flooding impacts during construction and operation are generally negligible to minor across the large majority of the study area with regards to afflux at residential buildings and on properties. Afflux (change in flood level from existing case as a result of the project) is generally up to 0.03 metres during construction and up to 0.02 metres during operation across most of the study area. Changes in flood hazard from existing are minimised and changes in duration of inundation from existing are generally negligible. Flooding impacts in the supplementary assessment are generally reduced from those presented in the EIS with afflux reducing by up to 0.07 metres in construction and by 0.01 to 0.03 metres during operation. Consequently, any increases from the existing case in flood hazard and duration of inundation are also reduced in the supplementary assessment.

There are potential increases in flow velocities from existing case during construction and operation which may have localised effects of erosion on parts of the floodplain and river banks in the vicinity of the project This includes sections of existing levees of the Hunter Valley Flood Mitigation Scheme. Impacts would be mitigated with monitoring of scouring and appropriate remedial works if required. There are no significant changes from the EIS in hydrologic and drainage impacts resulting from the project design refinements.

Non-compliances to the adopted flood management objectives have been identified for construction and operation. These relate to afflux above floor level of residential buildings and on urban and rural/recreational lands, changes to duration of inundation above floor level at residential buildings, increased length of inundation of a limited number of roads and afflux over railways.

The environmental management measures identified in the EIS have been updated and include recommendations for further detailed refinements of hydraulic modelling during detailed design and specific impact mitigation options for identified buildings and properties where the flood management criteria are exceeded. A database of identified buildings and properties where the criteria are exceeded has been developed and is presented in the **Appendix E** and **Appendix F**.

9 References

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia.

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BMT WBM (2012a) *Williamtown / Salt Ash Flood Study Review*, Final Report prepared for Port Stephens Council.

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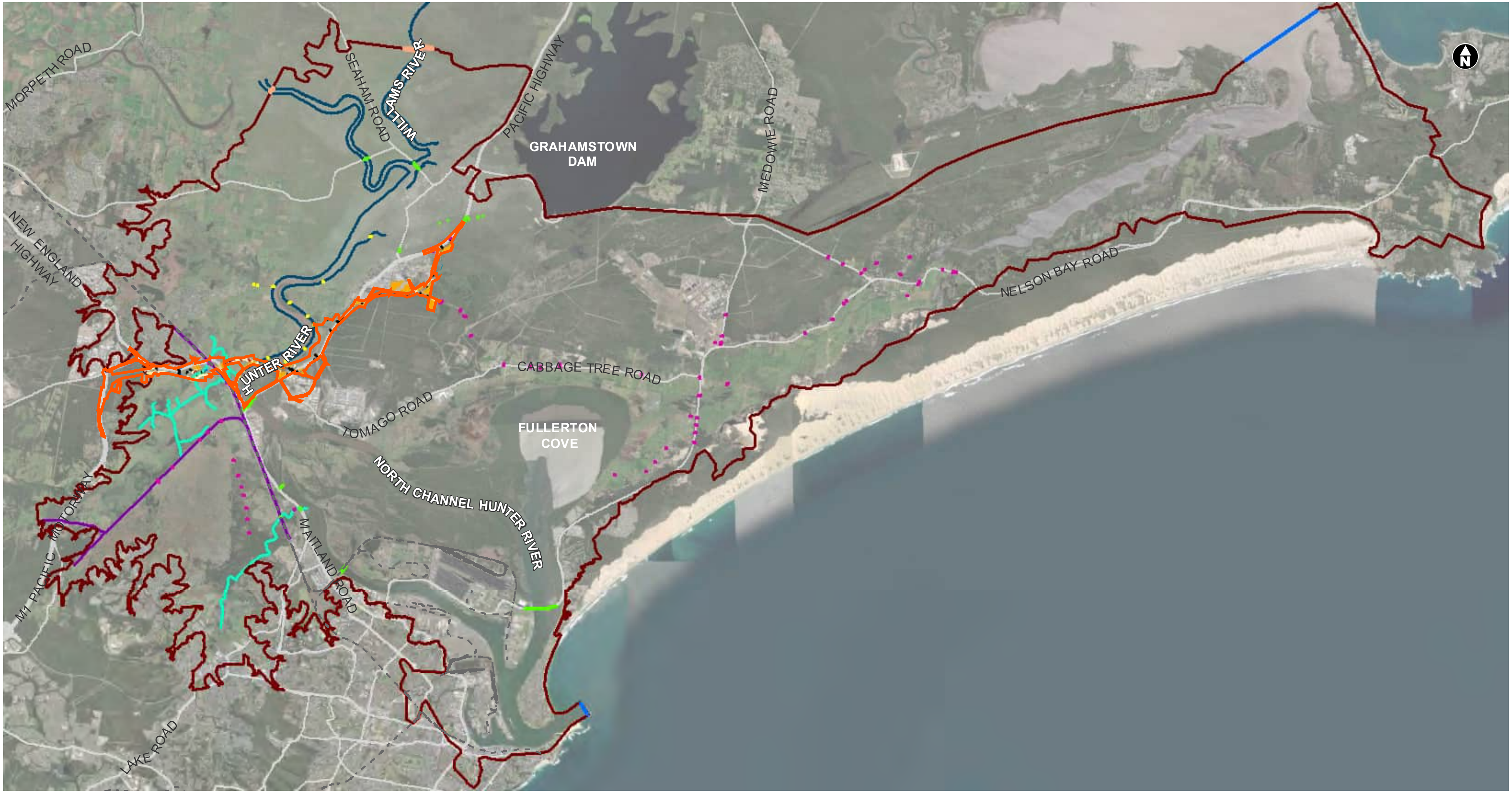
Transport for NSW (2021b) *M1 Pacific Motorway extension to Raymond Terrace Hydrology and Flooding Working Paper*

Transport for NSW (2022). *M1 Pacific Motorway extension to Raymond Terrace Submissions Report*

WMAwater (2010) *Hunter River Branxton to Green Rocks Flood Study.* Prepared for Maitland City Council.

Appendix A. Updated flood model configuration



TUFLOW model extent
Construction footprint
Ancillary sites
Construction phase water quality basin
Construction phase access track culverts
Construction phase access track
River inflow
Downstream boundary
Floodgates
Culverts
Permanent design culverts
Waterway crossing
Railway embankment breakline
Hexham Swamp channel breakline
Levee breakline

0 4 8km

Figure A-1 TUFLOW model configuration - Construction phase (map 1 of 2)

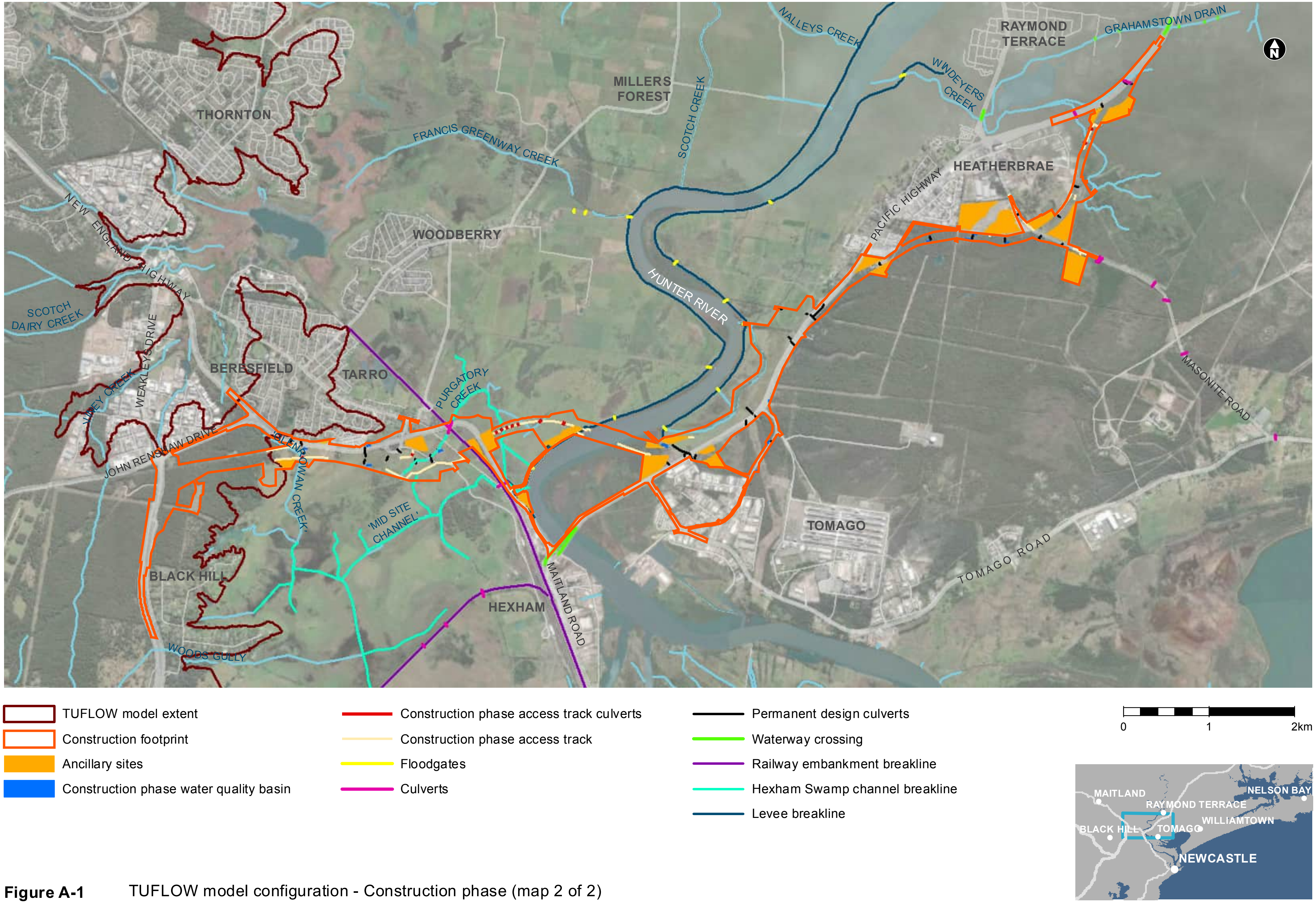


Figure A-1 TUFLOW model configuration - Construction phase (map 2 of 2)

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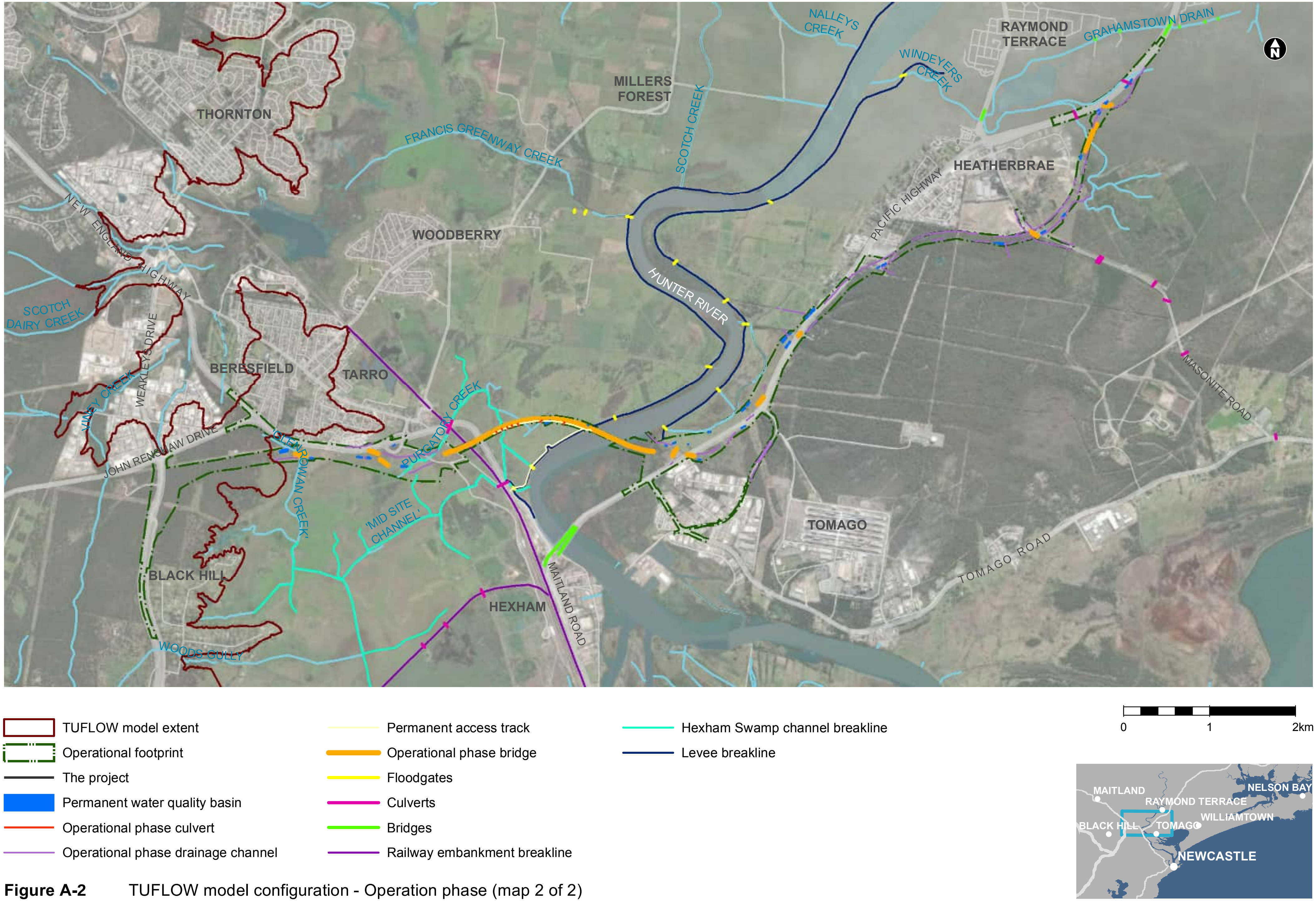
TUFLOW model extent
Operational footprint
The project
Permanent water quality basin
Operational phase culvert
Operational phase drainage channel
Permanent access track
Operational phase bridge
River inflow
Downstream boundary
Floodgates
Culverts
Bridges
Railway embankment breakline
Hexham Swamp channel breakline
Levee breakline

0 4 8km

Figure A-2 TUFLOW model configuration - Operation phase (map 1 of 2)



TUFLOW model extent
Operational footprint
The project
Permanent water quality basin
Operational phase culvert
Operational phase drainage channel
Permanent access track
Operational phase bridge
Floodgates
Culverts
Bridges
Railway embankment breakline
Hexham Swamp channel breakline
Levee breakline

Figure A-2 TUFLOW model configuration - Operation phase (map 2 of 2)

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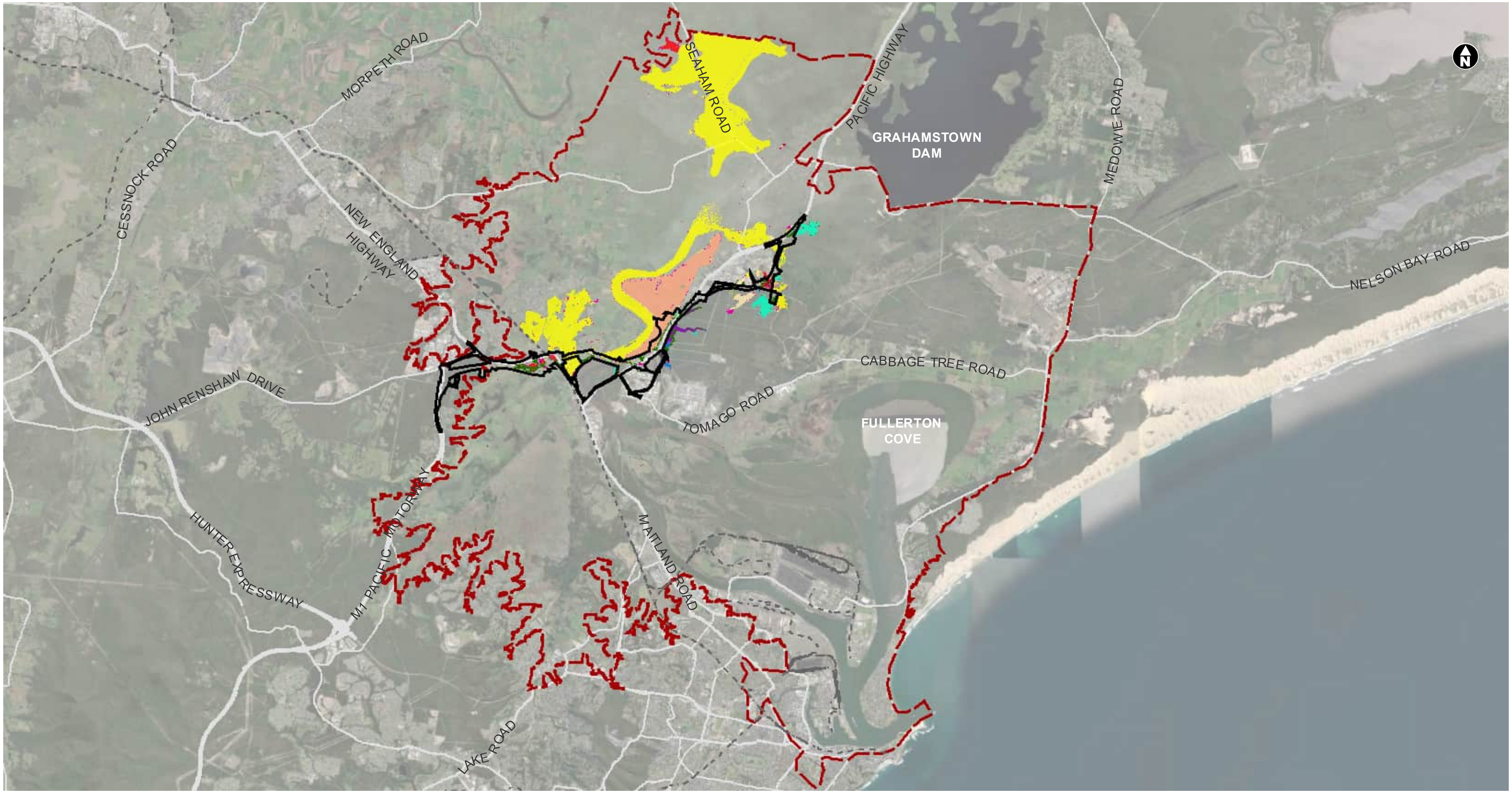
Appendix B. Updated Flood Impact Mapping – Construction



Flooding study area
Construction footprint
Railway

Change in flood level from existing case (m)

- < -0.4
- -0.4 - -0.25
- -0.25 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01 (not shown)
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.4
- > 0.4

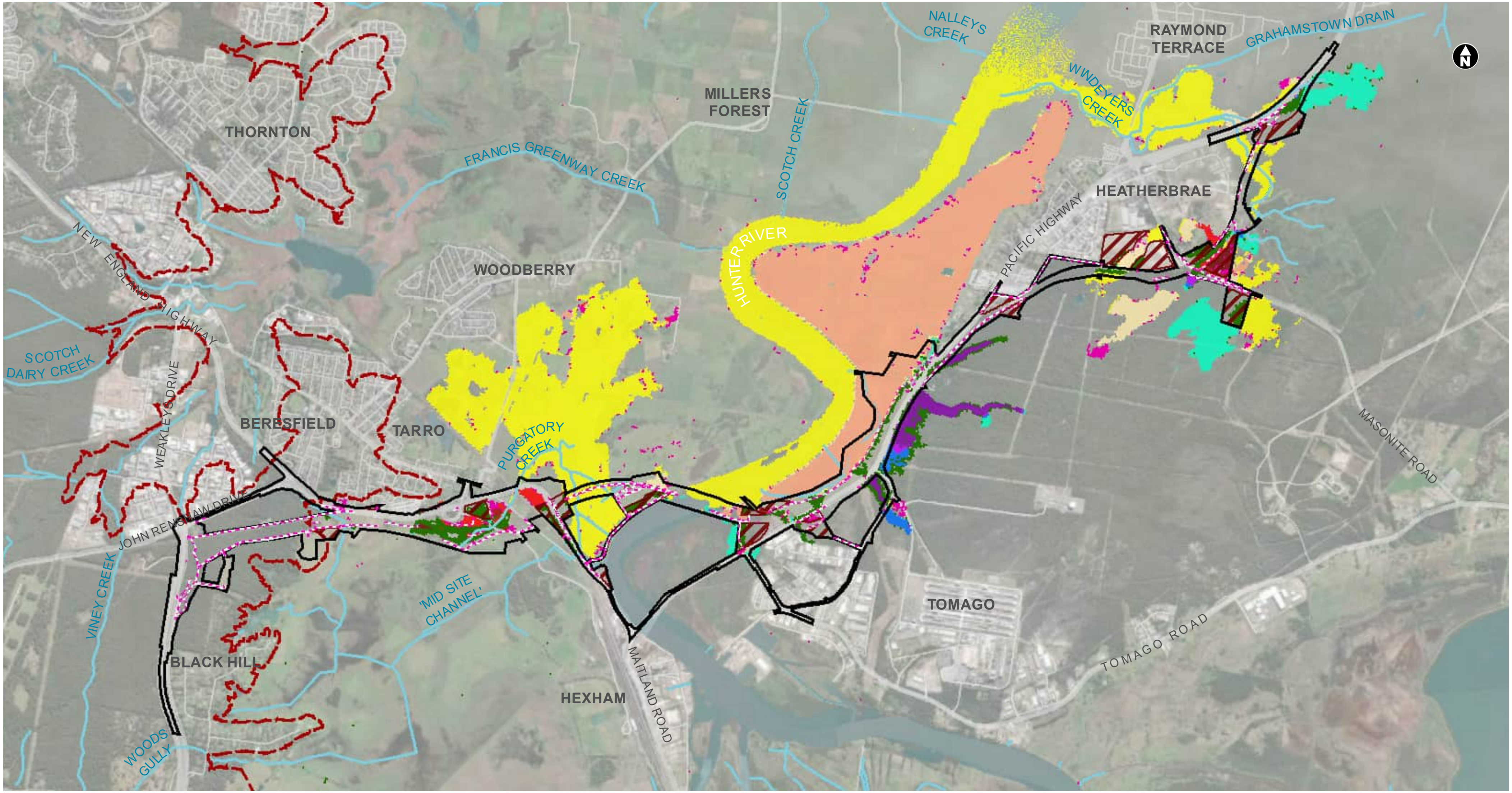
Change - Wet and Dry

- Was Wet Now Dry
- Was Dry Now Wet

0 4 8km

Figure B-1 Change in flood level - Construction phase - 20% AEP (map 1 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report\IA230000_CD_HF_Supp_B-1_ChangeFloodLevel_Construction_20_AEP_JAC_A4L_175000_V01.mxd



Flooding study area

Construction footprint

Ancillary facility

Access and haulage roads

Change in flood level from existing case (m)

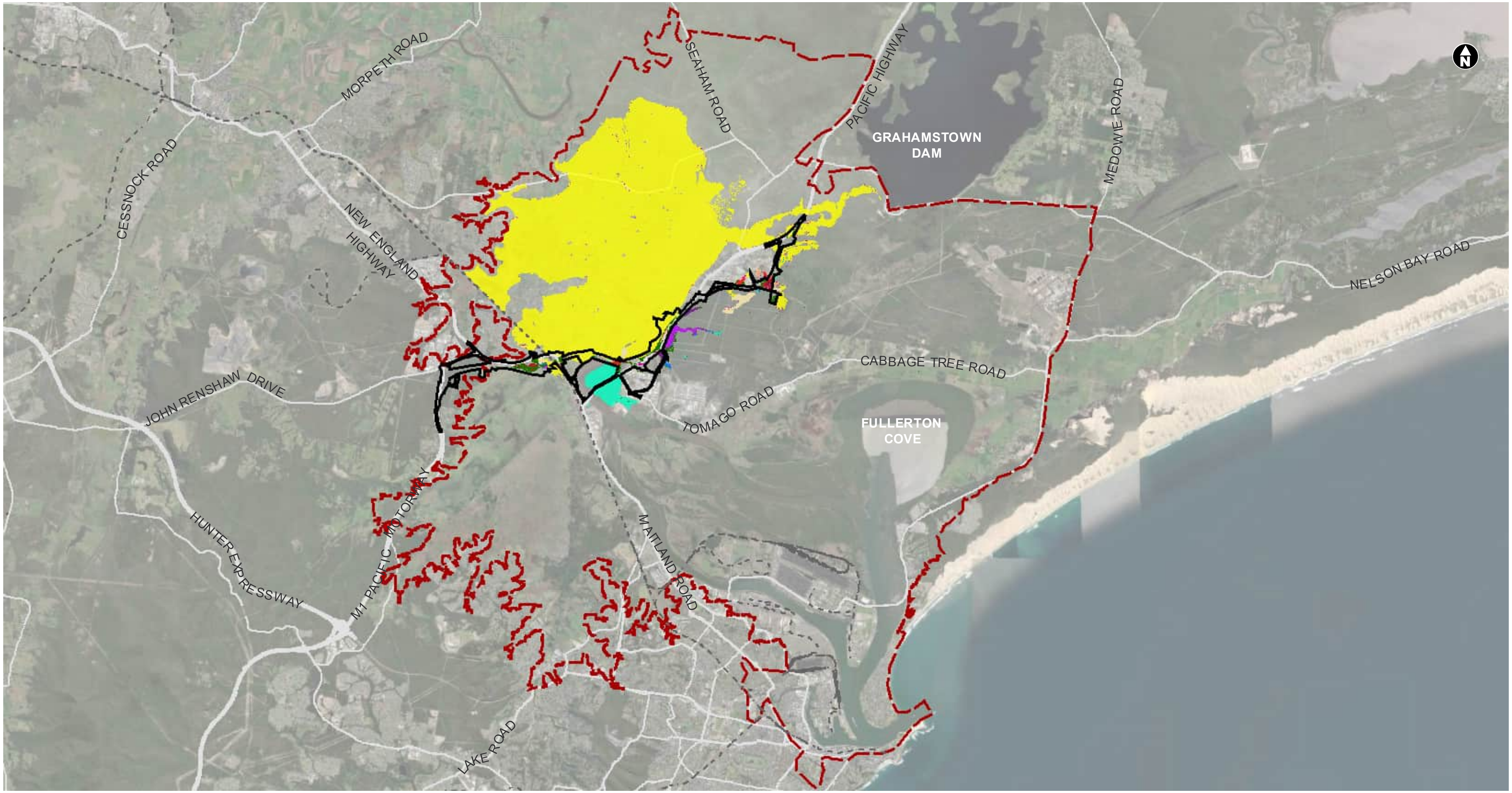
- < -0.4
- -0.4 - -0.25
- -0.25 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01 (not shown)
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.4
- > 0.4

Change - Wet and Dry

- Was Wet Now Dry
- Was Dry Now Wet

0 1 2km

Figure B-1 Change in flood level - Construction phase - 20% AEP (map 2 of 2)



Flooding study area
Construction footprint
Railway

Change in flood level from existing case (m)

- < -0.4
- -0.4 - -0.25
- -0.25 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01 (not shown)
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.4
- > 0.4

Change - Wet and Dry

- Was Wet Now Dry
- Was Dry Now Wet

0 4 8km

Figure B-2 Change in flood level - Construction phase - 10% AEP (map 1 of 2)

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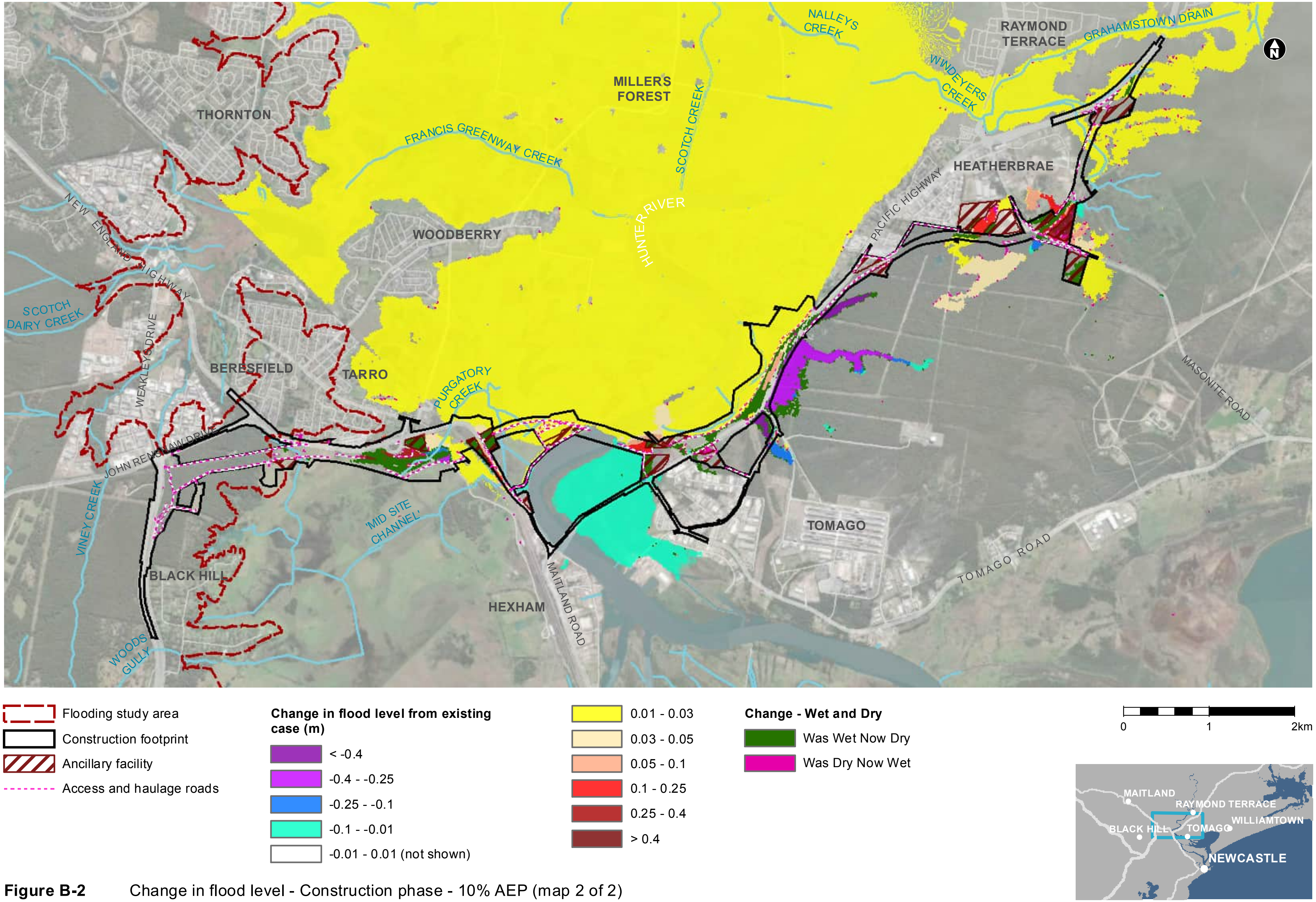

Figure B-2 Change in flood level - Construction phase - 10% AEP (map 2 of 2)

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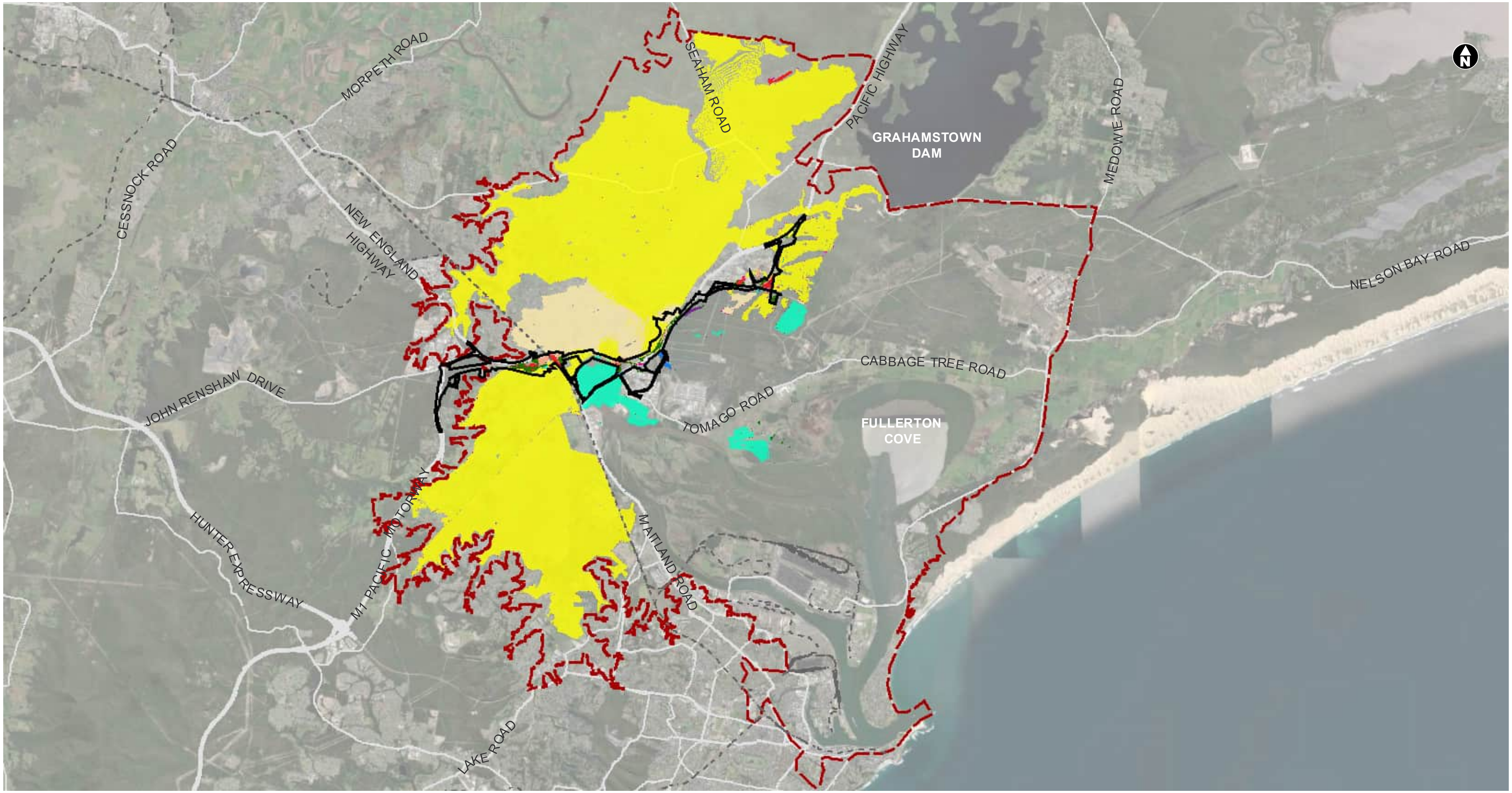


Flooding study area
Construction footprint
Railway

Change in flood level from existing case (m)

< -0.4
-0.4 - -0.25
-0.25 - -0.1
-0.1 - -0.01
-0.01 - 0.01 (not shown)
0.01 - 0.03
0.03 - 0.05
0.05 - 0.1
0.1 - 0.25
0.25 - 0.4
> 0.4

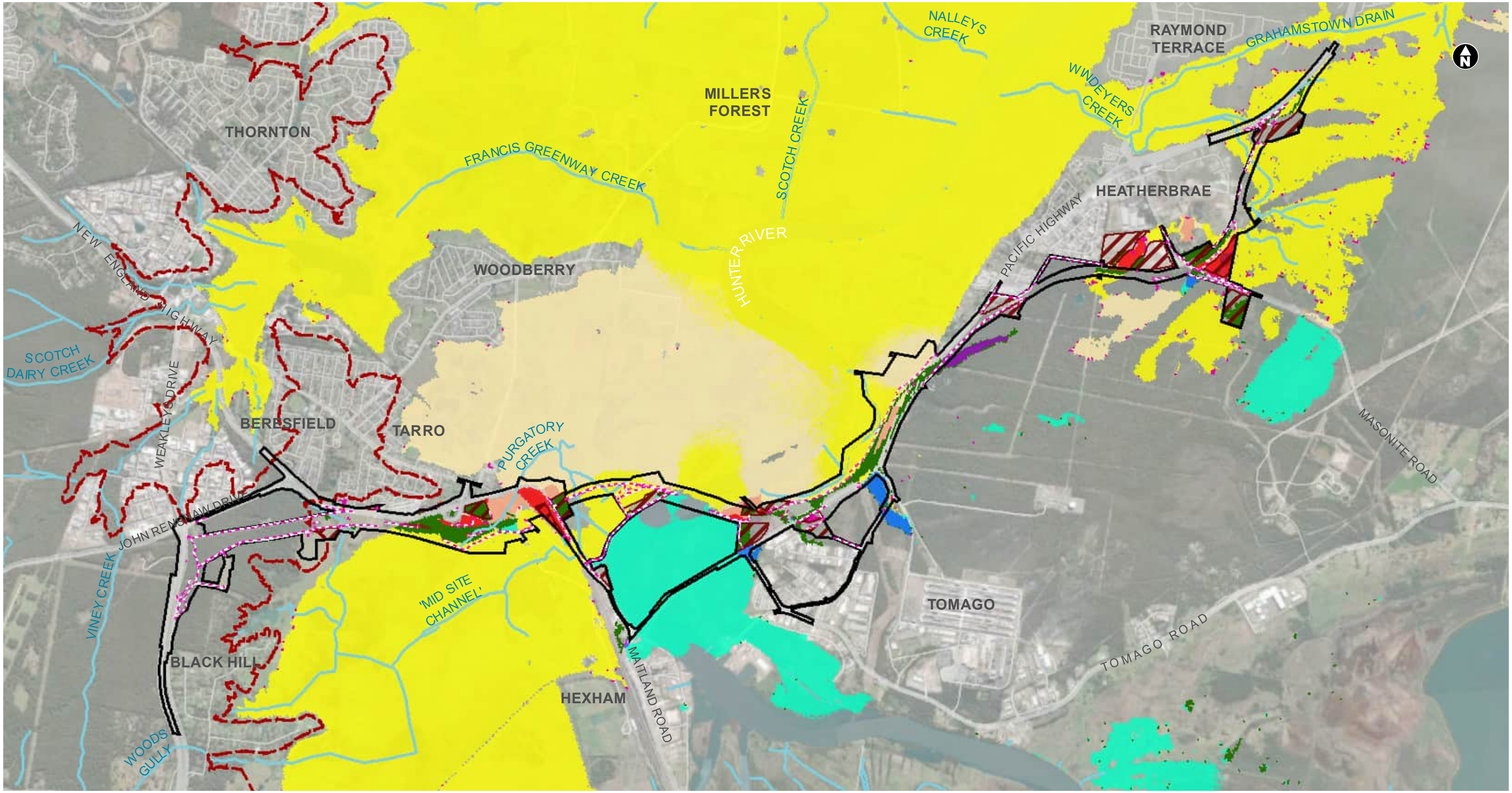
Change - Wet and Dry

Was Wet Now Dry
Was Dry Now Wet

0 4 8km

Figure B-3 Change in flood level - Construction phase - 5% AEP (map 1 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report\IA230000_CD_HF_Supp_B-3_ChangeFloodLevel_Construction_5_AEP_JAC_A4L_175000_V01.mxd



Flooding study area

Construction footprint

Ancillary facility

Access and haulage roads

Change in flood level from existing case (m)

- < -0.4
- -0.4 - -0.25
- -0.25 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01 (not shown)
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.4
- > 0.4

Change - Wet and Dry

- Was Wet Now Dry
- Was Dry Now Wet

0 1 2km

Figure B-3 Change in flood level - Construction phase - 5% AEP (map 2 of 2)

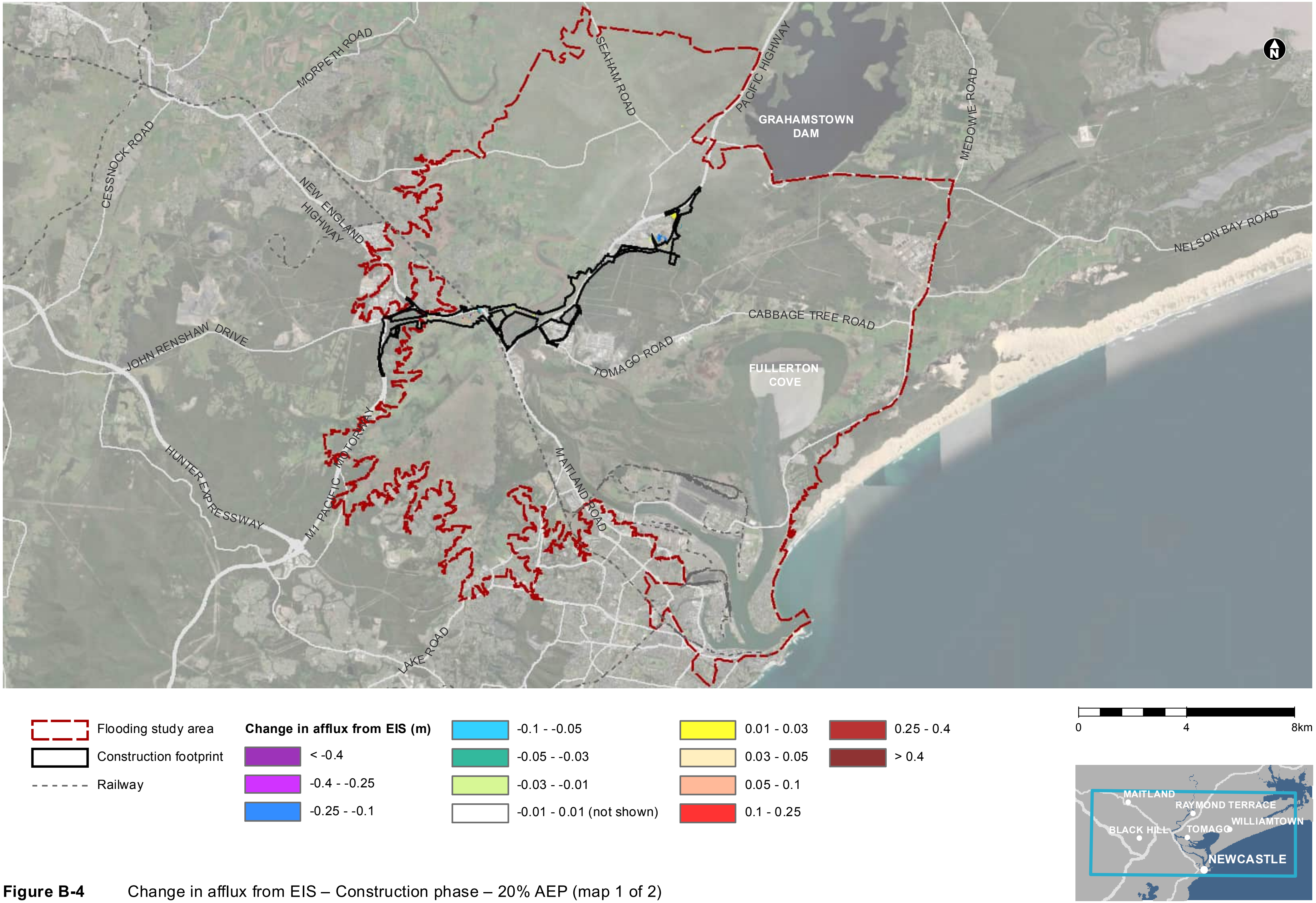


Figure B-4 Change in afflux from EIS – Construction phase – 20% AEP (map 1 of 2)

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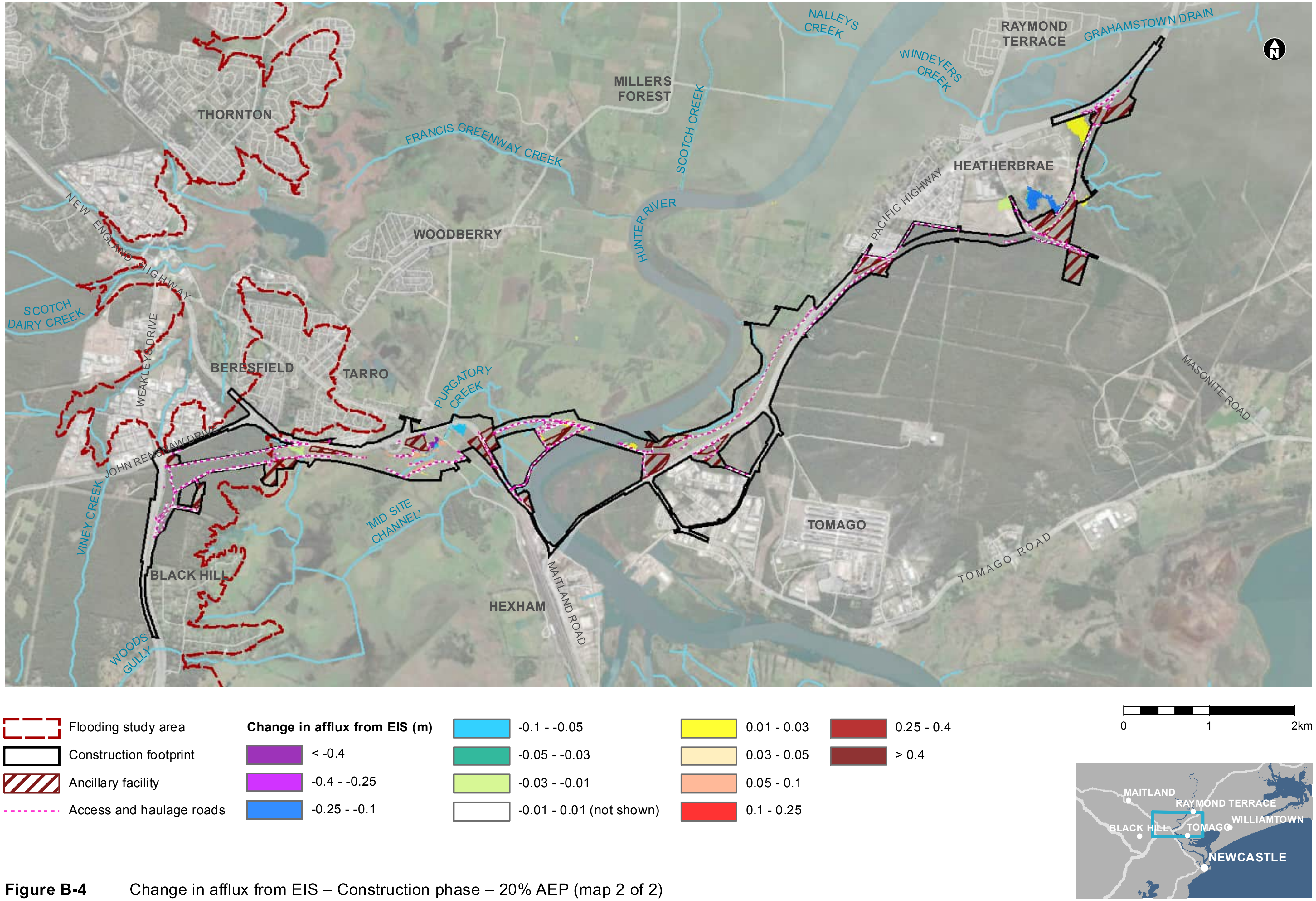

Figure B-4 Change in afflux from EIS – Construction phase – 20% AEP (map 2 of 2)

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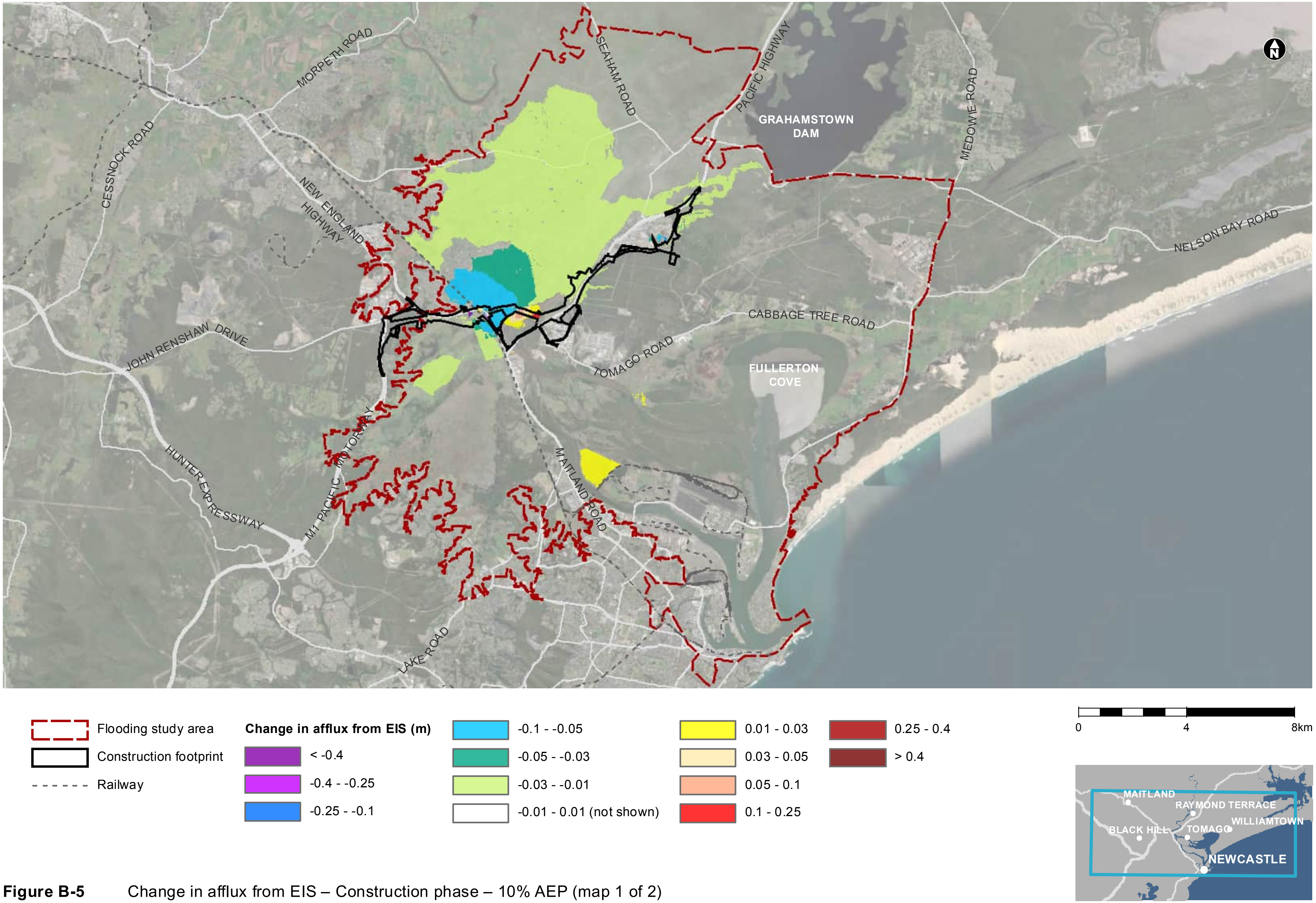

Flooding study area
Construction footprint
Railway

Change in afflux from EIS (m)

- < -0.4
- -0.4 - -0.25
- -0.25 - -0.1
- -0.1 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01
- -0.01 - 0.01 (not shown)
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.4
- > 0.4

Figure B-5 Change in afflux from EIS – Construction phase – 10% AEP (map 1 of 2)

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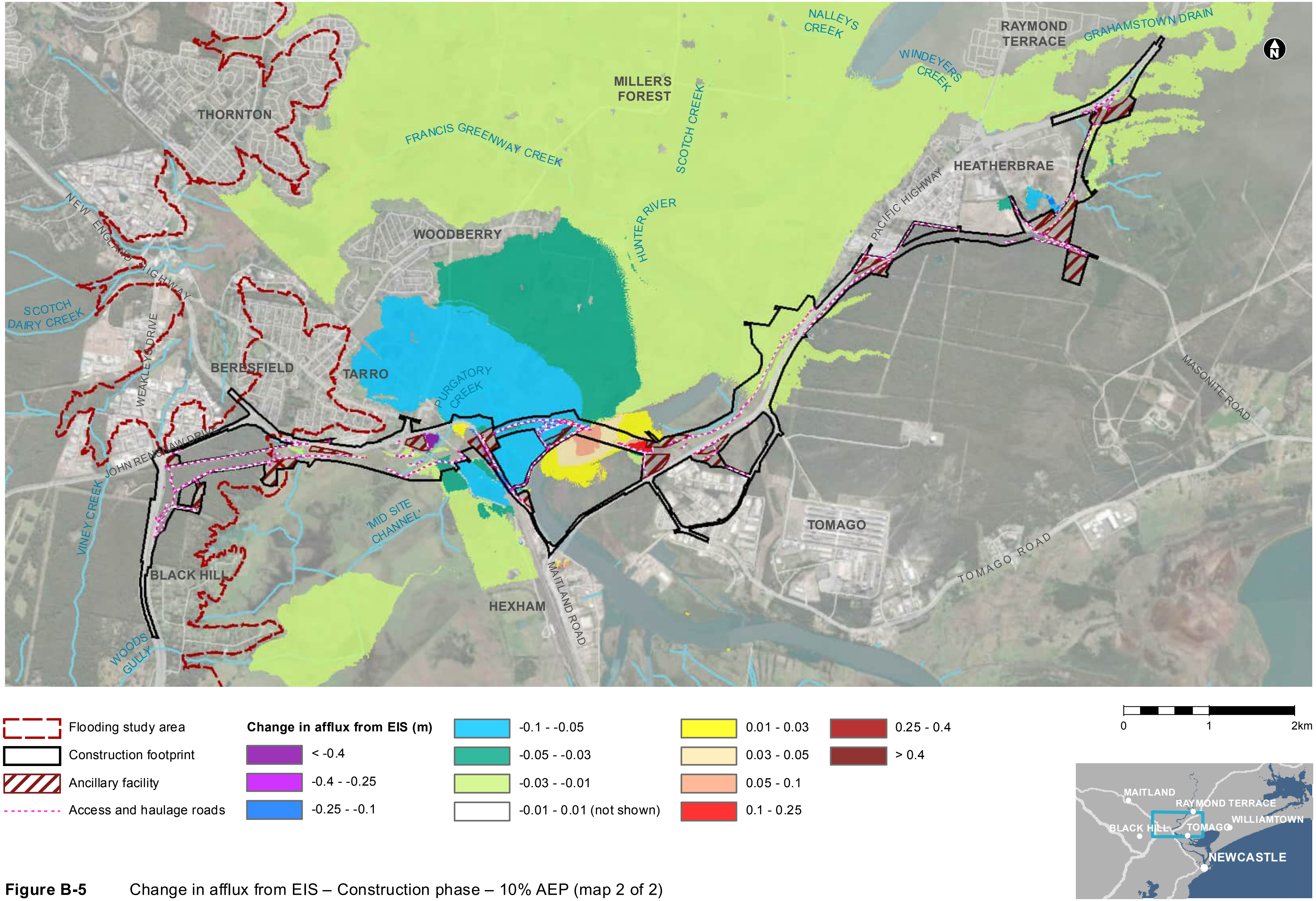

Figure B-5 Change in afflux from EIS – Construction phase – 10% AEP (map 2 of 2)

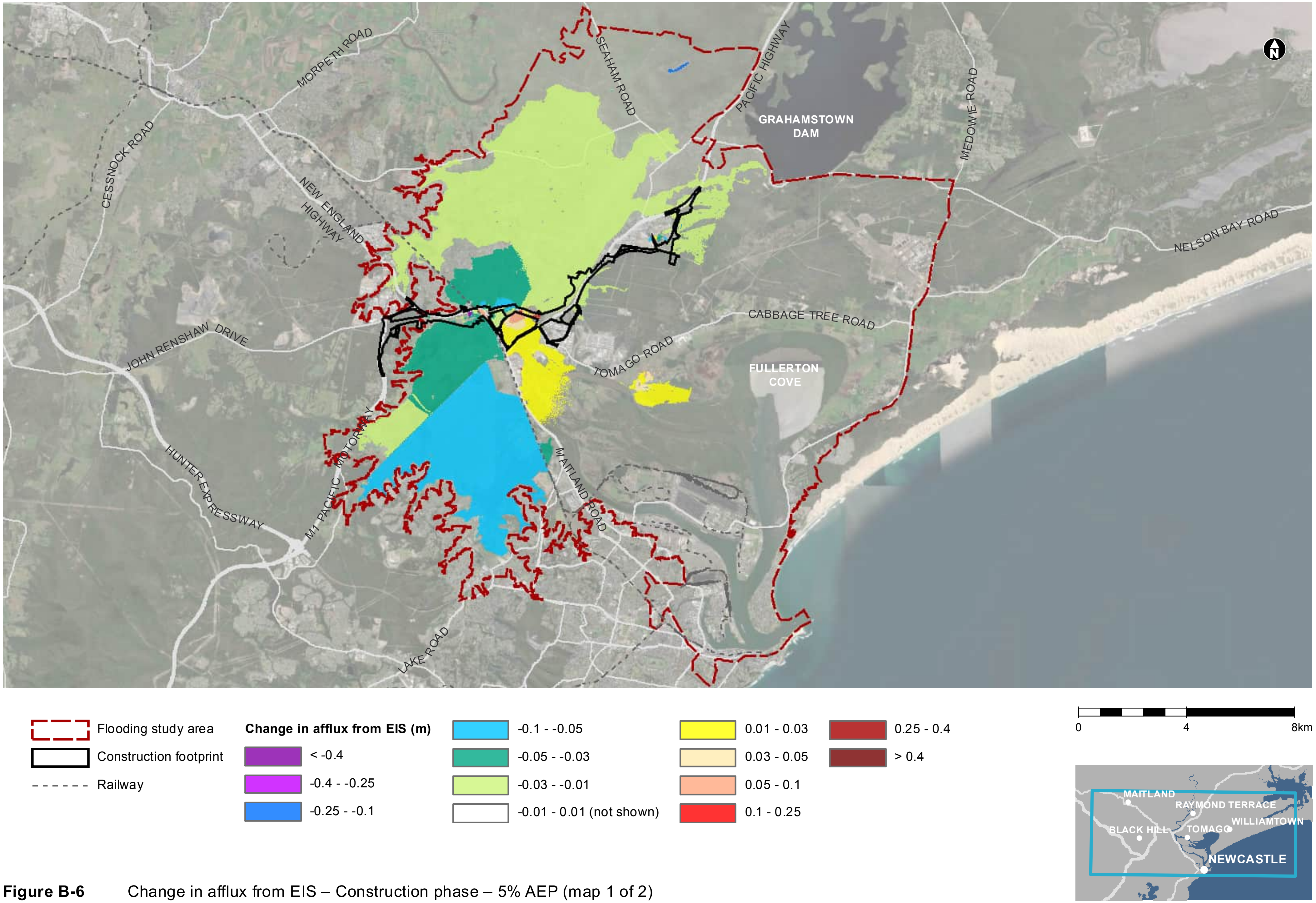

Figure B-6 Change in afflux from EIS – Construction phase – 5% AEP (map 1 of 2)

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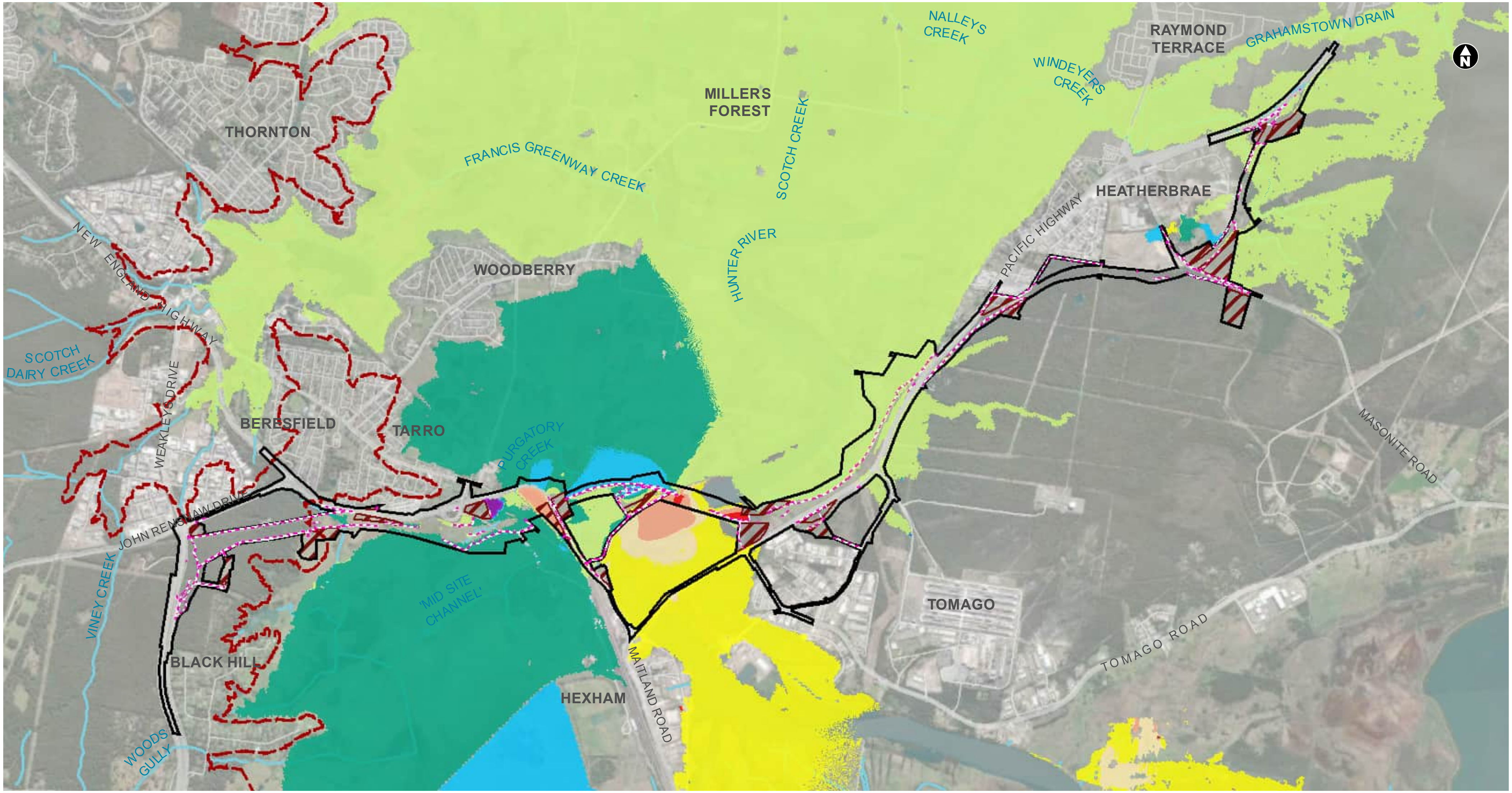


Flooding study area

Construction footprint

Ancillary facility

Access and haulage roads

Change in afflux from EIS (m)

< -0.4

-0.4 - -0.25

-0.25 - -0.1

-0.1 - -0.05

-0.05 - -0.03

-0.03 - -0.01

-0.01 - 0.01 (not shown)

0.01 - 0.03

0.03 - 0.05

0.05 - 0.1

0.1 - 0.25

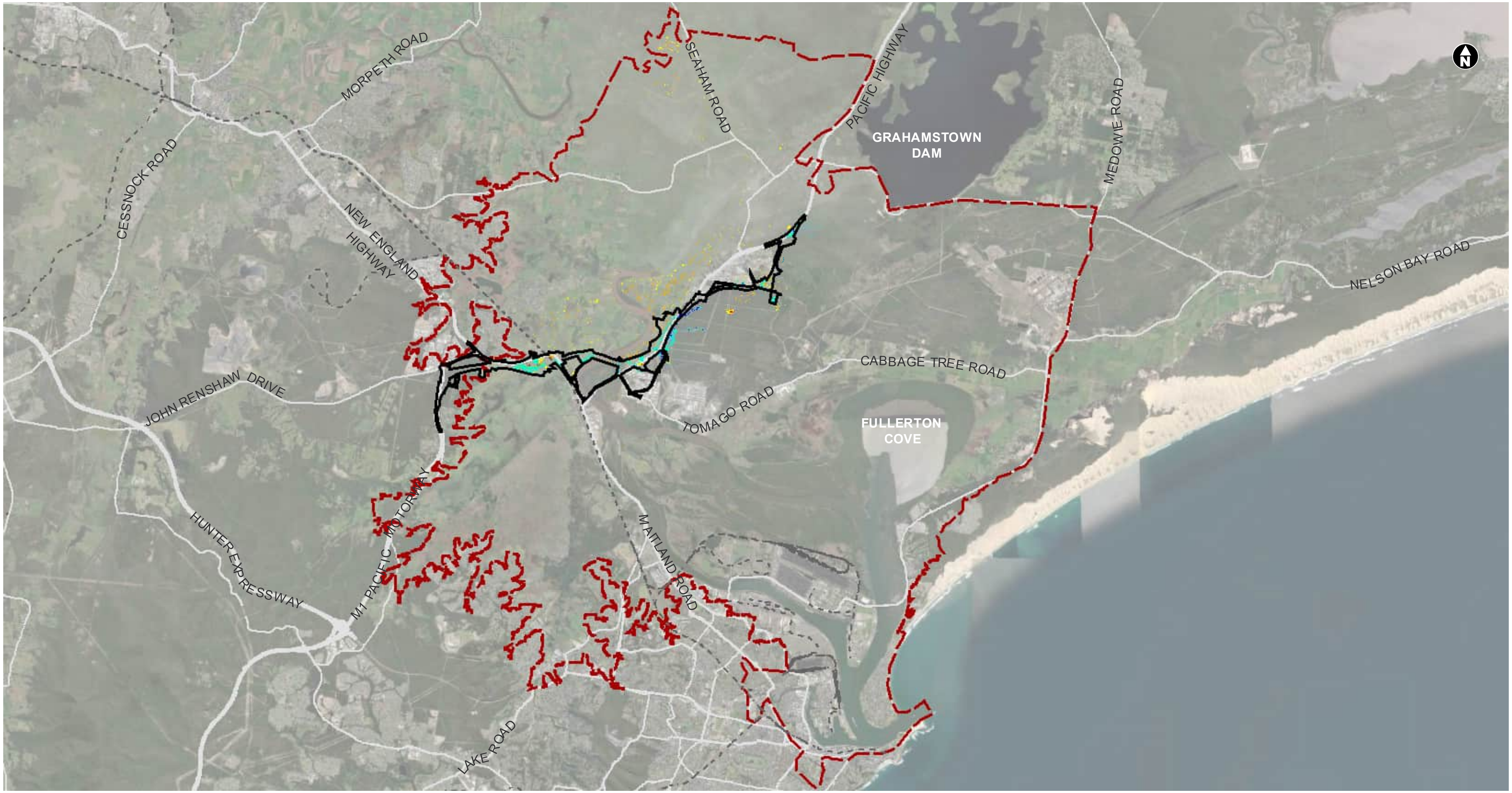
0.25 - 0.4

> 0.4

0 1 2km

Figure B-6 Change in afflux from EIS – Construction phase – 5% AEP (map 2 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\IA230000_CD_HFSupp_B-6_ChangeAfflux5Construction_JAC_A4L_175000_V02.mxd



Flooding study area
Construction footprint
Railway

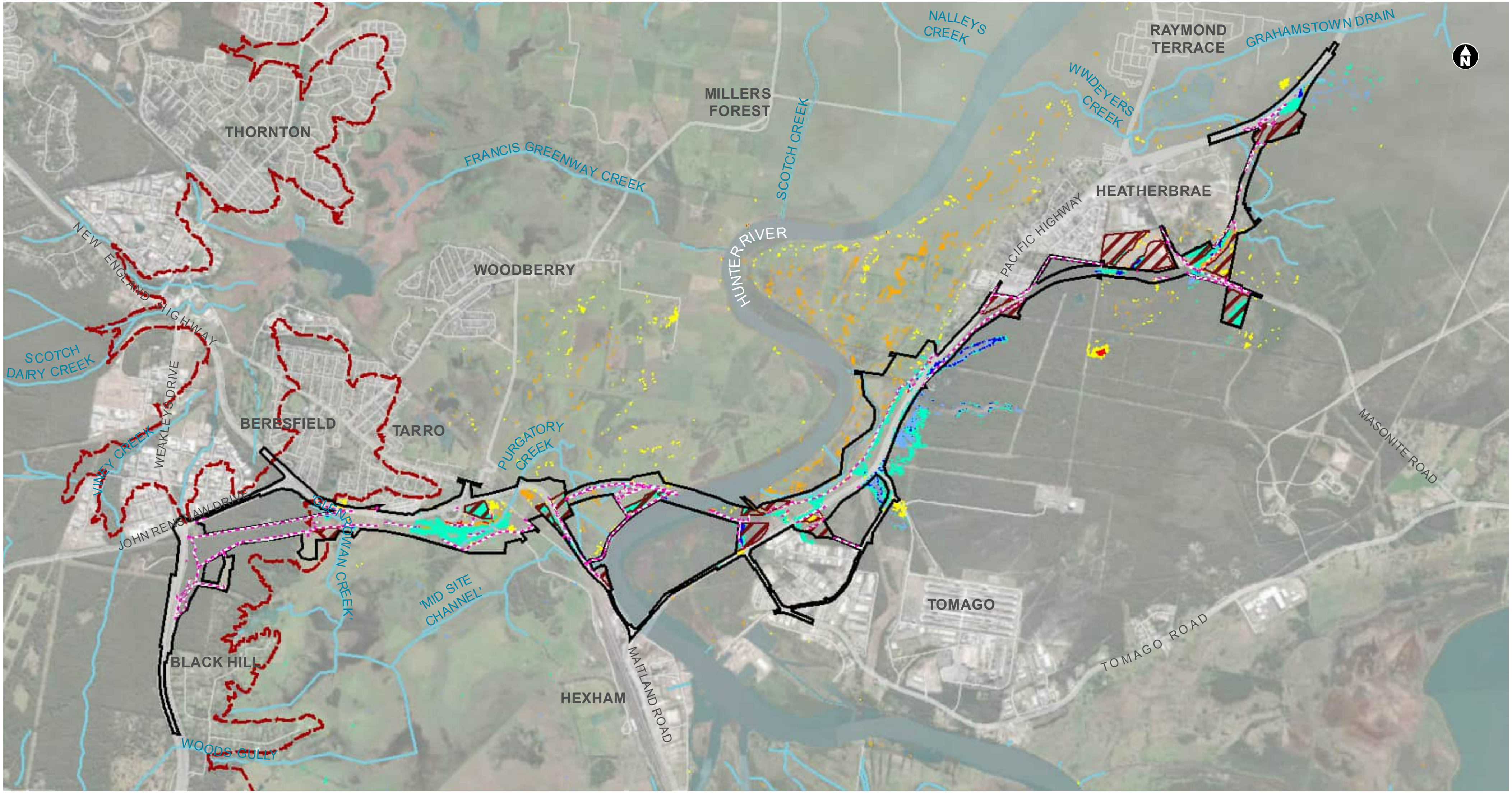
Change in hazard from existing case

Was high, now dry
Was high, now low
Was low, now dry

Unchanged (not shown)
Was dry, now low
Was low, now high
Was dry, now high

0 4 8km

Figure B-7 Change in flood hazard - Construction phase - 20% AEP (map 1 of 2)



Flooding study area	
Construction footprint	
Ancillary facility	
Access and haulage roads	

Change in hazard from existing case

- Was high, now dry
- Was high, now low
- Was low, now dry
- Unchanged (not shown)
- Was dry, now low
- Was low, now high
- Was dry, now high

0 1 2km

Figure B-7 Change in flood hazard - Construction phase - 20% AEP (map 2 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report\IA230000_CD_HF_B-7_ChangeFloodhazard_Construction_20_AEP_JAC_A4L_175000_V01.mxd

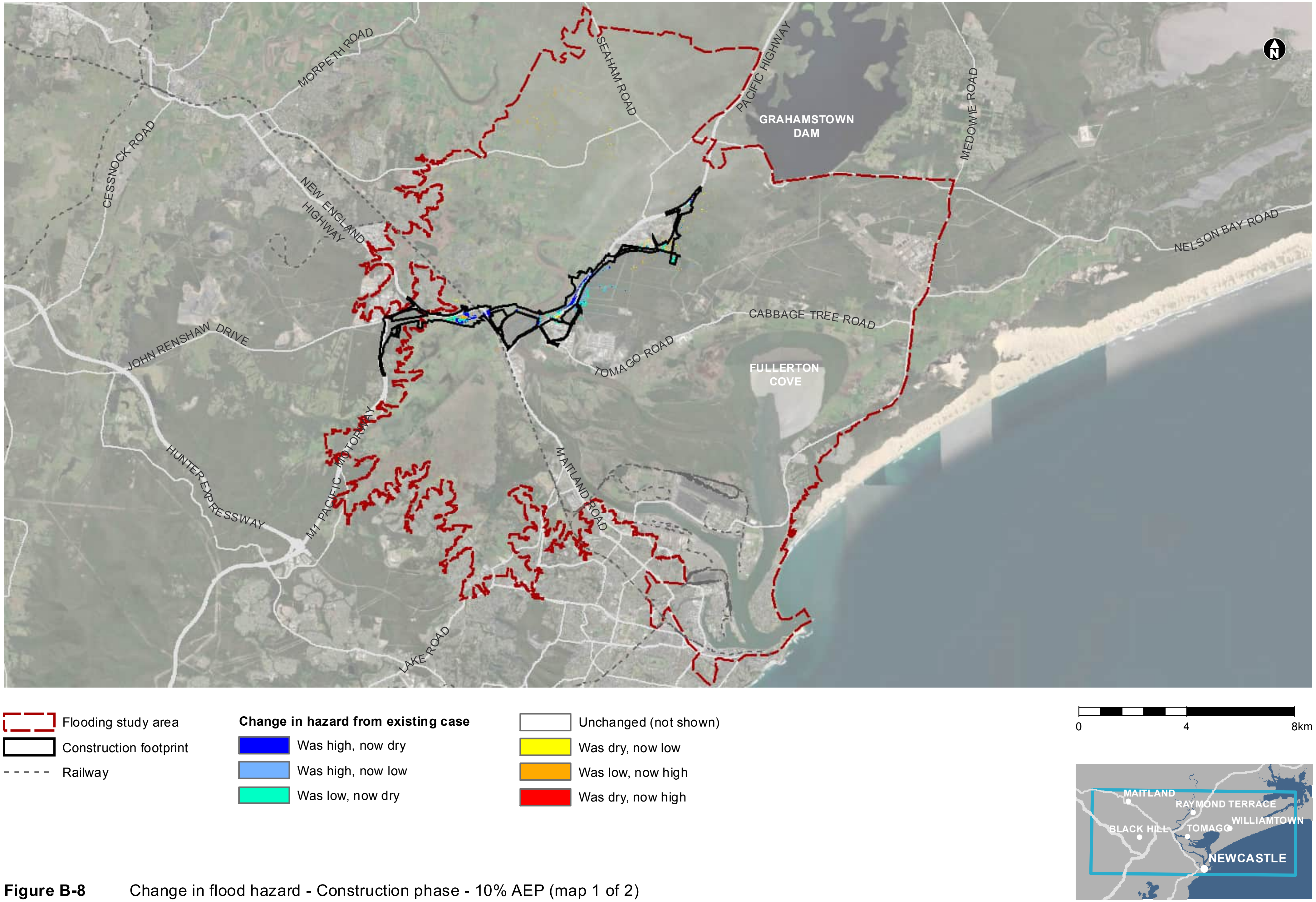
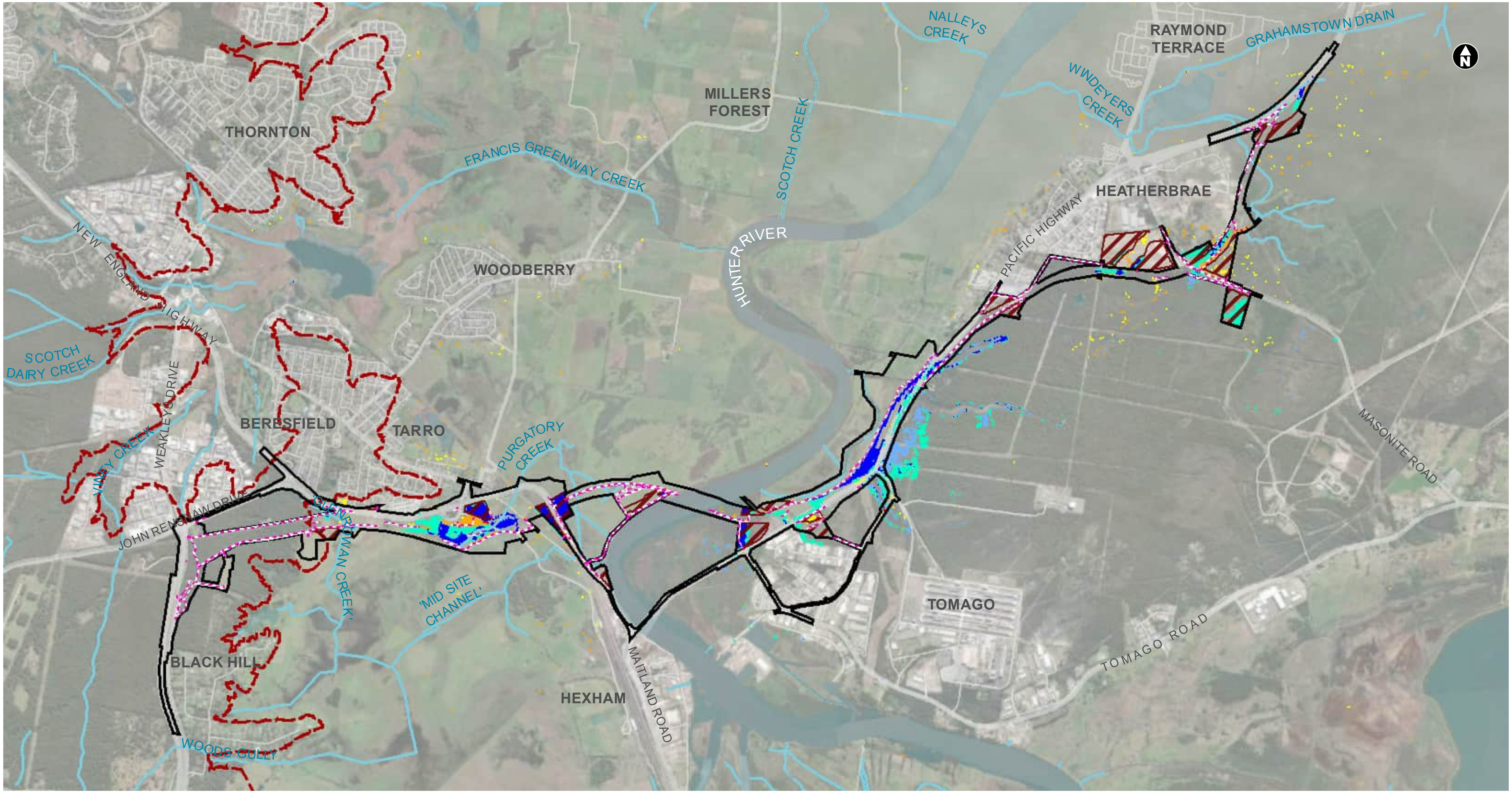


Figure B-8 Change in flood hazard - Construction phase - 10% AEP (map 1 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report\IA230000_CD_HF_B-8_ChangeFloodhazard_Construction_10_AEP_JAC_A4L_175000_V01.mxd



Flooding study area	**Change in hazard from existing case**	Unchanged (not shown)
Construction footprint	Was high, now dry	Was dry, now low
Ancillary facility	Was high, now low	Was low, now high
Access and haulage roads	Was low, now dry	Was dry, now high

Figure B-8 Change in flood hazard - Construction phase - 10% AEP (map 2 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report\IA230000_CD_HF_B-8_ChangeFloodhazard_Construction_10_AEP_JAC_A4L_175000_V01.mxd

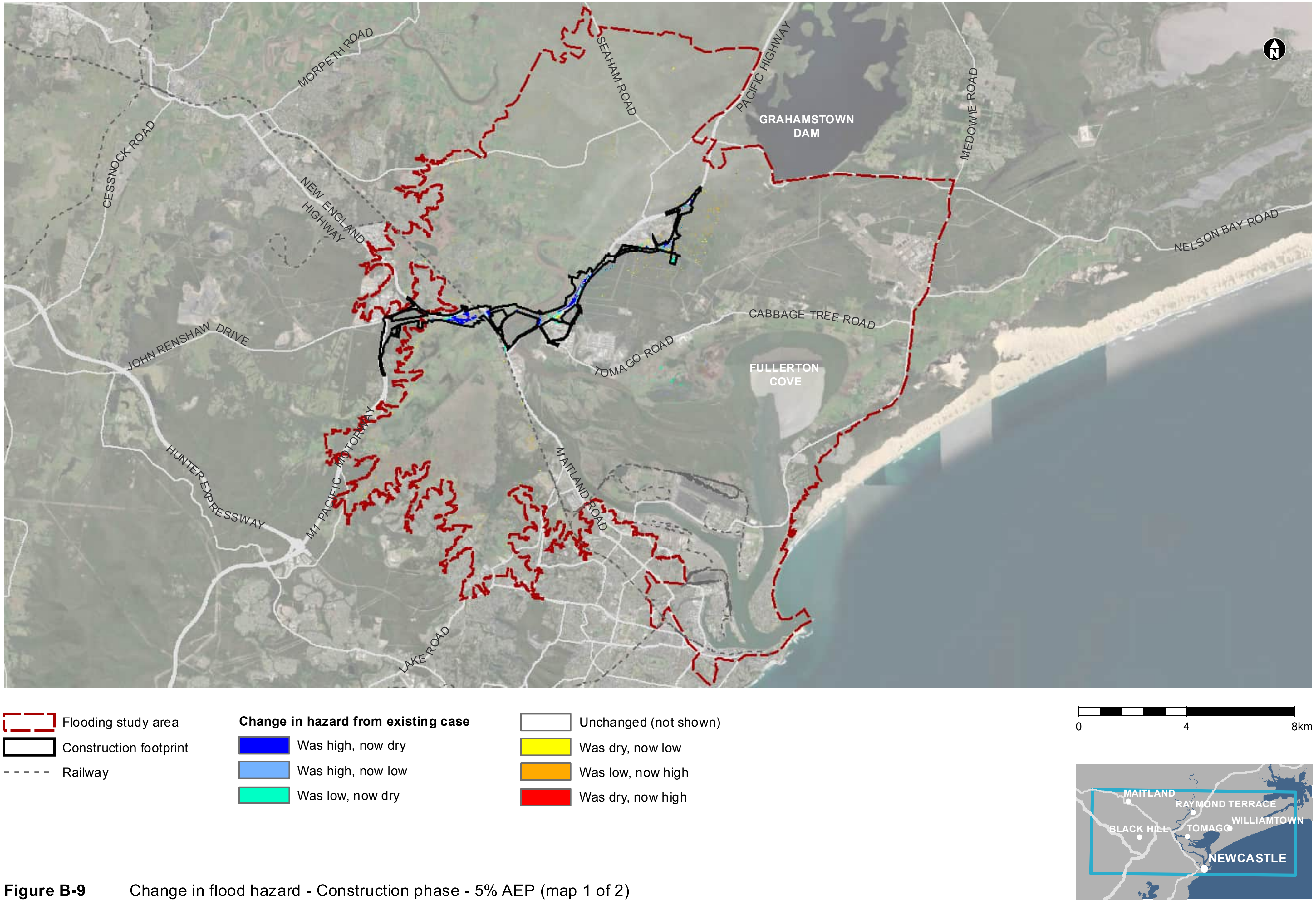
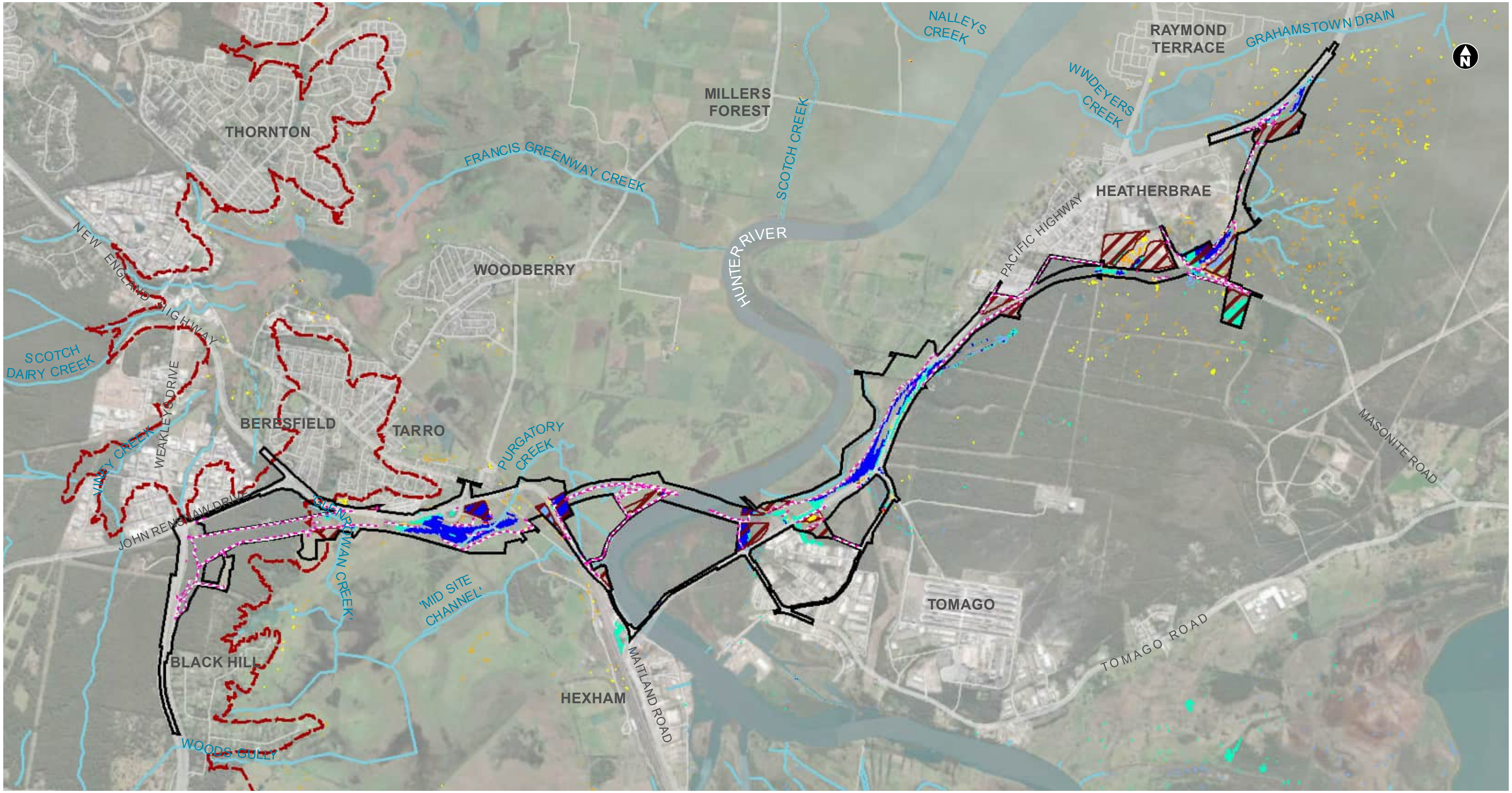


Figure B-9 Change in flood hazard - Construction phase - 5% AEP (map 1 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report\IA230000_CD_HF_B-9_ChangeFloodhazard_Construction_5_AEP_JAC_A4L_175000_V01.mxd



Flooding study area
Construction footprint
Ancillary facility
Access and haulage roads

Change in hazard from existing case

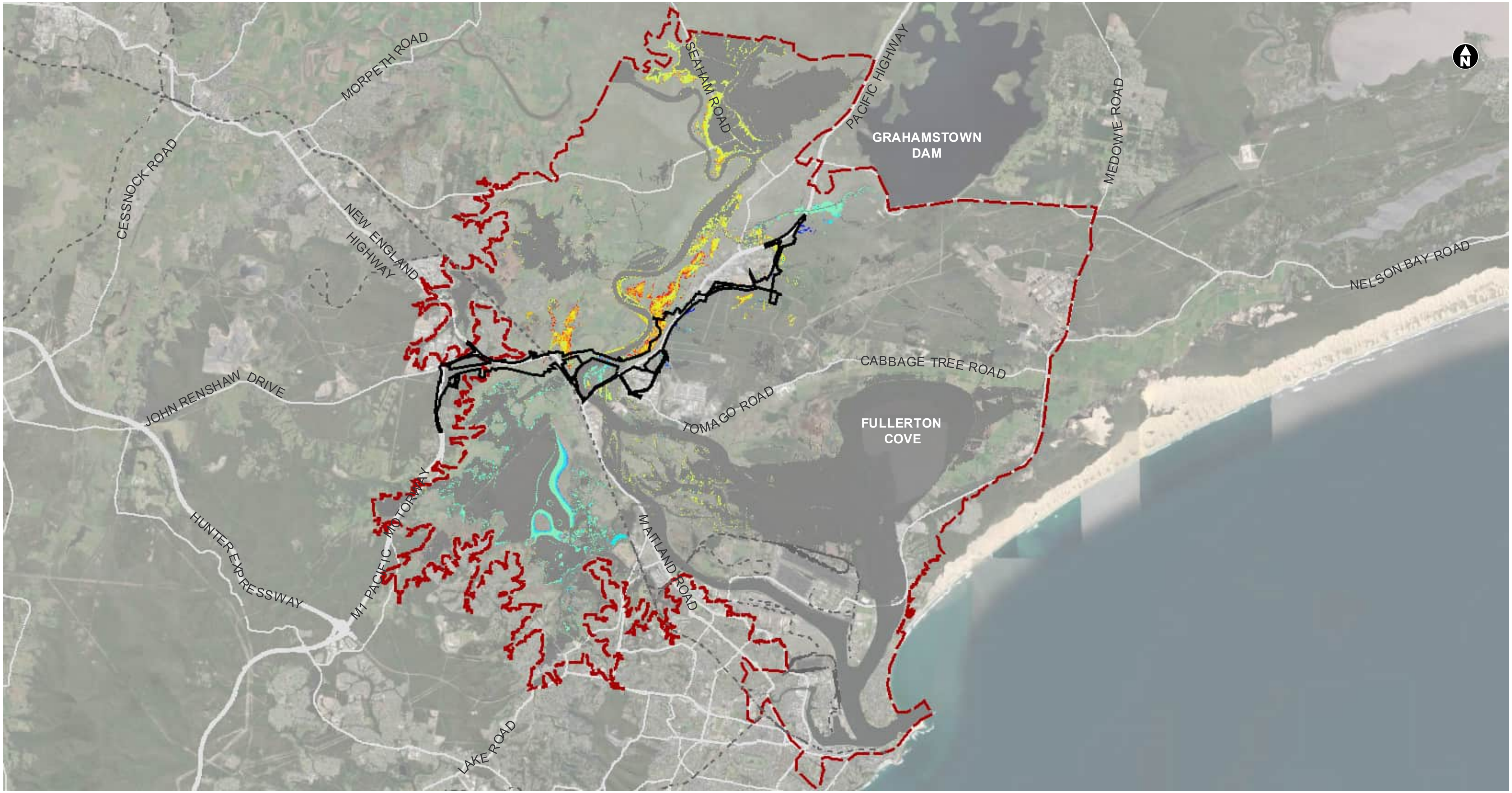
Was high, now dry
Was high, now low
Was low, now dry
Unchanged (not shown)
Was dry, now low
Was low, now high
Was dry, now high

0 1 2km

MAITLAND
RAYMOND TERRACE
WILLIAMTOWN
BLACK HILL
TOMAGO
NEWCASTLE

Figure B-9 Change in flood hazard - Construction phase - 5% AEP (map 2 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report\IA230000_CD_HF_B-9_ChangeFloodhazard_Construction_5_AEP_JAC_A4L_175000_V01.mxd



Flooding study area

Construction footprint

Railway

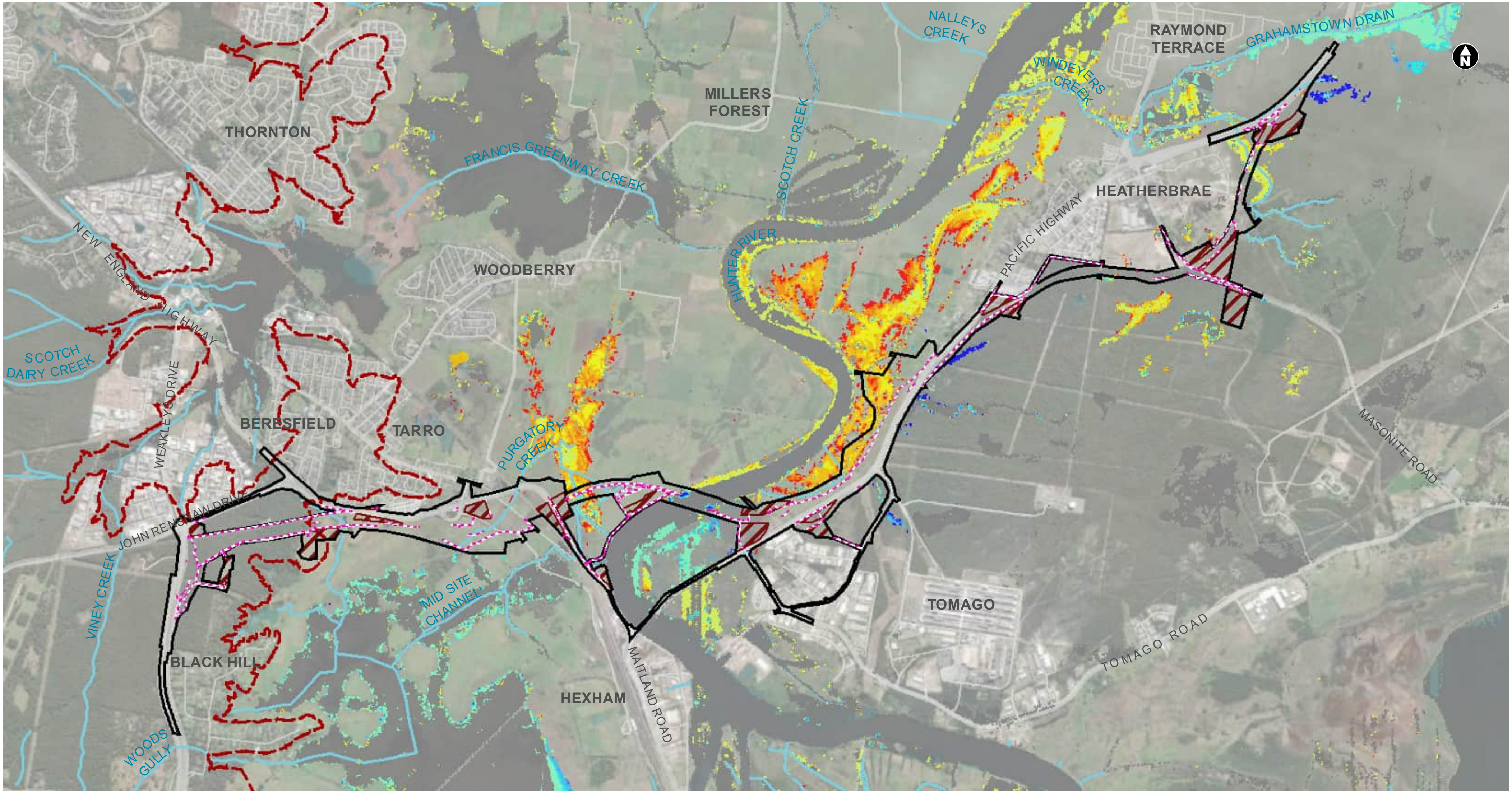
Change in duration of inundation from existing case (per cent)

< 50	-20 - -10
-50 - -30	-10 - -5
-30 - -20	-5 - -1
	-1 - 1
	1 - 5

5 - 10
10 - 20
20 - 30
30 - 50
> 50

0 4 8km

Figure B-10 Change in duration of inundation - Construction phase - 20% AEP (map 1 of 2)



Flooding study area
Construction footprint
Ancillary facility
Access and haulage roads

Change in duration of inundation from existing case (per cent)

< 50
-50 - -30
-30 - -20
-20 - -10
-10 - -5
-5 - -1
-1 - 1
1 - 5
5 - 10
10 - 20
20 - 30
30 - 50
> 50

0 1 2km

MAITLAND
RAYMOND TERRACE
WILLIAMTOWN
BLACK HILL
TOMAGO
NEWCASTLE

Figure B-10 Change in duration of inundation - Construction phase - 20% AEP

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\V02\IA230000_CD_HF_Supp_B-10_ChangeInundatonDuration20Construction_JAC_A4L_175000_V02.mxd

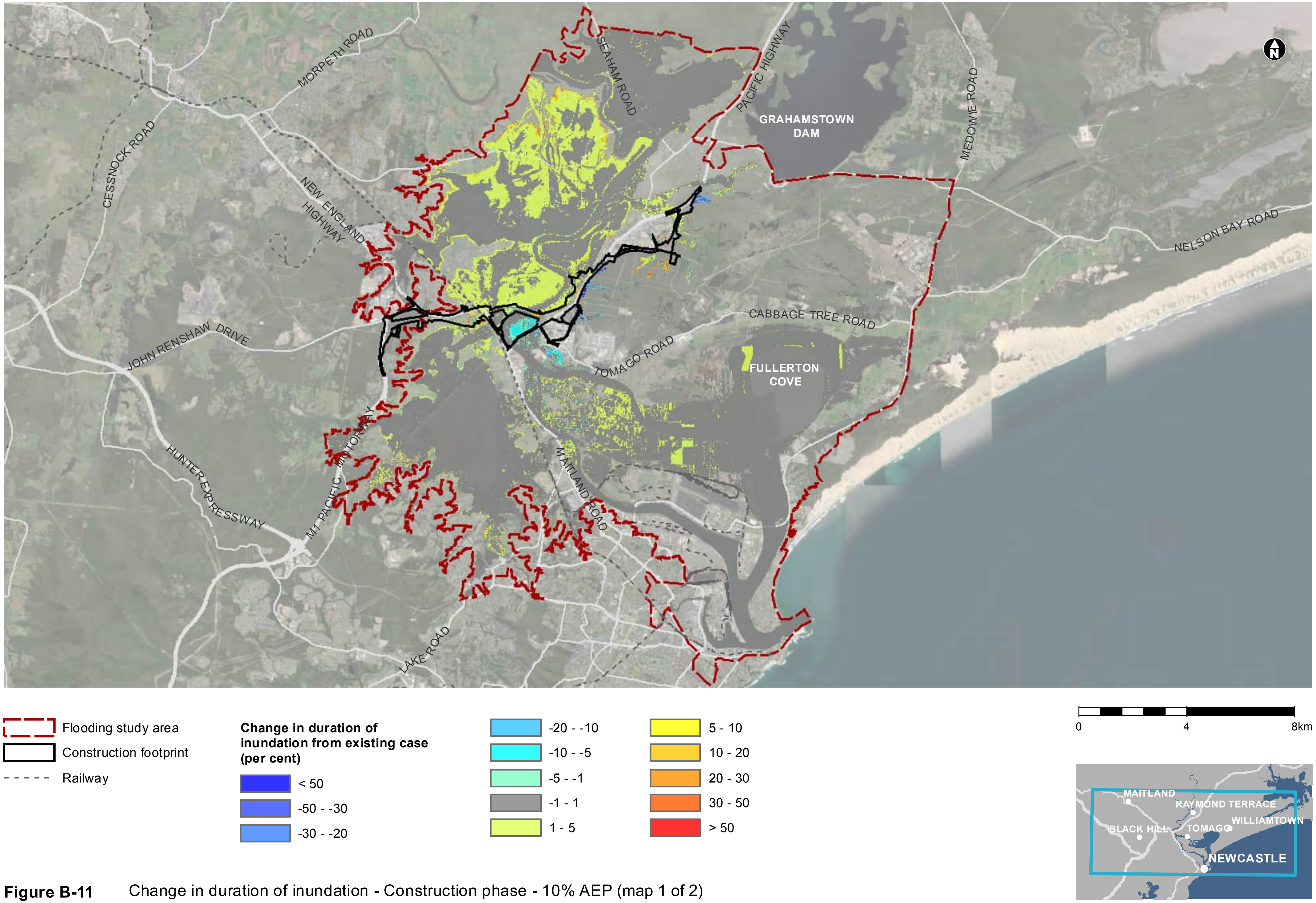


Figure B-11 Change in duration of inundation - Construction phase - 10% AEP (map 1 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\V02\IA230000_CD_HF_Supp_B-11_ChangeInundatonDuration10Construction_JAC_A4L_175000_V02.mxd

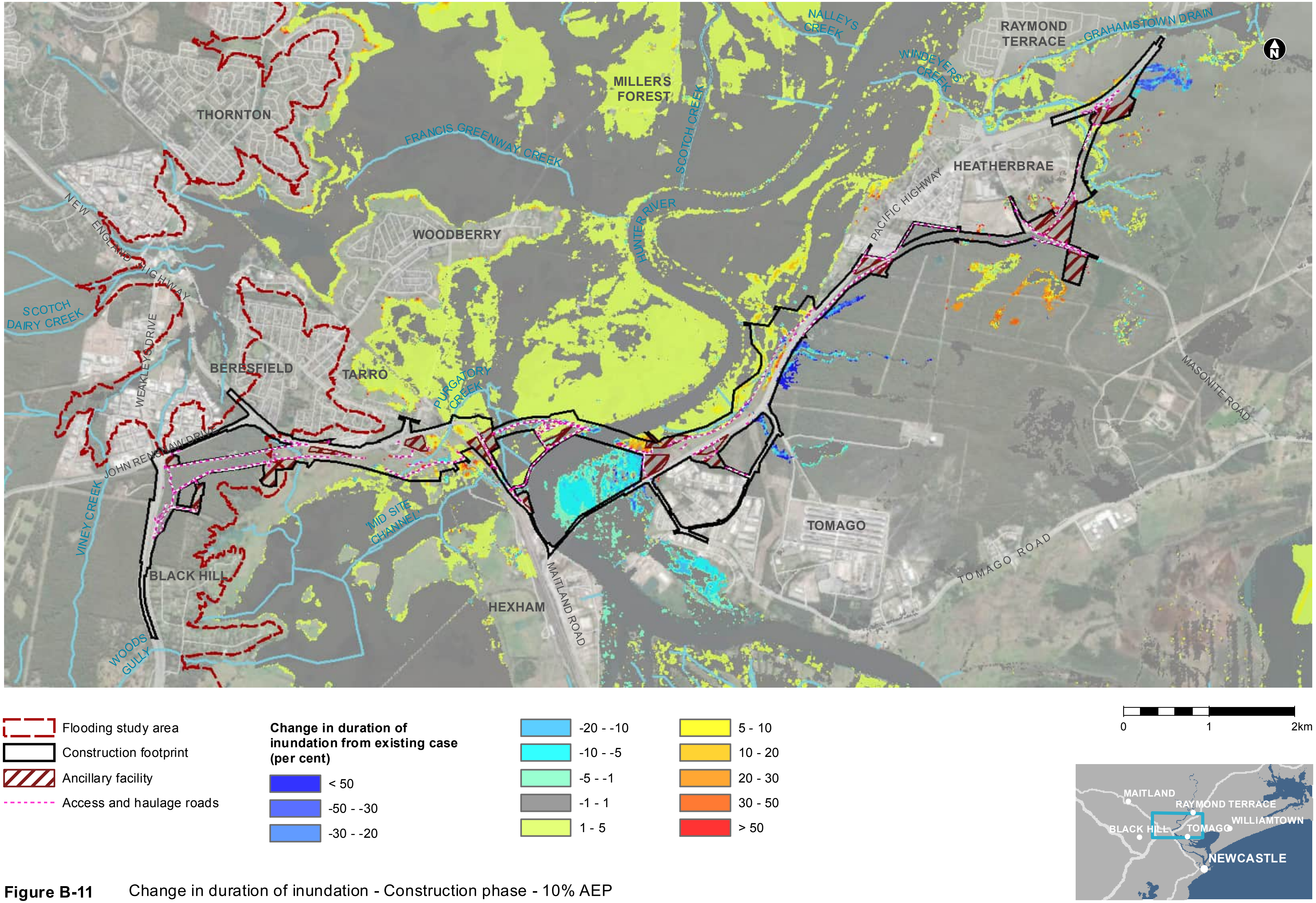
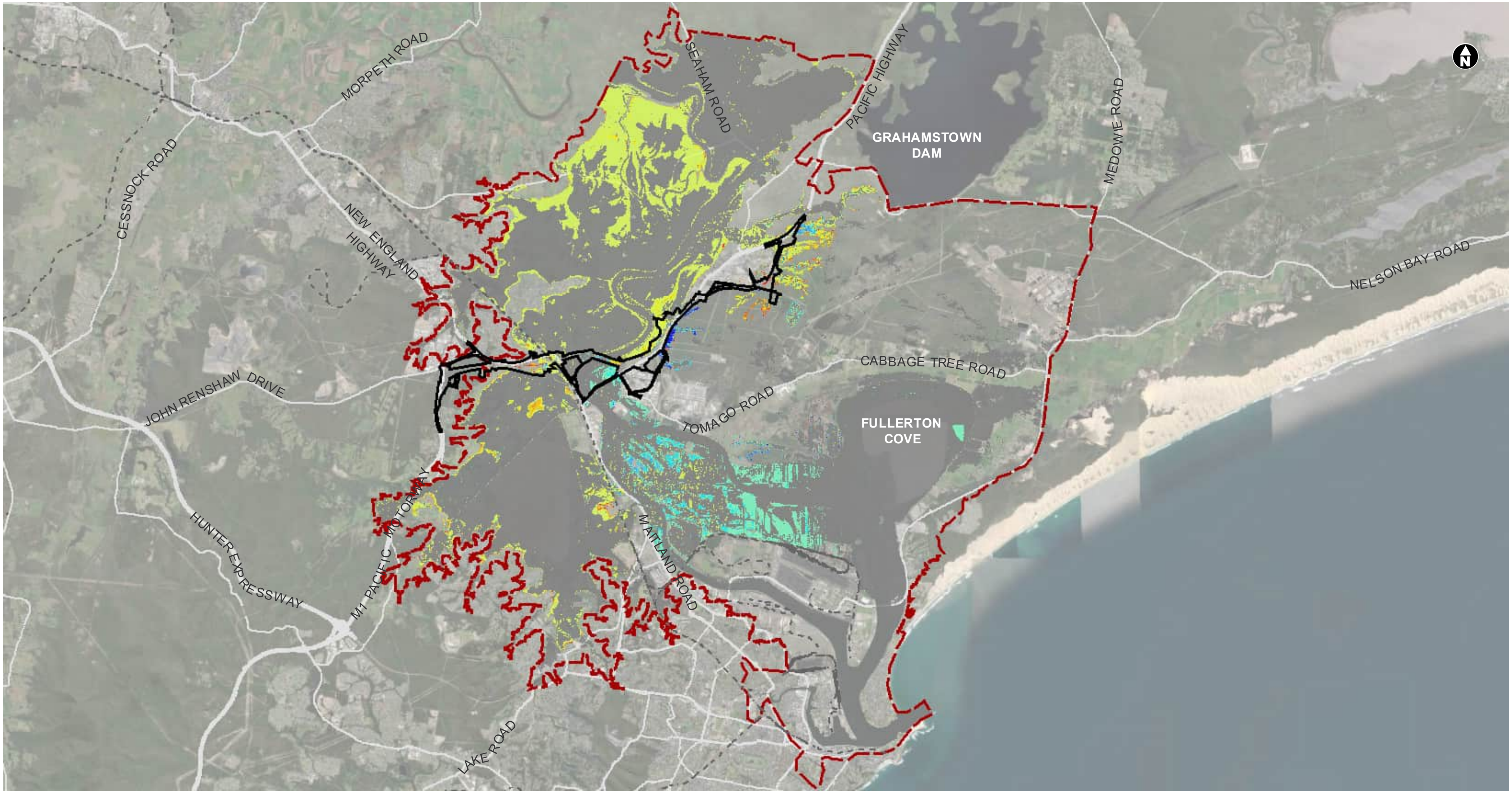


Figure B-11 Change in duration of inundation - Construction phase - 10% AEP

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\V02\IA230000_CD_HF_Supp_B-11_ChangeInundatonDuration10Construction_JAC_A4L_175000_V02.mxd



- Flooding study area
- Construction footprint
- Railway

Change in duration of inundation from existing case (per cent)

- < 50
- -50 - -30
- -30 - -20
- -20 - -10
- -10 - -5
- -5 - -1
- -1 - 1
- 1 - 5
- 5 - 10
- 10 - 20
- 20 - 30
- 30 - 50
- > 50

Figure B-12 Change in duration of inundation - Construction phase - 5% AEP (map 1 of 2)

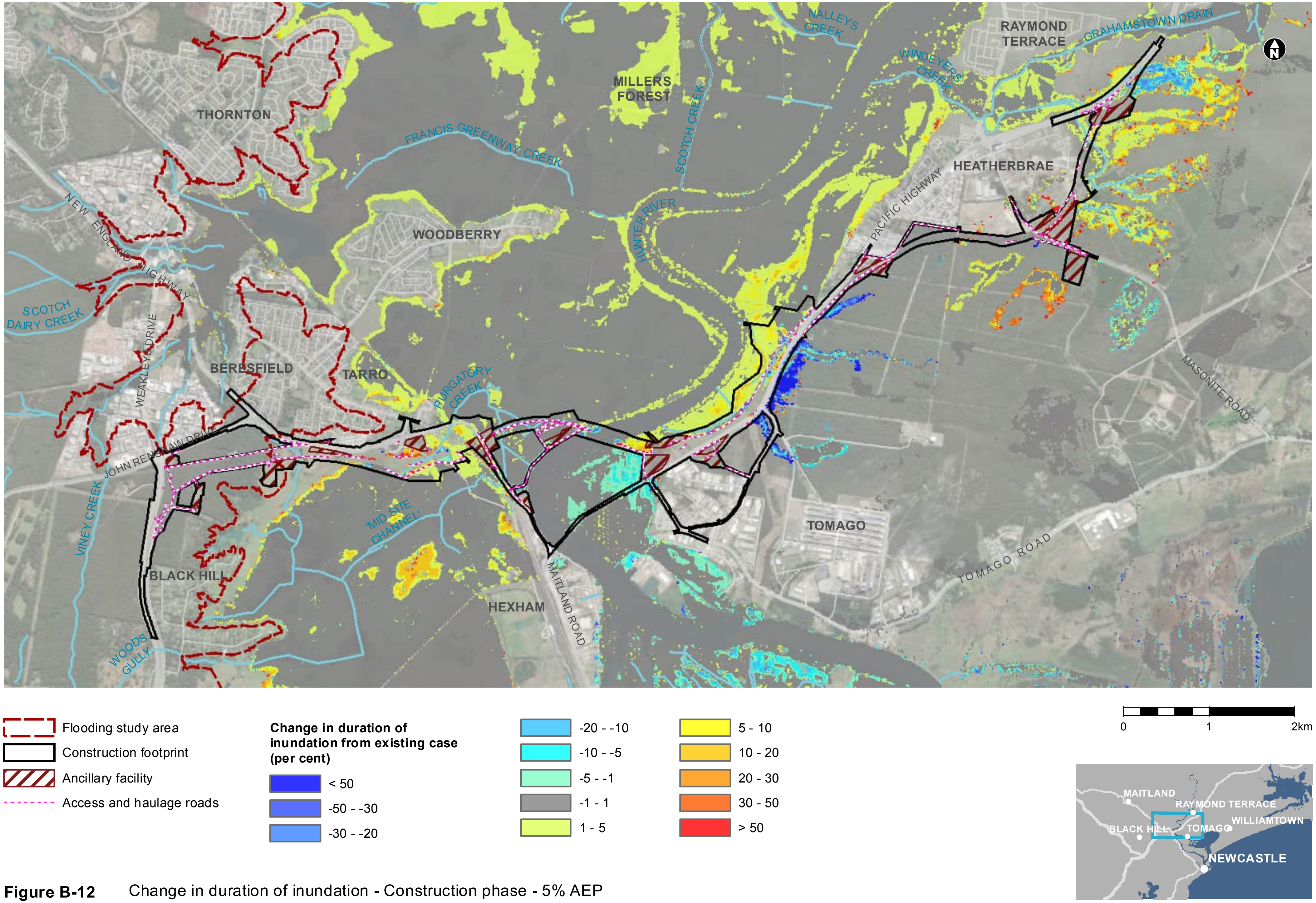
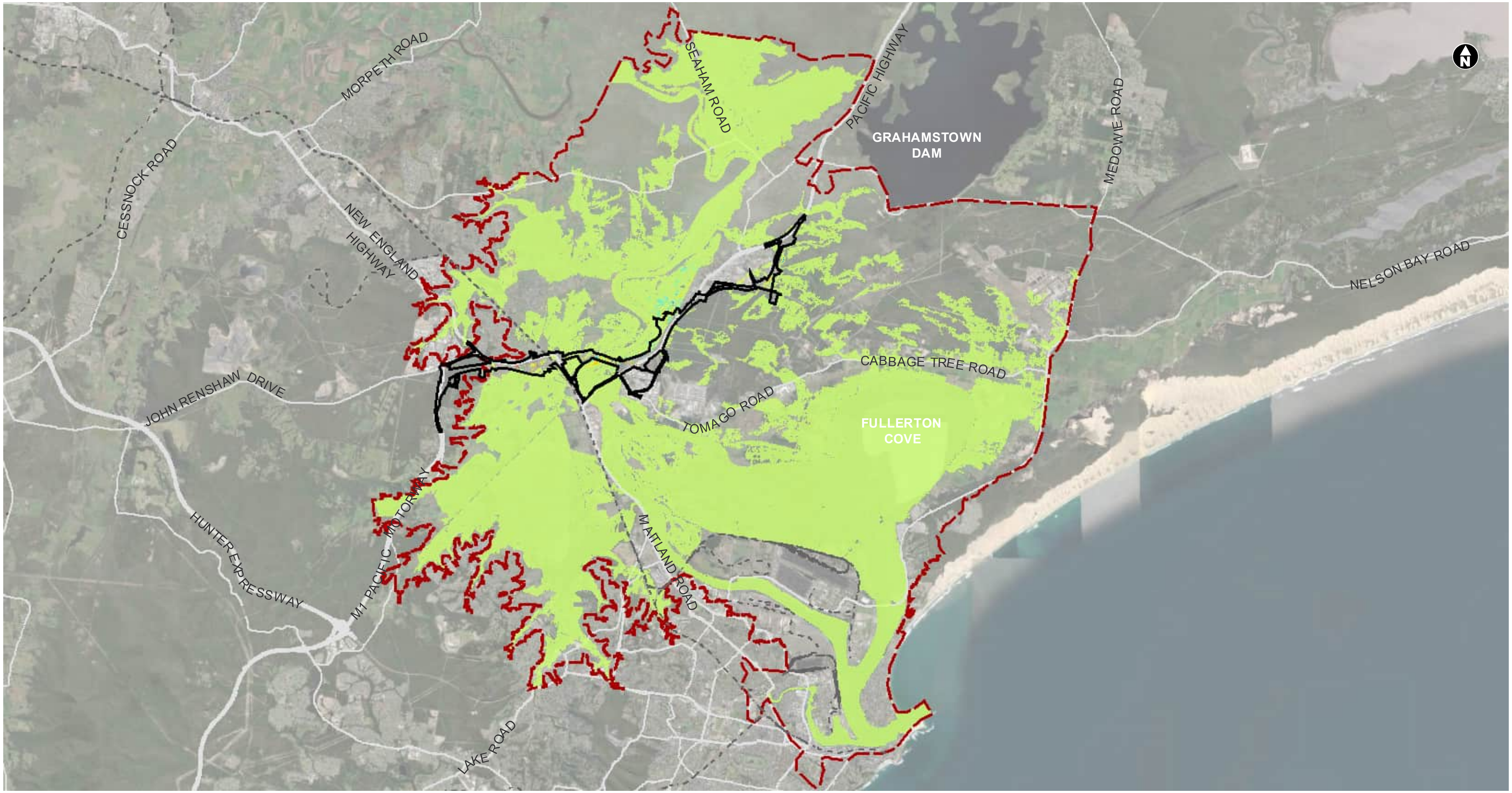


Figure B-12 Change in duration of inundation - Construction phase - 5% AEP

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\V02\IA230000_CD_HF_Supp_B-12_ChangeInundatonDuration5Construction_JAC_A4L_175000_V02.mxd



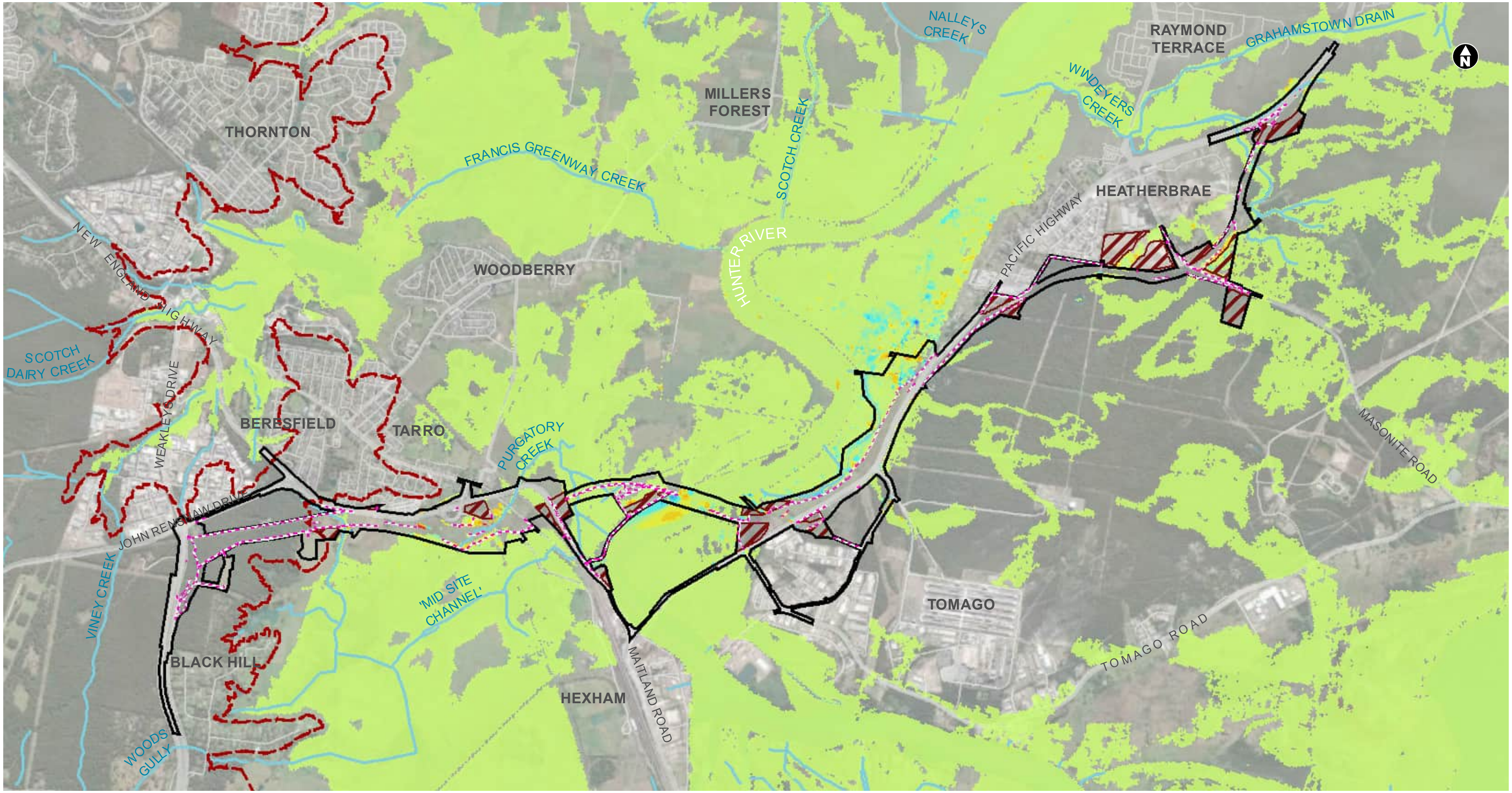
Flooding study area
Construction footprint
Railway

Change in velocity from existing case (m/s)

- < -1
- -1 - -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.05
- -0.05 - 0.05
- 0.05 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- >1

Figure B-13 Change in flow velocity - Construction phase - 20% AEP (map 1 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report\IA230000_CD_HF_B-13_ChangeFlowVelocity_Construction_20_AEP_JAC_A4L_175000_V01.mxd



Flooding study area
Construction footprint
Ancillary facility
Access and haulage roads

Change in velocity from existing case (m/s)

- < -1
- -1 - -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.05
- -0.05 - 0.05
- 0.05 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- >1

0 1 2km

Figure B-13 Change in flow velocity - Construction phase - 20% AEP (map 2 of 2)

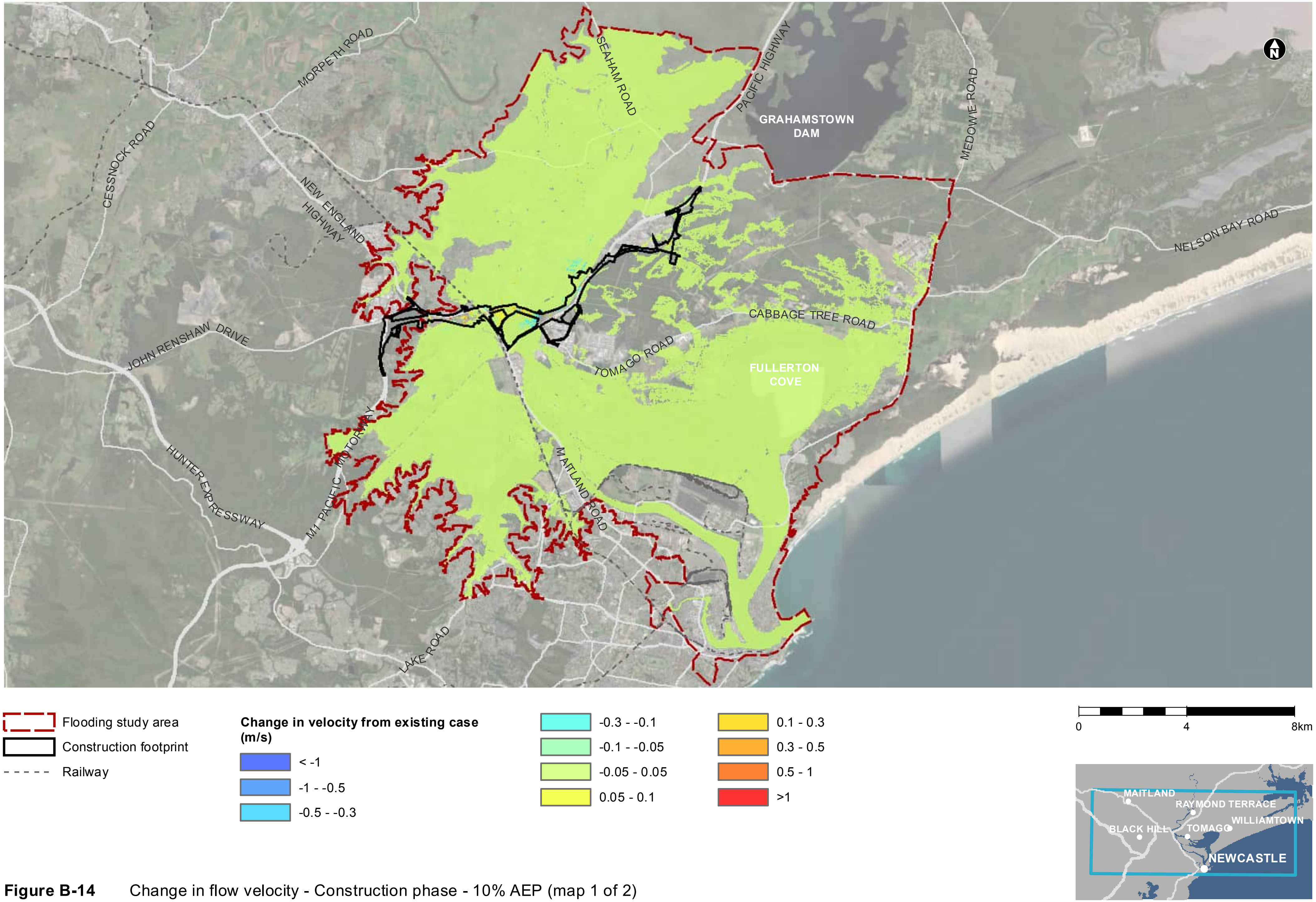


Figure B-14 Change in flow velocity - Construction phase - 10% AEP (map 1 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report\IA230000_CD_HF_B-14_ChangeFlowVelocity_Construction_10_AEP_JAC_A4L_175000_V01.mxd

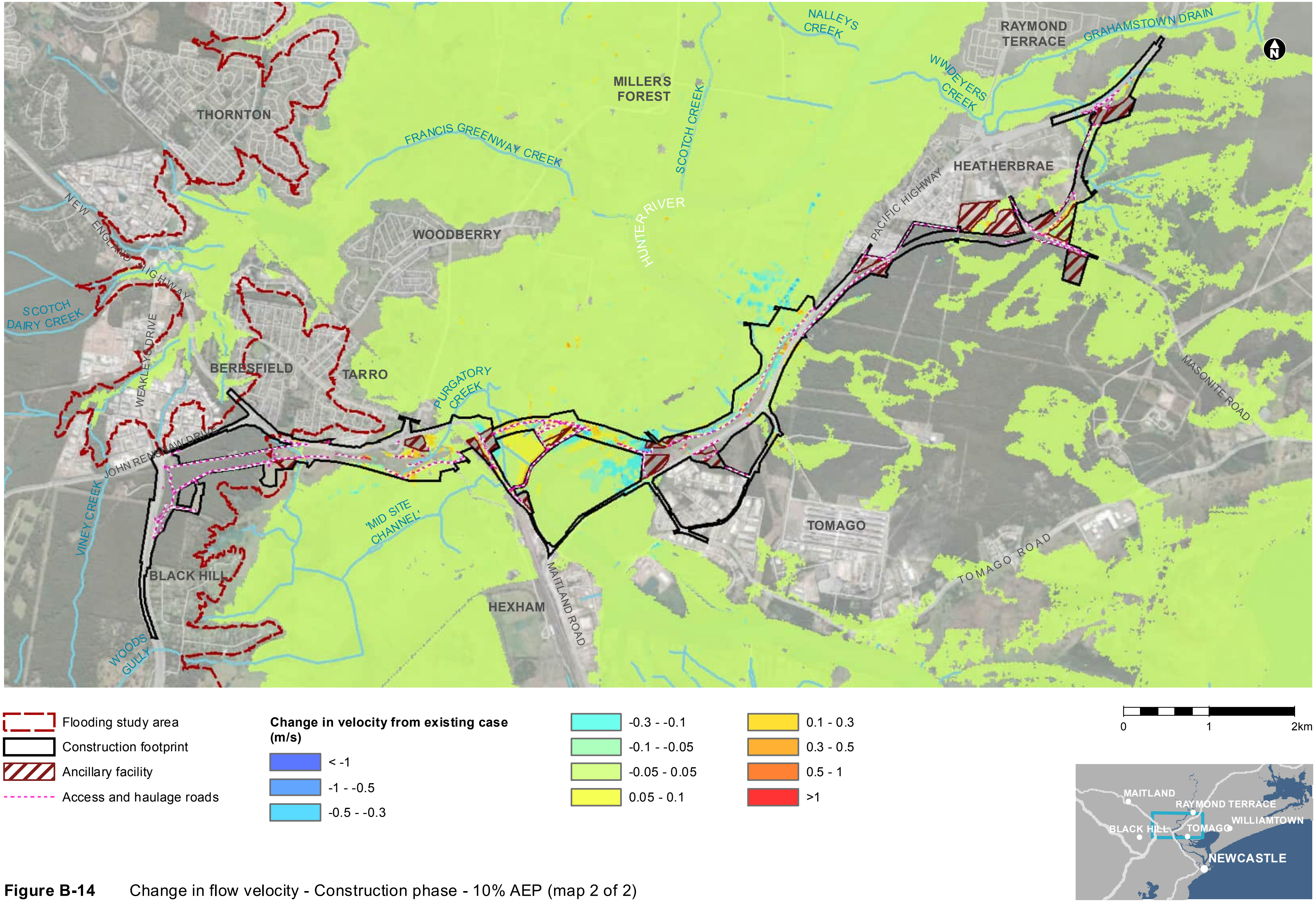
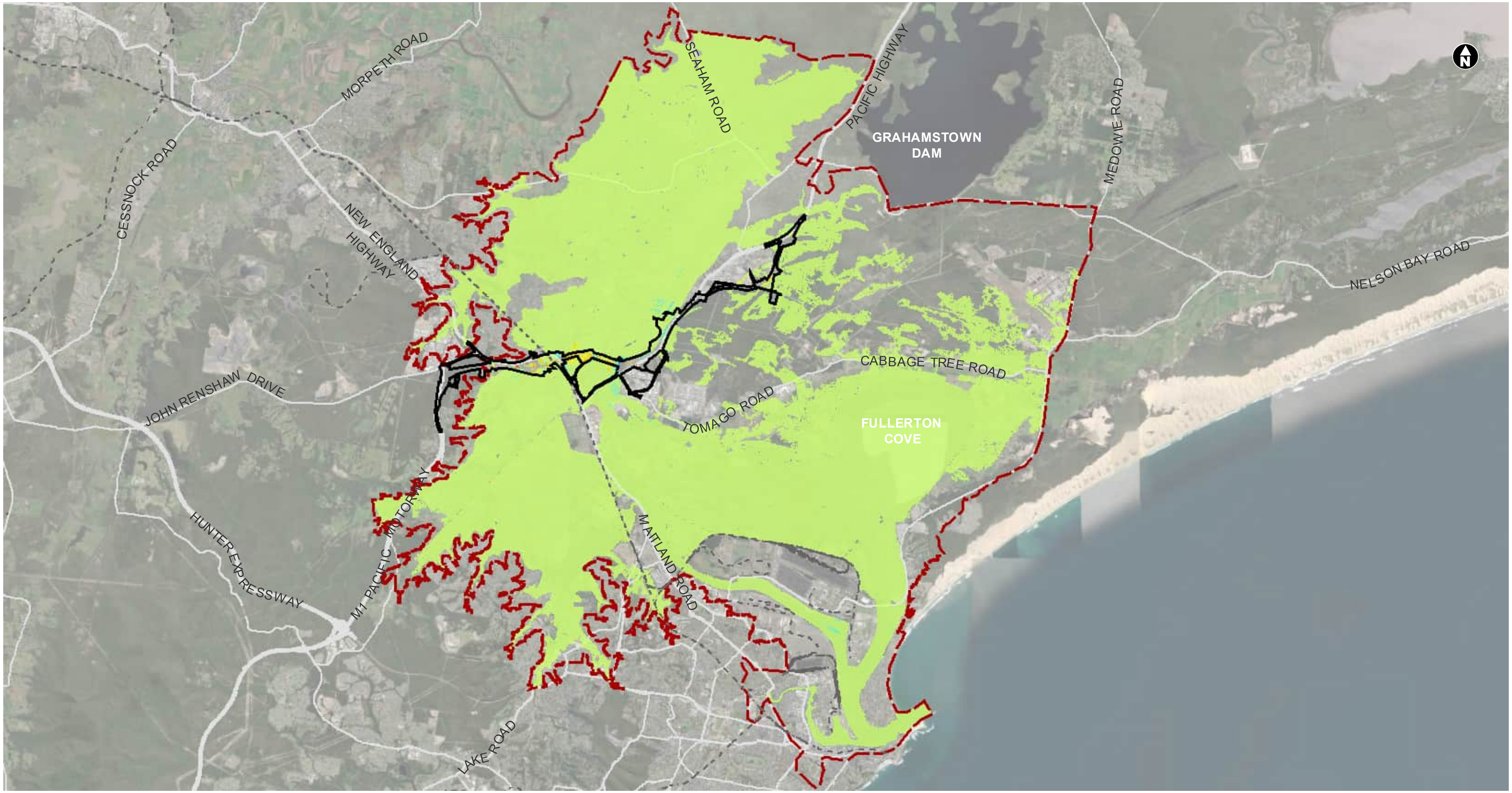


Figure B-14 Change in flow velocity - Construction phase - 10% AEP (map 2 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report\IA230000_CD_HF_B-14_ChangeFlowVelocity_Construction_10_AEP_JAC_A4L_175000_V01.mxd



Flooding study area
Construction footprint
Railway

Change in velocity from existing case (m/s)

- < -1
- -1 - -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.05
- -0.05 - 0.05
- 0.05 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- >1

Figure B-15 Change in flow velocity - Construction phase - 5% AEP (map 1 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report\IA230000_CD_HF_B-15_ChangeFlowVelocity_Construction_5_AEP_JAC_A4L_175000_V01.mxd

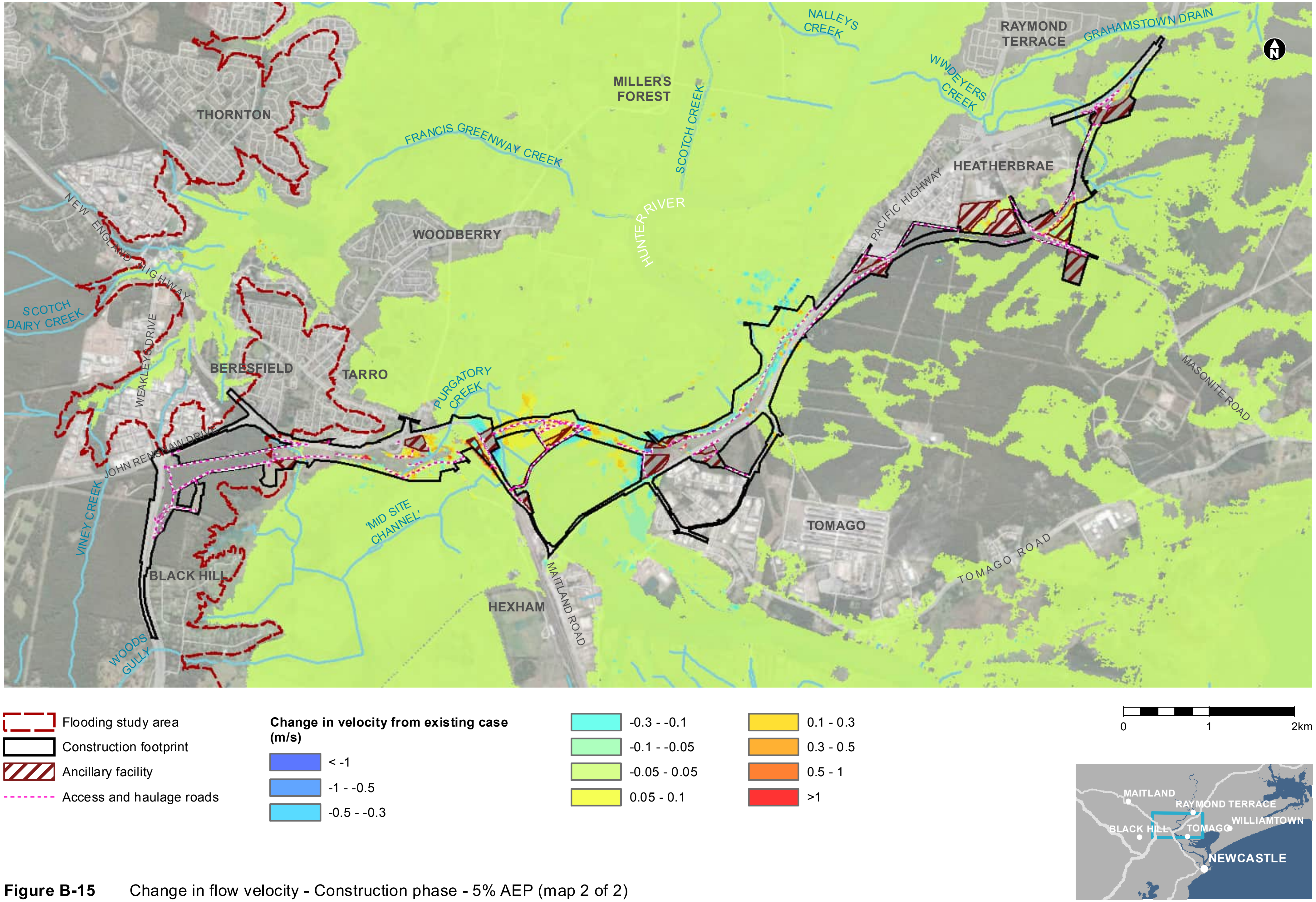
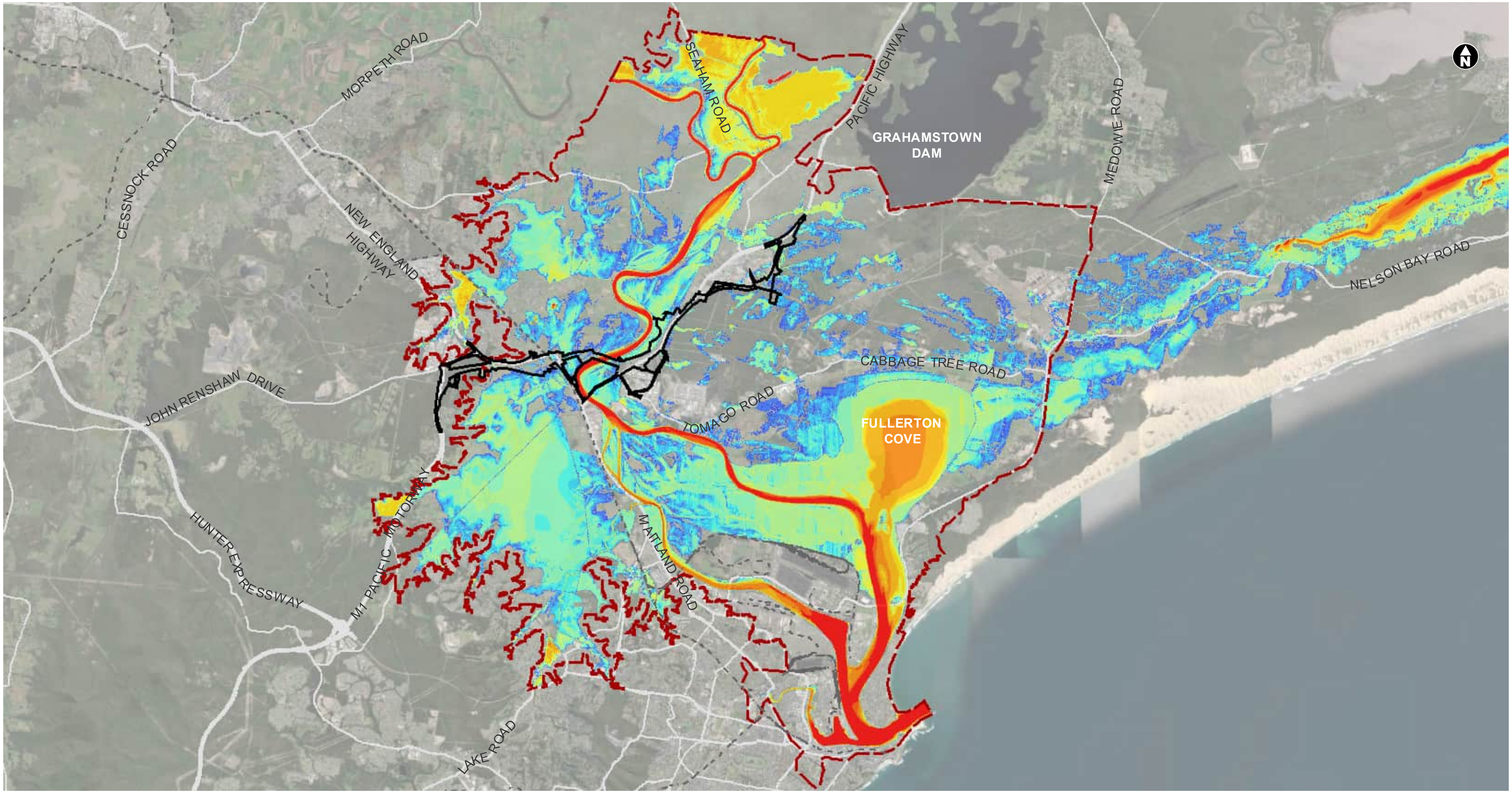


Figure B-15 Change in flow velocity - Construction phase - 5% AEP (map 2 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report\IA230000_CD_HF_B-15_ChangeFlowVelocity_Construction_5_AEP_JAC_A4L_175000_V01.mxd



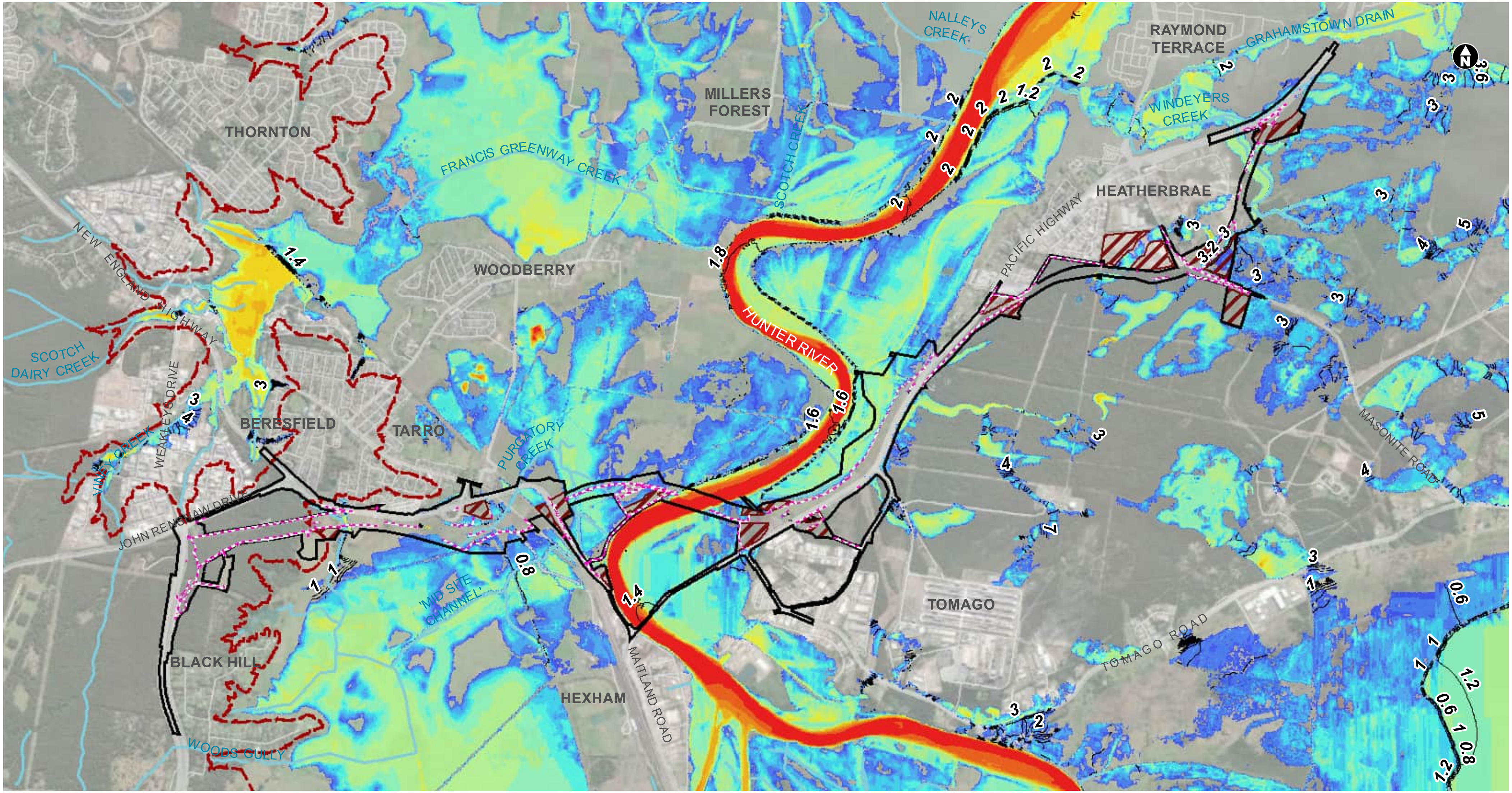
Flooding study area
Construction footprint
Railway

Flood depth (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- 0.4 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.2
- 1.2 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- 4.0 to 5.0
- > 5.0

0 4 8km

Figure B-16 Flood level and depth - Construction phase - 20% AEP (map 1 of 2)



Flooding study area
Construction footprint
Ancillary facility
Access and haulage roads
Flood level contour (0.2m AHD interval)

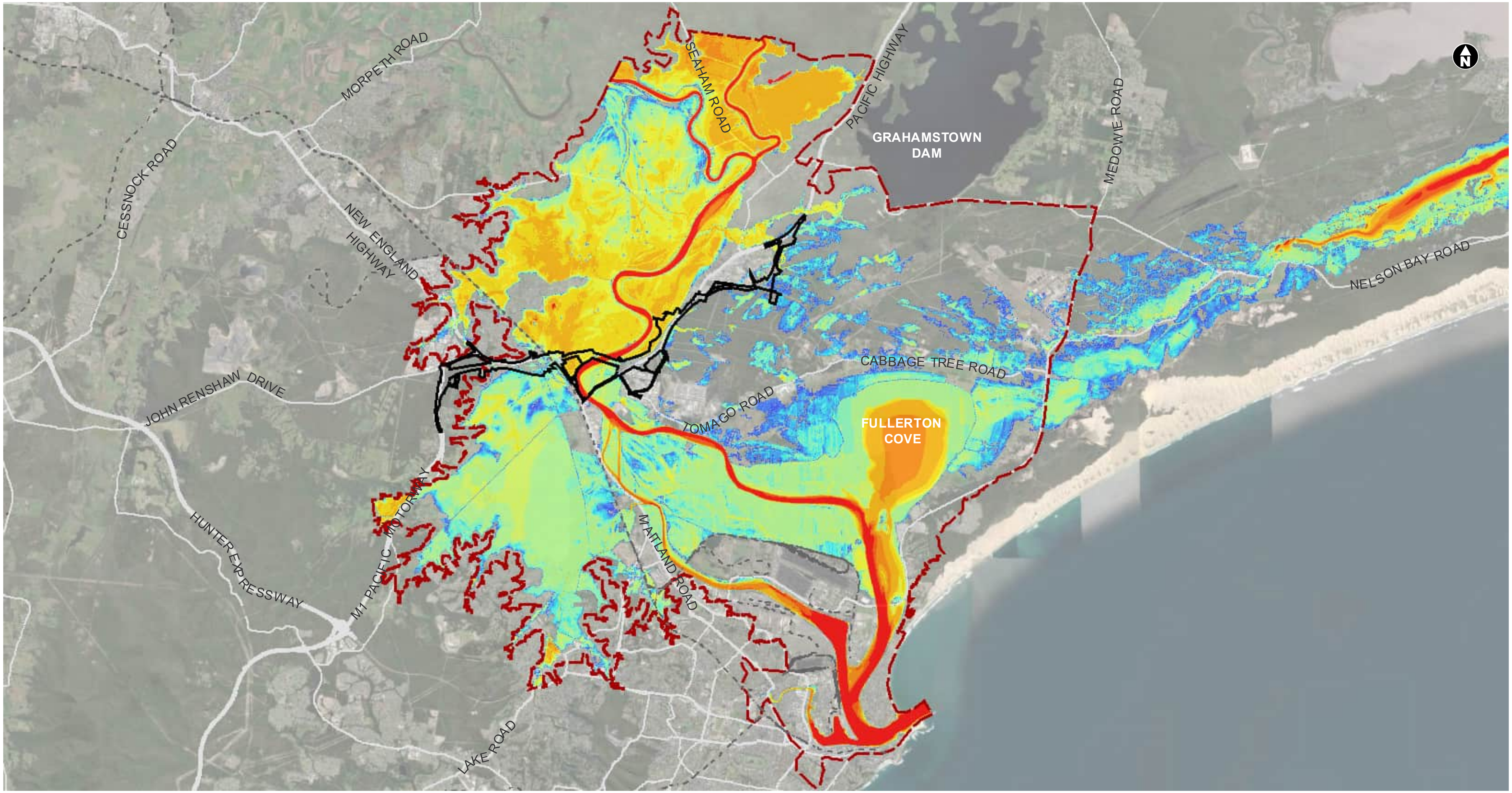
Flood depth (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- 0.4 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.2
- 1.2 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- 4.0 to 5.0
- > 5.0

0 1 2km

Figure B-16 Flood level and depth - Construction phase - 20% AEP (map 2 of 2)

Date: 28/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-16_LevelDepth_Construction_20_AEP_JAC_A4L_175000_V01.mxd



Flooding study area
Construction footprint
Railway

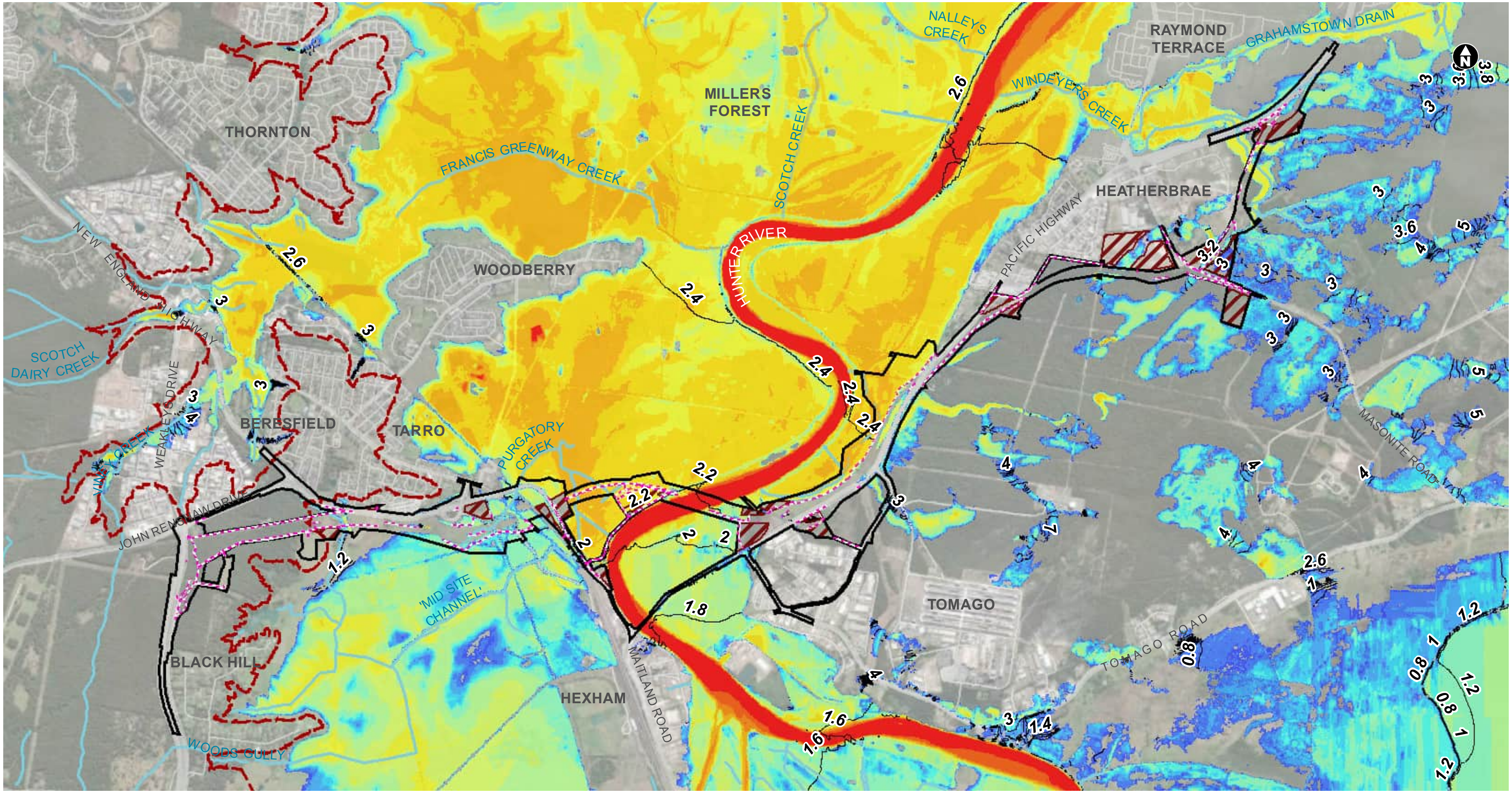
Flood depth (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- 0.4 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.2
- 1.2 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- 4.0 to 5.0
- > 5.0

0 4 8km

Figure B-17 Flood level and depth - Construction phase - 10% AEP (map 1 of 2)

Date: 28/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-17_LevelDepth_Construction_10_AEP_JAC_A4L_175000_V01.mxd



Flooding study area

Construction footprint

Ancillary facility

Access and haulage roads

Flood level contour (0.2m AHD interval)

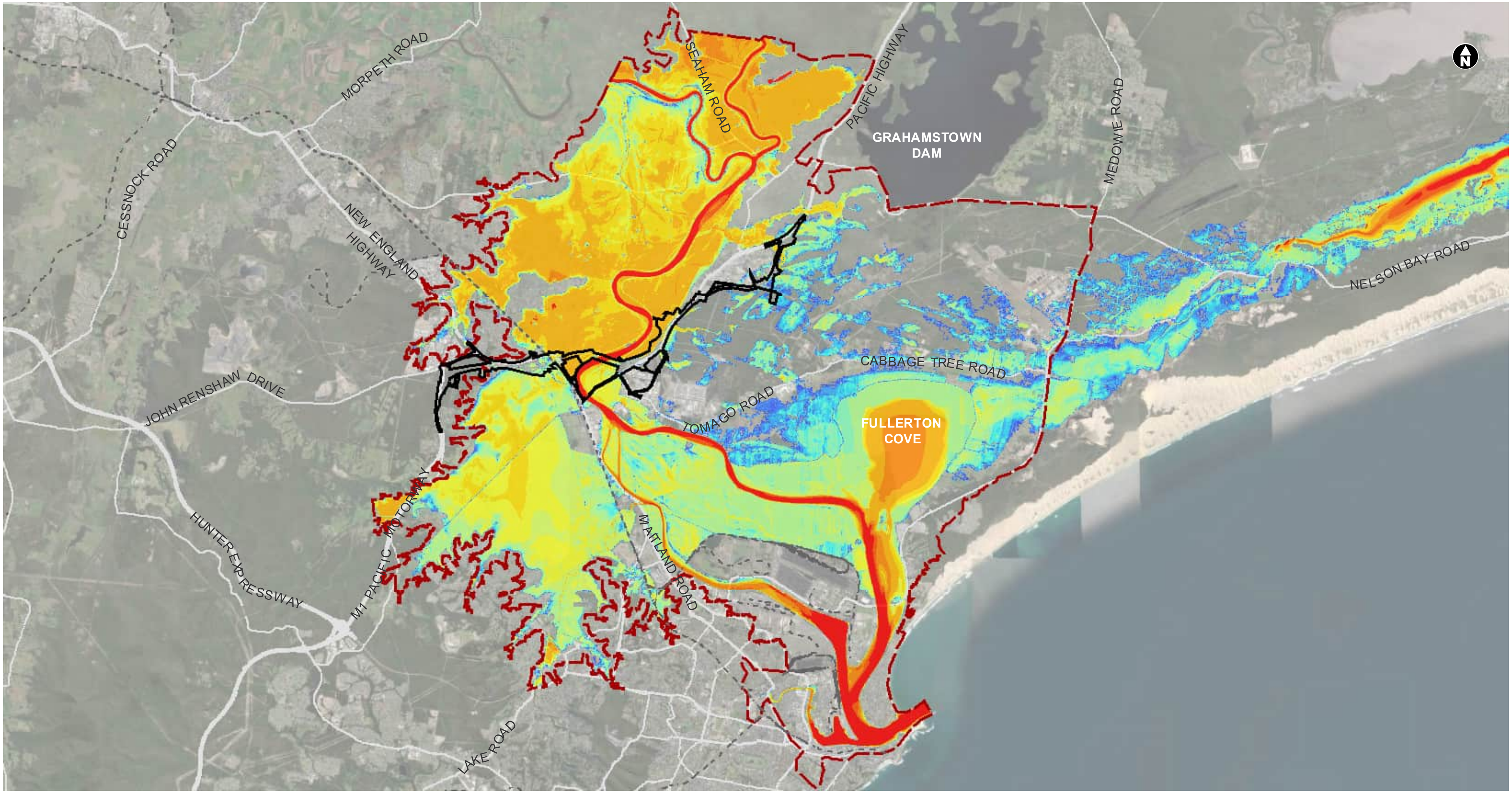
Flood depth (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- 0.4 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.2
- 1.2 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- 4.0 to 5.0
- > 5.0

0 1 2km

Figure B-17 Flood level and depth - Construction phase - 10% AEP (map 2 of 2)

Date: 28/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-17_LevelDepth_Construction_10_AEP_JAC_A4L_175000_V01.mxd



Flooding study area

Construction footprint

Railway

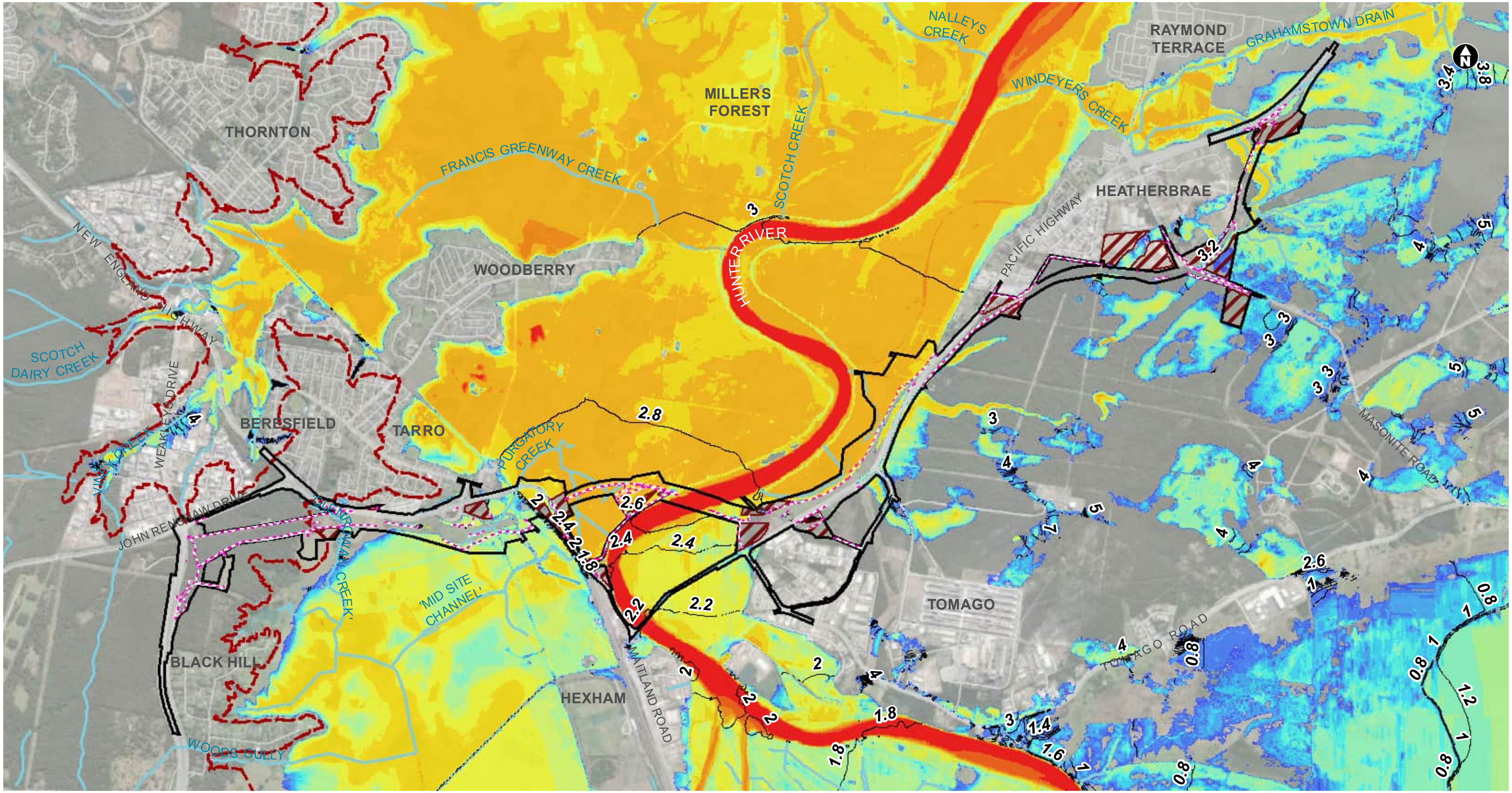
Flood depth (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- 0.4 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.2
- 1.2 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- 4.0 to 5.0
- > 5.0

0 4 8km

Figure B-18 Flood level and depth - Construction phase - 5% AEP (map 1 of 2)

Date: 28/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-18_LevelDepth_Construction_5_AEP_JAC_A4L_175000_V01.mxd



	Flooding study area
	Construction footprint
	Ancillary facility
	Access and haulage roads
	Flood level contour (0.2m AHD interval)

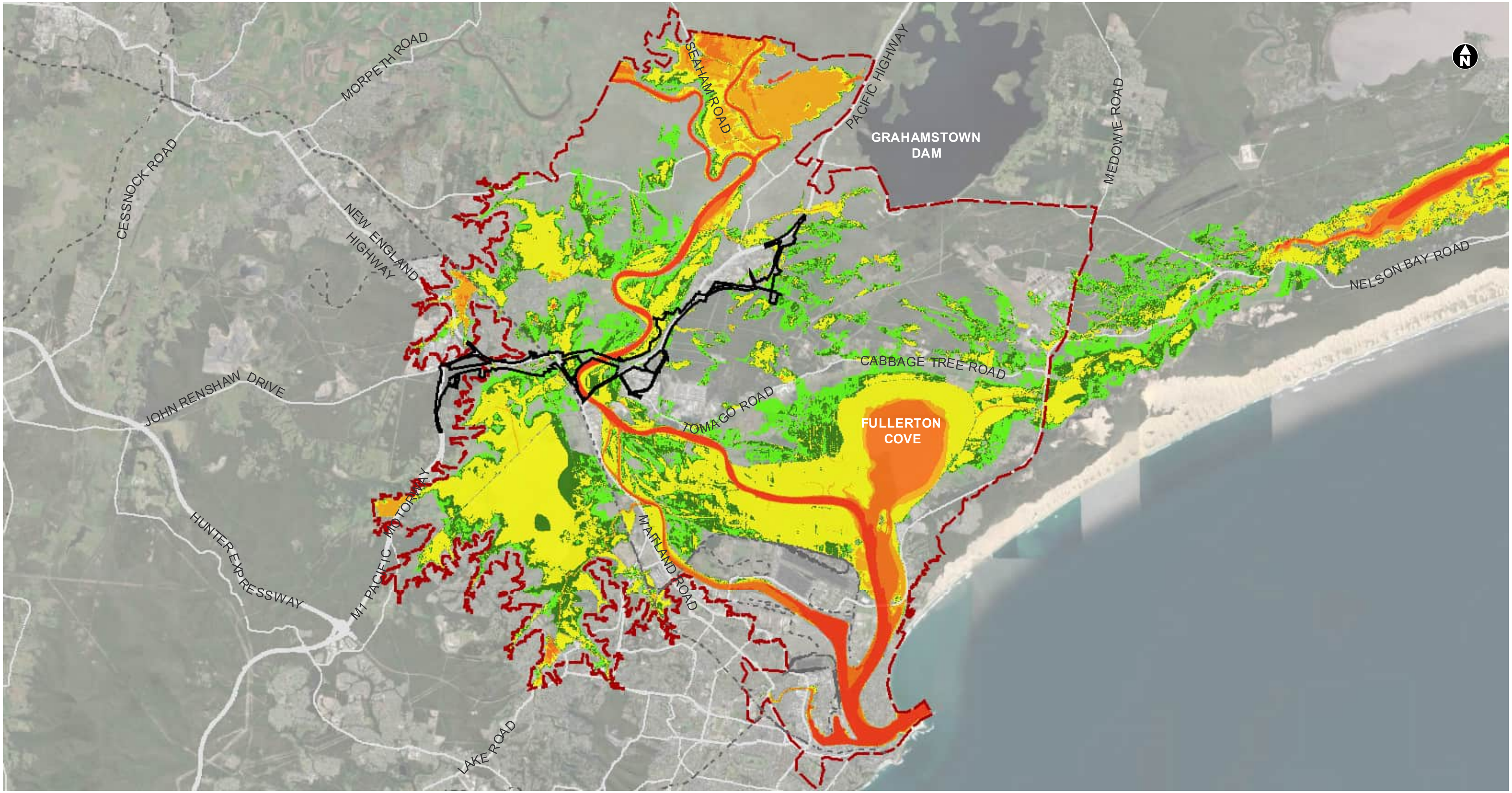
Flood depth (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- 0.4 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.2
- 1.2 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- 4.0 to 5.0
- > 5.0

0 1 2km

Figure B-18 Flood level and depth - Construction phase - 5% AEP (map 2 of 2)

Date: 28/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-18_LevelDepth_Construction_5_AEP_JAC_A4L_175000_V01.mxd



Flooding study area

Construction footprint

Railway

Flood hazard

H1 - No restrictions

H2 - Unsafe for small vehicles

H3 - Unsafe for vehicles, children and the elderly

H4 - Unsafe for people and vehicles

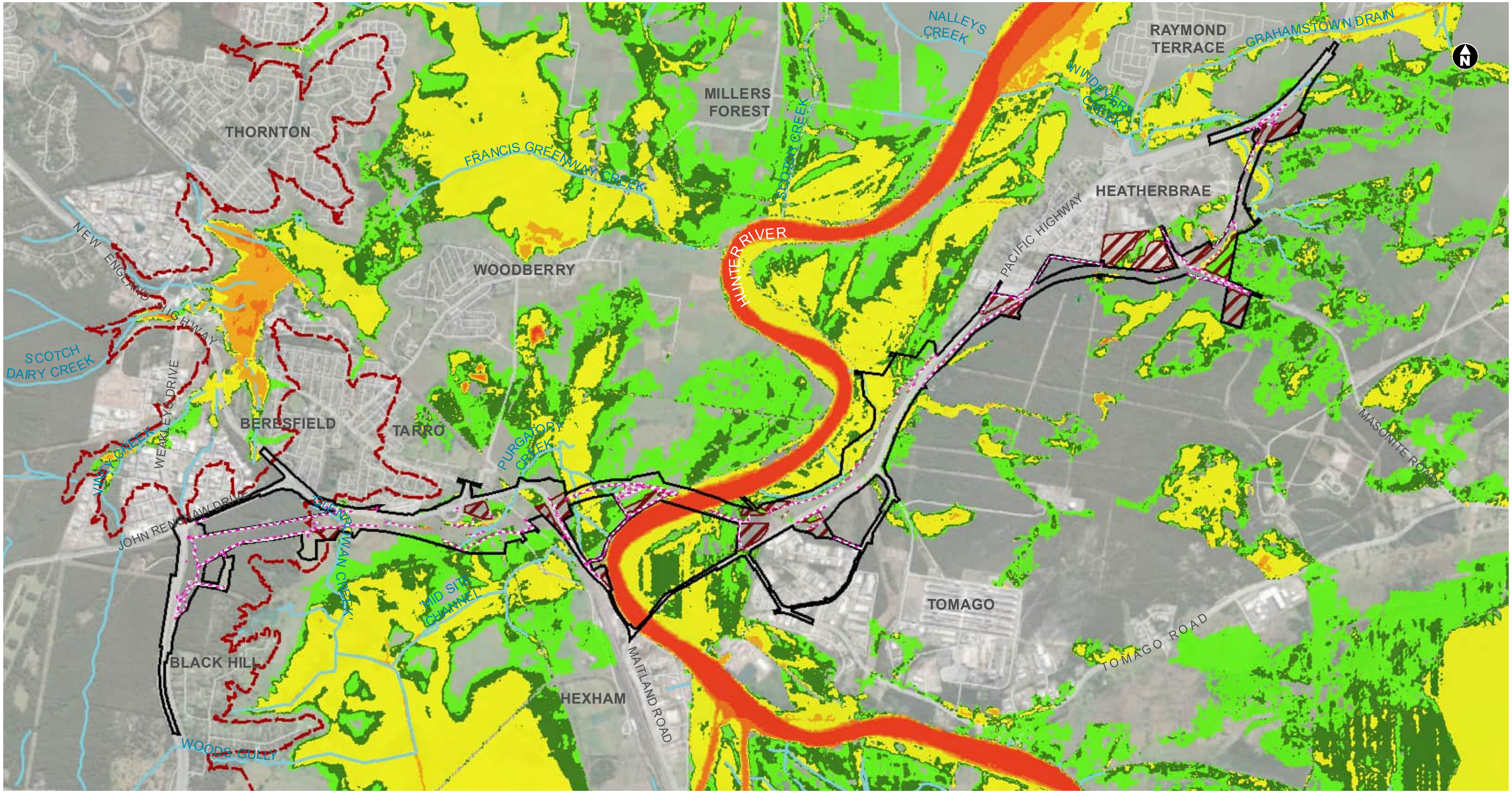
H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction

H6 - Not suitable for people, vehicles or buildings

0 4 8km

Figure B-19 Flood hazard - Construction phase - 20% AEP (map 1 of 2)

Date: 29/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-19_FloodHazard_Construction_20_AEP_JAC_A4L_175000_V01.mxd



Flooding study area

Construction footprint

Ancillary facility

Access and haulage roads

Flood hazard

H1 - No restrictions

H2 - Unsafe for small vehicles

H3 - Unsafe for vehicles, children and the elderly

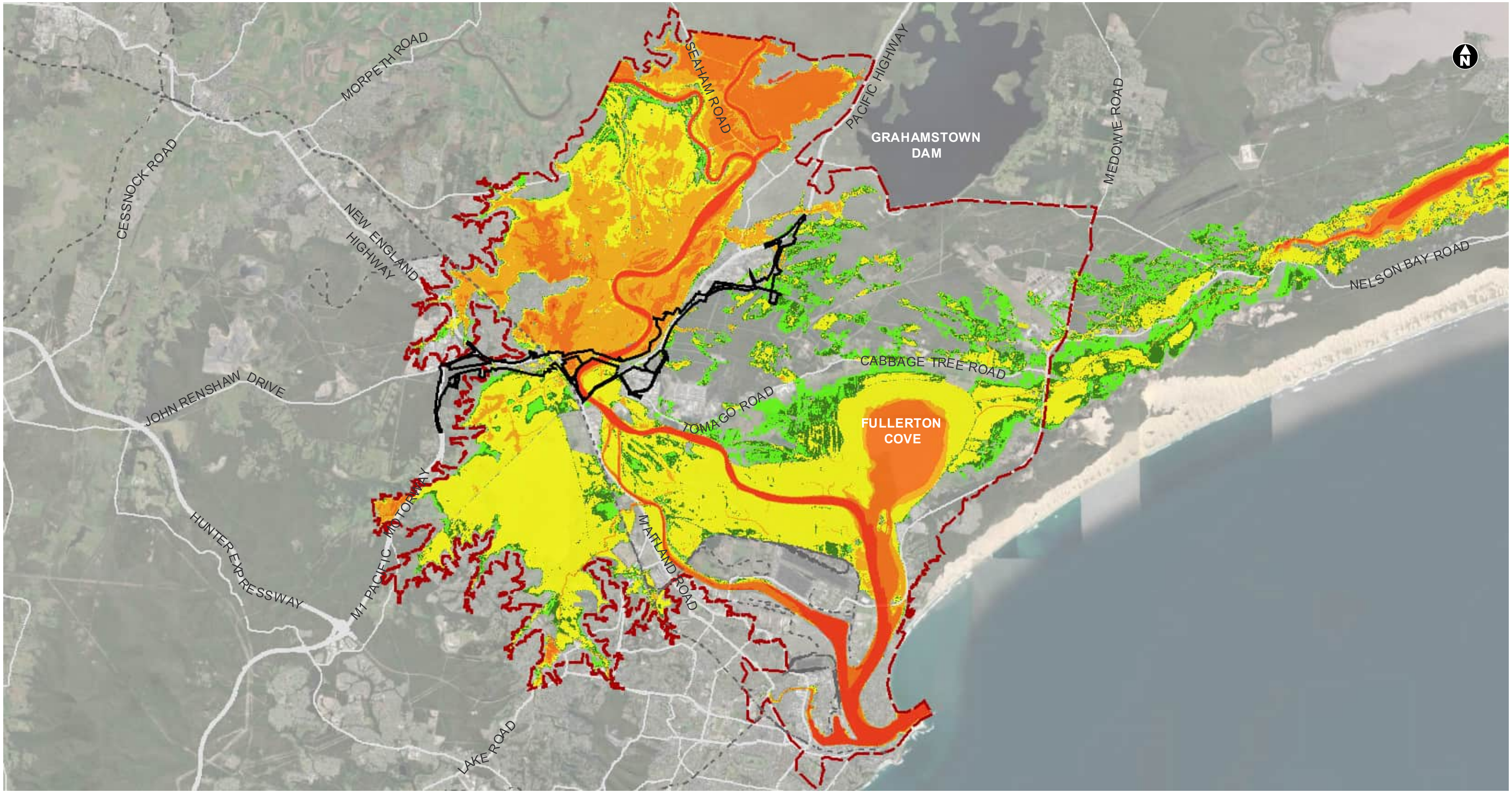
H4 - Unsafe for people and vehicles

H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction

H6 - Not suitable for people, vehicles or buildings

Figure B-19 Flood hazard - Construction phase - 20% AEP (map 2 of 2)

Date: 29/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-19_FloodHazard_Construction_20_AEP_JAC_A4L_175000_V01.mxd



Flooding study area

Construction footprint

Railway

Flood hazard

H1 - No restrictions

H2 - Unsafe for small vehicles

H3 - Unsafe for vehicles, children and the elderly

H4 - Unsafe for people and vehicles

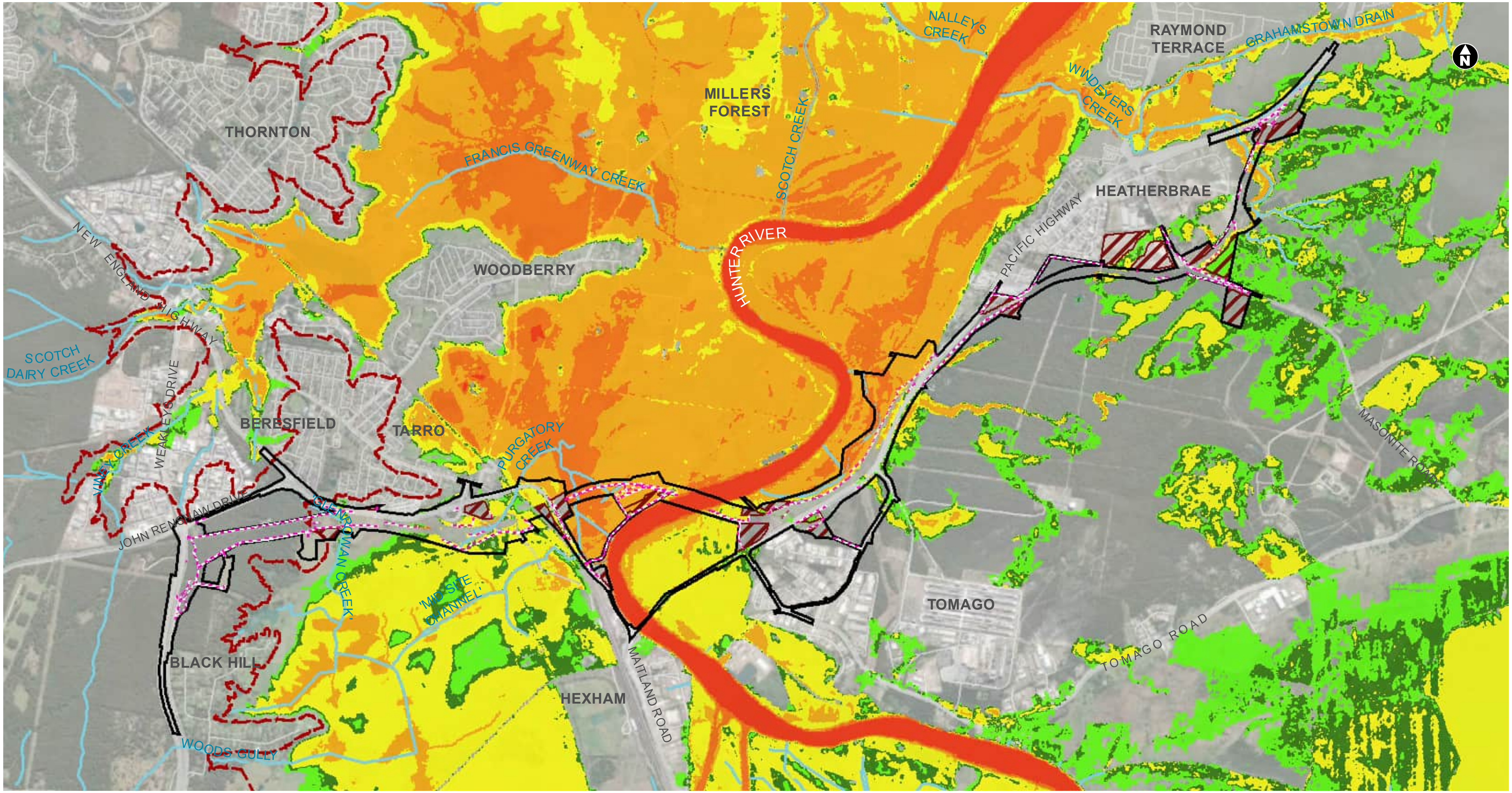
H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction

H6 - Not suitable for people, vehicles or buildings

0 4 8km

Figure B-20 Flood hazard - Construction phase - 10% AEP (map 1 of 2)

Date: 29/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Hydro_Flooding\IA230000_CD_HF_SuppFin_B-20_FloodHazard_Construction_10_AEP_JAC_A4L_175000_V01.mxd



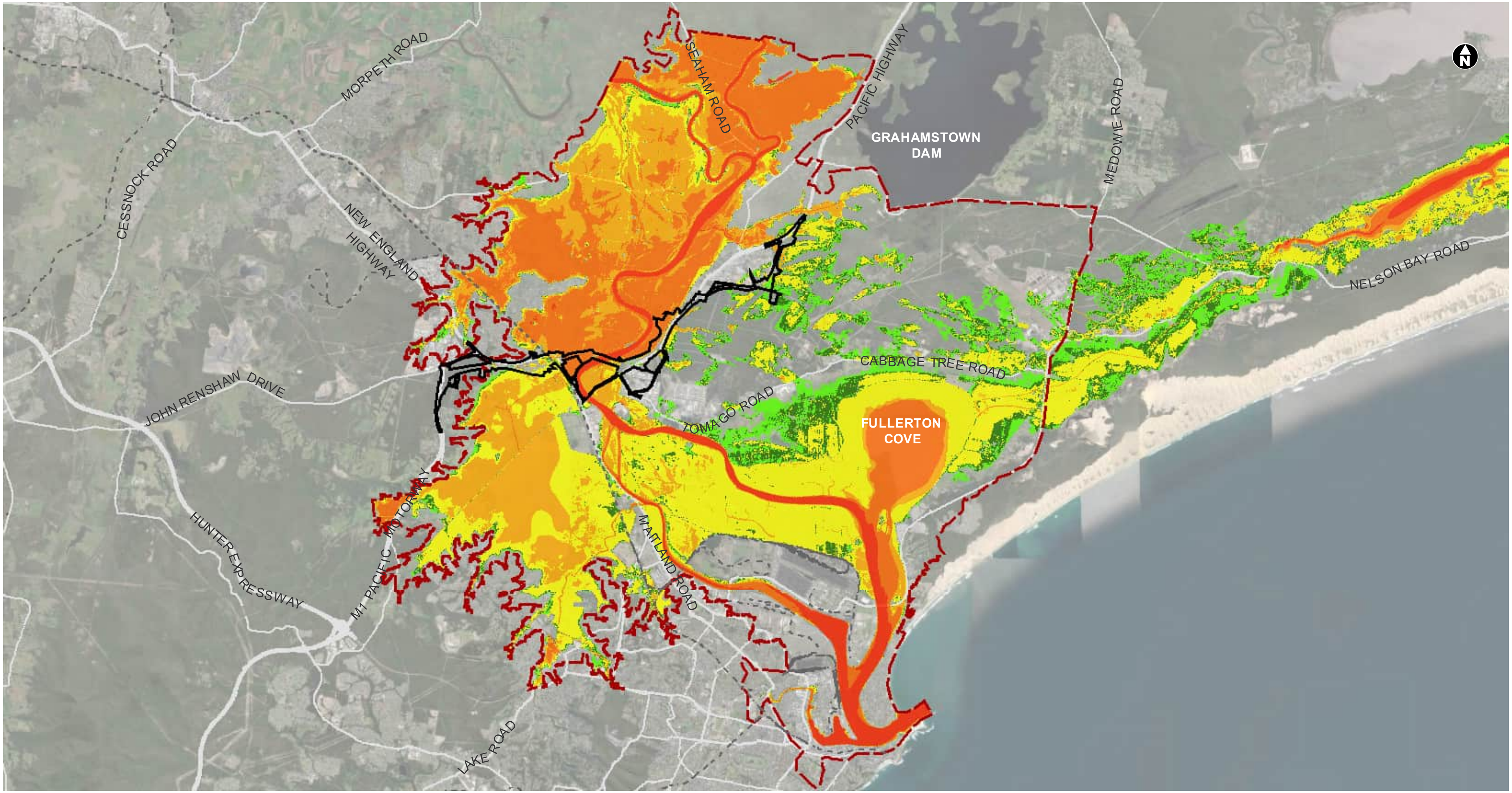
Flooding study area	
Construction footprint	
Ancillary facility	
Access and haulage roads	

Flood hazard

- H1 - No restrictions
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 1 2km

Figure B-20 Flood hazard - Construction phase - 10% AEP (map 2 of 2)



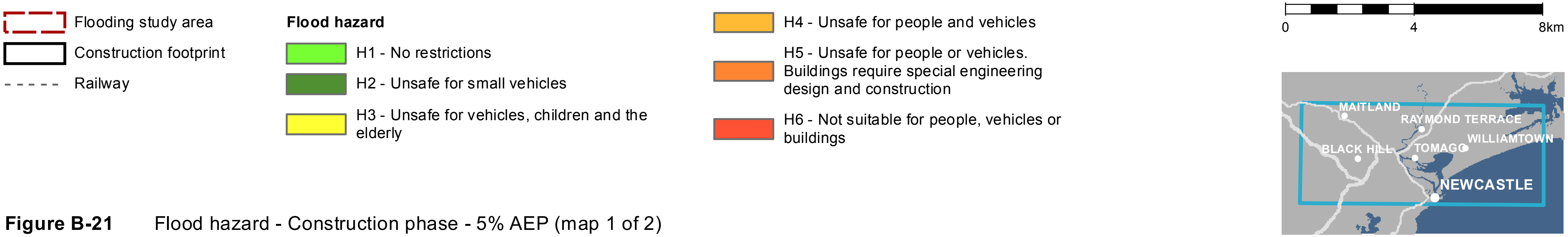


Figure B-21 Flood hazard - Construction phase - 5% AEP (map 1 of 2)

Date: 29/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Hydro_Flooding\IA230000_CD_HF_SuppFin_B-21_FloodHazard_Construction_5_AEP_JAC_A4L_175000_V01.mxd

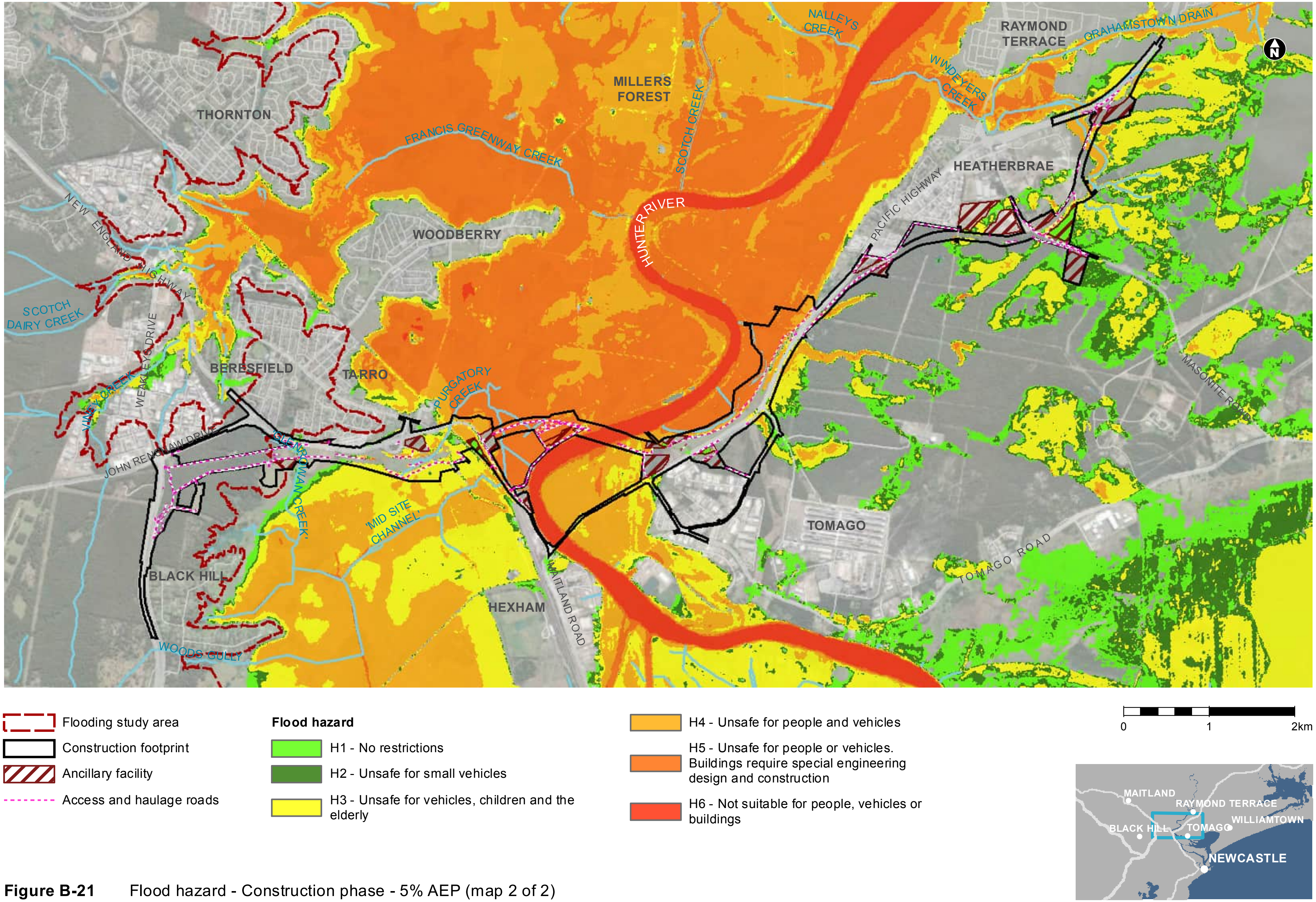


Figure B-21 Flood hazard - Construction phase - 5% AEP (map 2 of 2)

Date: 29/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Hydro_Flooding\IA230000_CD_HF_SuppFin_B-21_FloodHazard_Construction_5_AEP_JAC_A4L_175000_V01.mxd

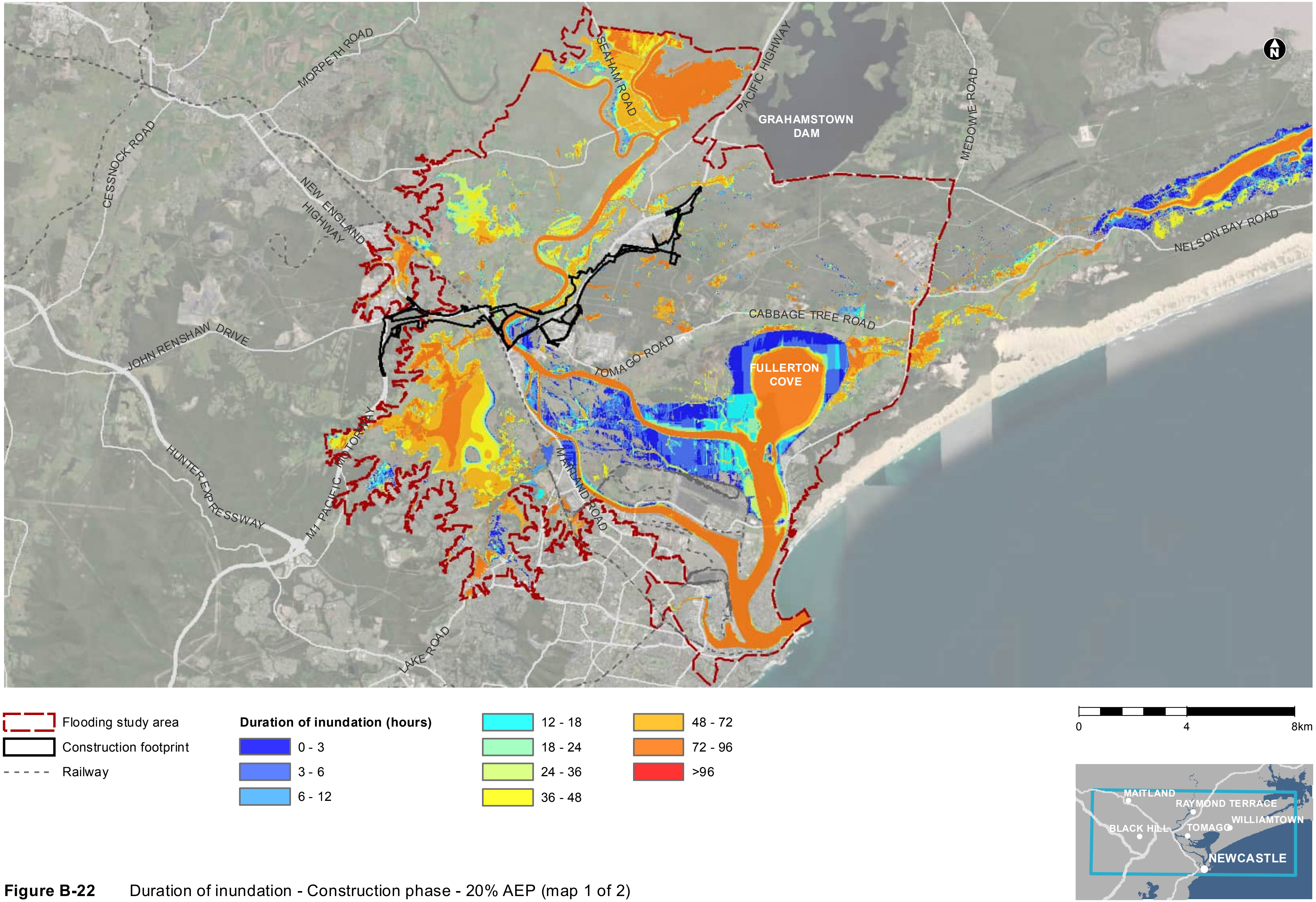


Figure B-22 Duration of inundation - Construction phase - 20% AEP (map 1 of 2)

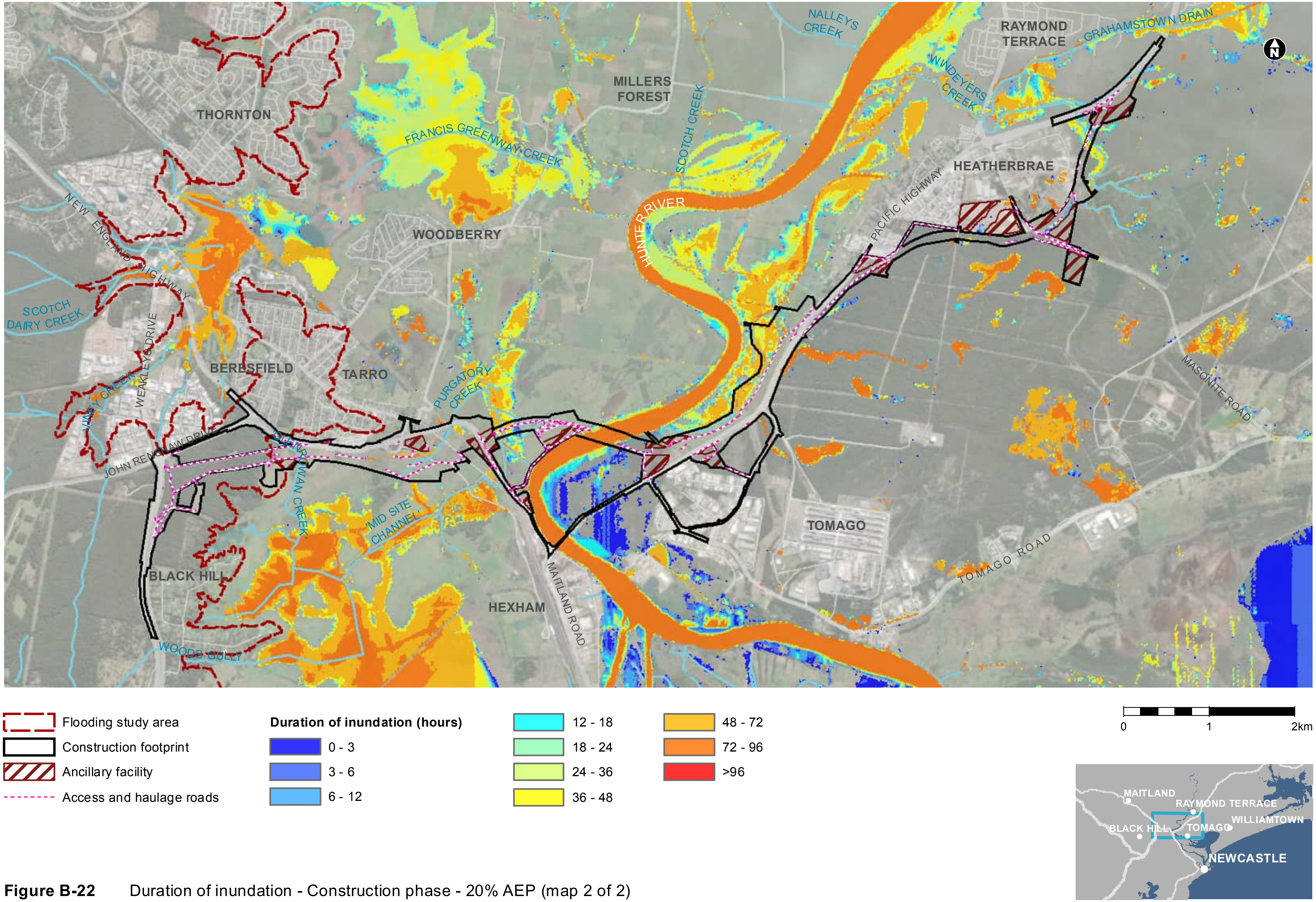
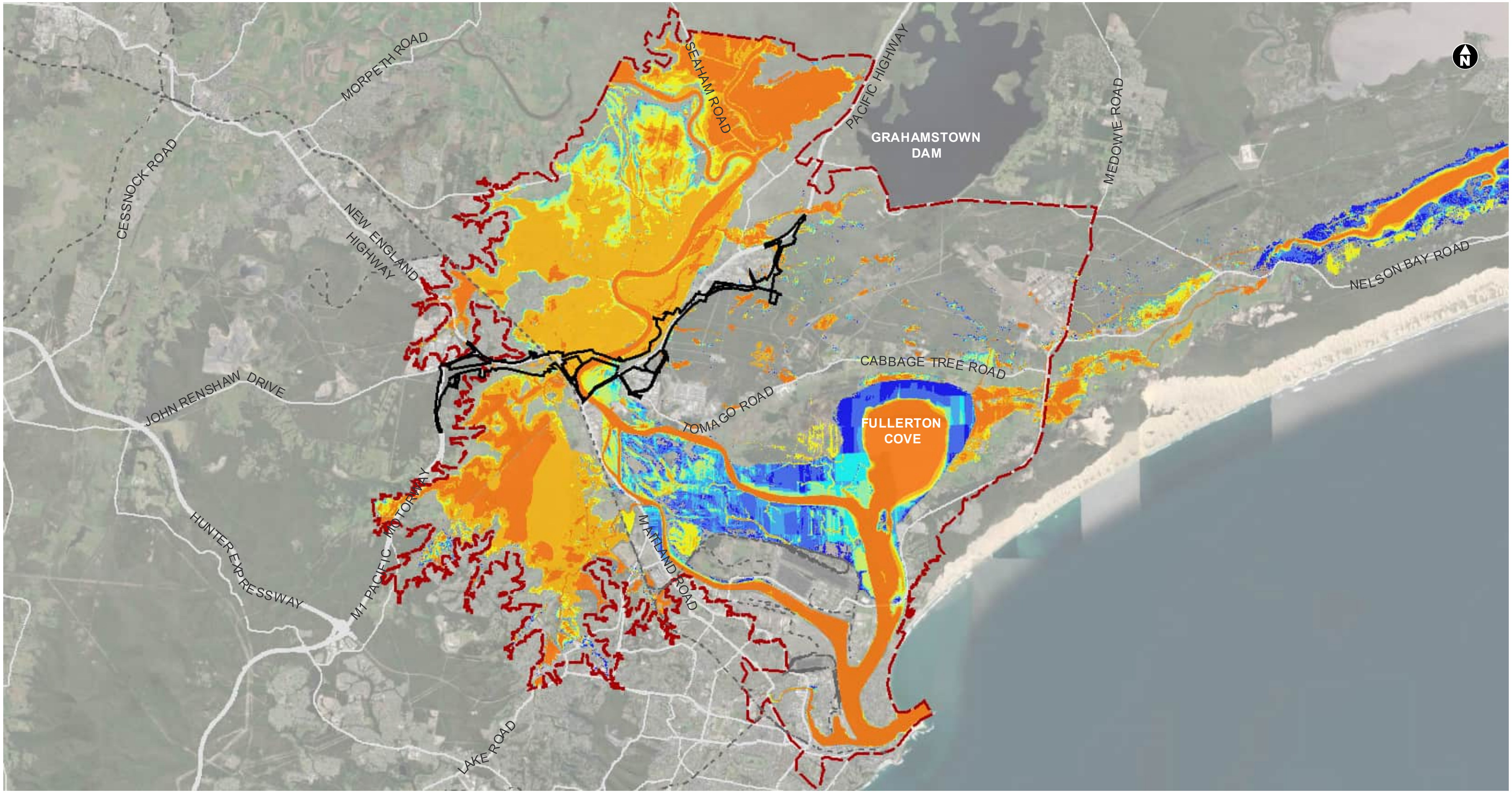


Figure B-22 Duration of inundation - Construction phase - 20% AEP (map 2 of 2)

Date: 2/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-22_DurationInundation_Construction_20_AEP_JAC_A4L_175000_V01.mxd



Flooding study area
Construction footprint
Railway

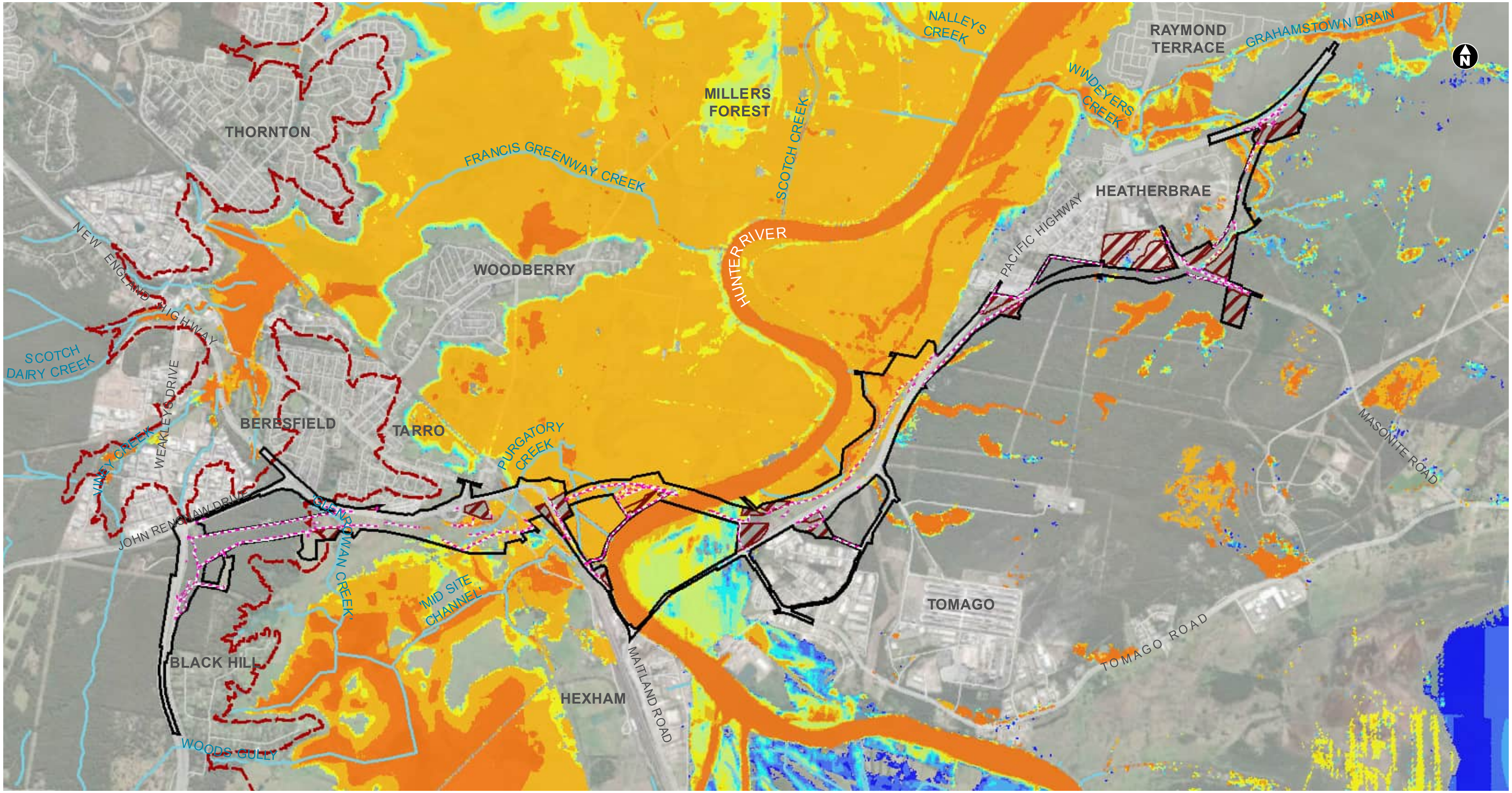
Duration of inundation (hours)

- 0 - 3
- 3 - 6
- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 36
- 36 - 48
- 48 - 72
- 72 - 96
- >96

0 4 8km

Figure B-23 Duration of inundation - Construction phase - 10% AEP (map 1 of 2)

Date: 2/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-23_DurationInundation_Construction_10_AEP_JAC_A4L_175000_V01.mxd



Flooding study area
Construction footprint
Ancillary facility
Access and haulage roads

Duration of inundation (hours)

0 - 3
3 - 6
6 - 12
12 - 18
18 - 24
24 - 36
36 - 48
48 - 72
72 - 96
>96

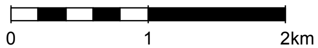
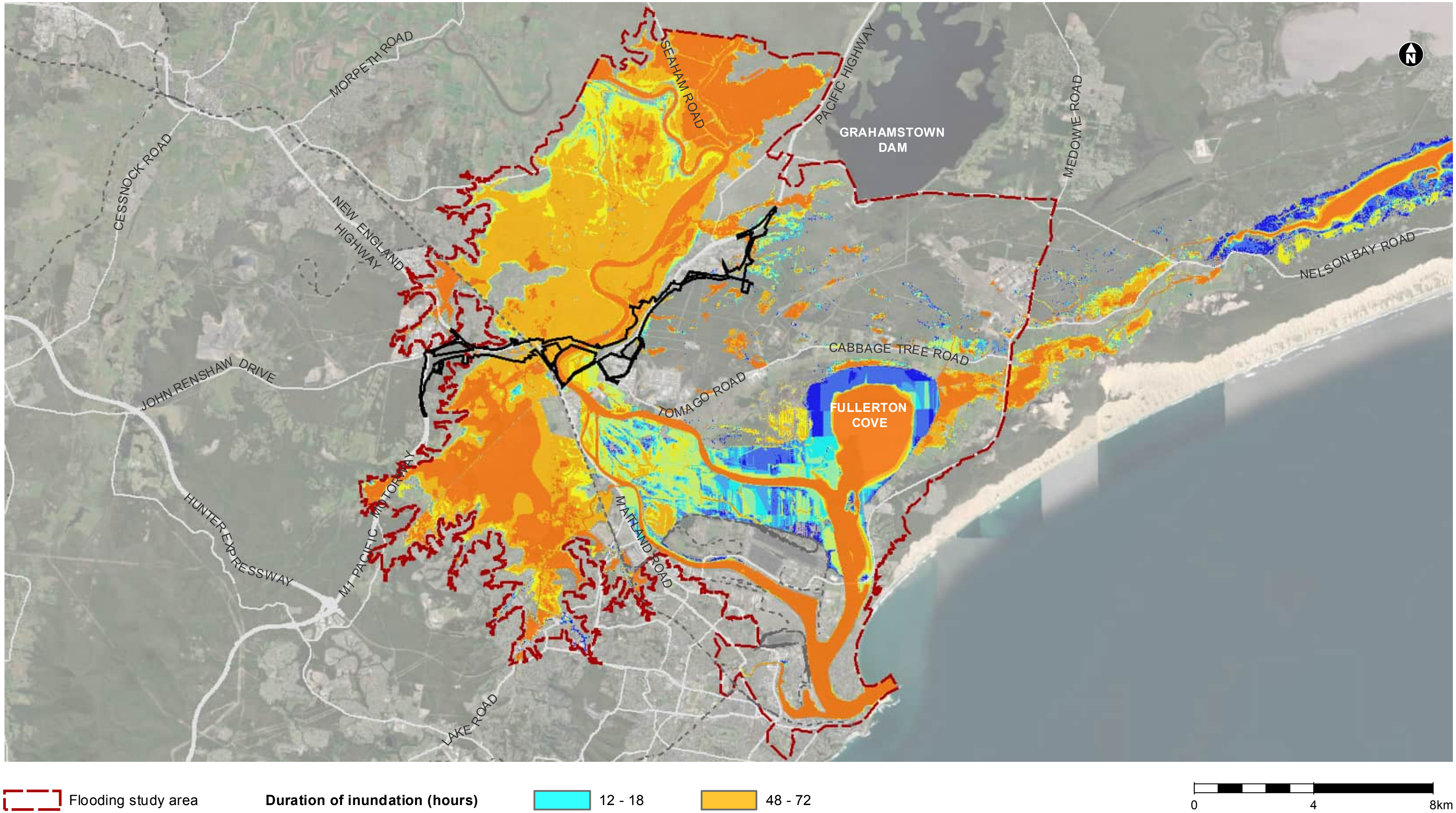


Figure B-23 Duration of inundation - Construction phase - 10% AEP (map 2 of 2)

Date: 2/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-23_DurationInundation_Construction_10_AEP_JAC_A4L_175000_V01.mxd



Flooding study area	
Construction footprint	
Railway	

Duration of inundation (hours)

- 0 - 3
- 3 - 6
- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 36
- 36 - 48
- 48 - 72
- 72 - 96
- >96

Figure B-24 Duration of inundation - Construction phase - 5% AEP (map 1 of 2)

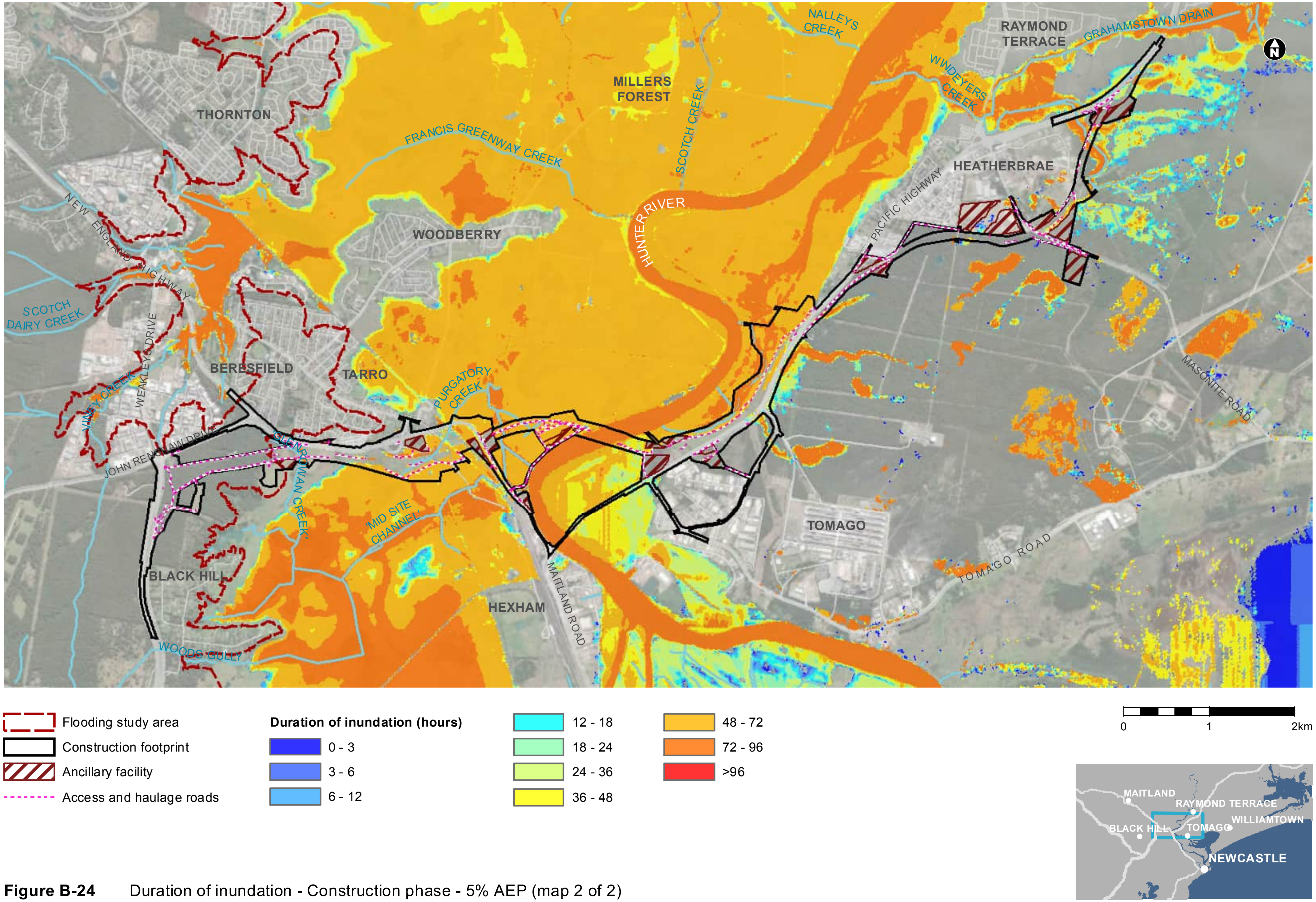


Figure B-24 Duration of inundation - Construction phase - 5% AEP (map 2 of 2)

Date: 2/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-24_DurationInundation_Construction_5_AEP_JAC_A4L_175000_V01.mxd

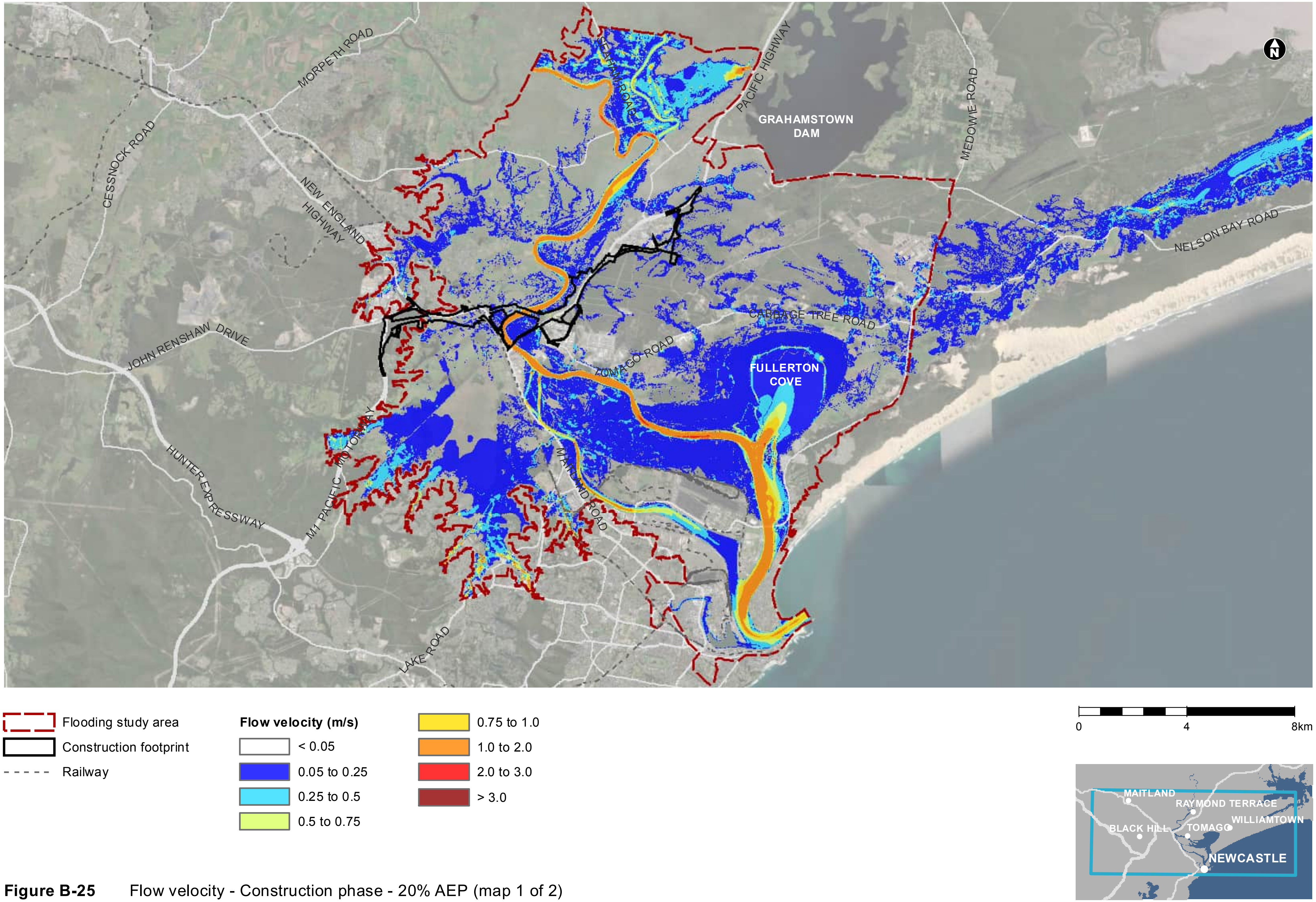
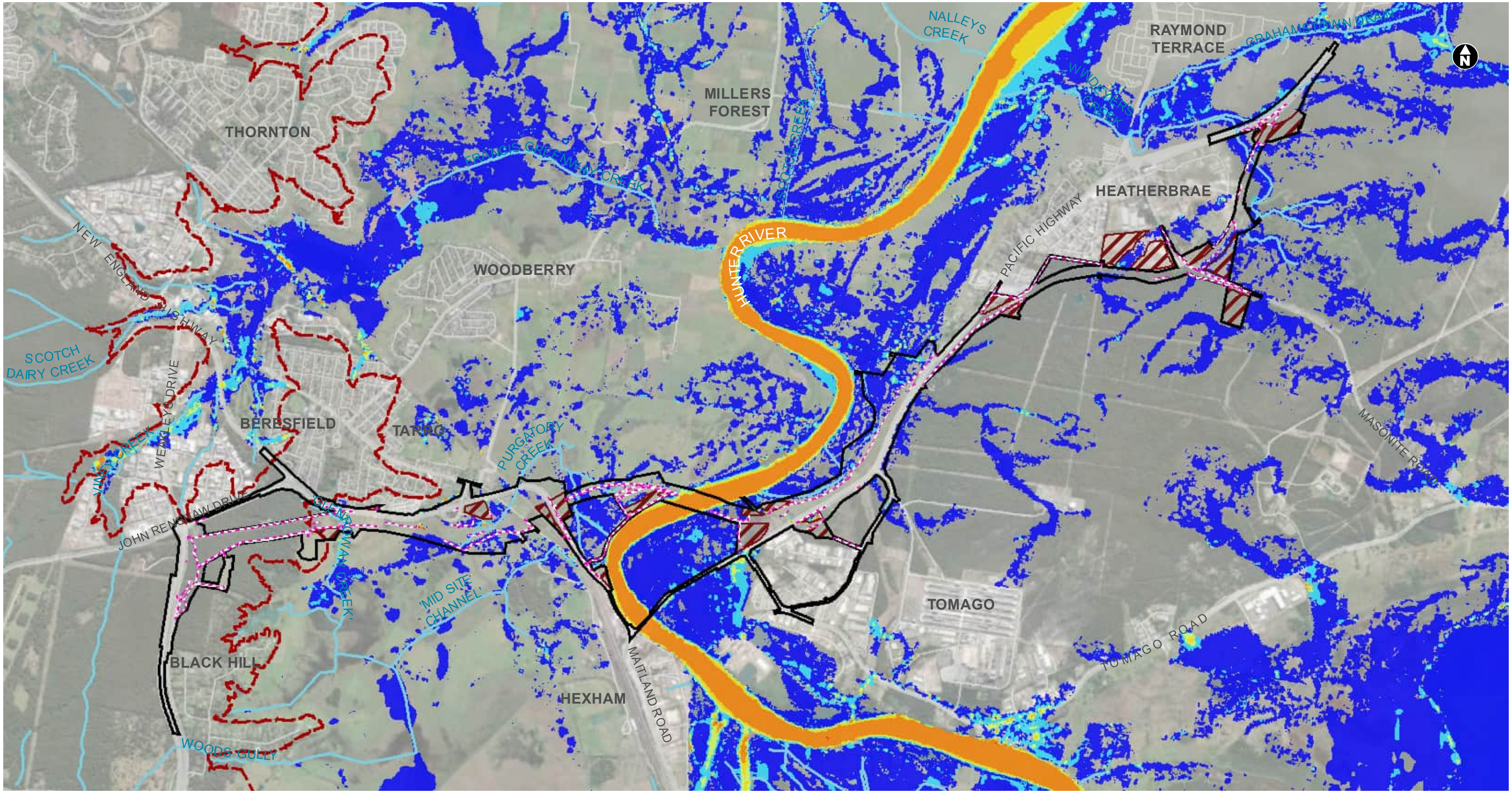


Figure B-25 Flow velocity - Construction phase - 20% AEP (map 1 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-25_Velocity_Construction_20_AEP_JAC_A4L_175000_V01.mxd



Flooding study area
Construction footprint
Ancillary facility
Access and haulage roads

Flow velocity (m/s)

< 0.05
0.05 to 0.25
0.25 to 0.5
0.5 to 0.75
0.75 to 1.0
1.0 to 2.0
2.0 to 3.0
> 3.0

Figure B-25 Flow velocity - Construction phase - 20% AEP (map 2 of 2)

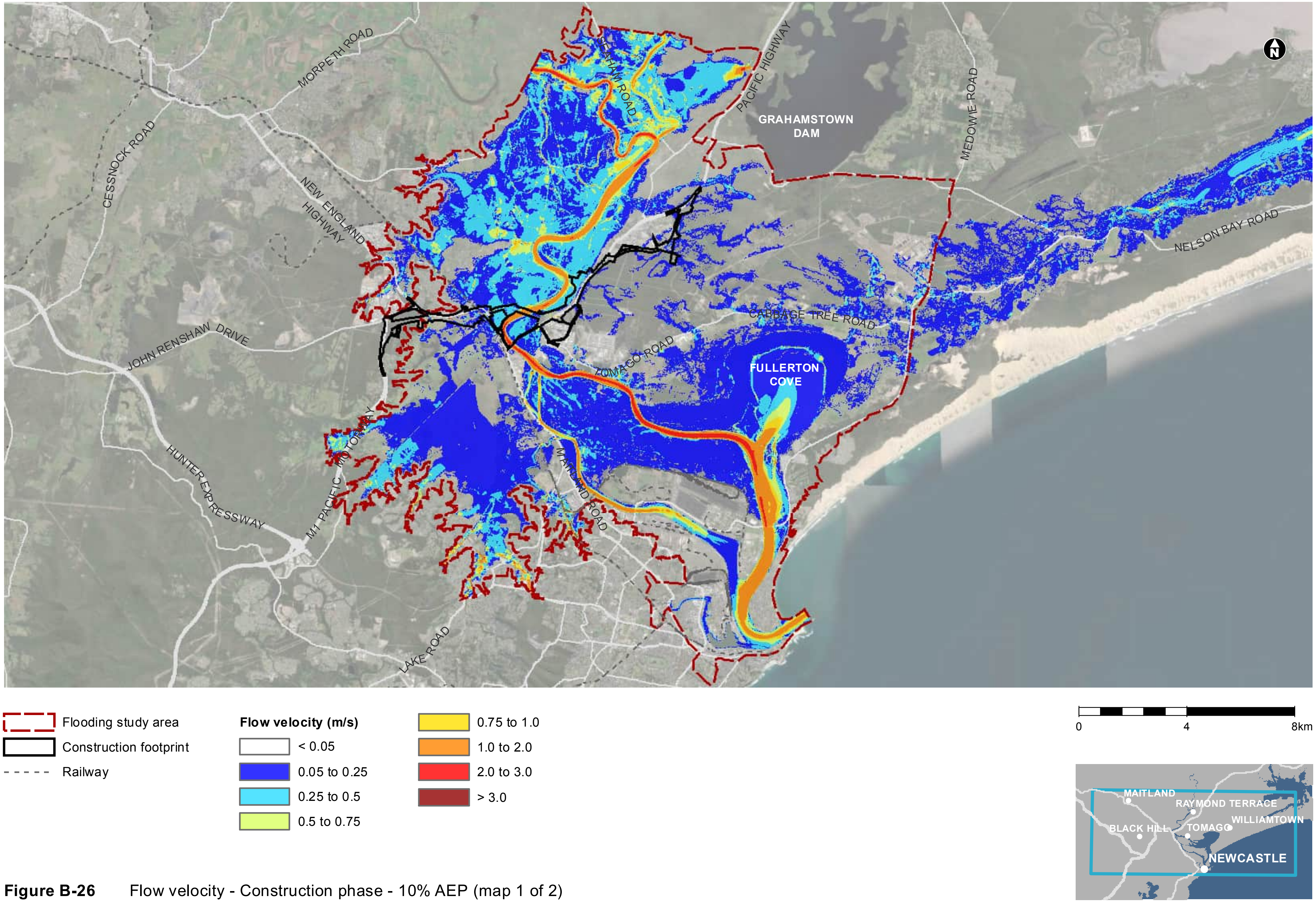


Figure B-26 Flow velocity - Construction phase - 10% AEP (map 1 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-26_Velocity_Construction_10_AEP_JAC_A4L_175000_V01.mxd

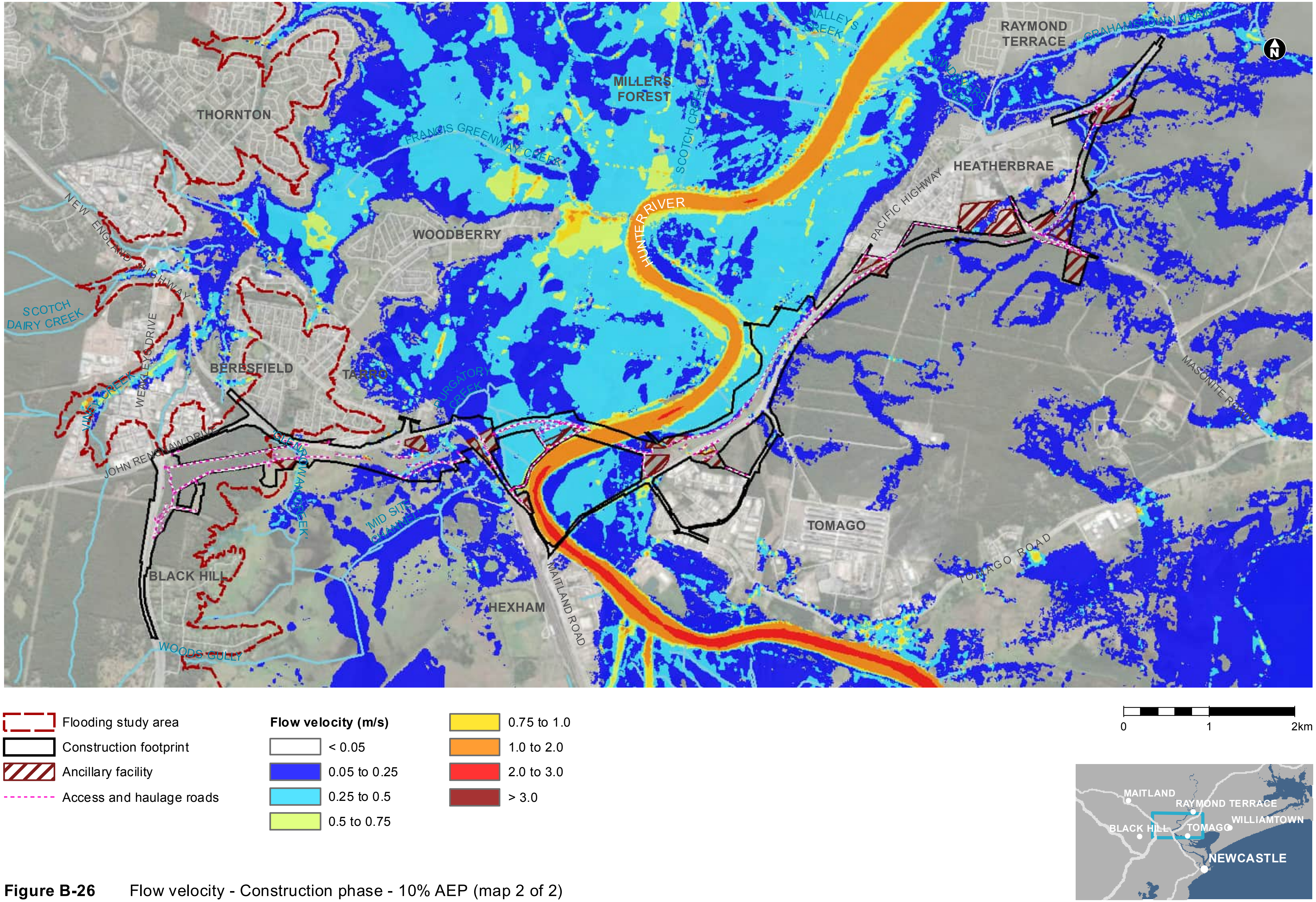


Figure B-26 Flow velocity - Construction phase - 10% AEP (map 2 of 2)

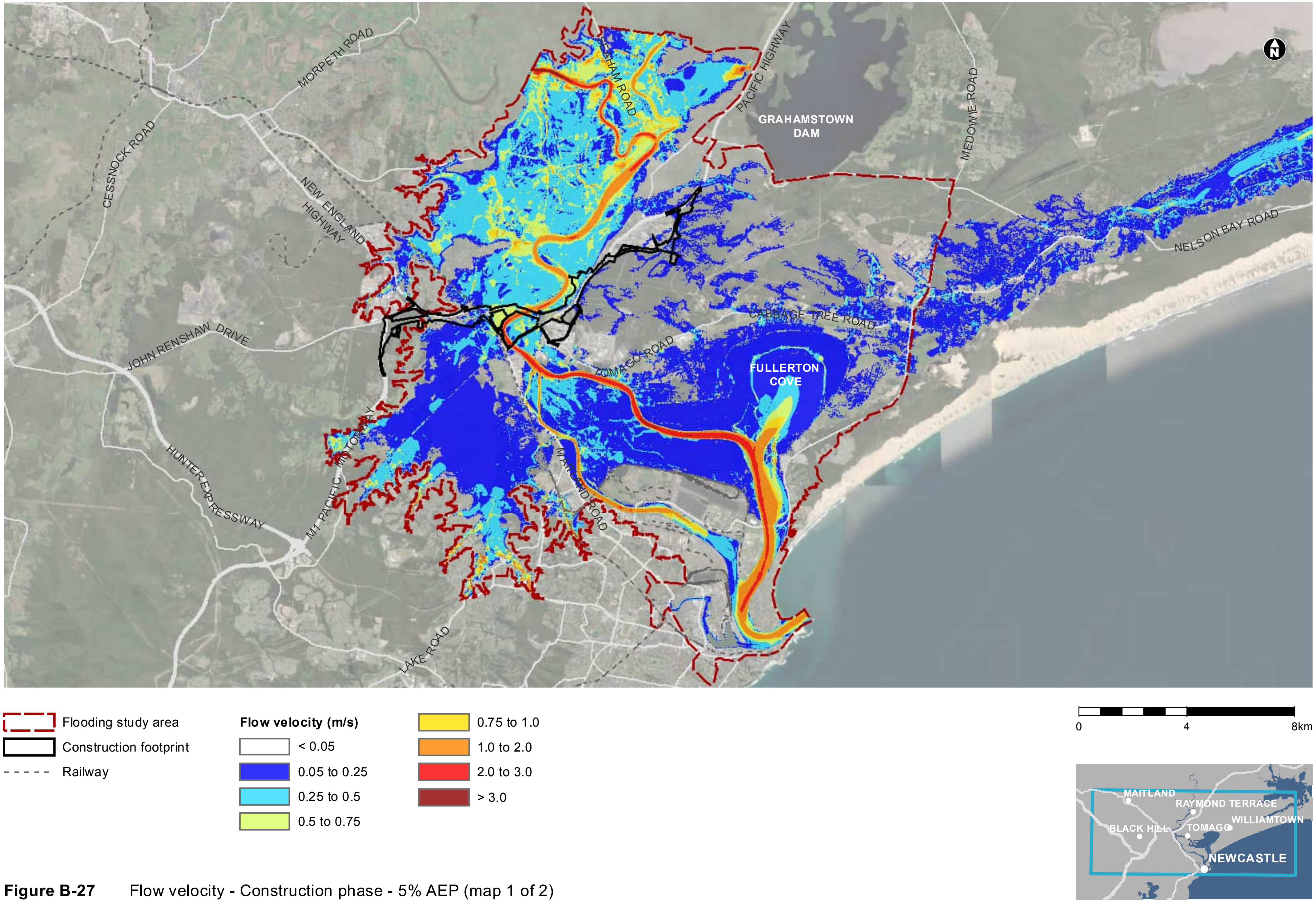


Figure B-27 Flow velocity - Construction phase - 5% AEP (map 1 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-27_Velocity_Construction_5_AEP_JAC_A4L_175000_V01.mxd

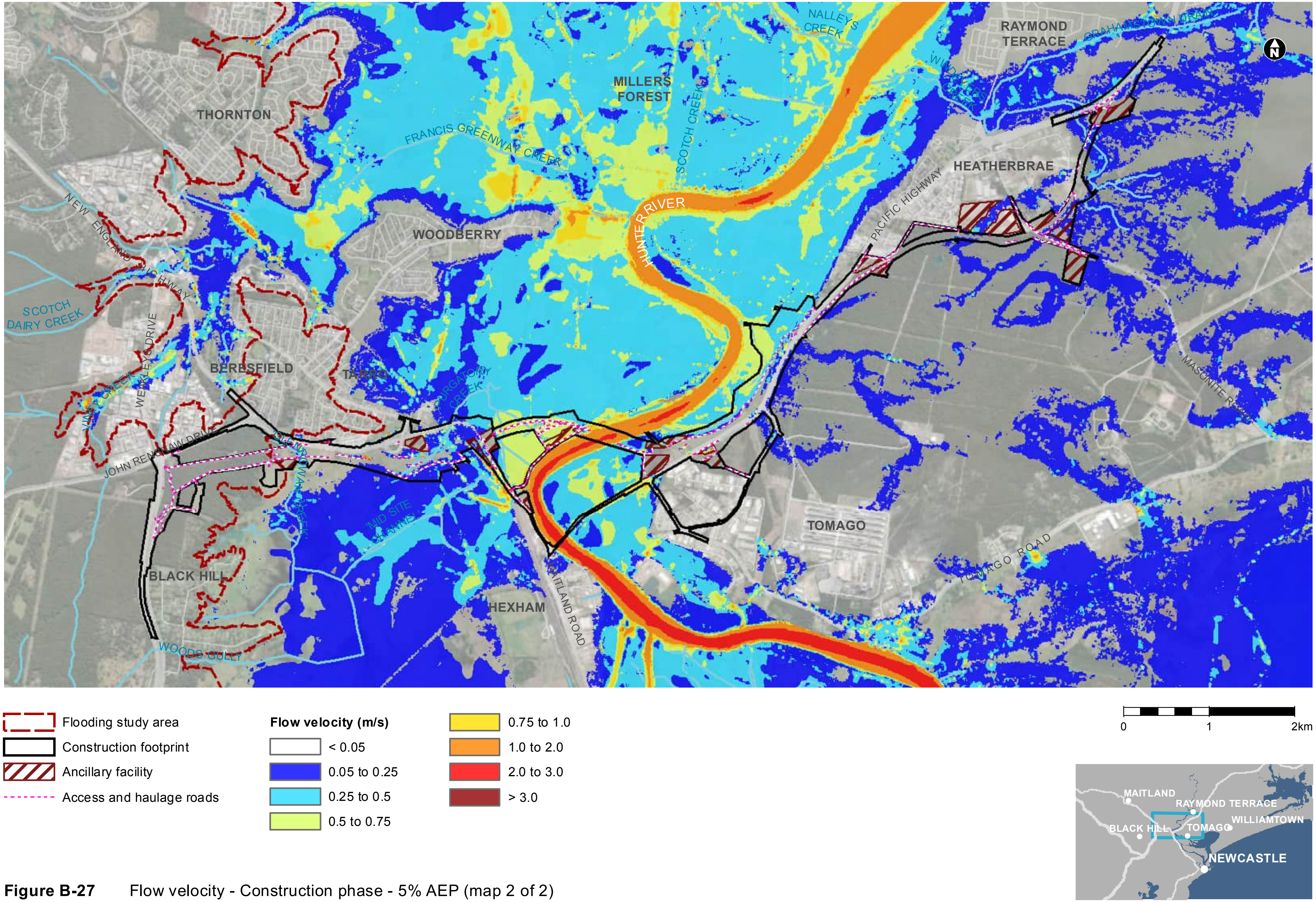
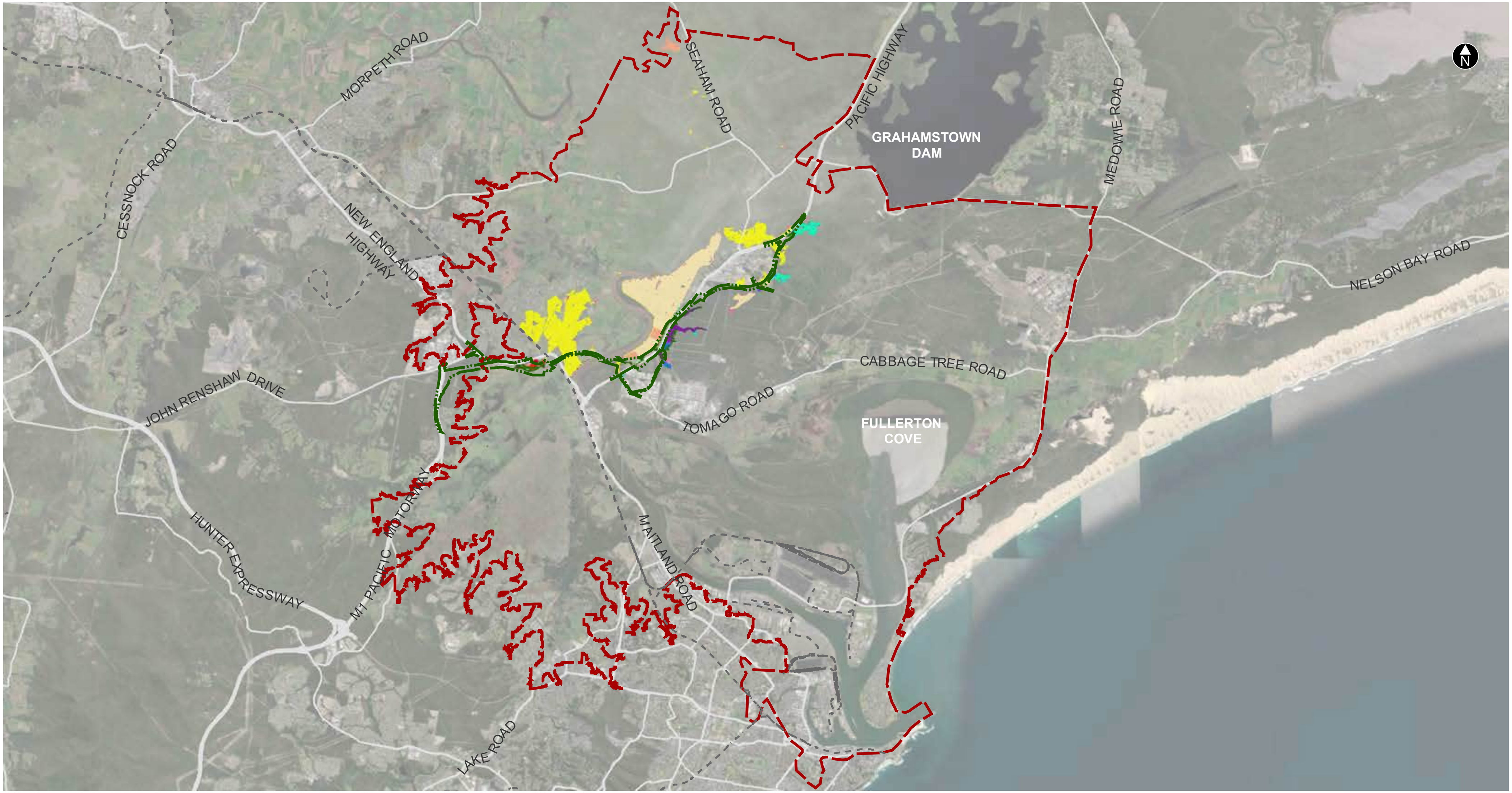


Figure B-27 Flow velocity - Construction phase - 5% AEP (map 2 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_B-27_Velocity_Construction_5_AEP_JAC_A4L_175000_V01.mxd

Appendix C. Updated Flood Impact Mapping – Operation



Flooding study area
Operational footprint
Railway

Change in flood level from existing case (m)

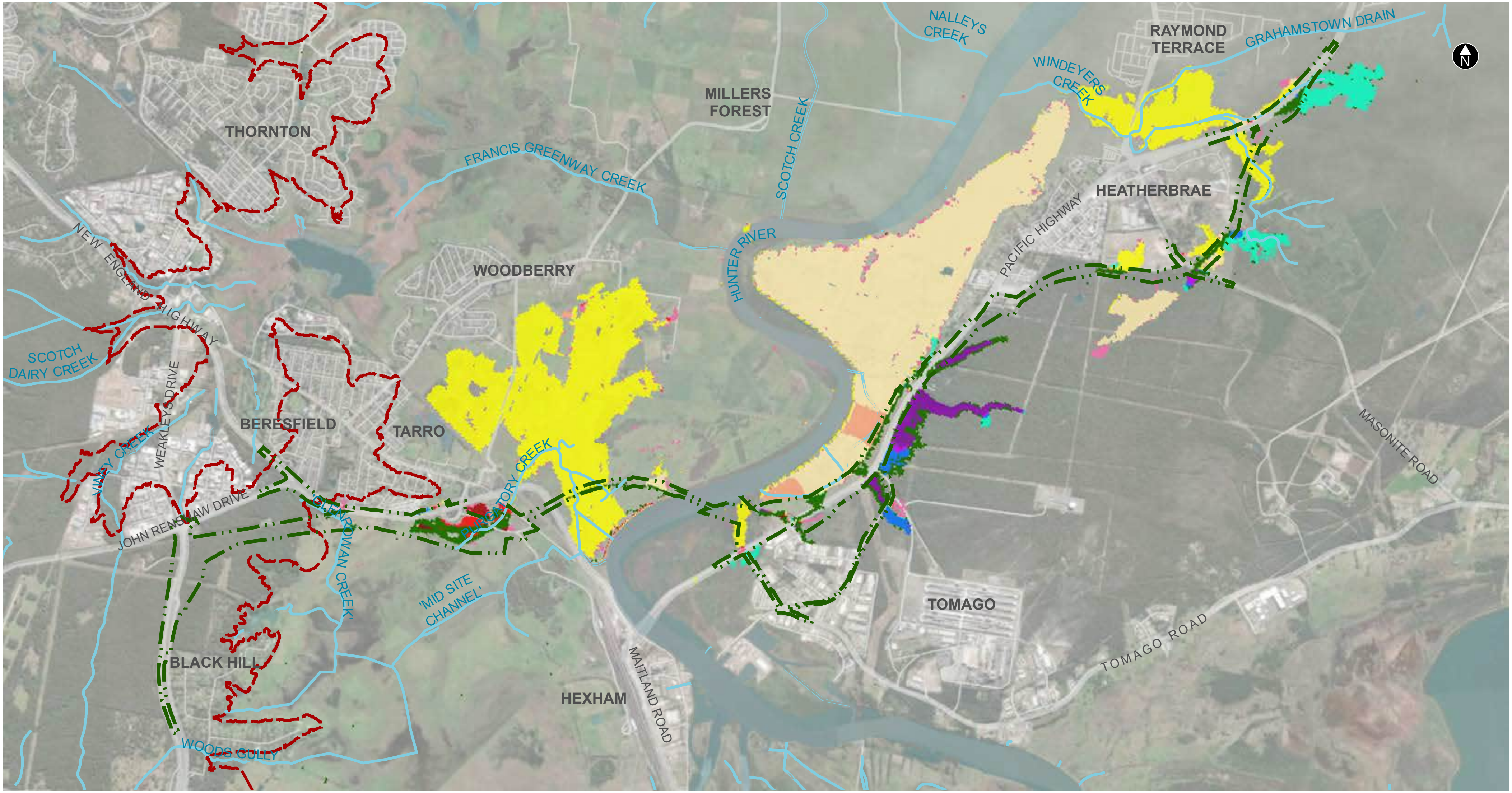
- < -0.4
- -0.4 - -0.25
- -0.25 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01 (not shown)
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.4
- > 0.4

Change - Wet and Dry

- Was wet now dry
- Was dry now wet

0 4 8km

Figure C-1 Change in flood level - Operation phase - 20% AEP (map 1 of 2)



Flooding study area
Operational footprint

Change in flood level from existing case (m)

- < -0.4
- -0.4 - -0.25
- -0.25 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01 (not shown)
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.4
- > 0.4

Change - Wet and Dry

- Was wet now dry
- Was dry now wet

0 1 2km

Figure C-1 Change in flood level - Operation phase - 20% AEP (map 2 of 2)

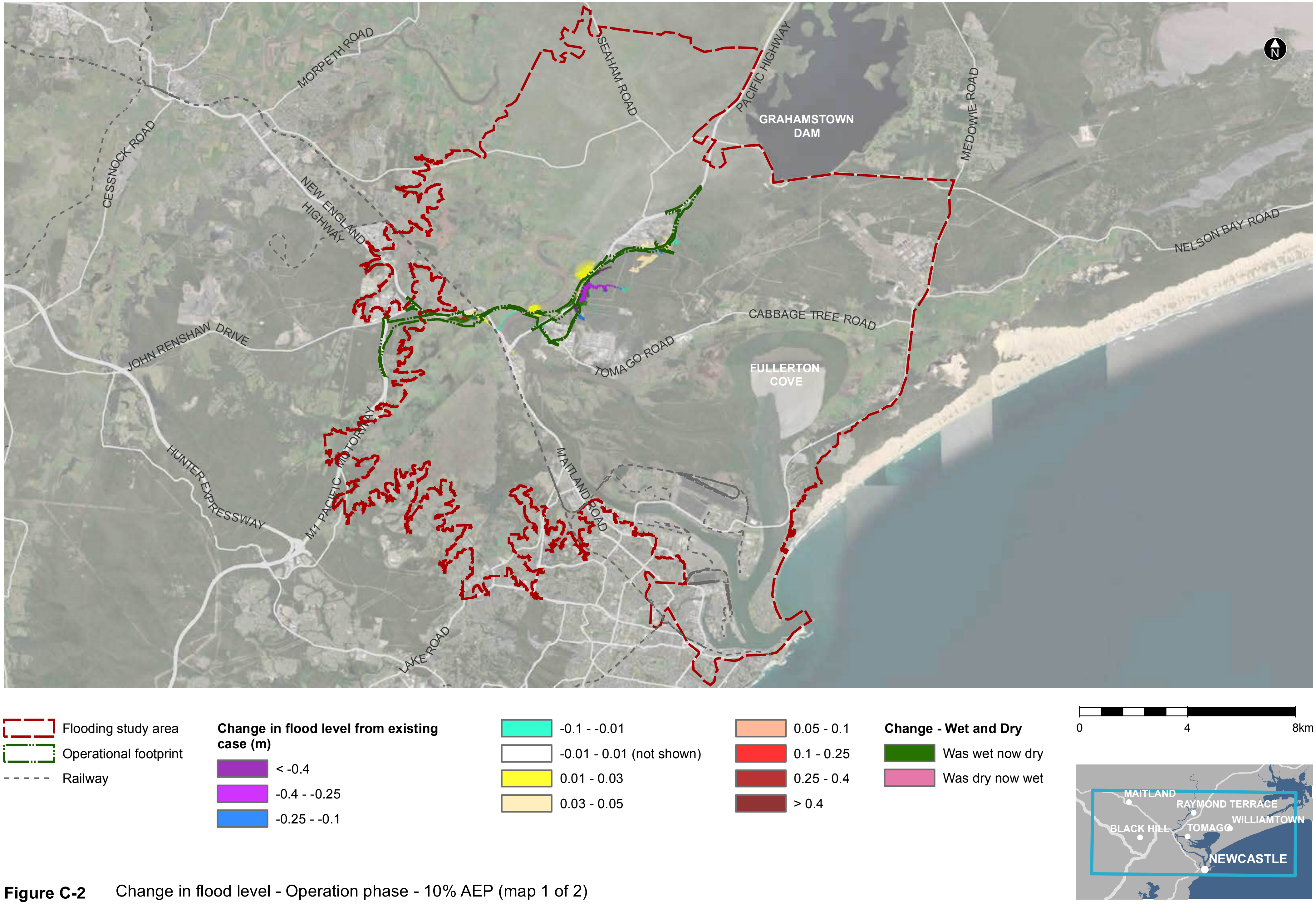
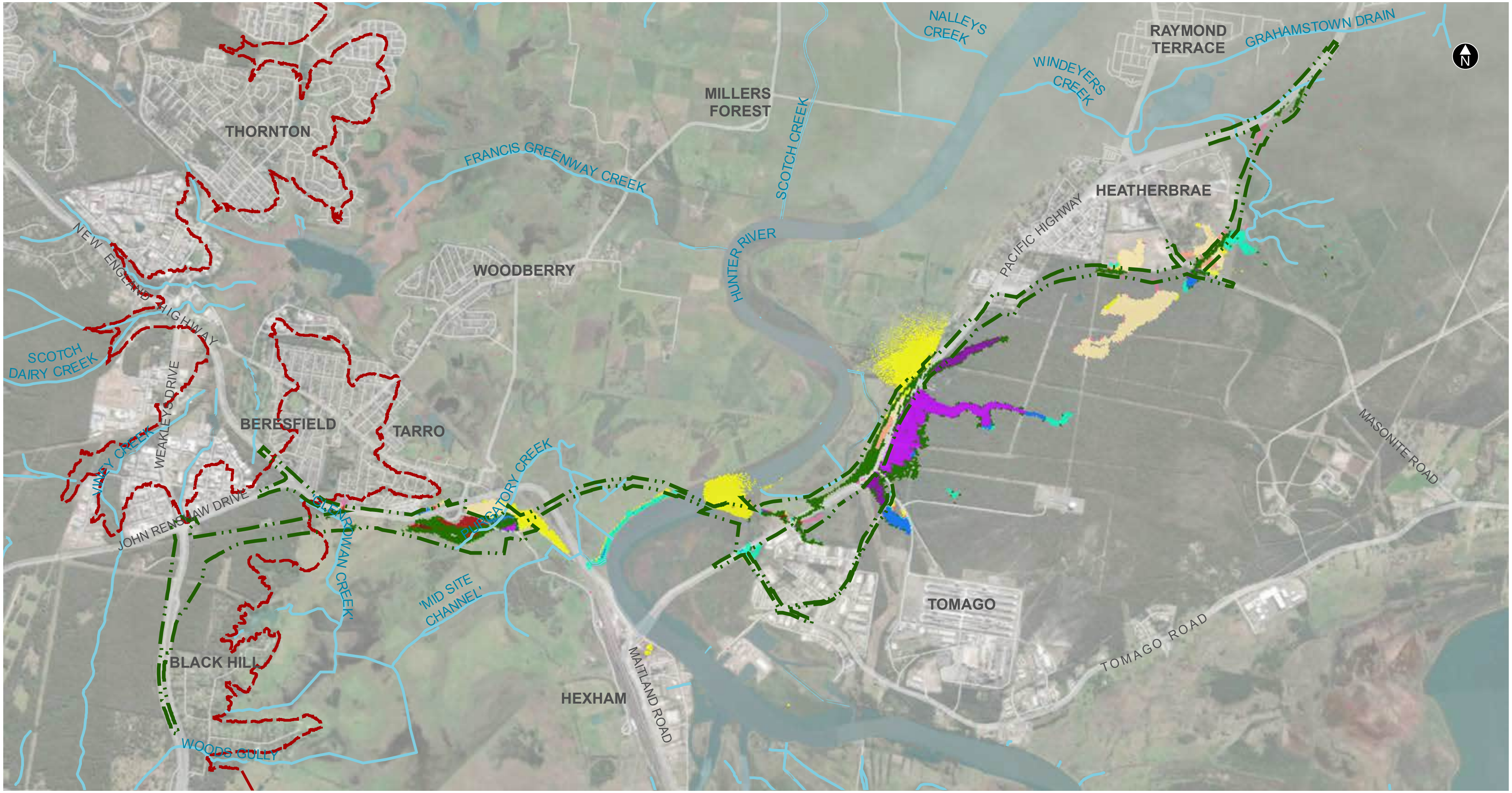


Figure C-2 Change in flood level - Operation phase - 10% AEP (map 1 of 2)

Date: 22/12/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Hydro_Flooding\Operation phase - Option B\IA230000_CD_HF_002_D2_ChangeFloodLevel10Operational_JAC_A4L_175000_V01.mxd



Flooding study area

Operational footprint

Change in flood level from existing case (m)

- < -0.4
- -0.4 - -0.25
- -0.25 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01 (not shown)
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.4
- > 0.4

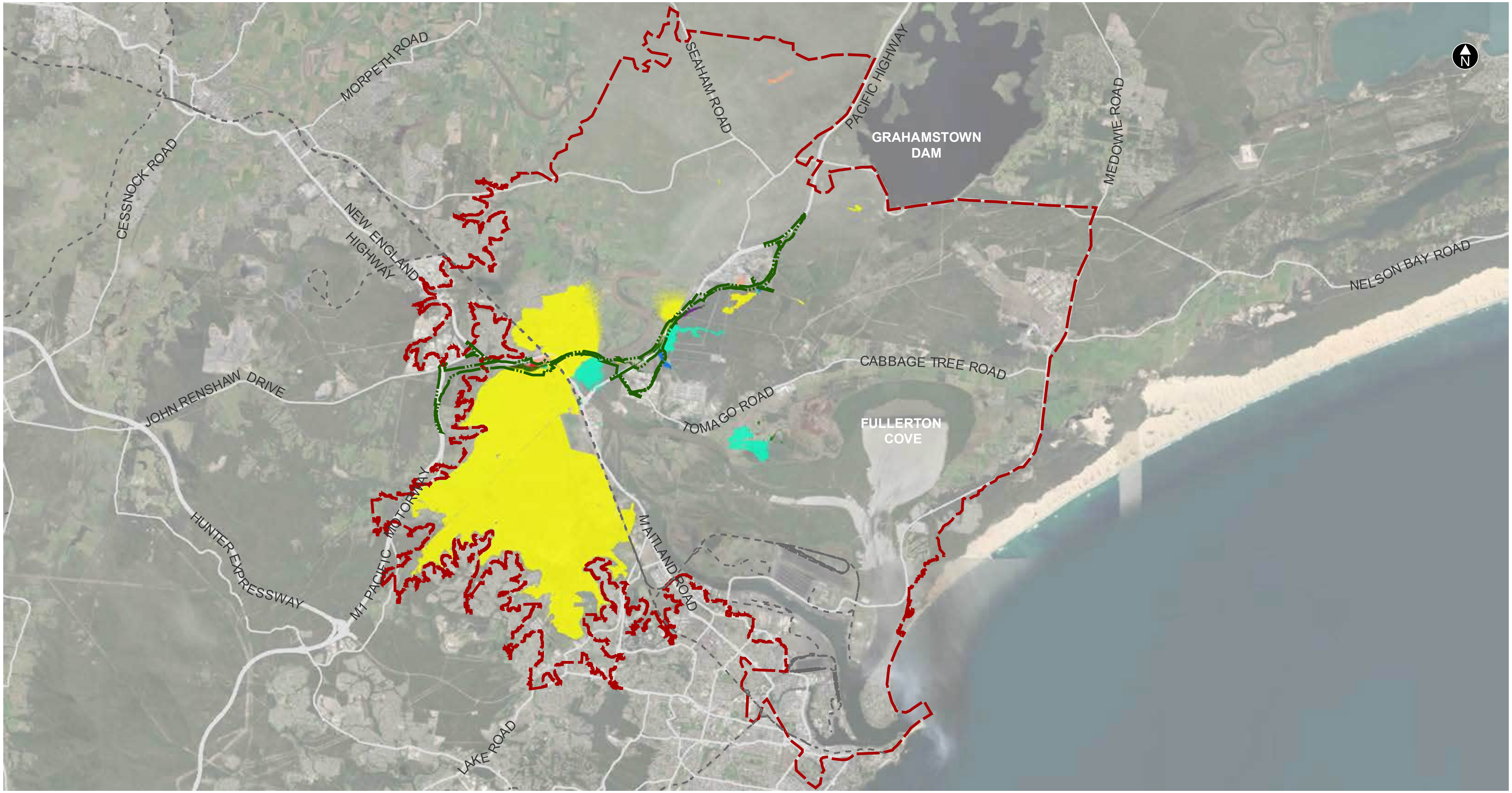
Change - Wet and Dry

- Was wet now dry
- Was dry now wet

0 1 2km

Figure C-2 Change in flood level - Operation phase - 10% AEP (map 2 of 2)

Date: 22/12/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Hydro_Flooding\Operation phase - Option B\IA230000_CD_HF_002_D2_ChangeFloodLevel10Operational_JAC_A4L_175000_V01.mxd



Flooding study area
Operational footprint
Railway

Change in flood level from existing case (m)

- < -0.4
- -0.4 - -0.25
- -0.25 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01 (not shown)
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.4
- > 0.4

Change - Wet and Dry

- Was wet now dry
- Was dry now wet

0 4 8km

Figure C-3 Change in flood level - Operation phase - 5% AEP (map 1 of 2)

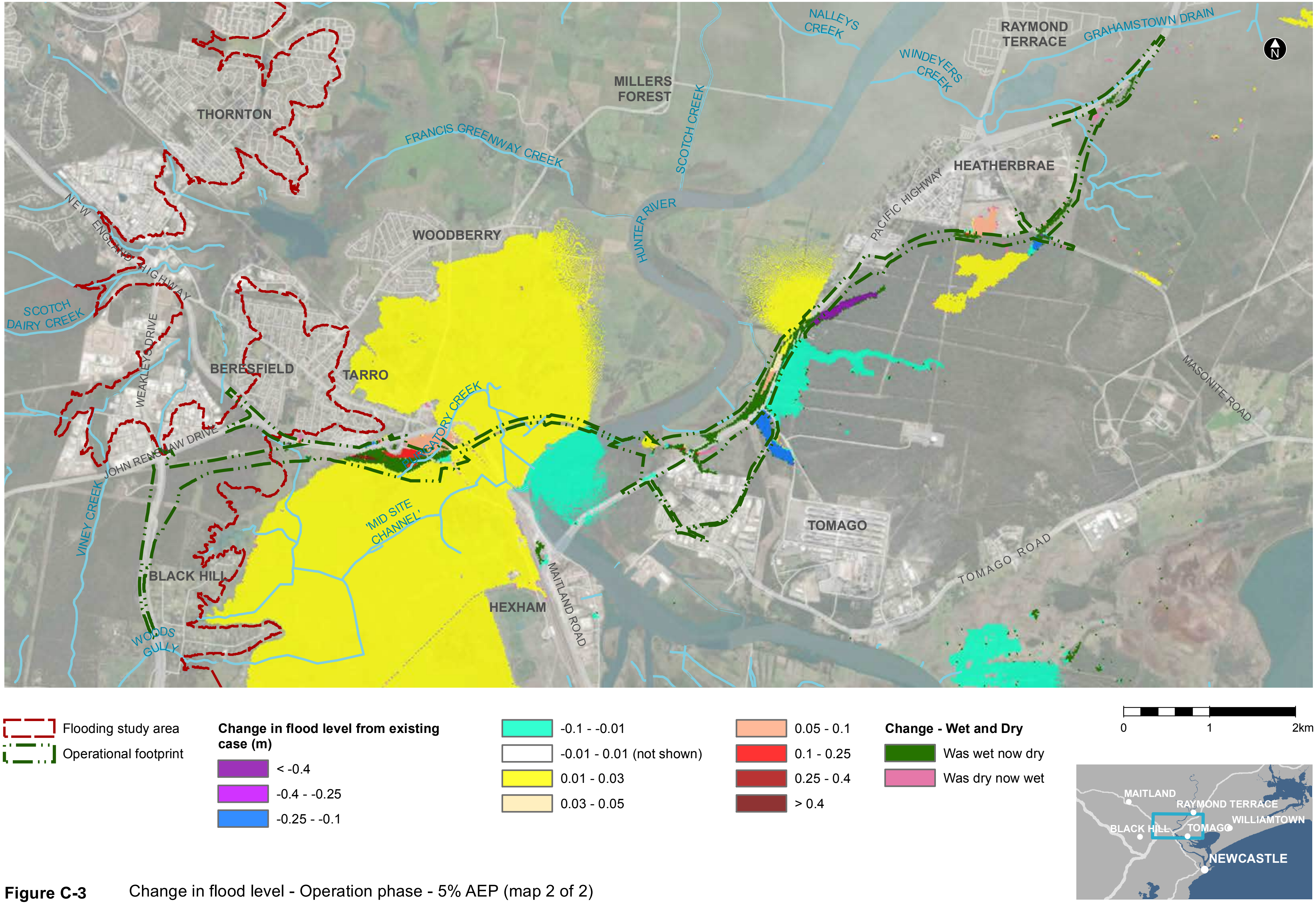


Figure C-3 Change in flood level - Operation phase - 5% AEP (map 2 of 2)

Date: 6/10/2021 Path: \\jacobs.com\ANZ\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Operation\IA230000_CD_HF_002_OptionB_ChangeFloodLevel5Operational_JAC_A4L_175000_V01.mxd

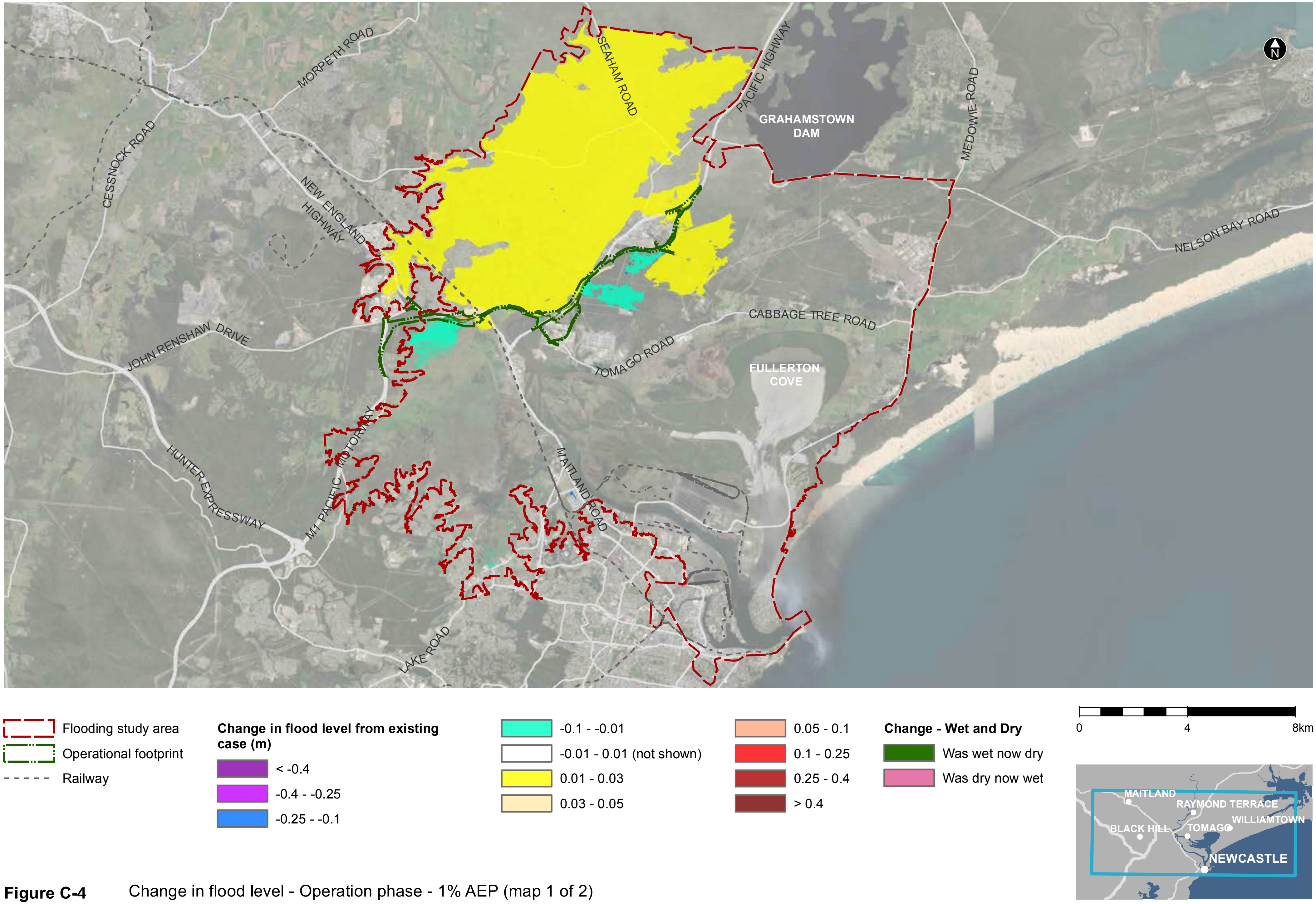
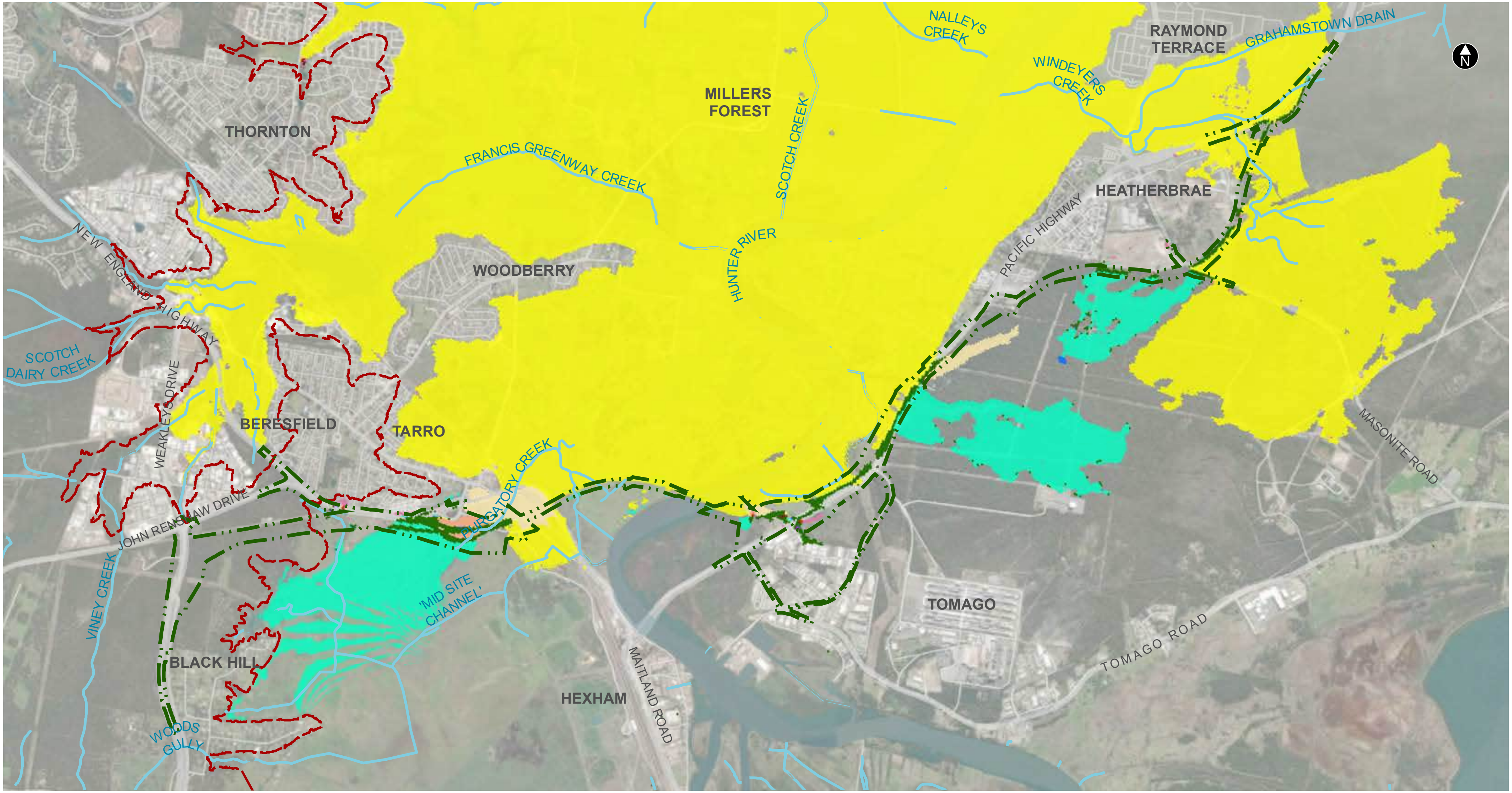


Figure C-4 Change in flood level - Operation phase - 1% AEP (map 1 of 2)

Date: 6/10/2021 Path: \\jacobs.com\ANZ\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Operation\IA230000_CD_HF_003_OptionB_ChangeFloodLevel1Operational_JAC_A4L_175000_V01.mxd



Flooding study area

Operational footprint

Change in flood level from existing case (m)

< -0.4

-0.4 - -0.25

-0.25 - -0.1

-0.1 - -0.01

-0.01 - 0.01 (not shown)

0.01 - 0.03

0.03 - 0.05

0.05 - 0.1

0.1 - 0.25

0.25 - 0.4

> 0.4

Change - Wet and Dry

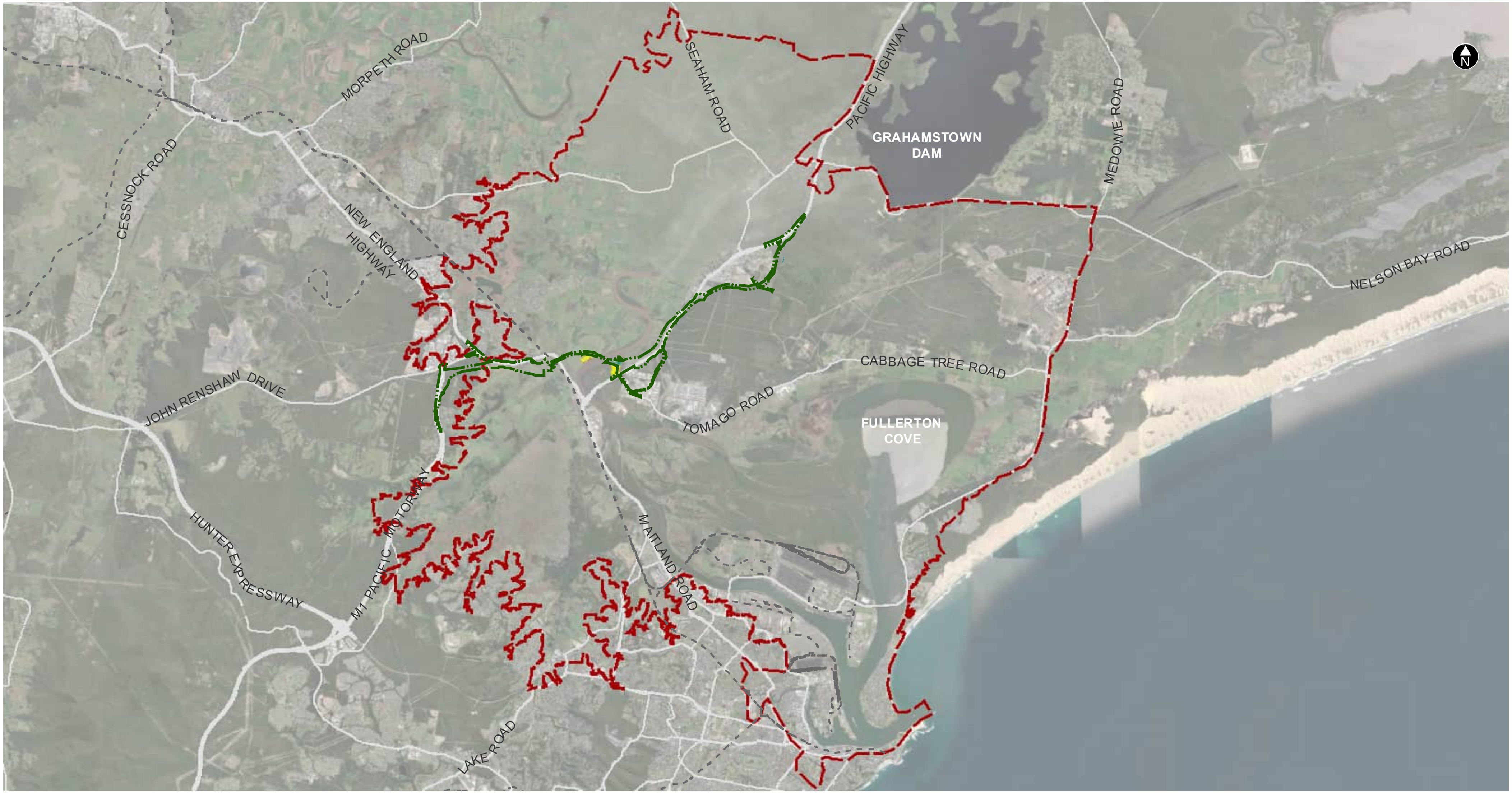
Was wet now dry

Was dry now wet

0 1 2km

Figure C-4 Change in flood level - Operation phase - 1% AEP (map 2 of 2)

Date: 6/10/2021 Path: \\jacobs.com\ANZ\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Operation\IA230000_CD_HF_003_OptionB_ChangeFloodLevel1Operational_JAC_A4L_175000_V01.mxd



Flooding study area
Operational footprint
Railway

Change in afflux from EIS (m)

< -0.4	-0.1 - -0.05
-0.4 - -0.25	-0.05 - -0.03
-0.25 - -0.1	-0.03 - -0.01
	-0.01 - 0.01 (not shown)
0.01 - 0.03	0.25 - 0.4
0.03 - 0.05	> 0.4
0.05 - 0.1	
0.1 - 0.25	

Figure C-5 Change in afflux from EIS – Operation phase – 20% AEP (map 1 of 2)

Date: 17/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\IA230000_CD_HFSupp_C-5_ChangeAfflux20Operational_JAC_A4L_175000_V02.mxd

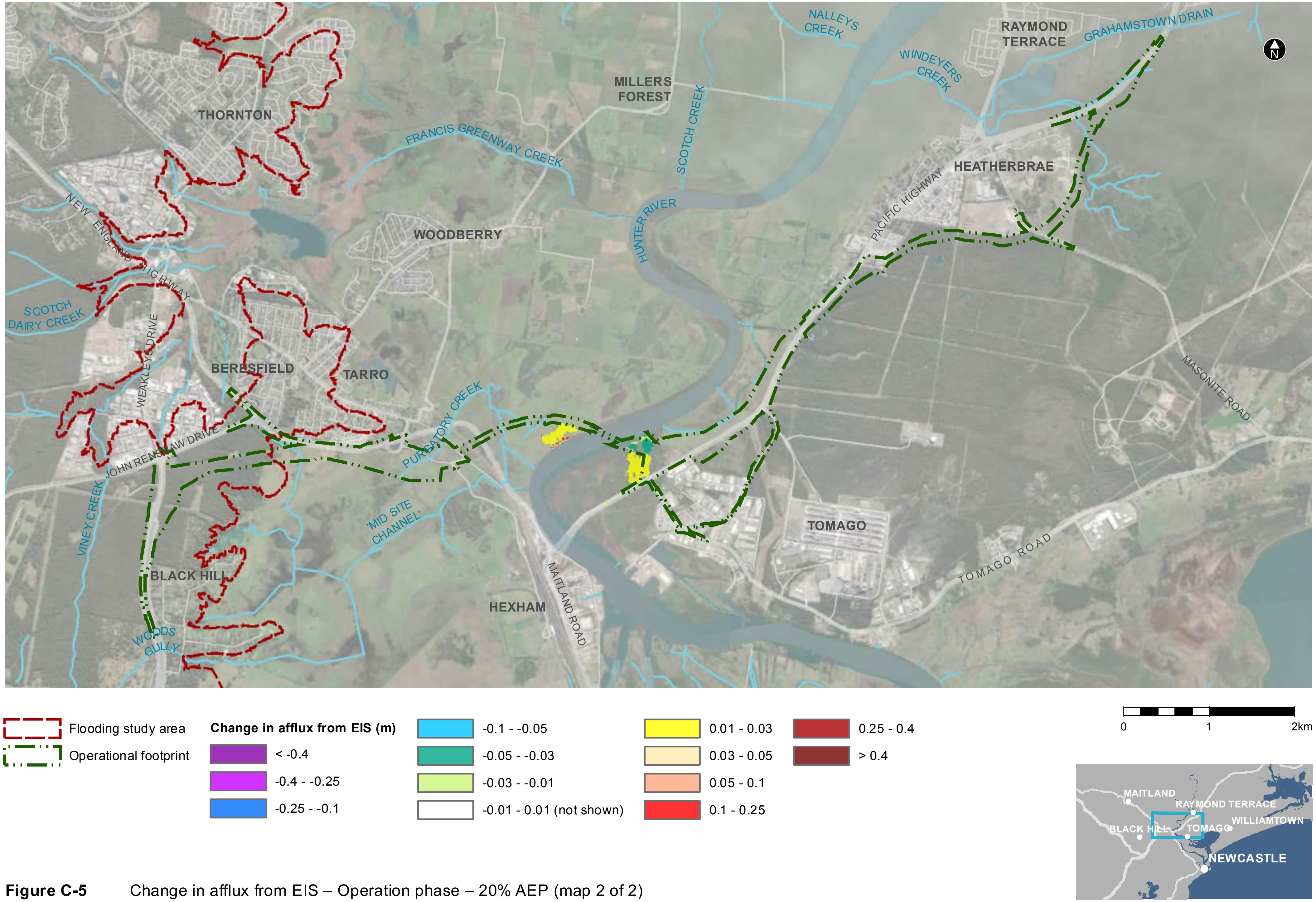


Figure C-5 Change in afflux from EIS – Operation phase – 20% AEP (map 2 of 2)

Date: 17/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\IA230000_CD_HFSupp_C-5_ChangeAfflux20Operational_JAC_A4L_175000_V02.mxd

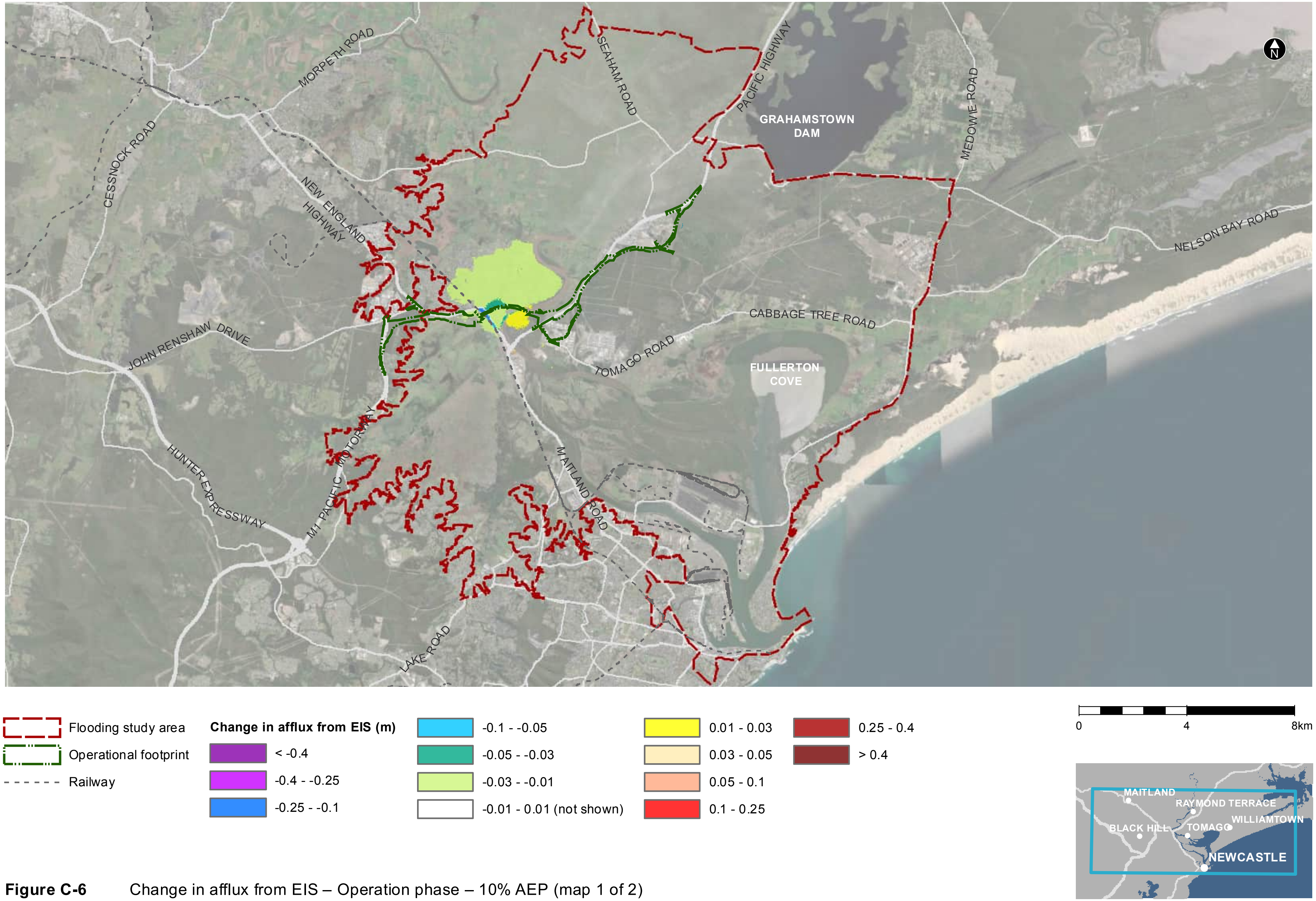
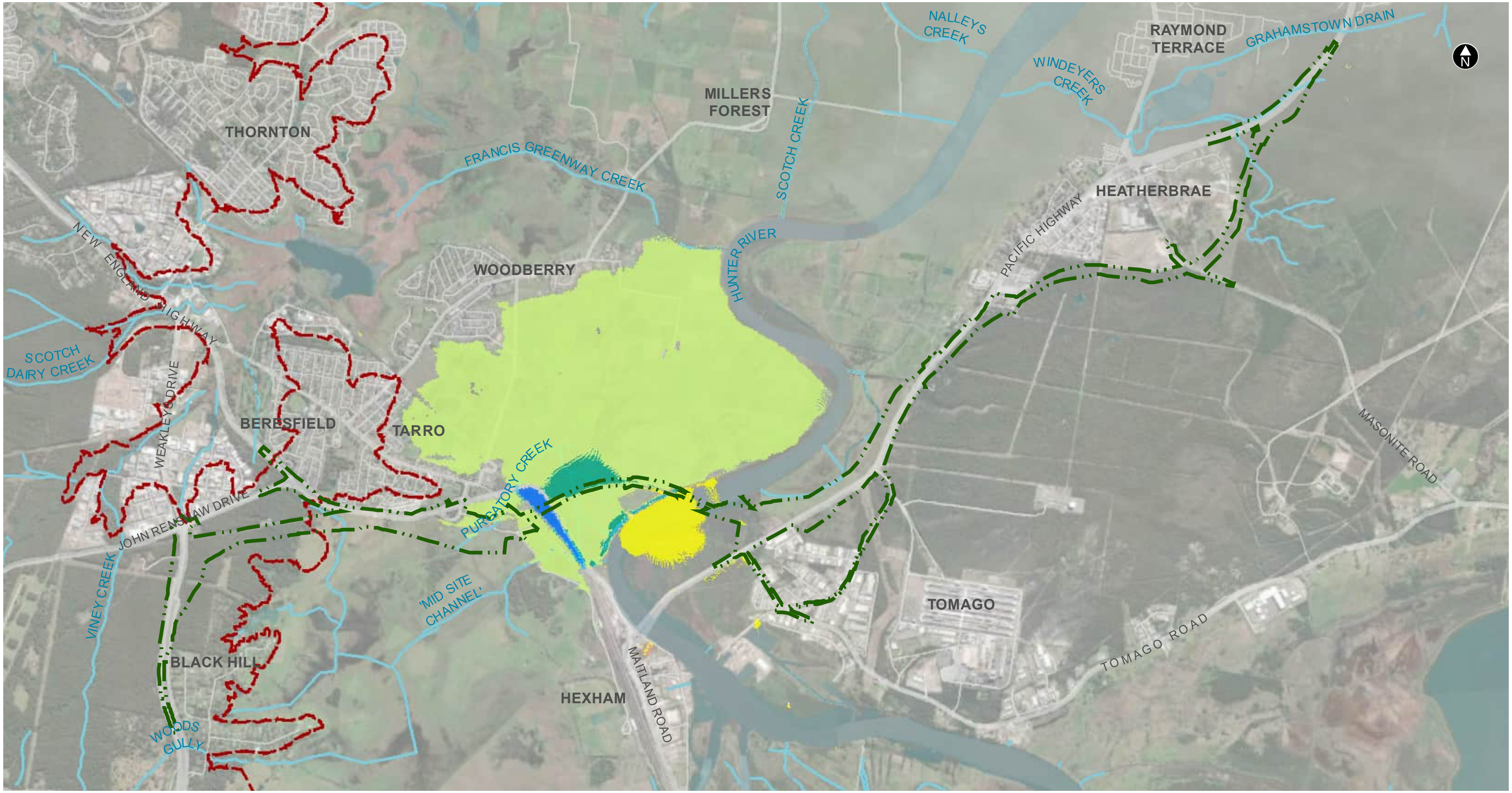


Figure C-6 Change in afflux from EIS – Operation phase – 10% AEP (map 1 of 2)

Date: 17/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\IA230000_CD_HFSupp_C-6_ChangeAfflux10Operational_JAC_A4L_175000_V02.mxd



Flooding study area

Operational footprint

Change in afflux from EIS (m)

< -0.4

-0.4 - -0.25

-0.25 - -0.1

-0.1 - -0.05

-0.05 - -0.03

-0.03 - -0.01

-0.01 - 0.01 (not shown)

0.01 - 0.03

0.03 - 0.05

0.05 - 0.1

0.1 - 0.25

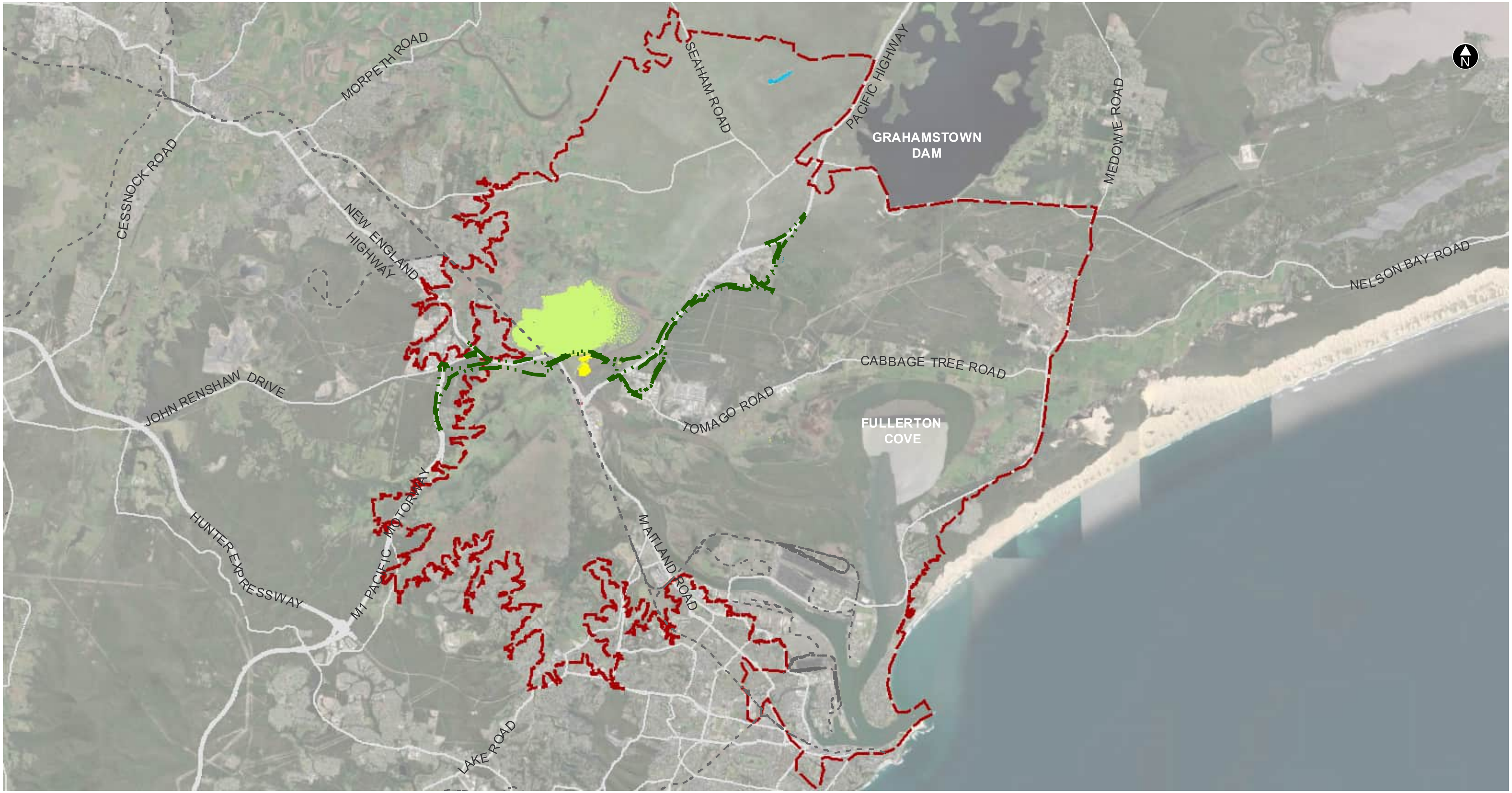
0.25 - 0.4

> 0.4

0 1 2km

Figure C-6 Change in afflux from EIS – Operation phase – 10% AEP (map 2 of 2)

Date: 17/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\IA230000_CD_HFSupp_C-6_ChangeAfflux10Operational_JAC_A4L_175000_V02.mxd



Flooding study area
Operational footprint
Railway

Change in afflux from EIS (m)

< -0.4	
-0.4 - -0.25	
-0.25 - -0.1	
-0.1 - -0.05	
-0.05 - -0.03	
-0.03 - -0.01	
-0.01 - 0.01 (not shown)	
0.01 - 0.03	
0.03 - 0.05	
0.05 - 0.1	
0.1 - 0.25	
0.25 - 0.4	
> 0.4	

Figure C-7 Change in afflux from EIS – Operation phase – 5% AEP (map 1 of 2)

Date: 17/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\IA230000_CD_HFSupp_C-7_ChangeAfflux5Operational_JAC_A4L_175000_V02.mxd

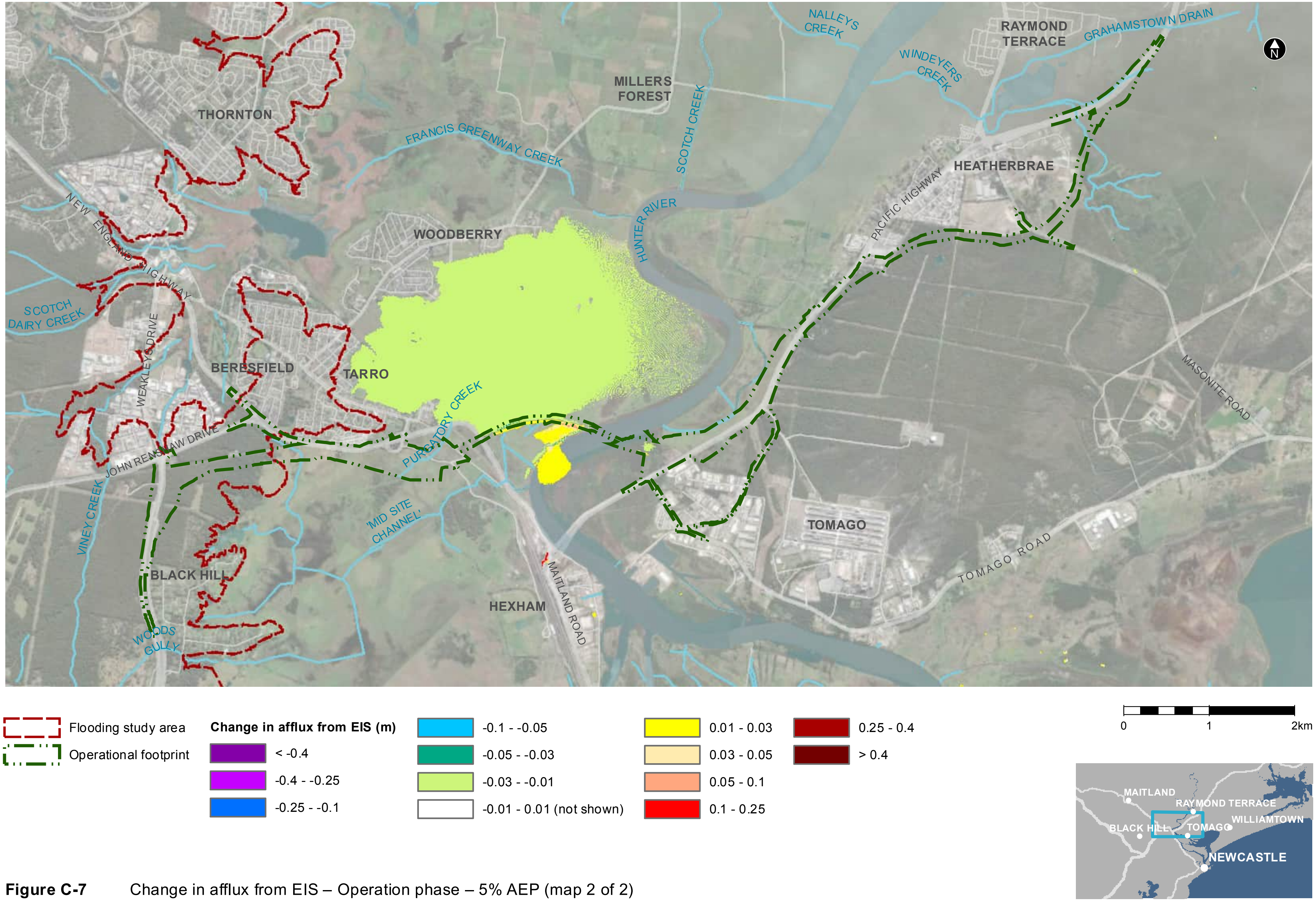


Figure C-7 Change in afflux from EIS – Operation phase – 5% AEP (map 2 of 2)

Date: 17/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\IA230000_CD_HFSupp_C-7_ChangeAfflux5Operational_JAC_A4L_175000_V02.mxd

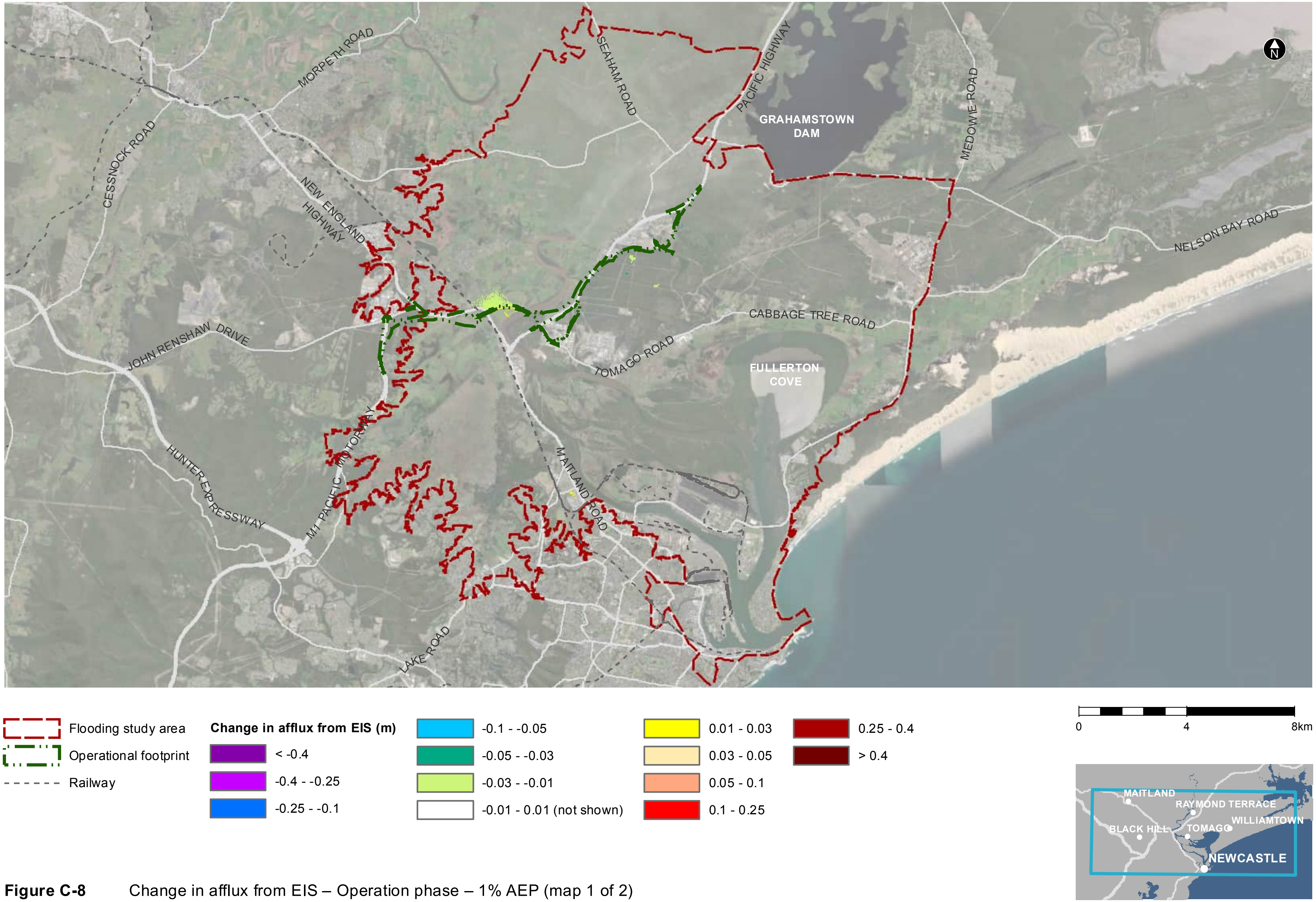


Figure C-8 Change in afflux from EIS – Operation phase – 1% AEP (map 1 of 2)

Date: 17/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\IA230000_CD_HFSupp_C-8_ChangeAfflux1Operational_JAC_A4L_175000_V02.mxd

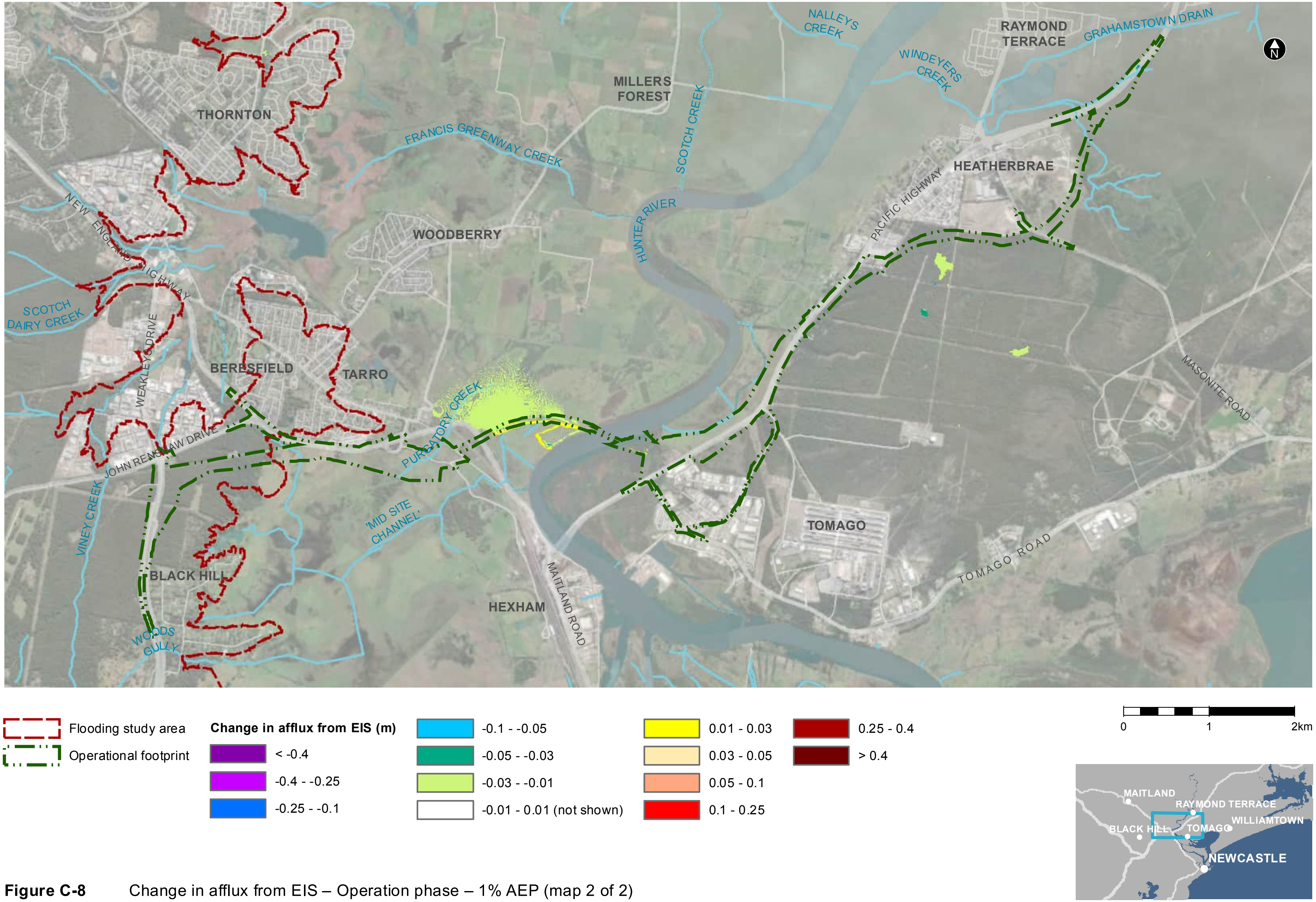


Figure C-8 Change in afflux from EIS – Operation phase – 1% AEP (map 2 of 2)

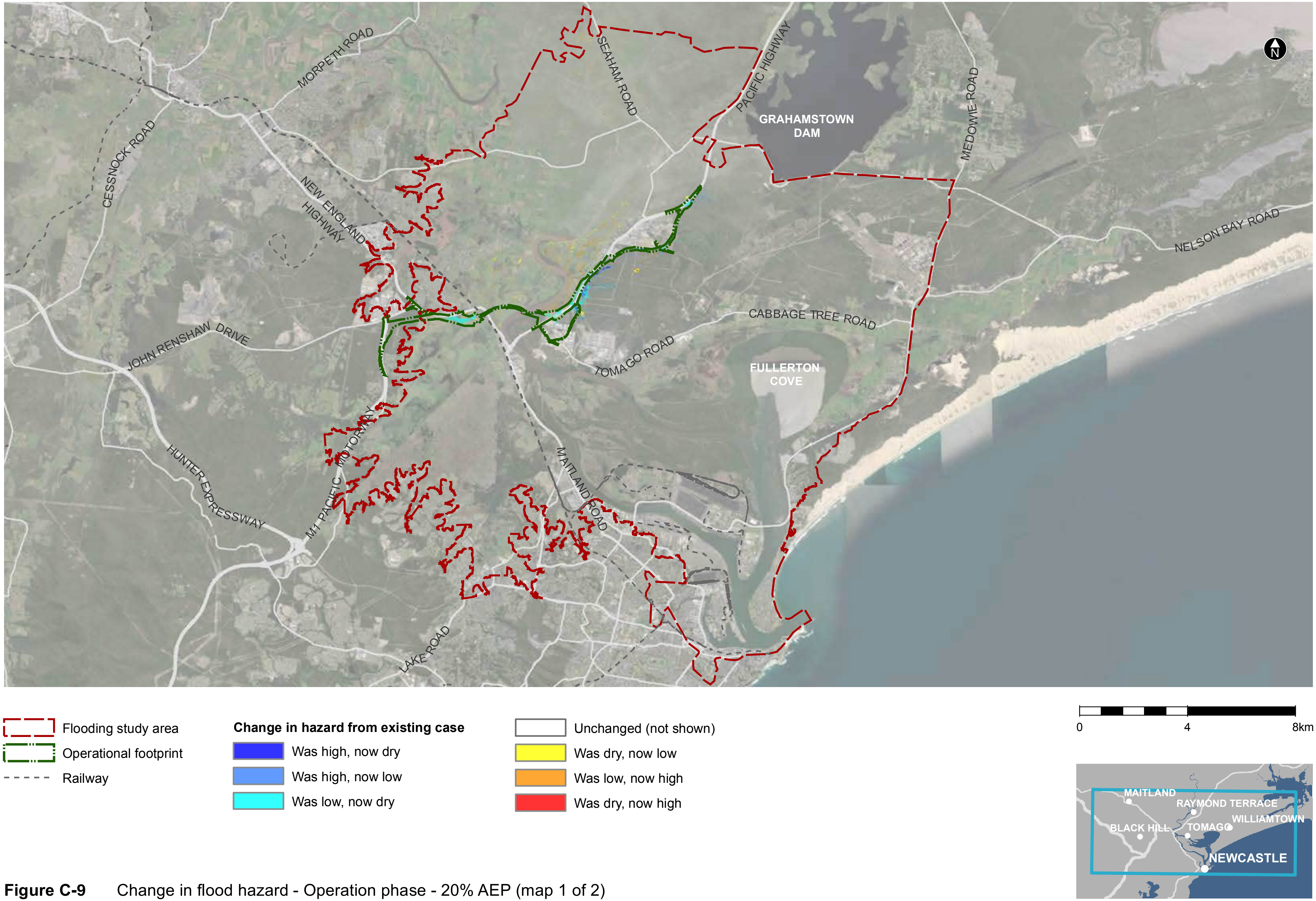
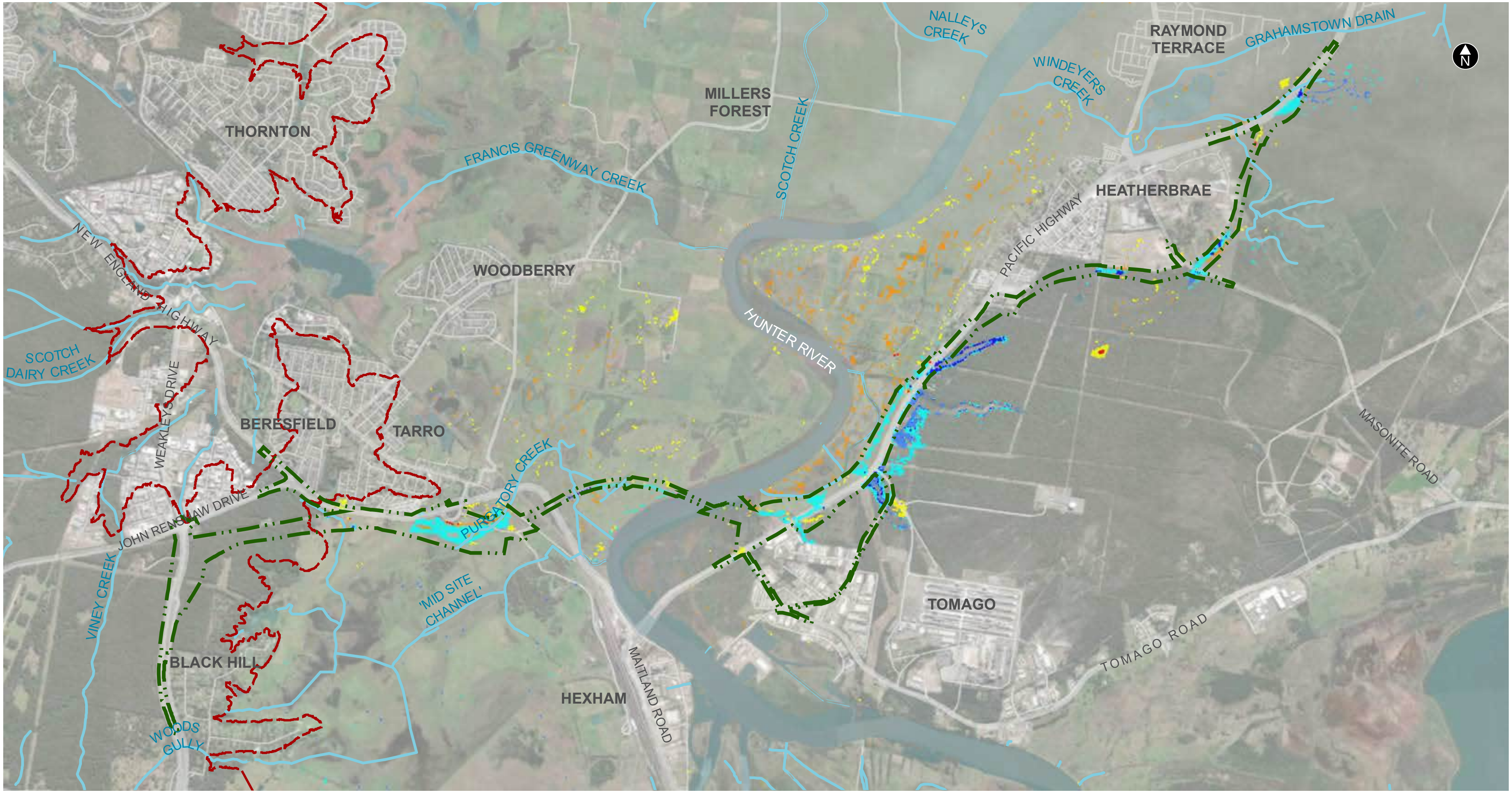


Figure C-9 Change in flood hazard - Operation phase - 20% AEP (map 1 of 2)

Date: 22/12/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Hydro_Flooding\Operation phase - Option B\IA230000_CD_HF_007_D7_ChangeFloodHazard_20_Operational_JAC_A4L_175000_V01.mxd



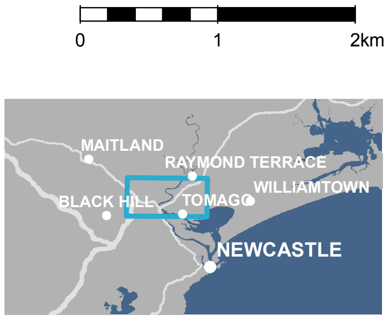
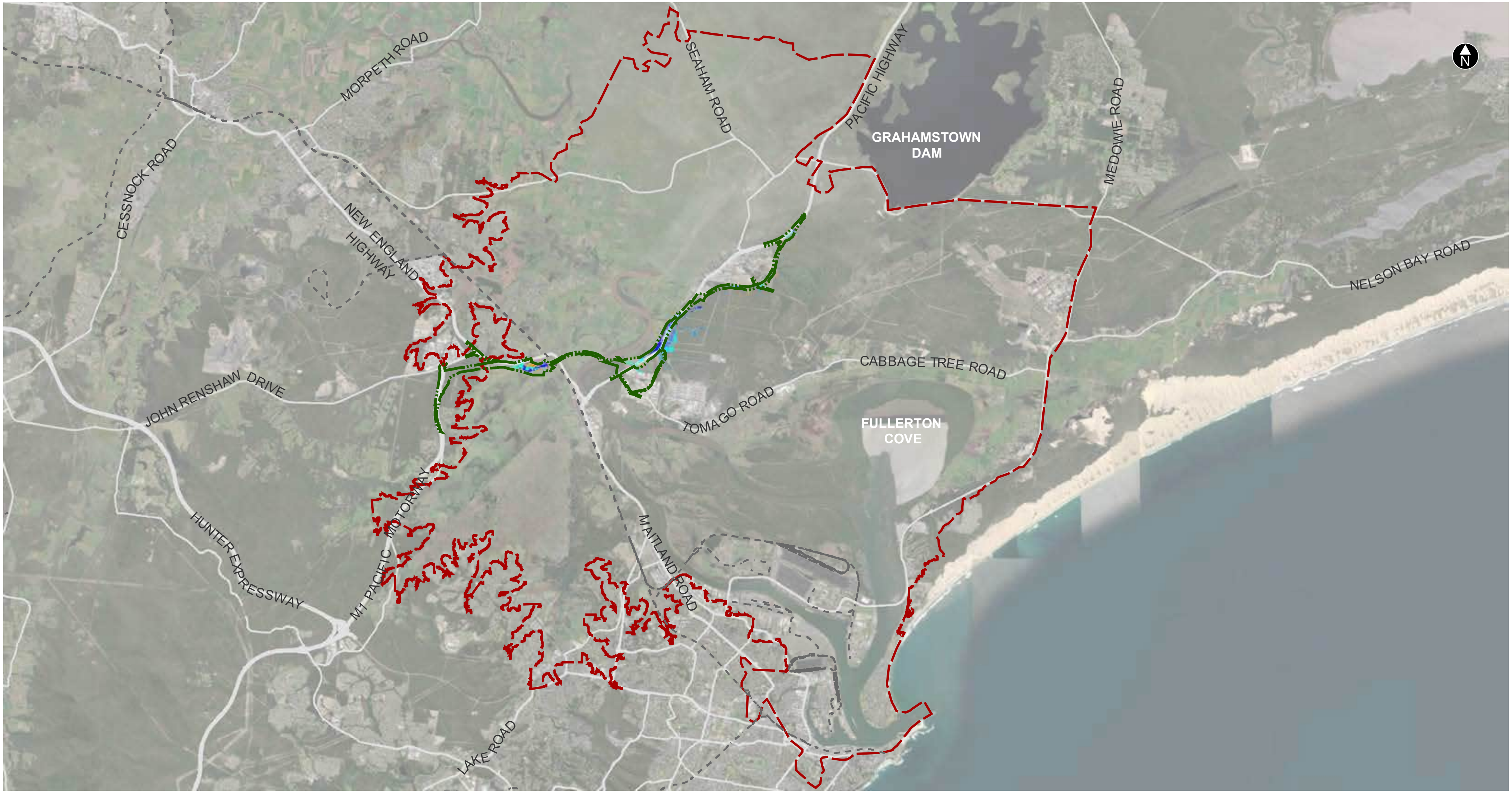


Figure C-9 Change in flood hazard - Operation phase - 20% AEP (map 2 of 2)



Flooding study area

Operational footprint

Railway

Change in hazard from existing case

Was high, now dry

Was high, now low

Was low, now dry

Unchanged (not shown)

Was dry, now low

Was low, now high

Was dry, now high

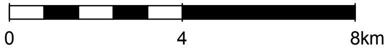


Figure C-10 Change in flood hazard - Operation phase - 10% AEP (map 1 of 2)

Date: 22/12/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Hydro_Flooding\Operation phase - Option B\IA230000_CD_HF_008_D8_ChangeFloodHazard_10_Operational_JAC_A4L_175000_V01.mxd

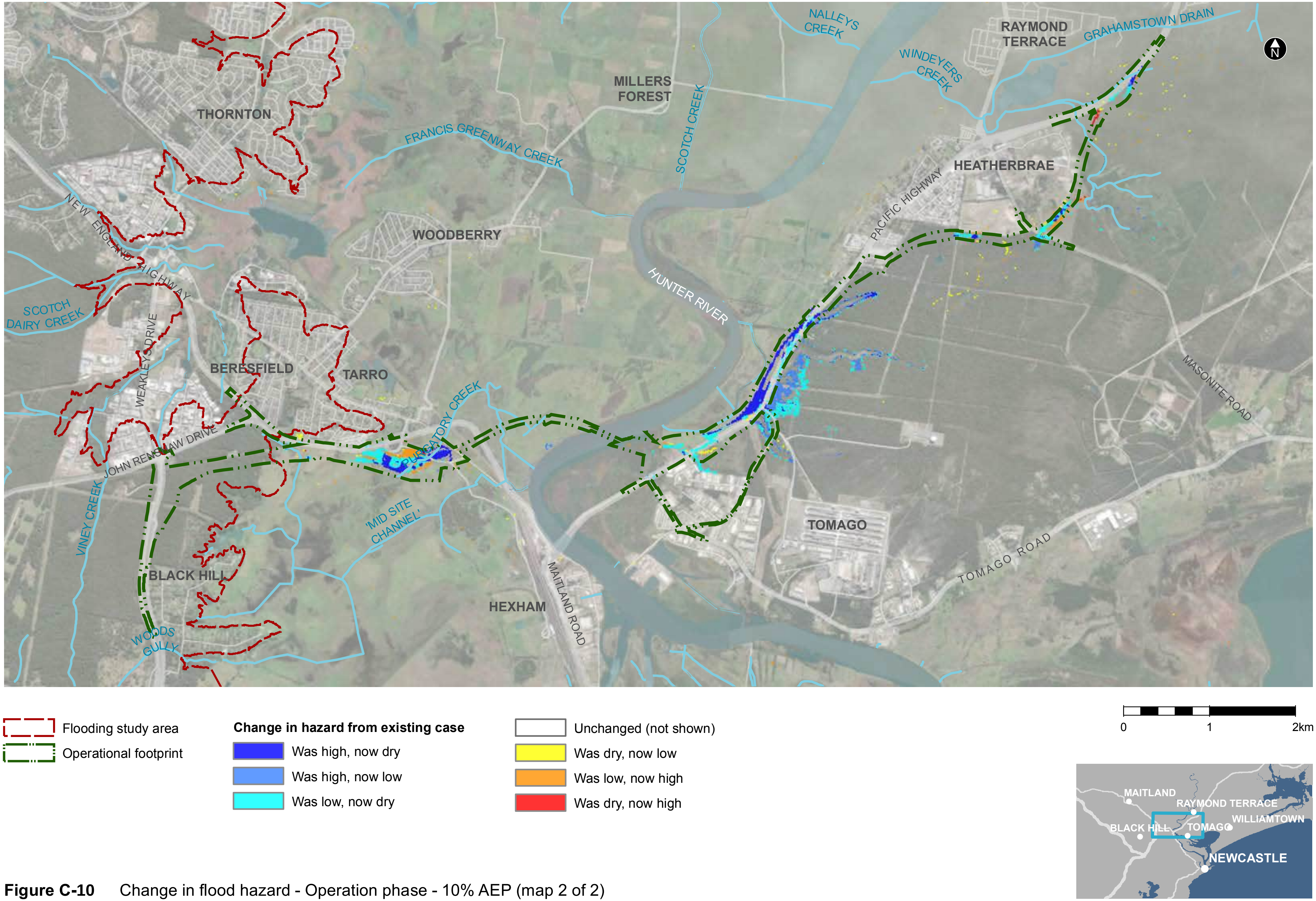


Figure C-10 Change in flood hazard - Operation phase - 10% AEP (map 2 of 2)

Date: 22/12/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Hydro_Flooding\Operation phase - Option B\IA230000_CD_HF_008_D8_ChangeFloodHazard_10_Operational_JAC_A4L_175000_V01.mxd

Flooding study area
Operational footprint
Railway

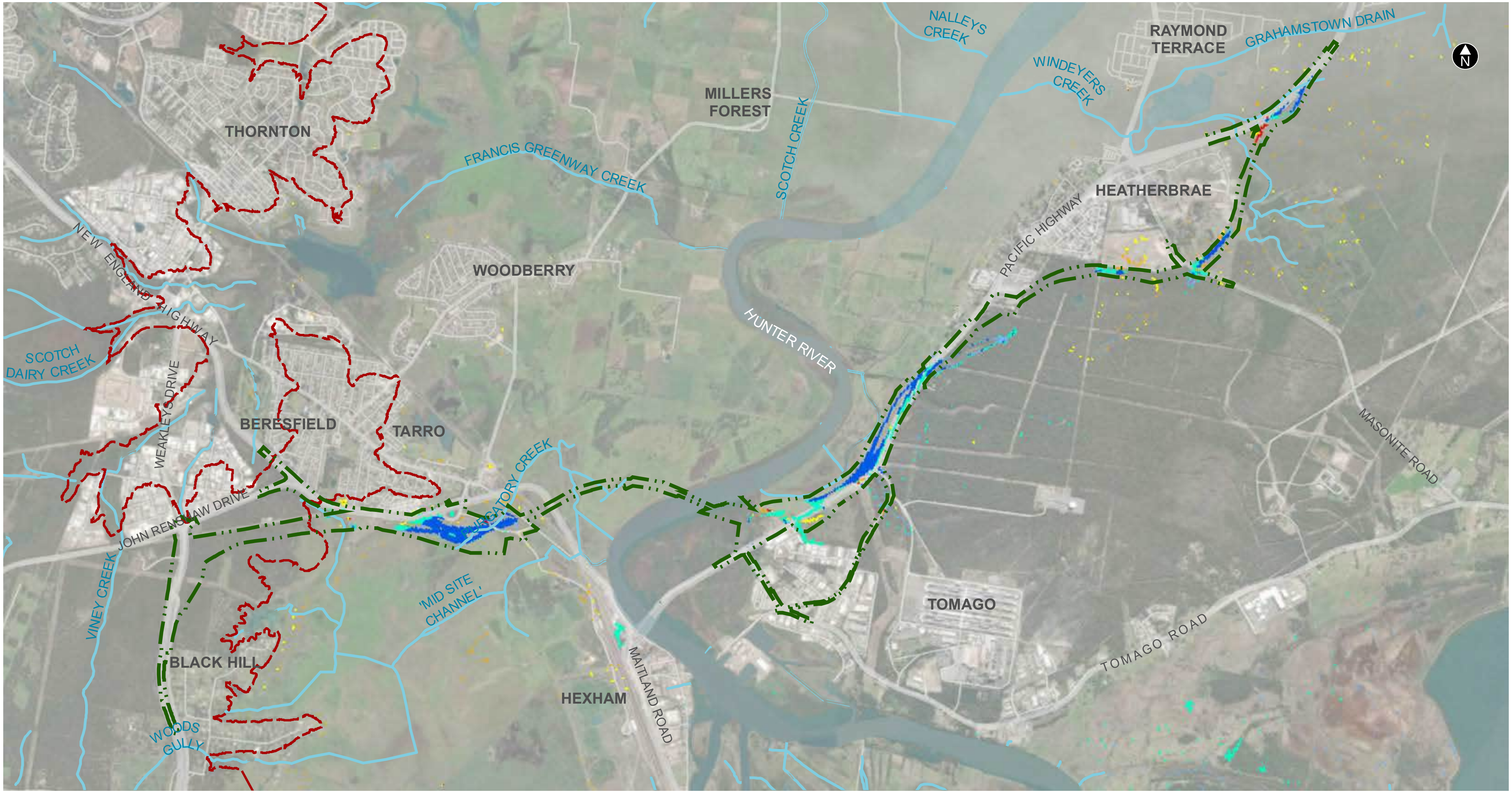
Change in hazard from existing case

Was high, now dry
Was high, now low
Was low, now dry
Unchanged (not shown)
Was dry, now low
Was low, now high
Was dry, now high

0 4 8km

Figure C-11 Change in flood hazard - Operation phase - 5% AEP (map 1 of 2)

Date: 6/10/2021 Path: \\jacobs.com\ANZ\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Operation\IA230000_CD_HF_008_OptionB_ChangeFloodHazard_5_Operational_JAC_A4L_175000_V01.mxd



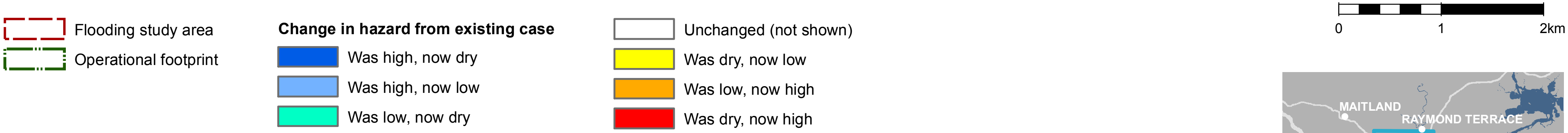
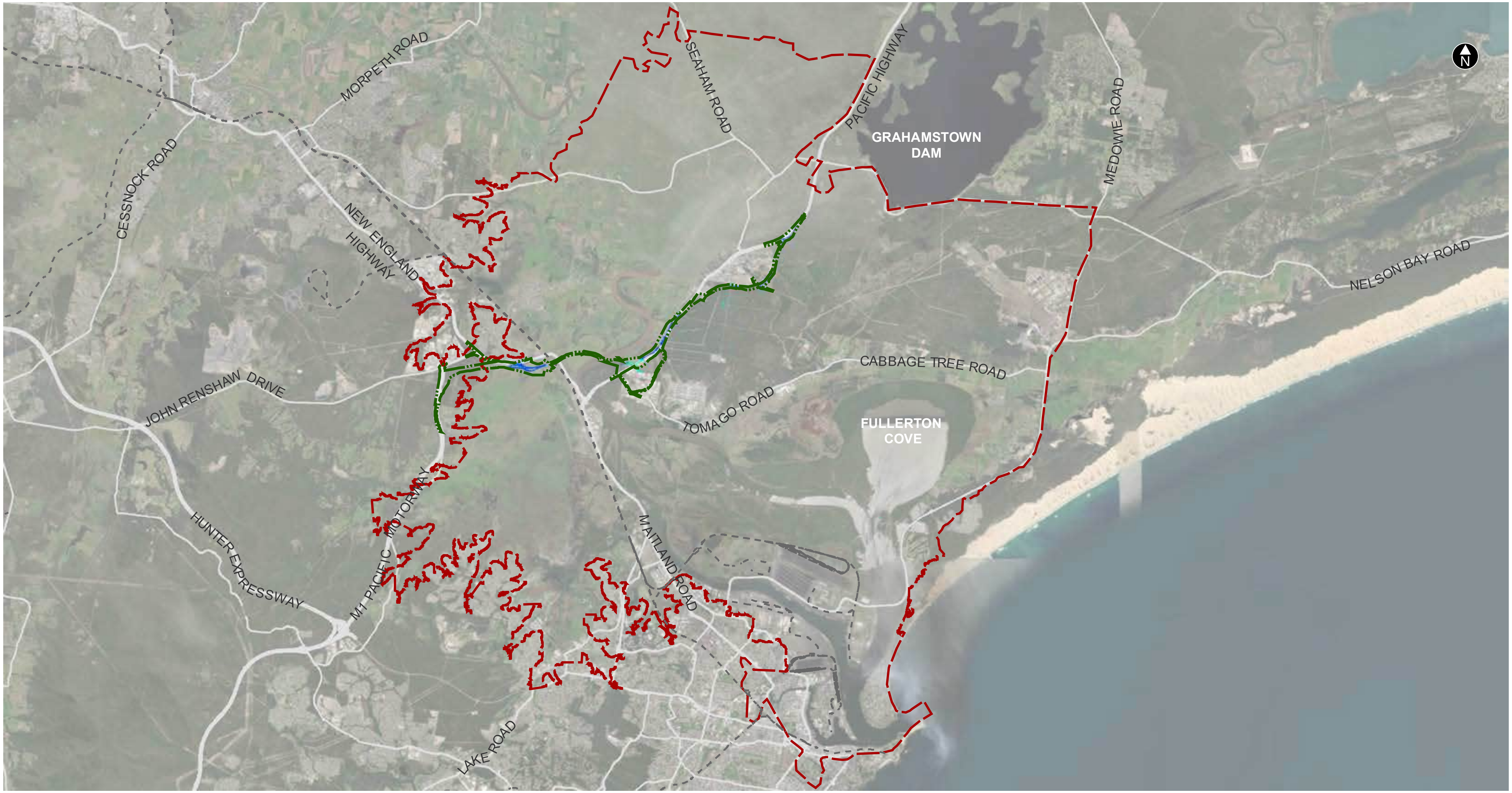


Figure C-11 Change in flood hazard - Operation phase - 5% AEP (map 2 of 2)

Date: 6/10/2021 Path: \\jacobs.com\ANZ\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Operation\IA230000_CD_HF_008_OptionB_ChangeFloodHazard_5_Operational_JAC_A4L_175000_V01.mxd



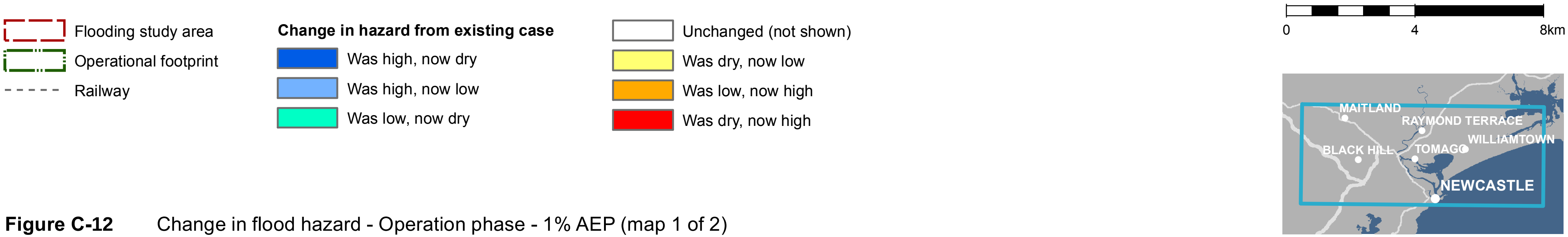


Figure C-12 Change in flood hazard - Operation phase - 1% AEP (map 1 of 2)

Date: 6/10/2021 Path: \\jacobs.com\ANZ\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Operation\IA230000_CD_HF_009_OptionB_ChangeFloodHazard_1_Operational_JAC_A4L_175000_V01.mxd

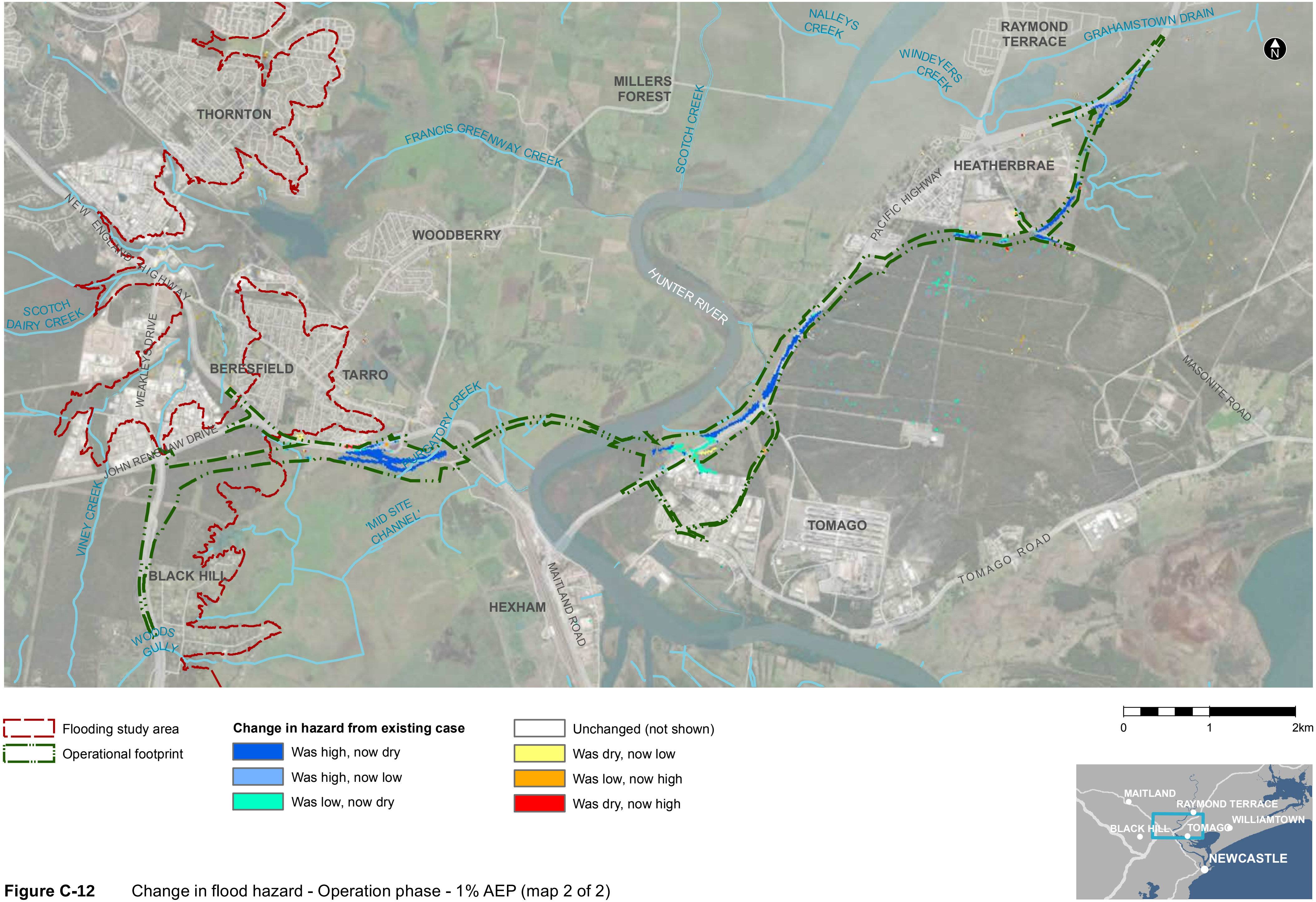
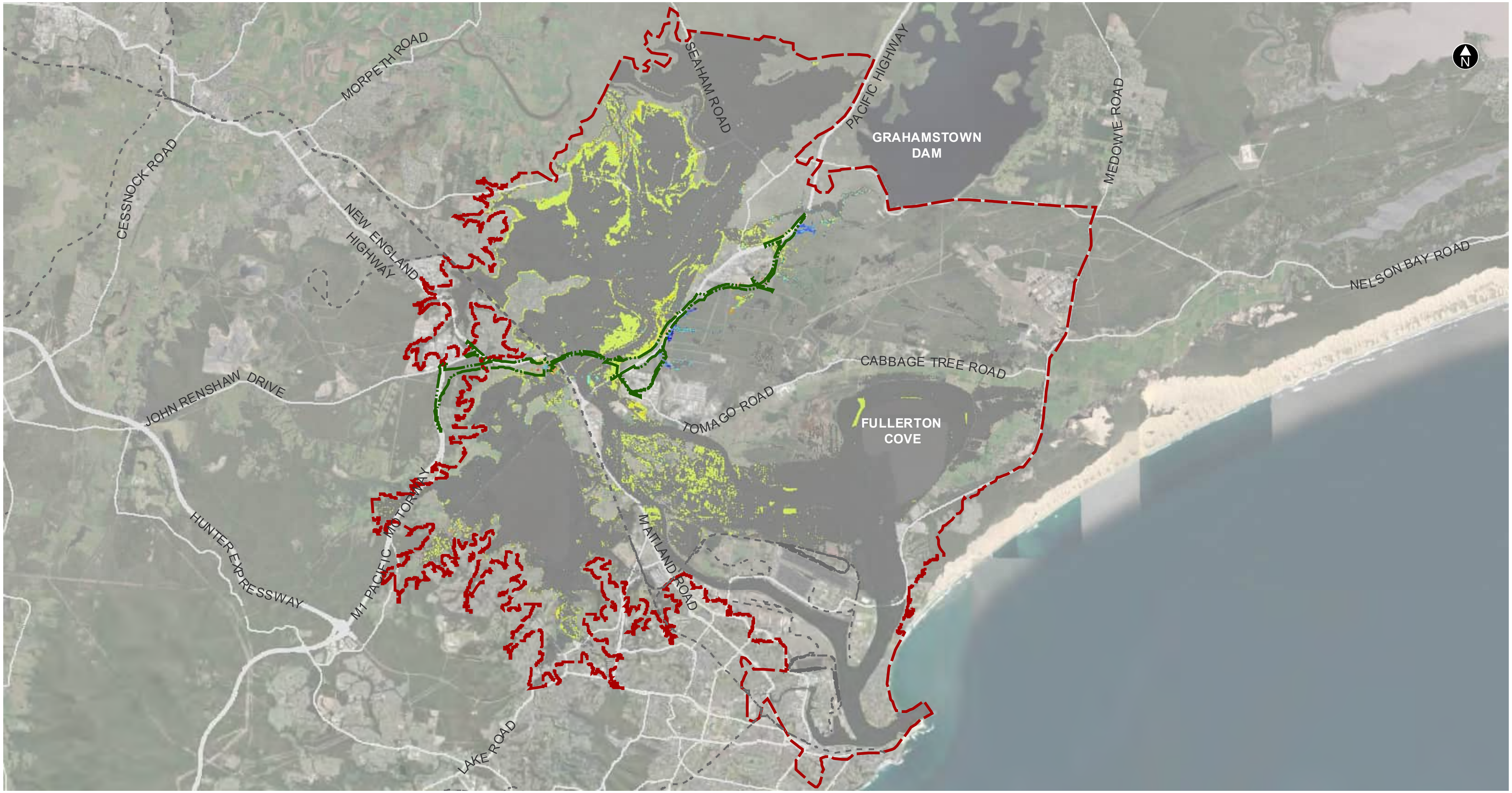


Figure C-12 Change in flood hazard - Operation phase - 1% AEP (map 2 of 2)

Date: 6/10/2021 Path: \\jacobs.com\ANZ\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Operation\IA230000_CD_HF_009_OptionB_ChangeFloodHazard_1_Operational_JAC_A4L_175000_V01.mxd



Flooding study area
Operational footprint
Railway

Change in duration of inundation from existing case (per cent)

< 50	-20 - -10	5 - 10	
-50 - -30	-10 - -5	10 - 20	
-30 - -20	-5 - -1	20 - 30	
	-1 - 1	30 - 50	
	1 - 5	> 50	

0 4 8km

Figure C-13 Change in duration of inundation - Operation phase - 20% AEP (map 1 of 2)

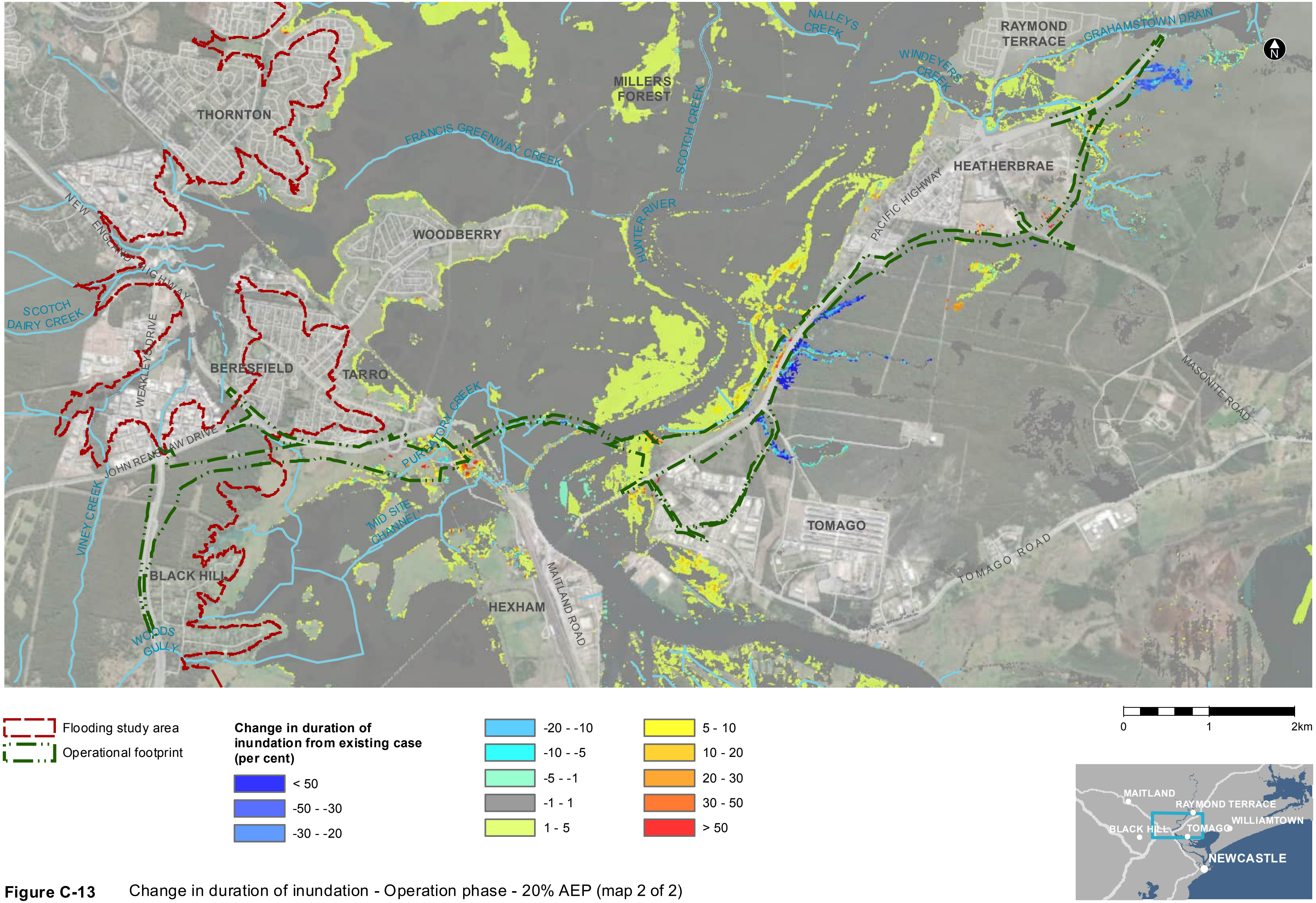
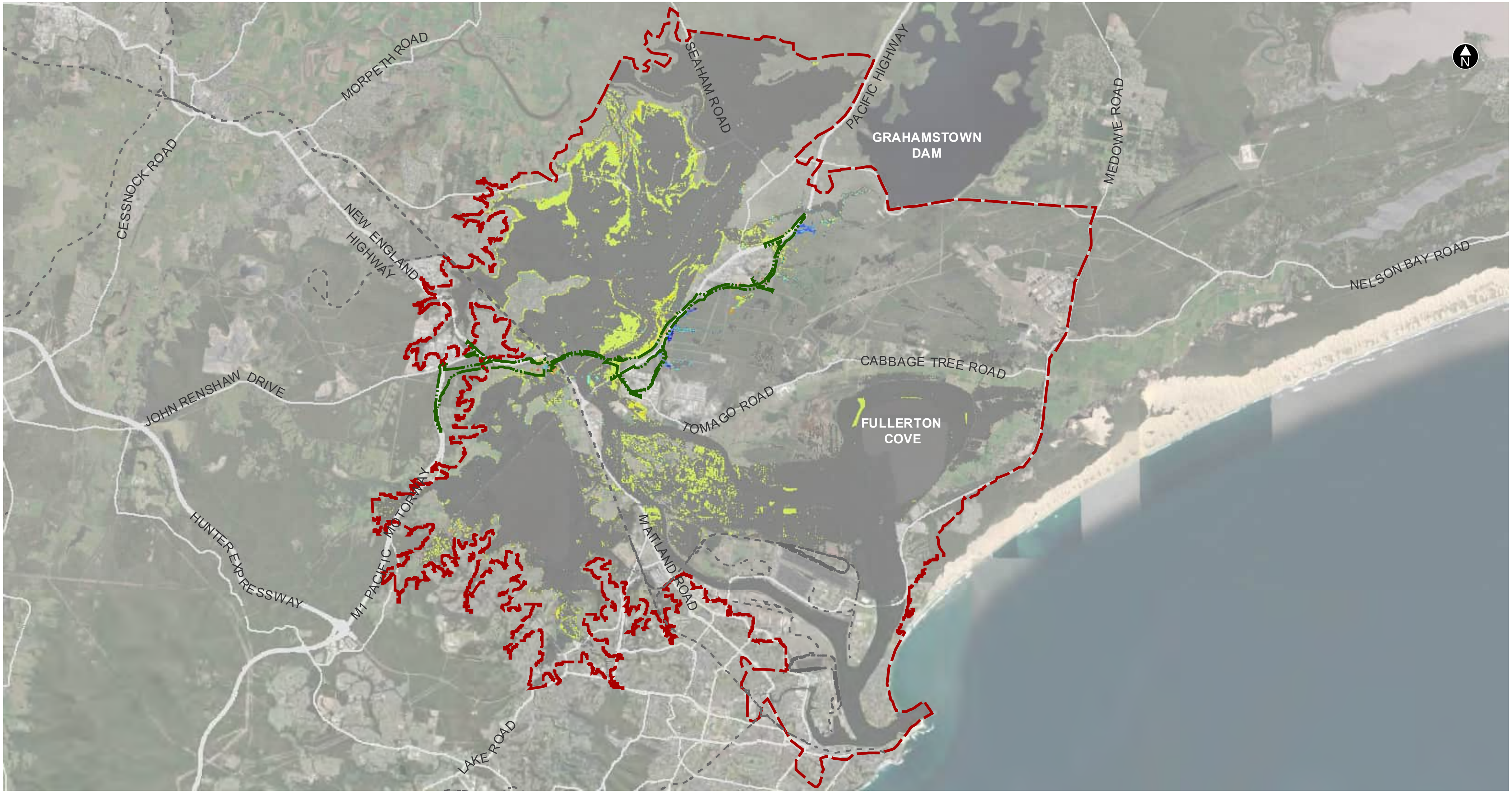


Figure C-13 Change in duration of inundation - Operation phase - 20% AEP (map 2 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\V02\IA230000_CD_HF_Supp_C-13_ChangeDurationInundation20Operational_JAC_A4L_175000_V02.mxd



Flooding study area
Operational footprint
Railway

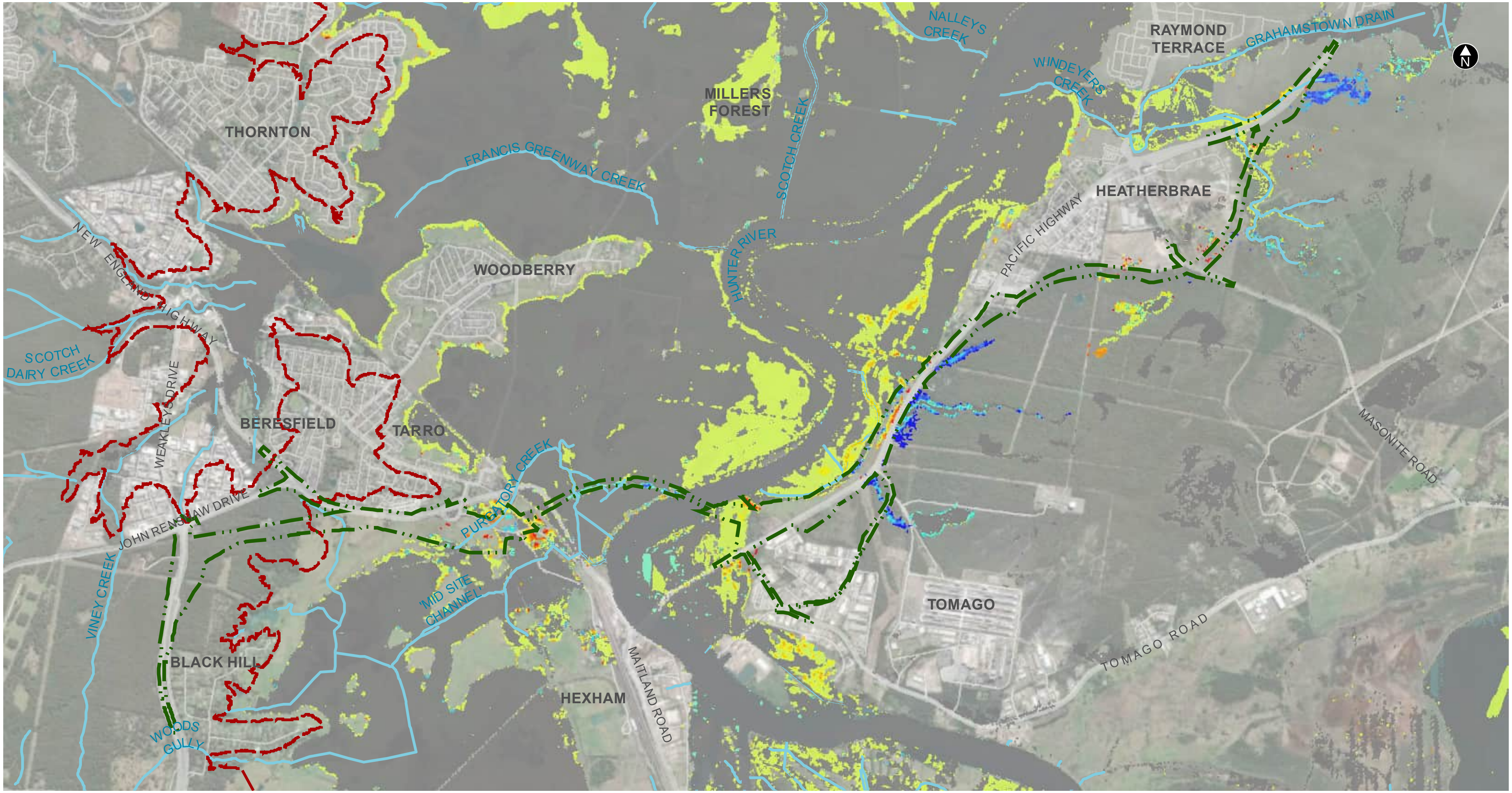
Change in duration of inundation from existing case (per cent)

< 50	5 - 10
-50 - -30	10 - 20
-30 - -20	20 - 30
-20 - -10	30 - 50
-10 - -5	> 50
-5 - -1	
-1 - 1	
1 - 5	

0 4 8km

Figure C-14 Change in duration of inundation - Operation phase - 10% AEP (map 1 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\V02\IA230000_CD_HF_Supp_C-14_ChangeDurationInundation10Operational_JAC_A4L_175000_V02.mxd



Flooding study area

Operational footprint

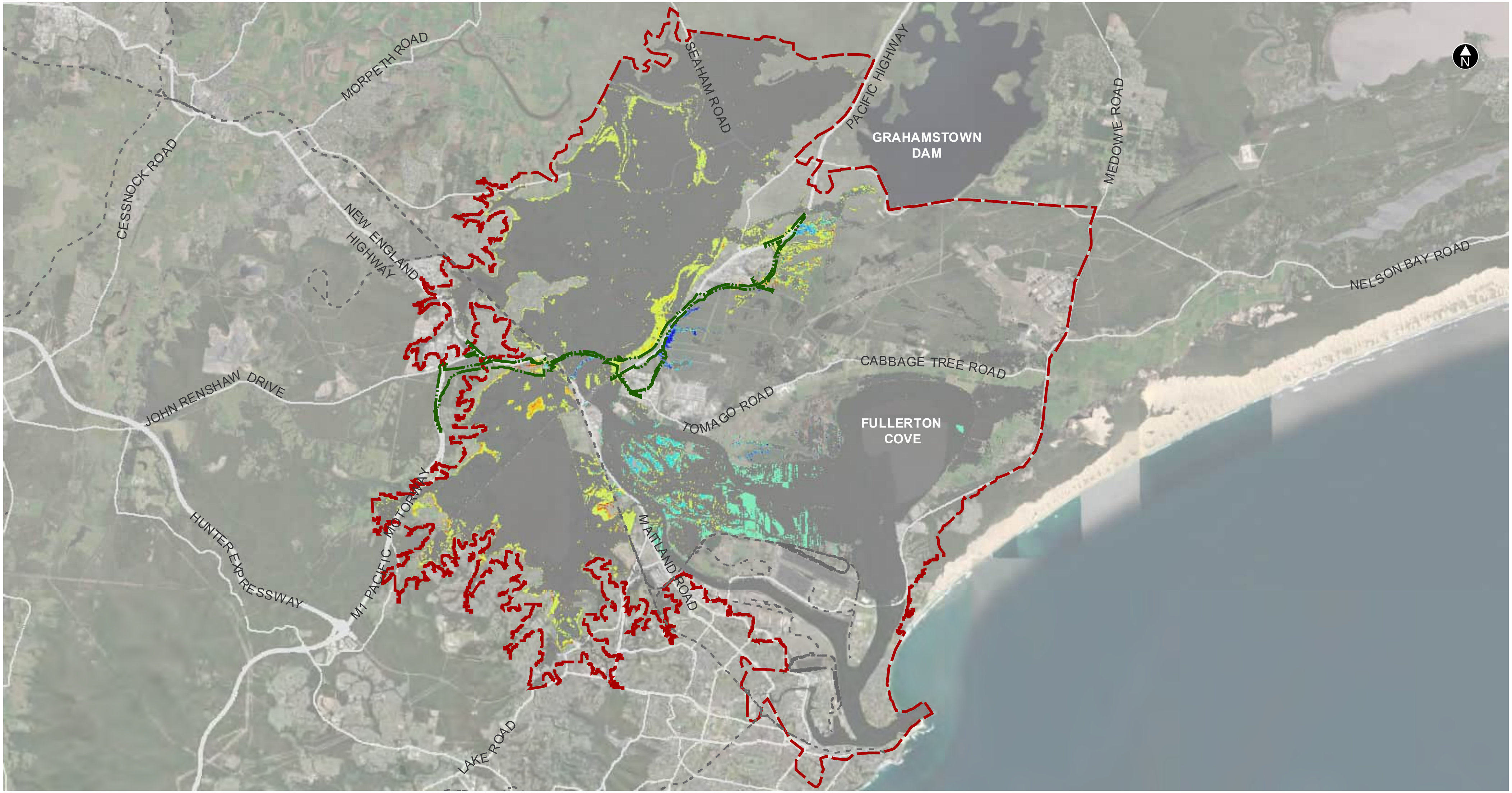
Change in duration of inundation from existing case (per cent)

< 50	
-50 - -30	
-30 - -20	
-20 - -10	
-10 - -5	
-5 - -1	
-1 - 1	
1 - 5	
5 - 10	
10 - 20	
20 - 30	
30 - 50	
> 50	

0 1 2km

Figure C-14 Change in duration of inundation - Operation phase - 10% AEP (map 2 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\V02\IA230000_CD_HF_Supp_C-14_ChangeDurationInundation10Operational_JAC_A4L_175000_V02.mxd



Flooding study area
Operational footprint
Railway

Change in duration of inundation from existing case (per cent)

- < 50
- -50 - -30
- -30 - -20
- -20 - -10
- -10 - -5
- -5 - -1
- -1 - 1
- 1 - 5
- 5 - 10
- 10 - 20
- 20 - 30
- 30 - 50
- > 50

0 4 8km

Figure C-15 Change in duration of inundation - Operation phase - 5% AEP (map 1 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\V02\IA230000_CD_HF_Supp_C-15_ChangeDurationInundation5Operational_JAC_A4L_175000_V02.mxd

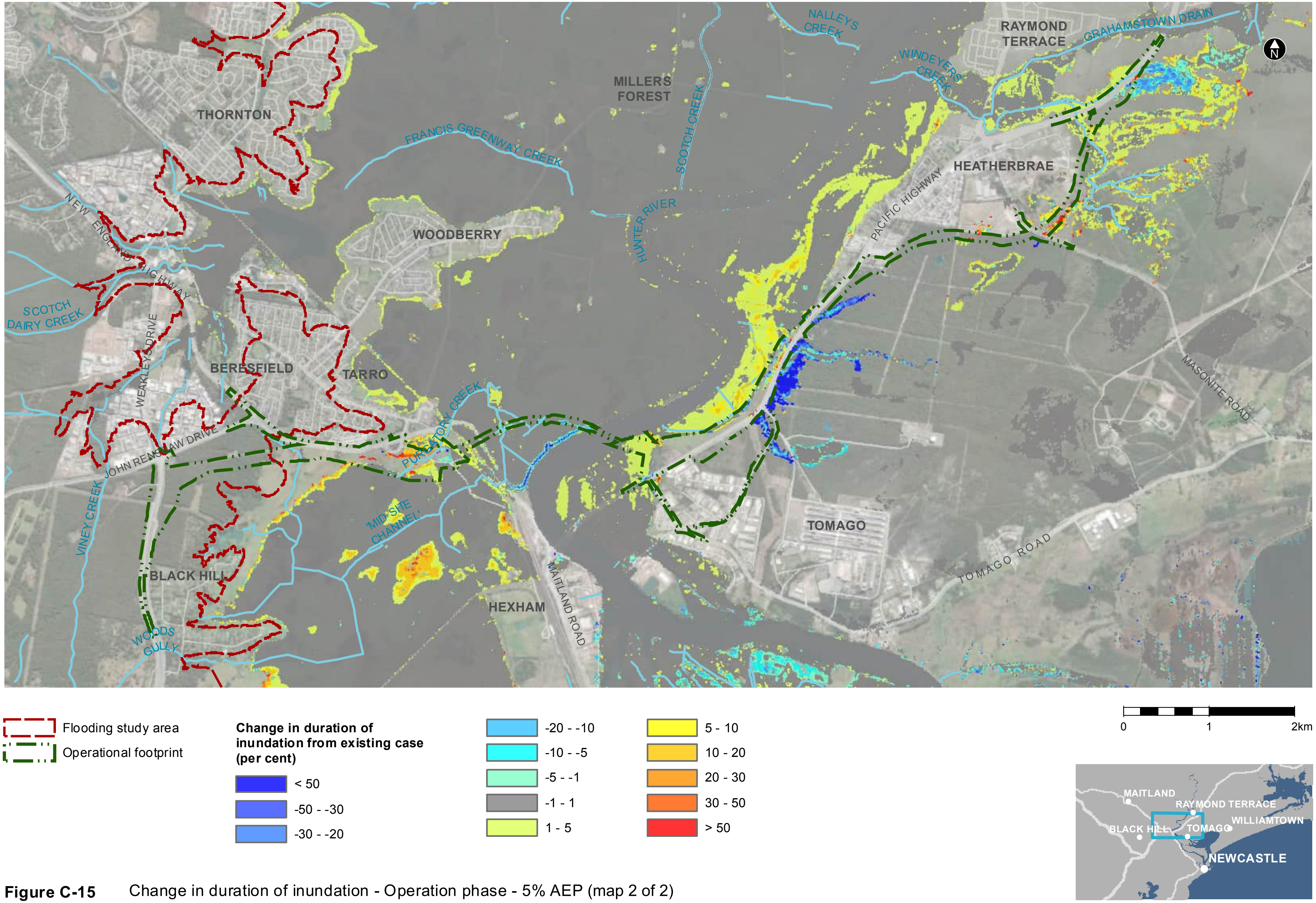
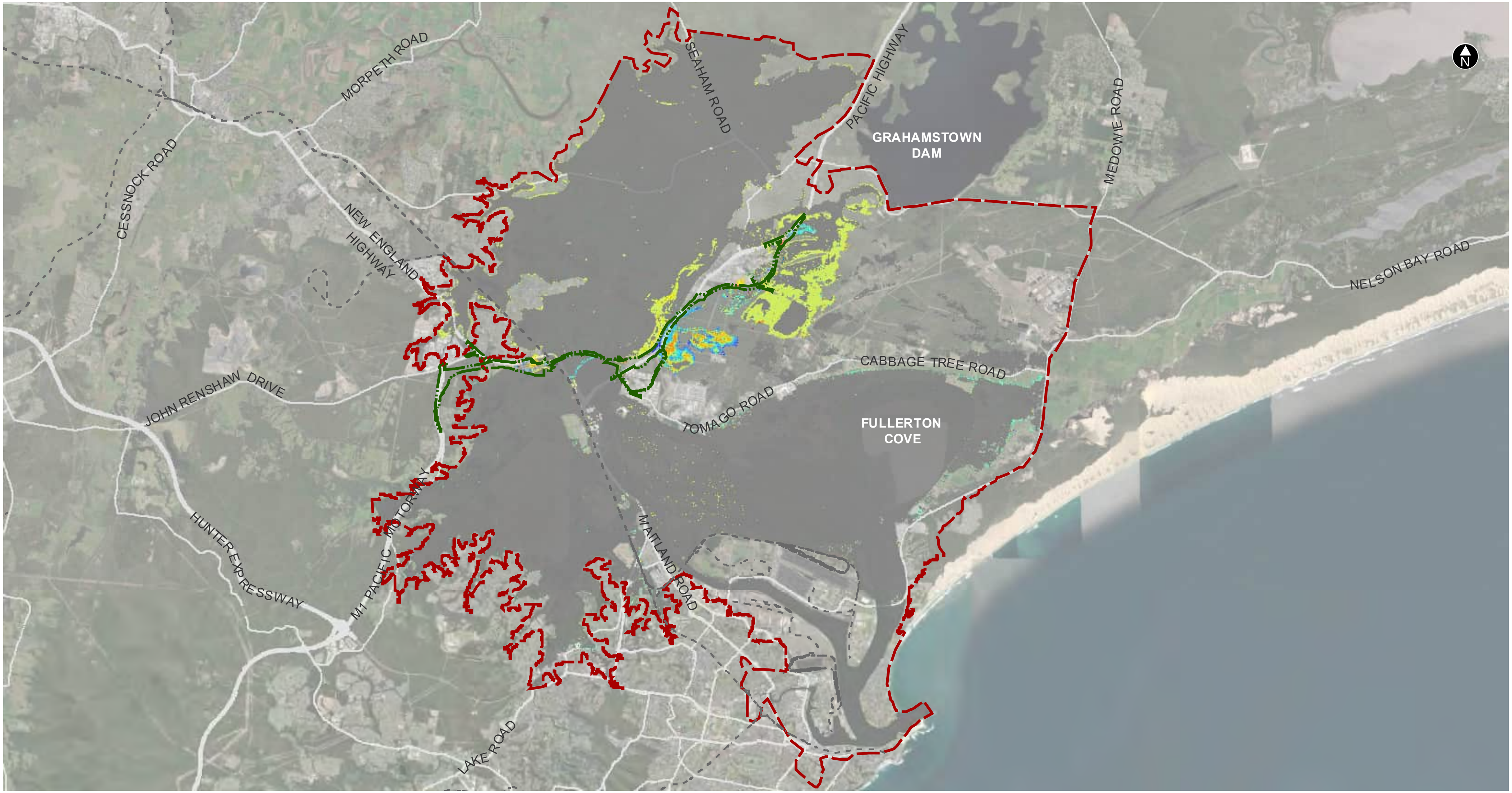


Figure C-15 Change in duration of inundation - Operation phase - 5% AEP (map 2 of 2)

Date: 22/02/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Construction\V02\IA230000_CD_HF_Supp_C-15_ChangeDurationInundation5Operational_JAC_A4L_175000_V02.mxd



Flooding study area

Operational footprint

Railway

Change in duration of inundation from existing case (per cent)

< 50

-50 - -30

-30 - -20

-20 - -10

-10 - -5

-5 - -1

-1 - 1

1 - 5

5 - 10

10 - 20

20 - 30

30 - 50

> 50

0 4 8km

Figure C-16 Change in duration of inundation - Operation phase - 1% AEP (map 1 of 2)

Date: 10/03/2022 Path: \\Jacobs.com\ANZ\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report\IA230000_CD_HF_Supp_C-16_ChangeDurationInundation1Operational_JAC_A4L_175000_V02.mxd

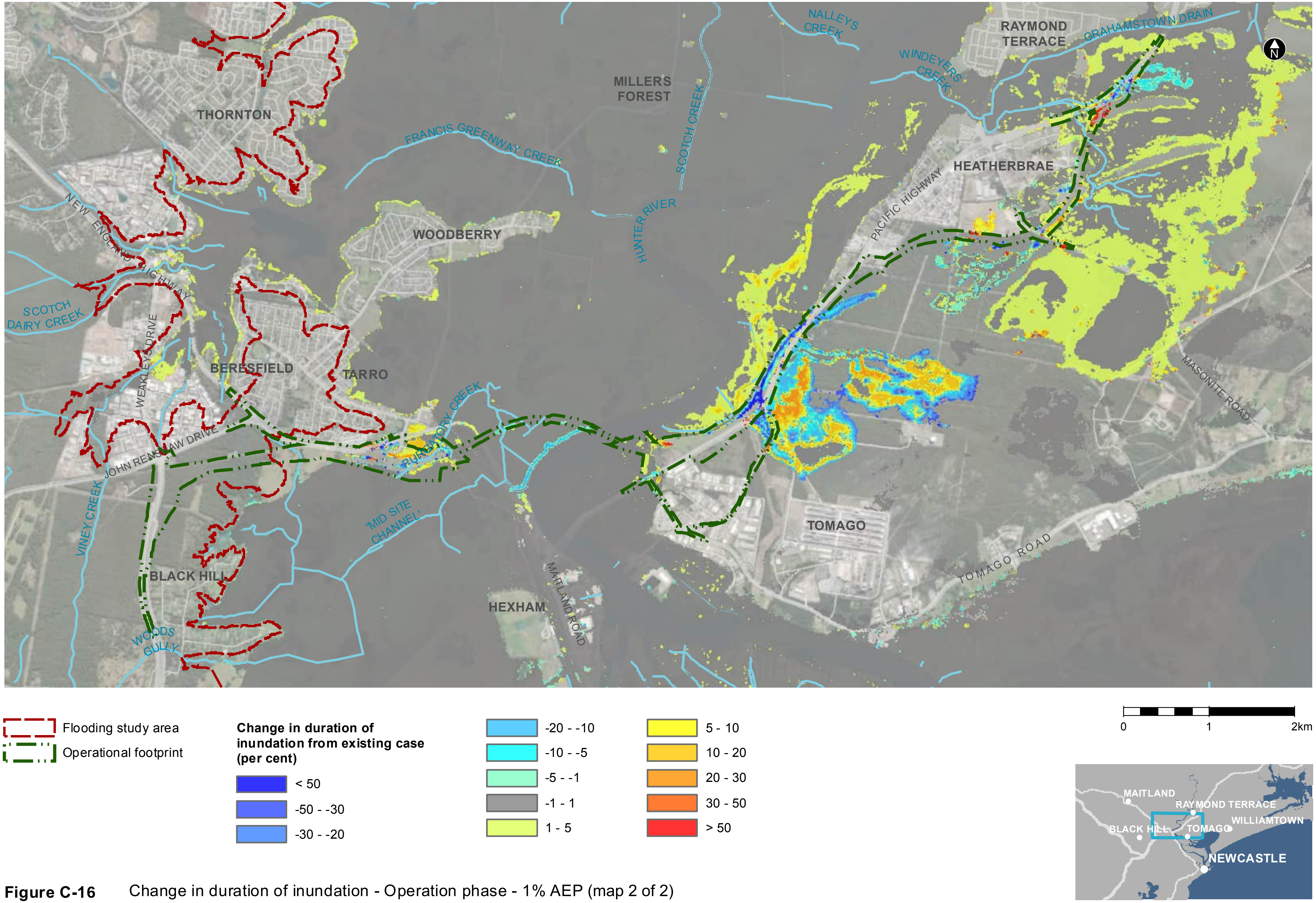
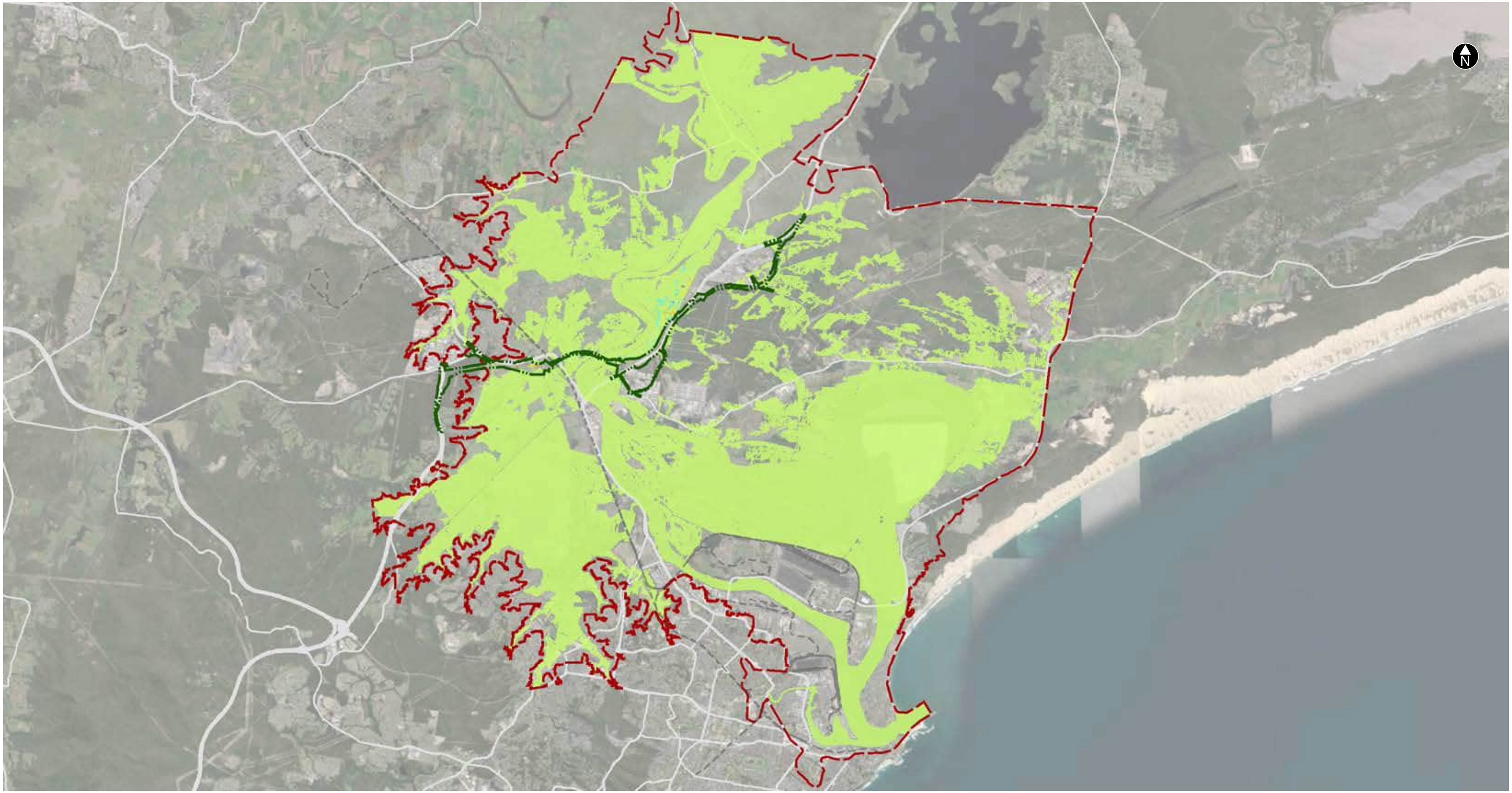


Figure C-16 Change in duration of inundation - Operation phase - 1% AEP (map 2 of 2)



Flooding study area

Operational footprint

Railway

Change in velocity from existing case (m/s)

< -1

-1 - -0.5

-0.5 - -0.3

-0.3 - -0.1

-0.1 - -0.05

-0.05 - 0.05

0.05 - 0.1

0.1 - 0.3

0.3 - 0.5

0.5 - 1

>1

Figure C-17 Change in flow velocity - Operation phase - 20% AEP (map 1 of 2)

Date: 22/12/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Hydro_Flooding\Operation phase - Option B\IA230000_CD_HF_003_D3_ChangeFlowVelocity20_Operational_JAC_A4L_175000_V01.mxd

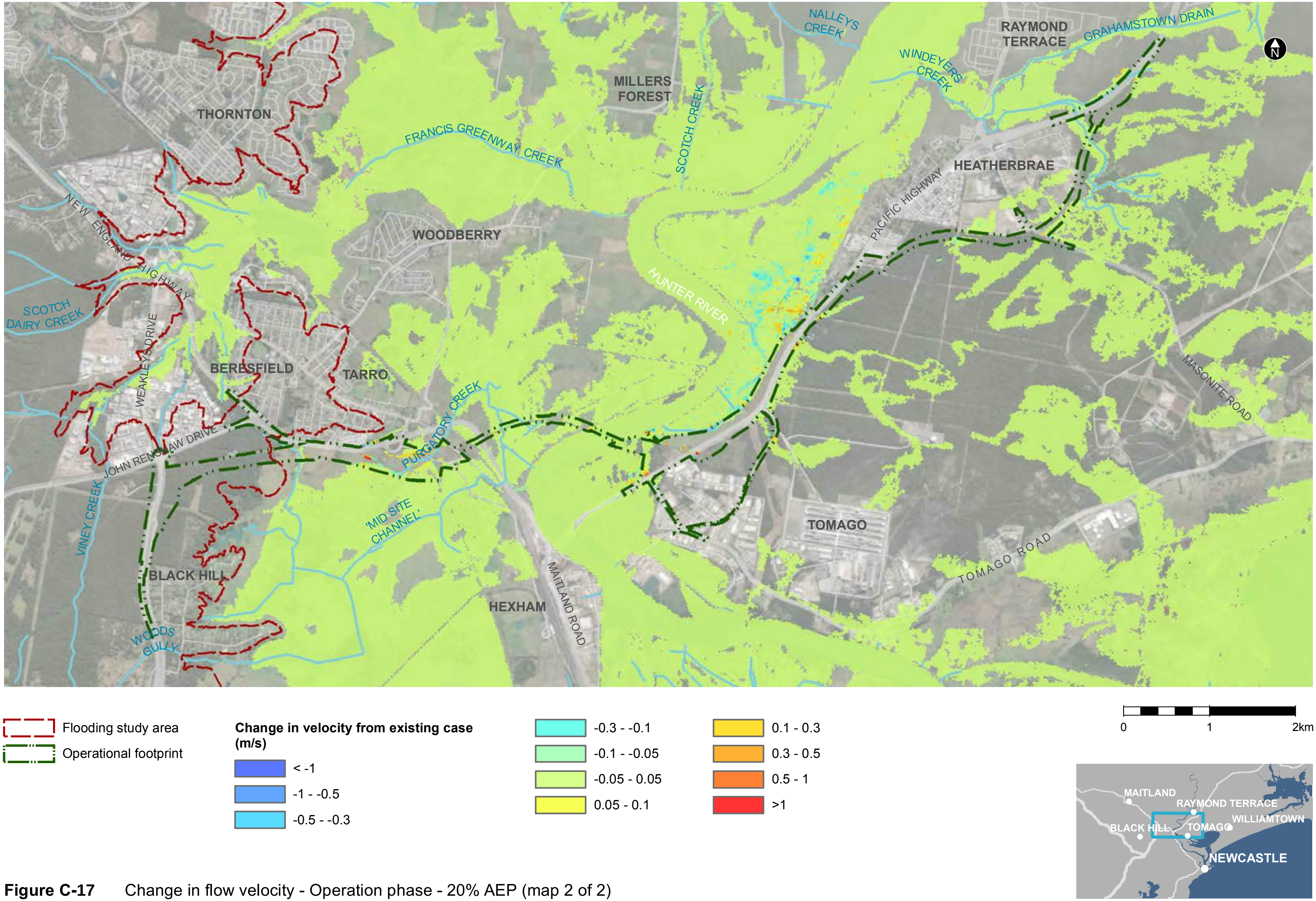
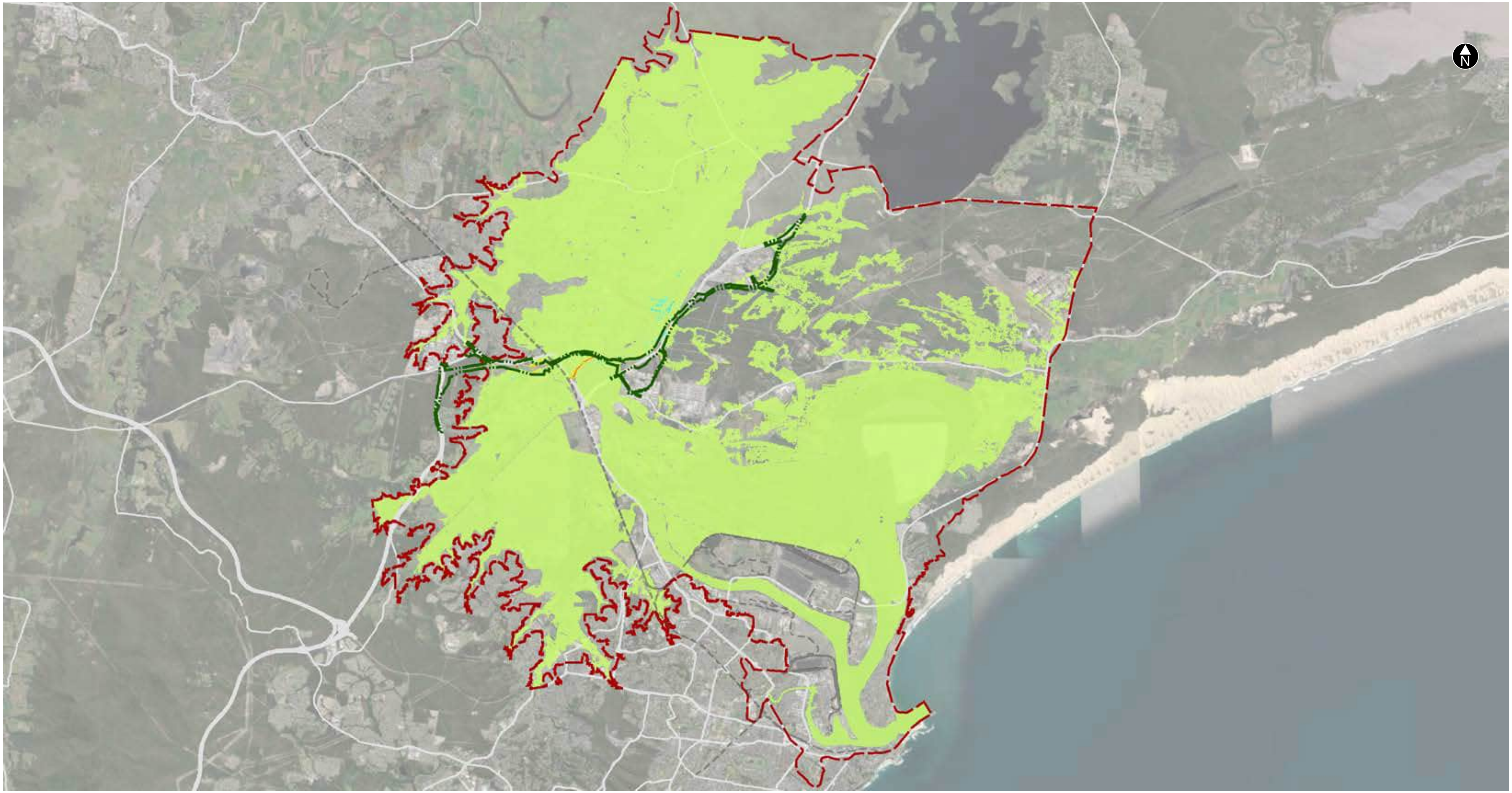


Figure C-17 Change in flow velocity - Operation phase - 20% AEP (map 2 of 2)

Date: 22/12/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Hydro_Flooding\Operation phase - Option B\IA230000_CD_HF_003_D3_ChangeFlowVelocity20_Operational_JAC_A4L_175000_V01.mxd



Flooding study area
Operational footprint
Railway

Change in velocity from existing case (m/s)

- < -1
- -1 - -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.05
- -0.05 - 0.05
- 0.05 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- >1

0 4 8km

Figure C-18 Change in flow velocity - Operation phase - 10% AEP (map 1 of 2)

Date: 22/12/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Hydro_Flooding\Operation phase - Option B\IA230000_CD_HF_004_D4_ChangeFlowVelocity10_Operational_JAC_A4L_175000_V01.mxd

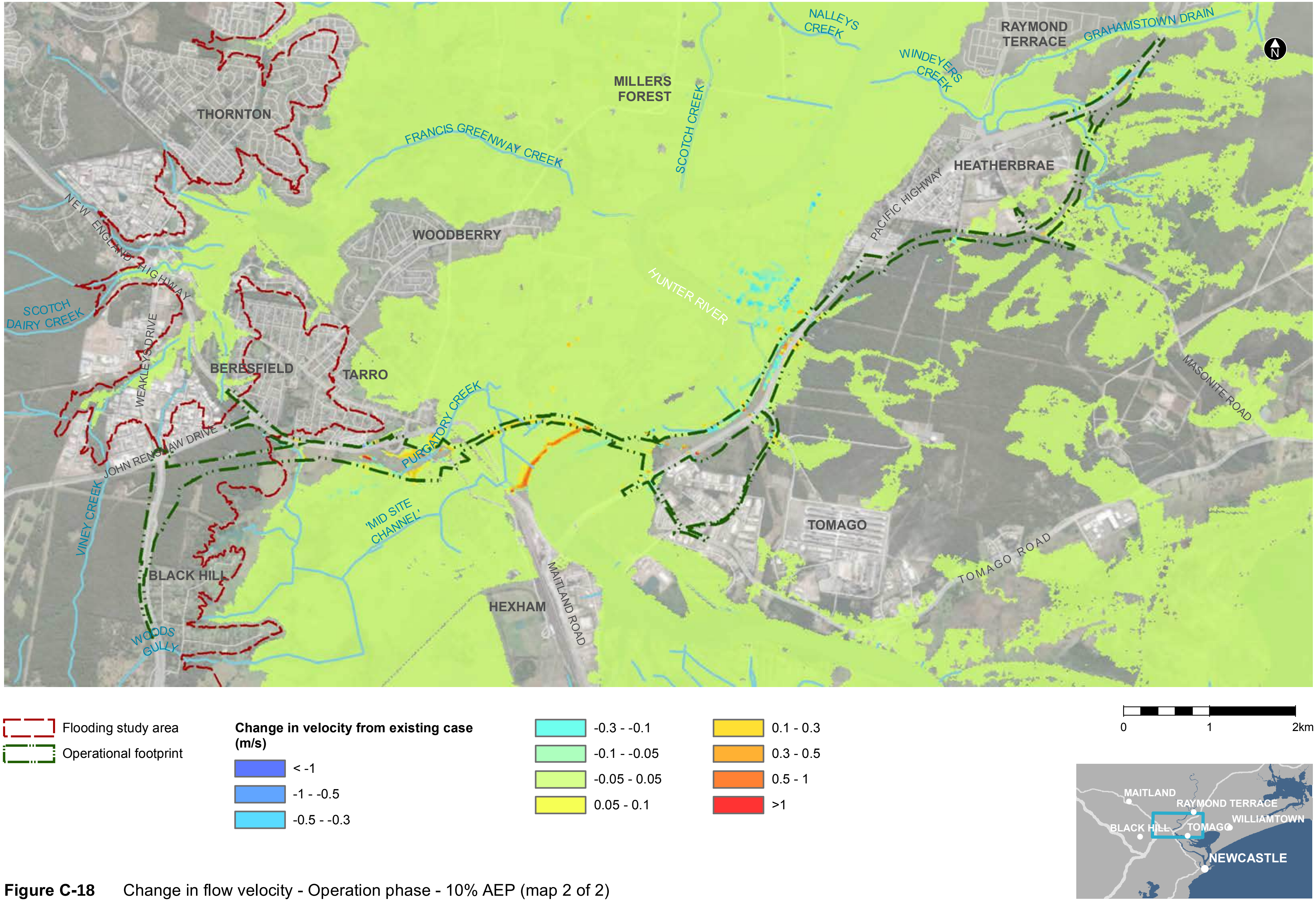
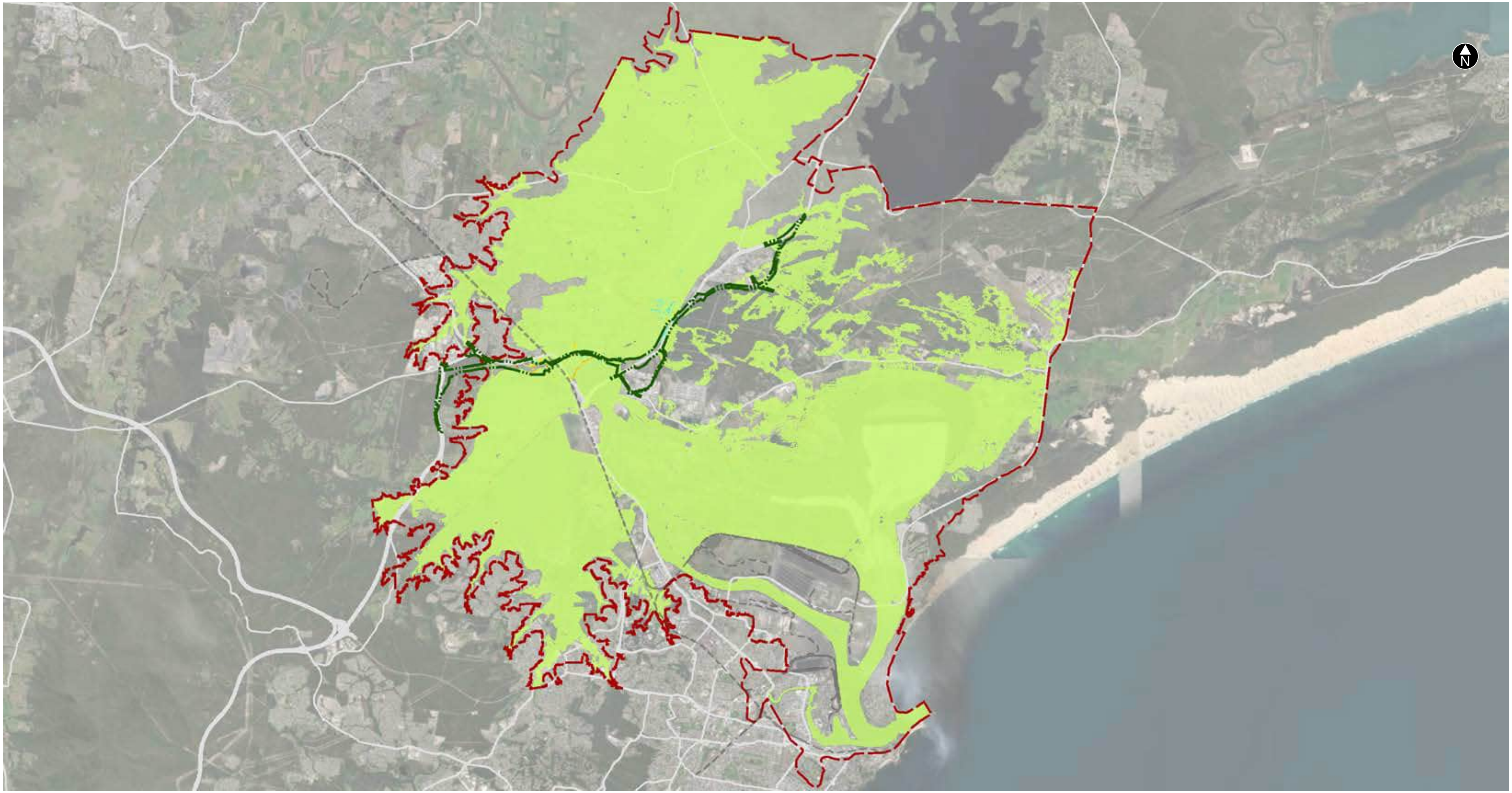


Figure C-18 Change in flow velocity - Operation phase - 10% AEP (map 2 of 2)

Date: 22/12/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Hydro_Flooding\Operation phase - Option B\IA230000_CD_HF_004_D4_ChangeFlowVelocity10_Operational_JAC_A4L_175000_V01.mxd



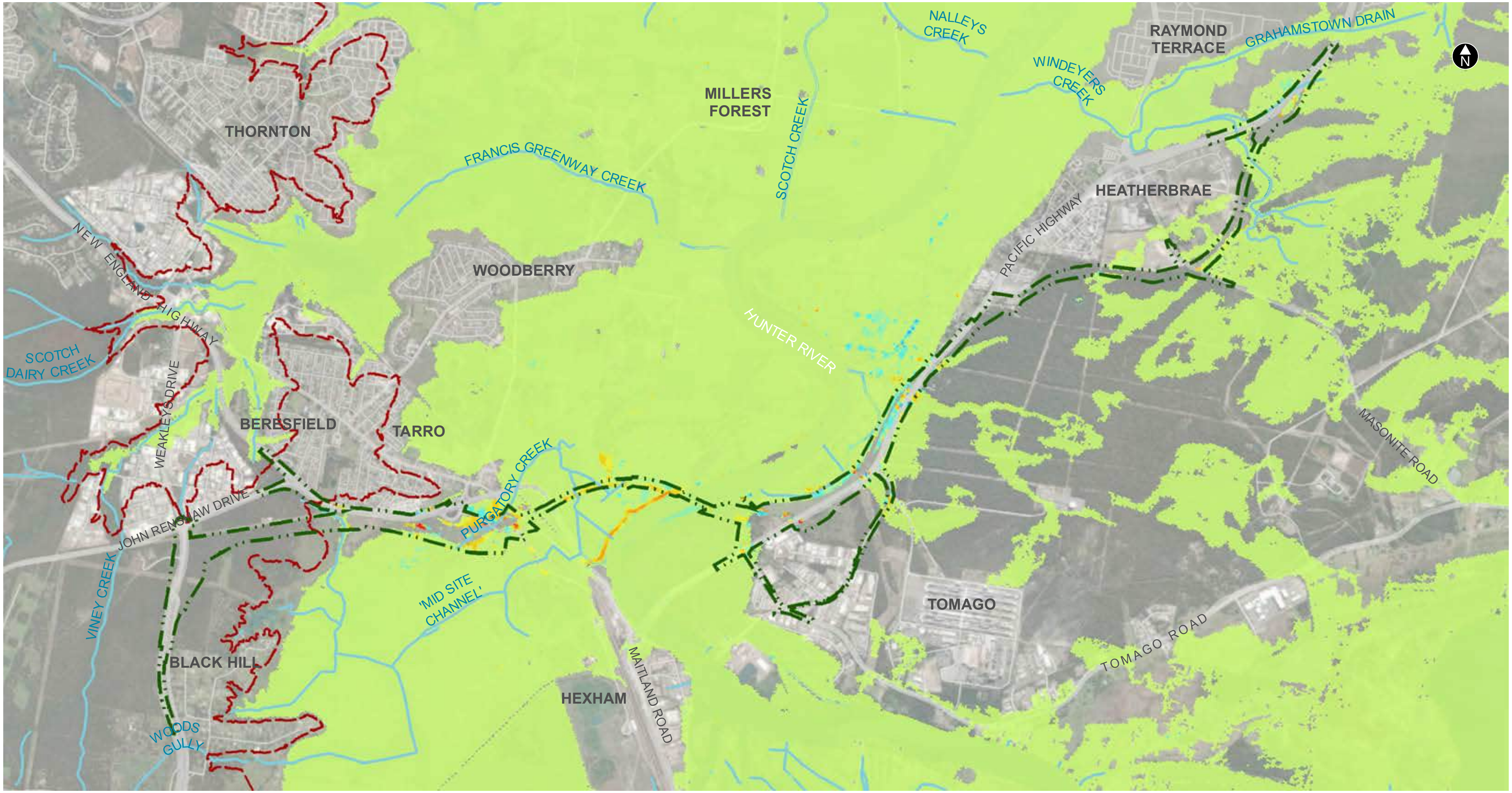
Flooding study area	
Operational footprint	
Railway	

Change in velocity from existing case (m/s)

- < -1
- -1 - -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.05
- -0.05 - 0.05
- 0.05 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- >1

Figure C-19 Change in flow velocity - Operation phase - 5% AEP (map 1 of 2)

Date: 30/09/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Operation\IA230000_CD_HF_004_OptionB_ChangeFlowVelocity5_Operational_JAC_A4L_175000_V01.mxd



Flooding study area

Operational footprint

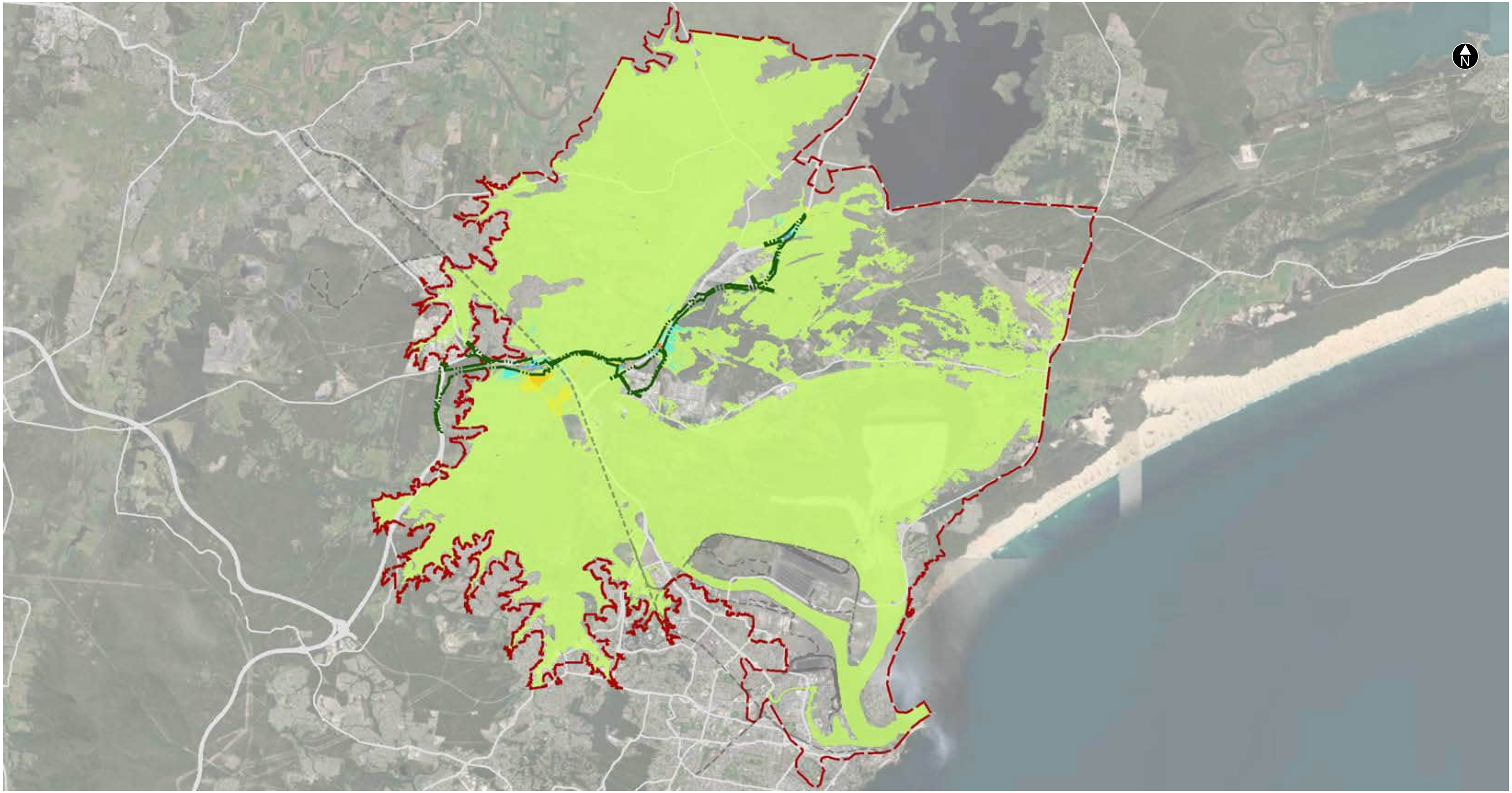
Change in velocity from existing case (m/s)

- < -1
- -1 - -0.5
- -0.5 - -0.3
- -0.3 - -0.1
- -0.1 - -0.05
- -0.05 - 0.05
- 0.05 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- >1

0 1 2km

Figure C-19 Change in flow velocity - Operation phase - 5% AEP (map 2 of 2)

Date: 30/09/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Operation\IA230000_CD_HF_004_OptionB_ChangeFlowVelocity5_Operational_JAC_A4L_175000_V01.mxd



Flooding study area
Operational footprint
Railway

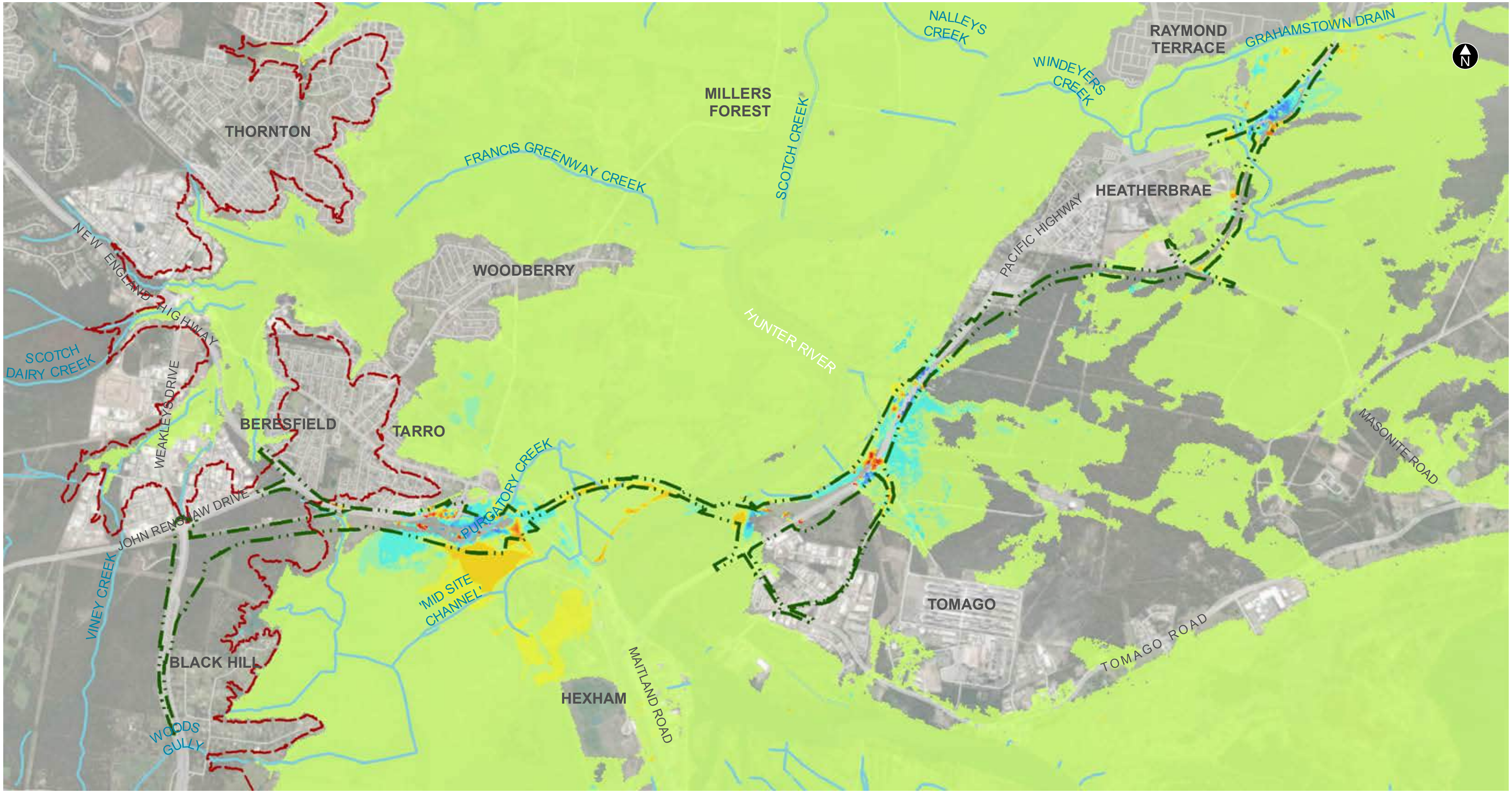
Change in velocity from existing case (m/s)

< -1
-1 - -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.05
-0.05 - 0.05
0.05 - 0.1
0.1 - 0.3
0.3 - 0.5
0.5 - 1
>1

0 4 8km

Figure C-20 Change in flow velocity - Operation phase - 1% AEP (map 1 of 2)

Date: 30/09/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Operation\IA230000_CD_HF_005_OptionB_ChangeFlowVelocity1_Operational_JAC_A4L_175000_V01.mxd



Flooding study area

Operational footprint

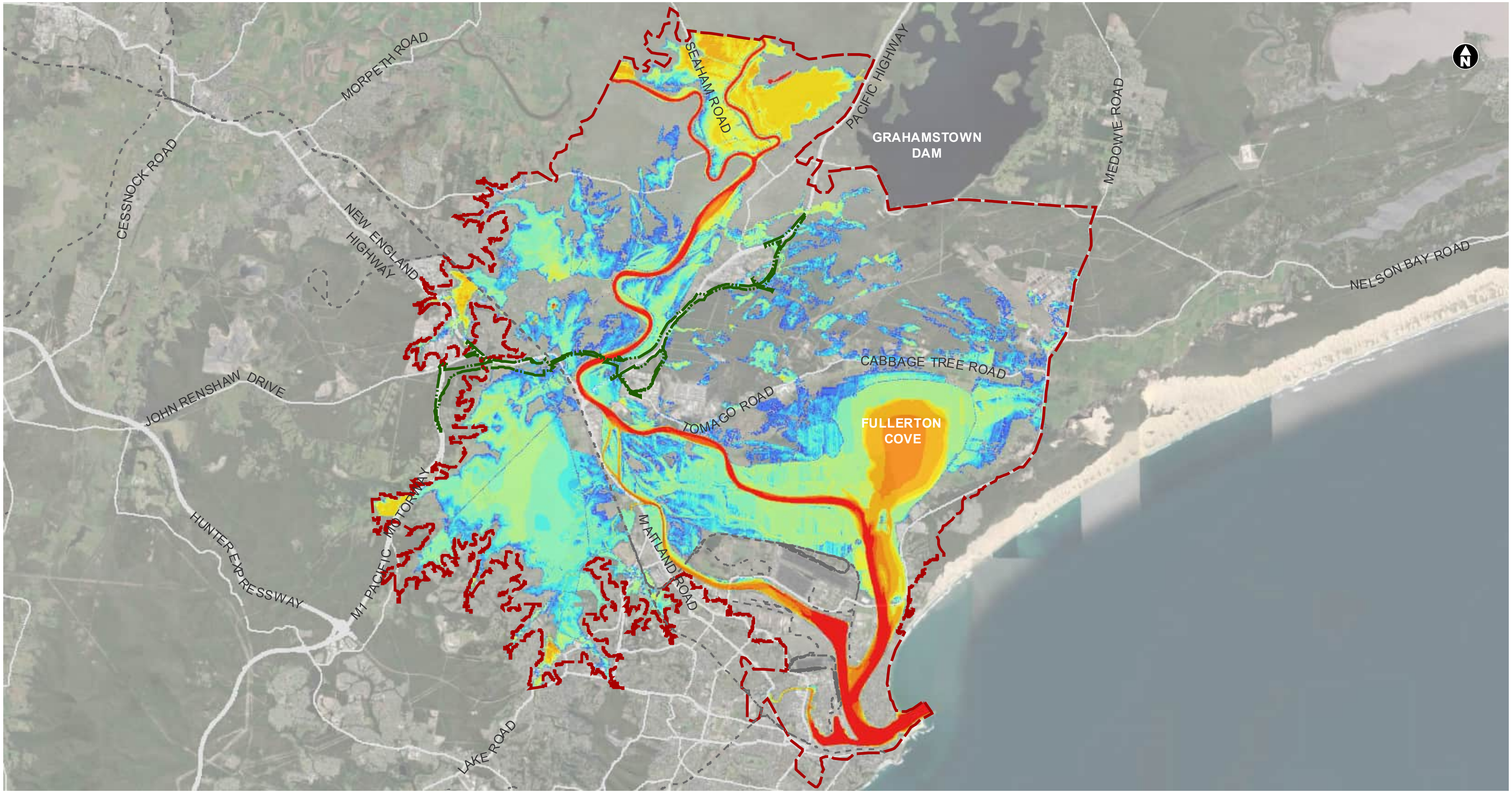
Change in velocity from existing case (m/s)

< -1	-0.3 - -0.1
-1 - -0.5	-0.1 - -0.05
-0.5 - -0.3	-0.05 - 0.05
	0.05 - 0.1
0.1 - 0.3	
0.3 - 0.5	
0.5 - 1	
>1	

0 1 2km

Figure C-20 Change in flow velocity - Operation phase - 1% AEP (map 2 of 2)

Date: 30/09/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\OptionB\Operation\IA230000_CD_HF_005_OptionB_ChangeFlowVelocity1_Operational_JAC_A4L_175000_V01.mxd



Flooding study area

Operational footprint

Railway

Flood depth (m)

< 0.05

0.05 to 0.1

0.1 to 0.2

0.2 to 0.3

0.3 to 0.4

0.4 to 0.5

0.5 to 0.7

0.7 to 1.0

1.0 to 1.2

1.2 to 1.5

1.5 to 2.0

2.0 to 3.0

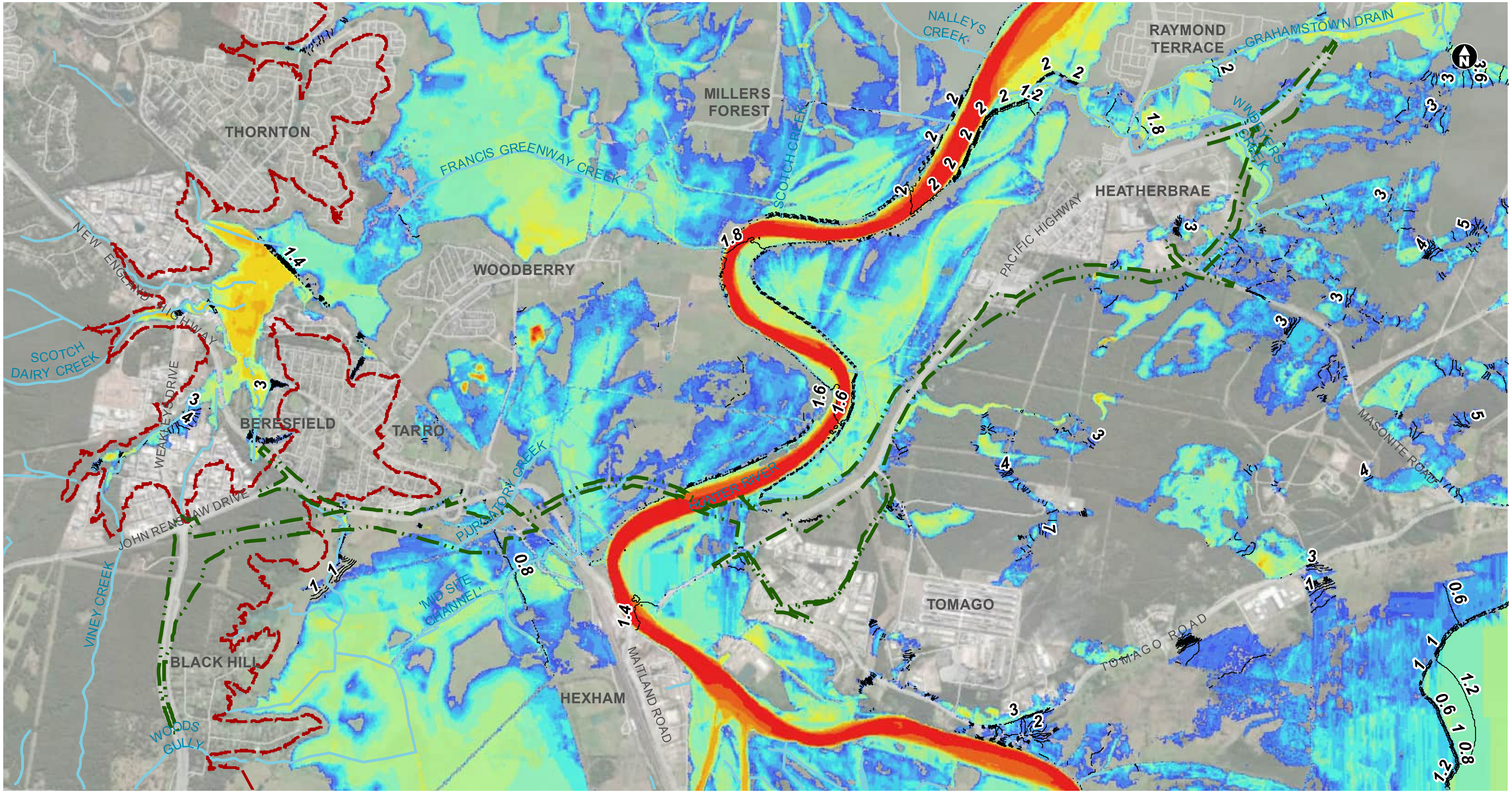
3.0 to 4.0

4.0 to 5.0

> 5.0

0 4 8km

Figure C-21 Flood level and depth - Operation phase - 20% AEP (map 1 of 2)



Flooding study area
Operational footprint
Flood level contour (0.2m AHD interval)

Flood depth (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- 0.4 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.2
- 1.2 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- 4.0 to 5.0
- > 5.0

0 1 2km

Figure C-21 Flood level and depth - Operation phase - 20% AEP (map 2 of 2)

Date: 28/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-21_LevelDepth_Operation_20_AEP_JAC_A4L_175000_V01.mxd

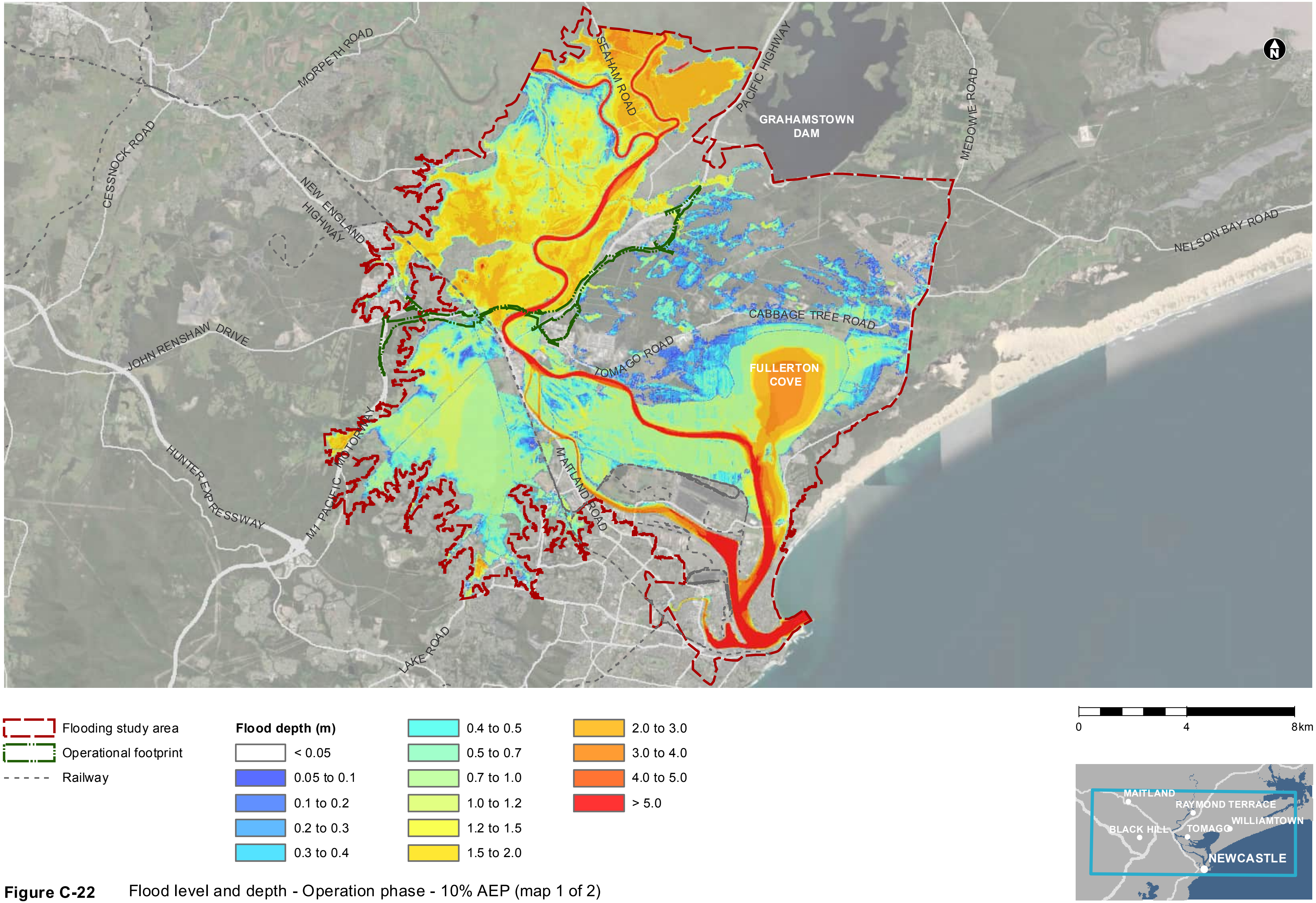
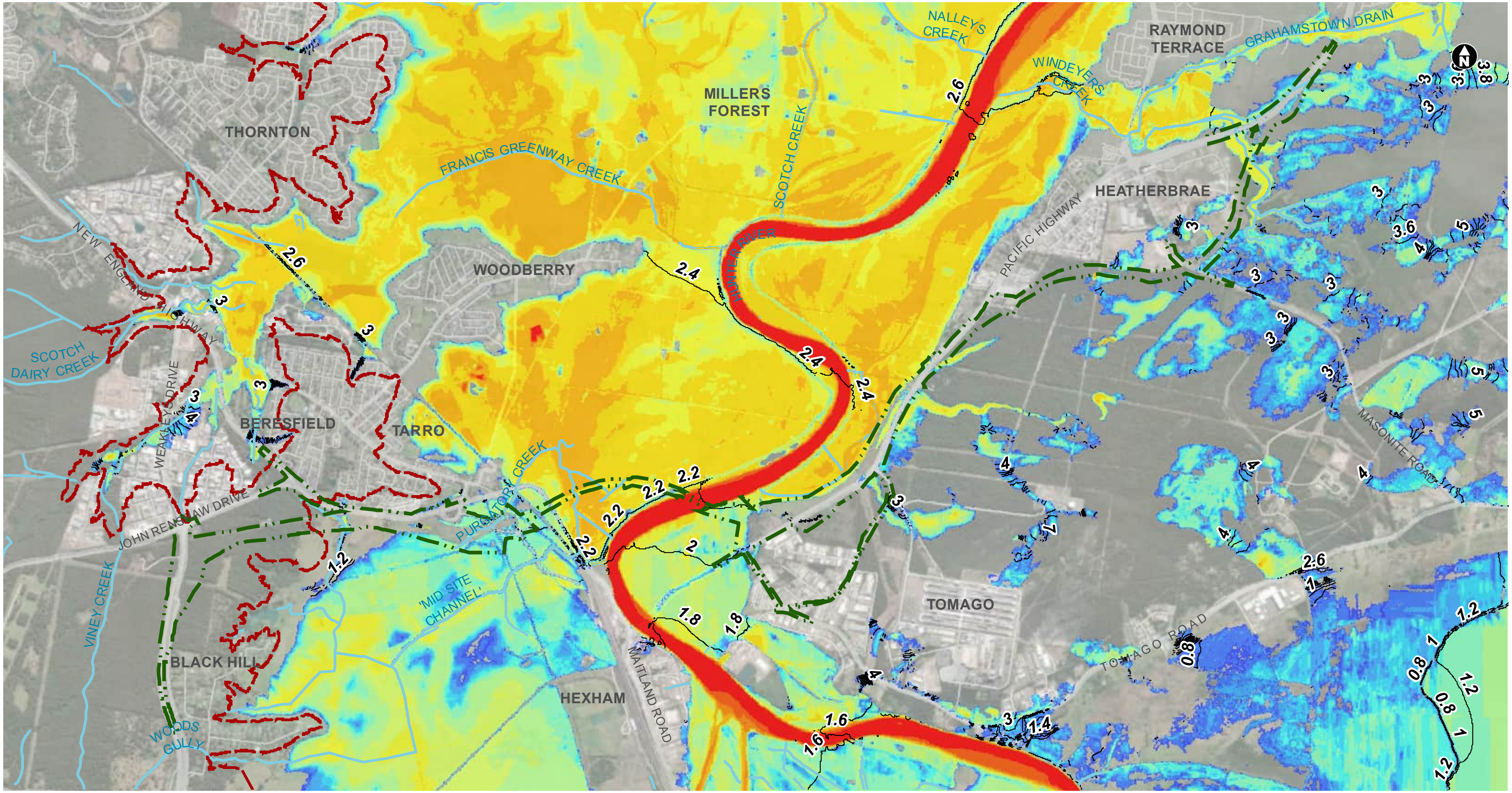


Figure C-22 Flood level and depth - Operation phase - 10% AEP (map 1 of 2)

Date: 28/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-22_LevelDepth_Operation_10_AEP_JAC_A4L_175000_V01.mxd



Flooding study area
Operational footprint
Flood level contour (0.2m AHD interval)

Flood depth (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- 0.4 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.2
- 1.2 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- 4.0 to 5.0
- > 5.0

Figure C-22 Flood level and depth - Operation phase - 10% AEP (map 2 of 2)

Date: 28/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-22_LevelDepth_Operation_10_AEP_JAC_A4L_175000_V01.mxd

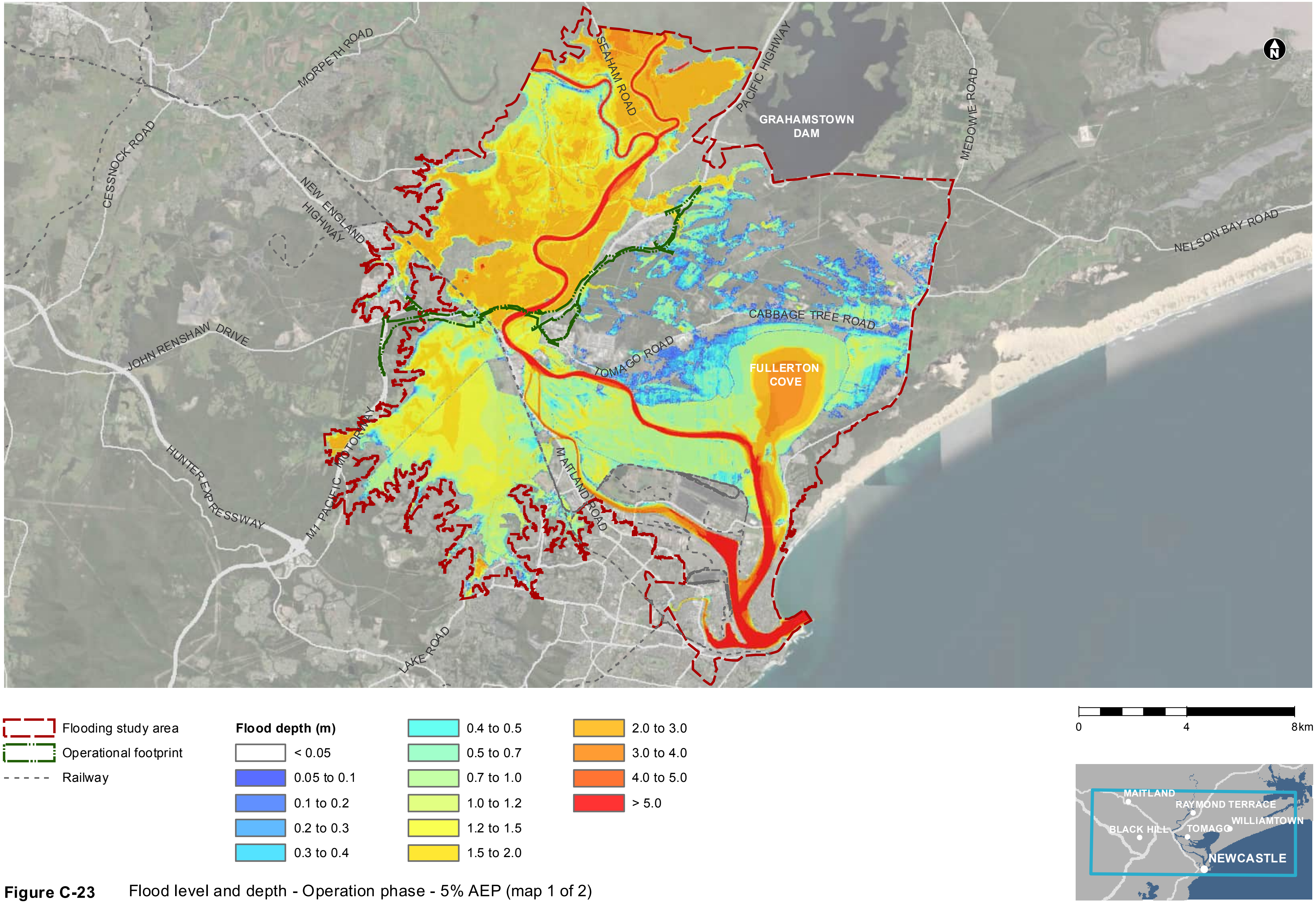


Figure C-23 Flood level and depth - Operation phase - 5% AEP (map 1 of 2)

Date: 28/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-23_LevelDepth_Operation_5_AEP_JAC_A4L_175000_V01.mxd

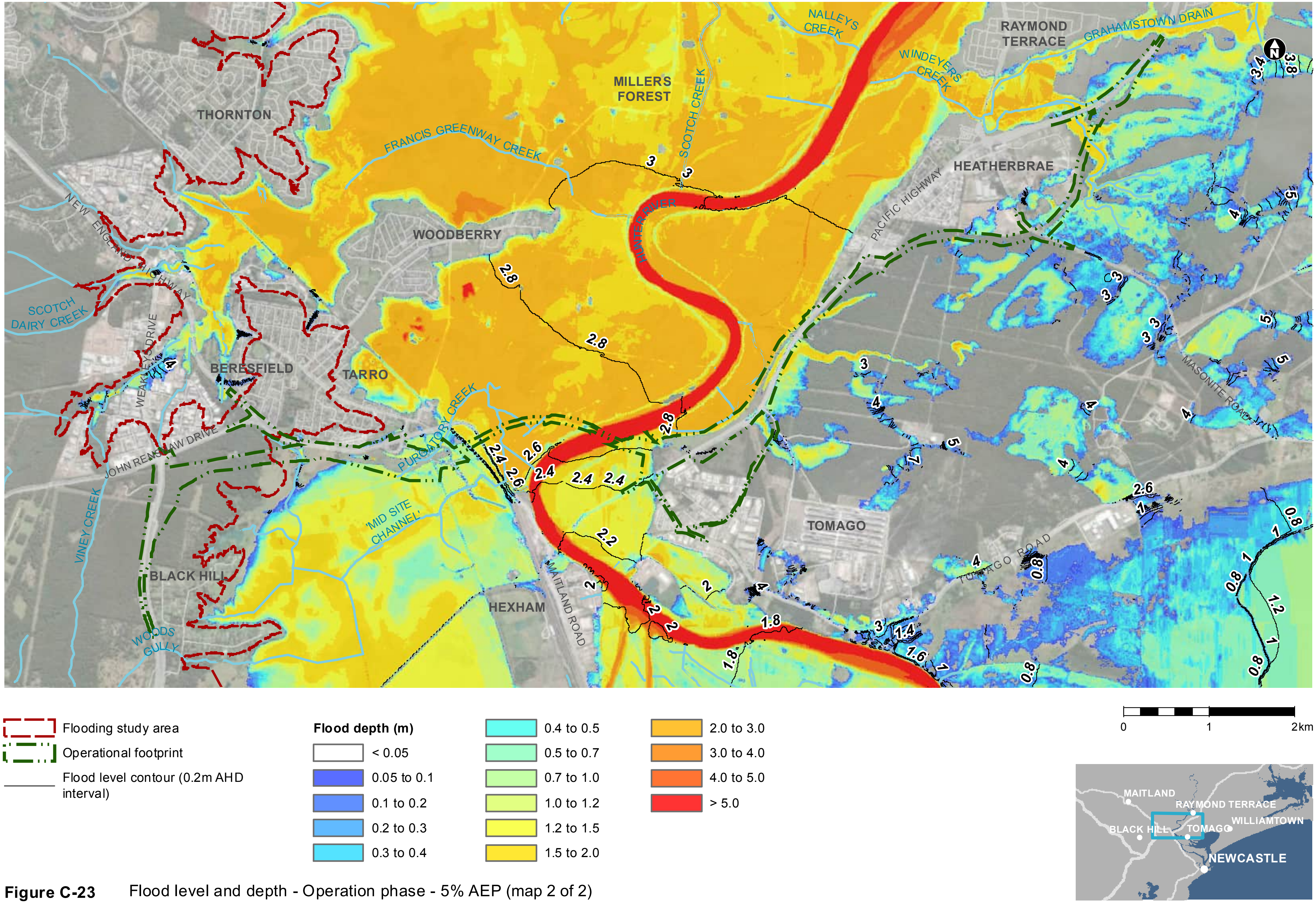
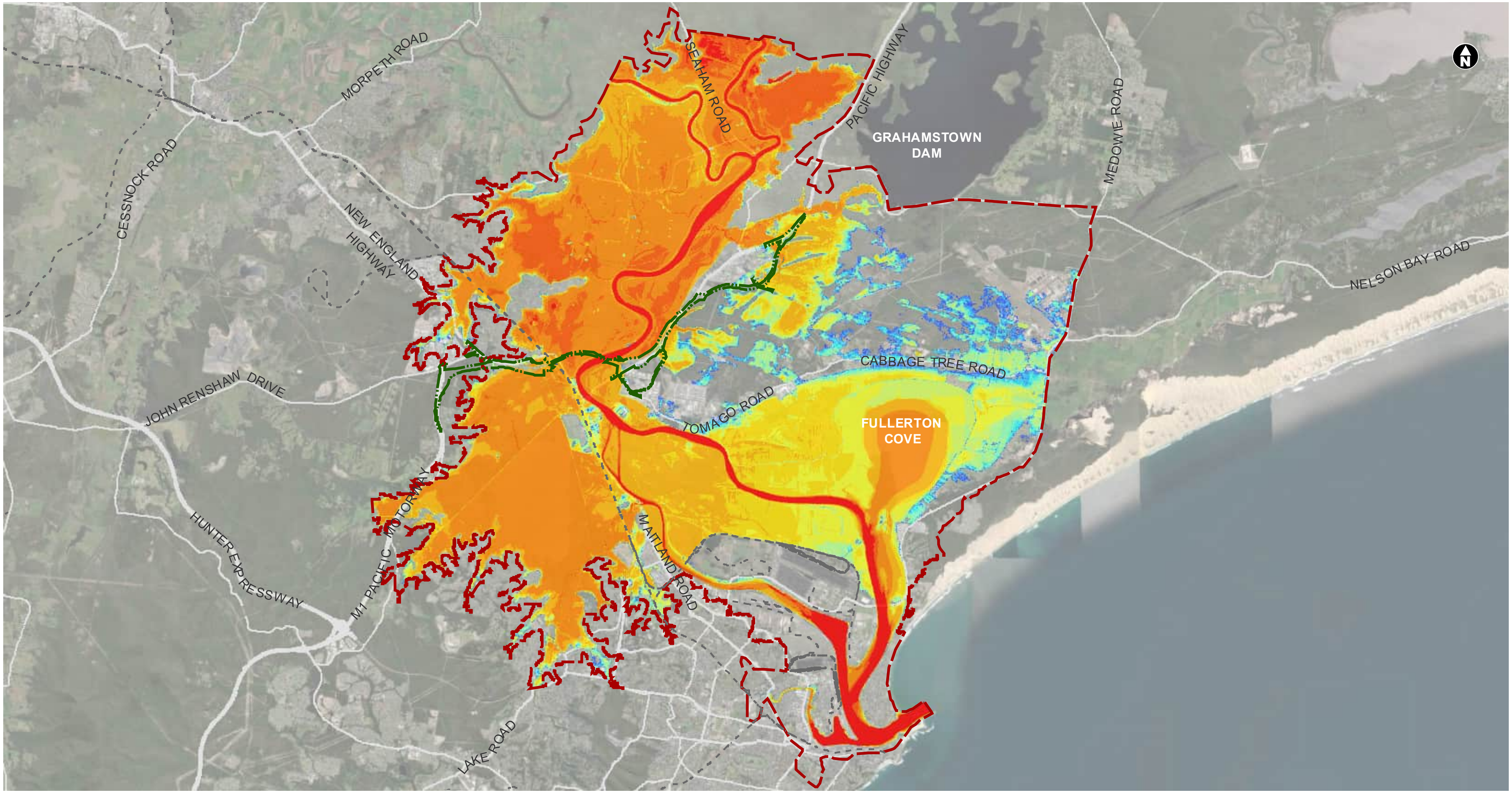


Figure C-23 Flood level and depth - Operation phase - 5% AEP (map 2 of 2)

Date: 28/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-23_LevelDepth_Operation_5_AEP_JAC_A4L_175000_V01.mxd



Flooding study area
Operational footprint
Railway

Flood depth (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- 0.4 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.2
- 1.2 to 1.5
- 1.5 to 2.0
- 2.0 to 3.0
- 3.0 to 4.0
- 4.0 to 5.0
- > 5.0

Figure C-24 Flood level and depth - Operation phase - 1% AEP (map 1 of 2)

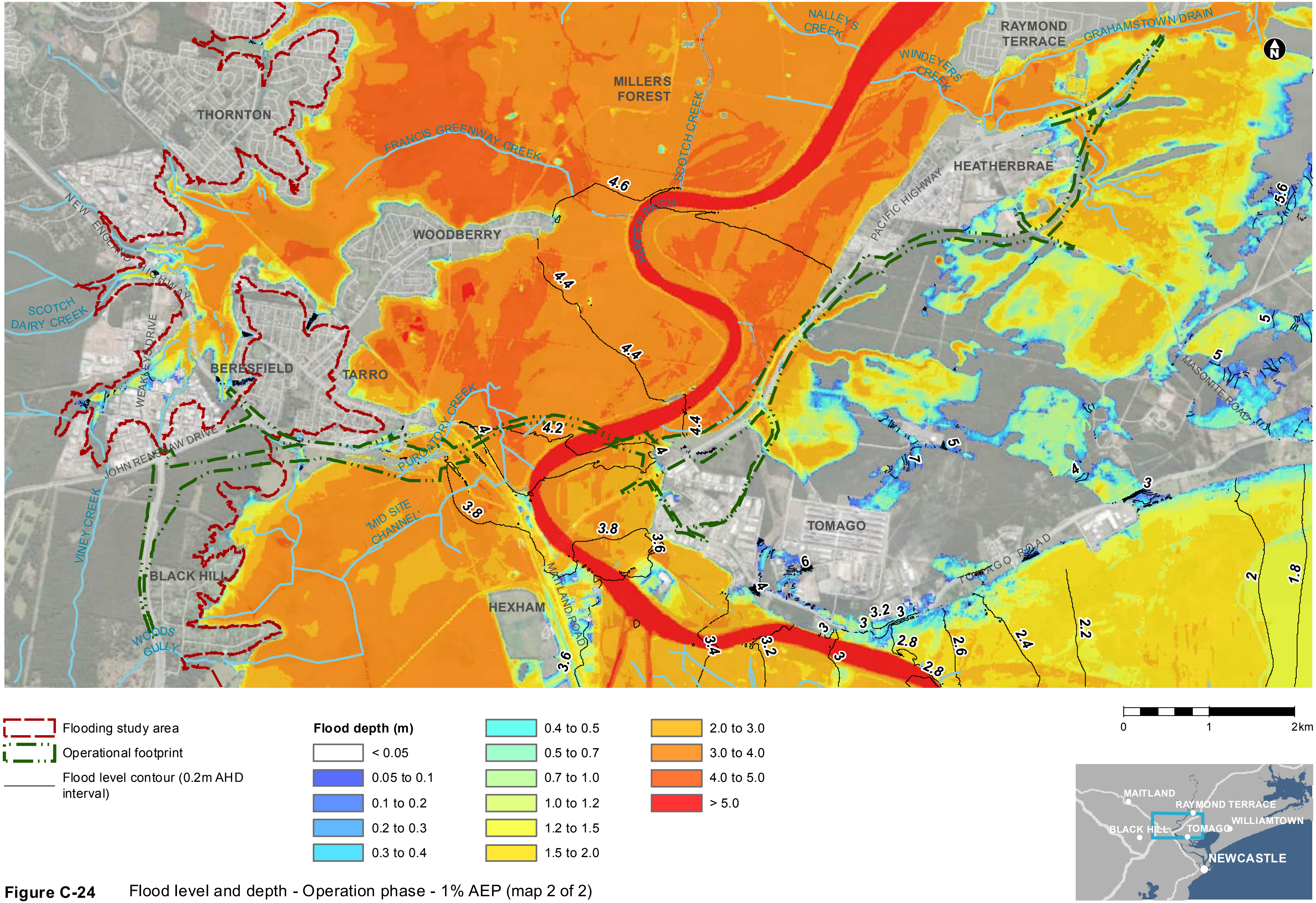
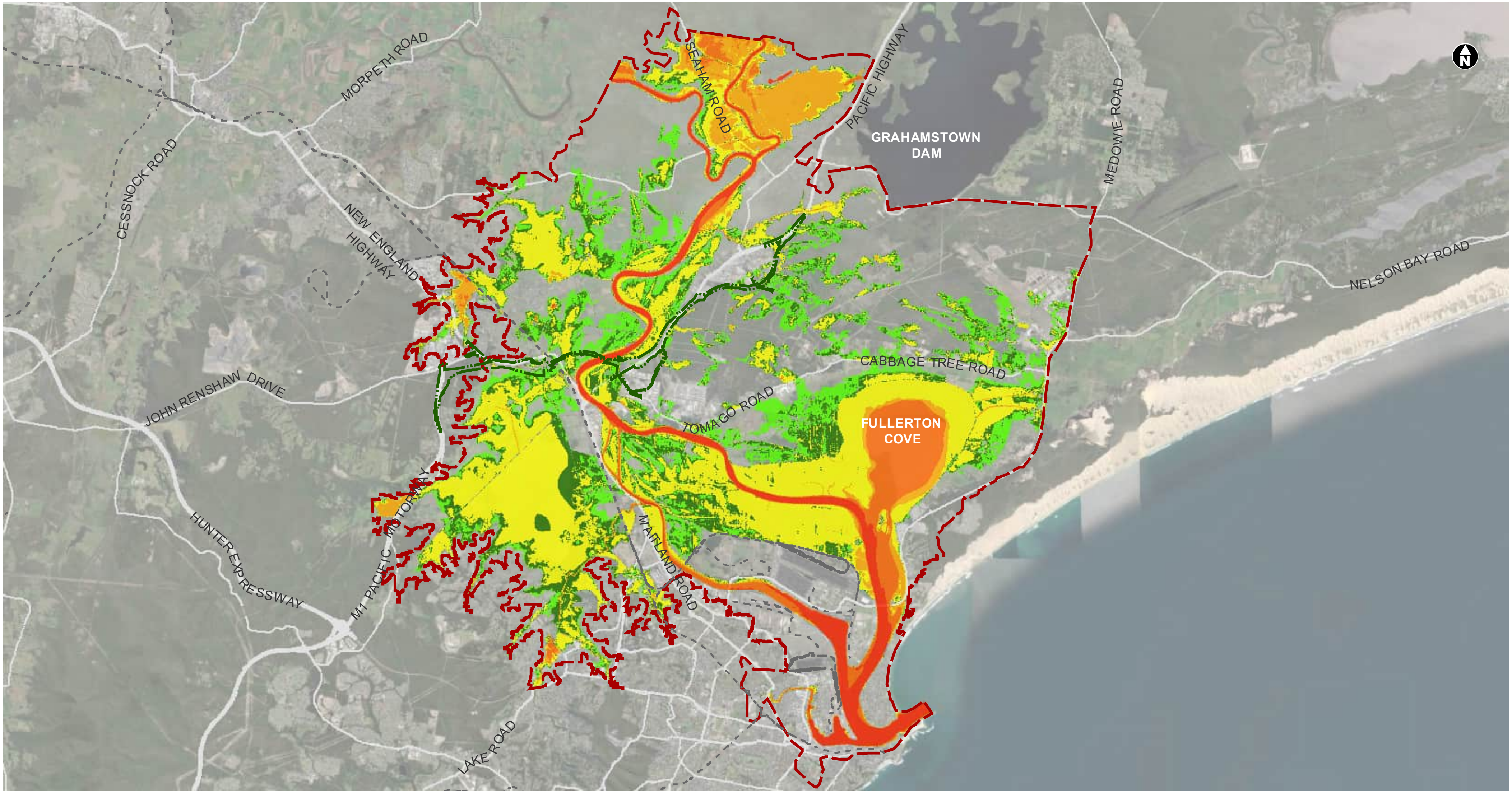


Figure C-24 Flood level and depth - Operation phase - 1% AEP (map 2 of 2)

Date: 28/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-24_LevelDepth_Operation_1_AEP_JAC_A4L_175000_V01.mxd

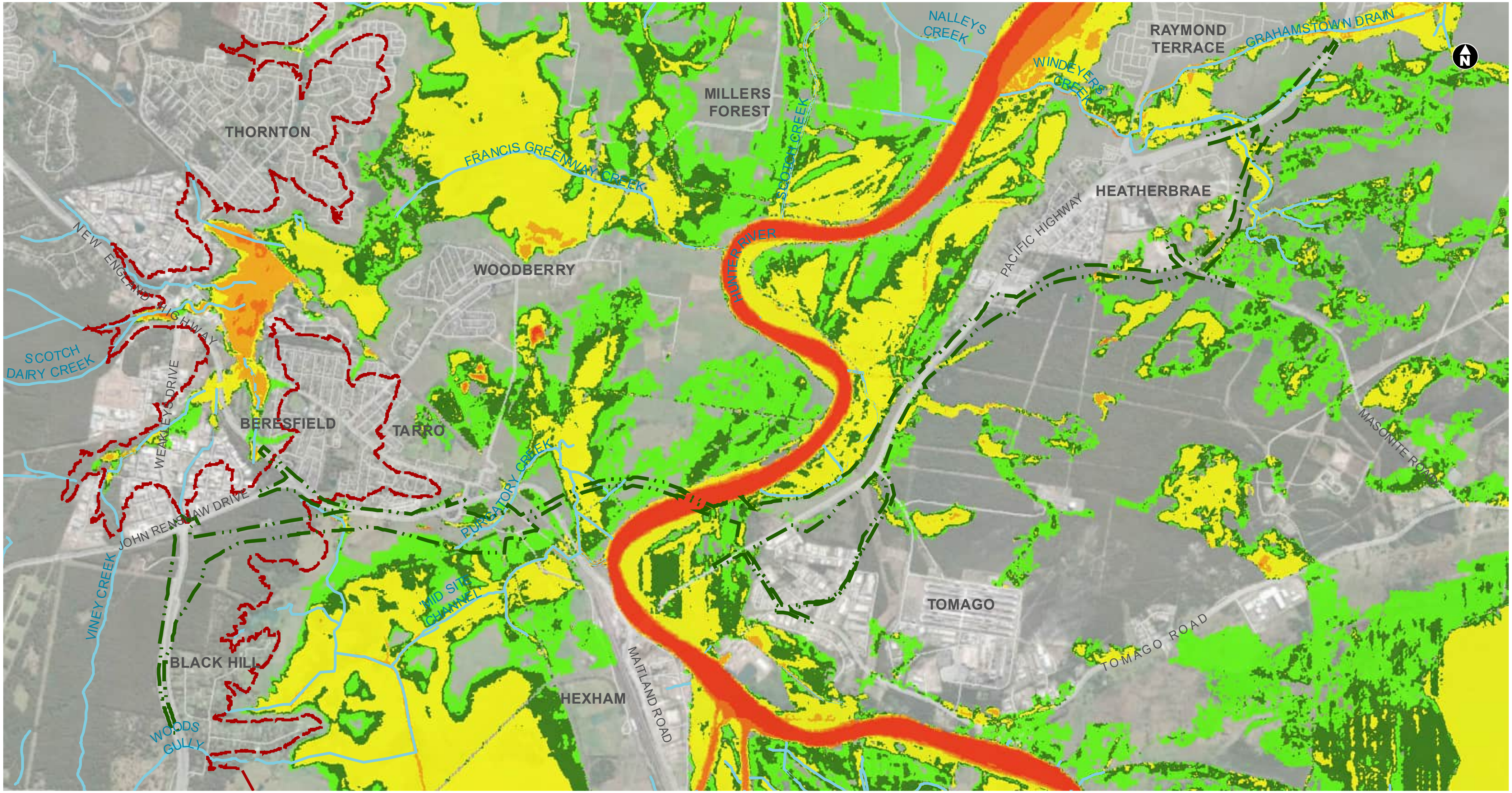


Flooding study area
Operational footprint
Railway

Flood hazard

H1 - No restrictions
H2 - Unsafe for small vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
H6 - Not suitable for people, vehicles or buildings

Figure C-25 Flood hazard - Operation phase - 20% AEP (map 1 of 2)



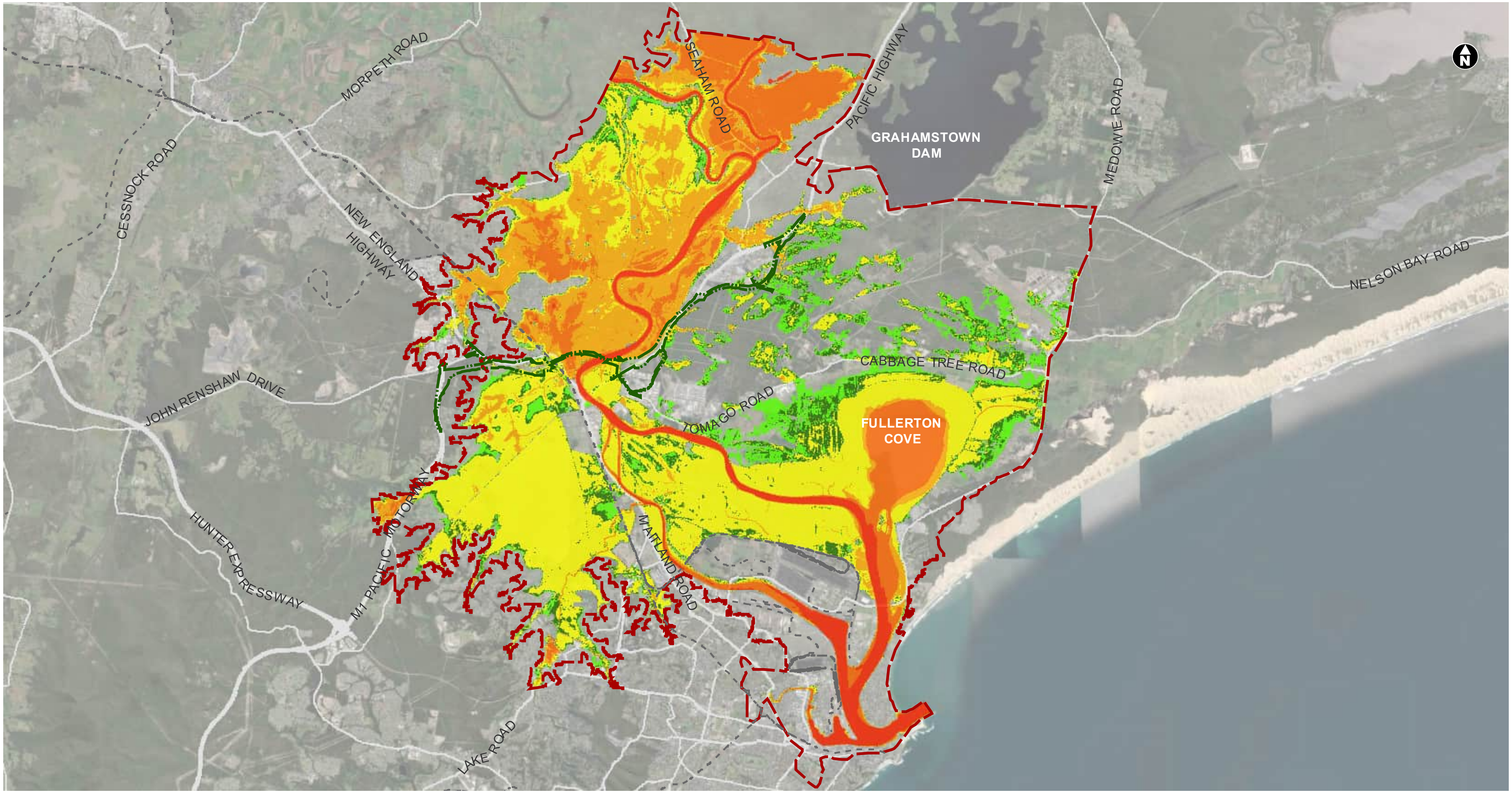
Flooding study area
Operational footprint

Flood hazard

H1 - No restrictions
H2 - Unsafe for small vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
H6 - Not suitable for people, vehicles or buildings

Figure C-25 Flood hazard - Operation phase - 20% AEP (map 2 of 2)

Date: 29/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-25_FloodHazard_Operation_20_AEP_JAC_A4L_175000_V01.mxd



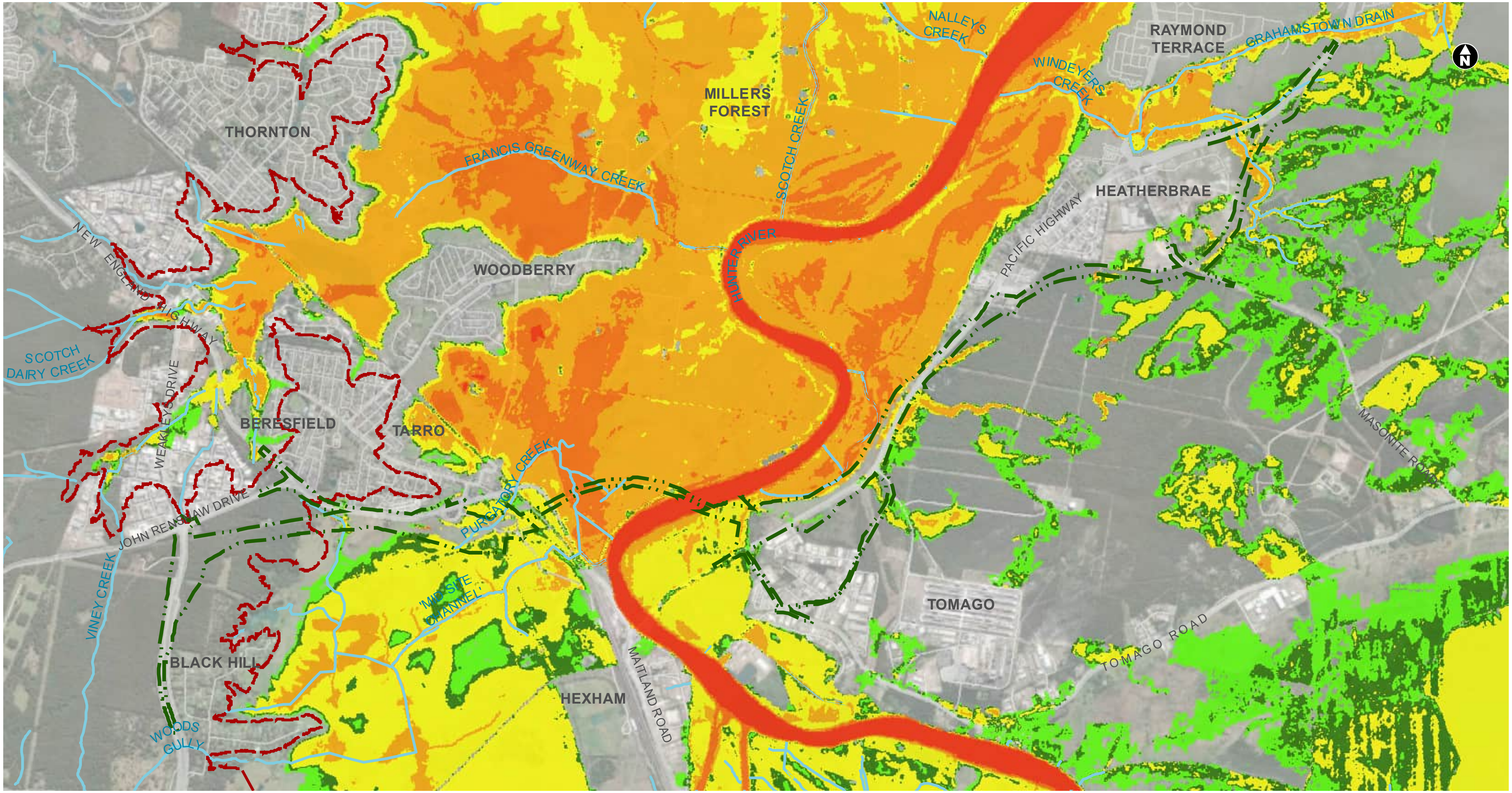
Flooding study area
Operational footprint
Railway

Flood hazard

H1 - No restrictions
H2 - Unsafe for small vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
H6 - Not suitable for people, vehicles or buildings

0 4 8km

Figure C-26 Flood hazard - Operation phase - 10% AEP (map 1 of 2)



Flooding study area
Operational footprint

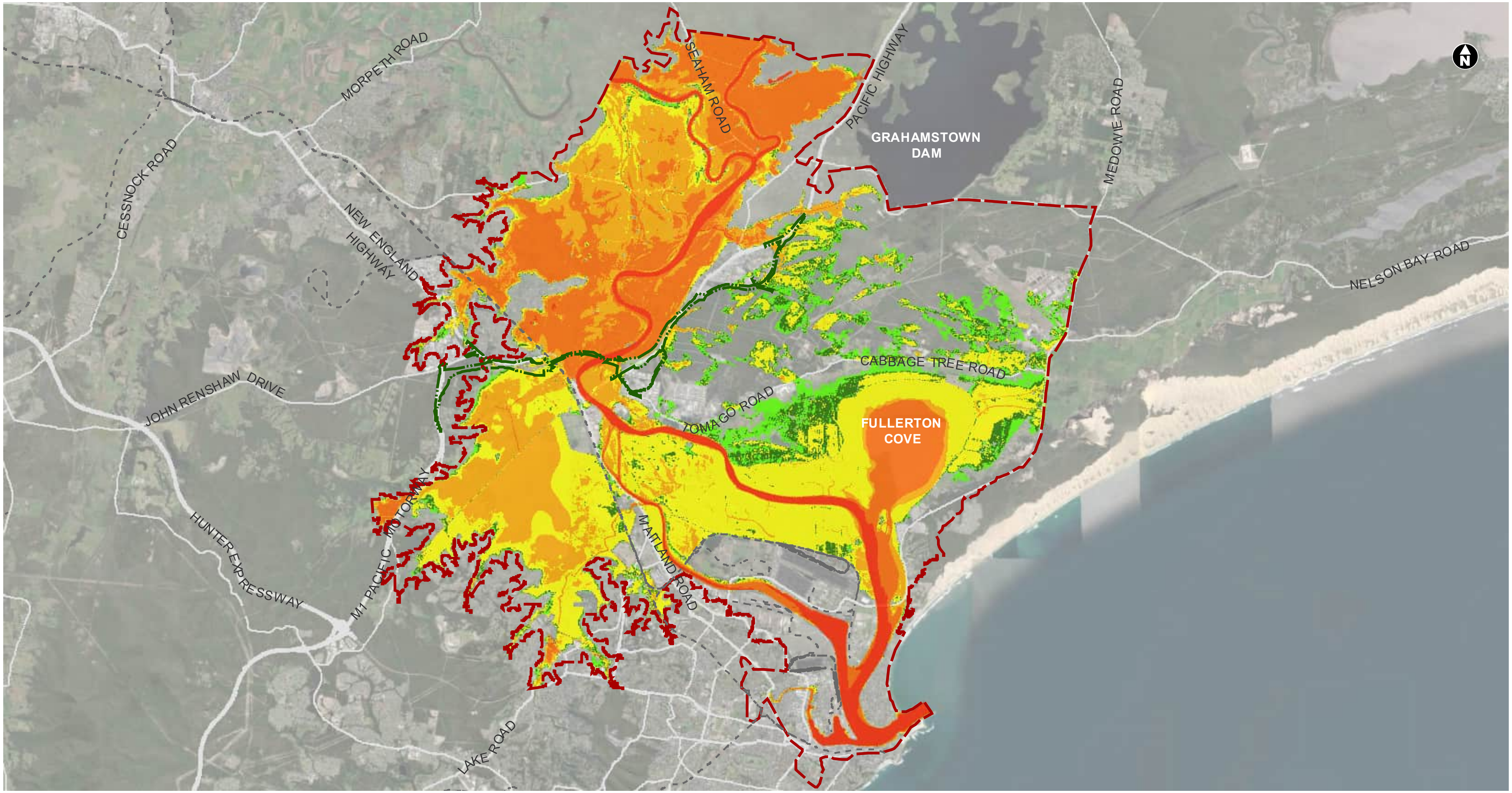
Flood hazard

H1 - No restrictions
H2 - Unsafe for small vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
H6 - Not suitable for people, vehicles or buildings

0 1 2km

Figure C-26 Flood hazard - Operation phase - 10% AEP (map 2 of 2)

Date: 29/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-26_FloodHazard_Operation_10_AEP_JAC_A4L_175000_V01.mxd



Flooding study area
Operational footprint
Railway

Flood hazard

H1 - No restrictions
H2 - Unsafe for small vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
H6 - Not suitable for people, vehicles or buildings

Figure C-27 Flood hazard - Operation phase - 5% AEP (map 1 of 2)

Date: 29/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-27_FloodHazard_Operation_5_AEP_JAC_A4L_175000_V01.mxd

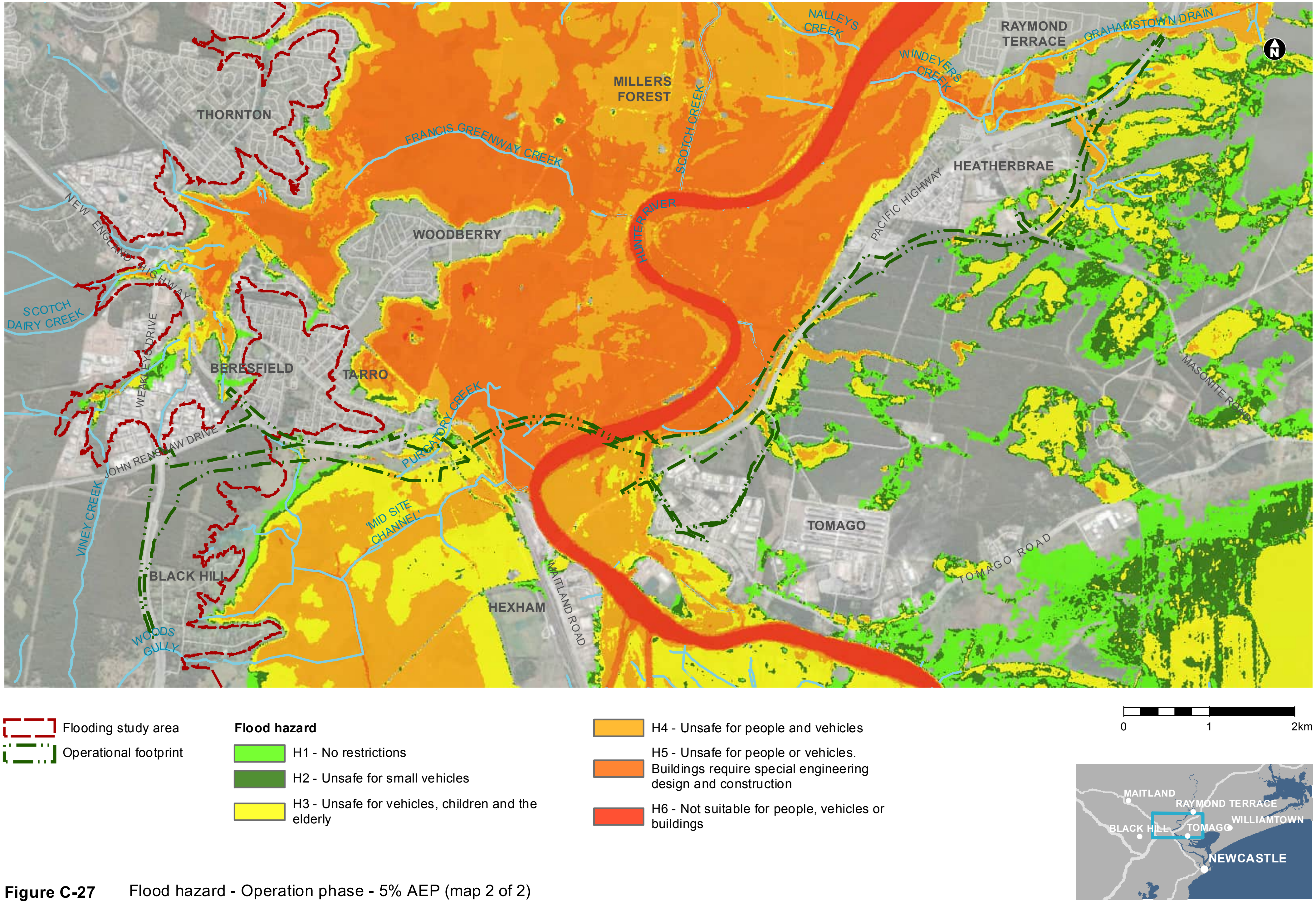
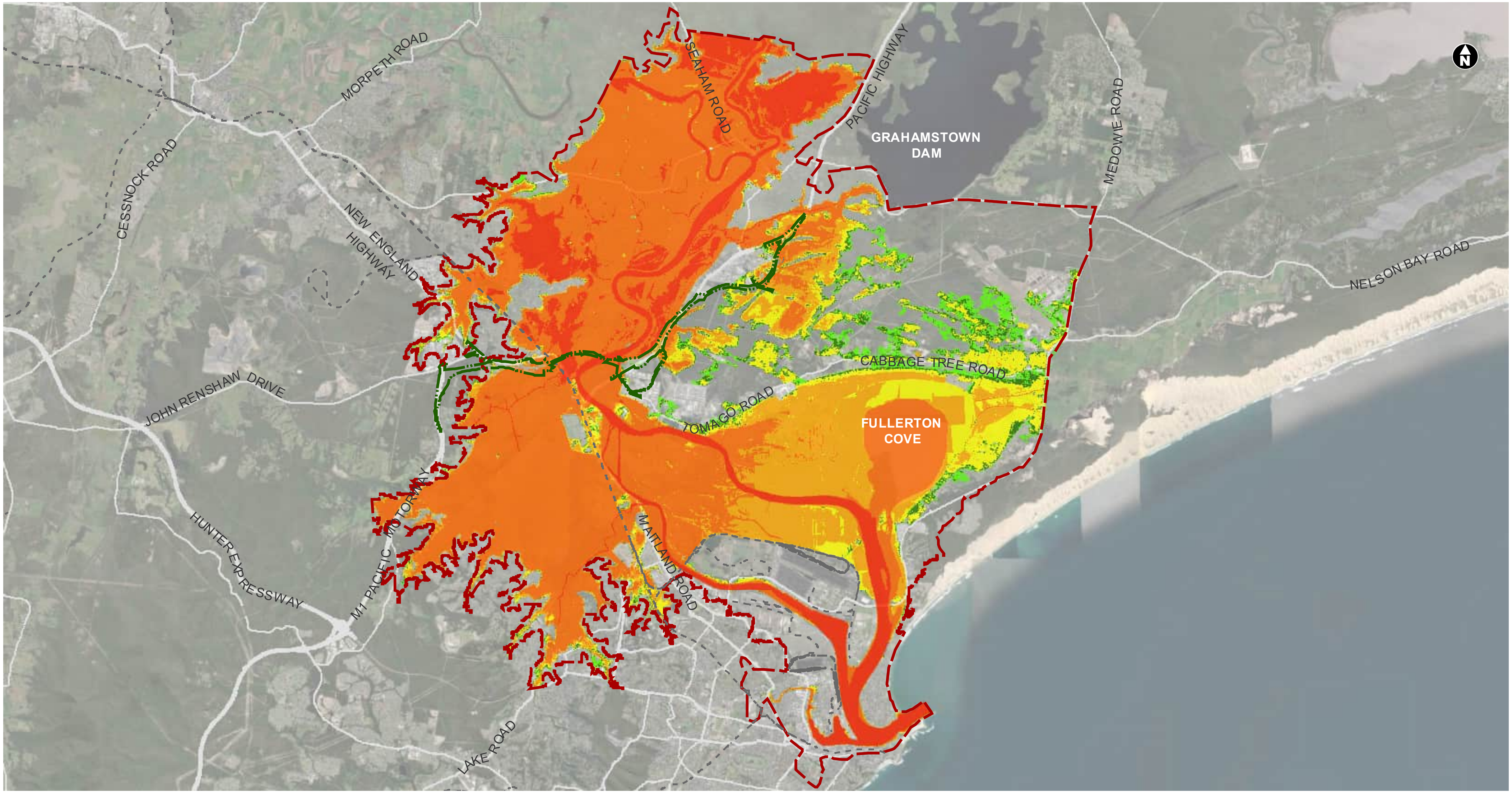


Figure C-27 Flood hazard - Operation phase - 5% AEP (map 2 of 2)

Date: 29/04/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-27_FloodHazard_Operation_5_AEP_JAC_A4L_175000_V01.mxd



Flooding study area

Operational footprint

Railway

Flood hazard

H1 - No restrictions

H2 - Unsafe for small vehicles

H3 - Unsafe for vehicles, children and the elderly

H4 - Unsafe for people and vehicles

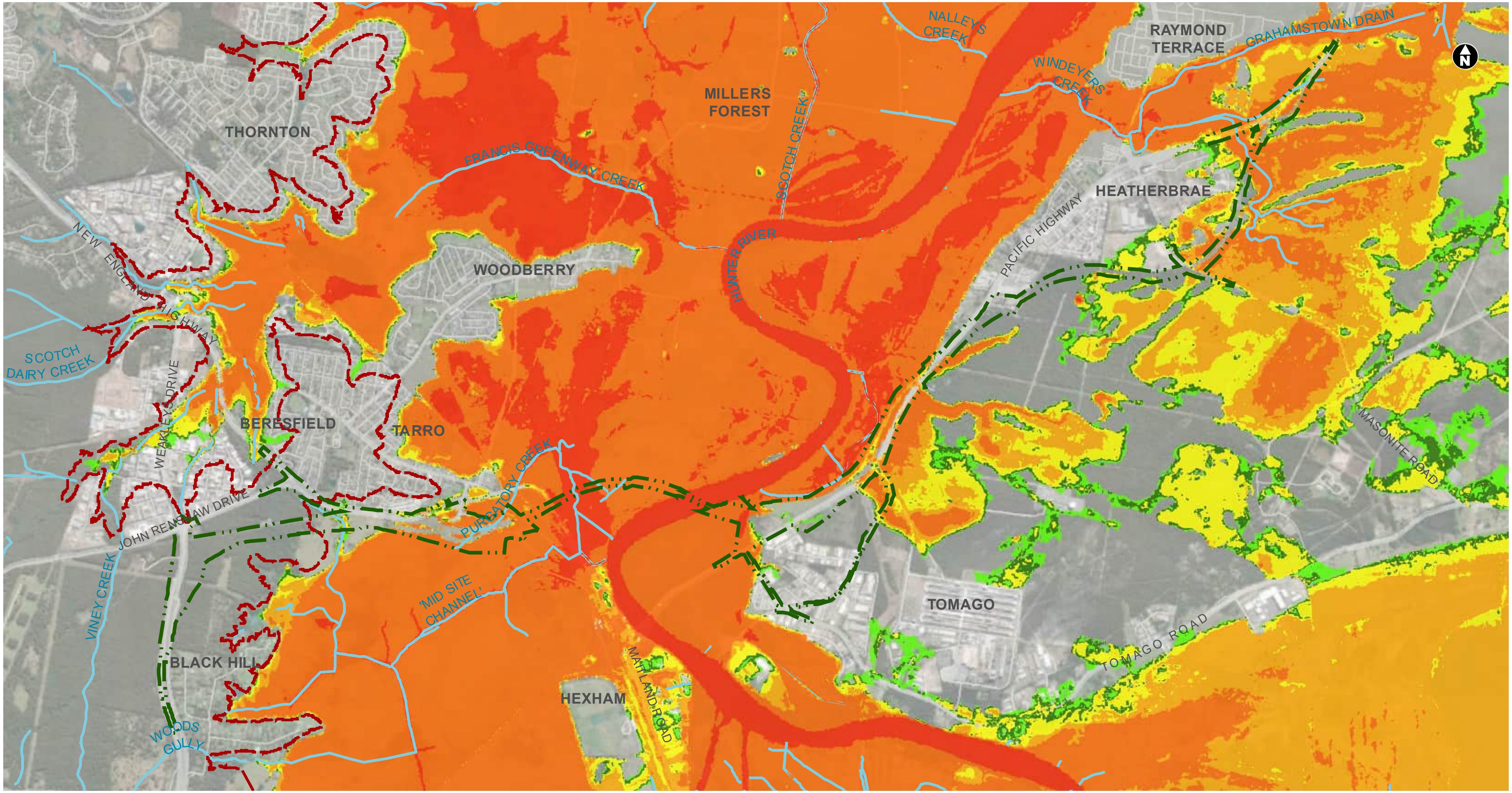
H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction

H6 - Not suitable for people, vehicles or buildings

0 4 8km

Figure C-28 Flood hazard - Operation phase - 1% AEP (map 1 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-28_FloodHazard_Operation_1_AEP_JAC_A4L_175000_V01.mxd



Flooding study area

Operational footprint

Flood hazard

H1 - No restrictions

H2 - Unsafe for small vehicles

H3 - Unsafe for vehicles, children and the elderly

H4 - Unsafe for people and vehicles

H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction

H6 - Not suitable for people, vehicles or buildings

0 1 2km

Figure C-28 Flood hazard - Operation phase - 1% AEP (map 2 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-28_FloodHazard_Operation_1_AEP_JAC_A4L_175000_V01.mxd

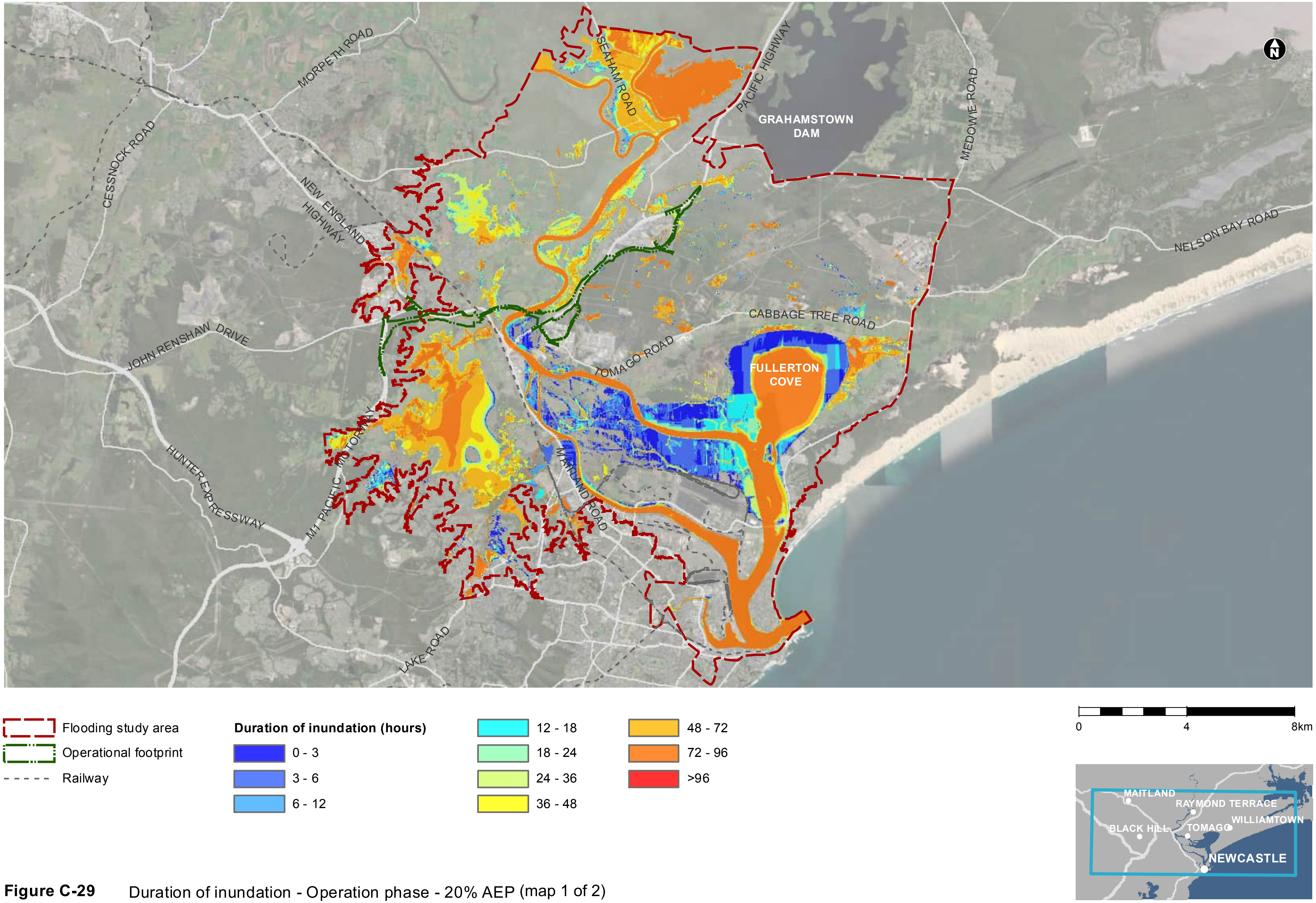
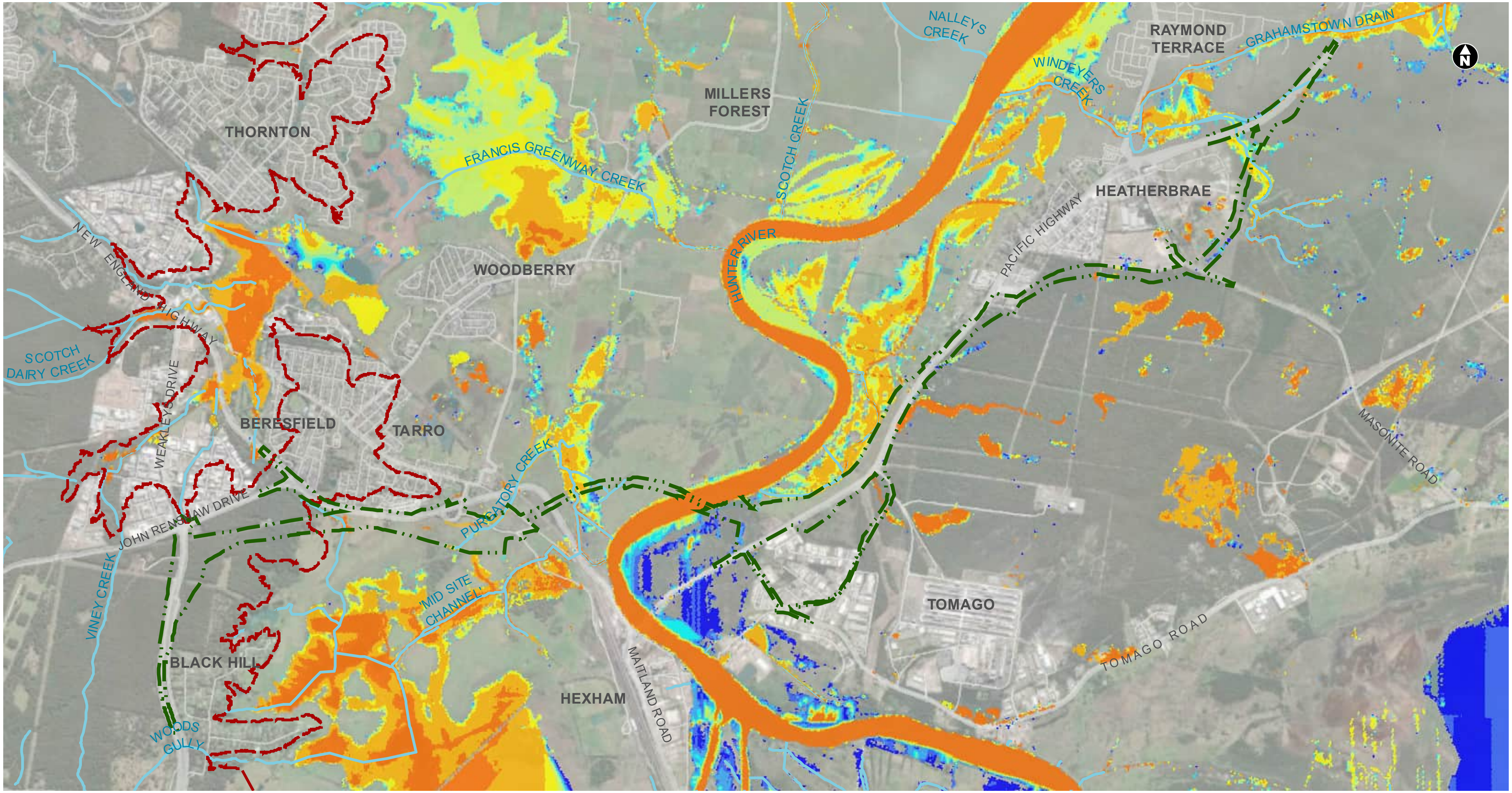


Figure C-29 Duration of inundation - Operation phase - 20% AEP (map 1 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-29_DurationInundation_Operation_20_AEP_JAC_A4L_175000_V01.mxd



Flooding study area

Operational footprint

Duration of inundation (hours)

0 - 3
3 - 6
6 - 12
12 - 18
18 - 24
24 - 36
36 - 48
48 - 72
72 - 96
>96

Figure C-29 Duration of inundation - Operation phase - 20% AEP (map 2 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-29_DurationInundation_Operation_20_AEP_JAC_A4L_175000_V01.mxd

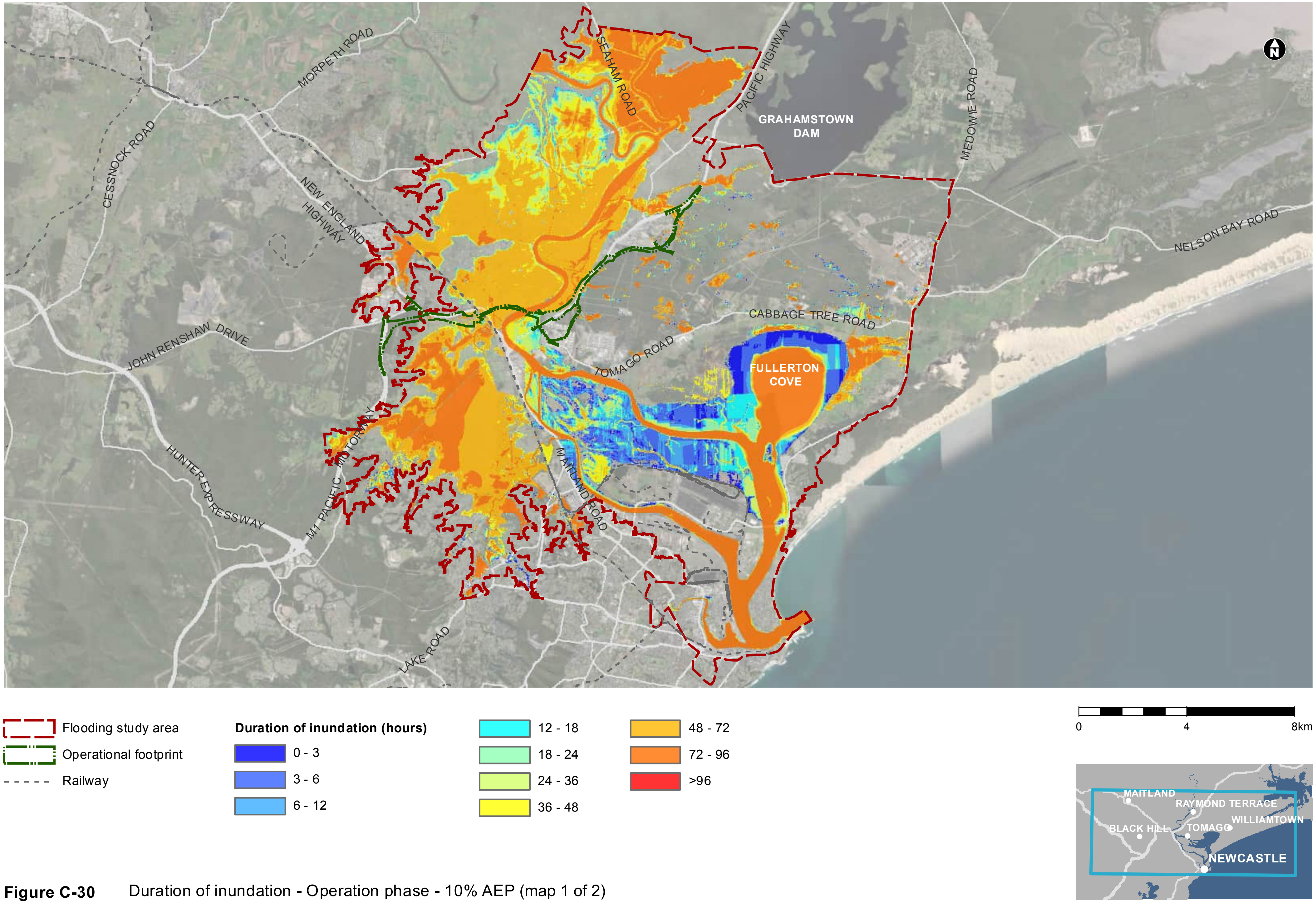


Figure C-30 Duration of inundation - Operation phase - 10% AEP (map 1 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-30_DurationInundation_Operation_10_AEP_JAC_A4L_175000_V01.mxd

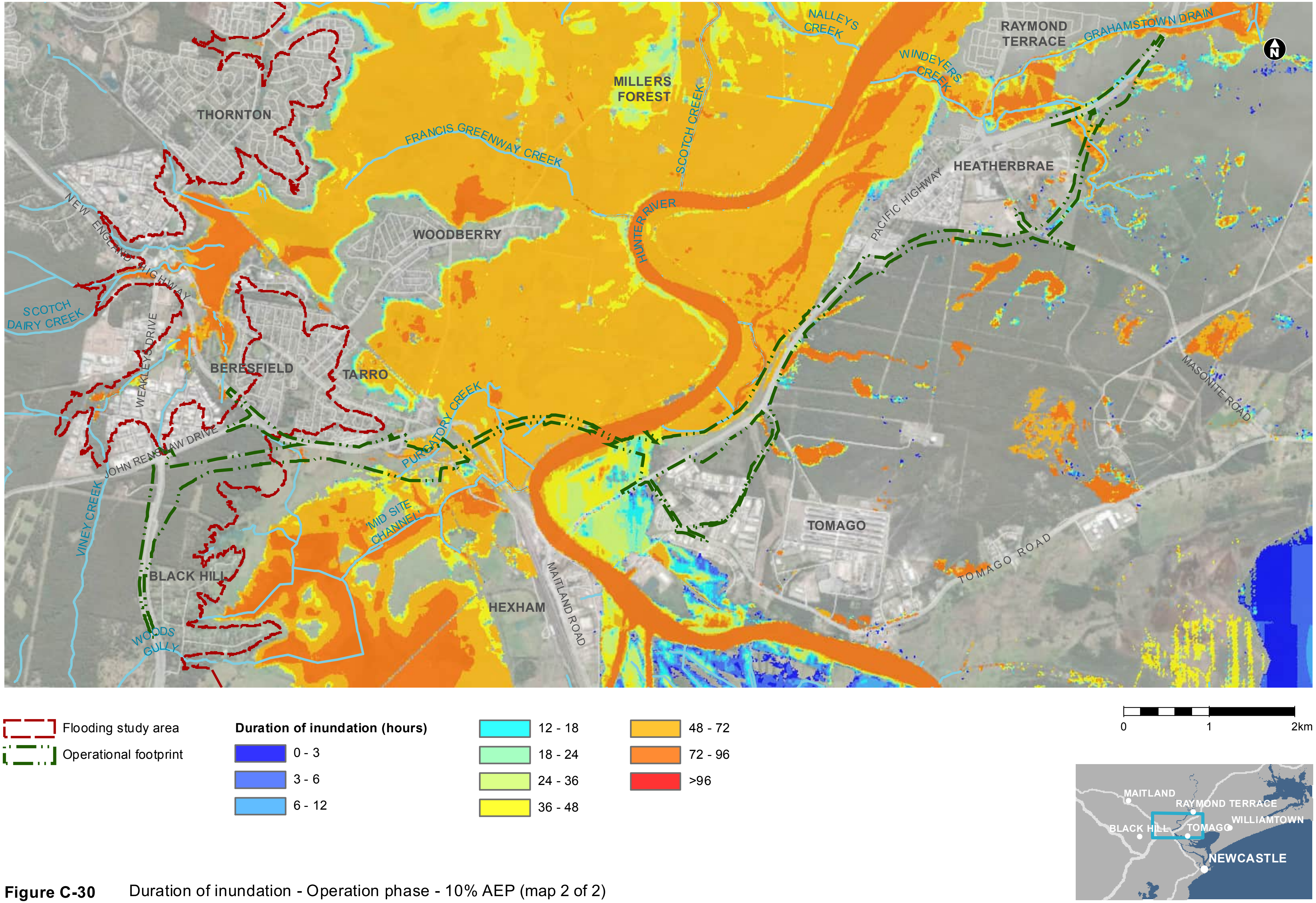


Figure C-30 Duration of inundation - Operation phase - 10% AEP (map 2 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-30_DurationInundation_Operation_10_AEP_JAC_A4L_175000_V01.mxd

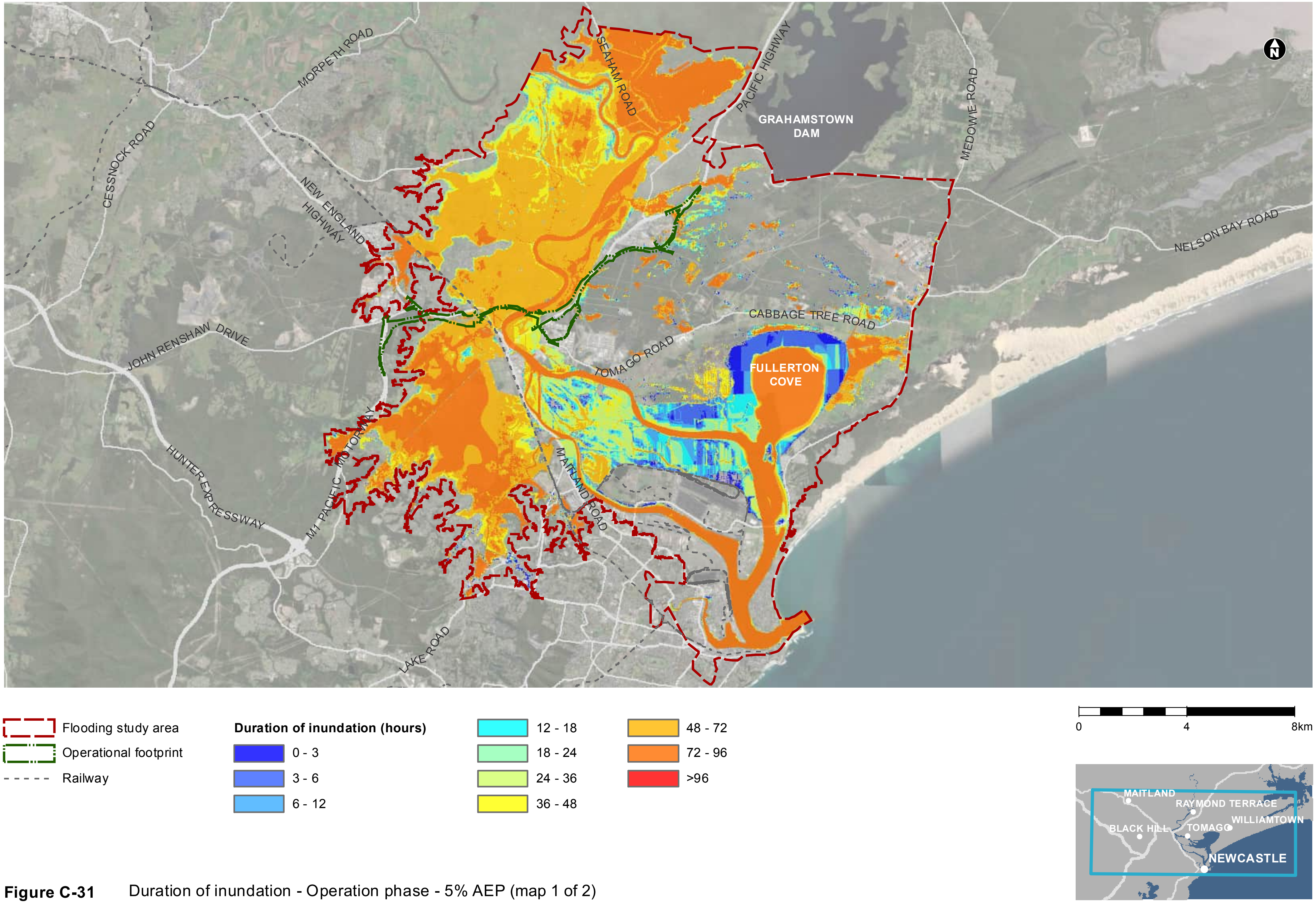
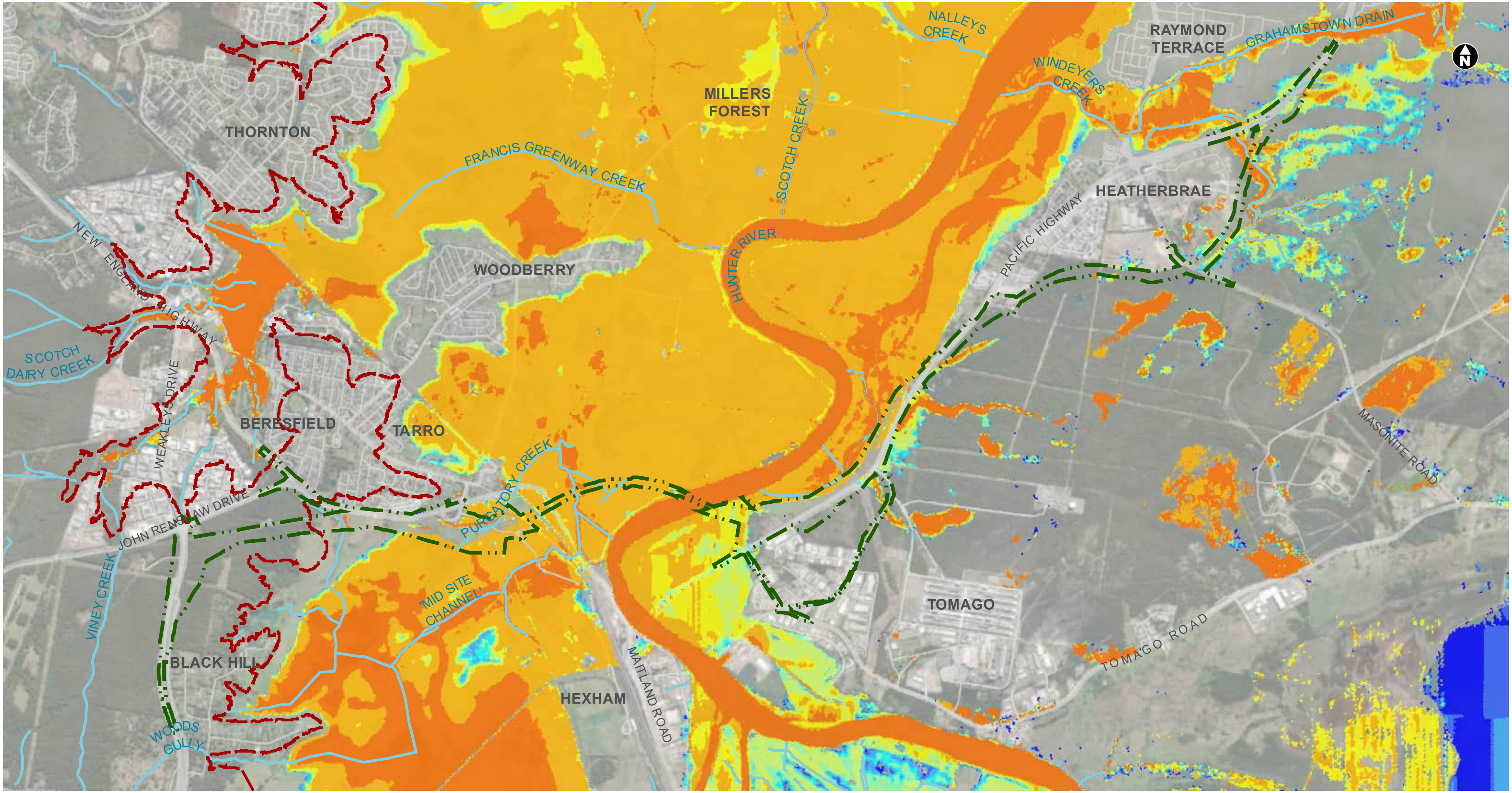


Figure C-31 Duration of inundation - Operation phase - 5% AEP (map 1 of 2)

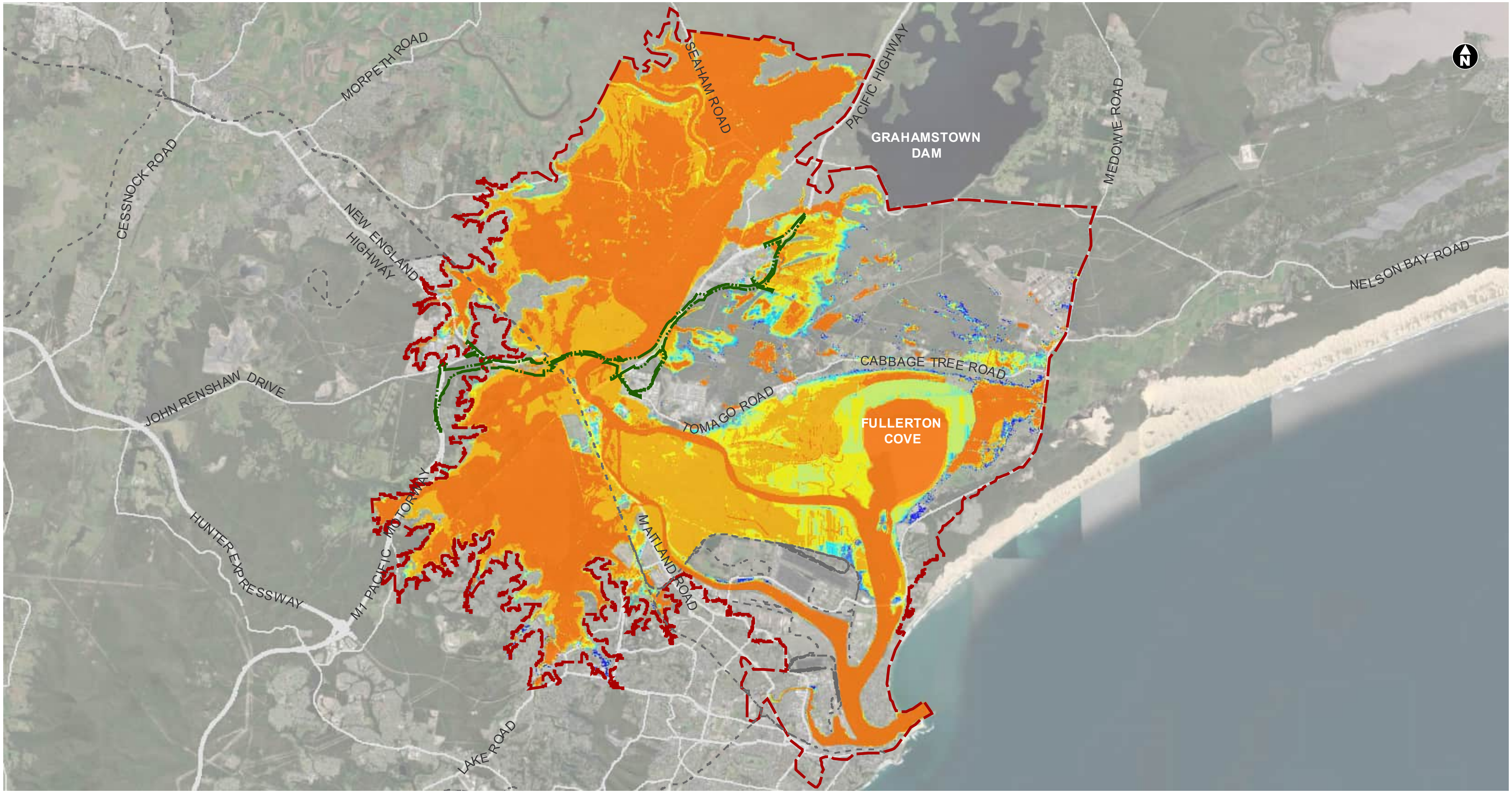
Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-31_DurationInundation_Operation_5_AEP_JAC_A4L_175000_V01.mxd



Flooding study area	**Duration of inundation (hours)**	12 - 18	48 - 72	
Operational footprint	0 - 3	18 - 24	72 - 96	
	3 - 6	24 - 36	>96	
	6 - 12	36 - 48		

0 1 2km

Figure C-31 Duration of inundation - Operation phase - 5% AEP (map 2 of 2)



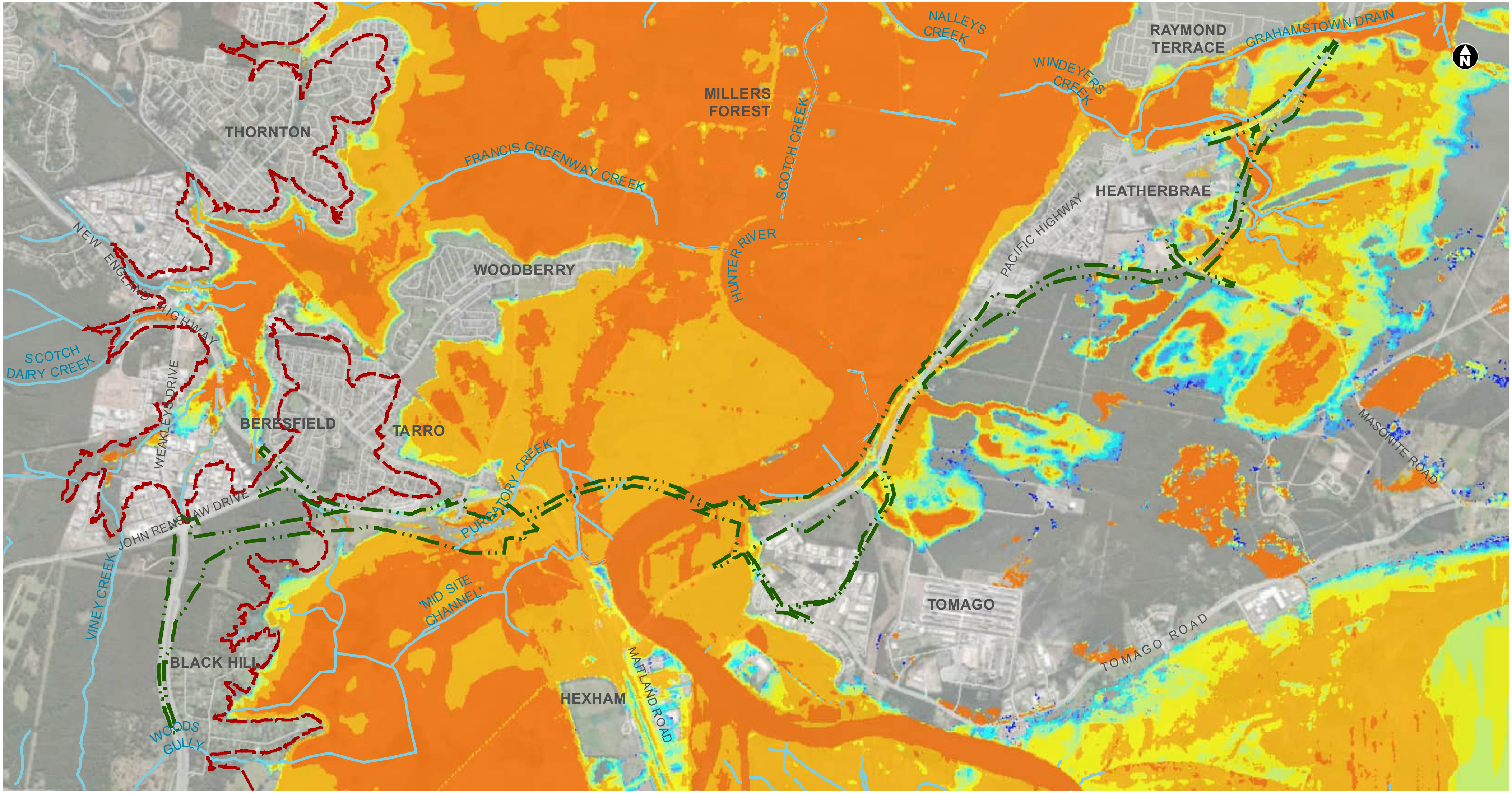
Flooding study area
Operational footprint
Railway

Duration of inundation (hours)

- 0 - 3
- 3 - 6
- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 36
- 36 - 48
- 48 - 72
- 72 - 96
- >96

0 4 8km

Figure C-32 Duration of inundation - Operation phase - 1% AEP (map 1 of 2)



Flooding study area

Operational footprint

Duration of inundation (hours)

0 - 3

3 - 6

6 - 12

12 - 18

18 - 24

24 - 36

36 - 48

48 - 72

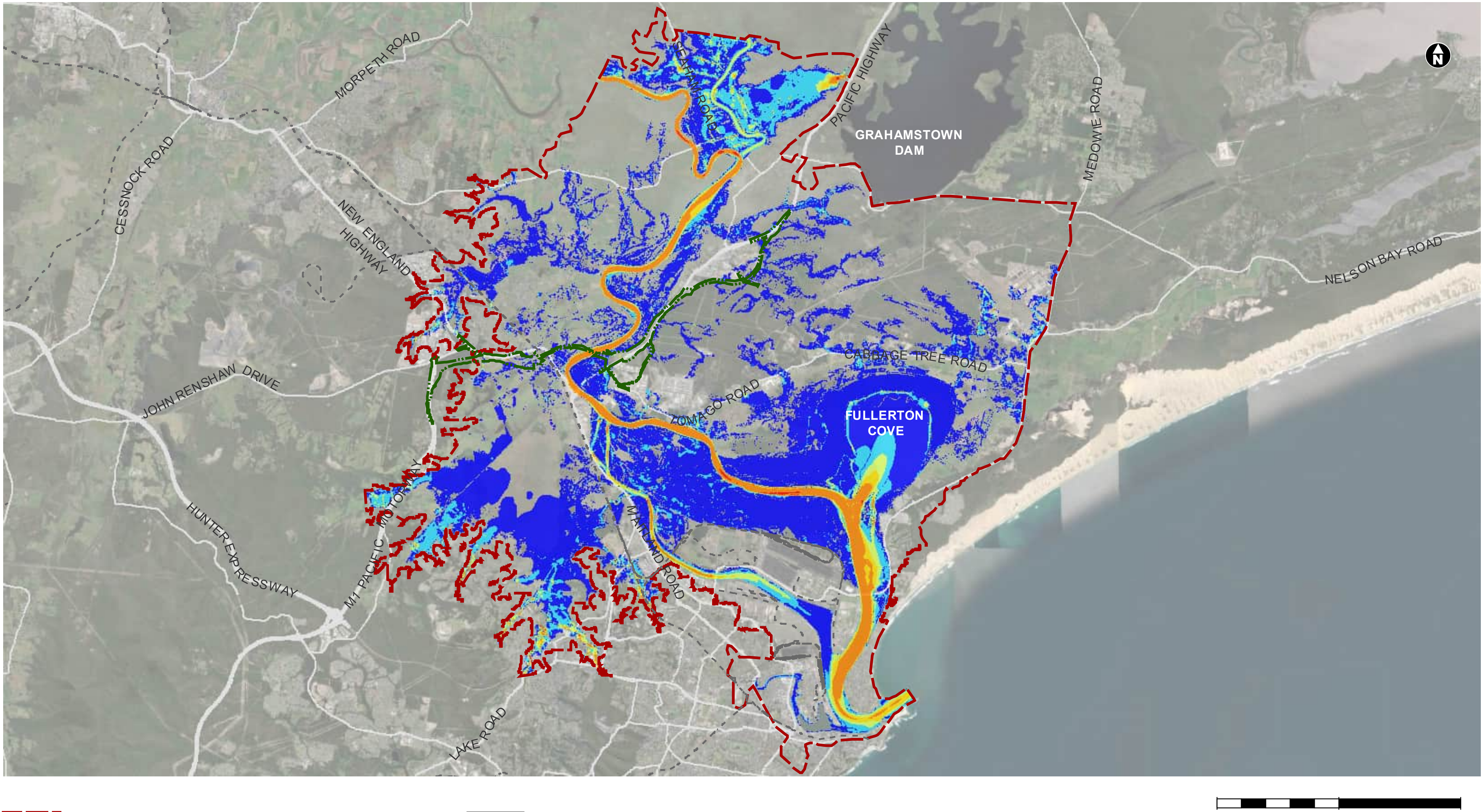
72 - 96

>96

0 1 2km

Figure C-32 Duration of inundation - Operation phase - 1% AEP (map 2 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-32_DurationInundation_Operation_1_AEP_JAC_A4L_175000_V01.mxd



	Flooding study area	**Flow velocity (m/s)**			0.75 to 1.0
	Operational footprint		< 0.05		1.0 to 2.0
	Railway		0.05 to 0.25		2.0 to 3.0
			0.25 to 0.5		> 3.0
			0.5 to 0.75		

Figure C-33 Flow velocity - Operation phase - 20% AEP (map 1 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-33_Velocity_Operation_20_AEP_JAC_A4L_175000_V01.mxd

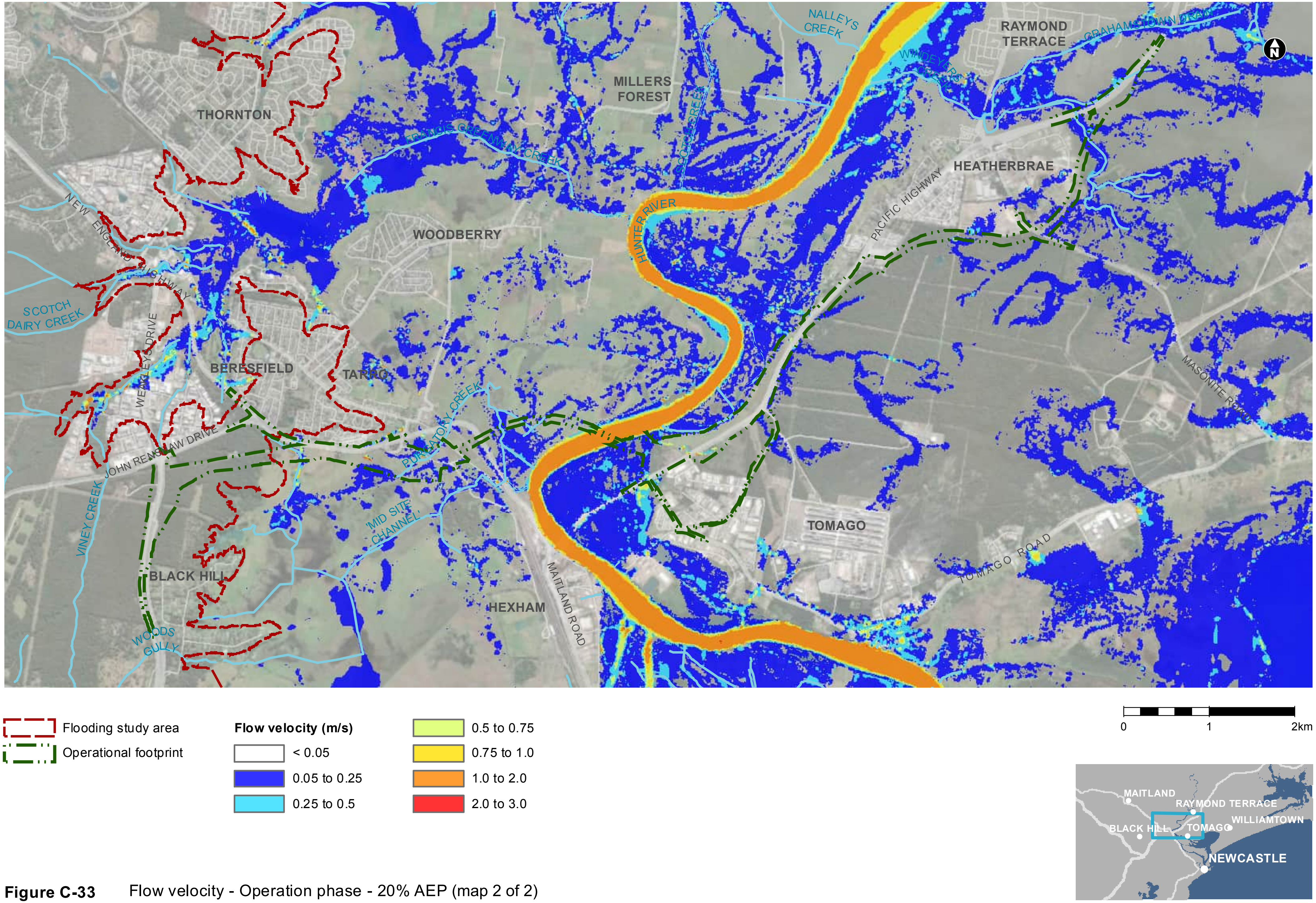
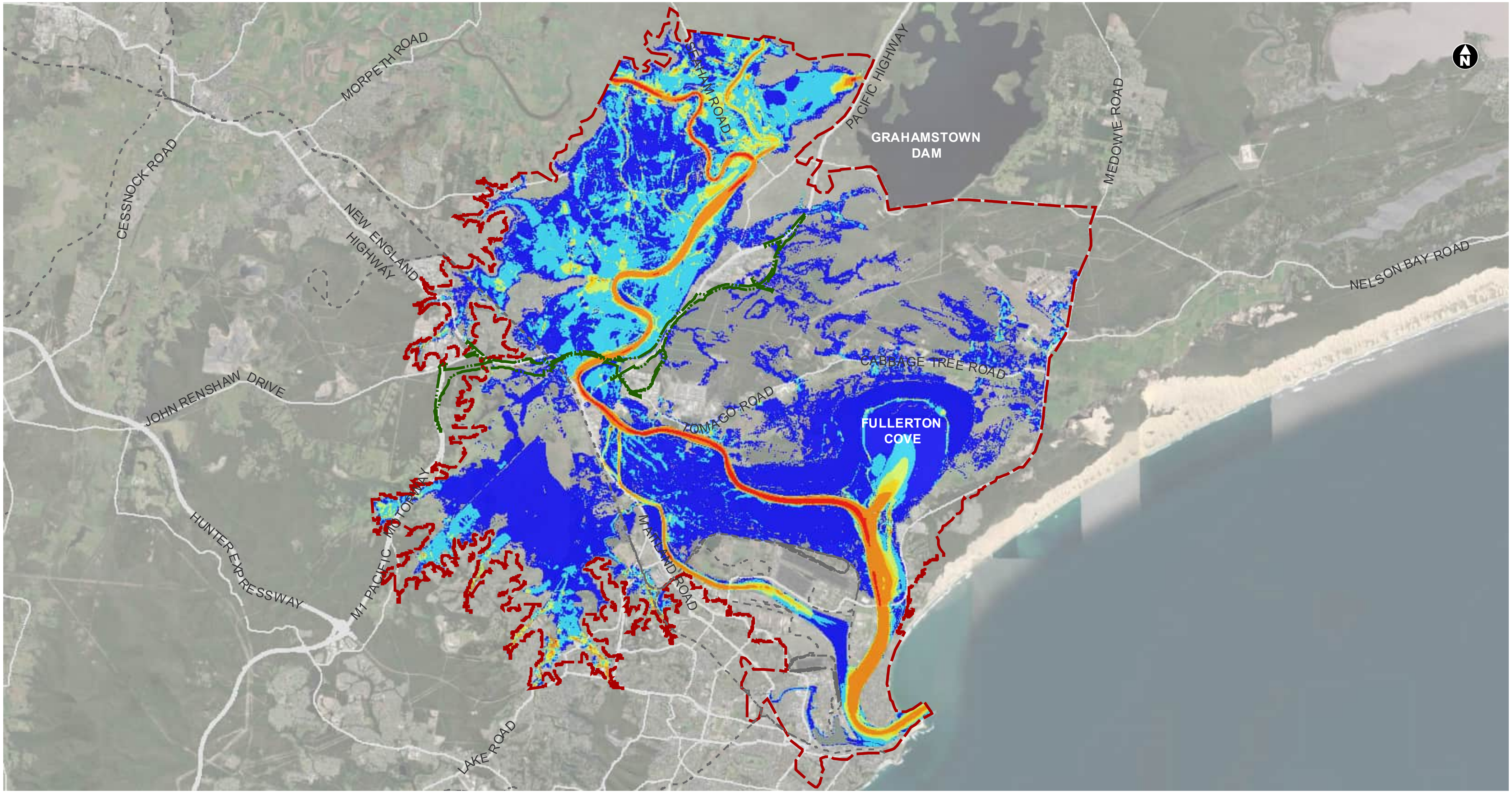


Figure C-33 Flow velocity - Operation phase - 20% AEP (map 2 of 2)

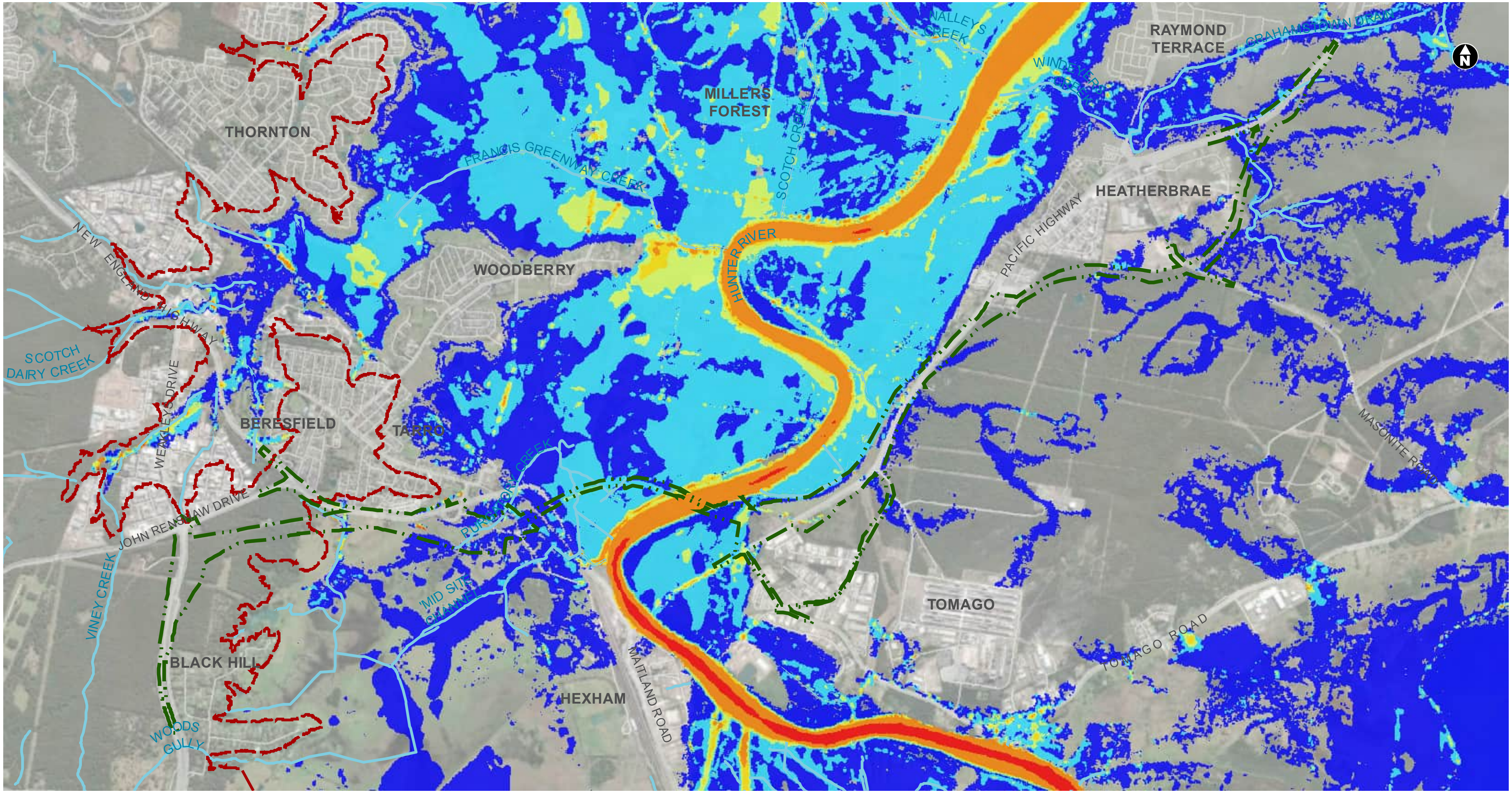
Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-33_Velocity_Operation_20_AEP_JAC_A4L_175000_V01.mxd



Flooding study area
Operational footprint
Railway

Flow velocity (m/s)
< 0.05
0.05 to 0.25
0.25 to 0.5
0.5 to 0.75
0.75 to 1.0
1.0 to 2.0
2.0 to 3.0
> 3.0

Figure C-34 Flow velocity - Operation phase - 10% AEP (map 1 of 2)



Flooding study area

Operational footprint

Flow velocity (m/s)

Flow velocity (m/s)
< 0.05
0.05 to 0.25
0.25 to 0.5
0.5 to 0.75
0.75 to 1.0
1.0 to 2.0
2.0 to 3.0

Figure C-34 Flow velocity - Operation phase - 10% AEP (map 2 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-34_Velocity_Operation_10_AEP_JAC_A4L_175000_V01.mxd

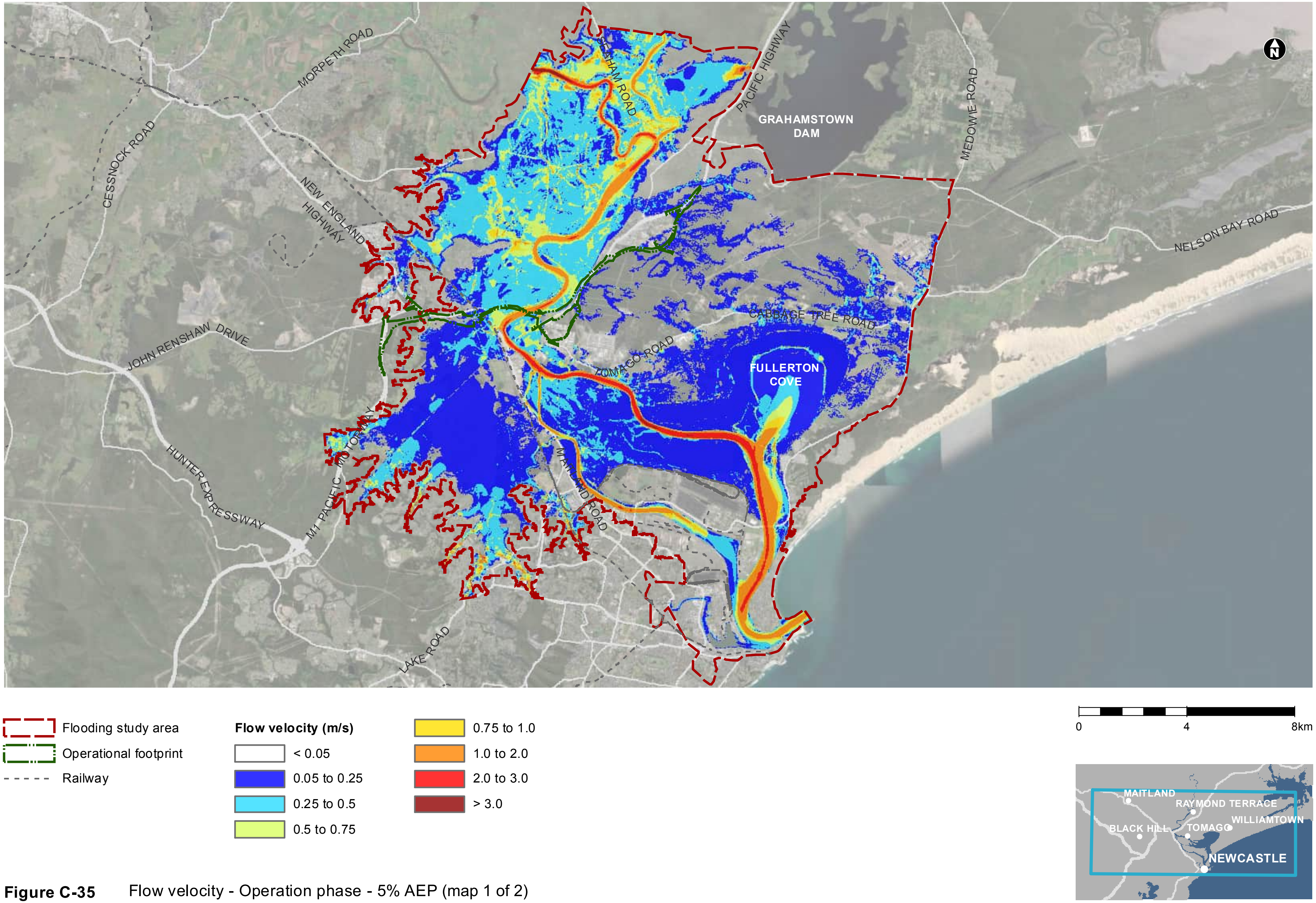
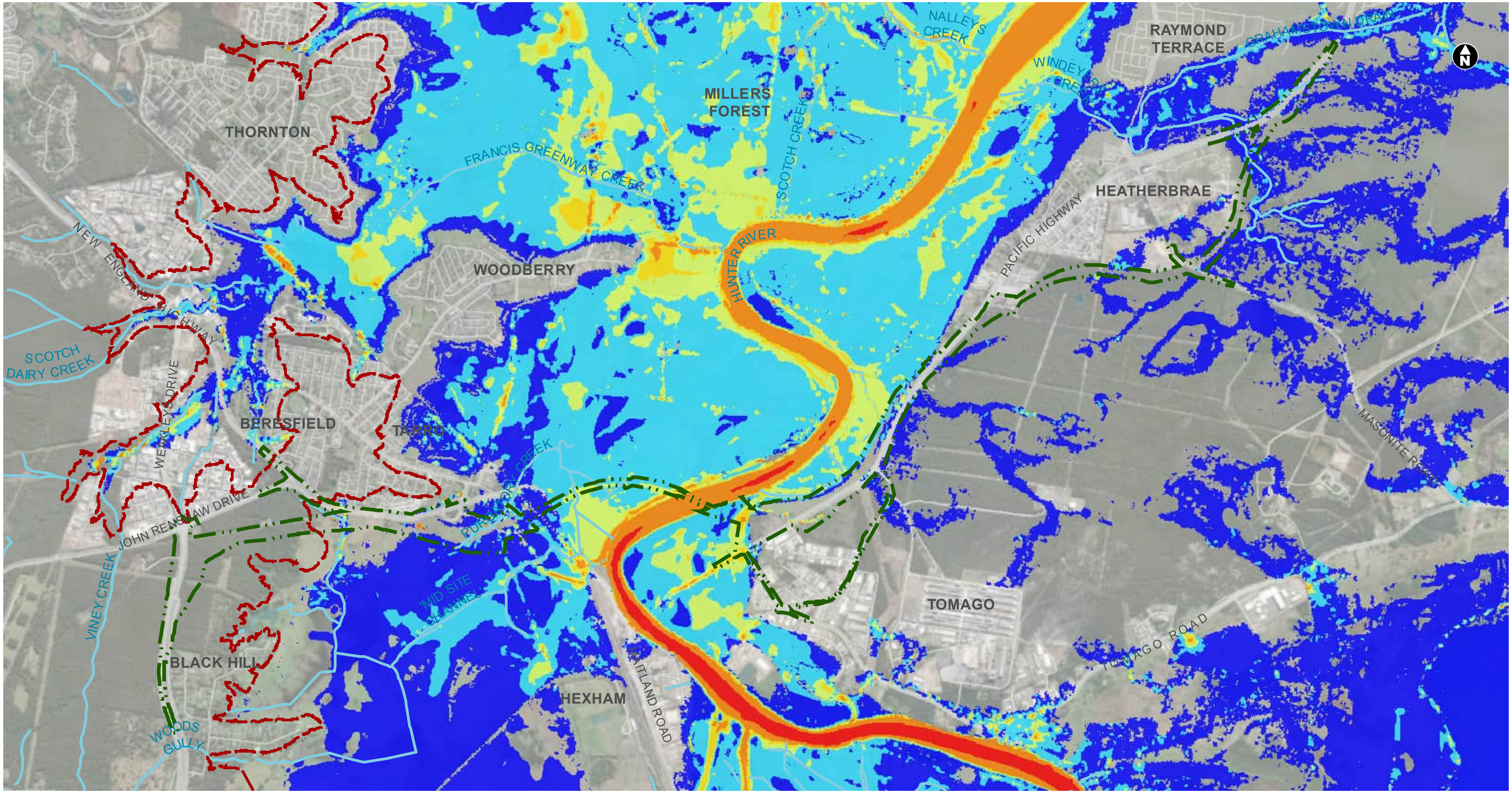


Figure C-35 Flow velocity - Operation phase - 5% AEP (map 1 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-35_Velocity_Operation_5_AEP_JAC_A4L_175000_V01.mxd



Flooding study area

Operational footprint

Flow velocity (m/s)

< 0.05

0.05 to 0.25

0.25 to 0.5

0.5 to 0.75

0.75 to 1.0

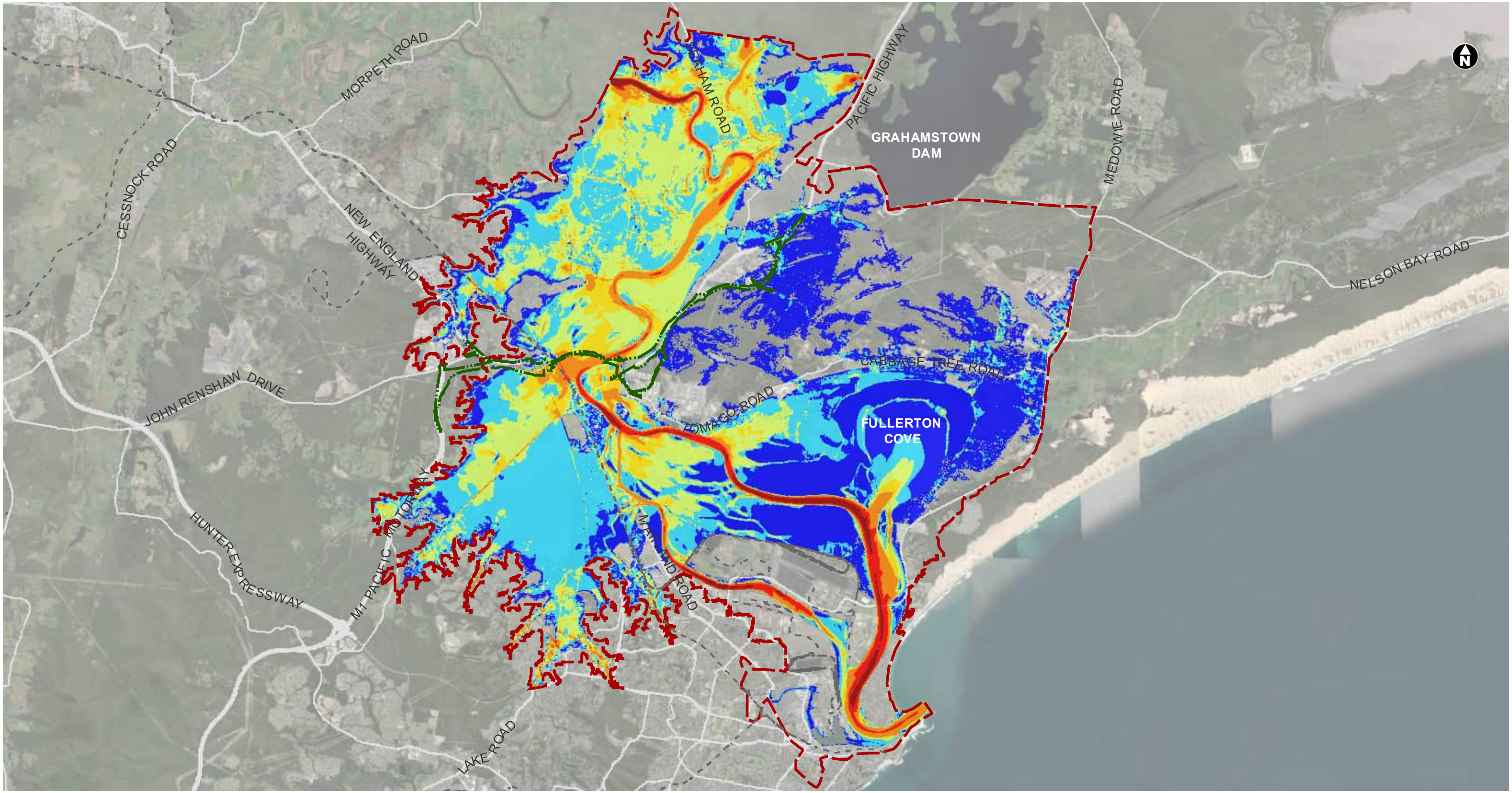
1.0 to 2.0

2.0 to 3.0

0 1 2km

Figure C-35 Flow velocity - Operation phase - 5% AEP (map 2 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-35_Velocity_Operation_5_AEP_JAC_A4L_175000_V01.mxd



Flooding study area	**Flow velocity (m/s)**		0.75 to 1.0
Operational footprint	< 0.05		1.0 to 2.0
Railway	0.05 to 0.25		2.0 to 3.0
	0.25 to 0.5		> 3.0
	0.5 to 0.75		

Figure C-36 Flow velocity - Operation phase - 1% AEP (map 1 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-36_Velocity_Operation_1_AEP_JAC_A4L_175000_V01.mxd

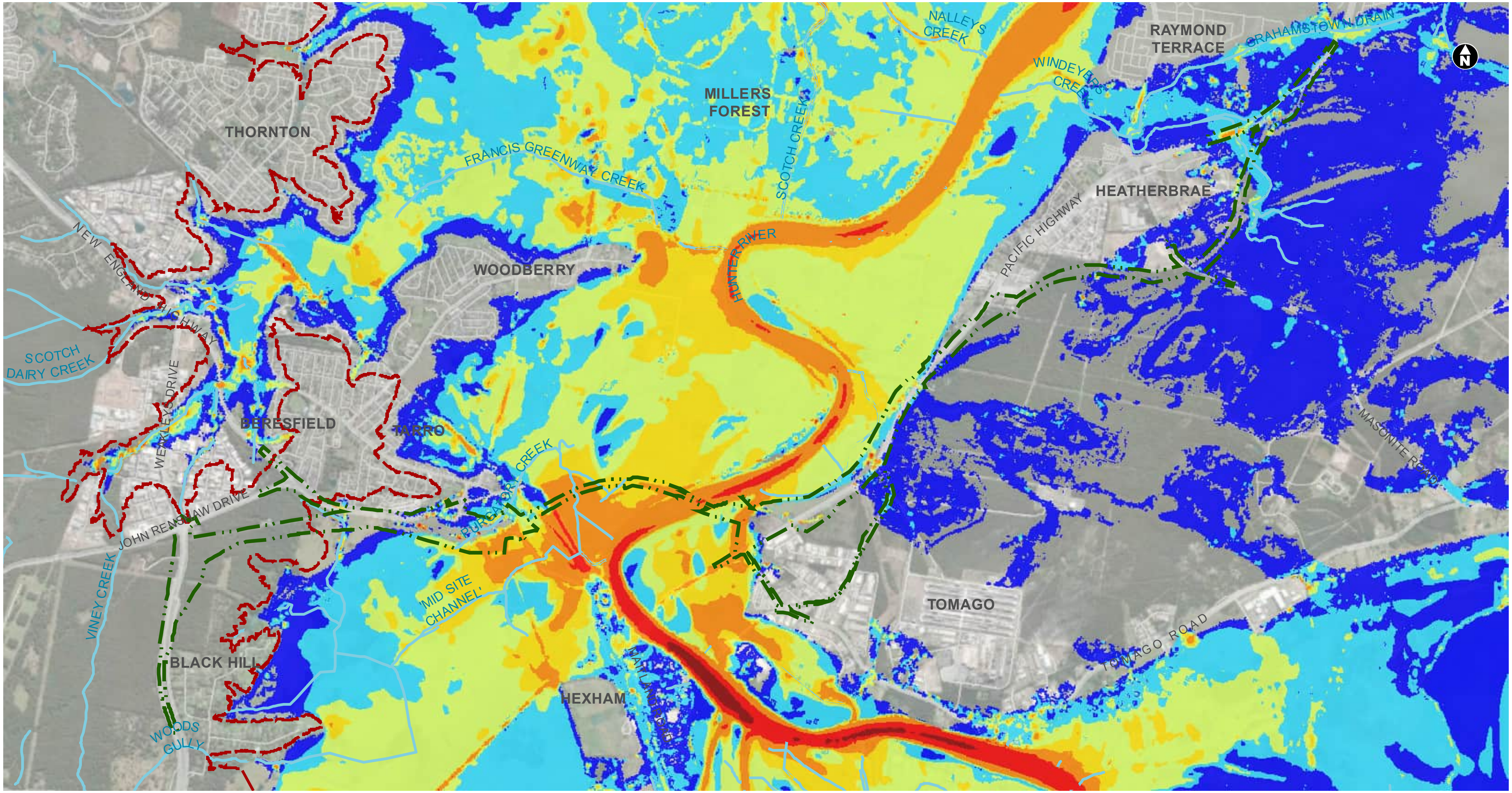


Figure C-36 Flow velocity - Operation phase - 1% AEP (map 2 of 2)

Date: 3/05/2022 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\Hydrology_AdditionalFloodModelling\Supp Report Final_Addn maps\IA230000_CD_HF_SuppFin_C-36_Velocity_Operation_1_AEP_JAC_A4L_175000_V01.mxd

Appendix D. Existing case flood impacts to buildings

Table D-1 Number of residential buildings flooded above floor in the existing case

Depth of flooding above floor (m)	20% AEP	10% AEP	5% AEP	1% AEP
0.0 – 0.1	10	24	24	29
0.1 – 0.5	21	33	55	69
0.5 – 1.0	5	14	26	90
1.0 – 1.5	0	0	5	78
1.5 – 2.0	1	1	1	67
> 2.0	0	0	0	38
Total	**37**	**72**	**111**	**371**

Appendix E. Construction Impacts comparison to EIS

Table E-1 Comparison of predicted flood level impacts (afflux) to EIS impacts at points of interest – Construction

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
1	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp in the 10% AEP event and larger and minor reductions in floodplain storage due to the new road embankments. Afflux of 0.01 m is predicted in the 10% AEP event and 0.09 m in the 5% AEP event.	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp in events larger than the 10% AEP event and minor reductions in floodplain storage due to the new road embankments. Zero afflux is predicted in the 10% AEP event and afflux of 0.03 m in the 5% AEP event. Afflux is within acceptable limit of 0.05 m for rural land use.	A reduction in the afflux from EIS of 0.01 m in the 10% AEP event and 0.06 m in the 5% AEP event is predicted. This is attributed to the refinements in the design including reductions in access track levels and ancillary site levels and footprint areas.
2	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp in the 10% AEP event and larger and minor reductions in floodplain storage due to the new road embankments. Afflux of 0.01 m is predicted in the 10% AEP event and 0.06 m in the 5% AEP event.	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp in events larger than the 10% AEP event and minor reductions in floodplain storage due to the new road embankments. Zero afflux is predicted in the 10% AEP event and afflux of 0.02 m in the 5% AEP event. Afflux is within acceptable limit of 0.1 m for rural and environmental conservation land use. There is an existing dwelling at this location. Flooding is below floor level in up to and including the 5% AEP.	A reduction in the afflux from EIS of 0.01 m in the 10% AEP event and 0.04 m in the 5% AEP event is predicted. This is attributed to the refinements in the design including reductions in access track levels and ancillary site levels and footprint areas.
3	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp and the area adjacent to the northern end of the Hexham Train Support Facility in the 10% AEP event and larger and minor reductions in floodplain storage due to the new road embankments. Afflux of 0.04 m is predicted in the 10% AEP event and 0.06 m in the 5% AEP event.	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp and the area adjacent to the northern end of the Hexham Train Support Facility in the 10% AEP event and larger and minor reductions in floodplain storage due to the new road embankments. Zero afflux is predicted in the 10% AEP event and afflux of 0.02 m in the 5% AEP event. There are existing maintenance buildings at this location at Hexham Train Support Facility. Flooding is below floor level in up to and including the 5% AEP.	A reduction in the afflux from EIS of 0.04 m in the 10% and 5% AEP events are predicted. This is attributed to the refinements in the design including reductions in access track levels and ancillary site levels and footprint areas.
4	The project causes increased overflows of floodwater from the Hunter River, over the New England Highway in the 10% AEP event and larger, causing increases in flood depths over the Main Northern Rail Line near Mid	The project causes increased overflows of floodwater from the Hunter River, over the New England Highway in the 10% AEP event and larger, causing increases in flood depths over the Main Northern Rail Line near Mid Site Creek. The project also	A reduction in the afflux from EIS of 0.17 m in the 10% and 0.02 m in the 5% AEP event. This is attributed to the refinements in the design including

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
	Site Creek. The project also results in reductions in floodplain storage due to filling of ancillary site AS 6. Afflux of up to 0.3 m is predicted in the 10% AEP event and 0.05 m in the 5% AEP event on the railway line in the vicinity of POI 4.	results in reductions in floodplain storage due to filling of ancillary site AS 6. Afflux of up to 0.13 m is predicted in the 10% AEP event and 0.03 m in the 5% AEP event on the railway line in the vicinity of POI 4.	reductions in access track levels and ancillary site levels and footprint areas.
5	Flooding at POI 5 is a result of floodwaters backflowing through the existing Purgatory Creek culvert under the New England Highway and overtopping of the New England Highway in the 10% AEP event and larger. The project causes increases in these flows due to the increased flood levels upstream of the viaduct, ancillary sites and access tracks. Afflux of up to 0.01 m is predicted in the 10% AEP event and 0.09 m in the 5% AEP event	Afflux of up to 0.01 m is predicted in the 10% AEP event and 0.06 m in the 5% AEP event. Afflux is within acceptable limit of 0.1 m for rural and environmental conservation land use. There is an existing dwelling at this location. Flooding is below the habitable floor level in up to and including the 5% AEP.	A reduction in the afflux from EIS of 0.03 m in the 5% AEP event, with no change in the 10% AEP event. This is attributed to the refinements in the design including reductions in access track levels and ancillary site levels and footprint areas.
6	Flooding of the Main North Rail Line at POI 6 occurs in the existing case in the 10% AEP event and larger. The project causes increased flood levels at POI 6 as a result of the viaduct, ancillary sites and access tracks. Afflux on the floodplain adjacent to the railway is 0.01 m in the 20% AEP event, which does not overtop the railway. Afflux is 0.08 m in the 10% and 5% AEP events.	Afflux on the floodplain adjacent to the railway is 0.01 m in the 20% AEP event, which does not overtop the railway. Afflux is 0.02 m in the 10% AEP event and 0.04 m in the 5% AEP event.	A reduction in the afflux from EIS of 0.06 m in the 10% AEP event and 0.04 m in the 5% AEP event, with no change in the 20% AEP event. This is attributed to the refinements in the design including reductions in access track levels and ancillary site levels and footprint areas.
7	Flooding at POI 7 occurs in the existing case in the 10% AEP event and larger. The project causes increased flood levels as a result of the viaduct, ancillary sites and access tracks. Afflux is 0.06 m in the 10% and 5% AEP events. Not flooded in 20% AEP event.	Afflux is 0.02 m in the 10% AEP event and 0.03 m in the 5% AEP event. Not flooded in 20% AEP event. There is an existing dwelling at this location. Flooding is below the habitable floor level in up to and including the 5% AEP.	A reduction in the afflux from EIS of 0.04 m in the 10% AEP event and 0.03 m in the 5% AEP event. This is attributed to the refinements in the design including reductions in access track levels and ancillary site levels and footprint areas.

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
8	Flooding at POI 8 occurs in a wetland area on Francis Greenway Creek, at western Woodbury Park in the 20% AEP event and larger. The project causes increased flood levels as a result of the viaduct, ancillary sites and access tracks. Afflux is 0.04 m in the 10% AEP event and 0.05 m in the 5% AEP event. The afflux is zero in the 20% AEP event.	Afflux is 0.02 m in the 10% AEP event and 0.03 m in the 5% AEP event. The afflux is zero in the 20% AEP event.	A reduction in the afflux from EIS of 0.02 m in the 10% AEP event and 0.01 m in the 5% AEP event, with no change in the 20% AEP event. This is attributed to the refinements in the design including reductions in access track levels and ancillary site levels and footprint areas.
9	Flooding at POI 9 occurs on low-lying rural land, on the eastern bank of the Hunter River at Heatherbrae, in the 20% AEP event and larger. The project causes increased flood levels as a result of the viaduct, ancillary sites and access tracks, in addition to increased cross-drainage flows from local catchment on the eastern side of the M1 Motorway. Afflux is 0.04 m in the 10% AEP event and 0.05 m in the 20% and 5% AEP events.	Afflux is 0.05 m in the 20% AEP event, 0.02 m in the 10% AEP event and 0.03 m in the 5% AEP event.	A reduction in the afflux from EIS of 0.02 m in the 10% AEP event and the 5% AEP event, with no change in the 20% AEP event. This is attributed to the refinements in the design including reductions in access track levels and ancillary site levels and footprint areas.
10	Flooding at POI 10 occurs on the western floodplain of the Hunter River in Millers Forest in the 20% AEP event and larger. The project causes increased flood levels as a result of the viaduct, ancillary sites and access tracks. Afflux is 0.03 m in the 10% AEP event and 0.05 m in the 5% AEP event. The afflux is zero in the 20% AEP event.	Afflux is 0.02 m in the 10% AEP and 5% AEP events. The afflux is zero in the 20% AEP event.	A reduction in the afflux from EIS of 0.03 m in the 10% AEP event and 0.02 m the 5% AEP event, with no change in the 20% AEP event. This is attributed to the refinements in the design including reductions in access track levels and ancillary site levels and footprint areas.
11	Flooding at POI 10 occurs at the southern end of Port Stephens Street in Raymond Terrace in the 20% AEP event and larger. The project causes increased flood levels as a result of the viaduct, ancillary sites and access tracks.	Afflux is 0.01 m in the 20% AEP and 10% AEP events and 0.02 m in the 5% AEP event	A reduction in the afflux from EIS of 0.01 m in the 10% AEP event and 0.02 m the 5% AEP event, with no change in the 20% AEP event. This is attributed to the refinements in the design including

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
	Afflux is 0.01 m in the 20% AEP event, 0.02 m in the 10% AEP event and 0.04 m in the 5% AEP event.		reductions in access track levels and ancillary site levels and footprint areas.
12	Flooding at POI 12 occurs in the existing case in the 10% AEP event and larger. The project causes increased flood levels as a result of the viaduct, ancillary sites and access tracks. Afflux is zero in the 10% and 5% AEP events.	Afflux is zero in the 10% and 5% AEP events.	No change from the EIS.
13	Flooding at POI 13 occurs at the Tomago Road intersection with the Pacific Highway in the 20% AEP event and larger. The project causes reduced flood levels at this location. Afflux is -0.02 m to -0.03 m in the 20% AEP and 10% AEP events and -0.14 m in the 5% AEP event.	Afflux is -0.02 m to -0.03 m in the 20% AEP and 10% AEP events and -0.11 m in the 5% AEP event.	No change from EIS for 20% and 10% AEP events. Minor increase in the afflux of 0.03 m in the 5% AEP event but remains as a reduction in flood levels from the existing case.
14	Flooding at POI 14 occurs in wetlands at the Hunter Regional Botanic Gardens in the 20% AEP event and larger. The project causes reduced flood levels due to increased cross-drainage capacity under the M1 Pacific Motorway in smaller events, and increased flood levels in larger events as a result of the viaduct, ancillary sites and access tracks. Afflux is -0.48 m in the 20% AEP event and -0.35 m in the 10% AEP event. The afflux is 0.02 m in the 5% AEP event.	Afflux is -0.48 m in the 20% AEP event and -0.37 m in the 10% AEP event. The afflux is zero in the 5% AEP event.	A reduction in the afflux from EIS of 0.02 m in the 10% AEP and 5% AEP events, with no change in the 20% AEP event. This is attributed to the refinements in the design including reductions in access track levels and ancillary site levels and footprint areas.
15	Flooding at POI 15 occurs in watercourses and ponds adjacent to the Raymond Terrace wastewater treatment plant. Flooding does	Afflux is 0.02 m in the 20%, 10% and 5% AEP events.	A reduction in the afflux from EIS of 0.01 m in the 10% AEP event and 0.02 m in the 5% AEP event, with no change in the 20% AEP event. This is attributed to the refinements in the design

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
	not inundate the treatment plant itself in up to the 5% AEP event in the existing case. The project causes increased flood levels, backing up from the Hunter River, as a result of the viaduct, ancillary sites and access tracks. Afflux is 0.02 m in the 20% AEP event and 0.03 m in the 10% AEP event. The afflux is 0.04 m in the 5% AEP event.		including reductions in access track levels and ancillary site levels and footprint areas.
16	Flooding at POI 16 occurs on the floodplain located between the Hunter River and Williams River at Nelsons Plains. The project causes increased flood levels, backing up from the Hunter River, as a result of the viaduct, ancillary sites and access tracks. Afflux is 0.01 m in the 20% AEP event and 0.02 m in the 5% AEP event. The afflux is zero in the 10% AEP event.	Afflux is 0.01 m in the 20% AEP and 5% AEP events. The afflux is zero in the 10% AEP event.	A reduction in afflux of 0.01 m in the 5% AEP event, with no change to afflux in the 20% and 10% AEP events. This is attributed to the refinements in the design including reductions in access track levels and ancillary site levels and footprint areas.

Table E-2 Comparison of predicted changes in flood hazard to EIS impacts at points of interest – Construction

Note: Flood hazard is reported for the 5% AEP event only.

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
1	In the 5% AEP event, the existing flood hazard category is H3, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H3, with no change in the construction phase.	No change.
2	In the 5% AEP event, the existing flood hazard category is H3, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H3, with no change in the construction phase.	No change.
3	In the 5% AEP event, the existing flood hazard category is H3, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H3, with no change in the construction phase.	No change.
4	In the 5% AEP event, the existing flood hazard category is H4, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H4, with no change in the construction phase.	No change.
5	In the 5% AEP event, the existing flood hazard category is H2, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H2, with no change in the construction phase.	No change.
6	In the 5% AEP event, the existing flood hazard category is H3, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H3, with no change in the construction phase.	No change.
7	In the 5% AEP event, the existing flood hazard category is H5, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H5, with no change in the construction phase.	No change.
8	In the 5% AEP event, the existing flood hazard category is H5, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H5, with no change in the construction phase.	No change.
9	In the 5% AEP event, the existing flood hazard category is H5, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H5, with no change in the construction phase.	No change.
10	In the 5% AEP event, the existing flood hazard category is H5, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H5, with no change in the construction phase.	No change.
11	In the 5% AEP event, the existing flood hazard category is H3, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H3, with no change in the construction phase.	No change.
12	In the 5% AEP event, the existing flood hazard category is H4, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H4, with no change in the construction phase.	No change.
13	In the 5% AEP event, the existing flood hazard category is H3, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H3, with no change in the construction phase.	No change.

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
14	In the 5% AEP event, the existing flood hazard category is H4, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H4, with no change in the construction phase.	No change.
15	In the 5% AEP event, the existing flood hazard category is H5, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H5, with no change in the construction phase.	No change.
16	In the 5% AEP event, the existing flood hazard category is H5, with no change in the construction phase.	In the 5% AEP event, the existing flood hazard category is H5, with no change in the construction phase.	No change.

Table E-3 Comparison of predicted changes in duration of inundation to EIS impacts at points of interest – Construction

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
1	In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	No change.
2	In the 5% AEP event the change in duration of inundation from existing case is less than +/- 1%.	In the 5% AEP event the change in duration of inundation from existing case is less than +/- 1%.	No change.
3	In the 5% AEP event the change in duration of inundation from existing case is 2%.	In the 5% AEP event the change in duration of inundation from existing case is less than 1%.	Reduction in the duration of inundation of over one percentage point.
4	In the 5% AEP event the change in duration of inundation from existing case is 10%.	In the 5% AEP event the change in duration of inundation from existing case is 5%, or less than 1 hour.	Reduction in the duration of inundation of five percentage points.
5	In the 5% AEP event the change in duration of inundation from existing case is 12%.	In the 5% AEP event the change in duration of inundation from existing case is 7%, or about 2 hours.	Reduction in the duration of inundation of five percentage points.
6	In the 5% AEP event the change in duration of inundation from existing case is 9%.	In the 5% AEP event the change in duration of inundation from existing case is 3%, or about 1 hour.	Reduction in the duration of inundation of six percentage points.
7	In the 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	In the 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	No change.

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
8	In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	No change.
9	In the 20% AEP event, the change in duration of inundation from existing case is 41%, increasing from 33 hours to 47 hours. In the 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	In the 20% AEP event, the change in duration of inundation from existing case is 41%, increasing from 33 hours to 47 hours. In the 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	No change.
10	In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	No change.
11	In the 10% AEP event the change in duration of inundation from existing case is 12% and in the 5% AEP the change is 3%.	In the 10% AEP event the change in duration of inundation from existing case is 7% (1 hour) and in the 5% AEP the change is 2% (less than 1 hour).	Reduction in the duration of inundation of five percentage points in the 10% AEP event and one percentage point in the 5% AEP event.
12	In the 5% AEP event the change in duration of inundation from existing case is 6%.	In the 5% AEP event the change in duration of inundation from existing case is 3% (less than 0.5 hours).	Reduction in the duration of inundation of three percentage points.
13	In the 5% AEP event the change in duration of inundation from existing case is -16%.	In the 5% AEP event the change in duration of inundation from existing case is -13%.	Increase in the duration of inundation of three percentage points, however, the change from existing case remains as a reduction in the duration of inundation.
14	Change in duration of inundation from existing case for -49% in the 20% AEP, -29% in the 10% AEP and -22% in the 5% AEP.	Change in duration of inundation from existing case for -49% in the 20% AEP, -29% in the 10% AEP and -22% in the 5% AEP.	No change.
15	In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	No change.
16	In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	In the 20%, 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	No change.

Buildings flooding analysis and impacts – Construction phase

Table E-4 Number of residential buildings with above-floor level afflux – Construction

Afflux (m)	Construction		
	20% AEP	10% AEP	5% AEP
0.01 – 0.02	0	8	7
0.02 – 0.03	0	6	41
0.03 – 0.05	0	0	0
> 0.05	0	0	0
Total	**0**	**14**	**48**

Table E-5 Number of residential buildings newly flooded above floor – Construction

Buildings	Construction		
	20% AEP	10% AEP	5% AEP
Residential	0	1	2

Table E-6 Number of residential buildings with duration of inundation above floor increased more than one hour – Construction

Buildings	Construction		
	20% AEP	10% AEP	5% AEP
Residential	0	8	17

Table E-7 Lot and DP for residential buildings with afflux criteria exceeded – construction case

Afflux (m)	20% AEP	10% AEP	5% AEP
0.01 – 0.02	0	1212/DP1098701 26/DP1086279 41/DP520489 13/DP846114 20/DP836869 1/DP198139 130/DP1098880 13/DP846114	1/DP196764 2/DP37947 1/DP745509 1/DP784901 1/DP137134 1/DP784901 5/DP37947
0.02 – 0.03	0	11/DP136048 4A/DP197 3A/DP197 1/DP743319 21/DP836869 1/DP996604	13/DP846114 1/DP59394 1212/DP1098701 26/DP1086279 11/DP136048 3/DP826318 41/DP520489 2/DP841531 4/DP550160 4A/DP197 1/DP1223052 3A/DP197 201/DP624230

Afflux (m)	20% AEP	10% AEP	5% AEP
			13/DP846114 20/DP836869 1/DP743319 1/DP150219 1/DP547041 55/DP1113554 1/DP443194 6/DP879262 2/DP826318 21/DP836869 782/DP746828 221/DP878608 781/DP746828 11A/DP197 1/DP996604 1/DP1213778 1/DP198139 2/DP372152 130/DP1098880 1/DP939636 13/DP846114 1/DP708213 1/DP1223052 2/DP198497 10/DP758871 1/DP111703 14/DP846114 13/DP846114
0.03 - 0.05	0	0	0
> 0.05	0	0	0
Total	**0**	**14**	**48**

Table E-8 Lot and DP for residential buildings with new above-floor flooding – construction case

Buildings	20% AEP	10% AEP	5% AEP
Residential	0	130/DP1098880	19/DP1133767, 1/DP150219

Table E-9 Lot and DP for residential buildings with change of duration of above-floor inundation greater than one hour – construction case

Buildings	20% AEP	10% AEP	5% AEP
Residential	0	3/DP826318 41/DP520489 4A/DP197 1/DP743319 1/DP996604 1/DP198139 130/DP1098880 14/DP846114	2/DP37947 1/DP745509 1/DP1223052 1/DP150219 1/DP547041 55/DP1113554 1/DP443194 1/DP137134 5/DP1088672 782/DP746828 781/DP746828

Buildings	20% AEP	10% AEP	5% AEP
			2/DP372152 1/DP708213 1/DP1223052 2/DP198497 1/DP111703 5/DP32557

Property and land use flooding analysis and impacts – Construction phase

Table E-10 Number of residential lots affected by change in peak flood depth – Construction

Change in peak flood depth (m)	20% AEP	10% AEP	5% AEP
Was wet now dry	0	0	0
< -0.01	4	2	2
-0.01–0.01	472	478	482
0.01–0.05	14	67	131
0.05–0.1	0	0	0
0.1–0.2	0	0	0
0.2–0.3	0	0	0
> 0.3	1	1	1
Was dry now wet	0	0	0

Table E-11 Number of commercial lots affected by change in peak flood depth – Construction

Change in peak flood depth (m)	20% AEP	10% AEP	5% AEP
Was wet now dry	0	0	0
< -0.01	0	0	0
-0.01–0.01	163	164	157
0.01–0.05	3	4	79
0.05–0.1	0	0	0
0.1–0.2	0	0	0
0.2–0.3	0	0	0
> 0.3	0	0	0
Was dry now wet	0	0	0

Table E-12 Number of industrial lots affected by change in peak flood depth – Construction

Change in peak flood depth (m)	20% AEP	10% AEP	5% AEP
Was wet now dry	3	4	8
< -0.01	4	5	22
-0.01–0.01	169	211	198
0.01–0.05	1	0	101
0.05–0.1	0	1	1
0.1–0.2	1	1	0
0.2–0.3	0	0	0
> 0.3	0	0	0
Was dry now wet	0	0	0

Table E-13 Lots with afflux criteria exceeded – construction case

Lot Number	Plan Number	Plan Label	Zoning	Zoning Code	AEP events where afflux exceeded
1200	1174968	DP1174968	General Industrial	IN1	20% 10%
100	849413	DP849413	Low Density Residential	R2	20% 10% 5%
1	1181217	DP1181217	Environmental Living	E4	20% 10% 5%
1015	1193555	DP1193555	Infrastructure	SP2	20% 10% 5%
906	1256183	DP1256183	General Industrial	IN1	20% 10% 5%
102	1038663	DP1038663	Environmental Conservation	E2	20% 10% 5%
12	863342	DP863342	Primary Production	RU1	20%
14	232594	DP232594	Primary Production	RU1	20%
13	232594	DP232594	Primary Production	RU1	20%
1	1073784	DP1073784	Primary Production	RU1	20%
2	1074258	DP1074258	Primary Production	RU1	20%
19	4297	DP4297	Primary Production	RU1	20%
2	1098770	DP1098770	Infrastructure	SP2	5%
12	863342	DP863342	Primary Production	RU1	20%

Appendix F. Operation Impacts comparison to EIS

Table F-1 Comparison of predicted flood level impacts (afflux) to EIS impacts at points of interest – Operation

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
1	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp in the 10% AEP event and larger and minor reductions in floodplain storage due to the new road embankments. Afflux of 0.00 m in the 20% and 10% AEP events, 0.04 m in the 5% AEP event and -0.01 m in the 1% AEP event is predicted.	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp in the 10% AEP event and larger and minor reductions in floodplain storage due to the new road embankments. Afflux of 0.00 m in the 20% and 10% AEP events, 0.03 m in the 5% AEP event and -0.01 m in the 1% AEP event is predicted.	A reduction in the afflux from EIS of 0.01 m in the 5% AEP event is predicted. This is attributed to the refinements in the design including reductions in access track levels No change in the 20%, 10% AEP and 1% AEP events.
2	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp in the 10% AEP event and larger and minor reductions in floodplain storage due to the new road embankments. Afflux of 0.00 m in the 20% and 10% AEP events, 0.03 m in the 5% AEP event and -0.01 m in the 1% AEP event is predicted.	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp in the 10% AEP event and larger and minor reductions in floodplain storage due to the new road embankments. Afflux of 0.00 m in the 20% and 10% AEP events, 0.02 m in the 5% AEP event and -0.01 m in the 1% AEP event is predicted. Afflux is within acceptable limit of 0.1 m for rural and environmental conservation land use. There is an existing dwelling at this location. Flooding is below floor level in up to and including the 5% AEP.	A reduction in the afflux from EIS of 0.01 m in the 5% AEP event is predicted. This is attributed to the refinements in the design including reductions in access track levels. No change in the 20%, 10% AEP and 1% AEP events.
3	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp and the area adjacent to the northern end of the Hexham Train Support Facility in the 10% AEP event and larger and minor reductions in floodplain storage due to the new road embankments. Afflux of 0.02 m in the 10% AEP events, 0.03 m in the 5% AEP event and 0.00 m in the 1% AEP event is predicted.	The project causes increased overflows of floodwater from the Hunter River into Hexham Swamp and the area adjacent to the northern end of the Hexham Train Support Facility in the 10% AEP event and larger and minor reductions in floodplain storage due to the new road embankments. Afflux of 0.00 m in the 10% AEP events, 0.02 m in the 5% AEP event and 0.00 m in the 1% AEP event is predicted. There are existing maintenance buildings at this location at Hexham Train Support Facility. Flooding is below floor level in up to and including the 5% AEP. Afflux is within acceptable limits.	A reduction in the afflux from EIS of 0.02 m in the 10% and 0.01 m in the 5% AEP events are predicted. This is attributed to the refinements in the design including reductions in access track levels. No change in the 1% AEP event.

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
4	The project causes increased overflows of floodwater from the Hunter River, over the New England Highway in the 10% AEP event and larger, causing increases in flood depths over the Main Northern Rail Line near Mid Site Creek. The project also results in reductions in floodplain storage due to filling of ancillary site AS 6. Afflux of up to 0.04 m is predicted in the 10% AEP event, 0.02 m in the 5% AEP event and 0.01 m in the 1% AEP event on the railway line in the vicinity of POI 4.	The project causes increased overflows of floodwater from the Hunter River, over the New England Highway in the 10% AEP event and larger, causing increases in flood depths over the Main Northern Rail Line near Mid Site Creek. The project also results in reductions in floodplain storage due to filling of ancillary site AS 6. Afflux of 0.00 m is predicted in the 10% AEP event, 0.02 m in the 5% AEP event and 0.01 m in the 1% AEP event on the railway line in the vicinity of POI 4.	A reduction in the afflux from EIS of 0.04 m in the 10% event. This is attributed to the refinements in the design including reductions in access track levels. No change in the 5% and 1% AEP event.
5	Flooding at POI 5 is a result of floodwaters backflowing through the existing Purgatory Creek culvert under the New England Highway and overtopping of the New England Highway in the 10% AEP event and larger. The project causes increases in these flows due to the increased flood levels upstream of the viaduct and access tracks. Afflux is predicted up to 0.03 m in the 10% AEP event, 0.06 m in the 5% AEP event and 0.04 m in the 1% AEP event	Afflux is predicted up to 0.01 m in the 10% AEP event, 0.05 m in the 5% AEP event and 0.04 m in the 1% AEP event. There is an existing dwelling at this location. Flooding is below the habitable floor level in up to and including the 5% AEP. Afflux in up to and including the 5% AEP event is within acceptable limit of 0.1 m for rural and environmental conservation land use. Afflux is non-compliant for above-floor flooding of dwelling in the 1% AEP event.	A reduction in the afflux from EIS of 0.02 m in the 10% and 0.01 m in the 5% AEP events are predicted. This is attributed to the refinements in the design including reductions in access track levels. No change in the 1% AEP event.
6	Flooding of the Main North Rail Line at POI 6 occurs in the existing case in the 10% AEP event and larger. The project causes increased flood levels at POI 6 as a result of the viaduct and access tracks. Afflux on the floodplain adjacent to the railway is 0.01 m in the 20% AEP event, which does not overtop the railway. Afflux is 0.03 m in the 10%, 5% and 1% AEP events.	Afflux on the floodplain adjacent to the railway is 0.01 m in the 20%,10% and 5% AEP events. Afflux is 0.02 m in the 1% AEP events	A reduction in the afflux from EIS of 0.02 m in the 10% and 5% AEP events and 0.01 m in the 1% AEP event, with no change in the 20% AEP event. This is attributed to the refinements in the design including reductions in access track levels.

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
7	Flooding at POI 7 occurs in the existing case in the 10% AEP event and larger. The project causes increased flood levels as a result of the viaduct and access tracks. Afflux is predicted up to 0.03 m in the 10% AEP event, 0.02 m in the 5% AEP event and 0.03 m in the 1% AEP event. Not flooded in 20% AEP event.	Afflux is predicted up to 0.01 m in the 10% AEP event, 0.01 m in the 5% AEP event and 0.02 m in the 1% AEP event. Not flooded in 20% AEP event. There is an existing dwelling at this location. Flooding is below the habitable floor level in up to and including the 5% AEP. Afflux in up to and including the 5% AEP event is within acceptable limit of 0.1 m for rural and environmental living land use. Afflux is non-compliant for above-floor flooding of dwelling in the 1% AEP event.	A reduction in the afflux from EIS of 0.02 m in the 10% AEP event, 0.01 m in the 5% AEP event and 0.01 m in the 1% AEP event. This is attributed to the refinements in the design including reductions in access track levels.
8	Flooding at POI 8 occurs in a wetland area on Francis Greenway Creek, at western Woodbury Park in the 20% AEP event and larger. The project causes increased flood levels as a result of the viaduct and access tracks. Afflux of 0.00 m in the 20% event, 0.02 m in the 10% AEP event, 0.03 2 in the 5% AEP event and 0.02 m in the 1% AEP event is predicted.	Afflux of 0.00 m in the 20% event, 0.01 m in the 10% AEP event, 0.01 in the 5% AEP event and 0.02 m in the 1% AEP event is predicted.	A reduction in the afflux from EIS of 0.01 m in the 10% AEP event and 0.02 m in the 5% AEP event, with no change in the 20% and 1% AEP events. This is attributed to the refinements in the design including reductions in access track levels.
9	Flooding at POI 9 occurs on low-lying rural land, on the eastern bank of the Hunter River at Heatherbrae, in the 20% AEP event and larger. The project causes increased flood levels as a result of the viaduct and access tracks, in addition to increased cross-drainage flows from local catchment on the eastern side of the M1 Motorway. Afflux of 0.05 m in the 20% event, 0.02 m in the 10% AEP event, 0.02 2 in the 5% AEP event and 0.03 m in the 1% AEP event is predicted.	Afflux of 0.05 m in the 20% event, 0.01 m in the 10% AEP event, 0.01 m in the 5% AEP event and 0.02 m in the 1% AEP event is predicted.	A reduction in the afflux from EIS of 0.01 m in the 10%, 5% and 1% AEP events, with no change in the 20% AEP event. This is attributed to the refinements in the design including reductions in access track levels.

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
10	Flooding at POI 10 occurs on the western floodplain of the Hunter River in Millers Forest in the 20% AEP event and larger. The project causes increased flood levels as a result of the viaduct and access tracks. Afflux of 0.00 m in the 20% event, 0.02 m in the 10% AEP event, 0.02 m in the 5% AEP event and 0.02 m in the 1% AEP event is predicted.	Afflux of 0.00 m in the 20% event, 0.01 m in the 10% AEP event, 0.01 m in the 5% AEP event and 0.02 m in the 1% AEP event is predicted.	A reduction in the afflux from EIS of 0.01 m in the 10% and 5% AEP events, with no change in the 20% and 1% AEP events. This is attributed to the refinements in the design including reductions in access track levels.
11	Flooding at POI 10 occurs at the southern end of Port Stephens Street in Raymond Terrace in the 20% AEP event and larger. The project causes increased flood levels as a result of the viaduct and access tracks. Afflux of 0.01 m in the 20% event, 0.01 m in the 10% AEP event, 0.01 m in the 5% AEP event and 0.02 m in the 1% AEP event is predicted.	Afflux of 0.00 m in the 20% event, 0.00 m in the 10% AEP event, 0.01 m in the 5% AEP event and 0.02 m in the 1% AEP event is predicted.	A reduction in the afflux from EIS of 0.01 m in the 20% and 10% AEP events, with no change in the 5% and 1% AEP events. This is attributed to the refinements in the design including reductions in access track levels.
12	Flooding at POI 12 occurs in the existing case in the 10% AEP event and larger. The project causes increased flood levels as a result of the viaduct and access tracks. Afflux of 0.00 m in the 10% AEP event, 0.00 m in the 5% AEP event and 0.02 m in the 1% AEP event is predicted. Not flooded in 20% AEP event.	Afflux of 0.00 m in the 10% AEP event, 0.00 m in the 5% AEP event and 0.01 m in the 1% AEP event is predicted. Not flooded in 20% AEP event.	A reduction in the afflux from EIS of 0.01 m in the 1% AEP events, with no change in the 5% and 1% AEP events. This is attributed to the refinements in the design including reductions in access track levels.
13	Flooding at POI 13 occurs at the Tomago Road intersection with the Pacific Highway in the 20% AEP event and larger. The project causes reduced flood levels at this location. Afflux is -0.03 m in the 20% AEP, -0.05 m in the 10% AEP event1 and -0.01 m in the 5% AEP event. Zero afflux in the 1% AEP event.	Afflux is -0.03 m in the 20% AEP, -0.05 m in the 10% AEP event1 and -0.01 m in the 5% AEP event. Zero afflux in the 1% AEP event.	No change from EIS.

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
14	Flooding at POI 14 occurs in wetlands at the Hunter Regional Botanic Gardens in the 20% AEP event and larger. The project causes reduced flood levels due to increased cross-drainage capacity under the M1 Pacific Motorway in smaller events, and increased flood levels in larger events as a result of the viaduct and access tracks. Afflux is -0.48 m in the 20% AEP event, -0.38 m in the 10% AEP event, -0.01 m in the 5% AEP event and -0.02 m in the 1% AEP event.	Afflux is -0.48 m in the 20% AEP event, -0.37 m in the 10% AEP event, -0.02 m in the 5% AEP event and -0.03 m in the 1% AEP event.	Increase in the afflux from EIS of 0.01 m in the 10% AEP event but remaining as a reduction from existing case. A reduction in the afflux from EIS of 0.01 m in the 5% AEP and 1% AEP events. No change in the 20% AEP event. This is attributed to the refinements in the design including reductions in access track levels.
15	Flooding at POI 15 occurs in watercourses and ponds adjacent to the Raymond Terrace wastewater treatment plant. Flooding does not inundate the treatment plant itself in up to the 5% AEP event in the existing case. The project causes increased flood levels, backing up from the Hunter River, as a result of the viaduct and access tracks. Afflux is 0.02 m in the 20%, 10%, 5% and 1% AEP events.	Afflux is 0.02 m in the 20%, 0.01 m in the 10% AEP event, 0.01 m in the 5% AEP event and 0.02 m in the 1% AEP event.	A reduction in the afflux from EIS of 0.01 m in the 10% AEP and the 5% AEP events, with no change in the 20% AEP and 1% AEP events. This is attributed to the refinements in the design including reductions in access track levels.
16	Flooding at POI 16 occurs on the floodplain located between the Hunter River and Williams River at Nelsons Plains. The project causes increased flood levels, backing up from the Hunter River, as a result of the viaduct and access tracks. Afflux is 0.01 m in the 20% AEP event, 0.00 m in the 10% AEP event, 0.01 m in the 5% AEP event and 0.02 m in the 1% AEP event	Afflux is 0.01 m in the 20% AEP event, 0.00 m in the 10% AEP event, 0.00 m in the 5% AEP event and 0.01 m in the 1% AEP event	A reduction in the afflux from EIS of 0.01 m in the 5% AEP and the 1% AEP events, with no change in the 20% AEP and 10% AEP events. This is attributed to the refinements in the design including reductions in access track levels.

Table F-2 Comparison of predicted changes in flood hazard to EIS impacts at points of interest – Operation

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
1	In the 5% AEP event, the existing flood hazard category is H3, while during operation the flood hazard category increases to H4. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H3, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	The increase in flood hazard category from H3 to H4 in the 5% AEP event, which is observed in the EIS, is eliminated in the updated modelling. No change from EIS in the 1% AEP event.
2	In the 5% AEP event, the existing flood hazard category is H3, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H3, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	No change.
3	In the 5% AEP event, the existing flood hazard category is H3, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H3, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	No change.
4	In the 5% AEP event, the existing flood hazard category is H4, with no change during operation. In the 1% AEP event, the existing flood hazard category is H6, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H4, with no change during operation. In the 1% AEP event, the existing flood hazard category is H6, with no change during operation.	No change.
5	In the 5% AEP event, the existing flood hazard category is H2, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H2, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	No change.
6	In the 5% AEP event, the existing flood hazard category is H3, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H3, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	No change.

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
7	In the 5% AEP event, the existing flood hazard category is H5, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H5, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	No change.
8	In the 5% AEP event, the existing flood hazard category is H5, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H5, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	No change.
9	In the 5% AEP event, the existing flood hazard category is H5, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, while during operation the flood hazard category increases to H6.	In the 5% AEP event, the existing flood hazard category is H5, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, while during operation the flood hazard category increases to H6.	No change.
10	In the 5% AEP event, the existing flood hazard category is H5, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H5, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	No change.
11	In the 5% AEP event, the existing flood hazard category is H3, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H3, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	No change.
12	In the 5% AEP event, the existing flood hazard category is H3, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H3, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	No change.

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
13	In the 5% AEP event, the existing flood hazard category is H3, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H3, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	No change.
14	In the 5% AEP event, the existing flood hazard category is H4, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H4, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	No change.
15	In the 5% AEP event, the existing flood hazard category is H5, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H5, with no change during operation. In the 1% AEP event, the existing flood hazard category is H5, with no change during operation.	No change.
16	In the 5% AEP event, the existing flood hazard category is H5, with no change during operation. In the 1% AEP event, the existing flood hazard category is H6, with no change during operation.	In the 5% AEP event, the existing flood hazard category is H5, with no change during operation. In the 1% AEP event, the existing flood hazard category is H6, with no change during operation.	No change.

Table F-3 Comparison of predicted changes in duration of inundation to EIS impacts at points of interest – Operation

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
1	In the 20% AEP event, the change in duration of inundation from existing case is 1.7%. In the 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 1%.	In the 20% AEP event, the change in duration of inundation from existing case is 1.7%. In the 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 1%.	No change.
2	In the 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 2%.	In the 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 2%.	No change.
3	In the 5% and 1% AEP events the change in duration of inundation from existing case is less than 2%.	In the 5% and 1% AEP events the change in duration of inundation from existing case is less than 2%.	No change.
4	In the 5% AEP event the change in duration of inundation from existing case is 4%. In the 1% AEP event the change in duration of inundation from existing case is less than 1%.	In the 5% AEP event the change in duration of inundation from existing case is 3%. In the 1% AEP event the change in duration of inundation from existing case is less than 1%.	Reduction in the duration of inundation of one percentage point in the 5% AEP event. No change in the 1% AEP event.
5	In the 5% AEP event the change in duration of inundation from existing case is 11%. In the 1% AEP event the change in duration of inundation from existing case is less than 1%.	In the 5% AEP event the change in duration of inundation from existing case is 9%. In the 1% AEP event the change in duration of inundation from existing case is less than 1%.	Reduction in the duration of inundation of two percentage points in the 5% AEP event. No change in the 1% AEP event.
6	In the 5% AEP event the change in duration of inundation from existing case is 4%. In the 1% AEP event the change in duration of inundation from existing case is 2%.	In the 5% AEP event the change in duration of inundation from existing case is 1%. In the 1% AEP event the change in duration of inundation from existing case is less than 1%.	Reduction in the duration of inundation of three percentage points in the 5% AEP event. Reduction in the duration of inundation of over one percentage points in the 1% AEP event.
7	In the 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	In the 10% and 5% AEP events the change in duration of inundation from existing case is less than +/- 1%.	No change.

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
8	In the 20%, 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 1%.	In the 20%, 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 1%.	No change.
9	In the 20% AEP event, the change in duration of inundation from existing case is 41%, increasing from 33 hours to 47 hours. In the 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 1%.	In the 20% AEP event, the change in duration of inundation from existing case is 41%, increasing from 33 hours to 47 hours. In the 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 1%.	No change.
10	In the 20%, 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 1%.	In the 20%, 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than +/- 1%.	No change.
11	In the 10% AEP event the change in duration of inundation from existing case is 6%, in the 5% AEP the change is 1% and in the 1% AEP the change is less than 1%.	In the 10% AEP event the change in duration of inundation from existing case is 3%, in the 5% AEP the change is less than 1% and in the 1% AEP the change is less than 1%.	Reduction in the duration of inundation of three percentage points in the 10% AEP event and less than one percentage point in the 5% and 1% AEP events.
12	In the 5% AEP event the change in duration of inundation from existing case is 2%. In the 1% AEP event the change in duration of inundation from existing case is less than 1%.	In the 5% AEP event the change in duration of inundation from existing case is 1%. In the 1% AEP event the change in duration of inundation from existing case is less than 1%.	Reduction in the duration of inundation of one percentage point in 5% AEP event. No change in 1% AEP event.
13	In the 5% AEP event the change in duration of inundation from existing case is -2%. In the 1% AEP event the change in duration of inundation from existing case is 1%.	In the 5% AEP event the change in duration of inundation from existing case is -1%. In the 1% AEP event the change in duration of inundation from existing case is 1%.	Increase in the duration of inundation of one percentage point in the 5% AEP event, however, the change from existing case remains as a reduction

POI	EIS potential flood impact	Amended potential flood impact	Change from EIS
			in the duration of inundation. No change in the 1% AEP event.
14	Change in duration of inundation from existing case for -83% in the 20% AEP, -44% in the 10% AEP, -35% in the 5% AEP and -16% in the 1% AEP event.	Change in duration of inundation from existing case for -83% in the 20% AEP, -44% in the 10% AEP, -35% in the 5% AEP and -16% in the 1% AEP event.	No change.
15	In the 20%, 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than 1%.	In the 20%, 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than 1%.	No change.
16	In the 20%, 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than 1%.	In the 20%, 10%, 5% and 1% AEP events the change in duration of inundation from existing case is less than 1%.	No change.

Buildings flooding analysis and impacts – Operation phase

Table F-4 Number of residential buildings with above-floor level afflux – Operation

Afflux (m)	20% AEP	10% AEP	5% AEP	1% AEP
0.01 – 0.02	0	0	0	134
0.02 – 0.03	0	0	0	0
0.03 – 0.05	0	0	0	0
> 0.05	0	0	0	0
Total	**0**	**0**	**0**	**134**

Table F-5 Number of residential buildings newly flooded above floor – Operation

Buildings	Operation			
	20% AEP	10% AEP	5% AEP	1% AEP
Residential	0	0	0	1

Table F-6 Number of residential buildings with duration of inundation above floor increased more than one hour – Operation

Buildings	Operation			
	20% AEP	10% AEP	5% AEP	1% AEP
Residential	0	1	3	2

Table F-7 Lot and DP for residential buildings with afflux criteria exceeded – Operation

Afflux (m)	20% AEP	10% AEP	5% AEP	1% AEP
0.01 – 0.02	0	0	0	2/DP522978 1/DP196764 13/DP846114 12/DP1098747 19/DP1133767 80/DP1073157 20/DP836869 1/DP383163 2/DP37947 1/DP500020 3/DP734735 101/DP804491 1/DP59394 1/DP745509 1212/DP1098701 /SP36553 2/DP784901 26/DP1086279 11/DP136048

Afflux (m)	20% AEP	10% AEP	5% AEP	1% AEP
				3/DP826318 16/DP10725 1/DP826318 41/DP520489 1/DP784901 2/DP841531 4/DP377329 4/DP550160 4A/DP197 1/DP1223052 1/DP1092524 3A/DP197 86/DP12628 3/DP150219 201/DP624230 1/DP573766 /SP91249 131/DP1078662 21/DP600470 131/DP1078662 13/DP846114 295/DP238805 3/DP37947 1/DP105420 20/DP836869 4/DP1219110 131/DP1078662 1/DP743319 1/DP150219 1/DP547041 15/DP660430 13/DP846612 23/DP1086280 55/DP1113554 1/DP996604 1/DP443194 6/DP879262 /SP36553 1/DP743838 4/DP262688 1/DP137134 2/DP826318 150/DP216071 1/DP550160 21/DP836869 40/DP1109229 221/DP1004163 12/DP1189457 5/DP1088672 800/DP1130875 104/DP1016640 1/DP1223052 1/DP1223052 782/DP746828 5/DP37947 221/DP878608 5/DP372152 31/DP734535 1/DP797962 9/DP197

Afflux (m)	20% AEP	10% AEP	5% AEP	1% AEP
				892/DP563229 1/DP999610 32/DP609041 1/DP963173 221/DP788354 781/DP746828 1/DP732306 /SP36553 1/DP784901 11A/DP197 143/DP882115 1/DP996604 1/DP1213778 2/DP1202026 1/DP198139 8/DP1101823 16/DP10725 2/DP372152 130/DP1098880 1/DP939636 14/DP660199 13/DP846114 1/DP708213 1/DP1223052 1/DP136263 41/DP853008 2/DP198497 121/DP810513 6/DP262053 5/DP262688 10/DP758871 4/DP37947 1/DP778933 20/DP600470 1/DP111703 2/DP714546 1/DP199811 17/DP977749 3/DP372152 14/DP846114 14/DP811451 13/DP846114 5/DP37947 221/DP878608 1/DP1223052 31/DP609041 788/DP535561 80/DP12628 123/DP1142098 11/DP37932 9/DP38509 23/DP776244 1/SP36091 1/SP40798 7/DP262459
0.02 – 0.03	0	0		0
0.03 - 0.05	0	0	0	0
> 0.05	0	0	0	0

Afflux (m)	20% AEP	10% AEP	5% AEP	1% AEP
Total	**0**	**0**	**0**	**134**

Table F-8 Lot and DP for residential buildings with new above-floor flooding – Operation

Buildings	20% AEP	10% AEP	5% AEP	1% AEP
Residential	0	0	0	37/DP260685

Table F-9 Lot and DP for residential buildings with change of duration of above-floor inundation greater than one hour – Operation

Buildings	20% AEP	10% AEP	5% AEP	1% AEP
Residential	0	1/DP198139	781/DP746828 1/DP111703 5/DP32557	13/DP846612 41/DP853008

Property and land use flooding analysis and impacts – Operation phase

Table F-10 Number of residential lots affected by change in peak flood depth – Operation

Change in peak flood depth (m)	20% AEP	10% AEP	5% AEP	1% AEP
Was wet now dry	0	0	0	0
< -0.01	2	2	3	9
-0.01–0.01	487	545	567	834
0.01–0.05	1	0	46	309
0.05–0.1	0	1	1	0
0.1–0.2	1	0	0	0
0.2–0.3	0	0	0	0
> 0.3	0	0	0	0
Was dry now wet	0	0	0	0

Table F-11 Number of commercial lots affected by change in peak flood depth – Operation

Change in peak flood depth (m)	20% AEP	10% AEP	5% AEP	1% AEP
Was wet now dry	0	0	0	0
< -0.01	0	0	0	0
-0.01–0.01	166	168	236	160
0.01–0.05	0	0	0	95
0.05–0.1	0	0	0	0
0.1–0.2	0	0	0	0
0.2–0.3	0	0	0	0
> 0.3	0	0	0	0
Was dry now wet	0	0	0	0

Table F-12 Number of industrial lots affected by change in peak flood depth – Operation

Change in peak flood depth (m)	20% AEP	10% AEP	5% AEP	1% AEP
Was wet now dry	3	4	6	6
< -0.01	4	4	9	15
-0.01–0.01	170	213	302	295
0.01–0.05	1	1	13	145
0.05–0.1	0	0	0	0
0.1–0.2	0	0	0	0
0.2–0.3	0	0	0	0
> 0.3	0	0	0	0
Was dry now wet	0	0	0	0

Table F-13 Lots with afflux criteria exceeded – operation case

Lot Number	Plan Number	Plan Label	Zoning	Zoning Code	AEP events where afflux exceeded
100	849413	DP849413	Low Density Residential	R2	20%, 10%, 5%
102	1084709	DP1084709	Environmental Conservation	E2	20% AEP
10	735235	DP735235	Environmental Conservation	E2	20% AEP
1	128309	DP128309	Environmental Conservation	E2	5% AEP

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