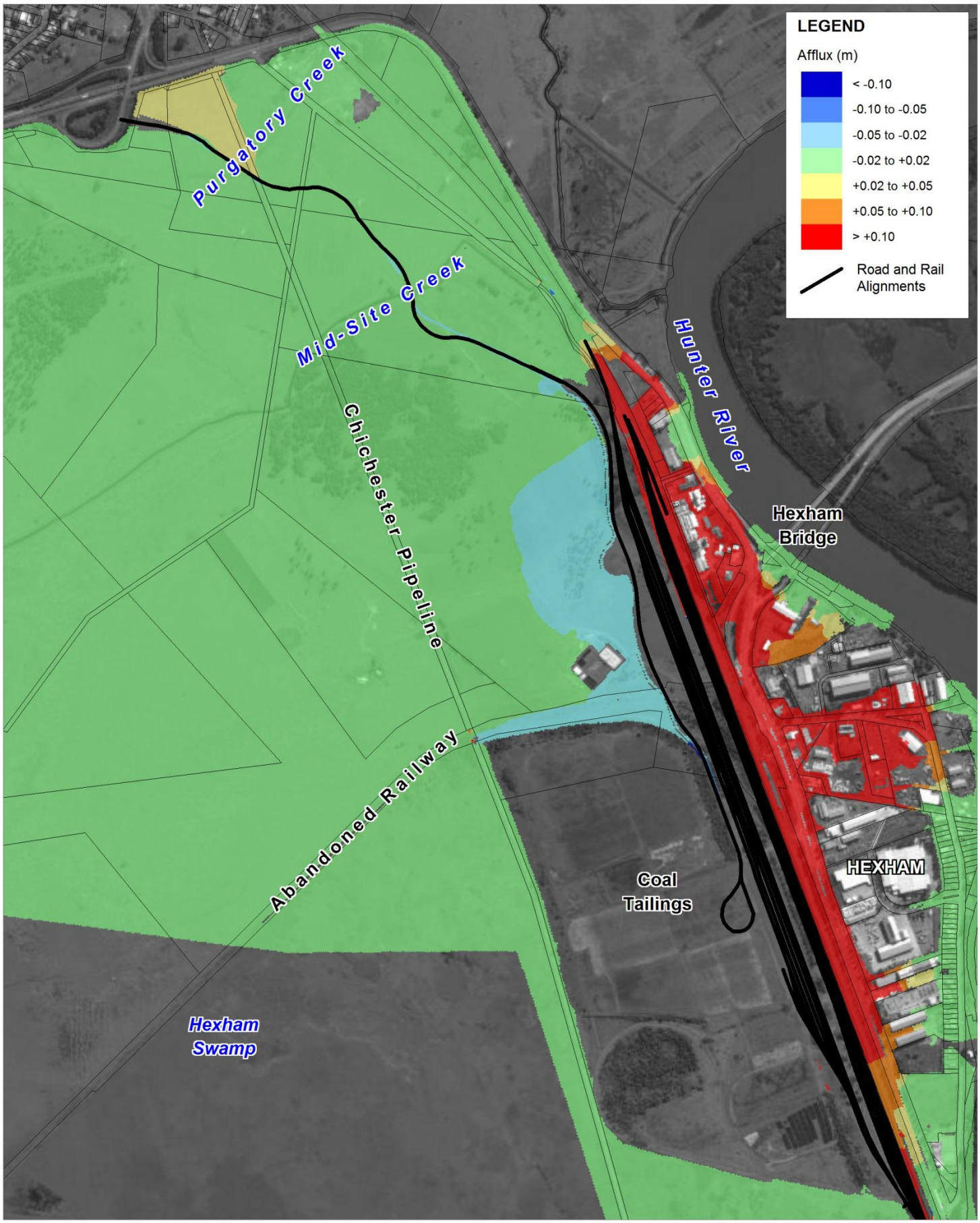


Title:

Unmitigated Peak Flood Level Impacts for an Event in the Order of a 2% AEP

Figure: 4-3

Rev: A

N

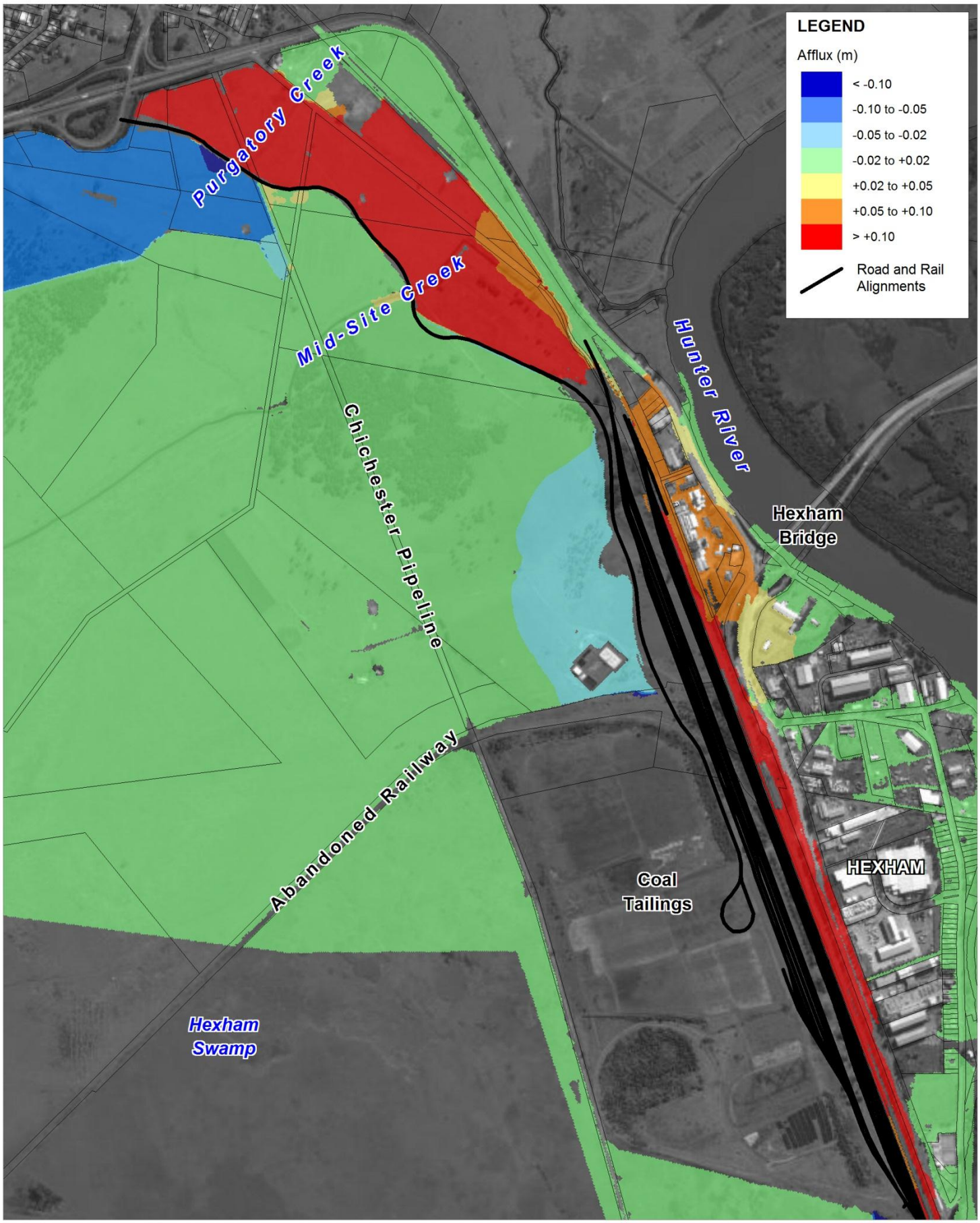
0 250 500m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N2335_QR_Hexham_Train_Support_Facility\MapInfo\Workspaces\DRG_050_130205_2%AEP_Local_h_Impact.WOR



Title:

Unmitigated Peak Flood Level Impacts for an Event in the Order of a 5% AEP

Figure: 4-4

Rev: A

N

0 250 500m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N2335_QR_Hexham_Train_Support_Facility\MapInfo\Workspaces\DRG_051_130205_5%AEP_Local_h_Impact.WOR

5 FLOOD MITIGATION

5.1 Description

As discussed in Section 4, there were localised flood impacts associated with the proposed works. These impacts are similar to what was presented in the previous individual EIS submissions for both the Train Support Facility and Relief Roads projects. These impacts were deemed unacceptable by the Office of Environment and Heritage and Newcastle City Council through the review process. Mitigation measures were therefore required to reduce flood impacts to an acceptable level. A number of potential mitigation options were considered, including:

- Provision of cross-drainage culverts;
- Lowering of the proposed design elevations; and
- Off-site flood mitigation works.

Each of the potential solutions would require cooperation from ARTC and Aurizon due to the similar nature of the two proposed developments.

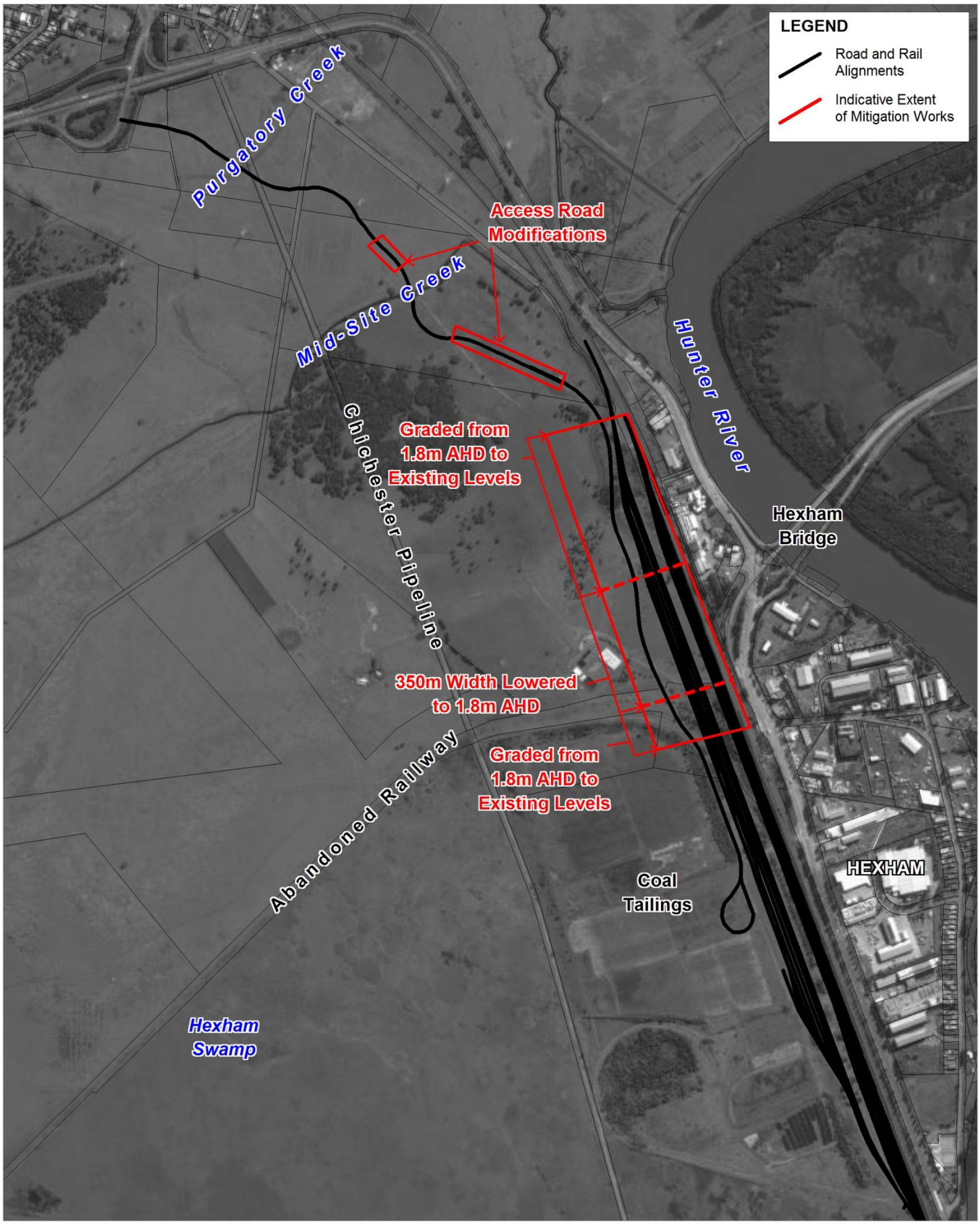
The off-site mitigation works principally would involve the construction of a levee on the right bank of the Hunter River in the Hexham locality to effectively block the flood flows that currently spill through the low point. Whilst this may provide an effective solution to the flooding and reduce the impact of the proposed works, there are inherent difficulties associated with the planning, design and construction on private land. With alternative solutions contained wholly within the project boundaries, the off-site flood mitigation were not considered further.

Given the volumes and flow rates of floodwater to be conveyed across both the access road and rail embankments of the Train Support Facility and Relief Roads, the scale of cross drainage works required to mitigate the flood impacts are such that the solution is very costly and has significant implications for both construction and ongoing maintenance and operations.

Of the two on-site mitigation options the lowering of design elevations was considered the most effective solution. The objective of the lowering selected sections of the both the access road and rail embankments is to effectively maintain the existing flow distributions without resulting in significant obstruction to the existing flow paths. Flood modelling was therefore undertaken to determine the extent of required lowering works and the residual flood impacts.

The broad extent of the proposed mitigation work, consisting lowered sections of both the proposed road and rail embankments is shown in Figure 5-1.

To mitigate flood impacts in Hexham the design elevations of the proposed works were lowered below the level of the existing rail for around an 800m length (approx. ch.175850 to ch.176640). This included a 350m length lowered to around 0.2m below the existing rail, with a design fill level of around 1.8m AHD and a top of rail level of around 2.0m AHD. This design modification essentially maintains the flow width of the existing floodway north of the coal tailings. This ensures that the mitigation solution will accommodate the full range of potential flood events. The lowering of levels to 0.2m below the existing rail accounts for a loss of efficiency in the flood waters flowing over an additional 150m width of embankment.



Title:

Extent of Flood Mitigation Works

Figure: 5-1

Rev: A

N

0 250 500m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N2335_QR_Hexham_Train_Support_Facility\MapInfo\Workspaces\DRG_061_130205_2%AEP_Mitigation.WOR

To mitigate flood impacts upstream of the access road the road surface elevation for a 300m was lowered to around 1.4m AHD. An additional 100m length was lowered to around 1.6m AHD. This is comparable to the levels of Woodlands Close which serves to limit extent of upstream flood impacts.

5.2 Mitigated Flood Impacts

As discussed in Section 3.2 the proposed works have a limited impact on regional flood behaviour. Flood impacts are largely restricted locally to Hexham and the area upstream of the access road alignment. For events up to a magnitude of around the 10% AEP the Hunter River does not spill over the highway. Under such conditions the proposed works will have no impact on flooding, as the relevant flood flow paths are not active. For flood events in the order of a 1% AEP or greater the Hunter River and Hexham Swamp floodplains are fully connected and the regional flood model provides an appropriate assessment of potential flood impacts. Figure 5-2 and Figure 5-3 show the impacts at the modelled 1% AEP event for peak flood level and velocity, respectively.

It can be seen from these figures that the proposed works have only a minor flood impact. The regrading of the rail corridor reduces the capacity to convey flood flows between the two areas of surrounding higher land. This results in a small redistribution of floodplain flows, pushing more water round to the west and through Hexham Swamp. However, the impact on flood levels in Hexham Swamp downstream of the access road alignment is relatively minor, at around 0.02m. There is also a corresponding reduction in peak flood levels to the east of the site.

As discussed in Section 4, there are localised flood impacts associated with the proposed works in Hexham and upstream of the access road. For these localised flood impacts the detailed flood model is required to best represent the potential flood impacts and flood mitigation of the proposed works. Figure 5-4 to Figure 5-7 show the mitigated impacts on peak flood levels and velocities for flood events in the order of the 5% AEP and 2% AEP magnitudes.

5.2.1 Impacts on Surrounding Land

When introducing a raised embankment across a major floodplain flow path there is always likely to be some level of flood impact. For the access road, flood impacts have been reduced through the lowering of the design elevations. However, some residual impact remains. The greatest impact on modelled flood behaviour is for an event of the order of a 5% AEP, for which the peak flood level upstream of the road alignment is typically increased by 0.05m to 0.1m. The impact is locally as high as 0.4m, but this is restricted to the Aurizon owned land at the western end of the access road. For events in the order of a 2% AEP the flood level impact is reduced to around 0.02m to 0.03m, as the floodplain depths increase and the access road becomes drowned. At the 1% AEP event the impacts are typically around 0.05m and are locally as high as 0.08m. These impacts are driven principally by a minor flow redistribution rather than the influence of the access road.

In Hexham the impacts on peak flood levels are largely restricted to the existing road and rail corridor to the east of the proposed works. Under existing conditions this corridor conveys flood waters in a southerly direction from Hexham Bridge. The proposed works result in a small increase in flood flows through this corridor, which were previously spilling over the existing railway in the vicinity of the coal tailings. For flood events in the order of a 5% AEP to 2% AEP the peak flood levels along the existing rail and road corridor typically increase by 0.05m to 0.1m. At the 1% AEP event the peak flood levels

in the corridor decrease by 0.05m to 0.1m, due to the minor redistribution of flood flow distribution discussed in Section 3.2.

The off-site impacts on peak flood velocities for the modelled events are insignificant. There are localised changes of up to 0.5m/s associated with a localised flow redistribution around the access road.

The flood impacts for the PMF event show some localised redistribution of peak flood velocities and localised peak flood depth increases of around 0.03m.

5.2.2 Impacts on Local Infrastructure

There is a modelled increase in peak flood levels of 0.05m to 0.1m along the Pacific Highway between Hexham Bridge and Hexham Bowling Club for events in the order of a 5% AEP and 2% AEP. This is due to a small increase in flood flows along the road corridor as a result of the proposed works. In terms of impacts to the road infrastructure, changes in flood frequency and duration are more important than impacts on peak flood level. The proposed works will not have a significant impact on flood frequency or duration of either the Pacific or New England Highways.

Figure 5-8 summarises the flood mechanisms which control the inundation of the Pacific and New England Highways in the vicinity of Hexham Swamp. There are four main locations at which significant overtopping of the roads can occur during a major flood event on the Hunter River. The frequency and duration of flooding are controlled by the flood levels in the Hunter River, which are not impacted by the proposed works.

When flood levels in the Hunter River exceed 2.0m AHD at Hexham Bridge the Pacific Highway will become overtopped with flood waters spilling into the lower lying land beyond. Some flow may also occur in a southerly direction along the road. It is this flow path which is impact by the proposed works. However, the frequency and duration of flooding will not be impacted as this is driven by the Hunter River flood conditions at Site B. Flooding of the Highway will occur once flood waters rise to above 2.0m AHD and will subside once the flood level drops below 2.0m AHD. Similar flood impacts and behaviour described for the Pacific and New England Highways also apply to the existing rail corridor in the vicinity of the coal tailings.

There are modelled flood level increases of up to 0.1m along Woodlands Close. Again, the frequency and duration of flooding will not be impacted as this is controlled by flood waters spilling across the New England Highway at Site A from Figure 5-8.

5.2.3 Impacts on Local Housing

The flood impacts to local housing are restricted to a single property located upstream of the access road. Here there is a modelled peak flood level increase of under 0.05m at the 1% AEP event and a 0.02m increase at the 2% AEP event. At other residential locations in the vicinity of the proposed works the flood impacts are negligible.

5.2.4 Impacts on Local Businesses

The flood impacts to local businesses located in Hexham are negligible. The mitigation solution in terms of the lowering rail lines has been designed with the objective of minimising the afflux within this locality, particularly where existing properties may be impacted.

There is potential for increased flood levels of 0.05m to 0.1m along the Pacific Highway corridor as discussed. However, the businesses located along the Pacific Highway are elevated on ground raised above the 2% AEP flood level and accordingly local increase in flood level has no impact to the property. At the 1% AEP event when the businesses are potentially flooded, there is a reduction in peak flood levels due to the minor flow redistribution described in Section 3.2. As discussed in Section 5.2.2, the flood frequency and duration of the Pacific Highway will not be impacted by the proposed works.

5.2.5 On-site Flood Risk

The development includes regrading of site elevations up to a level of over 3.0m AHD. Rail and building infrastructure that is situated at or above this level will remain flood free for flood events up to the order of around the 2% AEP. However the sections of the proposed works that have been lowered for flood mitigation purposes will flood more frequently. The flooding of the lowered section will be flooded once the existing rail is overtopped. This may occur during a flood event in the order of a 5% AEP. Although the proposed works will be elevated 0.2m below the existing rail, they will not be flooded more frequently as the flood waters must spill over the existing rail before spilling over the proposed works.

Flood waters will begin to flow over the lowered sections of the proposed works at around the 5% AEP event. Flood depths across the site would then increase with event magnitude, being over 0.5m for events in the order of a 2% AEP and almost 2.0m for an event around a 1% AEP magnitude. Modelled flood velocities across the lowered section of the proposed works are around 0.5m/s for a flood event in the order of a 2% AEP and may be locally as high as 1.0m/s. For an event in the order of a 1% AEP typical velocities across the site may be around 1.0m/s and locally as high as 1.5m/s.

The flood depths and velocities across the site have implications for the on-site rail and building infrastructure. It is recommended that critical infrastructure, such as electrical supply and equipment is elevated above the 1% AEP level and a suitable freeboard (typically 500mm), i.e. 4.2m AHD.

At the PMF event flood waters would be over 5m deep, with a velocity depth product of around 2.0. An event of this magnitude would likely result in extensive damage to on-site infrastructure.

Peak flood depths across the access road will be around 0.5m for events in the order of a 5% AEP and around 1.0m for events in the order of a 2% AEP. The flood depth across the access road at the modelled 1% AEP event is over 2m. Peak velocities across the access road can be expected to be up to around 2.0m/s for the range of modelled events.

5.2.6 Impacts on Geomorphology

The proposed works have a negligible impact on the flood flows within the Hunter River channel and so will not impact on the Hunter River geomorphology. The impacts of the proposed works are predominantly within the partially disconnected floodplain of Hexham Swamp and are restricted to

events of around a 5% AEP magnitude and greater. Due to the negligible impact on high frequency flood events no significant geomorphic impacts are anticipated.

Within Purgatory Creek local peak flood velocities are increased to around 3m/s through the access road cross drainage. However, this impact can be mitigated through the inclusion of appropriate scour protection works in the vicinity of the access road crossings. Impacts to flood velocities in the local floodplain areas are typically less than 0.2m/s.

5.2.7 Temporary Works

A flood impact assessment has also been carried out for temporary works during the construction phase, principally consisting of a section of the access road from the Tarro Road and connecting into Woodlands Close and an elevated temporary works platform/storage area. Both of these components incorporate extensive areas of fill, with the potential for associated flood impacts for events which may occur during the construction phase.

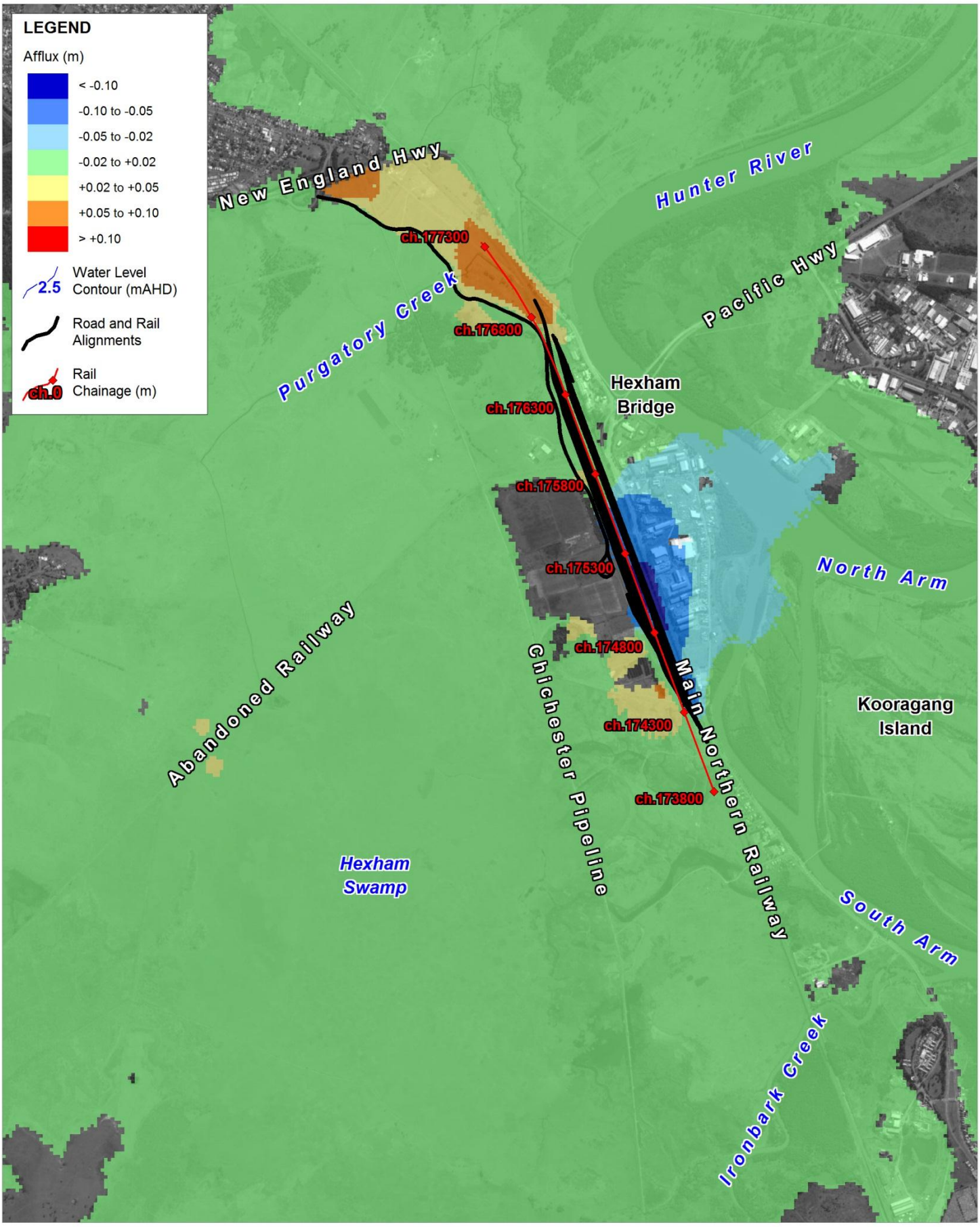
As with the consideration of the permanent access road, the temporary works would have the most impact for the 5% AEP and 2% AEP events. For lower events, there is minimal flow spilling across the New England Highway such that there is a no significant flow on the floodplain for the works to obstruct. For large events, the access road and other local controls are effectively drowned out, such that impacts are minimal.

The impacts in terms of changes in peak flood level conditions for the temporary works is shown in Figure 5-9. The temporary works provide for similar relative impact as the permanent access road.

The most significant impact is for events of the order of 5% AEP. The impact is locally as high as 0.4m, but this is restricted to the Aurizon owned land at the western end of the access road. The highest impact on other private property is for small section upstream of Woodlands Close where the peak increase in flood level is approximately 0.06m.

For events in the order of a 2% AEP the flood level impact is reduced to around 0.02m to 0.03m, as the floodplain depths increase and the access road becomes drowned.

Broadly the temporary works provide for similar impacts as the permanent access road, albeit slightly less in terms of absolute magnitude. Accordingly, the temporary works do not provide for any exacerbation of flood risk over and above the permanent works.



Title:

Impact of Proposed Works on Peak 1% AEP Flood Level with Flood Mitigation

Figure: **5-2**

Rev: **A**

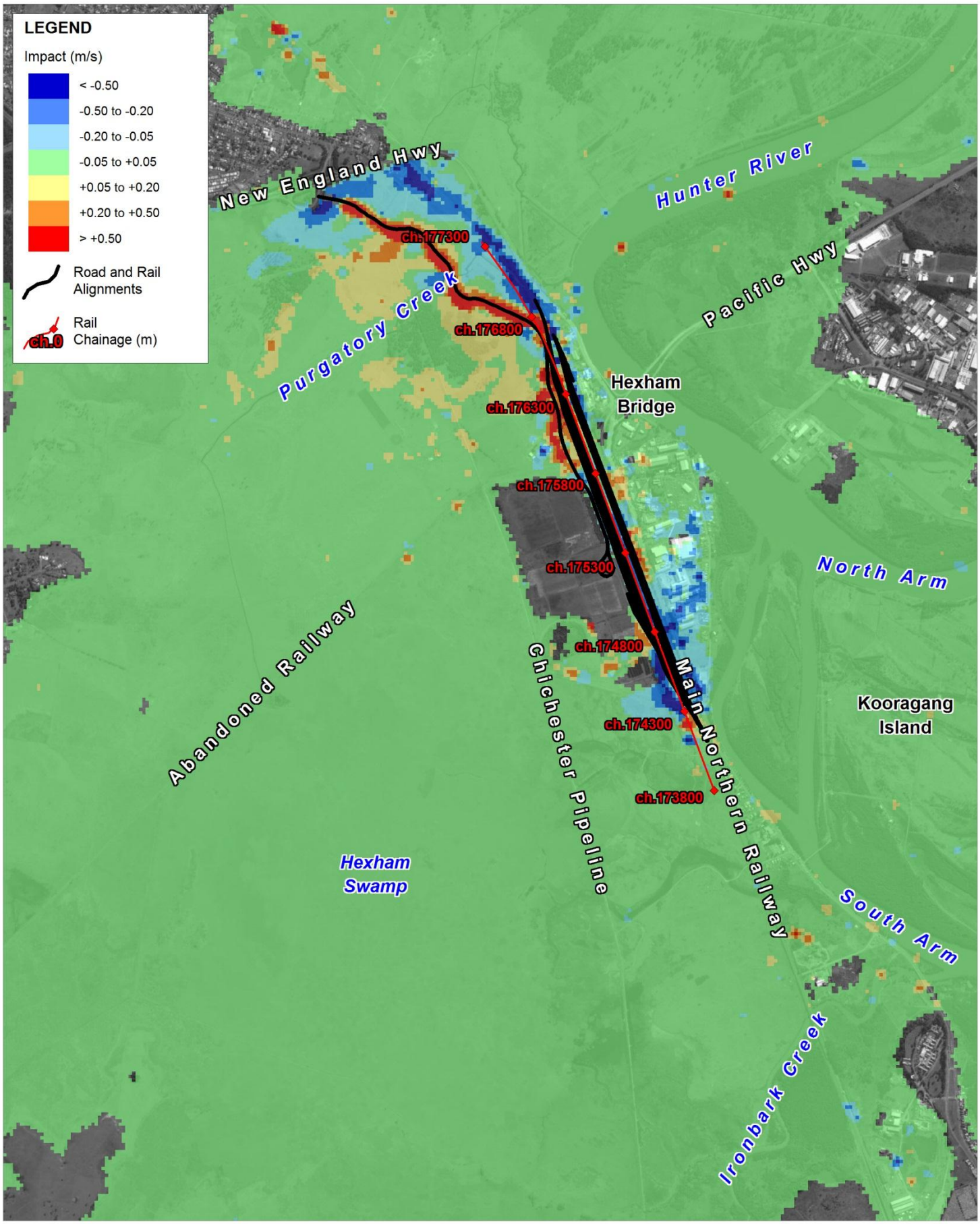
N

0 0.5 1km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N2335_QR_Hexham_Train_Support_Facility\MapInfo\Workspaces\DRG_052_130205_1%AEP_Mitigated_h_Impact.WOR



Title:

Impact of Proposed Works on Peak 1% AEP Flood Velocity with Flood Mitigation

Figure: 5-3

Rev: A

N

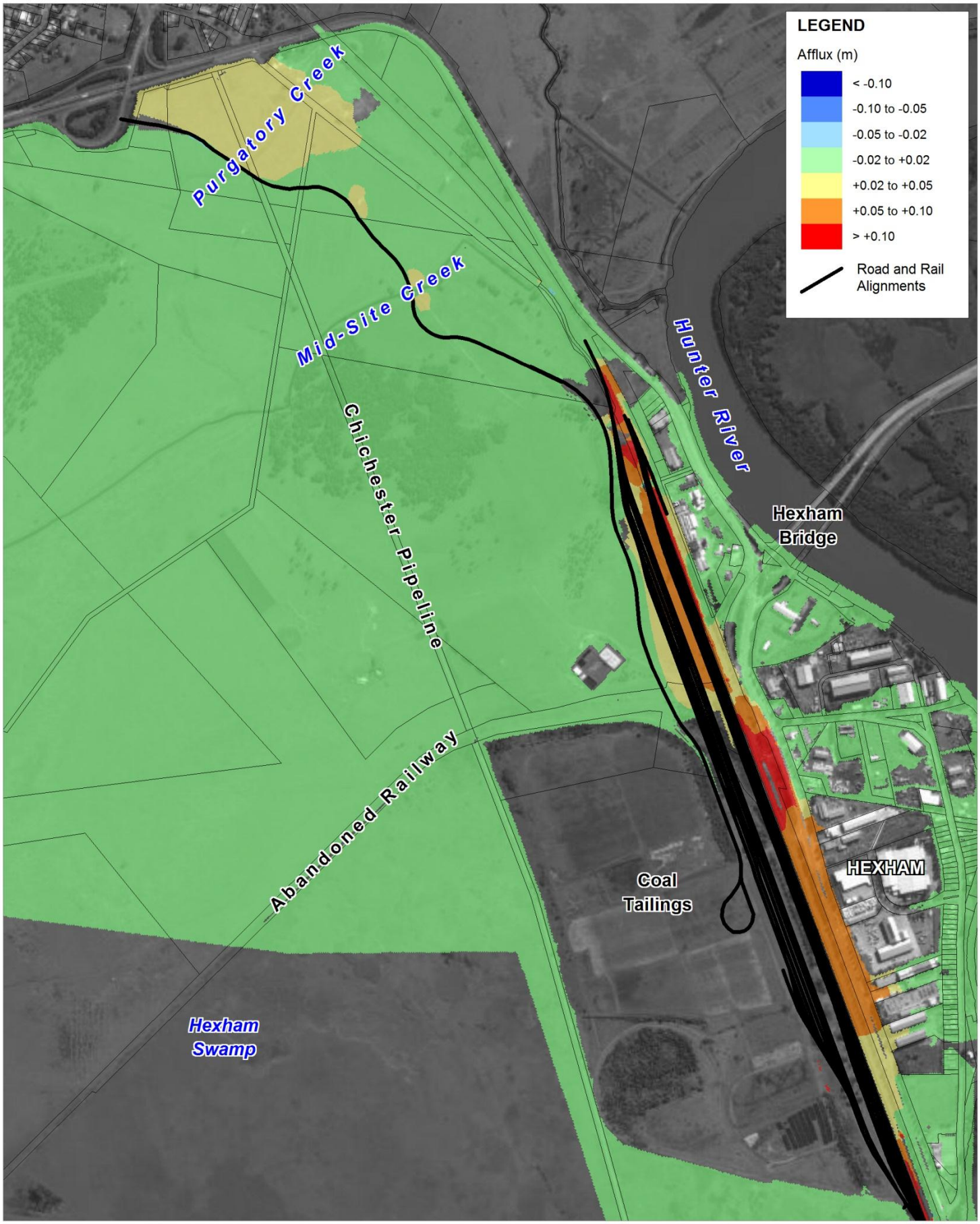
0 0.5 1km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N2335_QR_Hexham_Train_Support_Facility\MapInfo\Workspaces\DRG_053_130205_1%AEP_Mitigated_v_Impact.WOR



Title:

Impact of Proposed Works on Peak 2% AEP Flood Level with Flood Mitigation

Figure: 5-4

Rev: A

N

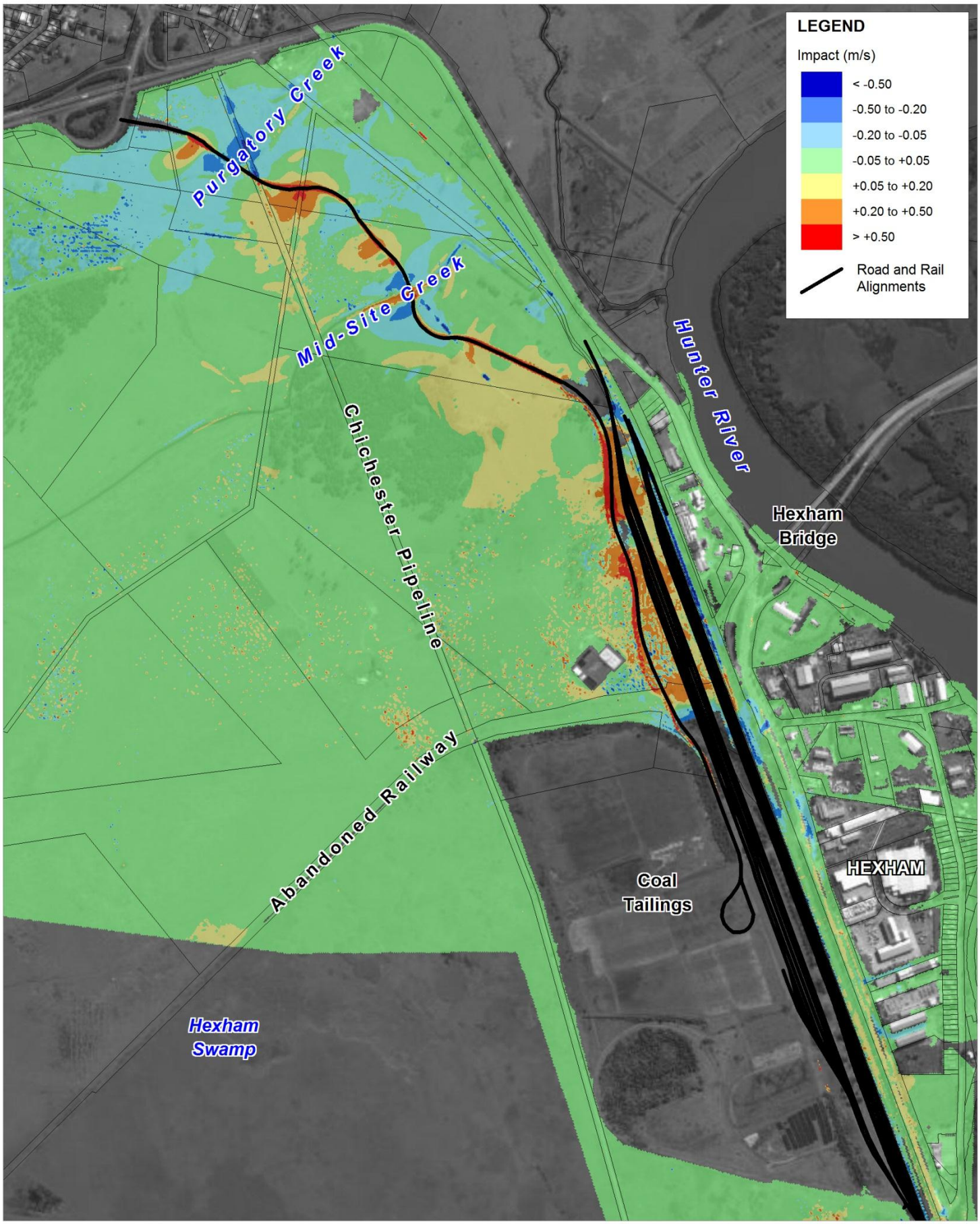
0 250 500m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N2335_QR_Hexham_Train_Support_Facility\MapInfo\Workspaces\DRG_054_130205_2%AEP_Mitigated_h_Impact.WOR



Title:

Impact of Proposed Works on Peak 2% AEP Flood Velocity with Flood Mitigation

Figure: 5-5

Rev: A

N

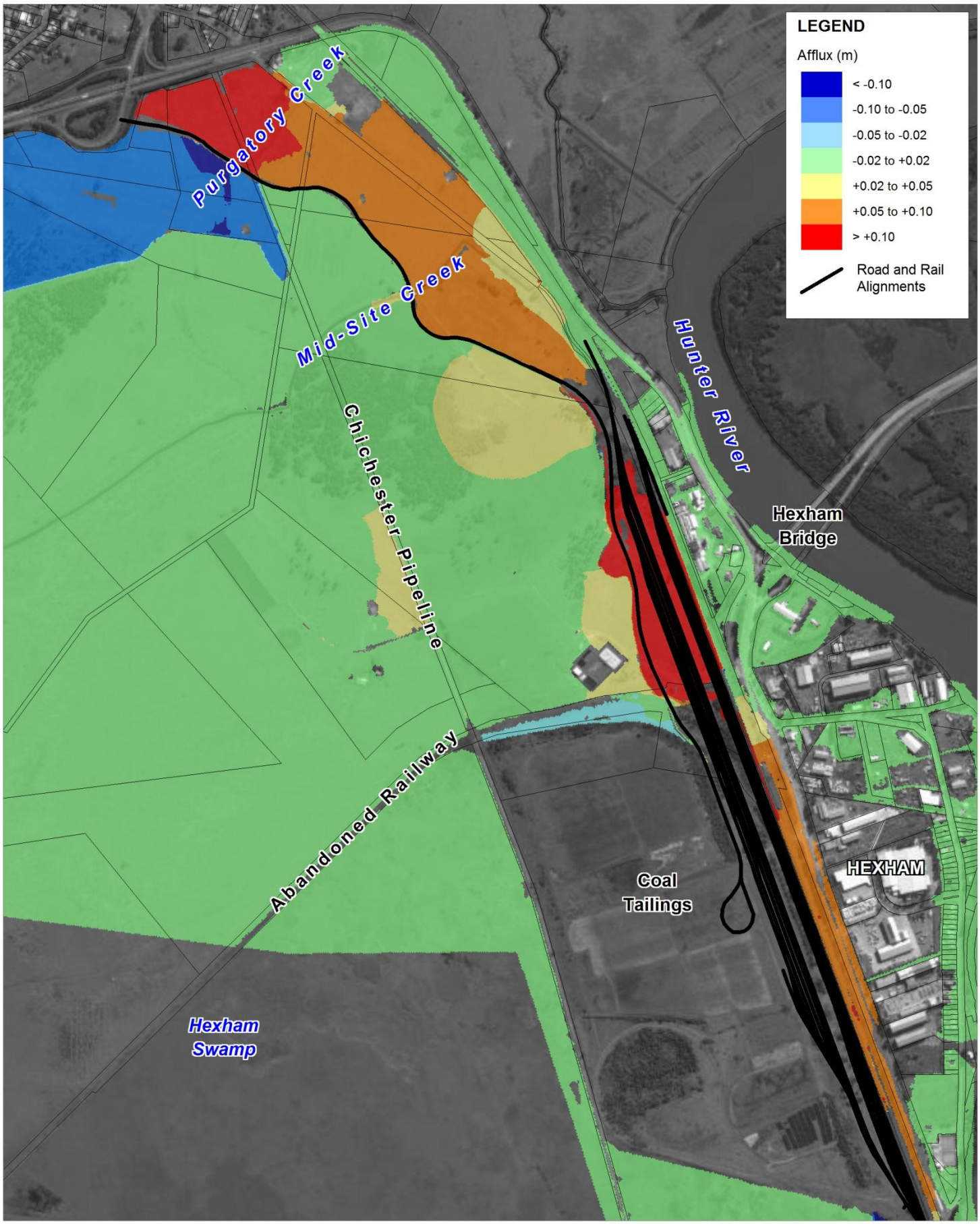
0 250 500m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N2335_QR_Hexham_Train_Support_Facility\MapInfo\Workspaces\DRG_055_130205_2%AEP_Mitigated_v_Impact.WOR



Title:

Impact of Proposed Works on Peak 5% AEP Flood Level with Flood Mitigation

Figure: 5-6

Rev: A

N

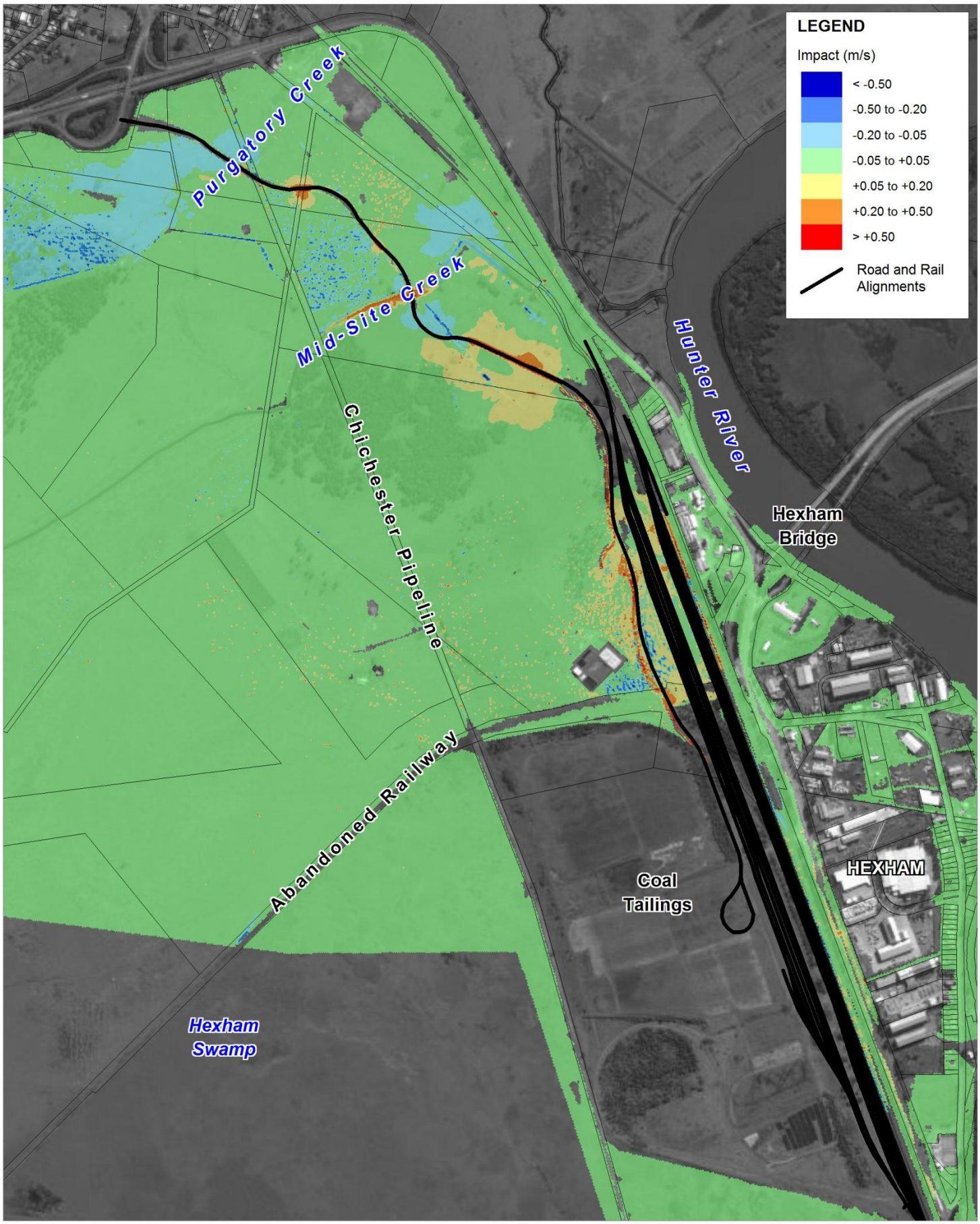
0 250 500m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N2335_QR_Hexham_Train_Support_Facility\MapInfo\Workspaces\DRG_056_130205_5%AEP_Mitigated_h_Impact.WOR



Title:

Impact of Proposed Works on Peak 5% AEP Flood Velocity with Flood Mitigation

Figure: 5-7

Rev: A

N

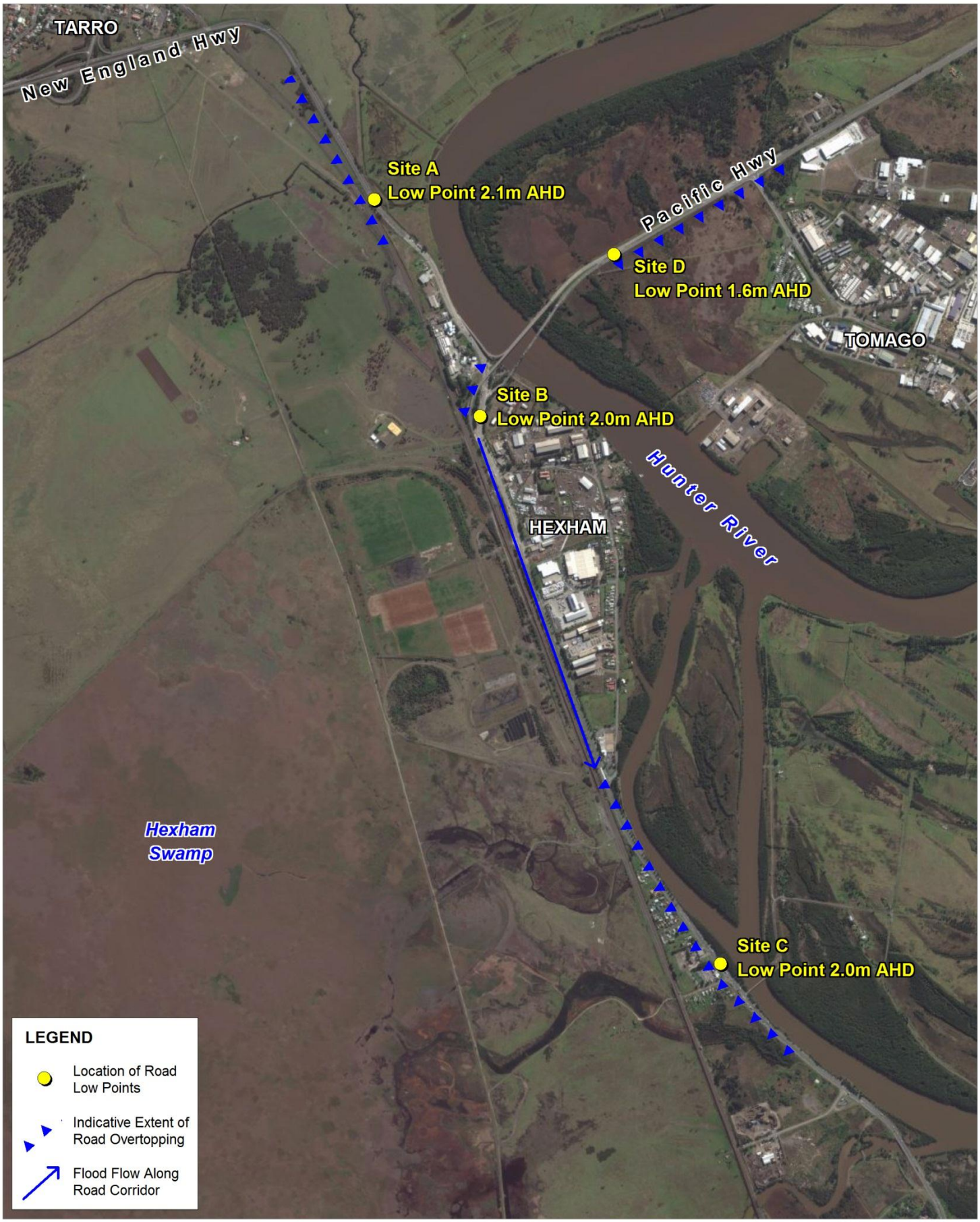
0 250 500m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N2335_QR_Hexham_Train_Support_Facility\MapInfo\Workspaces\DRG_057_130205_5%AEP_Mitigated_v_Impact.WOR



Title:

Flood Inundation of the Pacific and New England Highways

Figure: 5-8

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 0.5 1km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N2335_QR_Hexham_Train_Support_Facility\MapInfo\Workspaces\DRG_047_130213_Road_Inundation.WOR