Gateway Upgrade Project

11. Hydrology/Hydraulics

11

Return to Contents Page

11. Hydrology/Hydraulics

11.1 Introduction

The GUP has the potential to impact upon the hydraulic regime of a number of waterway corridors located along the alignment. As such this hydraulic assessment has been undertaken to achieve the following objectives:

- Provide Base Case (ie Existing Case), hydraulic details including flood levels, flows and velocities for the 100 year ARI design event;
- Determine impacts on the flood regime due to introduction of the works (eg bridge crossings, culverts and embankments) associated with the GUP; and
- Develop mitigation options to minimise the impact of the proposed works.

Due to the flood sensitive nature of the waterway corridors a detailed investigation has been undertaken in which numerous mitigation options have been considered. An hydraulic assessment report has been prepared that fully documents the investigation undertaken and this is presented in Appendix H. This section of the EIS provides an overview of the work undertaken and presents key outcomes.

11.2 Methodology

In order to assess the impacts of the GUP detailed 2-dimensional hydraulic models of Bulimba Creek and Kedron Brook Floodway were developed using the Danish Hydraulic Institute's MIKE 21 software package. For this investigation the 2-dimensional MIKE 21 modelling was adopted to enable more accurate modelling of the highly complex and meandering Bulimba Creek system and the skewed bridge crossing over Kedron Brook Floodway. This modelling approach uses a topographic surface (or terrain model) to accurately represent flowpaths. The topographic information was obtained from the Aerial Laser Survey (ALS) provided by AAMHatch.

Initial roughness values, boundary conditions and inflows to the MIKE 21 models were obtained from the hydraulic models developed during the Planning Study. Refinement of the roughness values was undertaken to calibrate the MIKE 21 model to the peak water levels from the Planning Study hydraulic models.

The MIKE 21 models were set up to represent a number of scenarios including:

- Base Case – consists of the 100 year ARI design event with Flood Regulation Lines (FRLs) in place. FRLs are a BCC requirement which define the waterway corridor for each creek and limit the extent and encroachment of development in this area;
- Developed Case – in this scenario the GUP were introduced into the MIKE 21 model and the impacts of these works determined; and
- Mitigation Options – a number of mitigation options were considered on both waterways including modifications to proposed structures, localised earthworks and refinement of the FRLs.

Full detail of the investigation undertaken is presented in the hydraulic assessment report in Appendix H.

TOR Requirements: Existing Environment

- Describe the watercourses in the area affected by the Project and outline the significance of these waters to the river / creek catchment system in which they occur including a description of existing drainage patterns, water quality and flows in major watercourses and wetlands;
- Provide details of the likelihood of flooding, history of flooding including extent, levels and frequency and a description of present and potential water uses downstream of the areas affected by the Project;
- Describe environmental values of waterways of the affected area in terms of:
  – Values identified in the Environmental Protection (Water) Policy;
  – Sustainability, including quantity; and
  – Physical integrity, fluvial processes and morphology of watercourses, including riparian zone vegetation and form.

TOR Requirements: Potential Impacts

This section is to define the potential impacts of the project on the water environment, to outline strategies for protecting water resource environmental values, how nominated quantitative standards and indicators may be achieved, and how the achievement of the objectives may be monitored, audited and managed.

The EIS should describe the possible environmental harm caused by the proposed works to environmental values for water as expressed in the Environmental Protection (Water) Policy.

Water management to address surface and groundwater quality, quantity, drainage patterns and sediment movements should be outlined. Key water management strategy objectives include:

- Maintenance of sufficient quantity and quality of surface waters to protect existing beneficial downstream uses of those waters (including maintenance of in-stream biota and downstream wetlands including the Moreton Bay Ramsar wetland);
- Protection of important local groundwater aquifers; and
- Measures proposed to avoid or minimise afflux resulting from changes to drainage patterns.

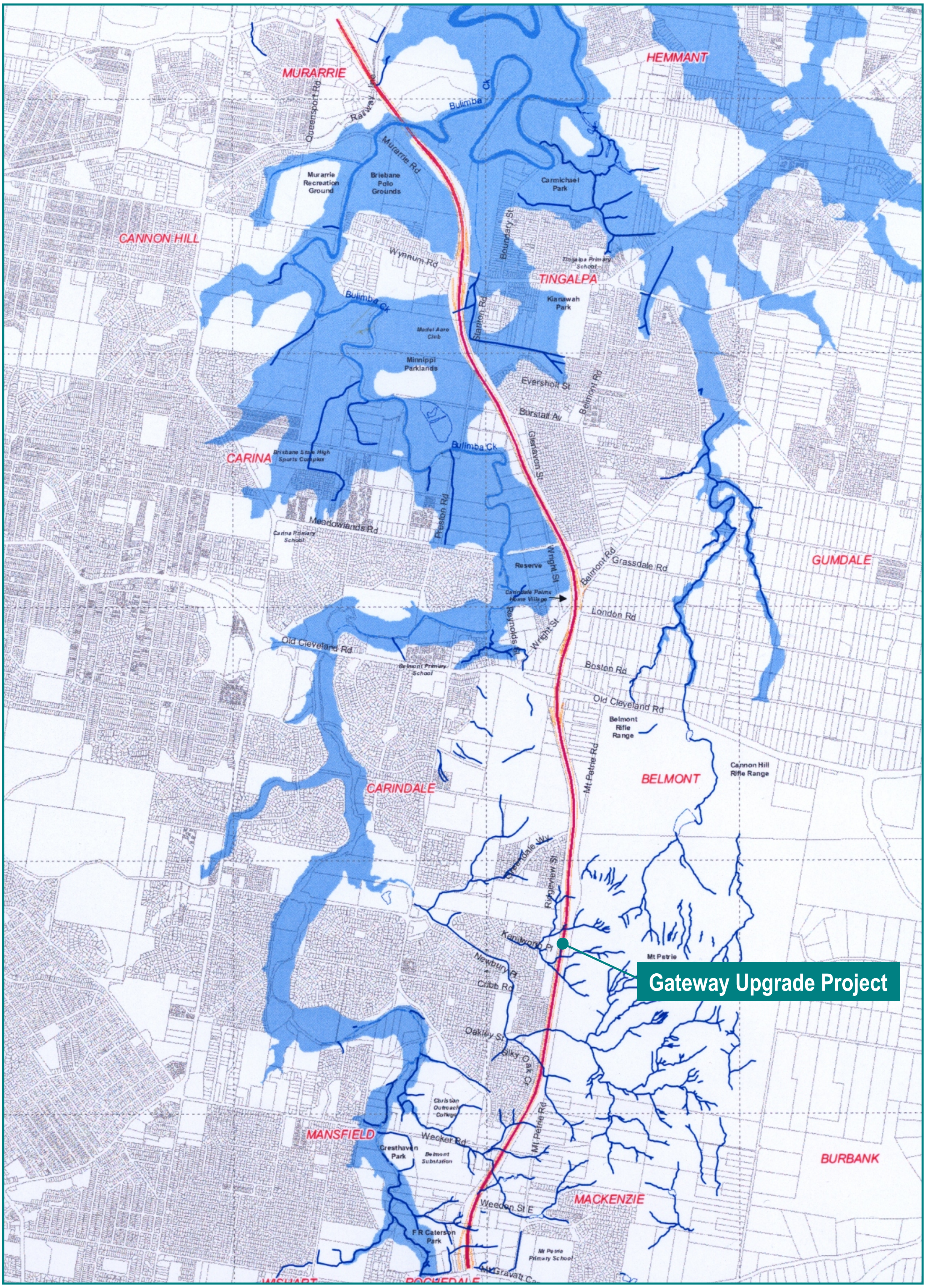
Reference should be made to State Planning Policy (SPP) 1/03:Mitigating the adverse Impacts of Flood, Bushfire and Landslide.

11.3 Mt Gravatt–Capalaba Road to Cleveland Branch Rail Line

11.3.1 Existing Environment

In this portion of the works, the GUP alignment closely follows that of the existing Gateway Motorway and as such does not create any new surface water crossing locations. Instead augmentation of a number of existing crossings is required, including the Bulimba Creek Bridge crossing, two Minimum Energy Loss (MEL) culverts and other minor culvert crossings (refer Section 3 and Volume 3 for details).

The main waterway in this area is Bulimba Creek, which is subject to tidal flows and ultimately drains into the Brisbane River. A large portion of the Bulimba Creek catchment has been developed for residential, commercial and industrial purposes. In the immediate vicinity of the Motorway, on the upstream side, there are several low lying paddocks and a number of houses, with industrial development on the downstream side. Under the 100 year ARI flood event, substantial inundation of the land adjacent to the Motorway occurs (refer Figure 11.1). This specifically impacts on a number of the upstream residences.



Source: GHD 2003

L:\graphics\jobs\579210NV\Q100 Flood.cdr May 2004

FIGURE 11.1
Bulimba Creek and Surrounding Environment

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Figure 11.2a presents the Base Case results for the 100 year ARI event as determined from the MIKE 21 model. Figure 11.2a shows the extent of the MIKE 21 model, including the areas of land with no flow. Arrows showing velocities and flow direction are also presented.

During the inspections of the Bulimba Creek crossing, an area of illegal fill was identified upstream and downstream of the existing bridge. This comprises an area of approximately 0.55ha. The removal of this fill has been assessed in the model as an Alternative Base Case. The results for this Alternative Base Case are presented on Figure 11.2b. As it is intended for this illegal fill to be removed, the results of the Alternative Base Case have been adopted as the scenario against which to compare the Developed Case results.

11.3.2 Potential Impacts

The proposed Gateway Motorway requires the construction of additional lanes on the downstream (eastern) side of the bridge. The proposed works have been represented in the MIKE 21 model and include:

- Construction of new bridge and filled embankments along the alignment of the new lanes;
- Additional piers to support the bridge duplication. These were initially modelled assuming the sizes and locations specified in the Planning Study; and
- Reinforcing of the existing bridge piers to support additional lanes on the existing structure.

The GUP works also require bridging of the two minimum energy culverts of Bulimba Creek and Minnippi Channel. These proposed works have been introduced into the MIKE 21 model and form the Developed Case.

The 100 year ARI Developed Case results are presented in Figure 11.3. Impacts immediately upstream include an increase in peak water levels of approximately 40mm, which drops to approximately 5mm at the Wynnum Road crossing. This increase directly impacts on properties located on Vane Street.

11.3.3 Mitigation Options

A series of mitigation options have been assessed with a view to mitigating the impact of the GUP in the vicinity of Bulimba Creek. This includes:

- Altered pier arrangements – to remove piers from the creek channel and align piers with flow direction; and
- Localised earthworks – to improve conveyance through existing multi-spanned crossing.

Full details of the investigative work undertaken for each mitigation option are presented in Appendix H.

The preferred mitigation option is presented in Figure 11.4. This option assumes the removal of illegal fill occurs and that additional localised earthworks are undertaken comprising a total area of 1.16ha. These proposed works fully mitigate against the hydraulic impact of the GUP.

11.4 Cleveland Branch Rail Line to Pinkenba Rail Line

From Lytton Road, the alignment crosses the Brisbane River downstream of the existing bridge crossing and then passes through the Royal Queensland Golf Course and industrial land in the vicinity of Kingsford Smith Drive. The alignment then crosses further industrial land near the Pinkenba Rail Line.

The Brisbane River is the largest river flowing into Moreton Bay and hence the principal river crossed by the GUP. Areas along the Brisbane River have been cleared and developed over the past decades. In the 1940s, the river mouth and river bed itself was dredged, leading to increased tidal penetration. The 100 year ARI Brisbane River event flood inundation is contained within the riverbanks. Taking this into account and the fact that the new bridge piers will be aligned with that of the existing bridge, the new bridge crossing should not significantly impact upon flood levels or flow distribution and therefore has not been the subject of a detailed investigation.

11.5 Pinkenba Rail Line to Nudgee Road

11.5.1 Existing Environment

This portion of the GUP alignment deviates substantially from the existing Motorway alignment and as such introduces a number of new waterway crossings. The alignment passes through the TCC site, on to Brisbane Airport land and finally crosses Kedron Brook Floodway before linking up with the existing Gateway Motorway at Nudgee. Existing surface water features in this area include:

- Kedron Brook Floodway;
- Tidally influenced engineered channels and remnant streams;
- Freshwater channels and remnant streams;
- Remnant mangrove and saltmarsh/claypan;
- Remnant freshwater wetlands; and
- Man made freshwater lakes and semi natural freshwater lagoons.

Figure 11.5 outlines the major tributaries and waterways within the proximity to the GUP and in the surrounding region. Within the Brisbane Airport precinct, a network of minor waterways drain into larger, engineered channels, including Landers Pocket Drain and a part of Schulz Canal before draining east and north to the Kedron Brook Floodway. The floodway is an engineered waterway that carries runoff from the Kedron Brook catchment into Moreton Bay immediately north of the Brisbane Airport and is 6km long and up to 4m deep at high tide.

Constructed during the depression to link Kedron Brook Floodway and Serpentine Creek, Schulz Canal was restructured with the Kedron Brook Floodway in the early 1980s as part of the Brisbane Airport redevelopment. Schulz Canal enters Kedron Brook Floodway at the start of the floodway.

Under the 100 year ARI event, extensive overbank flooding occurs on Kedron Brook Floodway, inundating a vast majority of the GUP corridor to the north of the Pinkenba Rail Line and to the east of the existing Gateway Motorway. A number of residential and commercial properties in this area are inundated during this flood event. Therefore, it is important that the proposed road structure does not increase existing flood levels.

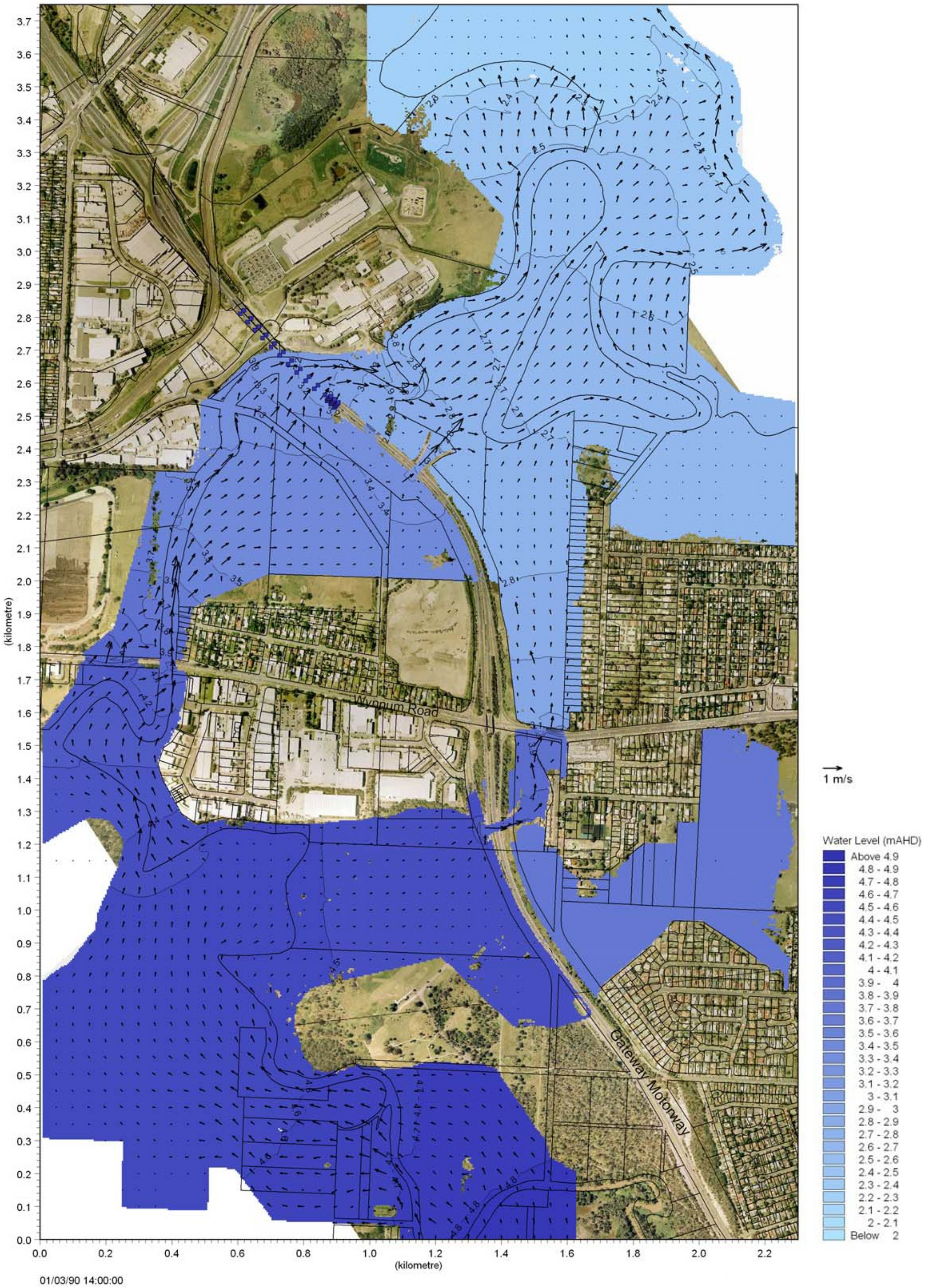

FIGURE 11.2a
Bulimba Creek Base Case
MIKE 21 Model Results - 100yr ARI Event

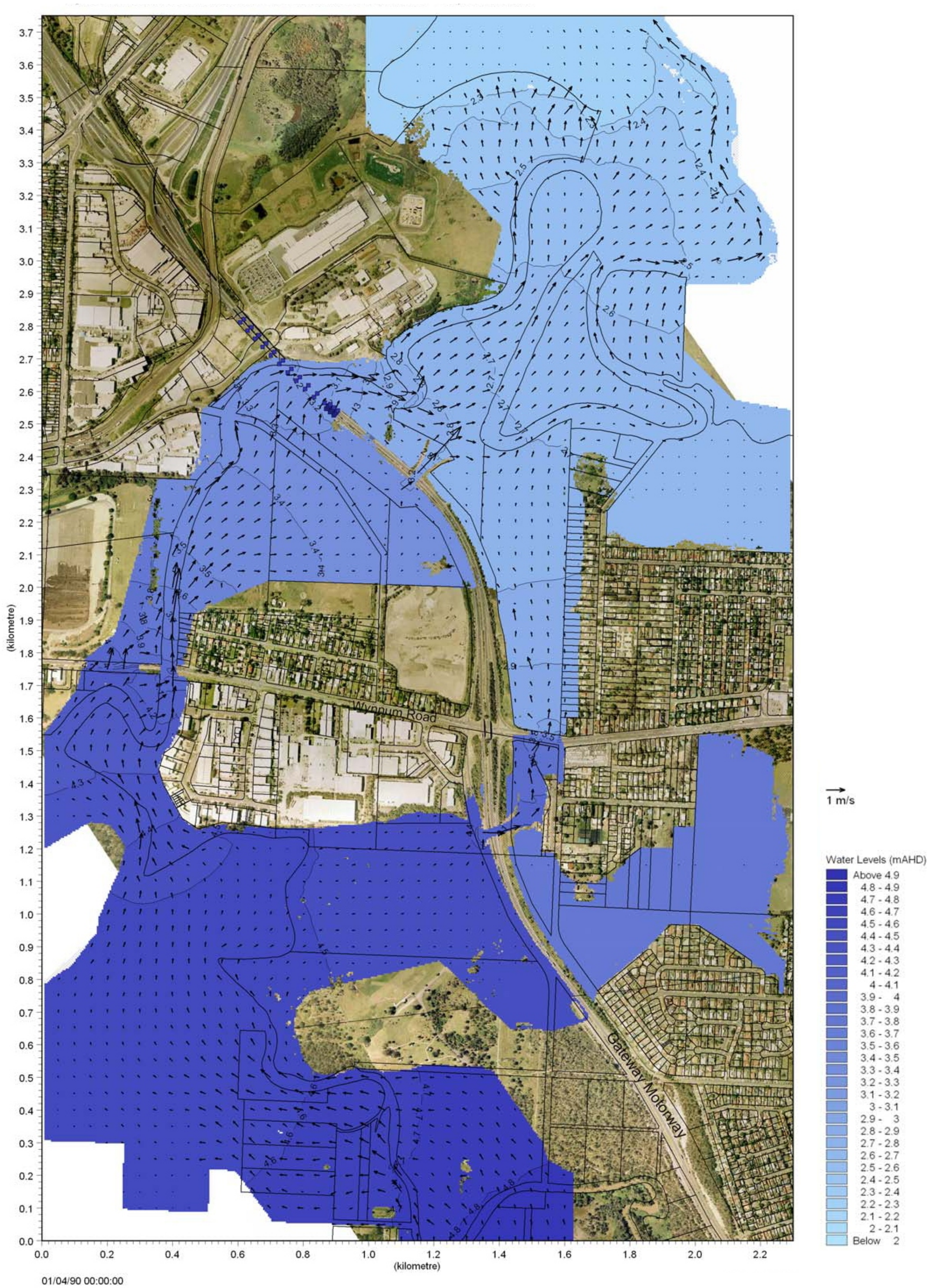

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FIGURE 11.2b
Bulimba Creek Alternative Base Case
MIKE 21 Model Results - 100yr ARI Event

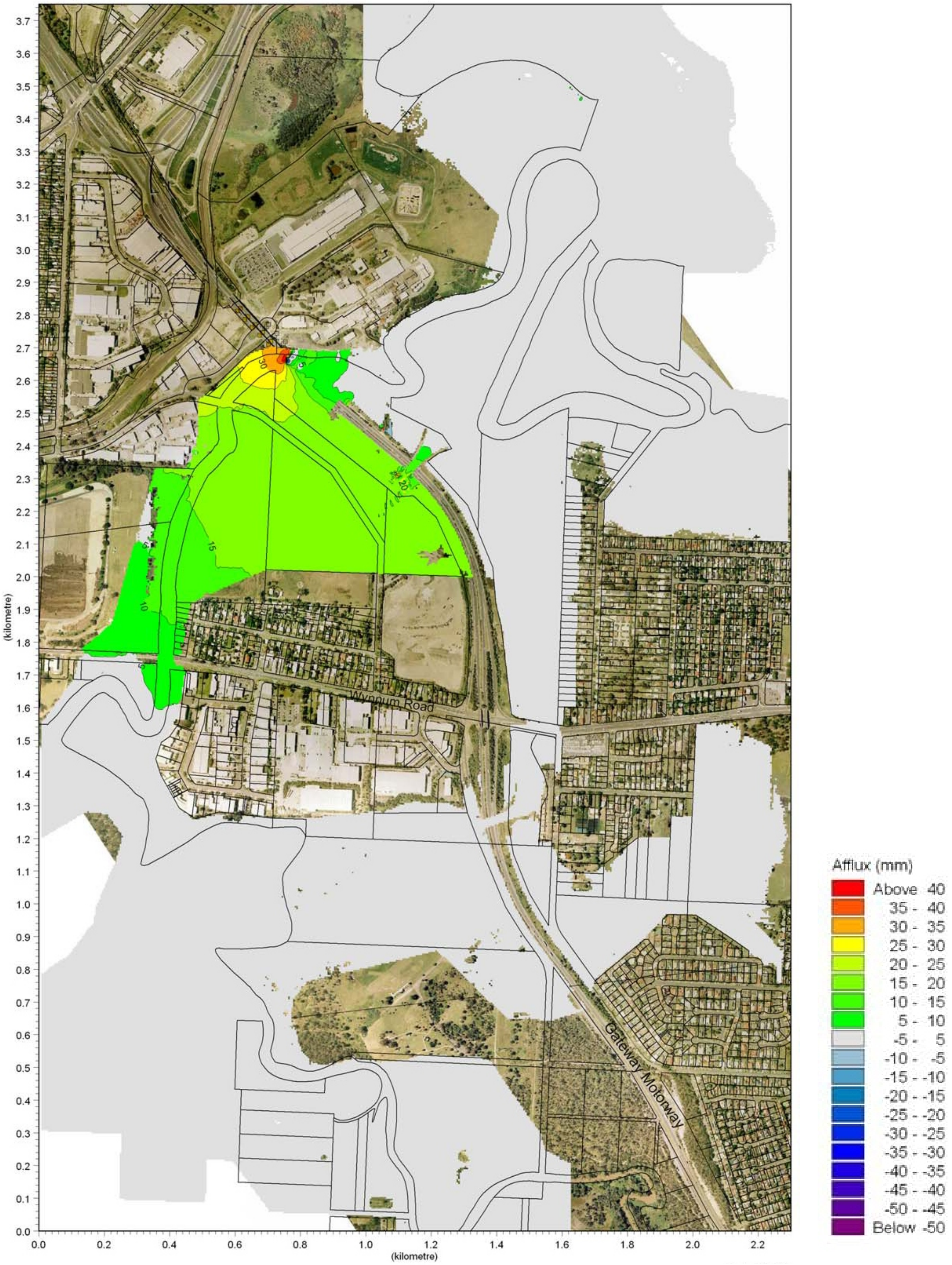

FIGURE 11.3
Bulimba Creek - Impact of Proposed Works

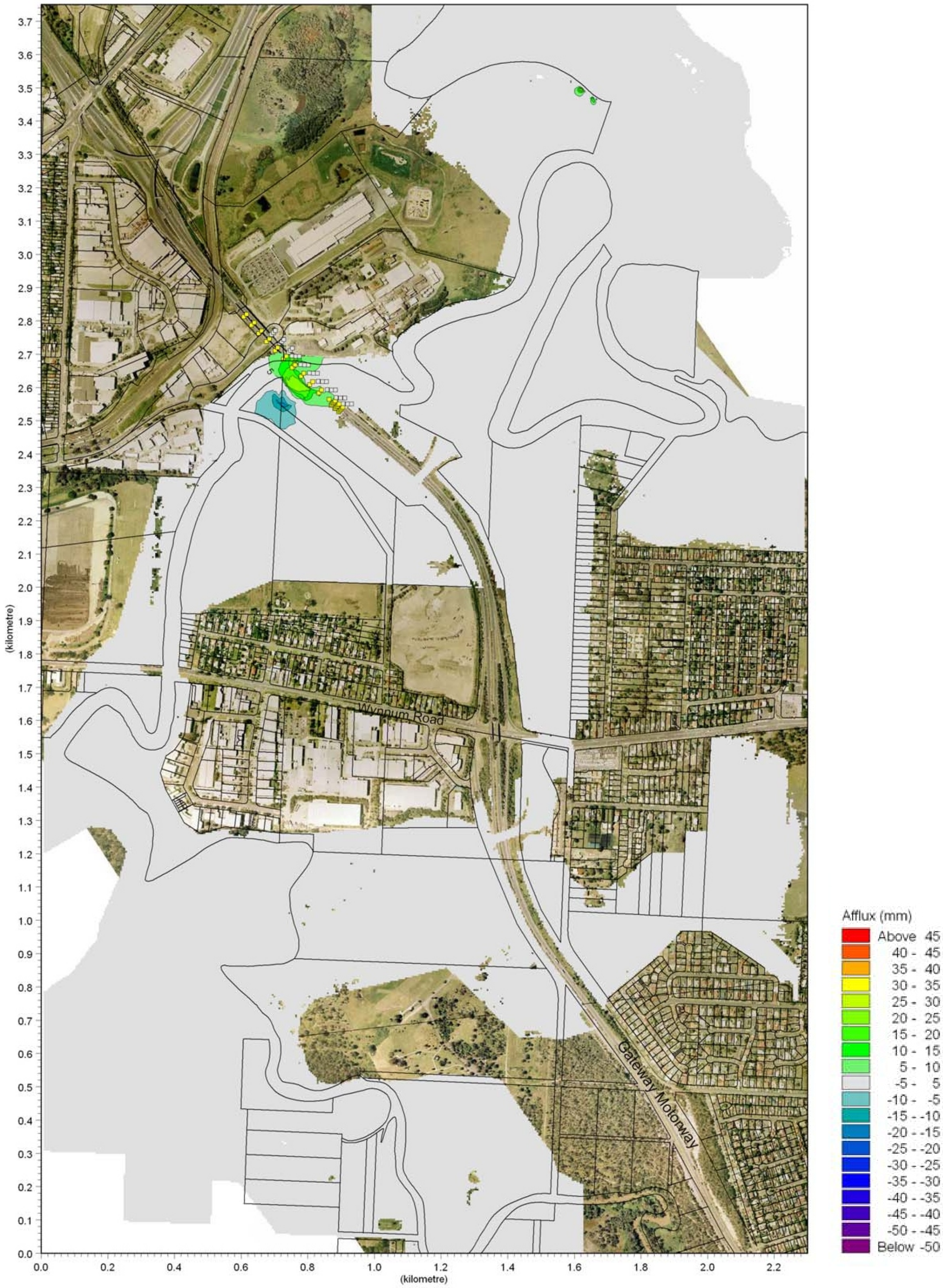

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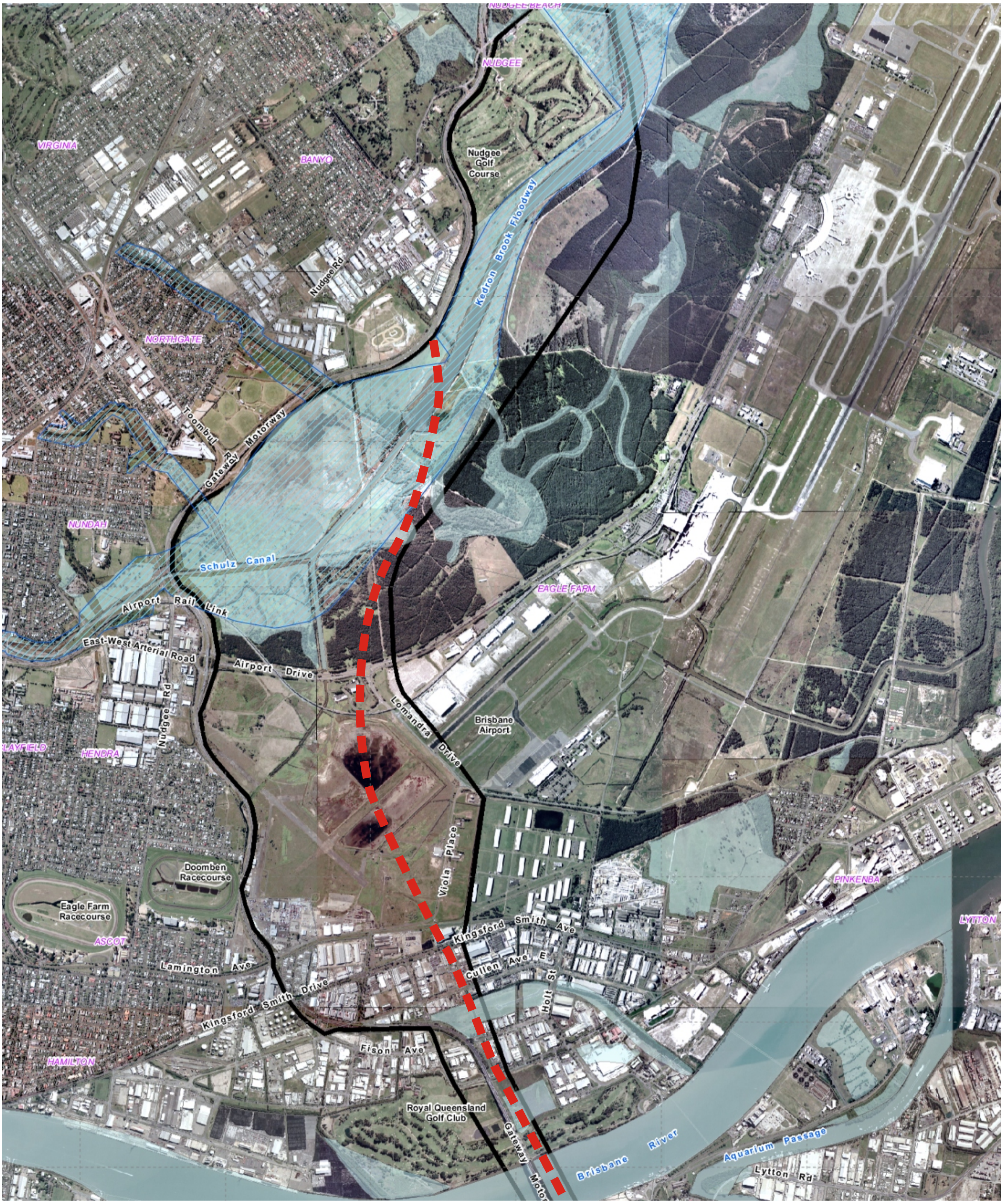
FIGURE 11.4
Bulimba Creek - Preferred Mitigation Option
MIKE 21 Model Results



Source: GHD 2003

KEY

- Waterways
- Waterway Corridor defined by FRLs
- GUP Corridor

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Figure 11.5
Kedron Brook and Surrounding Environment

The Kedron Brook Catchment Management Plan, prepared by BCC, records that 1,160 properties were inundated in 1974, and that creek flooding is an important issue in this catchment. Some of the strategies identified for the catchment in relation to flooding include:

- Continued monitoring of the FRLs;
- Maintaining flood height gauges in the catchment;
- Identification of areas where the cross sectional area of the Brook has been reduced due to siltation; and
- Restoration to the previous capacity as part of ongoing creek maintenance.

Figure 11.6 presents the Base Case results for the 100 year ARI event and the extent of the model, including the areas of no flow. Vectors showing velocities and flow direction are also presented on Figure 11.6.

11.5.2 Potential Impacts

The GUP requires the construction of a new roadway embankment through this section including minor and major cross drainage elements. The proposed drainage works involve the following:

- Provision of cross-drainage within the TCC site;
- Provision of cross-drainage within Brisbane Airport; and
- Construction of a new bridge crossing of Kedron Brook Floodway.

At this stage, allowances have been made for cross-drainage under the alignment to cater for runoff from both TCC and Brisbane Airport. The size and location of these structures have been selected to minimise potential impacts on existing drainage flowpaths. It is suggested that this provision be discussed further with both parties in the detailed design stage when layouts for both sites may be more clearly defined.

The proposed works in the Kedron Brook floodplain for the GUP consist of the construction of a new bridge crossing and the northern bifurcation ramp. These structures are above the 100 year ARI event flood levels and only the piers impact upon flood levels in the floodway. In addition, a small area of the roadway embankment encroaches into the waterway on both sides of the creek. The proposed new piers and approach embankments have been introduced into the MIKE 21 model and form the Developed Case.

The proposed pier arrangement and the 100 year ARI Developed Case results are presented in Figure 11.7. Impacts immediately upstream include an increase in peak water levels of approximately 15mm, which drops to approximately 10mm at the Battery Drain confluence. It is essential to reduce this impact as this increase in levels will propagate upstream on a number of tributaries entering the Kedron Brook Floodway. This includes Pound and Cannery Drains, where a number of properties are already at risk of flooding.

11.5.3 Mitigation Options

A series of mitigation options, have been evaluated to address the impact of the proposed crossing over Kedron Brook Floodway. The options include:

- Altered pier spacings and sizings;
- Localised adjustments to the FRLs;
- Localised earthworks downstream of the crossing; and
- Combinations of the above options.

Full details of the investigative work undertaken for each mitigation option are presented in Appendix H.

The MIKE 21 model results for the preferred mitigation option are presented in Figure 11.8. The proposed works consist of localised earthworks downstream of the bridge crossing location. The earthworks lower the ground levels in the area shown on Figure 11.8 by approximately 0.5m and allow this portion of the channel to convey flow as it previously was dry. A number of potential locations for earthworks were considered during the investigation and discounted due to potential environmental concerns.

The preferred mitigation option fully mitigates against the hydraulic impact of the proposed GUP works.

11.6 Potential Impact of Climate Change

The following documents provide information relevant to the potential impact of climate change:

- Climate Change in Queensland under Enhanced Greenhouse Conditions, Third Annual Report (1999-2000) prepared by CSIRO Atmospheric Research; and
- Walsh, KJE and Ryan, BF (2000): Tropical cyclone intensity increase near Australia as a result of climate change. Journal of Climate, Vol 13.

The potential for sea level rise is addressed by Walsh and Ryan (2000) with an increase in sea level of approximately 0.2m predicted to occur over the next 50 years. A range of 0.1m to 0.4m was identified in the CSIRO (1998-1999) report as part of discussions on storm surge analyses for Cairns.

Based on the current GUP design there is approximately 0.5m between the 100 year ARI event flood level and the bridge soffit on Kedron Brook Floodway and approximately 0.5m clearance for Bulimba Creek. An increase of approximately 0.2m – 0.4m will not bring the estimated 100 year flood levels into contact with the bridge soffit. The potential impact of possible future sea level rise should be confirmed during the detail design stage of the project.

11.7 Conclusions

The proposed GUP works have the potential to impact upon flood levels in a number of adjacent waterways. This is particularly significant for the Kedron Brook Floodway and Bulimba Creek systems where properties are already at risk of inundation under large flood events. It was therefore necessary to fully assess the potential impacts and derive achievable and practical mitigation measures to ameliorate the estimated impacts.

Detailed analysis of the waterways was undertaken through the development of 2-dimensional MIKE 21 hydraulic models of the creek systems. For this EIS the 2-dimensional MIKE 21 modelling was adopted to enable more accurate modelling of the highly complex and meandering Bulimba Creek system and the skewed bridge crossing over Kedron Brook Floodway.

The modelling undertaken determined that the proposed GUP works would increase flood levels locally without the introduction of measures to mitigate these increases in peak flood levels. A range of mitigation options have been examined at both crossing locations including:

- Altered pier shapes, sizes, skew angles and spacings;
- Localised earthworks; and
- Movement of FRLs.

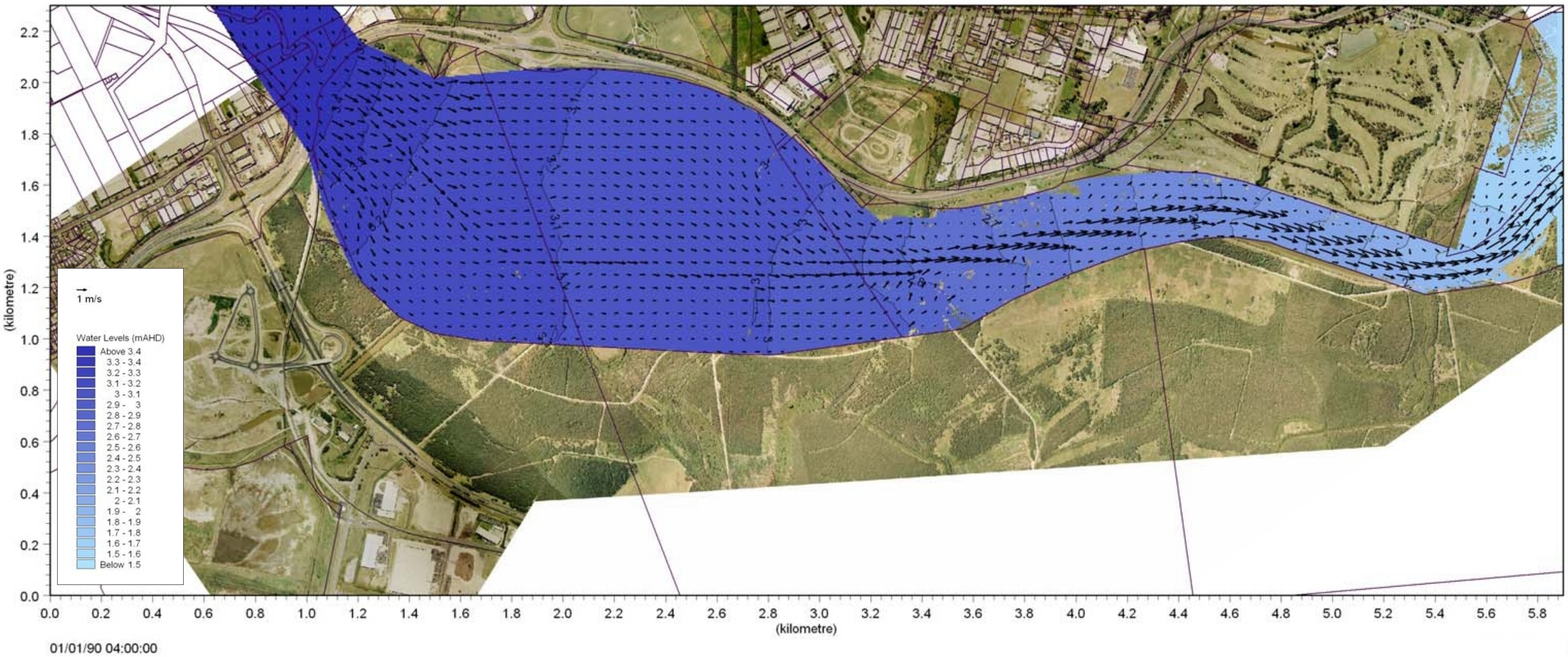

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FIGURE 11.6
Kedron Brook Base Case
MIKE 21 Model Results - 100yr ARI Event

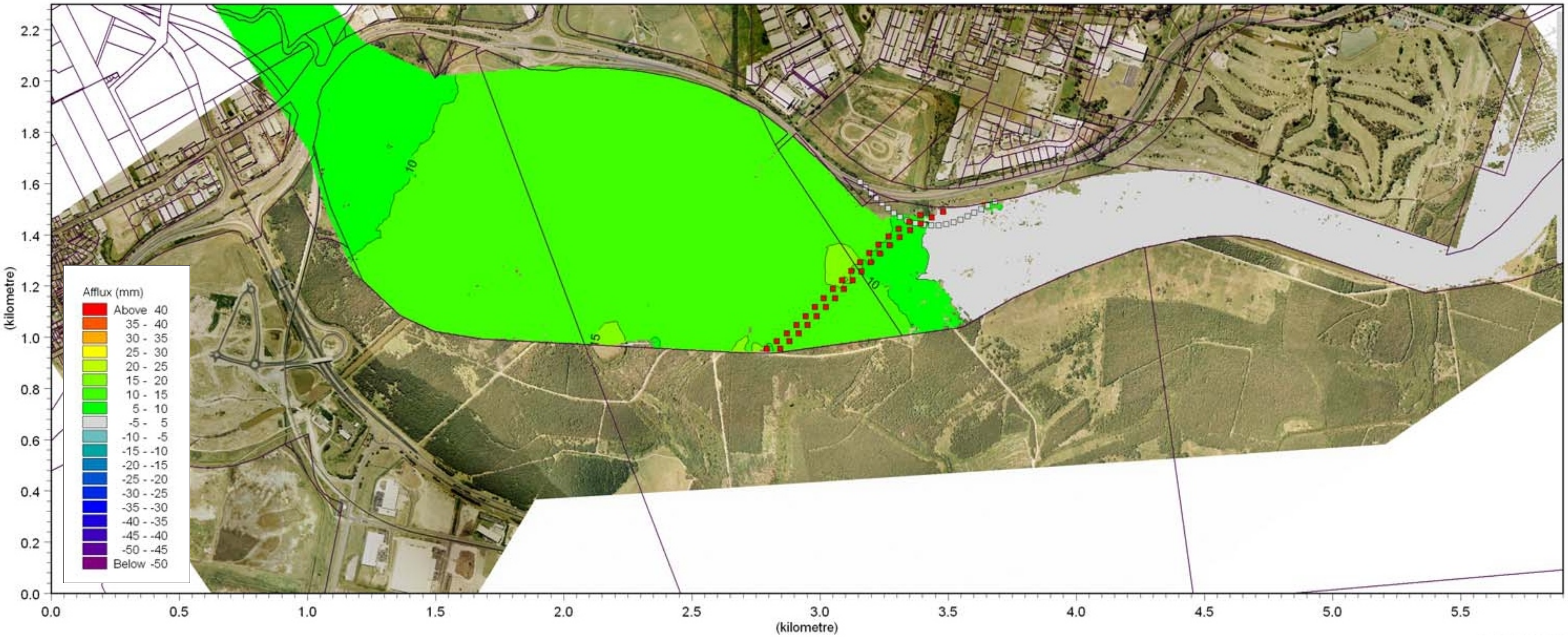

FIGURE 11.7
Kedron Brook - Impact of Proposed Works

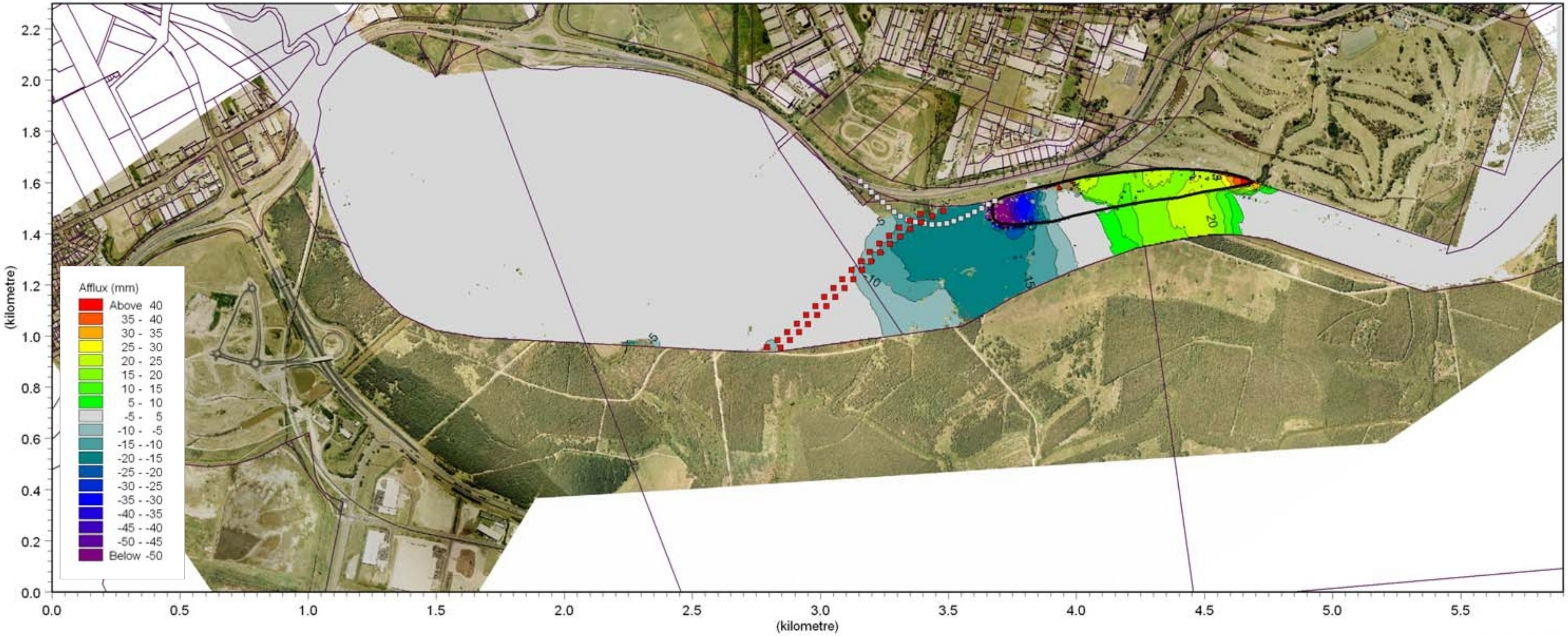

FIGURE 11.8
Kedron Brook - Preferred Mitigation Option
MIKE 21 Model Results

The preferred mitigation options on both waterways consists of localised earthworks within close proximity to the bridge crossings. On Bulimba Creek, removal of illegal fill is also required to improve the hydraulic performance of the bridge crossing. The extent of works proposed are presented in Figures 11.4 and 11.8 for Bulimba Creek and Kedron Brook Floodway, respectively.

Consideration of impacts on the MEL culverts on Bulimba Creek was also carried out with potential locations for bridge supports nominated to minimise impacts on the operation of these structures.

Taking into account the fact that the new Gateway Bridge piers will be aligned with that of the existing bridge, the new bridge crossing should not significantly impact upon flood levels or flow distribution.