Epsom Ascot Huntly Floodplain Management Study – Detailed Mitigation Assessment Summary

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Synopsis: **This report summarises the detailed assessment of the mitigation options identified to reduce and manage flooding in the Epsom, Ascot and Huntly regions of the City of Greater Bendigo**

REVISION/CHECKING HISTORY

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DISTRIBUTION

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Contents

Contents

Contents

List of Figures

List of Tables

1 Introduction

This detailed mitigation summary report is a summary of the previously issued detailed mitigation report (BMT 2019) for the Epsom-Ascot-Huntly Floodplain Management Study.

This report has been developed to simply present the findings from the flood impact and economic assessments of the 8 detailed mitigation options (Section 2). It also includes the details of the social, environmental and cultural considerations (Section 3) that will need be addressed as part of the detailed design.

For details regarding the base case modelling, existing flood conditions, the assessment of the flood damages and the list of preliminary mitigation options that were assessed, please refer to the Detailed Mitigation Report (BMT 2019).

2 Detailed Mitigation Assessment

2.1 Assessment of Mitigation Options

2.1.1 Hydraulic Assessment and Flood Impact Mapping

The effectiveness of each structural management scheme identified above has been assessed using the template model developed as part of the study. Each mitigation option has been incorporated into the hydraulic model forming a hydraulic modelling scheme. The results of each hydraulic modelling scheme were then compared to all design event results to ascertain the impact of each hydraulic modelling scheme.

The comparison involved the preparation of peak flood heights for each hydraulic modelling scheme. These were then subtracted from the existing case peak flood heights to produce a flood level difference, or flood impact, grid. The change in peak flood height was then colour contoured and mapped. The impacts maps for the modelled design events are presented for each scheme.

2.1.2 Financial Assessment

2.1.2.1 Background

The Victorian Government Department of Treasury and Finance outlines three main quantitative assessment tools that can be used to help assess and rank different options in a cost-benefit analysis; Net Present Value (NPV), Benefit-Cost Ratio (BCR) and the Internal Rate of Return (IRR).

Net Present Value

The Net Present Value (NPV) of an option equals the present value of the benefits (the sum of the discounted benefits) minus the present value of the costs. If the NPV is positive, the investment improves efficiency because it involves benefits that, overtime, more than outweigh the costs. If the NPV is negative, the proposal is inefficient (the costs outweigh the benefits).

The NPV is the Department of Treasury and Finance's preferred quantitative assessment tool when assessing options.

Benefit-Cost Ratio

The benefit-cost ratio (BCR) measure the ratio of the present value of benefits to the present value of costs. It is calculated by dividing the present value of the benefits of an option by the present value of its costs. The ratio must exceed one for the proposal to be assessed as generating a net benefit.

The Department of Treasury and Finance recommends that the BCR be reported with the NPV, but it does not recommend it as the only quantitative assessment tool for decision making purposes as it tends to result in bias towards small projects and projects with early returns.

2.1.2.3 Approach

The procedure for calculating the NPV and the BCR are outlined by the following equations (as outlined by the Department of Treasury and Finance):

$$\text{Net Present Value} = \sum_{T=0}^{T} \frac{B_t - (K_t + C_t)}{(1+d)^t}$$

$$Benefit\ Cost\ Ratio = \frac{\sum_{t=0}^{T} \frac{B_t - C_t}{(1+d)^t}}{\sum_{t=0}^{T} \frac{K_t}{(1+d)^t}}$$

Where B_t = benefits

K_t = capital cost

C_t = operating or recurrent cost

d = discount rate

t = year

A financial project life of 50 years was chosen for the Epsom Ascot Huntly Floodplain Management Plan. This does not imply that the projected structural life of the scheme is only 50 years. In fact, some measures could be effective in reducing the frequency of flooding for centuries to come. A financial project life is required in order to determine a timeframe for which the project costs and project benefits can be attributed to. The NPV and BCR have also been determined for a financial project life of 20 years to determine the sensitivity of the analysis to the project financial life.

In order to calculate the costs and benefits of the mitigation option, the relevant costs (capital costs and ongoing costs) and benefits (reduction in flood damages) are monetised and the values of the costs and benefits occurring in different time periods discounted to their present values. Discounting acknowledges the opportunity costs of investing in a particular project by determining what return the investment would have produced in an alternative use.

The Department of Treasury and Finance recommends discount rates based on three distinct categories. Category 2 relates to the provision of goods and services in traditional core service delivery areas of Government (ie: non-commercial), but those for which the benefits attributed to the project are more easily translated to monetary terms (eg: public housing, roads, and public housing). Whilst Category 1 is similar to Category 2, it is reserved for project where the benefits can be articulated but are not easily translated to monetary terms. Category 3 is used for commercial investments, and if therefore not applicable to the current assessment.

A discount rate of 7% is recommended by the Department of Treasury and Finance for Category 2 projects, whilst a discount rate of 4% is recommended for Category 1 projects. The NPV and BCR for each mitigation option have been determined using 7% as the discount rate (a discount rate also

adopted by Infrastructure Australia). The NPV and BCR were also determined using a discount rate of 4% to determine the sensitivity of the analysis to the adopted discount rate.

The discount rates adopted in this analysis are termed real discount rates. As such they can only be used in conjunction with real prices. Nominal prices (such as historical estimates of costs and benefits) need to be converted into real prices by adjusting for inflation. The Department of Treasury and Finance Technical Guide for Economic Evaluation states that *"agencies do not need to include expected inflation in their future costs and benefits"*. The benefits and costs used in the economic assessment, although based on nominal prices, have been converted to real prices by factoring the relevant numbers by the Consumer Price Index. Real prices have been used in the economic assessment.

It is important to recognise that the NPV and BCR assessment represents only the financial issues that must be considered in respect to the viability of a scheme. Other issues such as social, psychological and environmental impacts, although difficult to quantify, must be included in the complete assessment.

2.1.2.4 Example

Table 2-1 presents an example economic assessment (NPV and BCR) for three mitigation options. This example demonstrates that if the NPV was used as the decision tool, Option B or Option C would be considered the best options, however, if the BCR was used as the decision tool, Option A would be considered best option. If there was a budget constraint for the project the NPV and BCR could be used as joint decision tools, whilst Option B and Option C have the same NPV, Option B has a superior BCR.

Table 2-1 Hypothetical Mitigation Option Economic Assessment

Option	Costs	Benefits	NPV	BCR
A	$1M	$1.7M	$0.7M	1.7
B	$5M	$7M	$2M	1.4
C	$10M	$12M	$2M	1.2

2.1.3 Cost Estimates

The cost estimate is based on BMT's experience and judgement as a firm of practising engineers familiar with preliminary costings of flood mitigation options. This cost estimate cannot be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. The costings have included an allowance for engineering and design (15%), administration (9%) and project contingency (30%).

The land acquisition rates have been provided by the City of Greater Bendigo and are based on the best available information at the time. A contingency of 50% has been applied to the land acquisition costs.

The ongoing maintenance costs of the mitigation scheme are estimated to be 2% of the capital cost of the project.

2.2 Option M01

2.2.1 Description of Mitigation Option

This mitigation option (displayed in Figure 2-1) involves the removal and then reconstruction of the current levee along the eastern side of Bendigo Creek between Scott Street, White Hills and the junction with Back Creek (approximately 200 metres west of Bendigo-Tennyson Road, Huntly).

This option includes all necessary raising of road crossings and bridge decks, erosion control works and the removal of an isolated sediment embankment between Howard Street and Leans Road.

Whilst there is currently a 'levee' in place along the eastern edge of Bendigo Creek, this formation is probably better described as a spoil pile. It was formed through years of historic dredging of Bendigo Creek whereby the dredge material was removed from the creek alignment and placed on the banks of the Creek. Consequently, the 'levee' would not meet the current design standards for a levee for many reasons, including: lack of suitable material and lack of compaction. Additionally, the presence of trees (and their associated root systems) pose a risk to the structural integrity of the 'levee' and may contribute to a levee failure should a large flood event occur along Bendigo Creek.

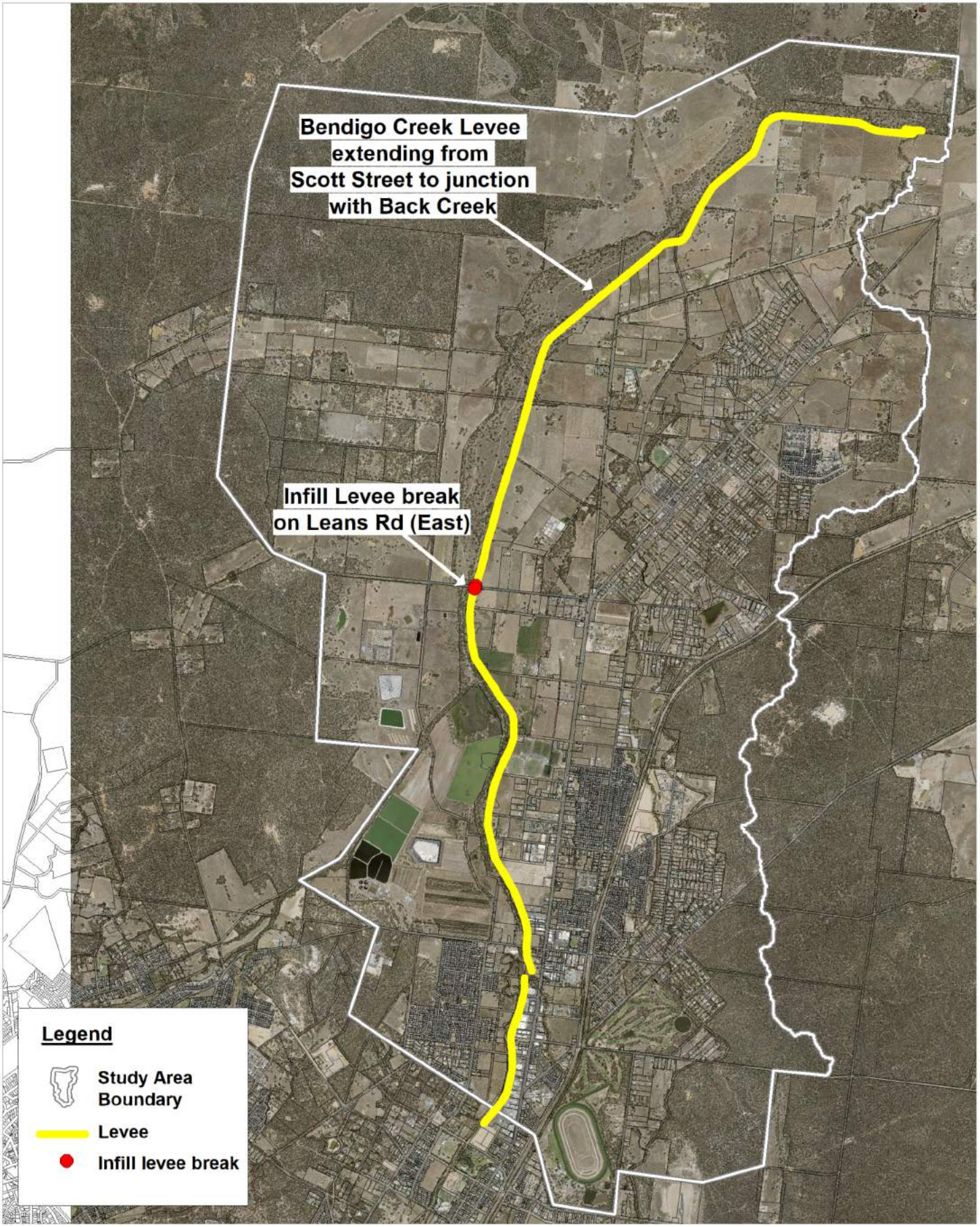
The construction of the mitigation option would be a challenging task as the current 'levee' formation is considered to be contaminated soil due the presence of various chemicals present in the dredge spoil from years of gold mining in the Bendigo region. The costing of this option has assumed that large amounts of the material in the existing 'levee' will be reused in the new levee, which is assumed to have a clay core and suitable surface treatments.

2.2.2 Flood Impact Assessment

A flood impact assessment has been undertaken to demonstrate the impact of the proposed mitigation options on flooding within the Epsom, Ascot and Huntly regions. For this particular mitigation option, the base case was modified to remove the levee, thus the impact shows the benefit of the presence of the levee (otherwise there would have been no change in the flood behaviour).

The flood level impact for the 1% AEP flood event is presented in Figure 2-2. The flood impact for the full range of modelled flood events is presented in BMT (2019).

In each of these figures the yellow colours indicate no change in the flood level (within a +/-5-millimetre range). The orange red colours indicate areas where the flood level has increased, while the green colours indicate areas where the flood level has decreased. The blue colour indicates an area that was dry and is now wet (due to the mitigation option), whilst the magenta colour indicates an area that was wet and is now dry (due to the mitigation option).



Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 1 Details

Figure: 2-1

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Approx. Scale

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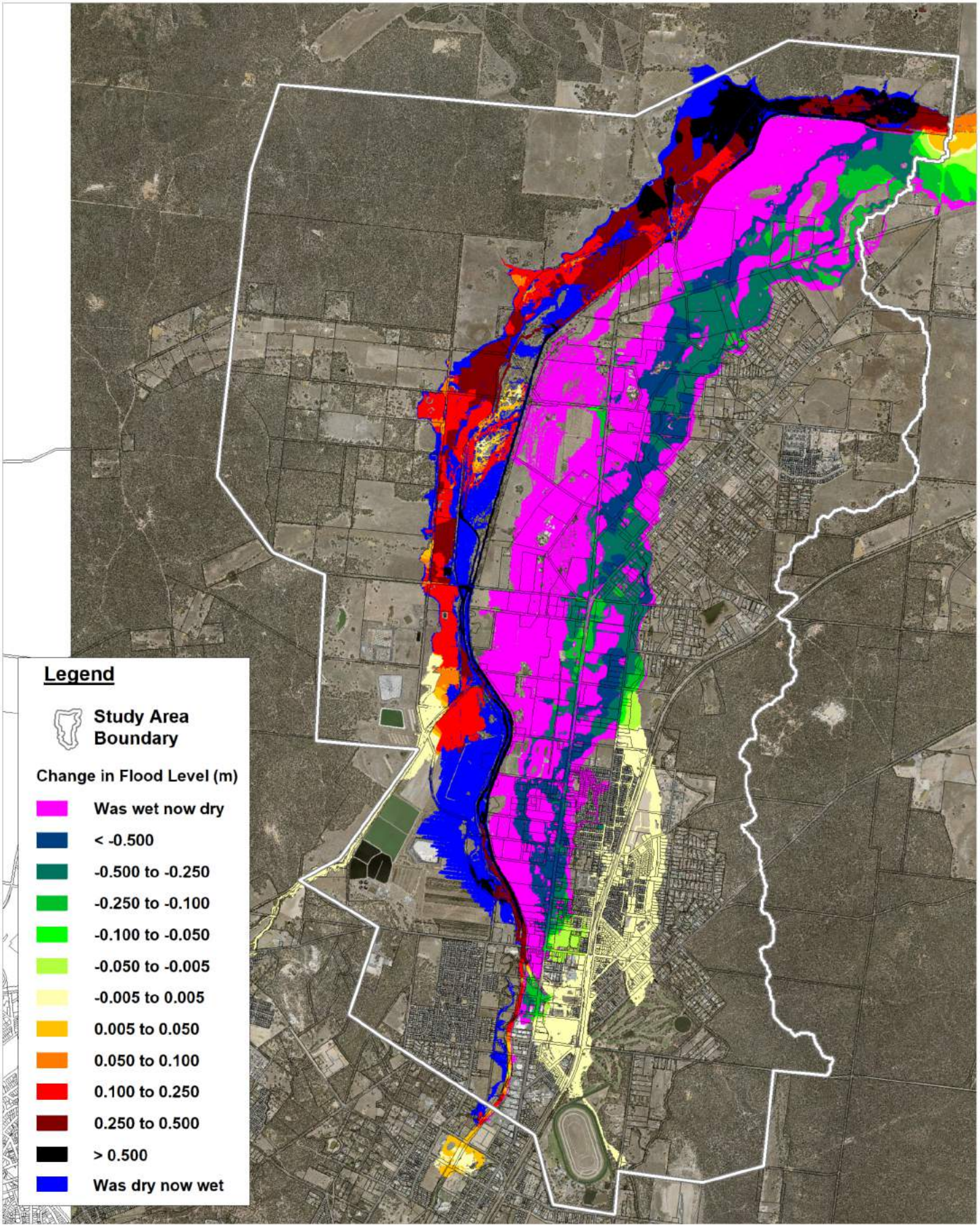

Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 1 Flood Level Impact - 1% AEP Event

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2.2.3 Option Costing

The scheme costings are presented in Table 2-2. The costings have been based on the unit rates shown in Appendix A. Where possible, these rates have been taken from Rawlinsons Australian Construction Handbook (2015), and have been updated to 2018 using the Consumer Price Index (as determined by the ATO).

As part the detailed design process, the costings in Table 2-2 may change as a result of design changes to the mitigation scheme (extent and location of works). These changes may be required because of the findings from the other supporting studies that will need to be undertaken during the detailed design phase (geotechnical investigations, environmental assessments, cultural heritage assessments, etc). The costs associated with these additional studies are not detailed in Table 2-2.

Table 2-2 M01 Cost Estimate[1]

Description	Total
Site Establishment (Site Office/Toilet Hire/Lunch Room)	$ 43,300
Traffic Management	$ 286,900
Site Preparation	$ 25,292,600
New Earthworks	$ 4,965,700
Landscaping (Native Grasses)	$ 3,568,200
Sub Total	**$ 34,156,700**
Engineering and Design (15%)	$ 5,123,505
Administration (9%)	$ 3,074,103
Capital Works Contingency (30%)	$ 10,247,010
Land Acquisition (incl. 50 % contingency)	$ 7,815,150
Total	**$ 60,416,468**

[1] This cost estimate is based on BMT's experience and judgement as a firm of practising engineers familiar with preliminary costings of flood mitigation options. This cost estimate cannot be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. The costings have included an allowance for engineering and design (15%), administration (9%) and project contingency (30%).

2.2.4 Economic Assessment

Mitigation Scheme One (M01) results in an AAD of $11,169,700, which is a reduction of $228,700 from the existing conditions AAD of $11,398,400. The cost benefit analysis for the Whole of Life costs is summarised in Table 2-3.

Table 2-3 M01 CBA Summary

Item	Existing	Scheme 1
Damages (PA)	$11,398,100	$ 11,169,700
Benefit (PA)		$ 228,700
Capital Costs		$ 52,601,318
Upfront Costs		$ 60,416,468
Maintenance (PA)		$ 1,052,026
NPV		$ (66,843,305)
BCR		-0.18

2.3 Option M01a

2.3.1 Description of Mitigation Option

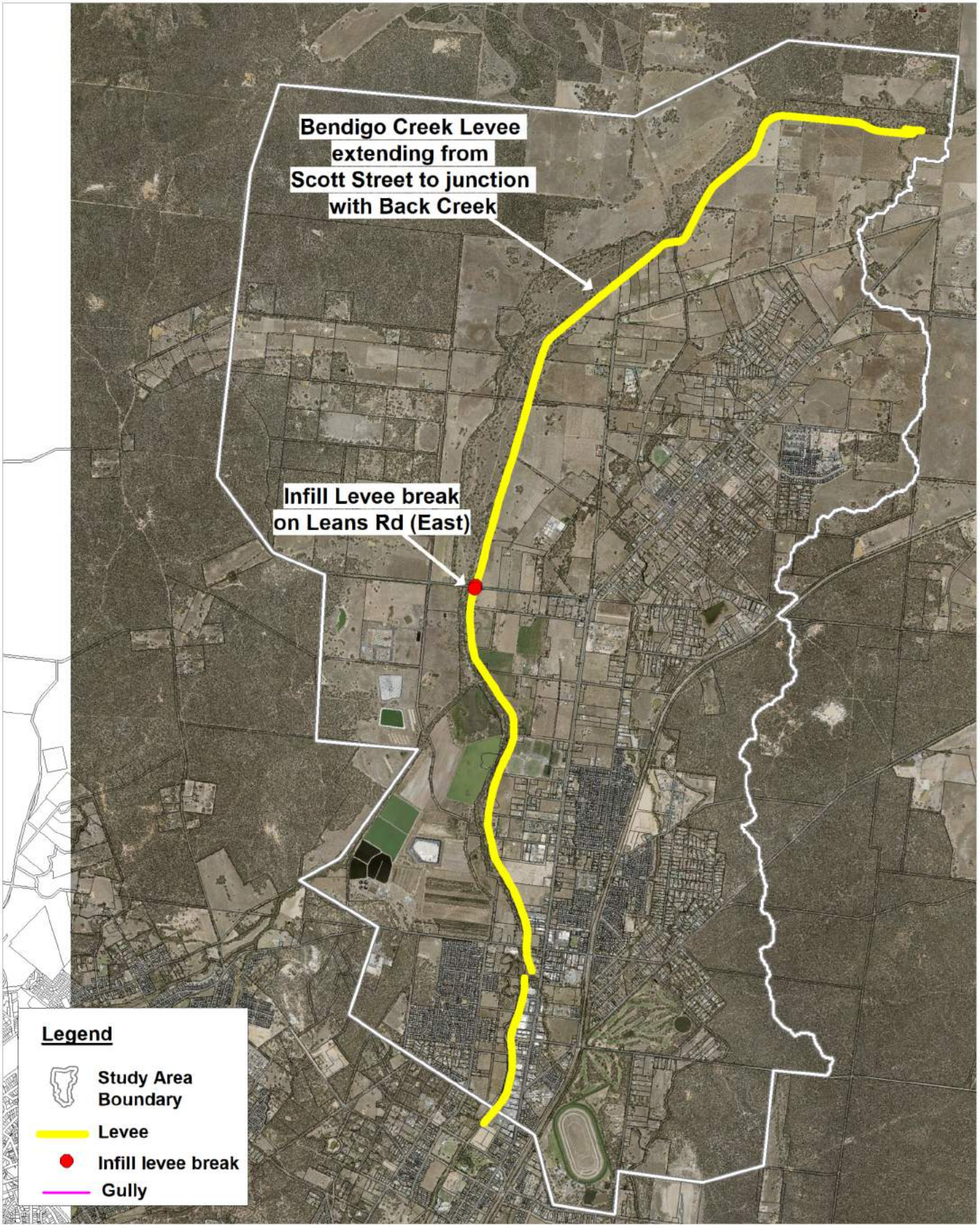
This mitigation option (displayed in Figure 2-3) is modified version of mitigation scheme 1 (Section 2.2). It was developed to determine the relative impacts of mitigation scheme 1, assuming the completion of mitigation scheme 24.

2.3.2 Flood Impact Assessment

A flood impact assessment has been undertaken to demonstrate the impact of the proposed mitigation options on flooding within the Epsom, Ascot and Huntly regions. For this particular mitigation option, the base case was modified to remove the levee, but to include the works associated with mitigation option 24.

The flood level impact for the 1% AEP flood event is presented in Figure 2-4. The flood impact for the full range of modelled flood events is presented in BMT (2019).

In each of these figures the yellow colours indicate no change in the flood level (within a +/-5-millimetre range). The orange red colours indicate areas where the flood level has increased, while the green colours indicate areas where the flood level has decreased. The blue colour indicates an area that was dry and is now wet (due to the mitigation option), whilst the magenta colour indicates an area that was wet and is now dry (due to the mitigation option).



Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 1a Details

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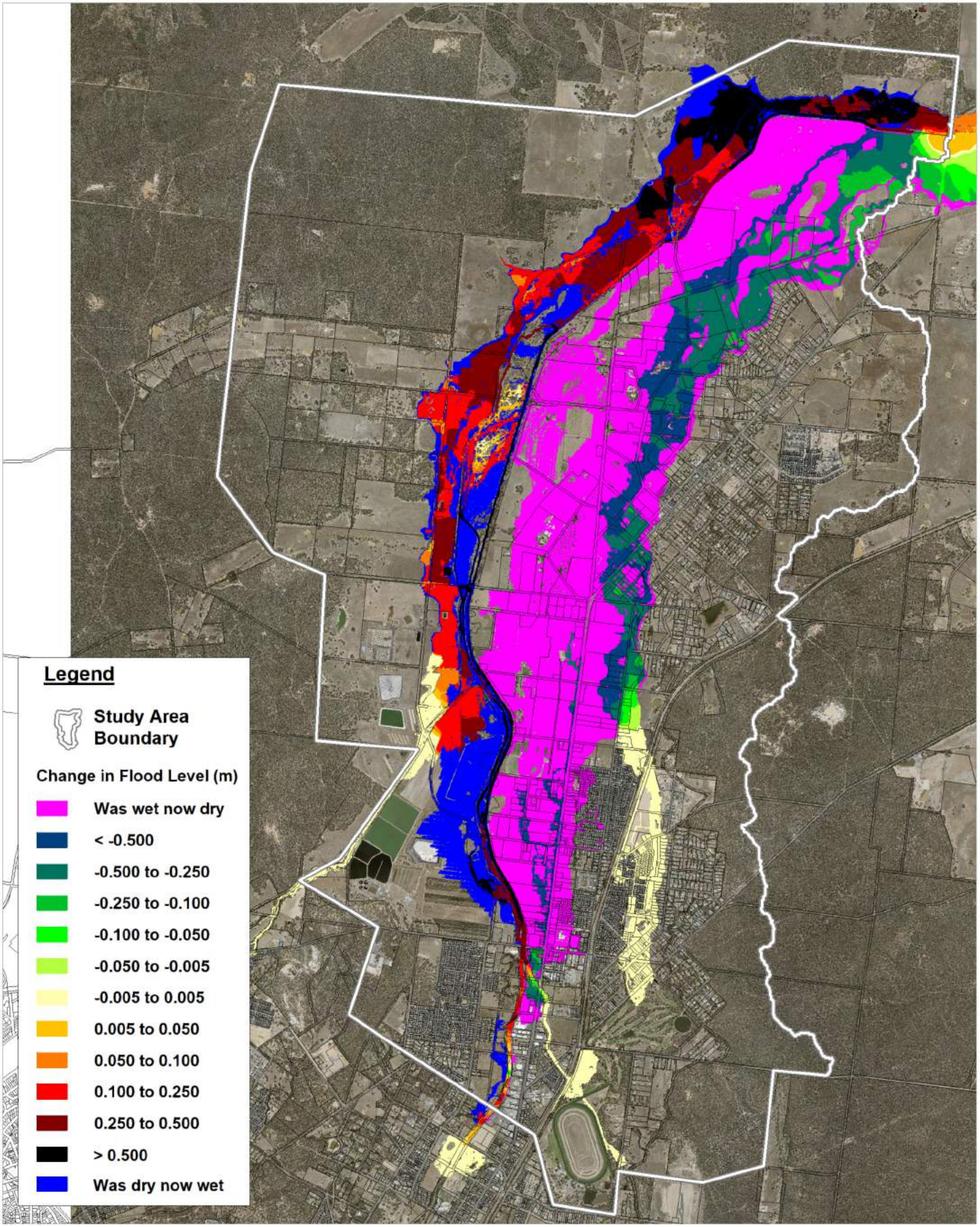

Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 1a Flood Level Impact - 1% AEP Event

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2.3.3 Option Costing

The scheme costings are presented in Table 2-4. The costings have been based on the unit rates shown in Appendix A. Where possible, these rates have been taken from Rawlinsons Australian Construction Handbook (2015), and have been updated to 2018 using the Consumer Price Index (as determined by the ATO).

As part the detailed design process, the costings in Table 2-4 may change as a result of design changes to the mitigation scheme (extent and location of works). These changes may be required because of the findings from the other supporting studies that will need to be undertaken during the detailed design phase (geotechnical investigations, environmental assessments, cultural heritage assessments, etc). The costs associated with these additional studies are not detailed in Table 2-4.

Table 2-4 M01a Cost Estimate[2]

Description	Total
Site Establishment (Site Office/Toilet Hire/Lunch Room)	$ 43,300
Traffic Management	$ 286,900
Site Preparation	$ 25,292,600
New Earthworks	$ 4,965,700
Landscaping (Native Grasses)	$ 3,568,200
Sub Total	**$ 34,156,700**
Engineering and Design (15%)	$ 5,123,505
Administration (9%)	$ 3,074,103
Capital Works Contingency (30%)	$ 10,247,010
Land Acquisition (incl. 50 % contingency)	$ 7,815,150
Total	**$ 60,416,468**

[2] This cost estimate is based on BMT's experience and judgement as a firm of practising engineers familiar with preliminary costings of flood mitigation options. This cost estimate cannot be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. The costings have included an allowance for engineering and design (15%), administration (9%) and project contingency (30%).

2.3.4 Economic Assessment

Mitigation Scheme One (a) (M01a) results in an AAD of $4,199,700, which is a reduction of $6,741,700 from the existing conditions AAD of $10,941,400. The cost benefit analysis for the Whole of Life costs is summarised in Table 2-5.

Table 2-5 M01a CBA Summary

Item	Existing	Scheme 1a
Damages (PA)	$ 10,941,400	$ 4,199,700
Benefit (PA)		$ 6,741,700
Capital Costs		$ 52,601,318
Upfront Costs		$ 60,416,468
Maintenance (PA)		$ 1,052,026
NPV		$ 23,040,956
BCR		1.41

2.4 Option M01b

2.4.1 Description of Mitigation Option

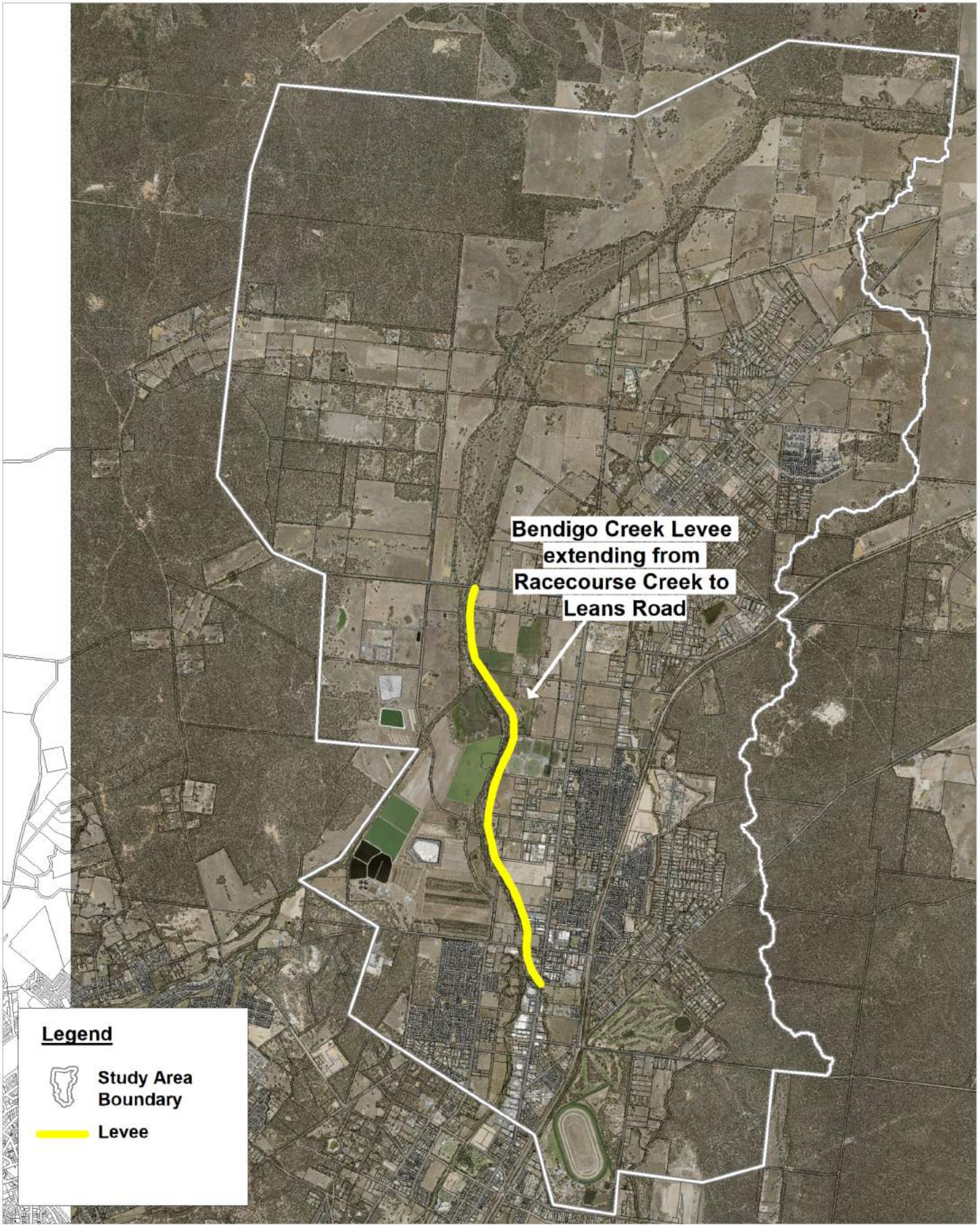
This mitigation option (displayed in Figure 2-5) is modified version of mitigation scheme 1a (Section 2.3). It was developed to determine if a shorter section of the reconstructed Bendigo levee could result in improved results from the economic assessment. The Bendigo Creek levee would only be reconstructed between Racecourse Creek and Leans Road (as opposed to the entire length of the levee). As with mitigation scheme 1(a), this scheme assumes the completion of mitigation scheme 24.

2.4.2 Flood Impact Assessment

A flood impact assessment has been undertaken to demonstrate the impact of the proposed mitigation options on flooding within the Epsom, Ascot and Huntly regions. For this particular mitigation option, the base case was modified to remove the levee, but to include the works associated with mitigation option 24.

The flood level impact for the 1% AEP flood event is presented in Figure 2-6. The flood impact for the full range of modelled flood events is presented in BMT (2019).

In each of these figures the yellow colours indicate no change in the flood level (within a +/-5-millimetre range). The orange red colours indicate areas where the flood level has increased, while the green colours indicate areas where the flood level has decreased. The blue colour indicates an area that was dry and is now wet (due to the mitigation option), whilst the magenta colour indicates an area that was wet and is now dry (due to the mitigation option).



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Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 1b Details

Figure: 2-5

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Approx. Scale

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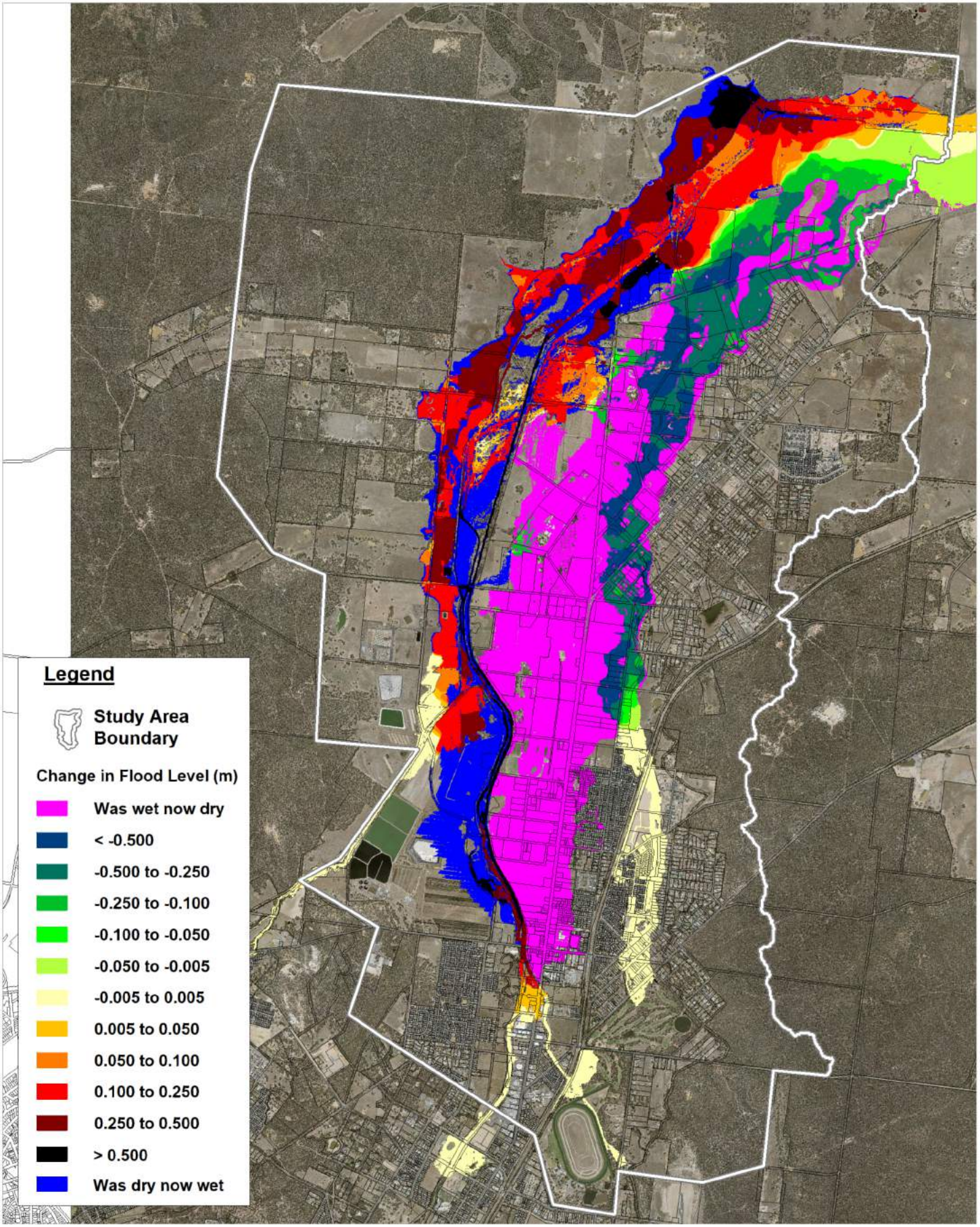

Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 1b Flood Level Impact - 1% AEP Event

Figure: 2-6

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2.4.3 Option Costing

The scheme costings are presented in Table 2-6. The costings have been based on the unit rates shown in Appendix A. Where possible, these rates have been taken from Rawlinsons Australian Construction Handbook (2015), and have been updated to 2018 using the Consumer Price Index (as determined by the ATO).

As part the detailed design process, the costings in Table 2-6 may change as a result of design changes to the mitigation scheme (extent and location of works). These changes may be required because of the findings from the other supporting studies that will need to be undertaken during the detailed design phase (geotechnical investigations, environmental assessments, cultural heritage assessments, etc). The costs associated with these additional studies are not detailed in Table 2-6.

Table 2-6 M01b Cost Estimate[3]

Description	Total
Site Establishment (Site Office/Toilet Hire/Lunch Room)	$ 32,700
Traffic Management	$ 215,200
Site Preparation	$ 5,054,500
New Earthworks	$ 3,558,700
Landscaping (Native Grasses)	$ 632,300
Sub Total	**$ 9,493,400**
Engineering and Design (15%)	$ 1,424,010
Administration (9%)	$ 854,406
Capital Works Contingency (30%)	$ 2,848,020
Land Acquisition (incl. 50 % contingency)	$ 3,701,583
Total	**$ 18,321,419**

[3] This cost estimate is based on BMT's experience and judgement as a firm of practising engineers familiar with preliminary costings of flood mitigation options. This cost estimate cannot be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. The costings have included an allowance for engineering and design (15%), administration (9%) and project contingency (30%).

2.4.4 Economic Assessment

Mitigation Scheme One (b) (M01b) results in an AAD of $4,192,800, which is a reduction of $6,748,600 from the existing conditions AAD of $10,941,400. The cost benefit analysis for the Whole of Life costs is summarised in Table 2-7.

Table 2-7 M01b CBA Summary

Item	Existing	Scheme 1b
Damages (PA)	$ 10,941,400	$ 4,192,800
Benefit (PA)		$ 6,748,600
Capital Costs		$ 14,619,836
Upfront Costs		$ 18,321,420
Maintenance (PA)		$ 292,397
NPV		$ 72,250,869
BCR		5.22

2.5 Option M01c

2.5.1 Description of Mitigation Option

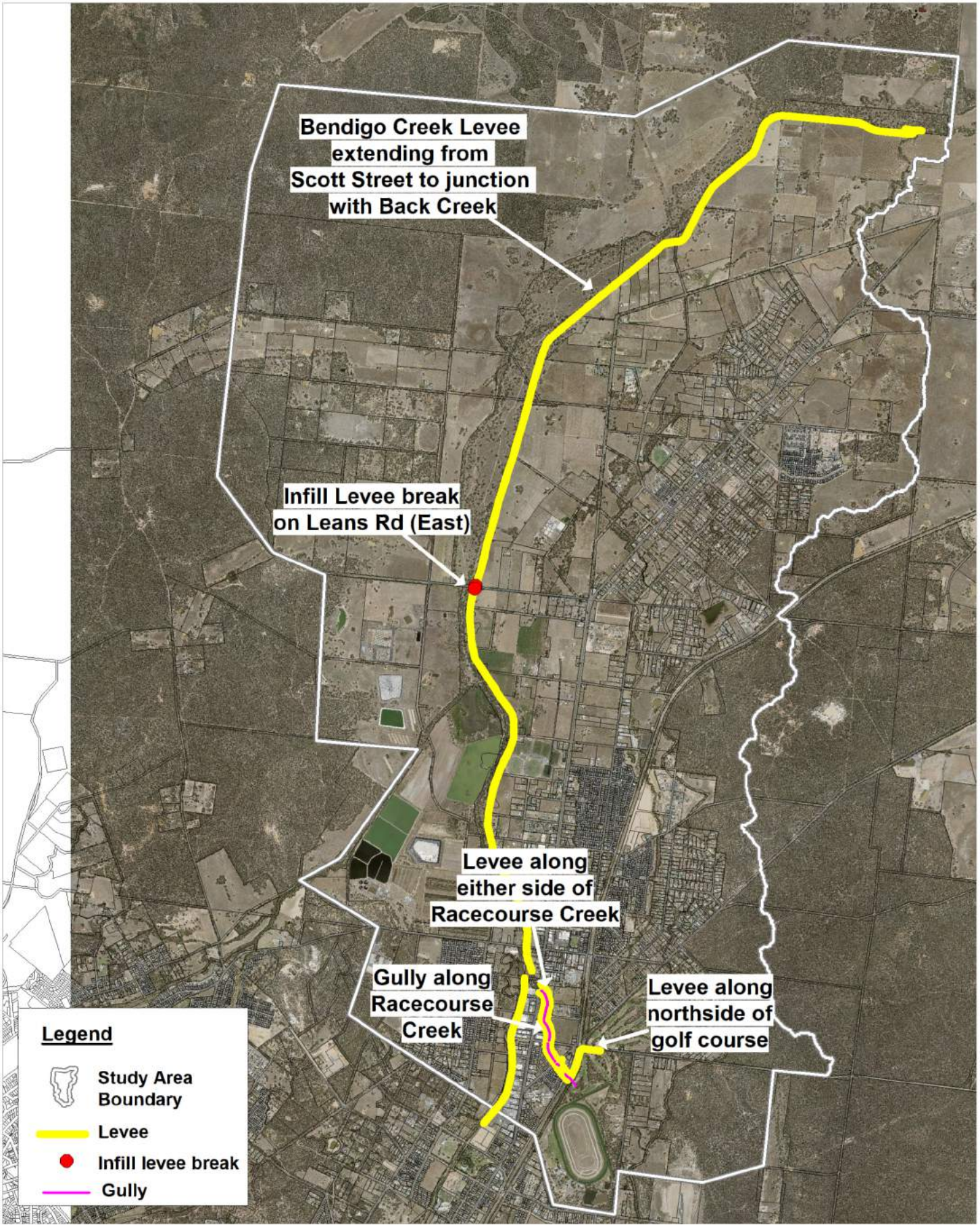
This mitigation option (displayed in Figure 2-7) is modified version of mitigation scheme 1a (Section 2.3). It was developed to determine the combined impacts of mitigation scheme 1 and mitigation scheme 24.

2.5.2 Flood Impact Assessment

A flood impact assessment has been undertaken to demonstrate the impact of the proposed mitigation options on flooding within the Epsom, Ascot and Huntly regions. For this particular mitigation option, the base case was modified to remove the levee.

The flood level impact for the 1% AEP flood event is presented in Figure 2-8. The flood impact for the full range of modelled flood events is presented in BMT (2019).

In each of these figures the yellow colours indicate no change in the flood level (within a +/-5-millimetre range). The orange red colours indicate areas where the flood level has increased, while the green colours indicate areas where the flood level has decreased. The blue colour indicates an area that was dry and is now wet (due to the mitigation option), whilst the magenta colour indicates an area that was wet and is now dry (due to the mitigation option).



Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 1c Details

Figure: 2-7

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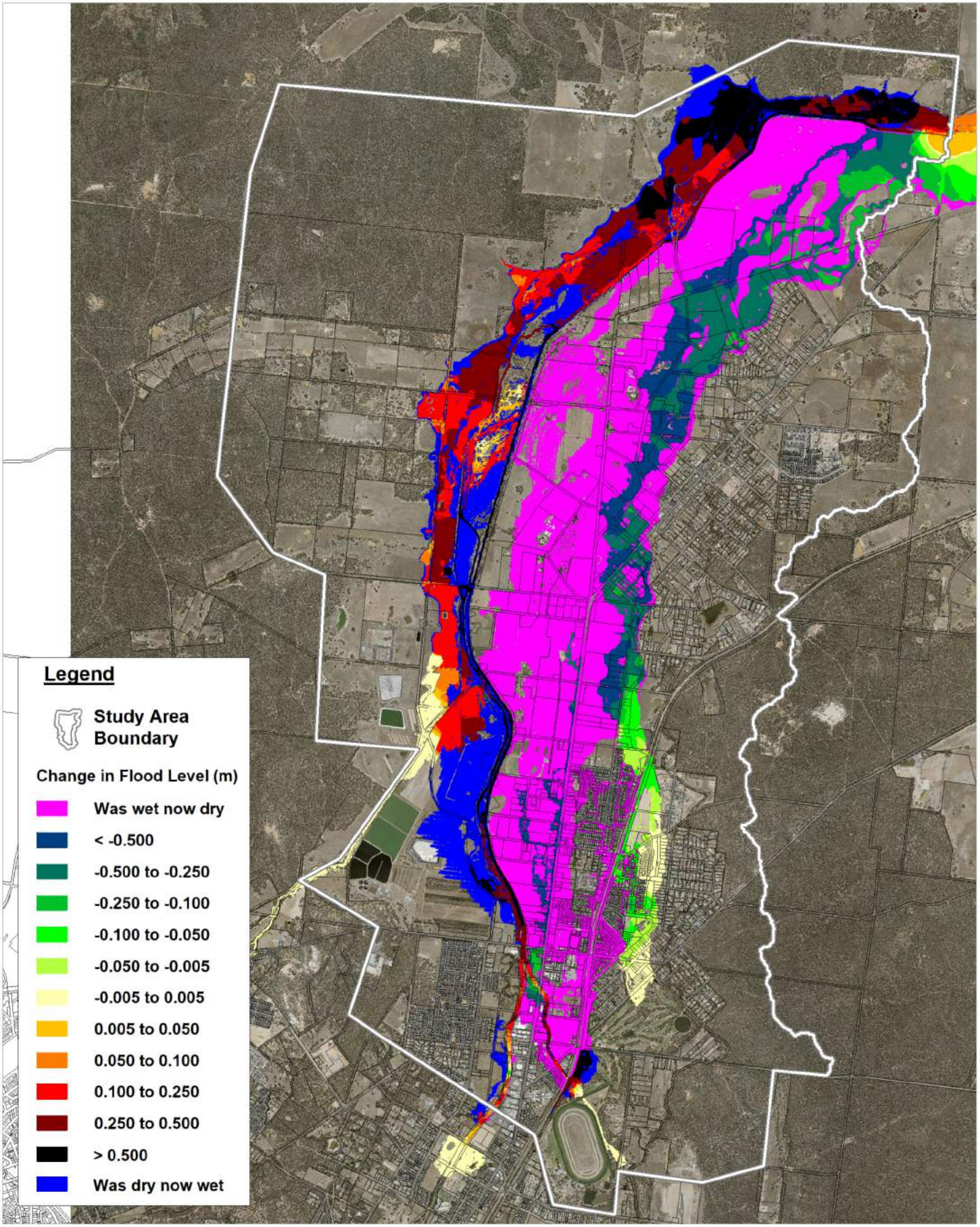

Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 1c Flood Level Impact - 1% AEP Event

Figure: 2-8

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Approx. Scale

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2.5.3 Option Costing

The scheme costings are presented in Table 2-8. The costings have been based on the unit rates shown in Appendix A. Where possible, these rates have been taken from Rawlinsons Australian Construction Handbook (2015), and have been updated to 2018 using the Consumer Price Index (as determined by the ATO).

As part the detailed design process, the costings in Table 2-8 may change as a result of design changes to the mitigation scheme (extent and location of works). These changes may be required because of the findings from the other supporting studies that will need to be undertaken during the detailed design phase (geotechnical investigations, environmental assessments, cultural heritage assessments, etc). The costs associated with these additional studies are not detailed in Table 2-8.

Table 2-8 M01c Cost Estimate[4]

Description	Total
Site Establishment (Site Office/Toilet Hire/Lunch Room)	$59,500
Traffic Management	$394,500
Site Preparation	$25,308,700
New Earthworks	$5,426,900
Landscaping (Native Grasses)	$3,577,000
Sub Total	**$ 34,766,600**
Engineering and Design (15%)	$ 5,214,990
Administration (9%)	$ 3,128,994
Capital Works Contingency (30%)	$ 10,429,980
Land Acquisition (incl. 50 % contingency)	$ 10,753,650
Total	**$ 64,294,214**

[4] This cost estimate is based on BMT's experience and judgement as a firm of practising engineers familiar with preliminary costings of flood mitigation options. This cost estimate cannot be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. The costings have included an allowance for engineering and design (15%), administration (9%) and project contingency (30%).

2.5.4 Economic Assessment

Mitigation Scheme One (c) (M01c) results in an AAD of $4,199,700, which is a reduction of $7,198,700 from the existing conditions AAD of $11,398,400. The cost benefit analysis for the Whole of Life costs is summarised in Table 2-9.

Table 2-9 M01c CBA Summary

Item	Existing	Scheme 1c
Damages (PA)	$ 11,398,400	$ 4,199,700
Benefit (PA)		$ 7,198,700
Capital Costs		$ 53,540,564
Upfront Costs		$ 64,294,214
Maintenance (PA)		$ 1,070,811
NPV		$ 25,482,145
BCR		1.42

2.6 Option M01d

2.6.1 Description of Mitigation Option

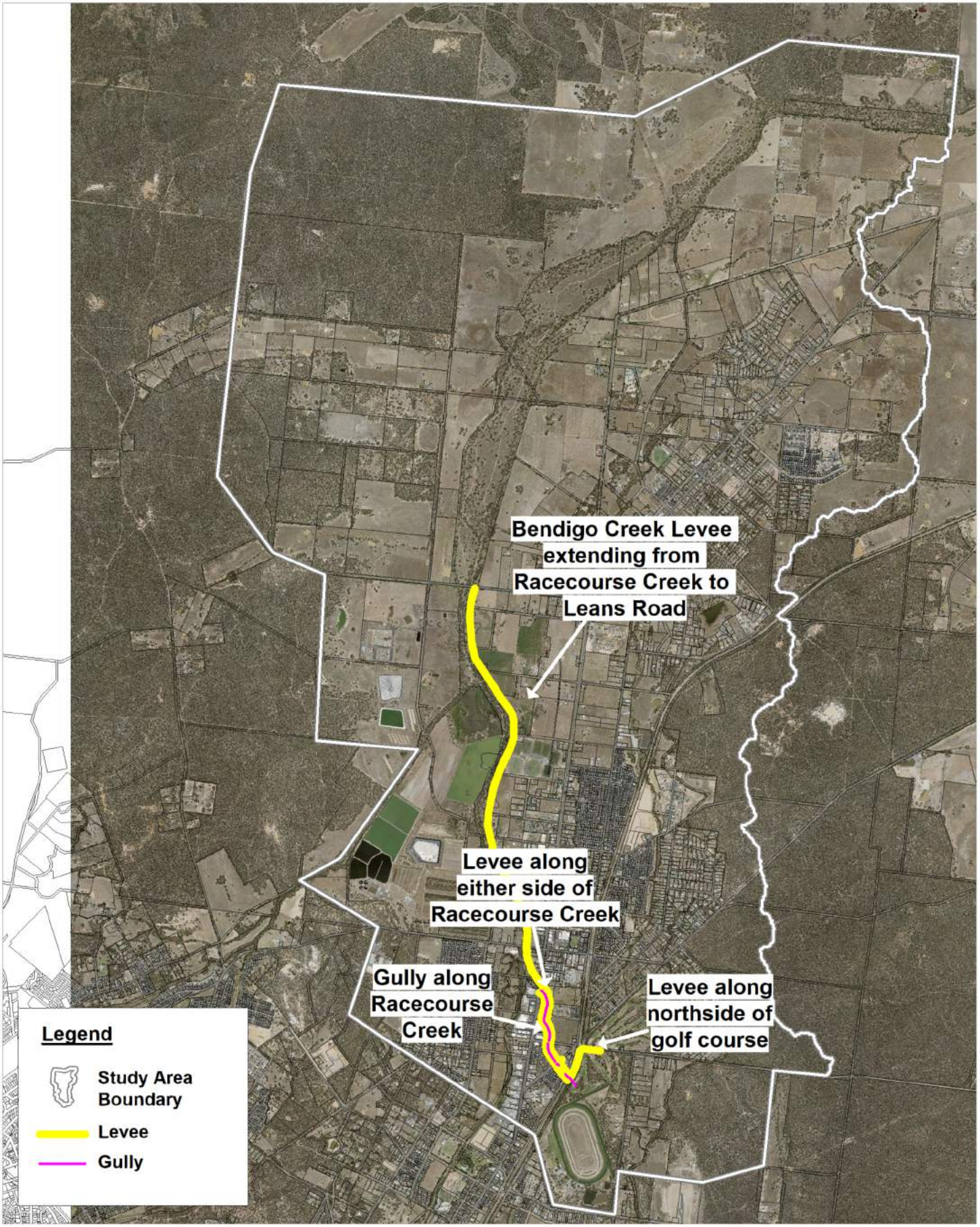
This mitigation option (displayed in Figure 2-9) is modified version of mitigation scheme 1b (Section 2.4). It was developed to determine if a shorter section of the reconstructed Bendigo levee could result in improved results from the economic assessment. The Bendigo Creek levee would only be reconstructed between Racecourse Creek and Leans Road (as opposed to the entire length of the levee). As with mitigation scheme 1(c), this scheme assumes the completion of mitigation scheme 24 as part of the overall scheme.

2.6.2 Flood Impact Assessment

A flood impact assessment has been undertaken to demonstrate the impact of the proposed mitigation options on flooding within the Epsom, Ascot and Huntly regions. For this particular mitigation option, the base case was modified to remove the levee.

The flood level impact for the 1% AEP flood event is presented in Figure 2-10. The flood impact for the full range of modelled flood events is presented in BMT (2019).

In each of these figures the yellow colours indicate no change in the flood level (within a +/-5-millimetre range). The orange red colours indicate areas where the flood level has increased, while the green colours indicate areas where the flood level has decreased. The blue colour indicates an area that was dry and is now wet (due to the mitigation option), whilst the magenta colour indicates an area that was wet and is now dry (due to the mitigation option).



Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 1d Details

Figure: 2-9

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Approx. Scale

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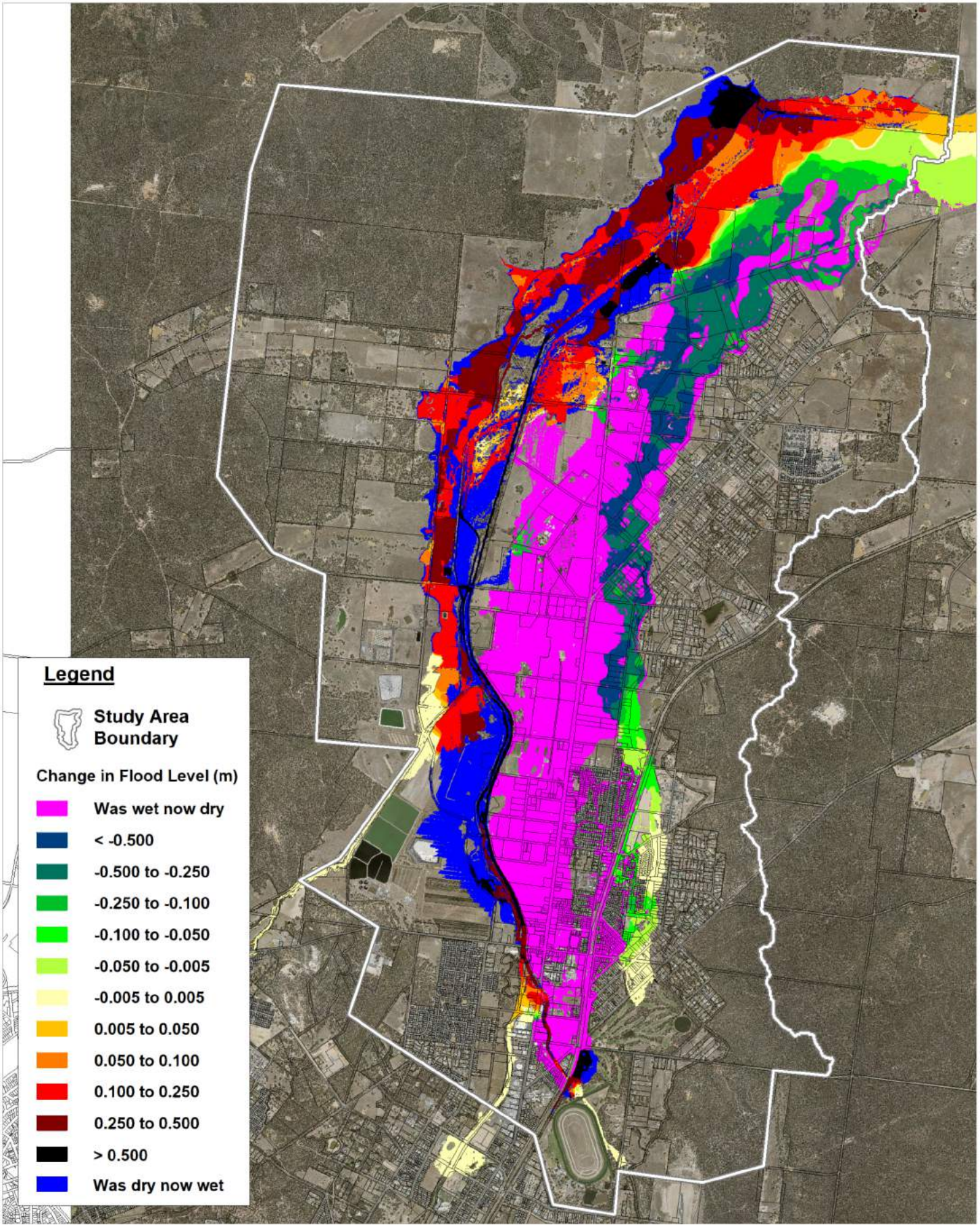

Title:

Epsom-Ascot-Huntly Floodplain Management Study
Mitigation Option 1d Flood Level Impact - 1% AEP Event

Figure: 2-10

Rev: A

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Approx. Scale

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Filepath : T:\M20754.DK.Epsom-Ascot FPMS\MapInfo\Drawings\R.M20754.006.04\EAH_Fig2-10_M01d_Dif_100y_Max_RevA.WOR

2.6.3 Option Costing

The scheme costings are presented in Table 2-10. The costings have been based on the unit rates shown in Appendix A. Where possible, these rates have been taken from Rawlinsons Australian Construction Handbook (2015), and have been updated to 2018 using the Consumer Price Index (as determined by the ATO).

As part the detailed design process, the costings in Table 2-10 may change as a result of design changes to the mitigation scheme (extent and location of works). These changes may be required because of the findings from the other supporting studies that will need to be undertaken during the detailed design phase (geotechnical investigations, environmental assessments, cultural heritage assessments, etc). The costs associated with these additional studies are not detailed in Table 2-10.

Table 2-10 M01d Cost Estimate[5]

Description	Total
Site Establishment (Site Office/Toilet Hire/Lunch Room)	$ 48,900
Traffic Management	$ 322,800
Site Preparation	$ 5,070,600
New Earthworks	$ 4,019,900
Landscaping (Native Grasses)	$ 641,100
Sub Total	**$ 10,103,300**
Engineering and Design (15%)	$ 1,515,495
Administration (9%)	$ 909,297
Capital Works Contingency (30%)	$ 3,030,990
Land Acquisition (incl. 50 % contingency)	$ 6,640,084
Total	**$ 22,199,166**

[5] This cost estimate is based on BMT's experience and judgement as a firm of practising engineers familiar with preliminary costings of flood mitigation options. This cost estimate cannot be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. The costings have included an allowance for engineering and design (15%), administration (9%) and project contingency (30%).

2.6.4 Economic Assessment

Mitigation Scheme One (d) (M01d) results in an AAD of $4,192,800, which is a reduction of $7,205,600 from the existing conditions AAD of $11,398,400. The cost benefit analysis for the Whole of Life costs is summarised in Table 2-11.

Table 2-11 M01d CBA Summary

Item	Existing	Scheme 1d
Damages (PA)	$ 11,398,400	$ 4,192,800
Benefit (PA)		$ 7,205,600
Capital Costs		$ 15,559,082
Upfront Costs		$ 22,199,166
Maintenance (PA)		$ 311,182
NPV		$ 74,692,059
BCR		4.60

2.7 Option M09

2.7.1 Description of Mitigation Option

This mitigation option (displayed in Figure 2-11) involves the construction of an infill levee at Leans Road to match the adjacent higher sections of the existing embankment. The proposed works will include changes to the approaches to Bendigo Creek and a new structure over Bendigo Creek to account for the changed height of the road in the vicinity.

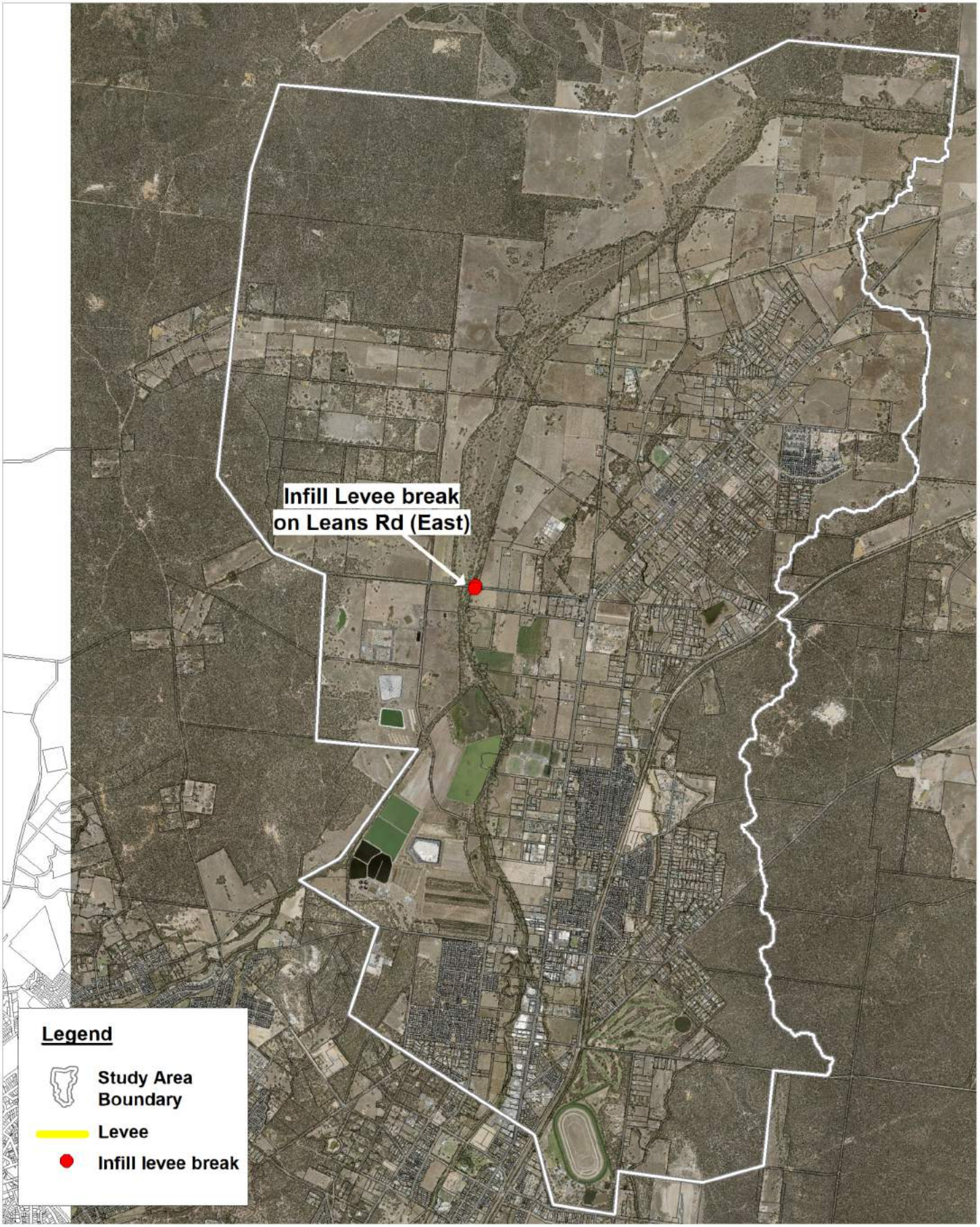
This option is aimed at prevented the flow break-out that currently occurs at Leans Road due to the lower level of the road compared to the adjacent section of embankment.

2.7.2 Flood Impact Assessment

A flood impact assessment has been undertaken to demonstrate the impact of the proposed mitigation options on flooding within the Epsom, Ascot and Huntly regions.

The flood level impact for the 1% AEP flood event is presented in Figure 2-12. The flood impact for the full range of modelled flood events is presented in BMT (2019).

In each of these figures the yellow colours indicate no change in the flood level (within a +/-5-millimetre range). The orange red colours indicate areas where the flood level has increased, while the green colours indicate areas where the flood level has decreased. The blue colour indicates an area that was dry and is now wet (due to the mitigation option), whilst the magenta colour indicates an area that was wet and is now dry (due to the mitigation option).



Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 9 Details

Figure: 2-11

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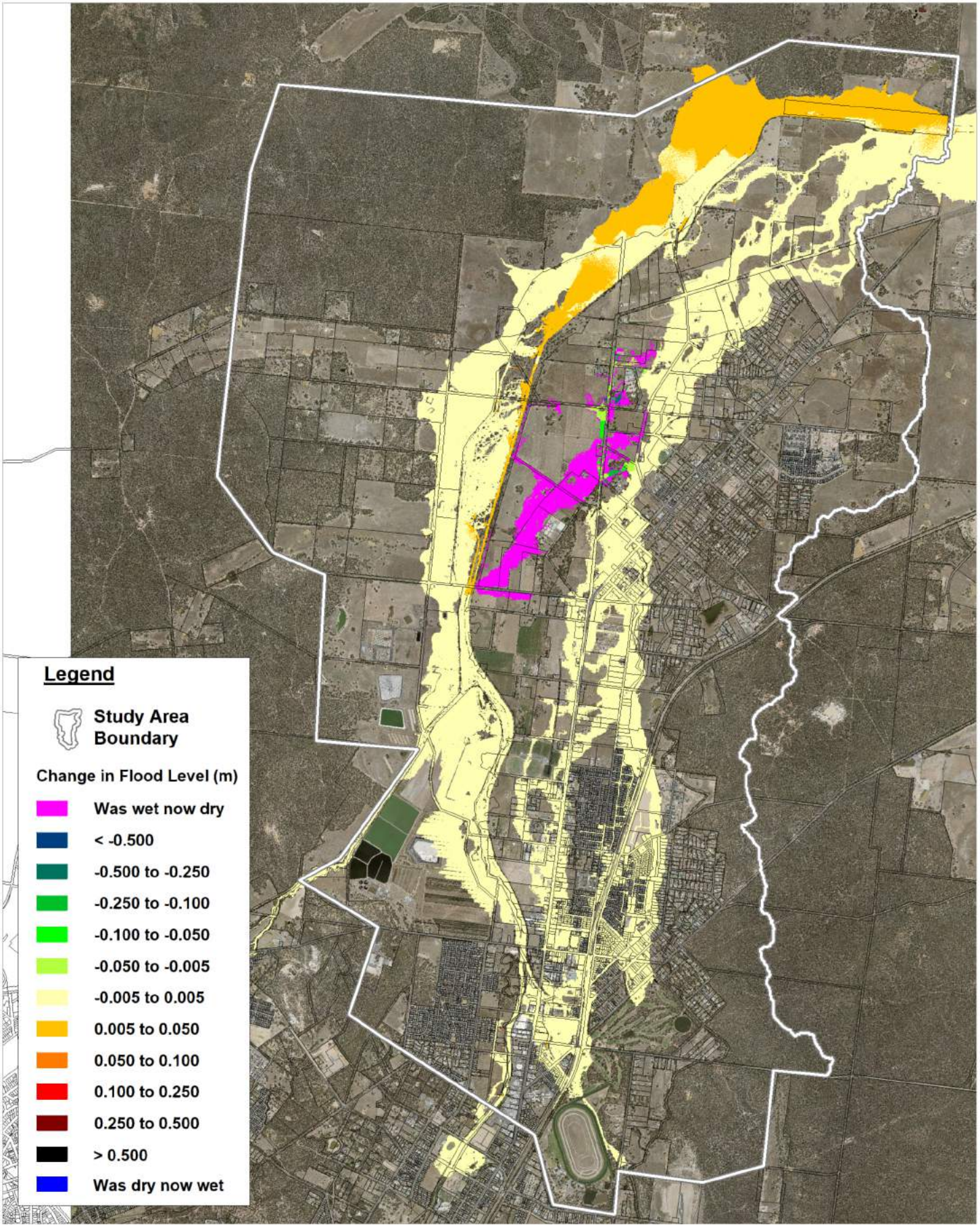

Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 9 Flood Level Impact - 1% AEP Event

Figure: 2-12

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Approx. Scale

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2.7.3 Option Costing

The scheme costings are presented in Table 2-12. The costings have been based on the unit rates shown in Appendix A. Where possible, these rates have been taken from Rawlinsons Australian Construction Handbook (2015), and have been updated to 2018 using the Consumer Price Index (as determined by the ATO).

As part the detailed design process, the costings in Table 2-12 may change as a result of design changes to the mitigation scheme (extent and location of works). These changes may be required because of the findings from the other supporting studies that will need to be undertaken during the detailed design phase (geotechnical investigations, environmental assessments, cultural heritage assessments, etc). The costs associated with these additional studies are not detailed in Table 2-12.

Table 2-12 M09 Cost Estimate[6]

Description	Total
Site Establishment (Site Office/Toilet Hire/Lunch Room)	$ 16,200
Traffic Management	$ 107,600
Site Preparation	$ 20,200
New Earthworks	$ 439,300
Landscaping (Native Grasses)	$ 7,900
Sub Total	**$ 591,200**
Engineering and Design (15%)	$ 88,680
Administration (9%)	$ 53,208
Capital Works Contingency (30%)	$ 177,360
Land Acquisition (incl. 50% contingency)	$ 600
Total	**$ 911,048**

[6] This cost estimate is based on BMT's experience and judgement as a firm of practising engineers familiar with preliminary costings of flood mitigation options. This cost estimate cannot be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. The costings have included an allowance for engineering and design (15%), administration (9%) and project contingency (30%).

2.7.4 Economic Assessment

Mitigation Scheme Nine (M09) results in an AAD of is $11,234,600, which is a decrease of $10,600 from the existing conditions AAD of $11,245,200. The cost benefit analysis for the Whole of Life costs is summarised in Table 2-13.

Table 2-13 M09 CBA Summary

Item	Existing	Scheme 9
Damages (PA)	$ 11,245,200	$ 11,234,600
Benefit (PA)		$ 10,600
Capital Cost		$ 910,448
Upfront Cost		$ 911,048
Maintenance (PA)		$ 18,209
NPV		$ (939,438)
BCR		-0.10

2.8 Option M09a

2.8.1 Description of Mitigation Option

This mitigation option (displayed in Figure 2-13) involves the widening of the existing Leans Road drainage structures and modifications to the waterway approaches.

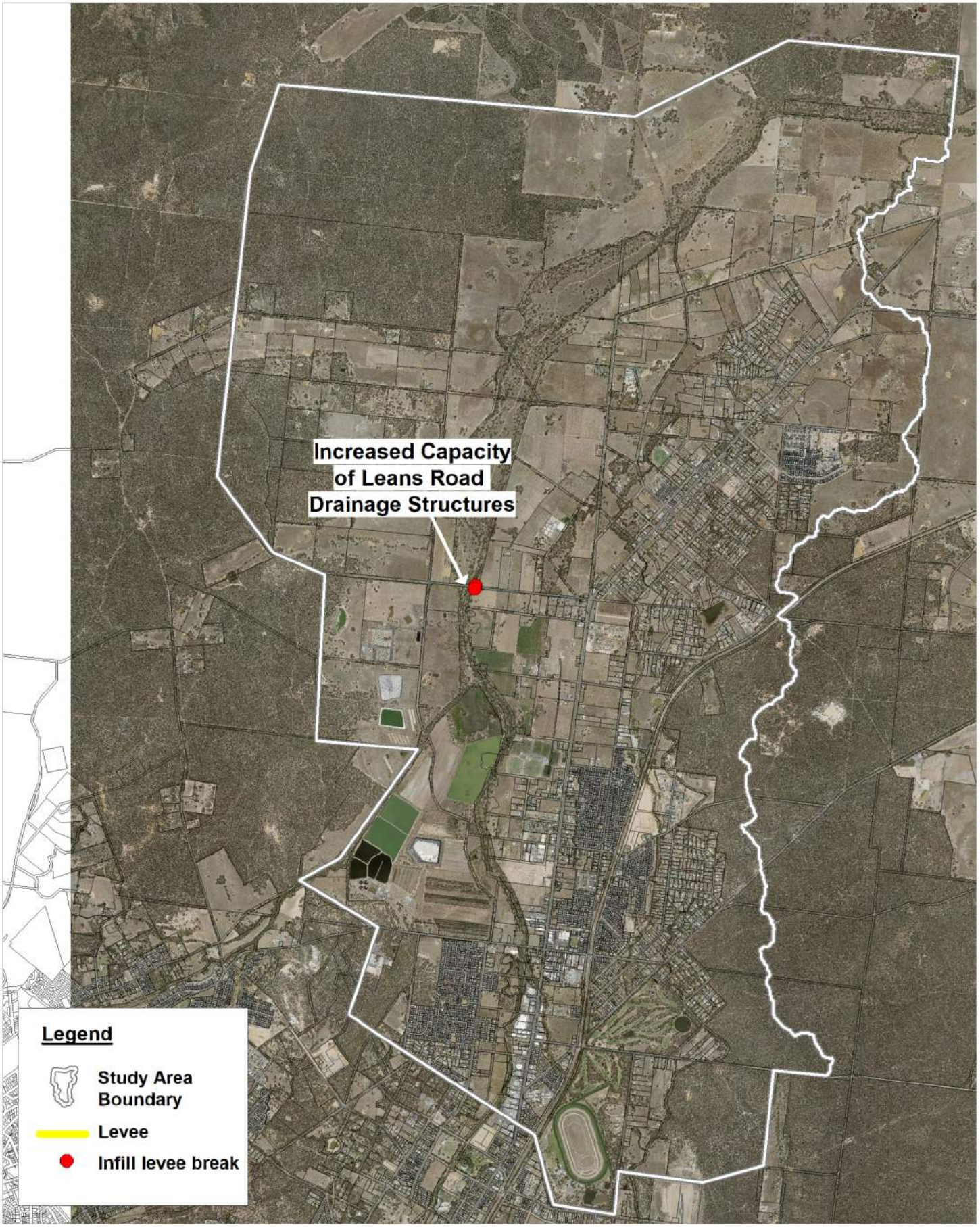
This option is aimed at preventing the flow breakout that currently occurs at Leans Road by lowering the flood level in Bendigo Creek adjacent to the breakout.

2.8.2 Flood Impact Assessment

A flood impact assessment has been undertaken to demonstrate the impact of the proposed mitigation options on flooding within the Epsom, Ascot and Huntly regions.

The flood level impact for the 1% AEP flood event is presented in Figure 2-14. The flood impact for the full range of modelled flood events is presented in BMT (2019).

In each of these figures the yellow colours indicate no change in the flood level (within a +/-5-millimetre range). The orange red colours indicate areas where the flood level has increased, while the green colours indicate areas where the flood level has decreased. The blue colour indicates an area that was dry and is now wet (due to the mitigation option), whilst the magenta colour indicates an area that was wet and is now dry (due to the mitigation option).



Title:

Epsom-Ascot-Huntly Floodplain Management Study
Mitigation Option 9a Details

Figure: 2-13

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Approx. Scale

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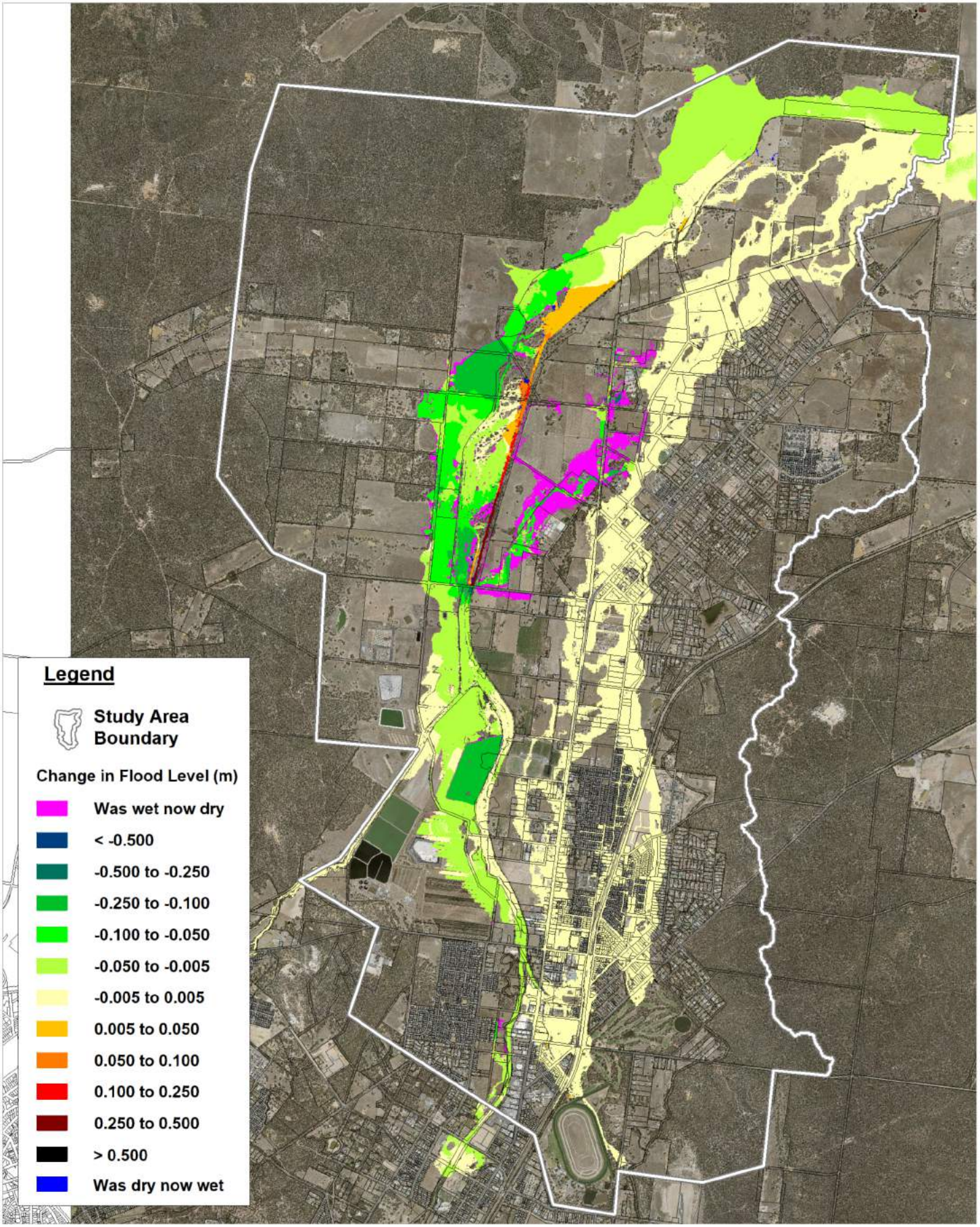

Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 9a Flood Level Impact - 1% AEP Event

Figure: 2-14

Rev: E

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Approx. Scale

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www.bmt.org

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2.8.3 Option Costing

The scheme costings are presented in Table 2-14. The costings have been based on the unit rates shown in Appendix A. Where possible, these rates have been taken from Rawlinsons Australian Construction Handbook (2015), and have been updated to 2018 using the Consumer Price Index (as determined by the ATO).

As part the detailed design process, the costings in Table 2-14 may change as a result of design changes to the mitigation scheme (extent and location of works). These changes may be required because of the findings from the other supporting studies that will need to be undertaken during the detailed design phase (geotechnical investigations, environmental assessments, cultural heritage assessments, etc). The costs associated with these additional studies are not detailed in Table 2-14.

Table 2-14 M09a Cost Estimate[7]

Description	Total
Site Establishment (Site Office/Toilet Hire/Lunch Room)	$ 16,200
Traffic Management	$ 107,600
Site Preparation	$ 42,900
New Earthworks / Bridge Structures	$ 2,378,100
Landscaping (Native Grasses)	$ 7,900
Sub Total	**$ 2,552,700**
Engineering and Design (15%)	$ 382,905
Administration (9%)	$ 229,743
Capital Works Contingency (30%)	$ 765,810
Land Acquisition (incl. 50% contingency)	$ 600
Total	**$ 3,931,758**

[7] This cost estimate is based on BMT's experience and judgement as a firm of practising engineers familiar with preliminary costings of flood mitigation options. This cost estimate cannot be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. The costings have included an allowance for engineering and design (15%), administration (9%) and project contingency (30%).

2.8.4 Economic Assessment

Mitigation Scheme Nine (a) (M09a) results in an AAD of is $11,215,100, which is a decrease of $30,100 from the existing conditions AAD of $11,245,200. The cost benefit analysis for the Whole of Life costs is summarised in Table 2-15.

Table 2-15 M09a CBA Summary

Item	Existing	Scheme 9a
Damages (PA)	$ 11,245,200	$ 11,215,100
Benefit (PA)		$ 30,100
Capital Cost		$ 3,931,158
Upfront Cost		$ 3,931,758
Maintenance (PA)		$ 78,623
NPV		$ (4,270,716)
BCR		-0.16

2.9 Option M18

2.9.1 Description of Mitigation Option

This mitigation option (shown in Figure 2-15) involved the significant vegetation removal and waterway shaping along Back Creek between Taylor Street and Ironstone Road.

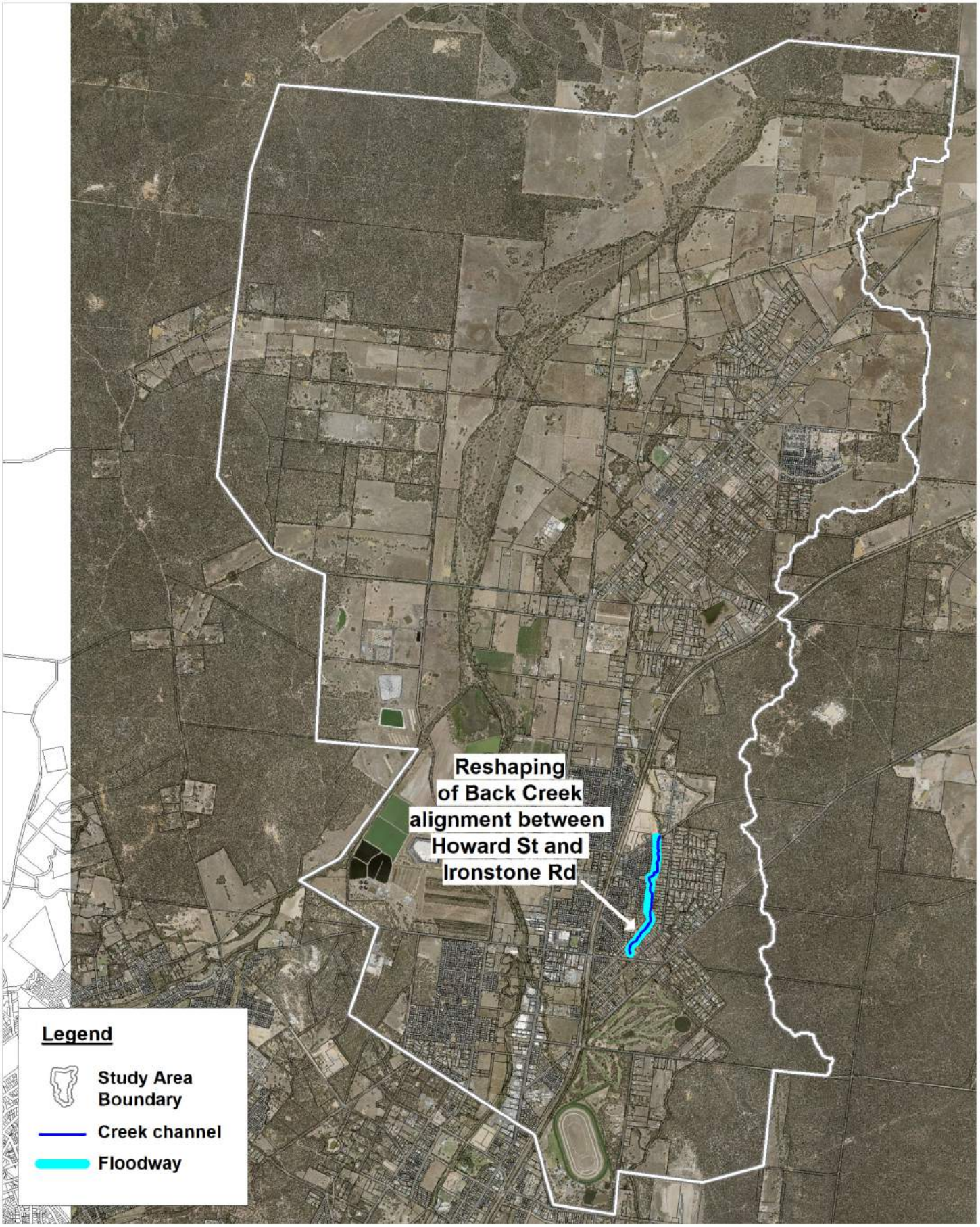
The proposed mitigation option will involve the removal of existing large vegetation, and the widening and shaping of the creek where possible to improve to improve the flow conveyance along the Back Creek system. The width of works varies along the length of the waterway depending on the available land area. This option does not change any of the existing drainage structures or roadway crossing of Back Creek between Taylor Street and Ironstone Road.

2.9.2 Flood Impact Assessment

A flood impact assessment has been undertaken to demonstrate the impact of the proposed mitigation options on flooding within the Epsom, Ascot and Huntly regions.

The flood level impact for the 1% AEP flood event is presented in Figure 2-16. The flood impact for the full range of modelled flood events is presented in BMT (2019).

In each of these figures the yellow colours indicate no change in the flood level (within a +/-5-millimetre range). The orange red colours indicate areas where the flood level has increased, while the green colours indicate areas where the flood level has decreased. The blue colour indicates an area that was dry and is now wet (due to the mitigation option), whilst the magenta colour indicates an area that was wet and is now dry (due to the mitigation option).



Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 18 Details

Figure: 2-15

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Approx. Scale

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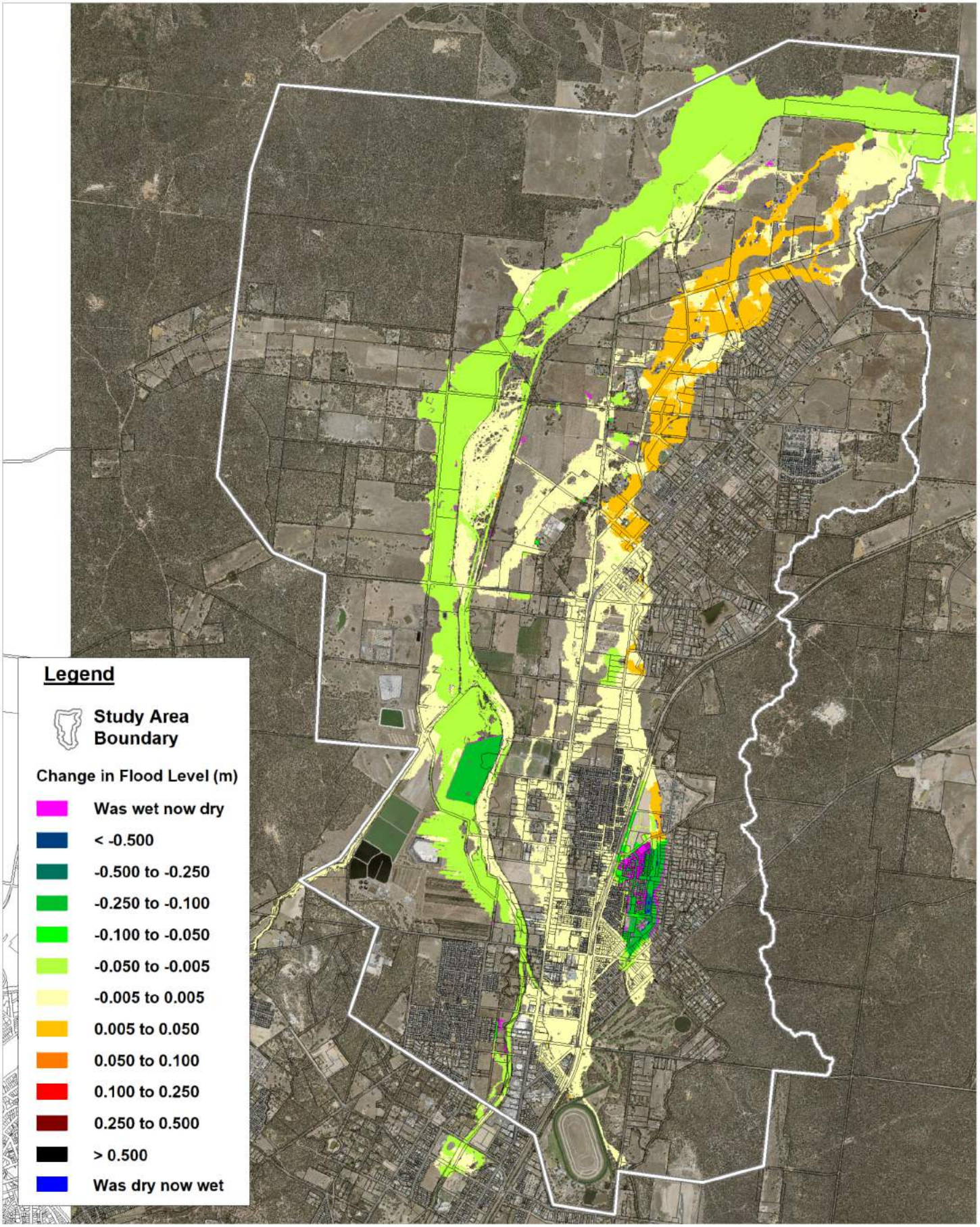

Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 18 Flood Level Impact - 1% AEP Event

Figure: 2-16

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Approx. Scale

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2.9.3 Option Costing

The scheme costings are presented in Table 2-16. The costings have been based on the unit rates shown in Appendix A. Where possible, these rates have been taken from Rawlinsons Australian Construction Handbook (2015), and have been updated to 2018 using the Consumer Price Index (as determined by the ATO).

As part the detailed design process, the costings in Table 2-16 may change as a result of design changes to the mitigation scheme (extent and location of works). These changes may be required because of the findings from the other supporting studies that will need to be undertaken during the detailed design phase (geotechnical investigations, environmental assessments, cultural heritage assessments, etc). The costs associated with these additional studies are not detailed in Table 2-16.

Table 2-16 M18 Cost Estimate[8]

Description	Total
Site Establishment (Site Office/Toilet Hire/Lunch Room)	$ 5,400
Traffic Management	$ 35,900
Site Preparation	$ 41,100
New Earthworks	$ 1,928,900
Landscaping (Native Grasses)	$ 188,900
Sub Total	**$ 2,200,200**
Engineering and Design (15%)	$ 330,030
Administration (9%)	$ 198,018
Capital Works Contingency (30%)	$ 660,060
Land Acquisition (incl. 50% contingency)	$ 708,300
Total	**$ 4,096,608**

[8] This cost estimate is based on BMT's experience and judgement as a firm of practising engineers familiar with preliminary costings of flood mitigation options. This cost estimate cannot be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. The costings have included an allowance for engineering and design (15%), administration (9%) and project contingency (30%).

2.9.4 Economic Assessment

Mitigation Scheme Eighteen (M18) results in an AAD of $10,576,500, which is a reduction of $668,700 from the existing conditions AAD of $11,245,200. The cost benefit analysis for the Whole of Life costs is summarised in Table 2-17.

Table 2-17 M18 BCR Summary

Item	Existing	Scheme 18
Damages (PA)	$ 11,245,200	$ 10,576,500
Benefit (PA)		$ 668,700
Capital Cost		$ 3,388,308
Upfront Cost		$ 4,096,608
Maintenance (PA)		$ 67,766
NPV		$ 4,528,063
BCR		2.18

2.10 Option M19

2.10.1 Description of Mitigation Option

This mitigation option (shown in Figure 2-17) involved the construction of a levee along the eastern side of Back Creek, running between Strickland Street and Taylor Street and extending north along Taylor Street towards Howard Street.

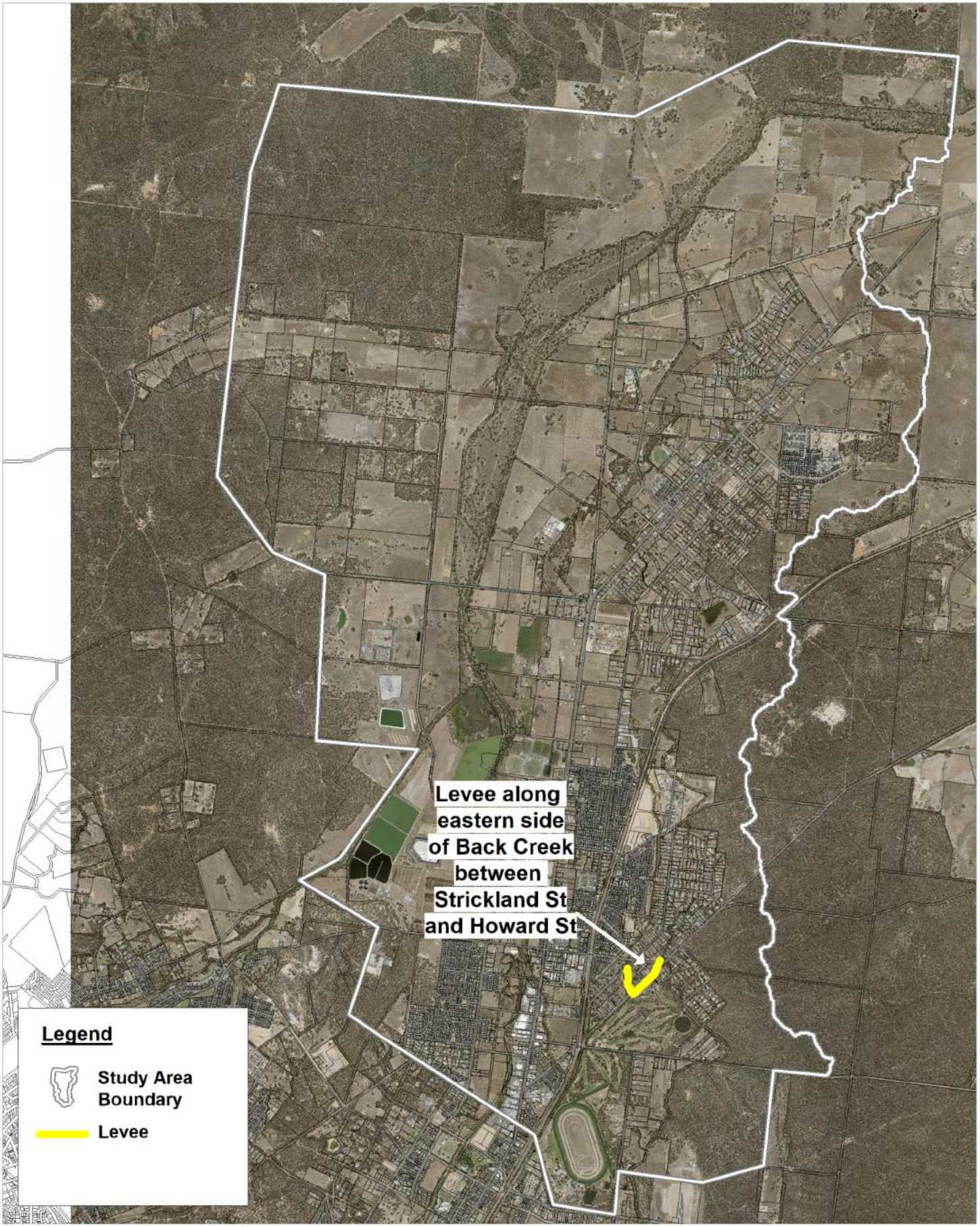
The intent of this mitigation option is the reduce the flood risk for a number of properties in the vicinity of Taylor Street, Strickland Street and Howard Street, downstream of the golf course.

2.10.2 Flood Impact Assessment

A flood impact assessment has been undertaken to demonstrate the impact of the proposed mitigation options on flooding within the Epsom, Ascot and Huntly regions.

The flood level impact for the 1% AEP flood event is presented in Figure 2-18. The flood impact for the full range of modelled flood events is presented in BMT (2019).

In each of these figures the yellow colours indicate no change in the flood level (within a +/-5-millimetre range). The orange red colours indicate areas where the flood level has increased, while the green colours indicate areas where the flood level has decreased. The blue colour indicates an area that was dry and is now wet (due to the mitigation option), whilst the magenta colour indicates an area that was wet and is now dry (due to the mitigation option).



Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 19 Details

Figure: 2-17

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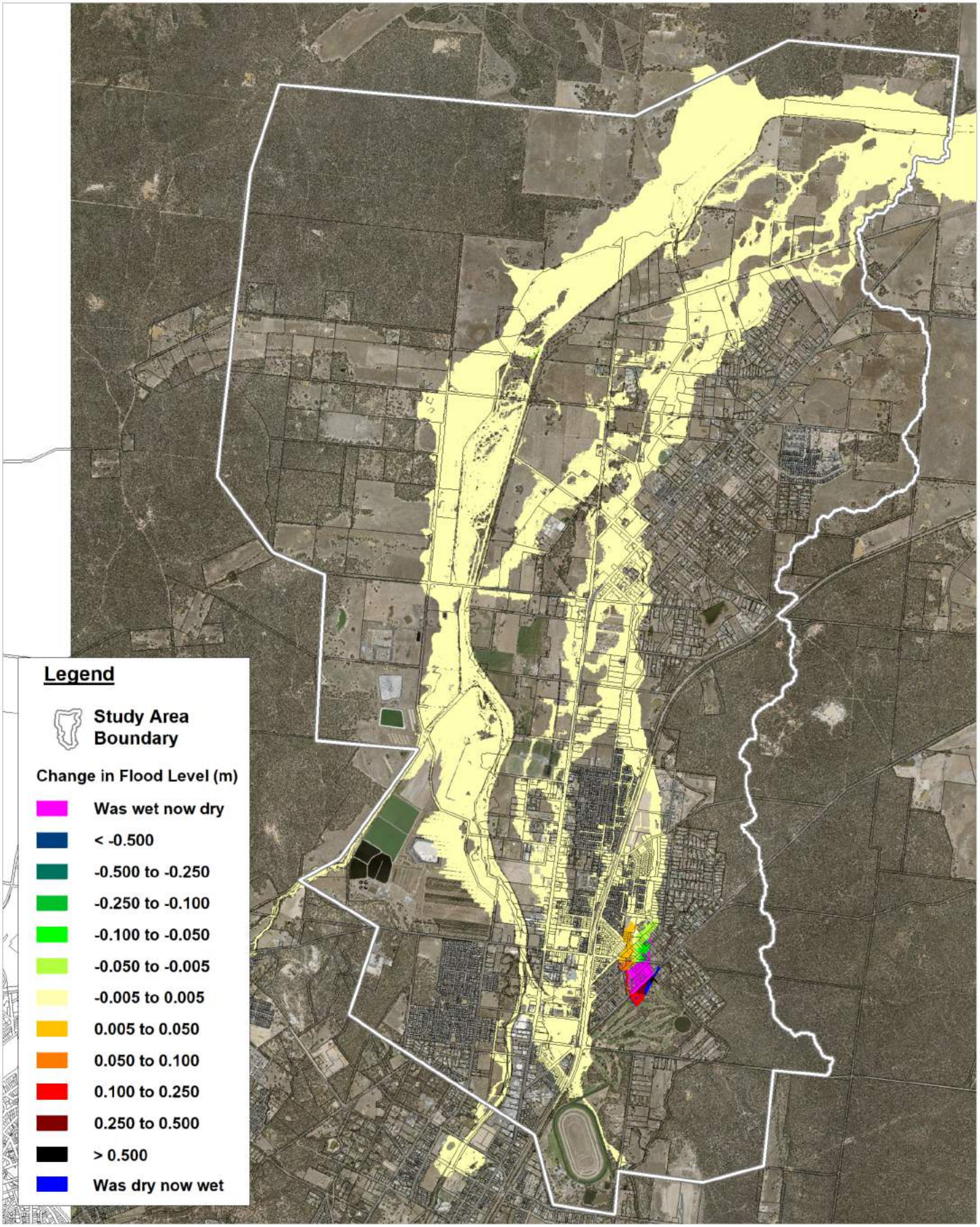

Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 19 Flood Level Impact - 1% AEP Event

Figure: 2-18

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Approx. Scale

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2.10.3 Option Costing

The scheme costings are presented in Table 2-18. The costings have been based on the unit rates shown in Appendix A. Where possible, these rates have been taken from Rawlinsons Australian Construction Handbook (2015), and have been updated to 2018 using the Consumer Price Index (as determined by the ATO).

As part the detailed design process, the costings in Table 2-18 may change as a result of design changes to the mitigation scheme (extent and location of works). These changes may be required because of the findings from the other supporting studies that will need to be undertaken during the detailed design phase (geotechnical investigations, environmental assessments, cultural heritage assessments, etc). The costs associated with these additional studies are not detailed in Table 2-18.

Table 2-18 M19 Cost Estimate[9]

Description	Total
Site Establishment (Site Office/Toilet Hire/Lunch Room)	$ 5,400
Traffic Management	$ 35,900
Site Preparation	$ 5,700
New Earthworks	$ 179,900
Landscaping (Native Grasses)	$ 5,200
Sub Total	**$ 232,100**
Engineering and Design (15%)	$ 34,815
Administration (9%)	$ 20,889
Capital Works Contingency (30%)	$ 69,630
Land Acquisition (incl. 50% contingency)	$ 554,250
Total	**$ 911,684**

[9] This cost estimate is based on BMT's experience and judgement as a firm of practising engineers familiar with preliminary costings of flood mitigation options. This cost estimate cannot be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. The costings have included an allowance for engineering and design (15%), administration (9%) and project contingency (30%).

2.10.4 Economic Assessment

Mitigation Scheme Nineteen (M19) results in an AAD of $11,203,900, which is a reduction of $41,300 from the existing conditions AAD of $11,245,200. The cost benefit analysis for the Whole of Life costs is summarised in Table 2-19.

Table 2-19 M19 CBA Summary

Item	Existing	Scheme 19
Damages (PA)	$ 11,245,200	$ 11,203,900
Benefit (PA)		$ 41,300
Capital Cost		$ 357,434
Upfront Cost		$ 911,684
Maintenance (PA)		$ 7,149
NPV		$ (374,046)
BCR		0.56

2.11 Option M24

2.11.1 Description of Mitigation Option

This mitigation option (shown in Figure 2-19) involved the construction of a pair of levees along both banks of Racecourse Creek between the railway line and Bendigo Creek, along with an additional levee extending eastwards from the railway line along Golf-Course Road.

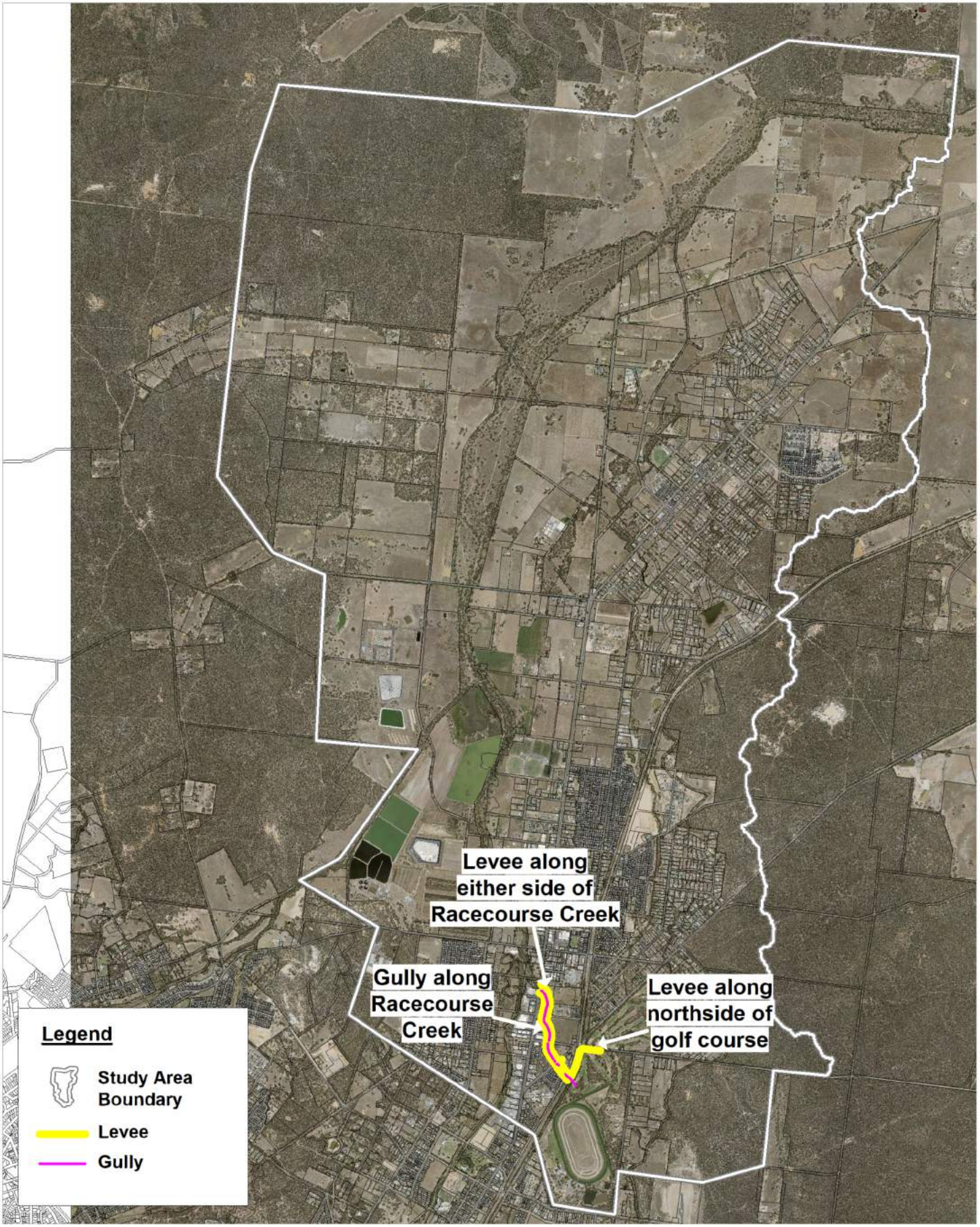
The intention of this mitigation option is to prevent floodwaters from breaking out of Racecourse Creek and flooding properties to the north. These levees help to direct the floodwaters that would have normally broken away from Racecourse Creek being directed into Bendigo Creek. This option does not include any changes to existing levees along Bendigo Creek.

2.11.2 Flood Impact Assessment

A flood impact assessment has been undertaken to demonstrate the impact of the proposed mitigation options on flooding within the Epsom, Ascot and Huntly regions.

The flood level impact for the 1% AEP flood event is presented in Figure 2-20. The flood impact for the full range of modelled flood events is presented in BMT (2019).

In each of these figures the yellow colours indicate no change in the flood level (within a +/-5-millimetre range). The orange red colours indicate areas where the flood level has increased, while the green colours indicate areas where the flood level has decreased. The blue colour indicates an area that was dry and is now wet (due to the mitigation option), whilst the magenta colour indicates an area that was wet and is now dry (due to the mitigation option).



Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 24 Details

Figure: 2-19

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Approx. Scale

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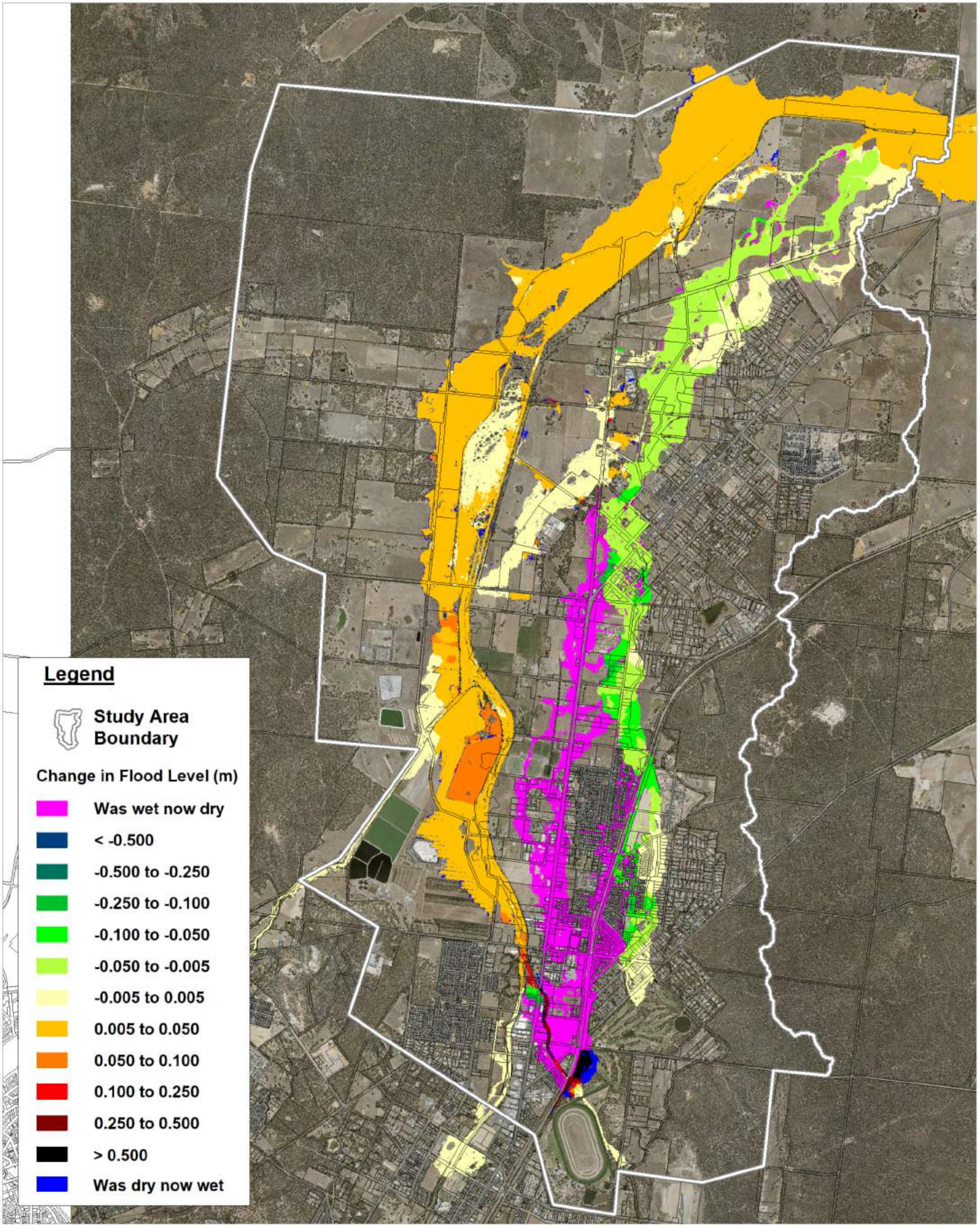

Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 24 Flood Level Impact - 1% AEP Event

Figure: 2-20

Rev: E

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0 1 2km

Approx. Scale

BMT

www.bmt.org

Filepath : T:\M20754.DK.Epsom-Ascot FPMS\MapInfo\Drawings\R.M20754.006.04\EAH_Fig2-20_M24_Dif_100y_MaxRevE.WOR

2.11.3 Option Costing

The scheme costings are presented in Table 2-20. The costings have been based on the unit rates shown in Appendix A. Where possible, these rates have been taken from Rawlinsons Australian Construction Handbook (2015), and have been updated to 2018 using the Consumer Price Index (as determined by the ATO).

As part the detailed design process, the costings in Table 2-20 may change as a result of design changes to the mitigation scheme (extent and location of works). These changes may be required because of the findings from the other supporting studies that will need to be undertaken during the detailed design phase (geotechnical investigations, environmental assessments, cultural heritage assessments, etc). The costs associated with these additional studies are not detailed in Table 2-20.

Table 2-20 M24 Cost Estimate[10]

Description	Total
Site Establishment (Site Office/Toilet Hire/Lunch Room)	$ 16,200
Traffic Management	$ 107,600
Site Preparation	$ 16,100
New Earthworks	$ 461,200
Landscaping (Native Grasses)	$ 8,800
Sub Total	**$ 609,900**
Engineering and Design (15%)	$ 91,485
Administration (9%)	$ 54,891
Capital Works Contingency (30%)	$ 182,970
Land Acquisition (incl. 50% contingency)	$ 2,938,500
Total	**$ 3,877,746**

[10] This cost estimate is based on BMT's experience and judgement as a firm of practising engineers familiar with preliminary costings of flood mitigation options. This cost estimate cannot be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. The costings have included an allowance for engineering and design (15%), administration (9%) and project contingency (30%).

2.11.4 Economic Assessment

Mitigation Scheme Twenty Four (M24) results in an AAD of $4,068,400, which is a reduction of $7,176,800 from the existing conditions AAD of $11,245,200. The cost benefit analysis for the Whole of Life costs is summarised in Table 2-21.

Table 2-21 M24 CBA Summary

Item	Existing	Scheme 24
Damages (PA)	$ 11,245,200	$ 4,068,400
Benefit (PA)		$ 7,176,800
Capital Cost		$ 939,246
Upfront Cost		$ 3,877,746
Maintenance (PA)		$ 18,785
NPV		$ 95,179,444
BCR		27.26

2.12 Option M47

2.12.1 Description of Mitigation Option

This mitigation option (shown in Figure 2-21) is an extension of mitigation option eighteen (M18) whereby the significant vegetation removal and waterway shaping along Back Creek extends from Howard Street (in Ascot) to the junction of Back Creek with Bendigo Creek.

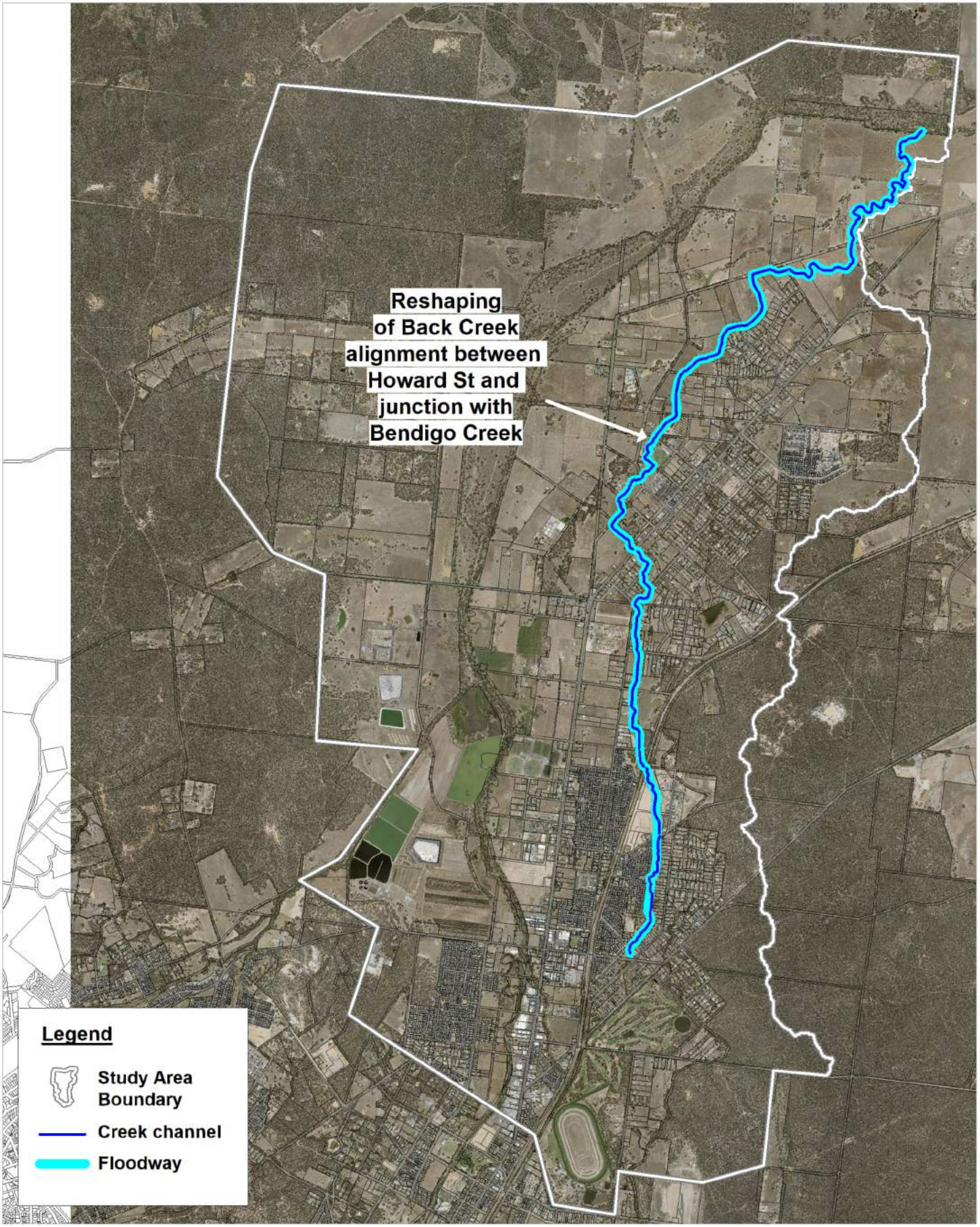
The proposed mitigation option will involve the removal of existing large vegetation, and the widening and shaping of the creek where possible to improve to improve the flow conveyance along the Back Creek system. The width of works varies along the length of the waterway depending on the available land area. This option does not change any of the existing drainage structures or roadway crossing of Back Creek between Howard Street and Bendigo Creek.

2.12.2 Flood Impact Assessment

A flood impact assessment has been undertaken to demonstrate the impact of the proposed mitigation options on flooding within the Epsom, Ascot and Huntly regions.

The flood level impact for the 1% AEP flood event is presented in Figure 2-22. The flood impact for the full range of modelled flood events is presented in BMT (2019).

In each of these figures the yellow colours indicate no change in the flood level (within a +/-5-millimetre range). The orange red colours indicate areas where the flood level has increased, while the green colours indicate areas where the flood level has decreased. The blue colour indicates an area that was dry and is now wet (due to the mitigation option), whilst the magenta colour indicates an area that was wet and is now dry (due to the mitigation option).



Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 47 Details

Figure: 2-21

Rev: A

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Approx. Scale

BMT

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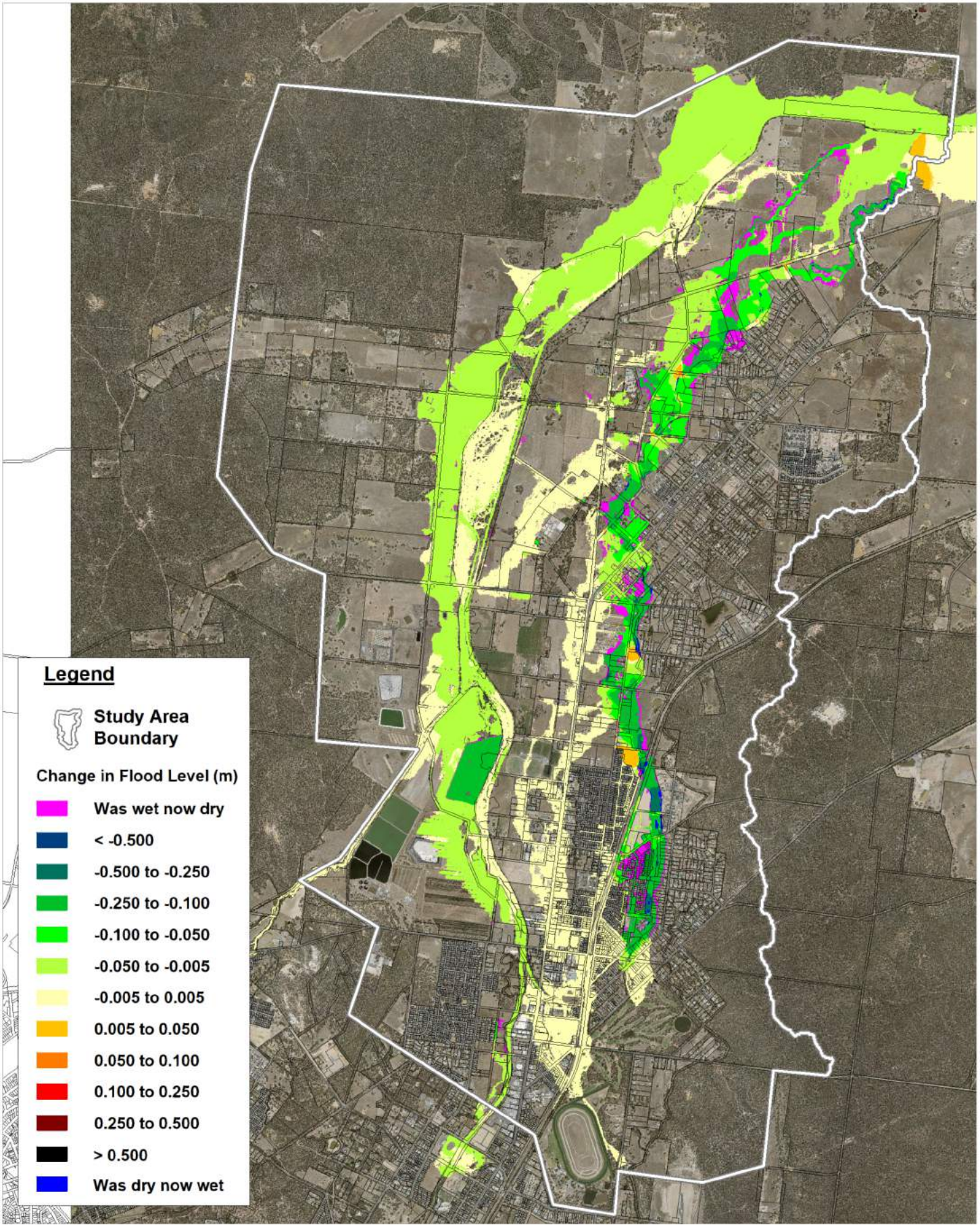

Title:

Epsom-Ascot-Huntly Floodplain Management Study
Mitigation Option 47 Flood Level Impact - 1% AEP Event

Figure: 2-22

Rev: E

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Approx. Scale

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2.12.3 Option Costing

The scheme costings are presented in Table 2-22. The costings have been based on the unit rates shown in Appendix A. Where possible, these rates have been taken from Rawlinsons Australian Construction Handbook (2015), and have been updated to 2018 using the Consumer Price Index (as determined by the ATO).

As part the detailed design process, the costings in Table 2-22 may change as a result of design changes to the mitigation scheme (extent and location of works). These changes may be required because of the findings from the other supporting studies that will need to be undertaken during the detailed design phase (geotechnical investigations, environmental assessments, cultural heritage assessments, etc). The costs associated with these additional studies are not detailed in Table 2-22.

Table 2-22 M47 Cost Estimate[11]

Description	Total
Site Establishment (Site Office/Toilet Hire/Lunch Room)	$ 10,800
Traffic Management	$ 71,700
Site Preparation	$ 302,000
New Earthworks	$ 14,483,700
Landscaping (Native Grasses)	$ 1,387,500
Sub Total	**$ 16,255,700**
Engineering and Design (15%)	$ 2,438,355
Administration (9%)	$ 1,463,013
Capital Works Contingency (30%)	$ 4,876,710
Land Acquisition (incl. 50% contingency)	$ 7,368,450
Total	**$ 32,402,228**

[11] This cost estimate is based on BMT's experience and judgement as a firm of practising engineers familiar with preliminary costings of flood mitigation options. This cost estimate cannot be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. The costings have included an allowance for engineering and design (15%), administration (9%) and project contingency (30%).

2.12.4 Economic Assessment

Mitigation Scheme Forty Seven (M47) result in an AAD of $9,964,900, which is a reduction of $1,280,300 from the existing conditions AAD of $11,245,200. The cost benefit analysis for the Whole of Life costs is summarised in Table 2-23.

Table 2-23 M47 CBA Summary

Item	Existing	Scheme 47
Damages (PA)	$ 11,245,200	$ 9,964,900
Benefit (PA)		$ 1,280,300
Capital Cost		$ 25,033,778
Upfront Cost		$ 32,402,228
Maintenance (PA)		$ 500,676
NPV		$ (19,055,136)
BCR		0.37

2.13 Option M48

2.13.1 Description of Mitigation Option

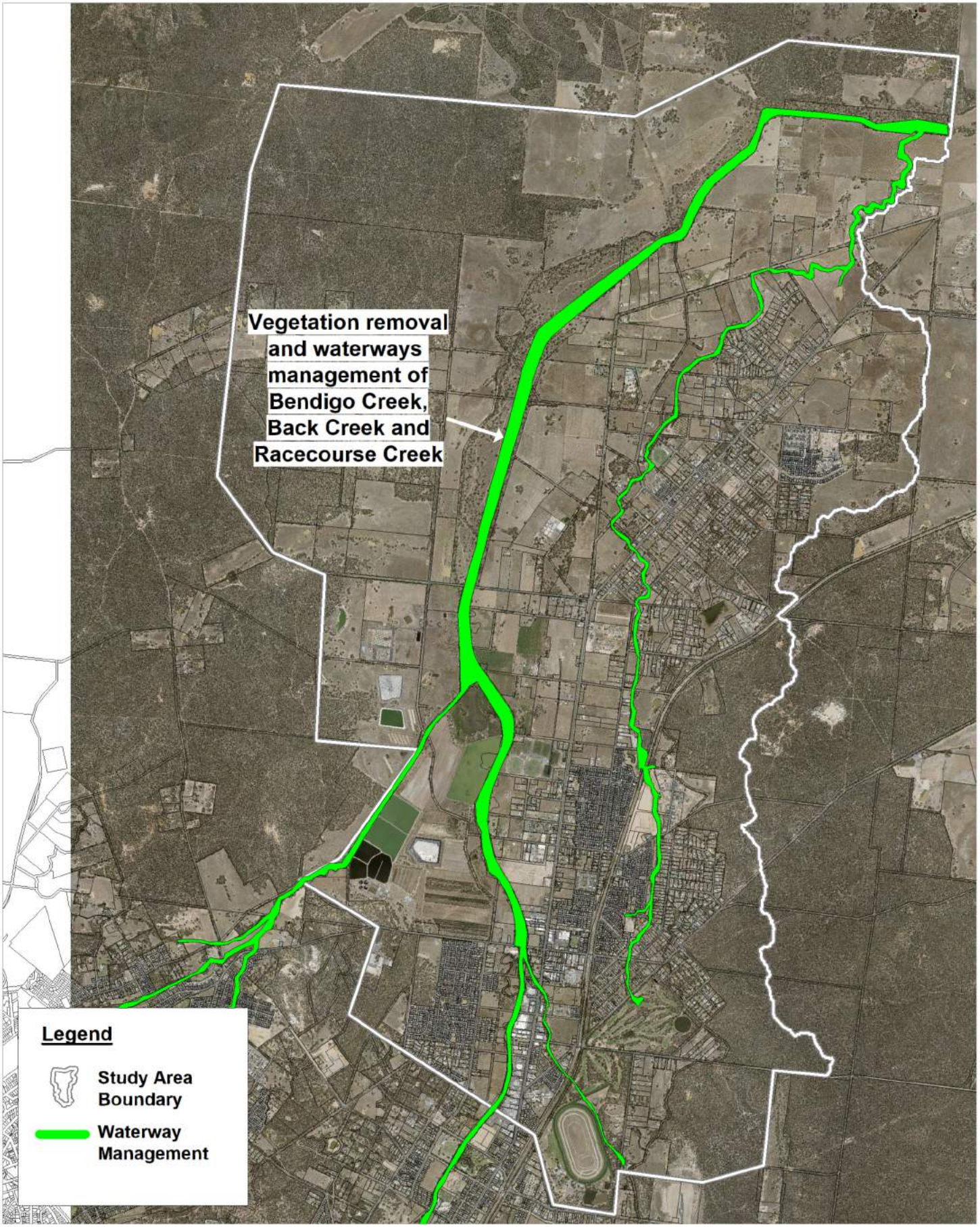
This mitigation option (shown in Figure 2-23) involves the selective removal of large woody vegetation from within the banks of Bendigo Creek, Racecourse Creek and Back Creek. As part of the mitigation option, the waterways between the banks will be re-vegetated with native grasses in a manner which attempts to preserve the natural appearance of the creek system whilst improving the conveyance of the system.

2.13.2 Flood Impact Assessment

A flood impact assessment has been undertaken to demonstrate the impact of the proposed mitigation options on flooding within the Epsom, Ascot and Huntly regions.

The flood level impact for the 1% AEP flood event is presented in Figure 2-24. The flood impact for the full range of modelled flood events is presented in BMT (2019).

In each of these figures the yellow colours indicate no change in the flood level (within a +/-5-millimetre range). The orange red colours indicate areas where the flood level has increased, while the green colours indicate areas where the flood level has decreased. The blue colour indicates an area that was dry and is now wet (due to the mitigation option), whilst the magenta colour indicates an area that was wet and is now dry (due to the mitigation option).



Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 48 Details

Figure: 2-23

Rev: A

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Approx. Scale

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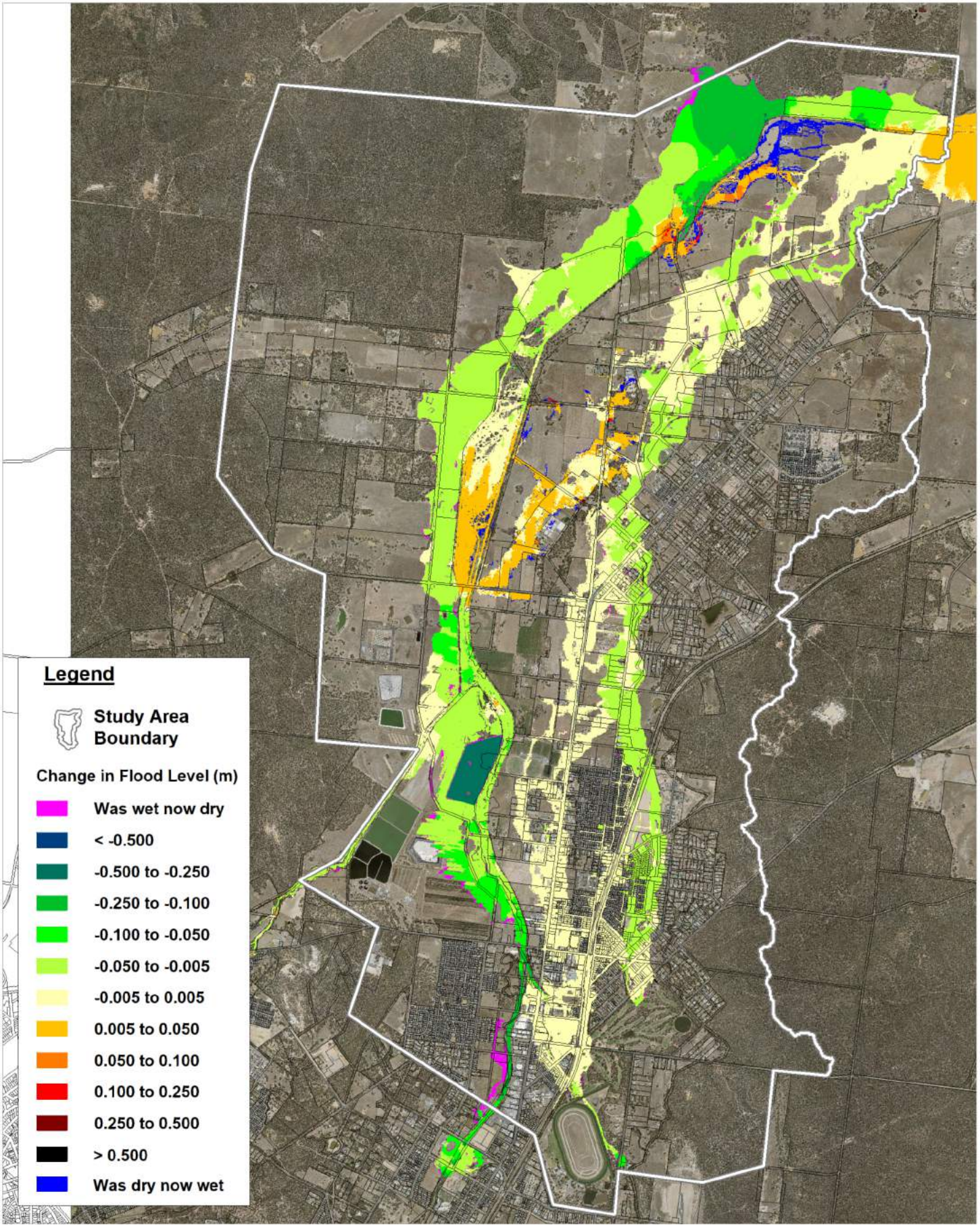

Title:

Epsom-Ascot-Huntly Floodplain Management Study Mitigation Option 48 Flood Level Impact - 1% AEP Event

Figure: 2-24

Rev: E

N

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Approx. Scale

BMT

www.bmt.org

Filepath : T:\M20754.DK.Epsom-Ascot FPMS\MapInfo\Drawings\R.M20754.006.04\EAH_Fig2-24_M48_Dif_100y_MaxRevE.WOR

2.13.3 Option Costing

The scheme costings are presented in Table 2-24. The costings have been based on the unit rates shown in Appendix A. Where possible, these rates have been taken from Rawlinsons Australian Construction Handbook (2015), and have been updated to 2018 using the Consumer Price Index (as determined by the ATO).

As part the detailed design process, the costings in Table 2-24 may change as a result of design changes to the mitigation scheme (extent and location of works). These changes may be required because of the findings from the other supporting studies that will need to be undertaken during the detailed design phase (geotechnical investigations, environmental assessments, cultural heritage assessments, etc). The costs associated with these additional studies are not detailed in Table 2-24.

Table 2-24 M48 Cost Estimate[12]

Description	Total
Site Establishment (Site Office/Toilet Hire/Lunch Room)	$ 10,800
Traffic Management	$ 71,700
Site Preparation	$ 302,000
New Earthworks	$ -
Landscaping (Native Grasses)	$ 1,387,500
Sub Total	**$ 1,772,000**
Engineering and Design (15%)	$265,800
Administration (9%)	$ 159,480
Contingency (30%)	$ 531,600
Land Acquisition (incl. 50% contingency)	$ -
Total	**$ 2,728,880**

[12] This cost estimate is based on BMT's experience and judgement as a firm of practising engineers familiar with preliminary costings of flood mitigation options. This cost estimate cannot be guaranteed as we have no control over Contractor's prices, market forces and competitive bids from tenderers. The costings have included an allowance for engineering and design (15%), administration (9%) and project contingency (30%).

2.13.4 Economic Assessment

Mitigation Scheme Forty Eight (M48) results in an AAD of $11,169,200, which is a reduction of $76,000 from the existing conditions AAD of $11,245,200. The cost benefit analysis for the Whole of Life costs is summarised in Table 2-25.

Table 2-25 M48 CBA Summary

Item	Existing	Scheme 48
Damages (PA)	$ 11,245,200	$ 11,169,200
Benefit (PA)		$ 76,000
Capital Cost		$ 2,728,880
Upfront Cost		$ 2,728,880
Maintenance (PA)		$ 272,888
NPV		$ (5,012,521)
BCR		-0.97

2.14 Summary of Options

Table 2-26 provides a summary of the benefits and total costs for each of mitigation options that was assessed (assuming a 50 year financial life and a discount rate of 7%). Whilst the majority of the mitigation options have a negative NPV (indicating that the costs of the mitigation options outweigh the benefits), mitigation options one(a) (M01a), one(b) (M01b), one(c) (M01c), one(d) (M01d), eighteen (M18) and twenty four (M24) have a positive NPV.

From an economic viewpoint, M01a, M01b, M01c, M01d and M24 result in significant reductions in flood damages (compared to M18), and despite the relatively high cost, the financial benefits (reduction in flood damages) outweigh the cost (of the scheme). However, M24 has a higher NPV and BCR when compared to M01a, M01b, M01c and M01d. It is worth noting that the economic assessment for M01a and M01b assume that mitigation scheme twenty four (M24) is already in place, whilst M01c and M01d include M24 as part of the mitigation scheme.

Table 2-26 Summary of Economic Assessment – Whole of Life Costs

Mitigation Option	Benefit (PA)	NPV	BCR
M01	$ 228,700	$ (66,843,305)	-0.18
M01a	$ 6,741,700	$ 23,040,956	1.41
M01b	$ 6,748,600	$ 72,250,869	5.22
M01c	$ 7,198,700	$ 25,482,145	1.42
M01d	$ 7,205,600	$ 74,692,059	4.60
M09	$ 10,600	$ (939,438)	-0.10
M09a	$ 30,100	$ (4,270,716)	-0.16
M18	$ 668,700	$ 4,528,063	2.18
M19	$ 41,300	$ (374,046)	0.56
M24	**$ 7,176,800**	**$ 95,179,444**	**27.26**
M47	$ 1,280,300	$ (19,055,136)	0.37
M48	$ 76,000	$ (5,012,521)	-0.97

The economic assessment is only one consideration when determining a recommended mitigation scheme. Other considerations, such as environmental, social or heritage issues also play a part in determining the viability of a proposed scheme. When taking into account these additional factors, mitigation schemes with a negative NPV, may not be viable due to environmental or cultural concerns. Alternatively, a scheme with a negative NPV may be viable due to its intangible social benefits (which are not captured as part of the economic assessment).

3 Social, Environmental and Cultural Considerations

3.1 Social Considerations

A number of social considerations need to be adequately addressed when determining a preferred flood mitigation scheme. Whilst economic benefits can be easily quantified, social benefits (or dis-benefits) can be much harder.

Flood mitigation works, particularly flood levees, can increase community growth by allowing development to occur region previously considered to be flood-prone or of high flood risk. This can often result in increased property values for both undeveloped and developed land. Reducing the flood risk can also reduce social disruption during flood events (as the mitigation option has reduced the flood risk).

However, the mitigation option can also result in disruption to the community. Several proposed mitigation options will require land acquisitions (of both public and private land) and the community will likely be disrupted during the construction of the various options (if they proceed). Some members of the community may also be accepting of the current flood risk due to a lifestyle choice, acknowledging that by living next to or near a natural waterway has an element of risk (in a similar vein to those who choose to live in a forested area and accept the bushfire risk).

A strong community consultation program (as has been implemented for the current study) is an effective way to ensure the concerns of the community are acknowledged and that their views are heard. Whilst it may not be possible to get consensus across an entire community, there could be slight design changes to the various options which ensure the vast majority of the community are accepting of the scheme.

3.2 Environmental Considerations

3.2.1 Environmental Protection and Biodiversity Conservation Act (1999)

Under the Environment Protection and Biodiversity Conservation (EPBC) Act (1999), certain actions or activities may require approval before being undertaken. If the proposed action could have a significant impact on the environment, the action will need to be referred to the Australian Government Minister for Environment for approval. Under the EPBC Act, nine matters of environmental significance are protected, including:

- World Heritage Properties
- National Heritage Places
- Wetlands of International Importance
- Listed threatened species and ecological communities
- Migratory species
- Commonwealth Marine Areas
- The Great Barrier Reef Marine Park

- Nuclear actions (including uranium mines)
- A water resource in relation to coal seam gas development and large coal mining development.

BMT has generated an EPBC Act Protected Matters Report for the City of Greater Bendigo (LGA) (included in BMT (2019)). This report has been generated to provide general guidance on matters and national environmental significance and other matters protected by the EPBC Act in the area of interest.

The EPBC Act Protected Matters Report identifies a number of threatened ecological communities, threatened species and migratory species that are known or likely to occur in the study area. BMT (2019) details the various ecological communities and species (flora and fauna) that are listed in the EPBC Protected Matters Report (and also includes a copy of the report itself.

Detailed flora and fauna surveys will need to be undertaken as part of the detailed design of the selected mitigation options to confirm the presence (or otherwise) of any threatened species of ecological communities. If any of the species are confirmed as being present within the extent of the proposed works, or likely to be impacted by the proposed works, then a referral of the project to the Australian Government Minister for Environment under the requirements of the EPBC Act will be required.

3.2.2 Victorian Environmental Legislation

3.2.3 Environment Protection Act 1970 (Vic)

The Environment Protection Act 1970 (Vic) establishes the Environment Protection Authority (Vic EPA) and makes provision for the Authority's powers, duties and functions. These relate to improving the air, land and water environments by managing waters, control of noise and control of pollution. The EPA Act regulates industrial development and activities through a permit and licensing framework with associated enforceable offences. The Act also requires the establishment of State Environment Protection Policies (SEPPs). SEPPs are subordinate legislation developed to provide more detailed requirements and guidance for the application of the Act to Victoria.

Any construction activities including the movement or disposal of contaminated fill will need to be done in accordance with the requirements of Environment Protection Act (1970).

A land contamination consultant will be required to determine the most effective methods for remediation, treatment and/or removal of the contaminated fill.

3.2.4 Environment Effects Act 1978 (Vic)

The Environment Effects Act 1978 (Vic) requires consideration to be given to projects which may have significant impacts on the Victorian environment. Like the Commonwealth EPBC Act if proposed projects are likely to impact on matters of regional or State environmental significance then an environmental impact assessment process is triggered.

The Ministerial guidelines for assessment of environmental affects under the Environment Effects Act 1978 includes the referral criteria for determining whether a project will potentially require the develop of an Environmental Effects Statement (EES).

3.2.5 Flora and Fauna Guarantee Act 1988 (Vic)

The Flora and Fauna Guarantee Act 1989 (FFG Act) provides a legislative and administrative framework for the conservation of biodiversity in Victoria. It covers both public land and private land (with 'land' defined to include water). It lists a number of threatened species and communities, and 'potentially threatening processes', and provides some tools to protect them.

The potentially threatening processes listed under the Flora and Fauna Guarantee Act (1988) that could occur as part of the proposed mitigation options include:

- Degradation of native riparian vegetation along Victorian rivers and streams; and
- Removal of wood debris from Victorian streams

3.2.6 Works on Waterways

The North Central Catchment Management Authority (NCCMA) has legal statutory authority under the Catchment and Land Protection Act 1994 (Vic) and Water Act 1989 (Vic), and has a responsibility to protect the waterways within its region. Their role requires them to monitor, administer and enforce control over all works which may impact upon designated waterways throughout their region. Bendigo Creek, Racecourse Creek and Back Creek are all designated waterways, and therefore any of the mitigation options that require works to be undertaken within the bed and banks of the waterway will require a Works on Waterways permit.

Part of the Works on Waterways permit is a requirement to ensure landholder consent is included (regardless of whether the works are conducted on private or public land). There may also be a requirement to undertake a Cultural Heritage Management Plan (Section 3.3).

Based on the Works on Waterways guidelines for General Works, approval for works would be based on there being no significant impact to the following criteria:

- Potential to de-stabilise the stream bank or bed
- Potential to alter flood levels
- Impact on riparian vegetation
- Impact on in-stream habitat
- Potential to affect water quality

It is acknowledged that all of the detailed mitigation options will result in changes to the flood levels and flood behaviour (this is the intent of the flood mitigation works). A key consideration is likely to be an assessment of whether individuals or communities are exposed to a greater risk of inundation in order to provide a benefit to other individuals or communities. The flood impact maps previously presented provide an indication of the likely changes in flood level due the proposed mitigation option.

3.3 Cultural Heritage Considerations

The Aboriginal Heritage Act (2006) and the Aboriginal Heritage Regulations (2007) provide for the protection and management of Victoria's Aboriginal heritage. The legislation provides protection for

all Aboriginal places, objects and human remains regardless of their inclusion on the Victorian Aboriginal Heritage Register or whether they are located on public or private land.

High Impact activities, such as the construction of levees and the excavation of land adjacent to a waterway, that occur in culturally sensitive landscapes can cause significant harm to Aboriginal cultural heritage. Therefore, as part of the detailed planning for the implementation of any of the detailed mitigation options, a Cultural Heritage Management Plan (CHMP) or a cultural heritage permit may be required.

A review of the Aboriginal Cultural Heritage Register and Information System (ACHRIS) shows that Bendigo Creek, Racecourse Creek and Back Creek have all been identified as areas of Cultural Heritage Sensitivity (Figure 3-1). Therefore, a Cultural Heritage Management Plan is likely to be required. However, if part of an area of cultural heritage sensitivity (other than a cave) has been subject to significant ground disturbance that part is not an area of cultural heritage sensitivity. This is an important consideration as a Management Plan will not need to be prepared if all of the area of Cultural Heritage Sensitivity within the activity area has been subject to significant ground disturbance.

The Aboriginal Heritage Regulations (2007) define significant ground disturbance of the topsoil or surface rock layer of the ground, or a waterway by machinery in the course of grading, excavating, digging, dredging or deep ripping. Further to this definition, the Victorian Civil and Administrative Tribunal (VCAT) has determined that the topsoil or surface rock layer include the former topsoil or former surface rock layer if that topsoil or surface rock layer is a naturally occurring surface level that is readily ascertainable and does not include the current topsoil or current surface rock layer if established by the mere filling of the land.

It is possible that Aboriginal cultural heritage places, objects or human remains exist within area deemed to no longer be of cultural heritage sensitivity due to the presence of significant ground disturbance. However, these Aboriginal places, objects or human remains are still protected by the Aboriginal Heritage Act (2006). In particular, it is an offence (under the Aboriginal Heritage Act) to harm Aboriginal cultural heritage unless acting in accordance with a Cultural Heritage Permit or approved Cultural Heritage Management Plan (regardless of whether a Management Plan was required).

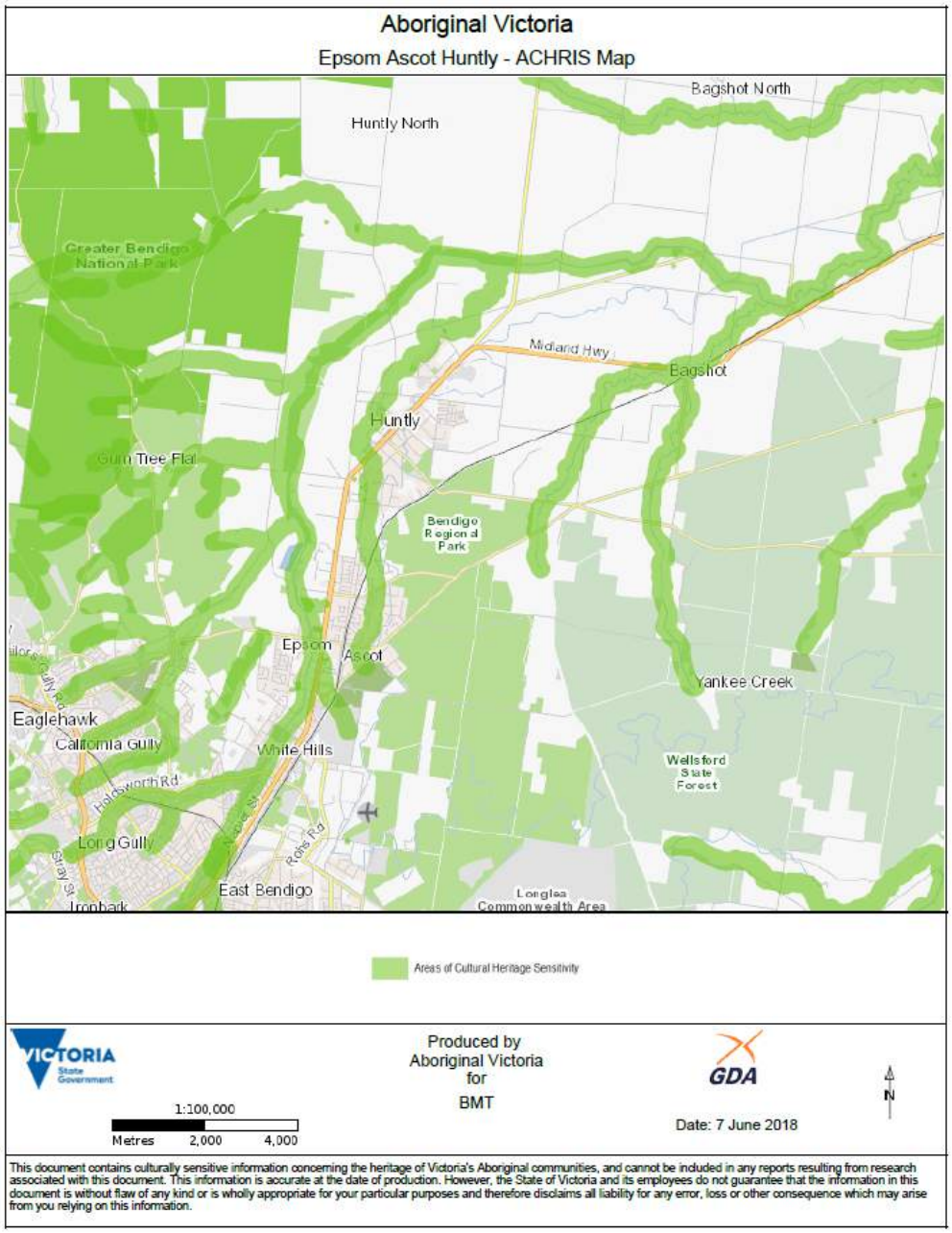

Figure 3-1 Cultural Heritage Sensitivity (ACHRIS Extract)

As part of the detailed design process of any mitigation options (works for all 7 options assessed as part of the detailed mitigation options are located within areas identified as having Cultural Heritage Sensitivity), Council will need to engage an expert to determine if:

a) a Cultural Heritage Management Plan is required for the proposed works (including consideration of whether the footprint of the proposed works has been previously subject to significant ground disturbance; and

b) if required, develop a suitable Cultural Heritage Management Plan for the proposed works.

3.3.1 Land Use Activity Agreement

The Land Use Activity Regime is a simplified alternative to the future acts regime of the Native Title Act 1993 (Cth). It provides procedural rights for recognised traditional owner groups over certain activities that occur on public land. The objective is to enable these activities to proceed, whilst accommodating third party interests and respecting the rights of traditional owners attached to the public land.

The Land Use Activity Regime is enable by Part 4 of the Native Title Act 1993 (Cth) and is given effect through a Land Use Activity Agreement (LUAA). A Land Use Activity Agreement exists between the Dja Dja Wurrung Clans Aboriginal Corporation (Indigenous Corporation Number 4421) and the State of Victoria. This agreement covers public land that falls within the Dja Dja Wurrung Recognition and Settlement Agreement Area, including the areas of Greater Bendigo (and the locations of the proposed mitigation options).

Under the agreement, a Public Land Authorisation (s28 (a) of the Native Title Act) that is a licence for the construction of works on a waterway is considered an Advisory Activity. The agreement sets out the Ministerial directions in relation to Advisory Activities.

3.4 Victorian Heritage Considerations

A review of the Victorian Heritage Database was undertaken to determine if any significant heritage places or objects protected under the Heritage Act 1995 are located within the footprint of any of the proposed mitigation options. The database also includes the Victorian Heritage Inventory which lists all known historical archaeological sites in Victoria.

This review indicates that there are no places or objects of significant heritage or known historical archaeological sites within the study area.

3.5 Planning Scheme Controls

3.5.1 Zone Codes

Depending on the accepted land uses under the various planning zones in the Greater Bendigo Planning Scheme for the footprint of the proposed works, an amendment to the planning scheme may be required to allow for the implementation of the mitigation option. Additional reports and assessment may be required to support a planning scheme amendment.

3.5.2 Overlays

3.5.2.1 Environmental Significance Overlay

The alignments of Bendigo Creek, Racecourse Creek and Back Creek are subject to an Environmental Significance Overlay (ESO). Shown on the relevant planning scheme maps as ESO1, the statement of environmental significance states the *"municipality contains a number of important streams and watercourses which maintain clean water, soil stability and habitat for flora and fauna. Bendigo's potable and agricultural water supply is dependent on these streams and watercourses. The management of land adjacent to streams and watercourses is necessary to reduce erosion, maintain vegetation and habitat and improve water quality."*

This overlay includes the following environmental objectives (amongst others):

- To protect and encourage the long-term future of flora and fauna habitat in and along watercourses;
- To conserve existing wildlife habitats close to natural watercourses and, where appropriate, to allow for generation and regeneration of habitats

However, a permit is not required to construct or carry out works by a public authority to regulate flooding. Therefore, the presence of the ESO may not be an impediment to the implementation of the mitigation scheme. Although, it is recommended that independent planning advice is obtained to confirm these requirements.

3.5.2.2 Flood Overlays

The study area is subject to a Land Subject to Inundation Overlay (LSIO) which was included as an amendment in the Greater Bendigo Planning Scheme. This LSIO was included in the planning scheme to implement the findings of the Bendigo Urban Flood Study.

This overlay is designed (in part) *"to ensure development maintains the free passage and temporary storage of floodwaters, minimises flood damage, is compatible with the flood hazard and local drainage conditions and will not cause any significant rise in flood level or flow velocity*". The schedule to the LSIO states that a permit is not required to construct or carry out flood mitigation works by the responsible authority or floodplain management authority.

However, the LSIO has been included in the Greater Bendigo Planning Scheme in two parts, designated LSIO1 and LSIO2, each with different permit requirements. All mitigation works include a construction footprint that includes land subject to either an LSIO1 or LSIO2 designation. However, the schedules for both LSIO1 and LSIO2 do not specifically state that a permit is not required for flood mitigation works. Flood mitigation works undertaken by either Council or the Floodplain Management Authority do not require a permit.

3.5.3 Updates to the Planning Scheme

Following the successful implementation of a flood mitigation scheme, the relevant planning scheme maps will need to be amended to demonstrate the revised 1% AEP flood extent, shown as the LSIO layer.

This amendment process will ensure the reduction in flood risk to the community is reflected in the planning scheme and that the associated requirements for development in a flood prone area (subject to an LSIO) and no longer applicable to the protected areas. However, Council should remain cognisant that should a flood mitigation measure fail (eg: levee breach), then the protected community will be subject to flooding.

3.6 Summary

This section has summarised the various social, environmental, cultural, heritage and planning scheme considerations that may impact the implementation of the various mitigation options assessed as part of this report.

All of the consideration raised in this section will need to be considered and a determination made as to whether they are relevant. This can only be achieved through further studies or investigations. The only consideration that appears to not be a concern at all is the consideration of items/places on the Victorian Heritage Register.

For example, all options include construction along a waterway, a cultural heritage assessment will be required, along with a works on waterways permit. Additionally, the construction will need to be carried out in accordance with the Environment Protection Act to ensure noise, dust and sediment pollution are managed.

If the flora and fauna assessment in the study area find a listed or threatened species (or community), then it is likely the requirements of the EPBC Act and the Environment Effects Act will be triggered. Whilst the information presented in this report indicates that a number of listed or threatened species may be impacted, this cannot be confirmed until a flora and fauna survey has been undertaken.

All mitigation options are designed to modify the flooding within a local (or broader) region, and therefore, once the mitigation measure has been implemented a planning scheme amendment to update to the LSIO in Greater Bendigo Planning Scheme should be undertaken.

4 Summary

This summary report, as well as those issued previously (BMT WBM 2016, BMT WBM 2017a, BMT WBM 2017b and BMT 2019) have documented the methodology and findings of the detailed mitigation assessment of the Epsom Ascot Huntly Floodplain Management Study. The study has defined the flood behaviour and flood damages in the Epsom, Ascot and Huntly regions of Bendigo and subsequently assessed many mitigation options through a two-stage process. 49 mitigation schemes were initially tested, with 7 undergoing a detailed assessment.

This report has detailed the flood impact assessment and economic assessment of the selected 7 mitigation options. Additionally, a number of social, environmental and cultural considerations have been raised to assist Council with the selection of the preferred mitigation scheme(s).

5 References

BMT (2019). Epsom-Ascot-Huntly Floodplain Management Study – Detailed Mitigation Assessment. R.M20754.005.04.Detailed_Mitigation.pdf. Report issued to City of Greater Bendigo, January 2019.

BMT WBM (2016). Epsom-Ascot-Huntly Floodplain Management Study – Preparation of Template Report. R.M20754.002.02.TemplateModel.pdf. Report issued to City of Greater Bendigo, December 2016.

BMT WBM (2017a). Epsom-Ascot-Huntly Floodplain Management Study – Mitigation Options (Preliminary Assessment). R.M20754.003.04.PrelimMitigation.pdf. Report issued to City of Greater Bendigo, August 2017.

BMT WBM (2017b). Epsom-Ascot-Huntly Floodplain Management Study – Damages Assessment. R.M20754.004.00.DamagesAssessment.pdf. Report issued to City of Greater Bendigo, September 2017.

Rawlinsons (2015). Australian Construction Handbook (Edition 33)

Water Technology (2013). *Bendigo Urban Flood Study Final Report*.

Appendix A Unit Rates and Cost Assumptions

A.1 General Rates

Item and Assumptions	Rate
Hire of Site Office, Lunch Room and Toilets	$425 /week
Traffic Management (incl. Signage)	$377.40 /day
Site Preparation – Clear Site of light vegetation and clear away	$0.37/m^2
Excavation in light soil to reduce levels	$18.65 /m^3
Disposal of contaminated soil to approved land fill	$450 /t
Transport of contaminated soil to landfill (up to 150 km away)	$3 /m^3/5km
New Fill (clay from local source)	$22.18 /m^3
Compaction of clay	$3.30 /m^2
Landscaping – Native Grasses (including seed, fertiliser, watering and maintenance for 6 months)	$17,000 /ha
Bridge Works – Conventional Bridge (two lane, 11 m wide), including safety rails.	$1700 /m^2
Road Surface (basecourse preparation and two coats of sprayed bitumen)	$14 /m^2

A.2 Land Acquisition Rates

Zone	Parent Property Size (m^2)		Land Rate ($/m^2)	
	Small	Large	Small	Large
C2Z	3,500	50,000	$150	$85
FZ	20,000	500,000	$9	$1.25
GRZ	700	30,000	$200	$40
IN1Z	5,000	120,000	$130	$32.50
IN3Z	4,000	100,000	$75	$17.50
LDRZ	2,000	200,000	$100	$3
MUZ	600	1,500	$225	$180
SUZ	2,000	200,000	$15	$2.50

Land acquisition rates for flood prone land (land liable to flooding under the 1% AEP existing conditions), was valued at $10/m^2 (as advised by Council)

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