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VicRoads Metropolitan South East Region

Report for Healesville-Koo Wee Rup Road Duplication Project

Preliminary Drainage Investigation Report

November 2006

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Executive Summary

VicRoads are undertaking a preliminary investigation into the potential duplication of the Healesville-Koo Wee Rup Road from south of the Pakenham Bypass to the South Gippsland Highway, bypassing the town of Koo Wee Rup. As part of this process, a preliminary drainage investigation into the potential main drain crossings was commissioned and undertaken, with the results provided in this report.

The entire length of road under consideration is in the Koo Wee Rup Flood Protection District, with the main drains being owned and managed by Melbourne Water. The area was once considered swampland until a vast network of drains were constructed in the early to mid 1900s to provide a drainage mechanism for the swamp, however the land is still prone to flooding and as a result of this Melbourne Water produced some guidelines for development within the area.

The main drain crossings for the road duplication and bypass involve the following: Deep Creek (RD 2.55 km); McGregors Drain (RD 5.3 km); McDonald Catch Drain (RD 12.0 km); North West Catch Drain (RD 12.05 km); Bunyip Main Drain (RD 12.05 km); Southern Boundary Main Drain (RD 12.1 km); and Koo Wee Rup South Drain (RD 14.4 km).

Flows and flood levels have been provided by Melbourne Water on some of these drains for the general vicinity of the road duplication, although the information available is not comprehensive. Additional information will be required in time as this road duplication project develops.

Drainage design criteria from VicRoads and Melbourne Water have been considered, with the final summarised requirements being:

- No increase in flood levels upstream or downstream as a result of the road duplication and bypass; and
- Accommodating flow up to the 100 year ARI flooding event in the drainage infrastructure for the main drains.

From the flows provided it appears that most of the new drainage infrastructure requirements will be bridge crossings due to the significant quantity of flow to be allowed for.

The proposed road duplication is generally likely to have limited impact on the flood levels providing adequate waterway crossings are provided and the new road section does not exceed the existing road levels. To the south, in the bypass section of the new road, it may be more difficult to limit flood level increases.

This preliminary investigation recommends that further hydrologic and hydraulic studies are undertaken to quantify the design flows and determine the impact of the proposed road duplication and bypass.

1. Introduction

VicRoads have contracted GHD Pty Ltd to undertake a preliminary drainage investigation for the early planning stages for the Healesville-Koo Wee Rup Road duplication project. This road is being investigated for upgrading from the Pakenham Bypass, south of Pakenham to the South Gippsland Highway, south of (and bypassing) Koo Wee Rup. Figure 1 below shows the location of the current Healesville-Koo Wee Rup Road in the area of interest.

The proposed upgrade would be a duplication of the existing road to form a high standard limited access control road. While some potential alignments have been considered, no decisions have been made as to a preferred alignment option. The general alignment of the road is anticipated to be approximately parallel and adjacent to the existing road where possible, although the alignment near and west of Koo Wee Rup is still not defined.

As described by VicRoads, the reason for the upgrade relates to the expected increase in traffic volume once the Pakenham Bypass is completed. The purpose of this study is to help identify current drainage information for the area as well as potential drainage issues that will impact on the design process for the future.

As part of the preliminary investigation by VicRoads, it has become apparent that there are some significant drainage issues that will need to be considered in this road duplication project. This drainage investigation interprets and reviews existing work done by others, collating the information, and considers further requirements and courses of action that will follow from this point in the progression of the road duplication investigation process. A very preliminary estimate of waterway area required to cater for the anticipated flows is also provided.

VICROADS

HEALESVILLE-KOO WEE RUP ROAD DUPLICATION PROJECT - DRAINAGE INVESTIGATION

Figure 1
Healesville-Koo Wee Rup Road
Locality Plan

PAKENHAM TOWNSHIP

PAKENHAM BYPASS

SHIRE OF CARDINIA

HEALESVILLE-KOO WEE RUP ROAD AREA OF STUDY

CORA LYNN

CITY OF CASEY

KOO WEE RUP TOWNSHIP

SOUTH GIPPSLAND HIGHWAY

WESTERN PORT BAY

LEGEND

- Roads
- Drains
- Municipal Boundaries
- Major Roads
- Healesville-Koo Wee Rup Road Area of Study
- Railway Lines

N
W E
S

SCALE 1 : 100,000 at A3

1 0 1 2 3 4 5 km

MAP GRID OF AUSTRALIA ZONE 55

LEVELS ARE TO AUSTRALIAN HEIGHT DATUM

GHD CLIENTS | PEOPLE | PERFORMANCE

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2. Background

2.1 Drainage Authority

The entire main drainage system for the proposed road is under the authority of Melbourne Water, and previous to that the Dandenong Valley Authority.
Melbourne Water have produced a document titled “Guidelines for Development within the Koo Wee Rup Flood Protection District” (October 2003), in conjunction with a number of other organisations including the City of Casey and the Shire of Cardinia. In this document they have outlined the flood characteristics of the area and highlighted the issues of the vast drainage network that converges in the Koo Wee Rup area, prior to release into the bay. A copy of this document is provided in Appendix A of this report.

The full length of the Healesville-Koo Wee Rup Road under consideration in this project is within the Shire of Cardinia. The Shire of Cardinia has authority for the minor drains in the area, which feed into the larger main drains.

While this report will concentrate entirely on the main drainage system as recognised and owned by Melbourne Water, it should be noted that there are also additional drains along the existing and proposed road alignment that are either council or privately owned. Although beyond the scope of this investigation, some of these drains are discussed briefly in Section 4.2, and in the overall scheme of the proposed road duplication they will need to be considered.

It should be noted that the “main drainage system” simply refers to the larger drains that are owned by Melbourne Water. Melbourne Water has control over larger (main) drains, and as a general rule this is defined as any drain with a contributing catchment area of 60 hectares or more. Catering for the main drains will cover a significant proportion of the cross drainage requirements of the proposed road duplication project.

2.2 Flood Plain Zones

The Healesville-Koo Wee Rup Road from south of the Pakenham Bypass to the Gippsland Highway is a 15 km length of road, with the entire length of this road existing in the Koo Wee Rup Flood Protection District, as classified by Melbourne Water. Of the 15 km of road classified in the Flood Protection District, 14 km of this is in Zone 1 and the remaining 1 km is in Zone 2.

This classification is clearly defined in the above mentioned document “Guidelines for Development within the Koo Wee Rup Flood Protection District” and summarised below.

The following is a brief summary of the key terms in this classification system:

Zone 1: Land that is subject to flooding as a result of drain overflows, where the 100 year ARI flood depth would be approximately 300 mm above the existing ground level in the vicinity. This particular zone describes the majority of the zoned land in the Koo Wee Rup Flood Protection District. [1]

Zone 2: Land that is subject to substantial flooding as a direct result of major drain overflows, where the 100 year ARI flood depth would be approximately 700 mm above the existing ground level in the vicinity.

Zone 3: This land is offered a high level of protection as a result of the reduction in flooding off the Bunyip Drain system due to the Yallock Outfall as well as the Bunyip Main Drain levee banks. The land in this zone is subject to minor flooding from the local drainage and minor levee bank system overflows. In this case, the 100 year ARI flood depth would be approximately 150 mm above the existing ground level in the vicinity.

Zone 4: The Koo Wee Rup Township. Similar to Zone 3 in that only local floodwaters and minor breeches of the Bunyip Main Drain levee system would generally affect the area. This zone is specifically for the township itself, and exact flood levels for a specific site should be requested through Melbourne Water if required.

Zone 5: The land that is liable to shallow overland flows but generally only as a result of local catchment issues and not as a result of any of the main drains. The 100 year ARI flood depth would be approximately 150 mm above the existing ground level in the vicinity.

In Appendix A of this report, Attachment A contains a map of the area showing all of these zones in the Koo Wee Rup Flood Protection District.

2.3 System Capacity

While an extensive drainage system network now exists to carry drainage away from the land and into Western Port Bay, the adjacent land and therefore drains have a very gentle grade and this contributes to the drains having a limited capacity. It is estimated by the drainage authorities that the main outlet drains have the approximate capacity to cater for flooding events from 7 to 15 year ARI, but some of the more minor drains feeding these would have a more limited capacity.

2.4 Historical Flooding Events

The largest historical flooding event in recent recorded history occurred in 1934. In that particular rainfall event from 30 November to 1 December, the Koo Wee Rup District received 170.2 mm of total rainfall, spread over the two days. It was estimated that this flooding event was a 150 to 200 year ARI event and left a huge impact on the Koo Wee Rup area, leaving over one thousand people homeless.

[1] Average Recurrence Interval (ARI): The average period in years between exceedance of a particular storm or flood event.

It was as a result of this event and similar but smaller flooding events that the construction of a diversion from Bunyip River at Cora Lynn to the Yallock Creek Outfall was prompted. This diversion is aimed primarily at protecting the township of Koo Wee Rup by reducing the flow in the Bunyip Main Drain (and adjacent or contributing drains) with the redistribution of some flow into the Yallock Creek.

2.5 Flood Information for the Road

Currently there does not appear to be any information available indicating the flooding characteristics of the existing Healesville-Koo Wee Rup Road or potential area of interest for the Koo Wee Rup Bypass.

What is known is that by definition the area of interest for the road duplication project is almost entirely in Zone 1, which indicates that the whole general area is subject to flooding up to approximately 300 mm in a 100 year ARI flooding event, above the general surrounding ground level. The existing road is usually higher than the general surrounding ground level, and therefore it could be assumed that it may well be either flooded to a depth less than 300 mm or in fact not at all in a 100 year flooding event, however there is no evidence to support this.

Likewise, for the small section of the road in Zone 2, allowance should be made to accept that the alignment may be flooded in a 100 year flood event.

3. Drainage Characteristics of the Area

3.1 Historical Development of the Drainage Area

The Koo Wee Rup district is quite well known for its unique drainage system and characteristics. The area is in low lying land due to its location between two tectonic plates. Movement of these plates caused the area to drop. Long before European settlement of the district, the area had been known to be a vast swampland. With more intense settlement of the area came the constructed drainage systems that still are in place today. These constructed drainage systems progressed very slowly from the mid to late 1800s and more rapidly in the early 1900s.

Extensive lengths of wide based earthen channels were constructed to reduce the swampland to a minimum and provide access to the rich soils of the area, mostly for agricultural purposes. However these drainage works also made way for settlement of the area to the east of the state, as previous to this the combination of the Dandenong Ranges and the Koo Wee Rup swamp had constricted access to the east.

The result of these works is that the vast Koo Wee Rup Flood Protection District, which once was swampland, is now layed out with an extensive network of drainage channels which drain the land well for the majority of the time, however during medium to large storm events the low lying land is still very much prone to flooding.

3.2 Drainage Layout

The entire Koo Wee Rup Flood Protection District is very flat, averaging land slopes of approximately 1 in 1000, but varying mostly from 1 in 500 to 1 in 4000. Because the land is so flat and adjacent to and discharging into Western Port Bay, the vast majority of the drainage network consists of channels or drains that are therefore also very flat in bed slope and generally quite shallow to accommodate the flat, low lying land surrounding them. In order to maximise the flow in the drains they tend to be quite wide, compared to their depth. These drains were mostly man-made and also constructed by hand and hand tools, as were the times.

The hydraulic implications of the low lying land are accentuated by the tide level of Western Port Bay. The design tide level used in analyses for these drains is set at 2.7 m AHD for the 100 year flood level analysis of the drains, which clearly creates a very flat hydraulic slope for flow as it enters the lower reaches of the Koo Wee Rup flood plain.

There are three main drainage systems operating (with separate outlets) in the Koo Wee Rup Flood Protection District. They are:

- Cardinia Creek/Toomuc Creek/Deep Creek Outfall;
- Bunyip Main Drain Outlet; and
- Yallock Creek Outlet.

It should be noted that higher in the catchment the Bunyip River and the Yallock Creek systems converge through a Bunyip Creek diversion outlet, although they diverge again and continue to outlet at separate locations. The diversion offers additional flood protection for the Koo Wee Rup township.

Figure 2 below shows these three main outlet systems.

3.3 Drainage Catchments

Exact drainage catchment boundaries were not available from Melbourne Water for this preliminary investigation, however an estimate of the approximate catchment boundaries for the three main creek systems in the area is provided in Figure 2, Drainage Catchments in the Koo Wee Rup Flood Protection District.

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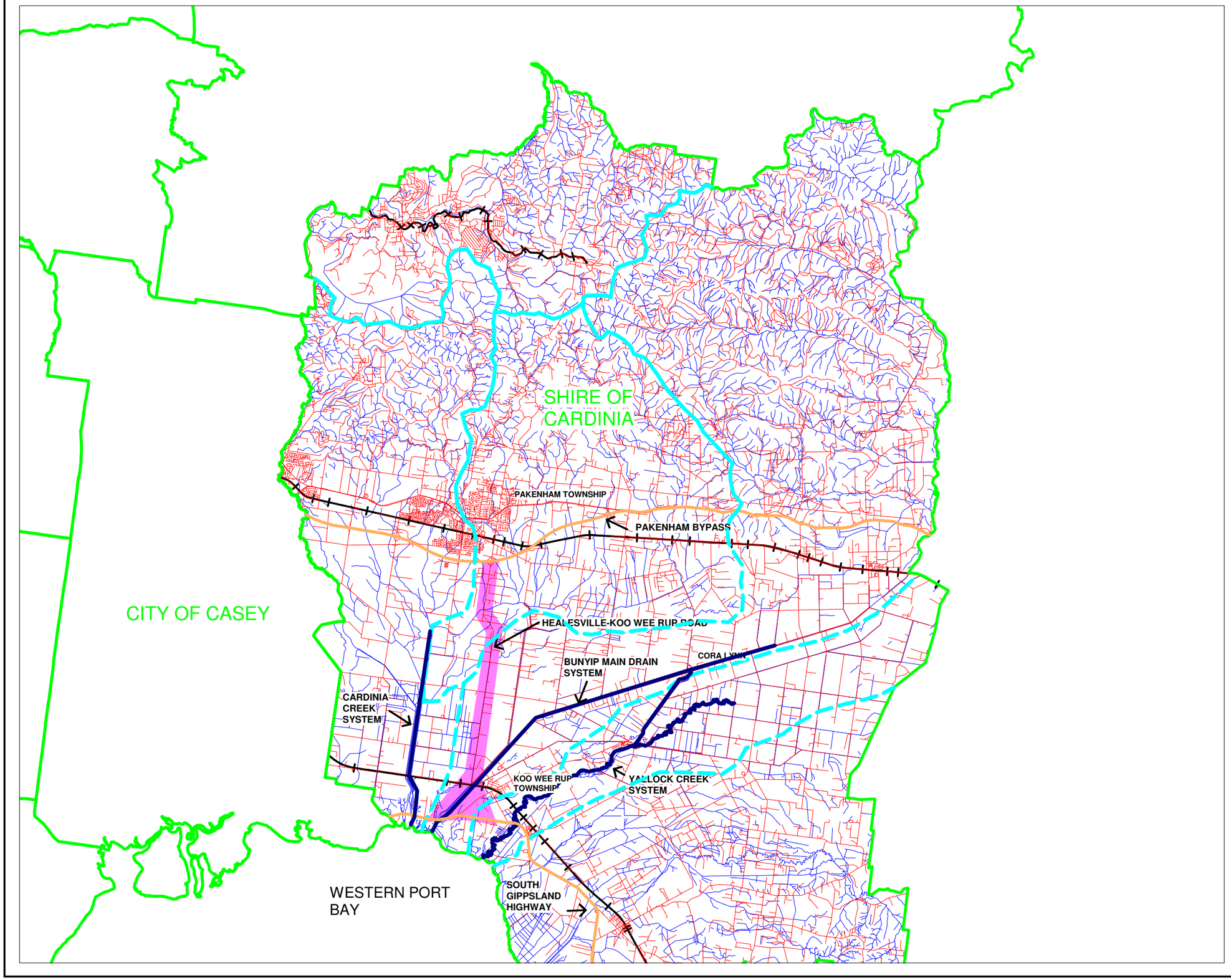
HEALESVILLE-KOO WEE RUP ROAD DUPLICATION PROJECT - DRAINAGE INVESTIGATION

Figure 2
Approximate Drainage Catchments in the Koo Wee Rup Flood Protection District



LEGEND

- Roads
- Drains
- Municipal Boundaries
- Major Roads
- Healesville-Koo Wee Rup Road Area of Study
- Railway Lines
- Major Catchment Drains
- Well Defined Catchment Boundaries
- Catchment Boundary with some transient flows

N W E S

SCALE 1 : 200,000 at A3

2 0 2 4 6 8 10 km

MAP GRID OF AUSTRALIA ZONE 55

LEVELS ARE TO AUSTRALIAN HEIGHT DATUM

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4. Identification of Main Drains and Waterway Crossings

4.1 Main Waterways

The main drains along the defined length of the Healesville-Koo Wee Rup Road being considered for duplication have been identified by Melbourne Water and are listed in Table 1 below.

Table 1 List of Main Drains

Approximate Distance (from northern end)	Name of Drain	Description of Location (with respect to the Healesville-Koo Wee Rup Road)
2.55 km	Deep Creek	Approximately 1.4 km south of Greenhill Road.
5.3 km (running parallel to the road)	McGregors Drain	This drain starts near the Deep Creek crossing, and follows the road alignment from approximately 0.8 km south of the Deep Creek crossing until it joins the Bunyip Main Drains systems just after the railway line leading into Koo Wee Rup. It crosses sides of the road from the east side (north) to the west side (south) at the Soldiers Road/Ellett Road intersection with the Healesville-Koo Wee Rup Road.
12.0 km *	McDonald Catch Drain	Runs underneath the existing Healesville-Koo Wee Rup Road, just upstream of the railway line.
12.05 km *	North West Catch Drain	Runs underneath the existing Healesville-Koo Wee Rup Road, just upstream of the railway crossing.
12.05 km *	Bunyip Main Drain	Runs underneath the existing Healesville-Koo Wee Rup Road, just upstream of the railway crossing.
12.1 km *	Southern Boundary Main Drain	Runs underneath the existing Healesville-Koo Wee Rup Road, just upstream of the railway crossing.
14.4 km *	Koo Wee Rup South Drain	This drain runs approximately east to west, south of Koo Wee Rup, and then turns south and crosses the South Gippsland Highway around one potential location the Koo Wee Rup Bypass Road may intersect the South Gippsland Highway.

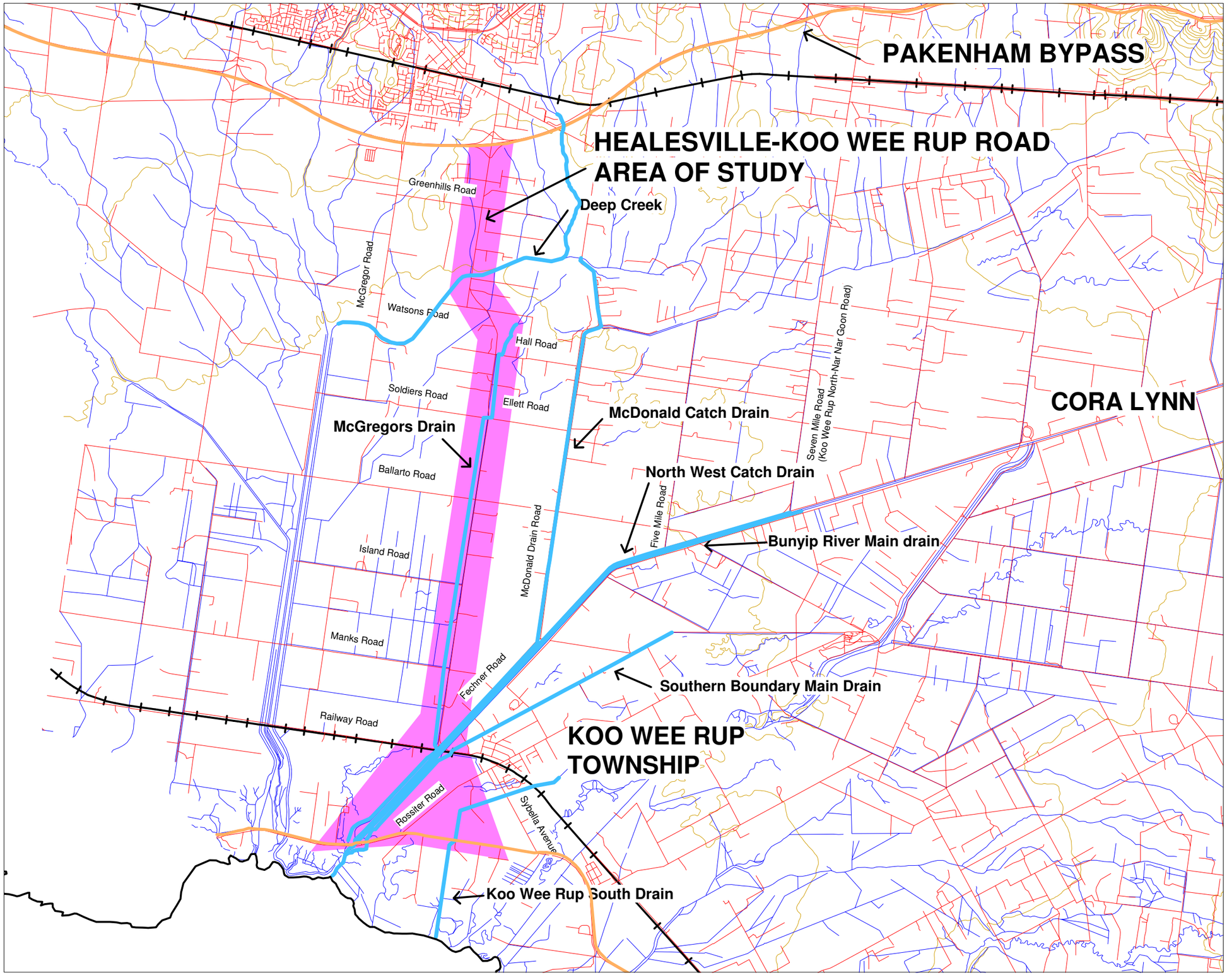
* This running distance may vary depending on the chosen road duplication alignment. The running distance cited refers approximately to the shortest route.

Figure 3 shows the area of interest, including the entire length of road under consideration for the proposed duplication and the seven main drains in relation to the existing road alignment.

VICROADS

HEALESVILLE-KOO WEE RUP ROAD DUPLICATION PROJECT - DRAINAGE INVESTIGATION

Figure 3
Area of Interest and Main Drain Layout Information



LEGEND

- Roads
- Drains
- Municipal Boundaries
- Major Roads
- Healesville-Koo Wee Rup Road Area of Study
- Railway Lines
- Main Drains along Road Alignment

N
W E
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SCALE 1 : 75,000 at A3

0.75 0 0.75 1.5 2.25 3 3.75 km

MAP GRID OF AUSTRALIA ZONE 55

LEVELS ARE TO AUSTRALIAN HEIGHT DATUM

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4.2 Other Drains and Connections

The above list is not a comprehensive list of all drains that exist in the vicinity of the works, but rather a list of Melbourne Water Main Drains in the area that the road duplication would be affected by. Other drains may exist, including council drains or private drains, but these would generally be more minor in nature. Note however that there are connections that the more minor drains would have to the main drains that would also affect the total works requirement for this project. For example, drains that would connect up to the McGregors Drain that runs parallel to the road and need to pass under the road duplication. These minor drain connections would include the following:

- McGregors Catchment Drain and Fogartys Drain (approximately 1 km north and parallel to Post Office Road);
- McGregors Catchment Drain and Soldiers Road Drains (may not connect into);
- McGregors Catchment Drain and Ellett or Post Office Road Drain;
- McGregors Catchment Drain and Ballarto Road Drain;
- McGregors Catchment Drain and Island Road Drain;
- McGregors Catchment Drain and McGregors Catchment Drain Diversion;
- McGregors Catchment Drain and Manks Road Drain (may not connect into);
- McGregors Catchment Drain and McKays Drain; and
- South Gippsland Highway and Coast Road Drain (drain runs parallel to the Sth Gippsland Hwy, affects on this drain depend on road duplication alignment).

(These drains have been located from the Koo Wee Rup Swamp Disaster Plan/Flood Protection District Drawing, Drg No. 138506.)

In addition to these there may be other minor drain connections required. No attempt has been made to determine anything further regarding these more minor drain connections as that is beyond the scope of this study.

5. Flow and Flood Level Information for Main Drains

5.1 Main Drain Flows

The flows listed in Table 2 below have been provided by Melbourne Water and represent the best information known at this time by Melbourne Water.

Table 2 Main Drains and Flow Information

Name of Drain	Flow (m^3/s)	ARI (years)	Location for which flow is relevant
Deep Creek	98	100	Bald Hill Road (near Pakenham Bypass)
McGregors Drain	No information available	No information available	
McDonald Catch Drain	87	100	Junctions of McDonald Drain with Koo Wee Rup Road
North West Catch Drain	38.5 No information available	5 100	At 7 Mile Road (Koo Wee Rup North-Nar Nar Goon Road)
Bunyip Main Drain	570 385 260	100 50 20	At the railway line, west of Koo Wee Rup.
Southern Boundary Main Drain	63	100	At the railway line, west of Koo Wee Rup.
Koo Wee Rup South Drain	100	100	At Sybella Avenue, south-east of Koo Wee Rup

Figure 4 below shows the main drainage systems as they intersect with the proposed road duplication project and the location along these drains that the flows and flood levels are relevant.

It should be noted that these flows are generally attributed to a location closest to the road alignment, but may not be the exact flow at the road duplication or bypass. They are generally indicative of the anticipated flows being the closest flow to the location of interest as provided by Melbourne Water.

It should also be noted that the flows provided by Melbourne Water have typically been associated with the road alignment to provide an indicative understanding.

An example of this issue is with the North West Catch Drain where the flow provided is relevant for the corner at 7 Mile Road, which is approximately 9 km upstream of the potential road duplication crossing (on the closest route). Design flows can vary (up or down) depending on distance away from the location of interest if there is attenuation or further catchment contributions with cumulative peaks contributing.

As further drainage design continues over the years of the design time frame for this road project, these flows should be confirmed with Melbourne Water in case more detailed information becomes available.

5.2 Derivation of Flow Information

The flows provided in Table 2 above by Melbourne Water have been derived by a variety of methods.

There are RORB models available for the flows in the main outfall drains, including Bunyip Main Drain and Deep Creek (note that Deep Main Drain flows into the Cardinia Creek system, not into the Bunyip Main Drain system). The original RORB model was formed in 1994 and it was modified in 1996.

In addition to this, the Deep Creek flow was determined in a study by Water Technology for the Pakenham Bypass in March 2005, confirming a flow in the order of 98 m^3/s.

Finally, the flow for the Southern Boundary Main Drain was calculated by Melbourne Water using the Rational Method.

5.3 Main Drain Flood Levels

The flood levels listed in Table 3 below have been provided by Melbourne Water and represent the best information known at this time by Melbourne Water.

Table 3 Main Drain 100 Year Flood Level Information at the Road Duplication Intersection

Name of Drain	Flood Level (m AHD)	ARI (years)	Location for which flood level is relevant
Deep Creek	8.0	100	Upstream of Watsons Road
McGregors Drain	No information available	No information available	-
McDonald Catch Drain	6.79	100	Junctions of McDonald Drain Road with Fechner Road
North West Catch Drain	No information available	No information available	-
Bunyip Main Drain	4.76 - -	100 50 20	At the railway line, west of Koo Wee Rup. This flood level is relevant for the section contained within the levees, although the levees will not contain all the flow and some will spill into the northern flood plain.
Southern Boundary Main Drain	No information available	No information available	-
Koo Wee Rup South Drain	No information available	No information available	-

This list of flood levels is not comprehensive of all the information known about flood levels in the vicinity of the Healesville-Koo Wee Rup Road. Figure 4 shows all information known regarding 100 year flood levels in the vicinity of the road duplication project. However it should be noted that for some drains there is no flood level information available. There is additional flood level information available for intermediate points along the drains in some locations, and this information can be found in Appendix B as part of the correspondence provided by Melbourne Water for this project dated 8 March 2006.

It should also be noted that while all flood level information provided by Melbourne Water and stated in this report is for a 100 year ARI flooding event, it is possible that the ultimate design criteria for accommodating flooding levels may not be to 100 year ARI standard. This particular criteria will be set as the highest standard required by either VicRoads or Melbourne Water.

When further hydraulic modelling is being undertaken for this project during future investigations, it would be preferable to obtain Melbourne Water's original hydraulic modelling files to provide a consistent basis for the hydraulic modelling under the new conditions (such as survey, new bridge/culvert design, etc), if this is possible. It will also be important at that stage to determine the appropriate and applicable flood levels for the drainage crossings more precisely to provide afflux and flood level conditions.

A copy of all information provided by Melbourne Water is contained in Appendix B of this report.

5.4 Derivation of Flood Levels

Flood levels for the main drains were derived and provided by Melbourne Water. The flood levels for the Bunyip Main Drain were derived from a HEC-RAS model and possibly also from a MIKE 11 model.

Melbourne Water is not planning to do any additional studies on the hydrologic or hydraulic characteristics of the drains intersecting this proposed road duplication project in the near future.

VICROADS

HEALESVILLE-KOO WEE RUP ROAD DUPLICATION PROJECT - DRAINAGE INVESTIGATION

Figure 4
100 Year Design Flows and Flood Levels for Main Drains

PAKENHAM BYPASS

98 m3/s

HEALESVILLE-KOO WEE RUP ROAD AREA OF STUDY

Deep Creek

Bald Hill Road

Greenhills Road

McGregor Road

FL 8.0 m

Watsons Road

Hall Road

Soldiers Road

Ellett Road

McGregors Drain

McDonald Catch Drain

CORA LYNN

Seven Mile Road (Koo Wee Rup North-Nar Nar Goon Road)

Ballarto Road

North West Catch Drain

Five Mile Road

McDonald Drain Road

Island Road

Bunyip River Main Drain

87 m3/s

FL 6.79 m

Manks Road

Fechner Road

Southern Boundary Main Drain

Railway Road

KOO WEE RUP TOWNSHIP

Bunyip River MD 570 m3/s

FL 4.76 m

63 m3/s

Rossiter Road

100 m3/s

Sybella Avenue

Koo Wee Rup South Drain

LEGEND

- Roads
- Drains
- Municipal Boundaries
- Major Roads
- Healesville-Koo Wee Rup Road Area of Study
- Railway Lines
- Main Drains along Road Alignment
- 87 m3/s — 100 Year ARI Flow and Location
- FL 6.79 m — 100 Year ARI Flood Level (AHD)

N W E S

SCALE 1 : 75,000 at A3

0.75 0 0.75 1.5 2.25 3 3.75 km

MAP GRID OF AUSTRALIA ZONE 55

LEVELS ARE TO AUSTRALIAN HEIGHT DATUM

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6. Drainage Crossing Design Criteria

6.1 General Information

In most road design projects the design criteria are generally formed based on the requirements of all affected parties involved and their normal design criteria expectations for the type of road development project being considered. In this particular case the drainage criteria will be formed on the basis of the requirements from VicRoads, Melbourne Water and the Shire of Cardinia (although the Shire of Cardinia will have reduced influence in the main drainage criteria) with dominant interests in road standards, main drains and council drains respectively.

The general criteria that will define the drainage requirements often include the following:

- Allowance for flows to be transferred within the drainage structure up to the stated ARI in years;
- Flows to be confirmed based on existing, rural or fully developed catchment upstream;
- Afflux criteria;
- Issues regarding the filling in of the flood plain; and
- Water Sensitive Design needs for treatment of runoff from the road.

6.2 VicRoads Requirements

VicRoads generally set out the requirements for all road design projects in accordance with Part 7 of the Road Design Guidelines. These guidelines indicate that there are a number of factors to consider when determining an appropriate design ARI for flood protection for a road, and these include:

- Damage to assets as a result of the flooding (eg, to property, structures and roads), including added maintenance costs;
- Delays to traffic or diversion time and distances if flooding does occur; and
- What the additional cost would be to allow for a greater level of protection from flooding.

Given these factors, Table 7.2.4 of the Road Design Guidelines, Part 7, indicates that an appropriate level of protection for flow beneath bridges or major structures is 100 years, and for cross drainage under freeways and arterial roads is 50 year.

In addition to this, Part 7.4.3.3 (b) of the Road Design Guidelines regarding guidelines for surface flows states that “channel flows on freeways generally should be confined to the shoulders; in the 50 year ARI storm, flooding or ponding should not extend across more than half of the left lane”.

VicRoads requirements do not explicitly discuss flood plain, afflux or similar related issues, but defer to the needs of the relevant water authority in the area. The exception to this would be if the flooding event were to have an adverse affect on the road structure as a result of prolonged flooding.

6.3 Melbourne Water Requirements

In Melbourne Water's letter to VicRoads dated 8 March 2006, Melbourne Water have recommended the following, in relation to the proposed road duplication project and the main drain intersections or impacts:

- The finished level of the duplicated road should be set no higher than the existing road finished levels to ensure there will be no increase in flood level. If this is not possible, additional bridging may be required to ensure U/S flood levels are not increased;
- The flood plains are low-lying areas adjacent to rivers, creeks and earth drains and studies may be required to demonstrate no increase in upstream flood levels; and
- Any new crossover should be referred to Melbourne Water prior to final designs.

After additional discussions with Melbourne Water regarding the investigation stages of this project, the following additional comments were obtained:

- Filling in the flood plain will be allowed subject to no increase in flood levels on the upstream or downstream sides of the area in question;
- The document "Guidelines for Development within the Koo Wee Rup Flood Protection District" should be applied in the design of this road duplication project; and
- The road should be constructed taking into account Water Sensitive Urban Road Design principles (WSURD).

It should be noted that while Melbourne Water generally have a particular standard that is required, there may be the opportunity to renegotiate particular items or ask for them to be reconsidered, say on the grounds that in a specific situation the regulation may be less appropriate or if a criteria is very difficult to meet exactly, but can be met in the majority, particularly if there are proven to be no adverse (third party) affects as a result of the variation.

6.4 Ultimate Road Design Criteria

Considering the criteria set by both VicRoads and also Melbourne Water, the following is the culminated set of drainage requirements for the new duplicated road. It represents the highest collective standard required, where necessary:

- Allowance for transfer of flows up to 100 year ARI to be accommodated in the main drainage crossings of the duplicated road;

- Afflux criteria set at the waterway crossing such that no increase in upstream or downstream flood levels will be experienced as a result of the road duplication project;
- Water Sensitive Urban Road Design principles should be applied for treatment of runoff from the road;
- The document “Guidelines for Development within the Koo Wee Rup Flood Protection District” should be applied in the design of this road duplication project;
- Any new crossover should be referred to Melbourne Water prior to final designs;
- Consideration should be given to issues such as the damage to assets as a result of the flooding (eg, to property, structures and roads), including added maintenance costs;
- Delays to traffic or diversion time and distances if flooding does occur; and
- What the additional cost would be to allow for a greater level of protection from flooding.

7. Requirements for New Drainage Crossings

7.1 Drainage Crossings for the New Road

Whilst the exact alignment of the section of road north of Koo Wee Rup is still to be determined, it is expected that it will be adjacent to the existing road on either the eastern or western side and possibly may even swap sides depending on the design constraints. The main drain crossings in this section are the Deep Creek and McGregors Drains, however the McGregors Drain runs right beside the existing road for the majority of this length and crosses under the road near the Soldiers Road/Ellett Road intersection.

For the section of road adjacent to and south of Koo Wee Rup, the potential road alignment is less defined as there is no existing road alignment to follow, and there are major issues to overcome in terms of determining how to incorporate the crossing of the main Bunyip Main Drain and its series of parallel contributing drains, along with the railway line at that point. The only other main drain to contend with along this section is possibly the Koo Wee Rup South Drain although this will depend on the potential alignment of the new road.

7.2 Infrastructure Requirements

The following is a list of new waterway crossings that will need to be constructed over the main drains that intersect with the proposed road duplication project. These waterway crossings all assume that the road duplication will occur adjacent to the existing road alignment north of the Koo Wee Rup township and also that the new road alignment south of Koo Wee Rup approximately assumes a north-south orientation rather than parallelling the Bunyip River Main Drain and associated drains.

Table 4 below also includes an estimate as to whether a bridge or culverts would be expected, the 100 year ARI flow expected, and based on a very approximate estimate of velocity of 1.0 m/s, the estimated waterway area required to accommodate the maximum flow design criteria. The approximate waterway area determined is highly dependant on the velocity assumed. This velocity was assumed on the basis that the surrounding land is quite flat and the area is well known for being slow to drain.

The approximate waterway area in Table 4 is the area below the water level. Additional opening area will be required to provide freeboard to the bridge soffit (Melbourne Water states their freeboard requirements in Appendix B, as 600 mm above the 100 year ARI flood level).

As the design progresses the required waterway areas should be determined using hydraulic modelling using more detailed survey, road concepts, design criteria and design flows as appropriate.

Table 4 New Waterway Crossings

Running Distance	Main Drain	Expected Bridge or Culvert	Design Flow (m^3/s) (for a 100 year ARI event)	Very Approximate Waterway Area Required (m^2)
2.55 km	Deep Creek	Bridge	98	98
5.3 km (running parallel to the road)	McGregors Drain	Not enough information available to determine.	Information not available	-
12.0 km *	McDonald Catch Drain	All of these drains run in parallel to each other and would require one large bridge to span them all.	87	87
12.05 km *	North West Catch Drain		Information not available	-
12.05 km *	Bunyip Main Drain		570	570
12.1 km *	Southern Boundary Main Drain		63	63
14.4 km *	Koo Wee Rup South Drain	Bridge	100	100

* This running distance may vary depending on the chosen road duplication alignment and refers to the shortest route (north-south alignment), as does the description.

Due to the shallow nature of the drainage system is it expected that relatively large bridge spans will be necessary to provide the required waterway areas.

8. Impact of Road Duplication on Drainage

By definition, the proposed impact of the Healesville-Koo Wee Rup Road Duplication project on the drainage system will be very minor if the design criteria set out are being adhered to for all flows up to the 100 year ARI.

Care will need to be taken in ensuring that embankment stability is maintained during and after the construction of these new crossings. In addition to this it will be necessary to consider the water quality aspects during construction, such as accommodating and treating runoff from the construction site with high suspended solids (ie. runoff from bare earth surfaces).

It should be noted that with this road duplication project and it's associated works there is the potential to create land locked depressions.

Positive afflux is usually defined as the expected increase in flood level, relative to the current conditions (comparison is seldom made to historical conditions, say prior to any road construction).

For the section of duplicated road, it could be expected that there might be some afflux, however, because there is an existing road defining the vertical alignment and flow distribution it would be reasonable to expect that afflux would be relatively minor.

The afflux in the section of bypass road may be more significant than that of the duplicated section. This is because there is not an existing road that already influences the current flood flows. While afflux from the proposed bypass is anticipated to be larger and or more difficult to reduce, the backwater effects from downstream conditions (say at Western Port Bay) may reduce the impact of the proposed works.

Whether the alignment of the bypass section runs parallel to the Bunyip Main Drain or crosses over the drain and continues on to the south east before connecting into South Gippsland Highway, it is likely to influence the potential changes in flood level. Assuming that the alignment is not dictated by other non drainage criteria it is recommended that the relative hydraulic merits of various alignments are assessed using appropriate modelling prior to adopting a preferred route.

For both the duplicated and bypass sections, additional hydraulic modelling with more detailed design concepts would be required to verify the above comments and quantify the expected impact on flood levels

9. Conclusions

The main drains along the route of the Healesville-Koo Wee Rup Road duplication are owned by Melbourne Water. The main drains impacting the potential road alignments for this road duplication have been identified and quantified in terms of anticipated design flow and flood levels, where this information has been available from Melbourne Water. The vast majority of these crossings will probably need to be bridge designs and will need to accommodate the substantial but shallow flows that are so indicative of the area (hence the need for long spans).

Design drainage criteria have been identified, the major principles of these being:

- No increase in flood levels upstream or downstream as a result of the road duplication and bypass; and
- Accommodating flow up to the 100 year ARI flooding event in the drainage infrastructure for the main drains.

Very approximate waterway area expectations have been outlined in this report, however these will require further investigation as the concept is refined in future studies.

The exact influence of the road duplication and bypass on flood levels can only be determined to any reliable degree by hydraulic modelling.

10. Recommendations

As a result of this investigation it has become apparent that there are several issues regarding drainage that require further consideration.

Firstly the following is a list of required information that has not been provided:

- Flow information for the McGregors Drain;
- Flow information for the North West Catch Drain for the 100 year flooding event; and
- All flood level information for the 100 year flooding event including the Koo Wee Rup South Drain, North West Catch Drain, McGregors Drain and the Southern Boundary Main Drain.

Considering the above and all the information that is known, the following issues should then be pursued:

- Consideration of combining the Bunyip Main Drain and all other drains running parallel to this at the crossing of the road. This may require extensive hydraulic studies, however this may be worthwhile considering the potential to decrease the span of the bridge over the channels. Early indications from MW regarding this issue show a good possibility of approving this kind of arrangement as long as the following design conditions were met:
  - No increase in flood levels;
  - No increase in velocities, depths or velocity ratios;
  - No significant impact upon the environment;
  - Hydraulic modelling of the proposed arrangement would be required to demonstrate these conditions being achieved;
- Obtaining a comprehensive list of flows for the design ARI event along the main drains for the point of intersection with the proposed duplicated road;
- Obtaining more detailed survey of the existing crossings with a view to using this in hydraulic modelling. Further discussions with Melbourne Water would be required to determine the hydraulic modelling required for future analysis and obtaining if possible a copy of the hydraulic models previously used by Melbourne Water. This would enable some hydraulic modelling of the main drainage crossings with a view to determining with more confidence the waterway area required, which is quite critical to determining realistic costs for the main drainage crossings; and
- Discussions with the local council should be undertaken with a view to obtaining further drainage information regarding the more minor drains feeding into the main drains.

It is recommended that VicRoads consider the information provided in this report and upon deciding on a more precise alignment (or alternatively selecting several well defined alignments) proceed to a conceptual design stage for all main drain crossings of the duplicated road alignment, focussing on the issues raised above.

11. References

From Swampland to Farmland: A History of the Koo-Wee-Rup Flood Protection District, David Roberts, Rural Water Commission of Victoria, 1985

Guidelines for Development within the Koo Wee Rup Flood Protection District, Melbourne Water, October 2003

Part 7 (Drainage) Road Design Guidelines, VicRoads, September 1999.

Appendix A

Melbourne Water Report

Guidelines for Development within the Koo Wee Rup Flood Protection District

Guidelines for Development within the Koo Wee Rup Flood Protection District

Melbourne Water

Guidelines for Development within the Koo Wee Rup Flood Protection District

Acknowledgements

Melbourne Water prepared the Guidelines with the assistance of a specially appointed Reference Committee of experienced people who provided valuable comment and advice on the contents of the Guidelines. The members are listed inside the back cover of this document.

Feedback and enquiries

Melbourne Water welcomes feedback on these Guidelines at any time.

Comments in writing should be addressed to:

The Manager Catchment Planning
Planning Group
Melbourne Water
GPO Box 4342
Melbourne Vic.3001

Enquiries or verbal comments may be made by contacting:

Manager Land Development – South East
Telephone: 9235 2522

Further information on development requirements can be found in:

- Guidelines for Development in Flood-Prone Areas
- Melbourne Water's Land Development Manual.

Copies of the Guidelines may be obtained by ringing 9235 2197 or visit our website at www.melbournewater.com.au

Authority

Group Manager, Planning
Melbourne Water Corporation

Next scheduled Review

October 2003
Version 1.0

Victoria
The Place To Be

City of Casey

CARDINIA

Melbourne Water

Contents

Abbreviations

ARI Average Recurrence Interval

KWRFPD Koo Wee Rup Flood Protection District

AHD Australian Height Datum

1. Introduction

Melbourne Water is responsible for regional drainage, floodplain management and waterway management, including the protection and improvement of water quality in the waterways across the Greater Melbourne area. As part of this responsibility Melbourne Water has prepared *Guidelines for Development in Flood-Prone Areas* that outline Melbourne Water's guidelines for development within areas affected by flooding.

Floodplains are low-lying areas adjacent to rivers, creeks and man-made drainage channels. Rain events extending from several hours to one or more days in duration can result in the inundation of these areas.

The area within and surrounding Koo Wee Rup Flood Protection District (KWRFPD) forms one of Melbourne's largest and most unique floodplains. This area is one of Victoria's richest agricultural regions and pressures for further agricultural activity and associated development has increased the need for a consistent approach to development requirements.

The aim of this document is to provide guidelines for development within the KWRFPD and surrounding areas which will minimise flood damage and community losses, and which take into consideration the unique flooding nature and history of the district. It incorporates best practice in floodplain management and is designed to protect water quality within the district (and Western Port) in accordance with the provisions of relevant State Environment Protection policies.

1.1 Location and History of the KWRFPD

The KWRFPD lies in what was originally known as the Koo Wee Rup Swamp (Figure 1), which was formed from a tectonically depressed basin between the Tyabb and Heath Hill Faults and covers an area of approximately 400km^2. The Swamp was fed by a catchment 2208km^2 in area that included the three major drainage basins of Cardinia Creek, Bunyip River and Lang Lang River catchments.

Prior to European Settlement, the Yallock Creek formed the only permanent outlet from the swamp into the Western Port Bay. In the late 19th century the swamp was slowly drained with a network of constructed channels and improved outfalls to Western Port. This early drainage system allowed limited

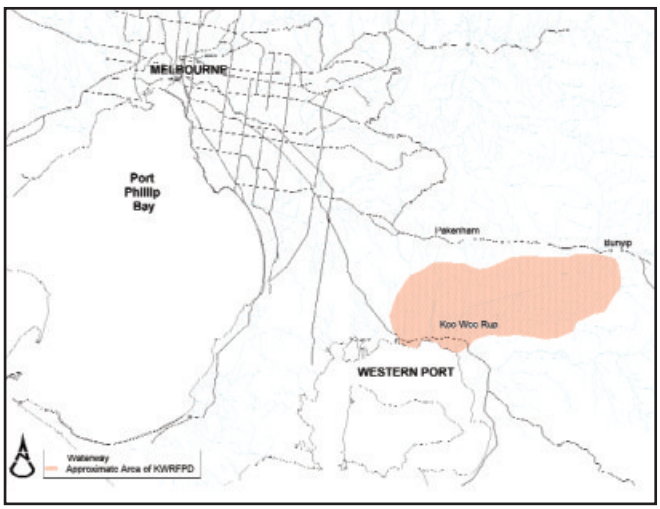


Figure 1: Location plan

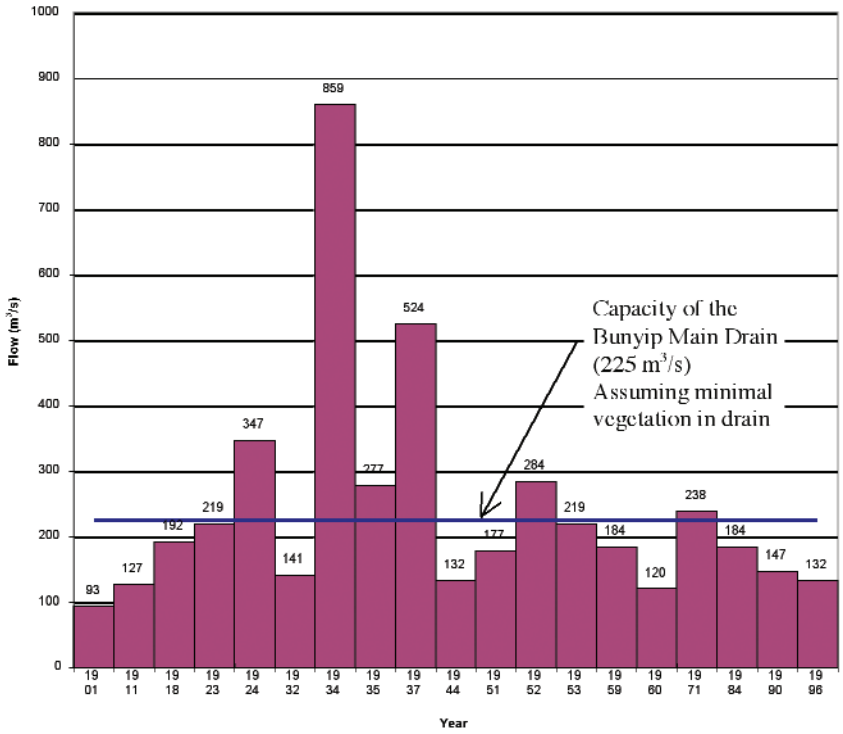


Figure 2: Significant flows in the Bunyip Main Drain

agricultural activities within the reclaimed swamp between floods, and passage through the swamp to Gippsland. Today, the drainage system that includes the two main carrier drains (the Cardinia Outfall Drain and the Bunyip Main Drain) provides a relatively high level of flood protection for a rural area and, allows intense and productive agricultural activities.

These main carrier drains will take flows from a storm event of an intensity experienced once every 7 years in some locations and 15 years in other locations (i.e. 7-15-year Average Recurrence Interval (ARI) event). Local drains may flood more frequently.

1.2 Flooding Within the District

The KWRFPD has flooded many times in the 20th century. The largest flood on record (approximately 150-200-year ARI event) occurred in 1934, when the entire district was inundated and more than 1000 people were made homeless. Figure 2 shows significant flows in the Bunyip Main Drain over the past century.

Following the 1934 flood and regular flooding of the district, construction of the Yallock Outfall commenced in the 1950s. The outfall splits the flow of the Bunyip Main Drain at Cora Lynn and thus provides flood protection from the overtopping of the Bunyip Main Drain for the Koo Wee Rup Township.

Flooding in the district results from not only the overtopping of the main carrier levees but also as a result of floodwaters from the local catchments exceeding the capacity of the local drainage system.

Flooding within the district is characterised by large areas of water pondage, particularly behind raised roads and levees. Due to the extremely flat nature of the terrain, even relatively minor events can inundate large areas within the district.

2. Description of Zones and Flooding

The Guidelines for Development in Flood-Prone Areas describes floodplains as either Active Floodways, where the majority of the flow will occur, or Fringe Areas, where the water is shallow and does not carry a significant proportion of the flows.

Flooding within the KWRFPD is characterised by large expanses of slow-moving water, with considerable water pondages, concentrated flow paths and localised areas of higher ground scattered throughout the floodplain. The active and fringe definitions do not adequately describe these flooding conditions in this area.

Instead, the district has been split into five general zones based on the average depth of flooding over that zone for a 100-year ARI event. Areas of ponded water, high ground and concentrated flow paths have been identified following a detailed survey of the district. The five zones allow for an approximate depth of flooding to be provided for the property, which may then be analysed further to ascertain an accurate flood level or flood depth above ground upon referral of an accurate and clear building location plan. The location plan coupled with the survey information available to Melbourne Water may be used to determine the average natural surface of the surrounding area to provide a flood level to the Australian Height Datum (AHD).

2.1 Zone (refer also to Map in Attachment A)

The five zones can be generally described as follows:

Zone 1

This zone contains the majority of the district (areas bordering the district are similar in nature). Zone 1 is subject to flooding due to overflows from drains. The 100-year ARI flood depth is generally 300mm above the general surrounding ground level.

Zone 2

Zone 2 is liable to deep flooding as a result of concentrated overflows from a major drain. The 100-year ARI flood depth is generally 700mm above the general surrounding ground level.

Please note that some flood modelling has been undertaken within these zones and a flood level may be available upon request.

Zone 3

This area has a high level of protection from the Bunyip floodwaters because of the Yallock Outfall and the Bunyip Main Drain levee banks. Zone 3 is liable to flooding from the local drainage and minor overflows of the main levee bank system. The 100-year ARI flood depth is generally 150mm above the general surrounding ground level.

Zone 4: The Koo Wee Rup Township

The Township of Koo Wee Rup is liable to flooding from local floodwaters and minor overflows of Bunyip Main Drain floodwaters from the main levee system. Flood levels are available from Melbourne Water upon request.

Zone 5

This area is not affected by overflows from any of the main waterways. Parts of the area are liable to shallow overland flows from local catchments and need to be considered in site layout. The 100-year ARI flood depth is generally 150mm above the surrounding ground level.

2.2 Ponded Areas

Ponded areas occur where the passage of floodwaters will be restricted or blocked due to raised roads, levees, railways or natural depressions. In these areas the floodwater has a uniform or flat surface, whereas other areas have a floodwater surface that grades accordingly with the general ground surface. A flood level specified in metres to Australian Height Datum (AHD) may be provided in ponded areas. Development may be unsafe where the depth of the pondage exceeds 0.5m.

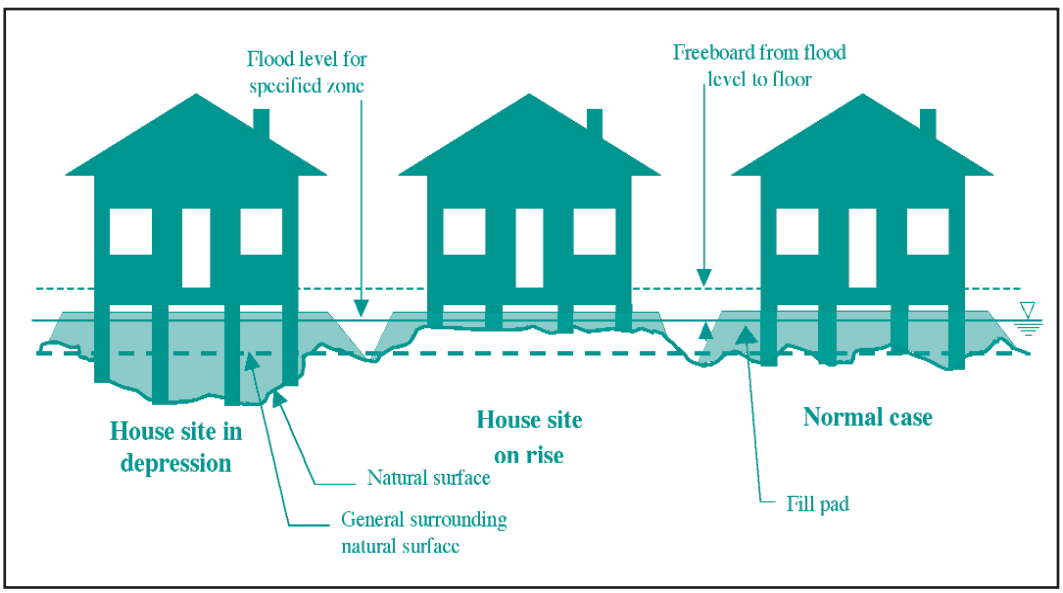


Figure 3. Cross section of house and fill pad relative to "general surrounding ground level. The term 'flood level above the general surrounding ground level' allows some flexibility in setting the flood level. It allows for minor variations in ground level. For example, if a building site is on a piece of local high ground then the flood depth would be reduced. On the other hand, if the site is in a depression, the flood depth would be increased and this is not recommended.

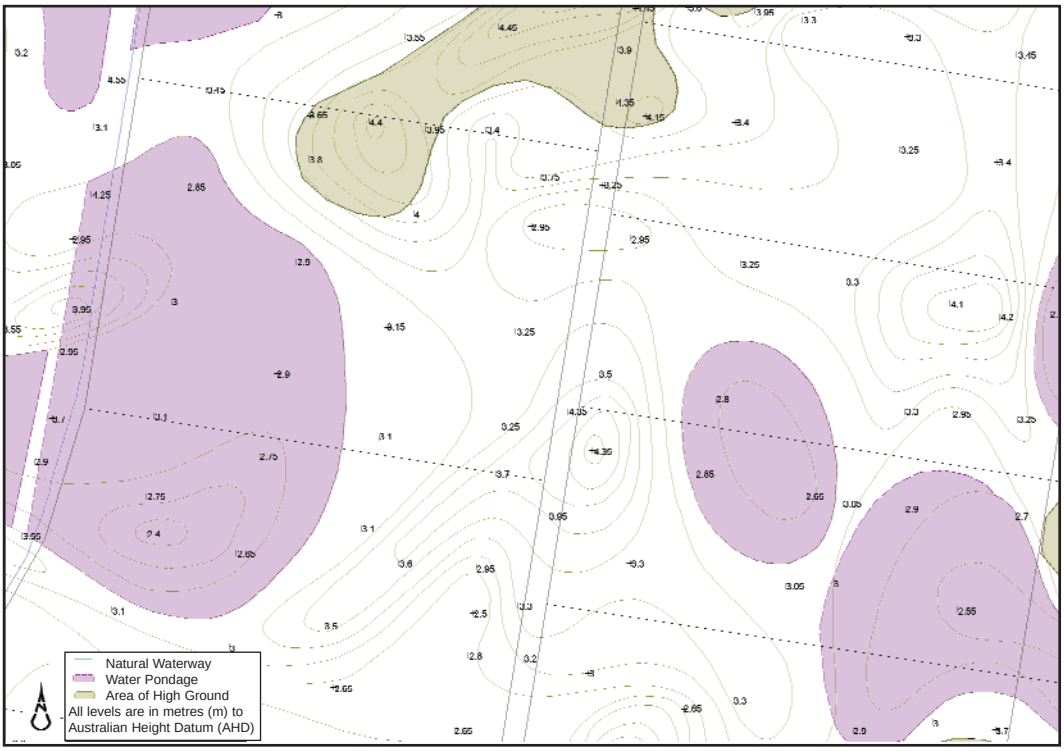


Figure 4: Identification of areas of water pondage and high ground.

2.3 High Ground

These are areas where the land will not be subject to flooding for a 100-year ARI event. It is advisable that buildings be sited within high-ground areas; however, development requirements for the surrounding zone will still apply.
For example, buildings on high ground adjacent to floodplain areas should have floors set above the surrounding flood zone.

2.4 Concentrated Flow Paths

In these areas, flows will be concentrated, either along shallow gullies or defined channels, and the velocities and depth of flow will be greater than the surrounding area. Any development within these flow paths is inadvisable.

3. Requirements

The following guidelines have been prepared to promote best-practice management of development in the KWRFPD. The development guidelines within the KWRFPD will vary depending on whether the referral is for a building permit or for subdivision. The development guidelines will now be described *(and summarised in Attachment B)*.

3.1 Building Permit Referrals

3.1.1 Dwellings

Freeboard is the height above a defined flood level, which is required to provide a factor of safety when setting floor levels for developments. It allows for factors such as wave action, settlement of levees and the possibility of events greater than the adopted standard.

State building regulations specify a minimum general freeboard requirement of 300mm above the 100-year ARI flood level. However, Melbourne Water considers a larger freeboard requirement is applicable for development in the majority of the KWRFPD. This is due to the large expanses of water that will occur during a flood event and the increased risk of higher levels due to wave action.

Due to the nature of the flooding within the KWRFPD; that is, the extent of flooding and possible duration of floodwaters, Melbourne Water recommends fill pads for all new dwellings (with the exception of Zones 3 and 5 and in built-up areas where the lots are smaller than 800m^2). Fill pads will provide an area around the dwelling that may act as a place of refuge for livestock and storage for machinery.

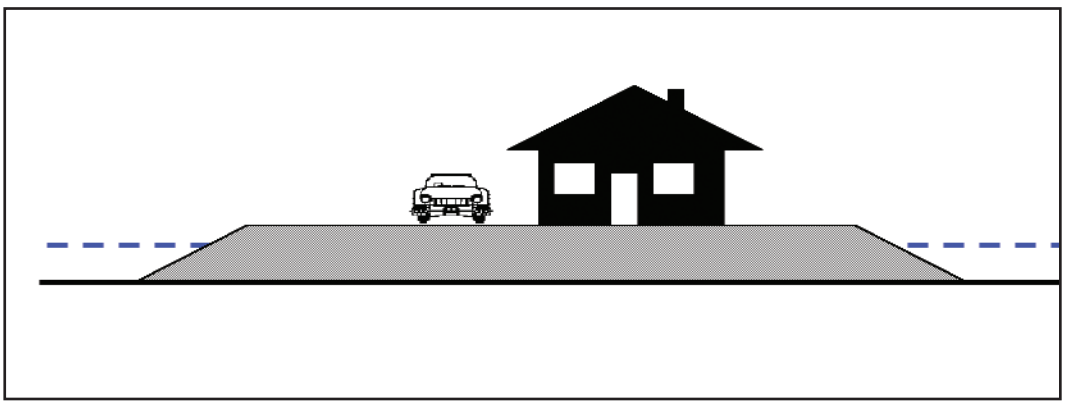


Figure 5: Fill Pad Cross Section

The requirements for dwellings vary depending on the Zone they are in. The requirements for dwellings for each zone are as follows:

Zone 1

- Floor levels of any new dwelling to be a minimum of 600mm above the applicable flood level.
- A fill pad that extends at least 5m beyond the building and a minimum of 150mm above the flood level.

Zone 2

- Floor levels of any new dwelling to be a minimum of 600mm above the applicable flood level; however, building may not be permitted where the depth is more than 500mm.
- A fill pad that extends at least 5m beyond the building and a minimum of 150mm above the flood level.

Zone 3

- Floor levels of any new dwelling to be a minimum of 300mm above the applicable flood level.

Zone 4

- Floor level of any new dwelling to be constructed a minimum of 300mm above the applicable flood level. (The relaxation of the 600mm freeboard requirement within this zone is on the basis that future works will be done to lower flood levels. Freeboard requirements will be put up to 600mm upon completion of these drainage works. Melbourne Water is proposing future works that will lower the applicable flood levels by approximately 300mm. Upon completion of these drainage works the freeboard requirement of 600mm will be satisfied).
- A fill pad that extends at least 5m beyond the building and a minimum of 150mm above the designated flood level on lots greater than 800m^2.

Zone 5

- Floors are to be a minimum of 450mm above the natural ground surface or 300mm above the applicable flood level, whichever is greater.

3.1.2 Non-Habitable Outbuildings

For any non-habitable outbuilding constructed within the KWRFPD, floor levels are to be a minimum of 300mm above the applicable flood level for a building with a concrete floor or 150mm above the applicable flood level for an earthen floor.

3.1.3 Special Cases

Extensions

Please refer to the *Guidelines for Development in Flood-Prone Areas* for requirements. Please note the freeboard requirements for the flood zone.

Milking Sheds

Milking sheds are to be constructed in consultation with EPA Victoria and the Department of Natural Resources and Environment. Sheds are to be constructed at or above the applicable flood level and adequate waste treatment must be provided on site to ensure that no material from the milking operations is discharged into the drainage system for up to a 100-year ARI event.

Poultry Farms

All new poultry farms should be constructed in accordance with the *Victorian Code for Broiler Farms*. This code is incorporated in the Victorian Planning Provisions and all planning schemes in Victoria and in the Best Practice Guidelines it says that sheds must not be located in areas designated as subject to inundation. Melbourne Water requirements include the following criteria:

1. Where sheds are adjacent to floodplains, sheds are to be constructed on a clay fill pad that is a minimum of 600mm above the applicable flood level. Some consideration may be given to the freeboard requirement if flood-proofing measures are undertaken to the satisfaction of Melbourne Water.

2. The drainage system in the KWRFPD cannot accept any increase in stormwater flows resulting from development, such as poultry farms. All such developments must therefore incorporate an on-site stormwater retention dam. An on-site retention dam must be provided that controls runoff from only the impervious surfaces within the development. The requirements of this detention are:
   - 900m^3 of freeboard storage in a dam above full supply level per hectare of catchment area (and including the dam area in this);
   - Freeboard storage to be no more than 450mm deep;
   - Outlet from the dam to be controlled to 3 l/s per hectare of catchment (including dam area again); and
   - The dam should be lined with an impervious lining and the freeboard provision should be above the natural surface to avoid possible groundwater problems.

3. No material other than stormwater must be discharged into the drainage system (including the site detention dam). Adequate waste treatment must be provided on site to cater for this requirement.

4. All buildings or dams associated with the poultry farm are to be set back a minimum of 60m from the centreline of any Melbourne Water watercourse.

5. Dead birds, litter, shavings or the like arising from the use of the poultry farm must not be spread or stored on site.

6. Design drawings and details of the site layout must be submitted to Melbourne Water for comment and approval prior to commencement of any works on site.

3.2 Subdivision referrals

To ensure that new allotments provide a suitable area for the construction of new buildings, fill pads are a requirement of subdivisions within the KWRFPD where siting of development on high ground is not possible. These requirements include those mentioned below (unless otherwise agreed to in writing by Melbourne Water).

3.2.1 Allotments Greater Than 1 Hectare

- A fill pad is required of at least 1000m^2 and a minimum of 450mm above the applicable flood level; and
- The Plan of Subdivision should specify a building envelope on this fill pad.

3.2.2 Allotments Measuring Between 800m^2 and 1 Hectare

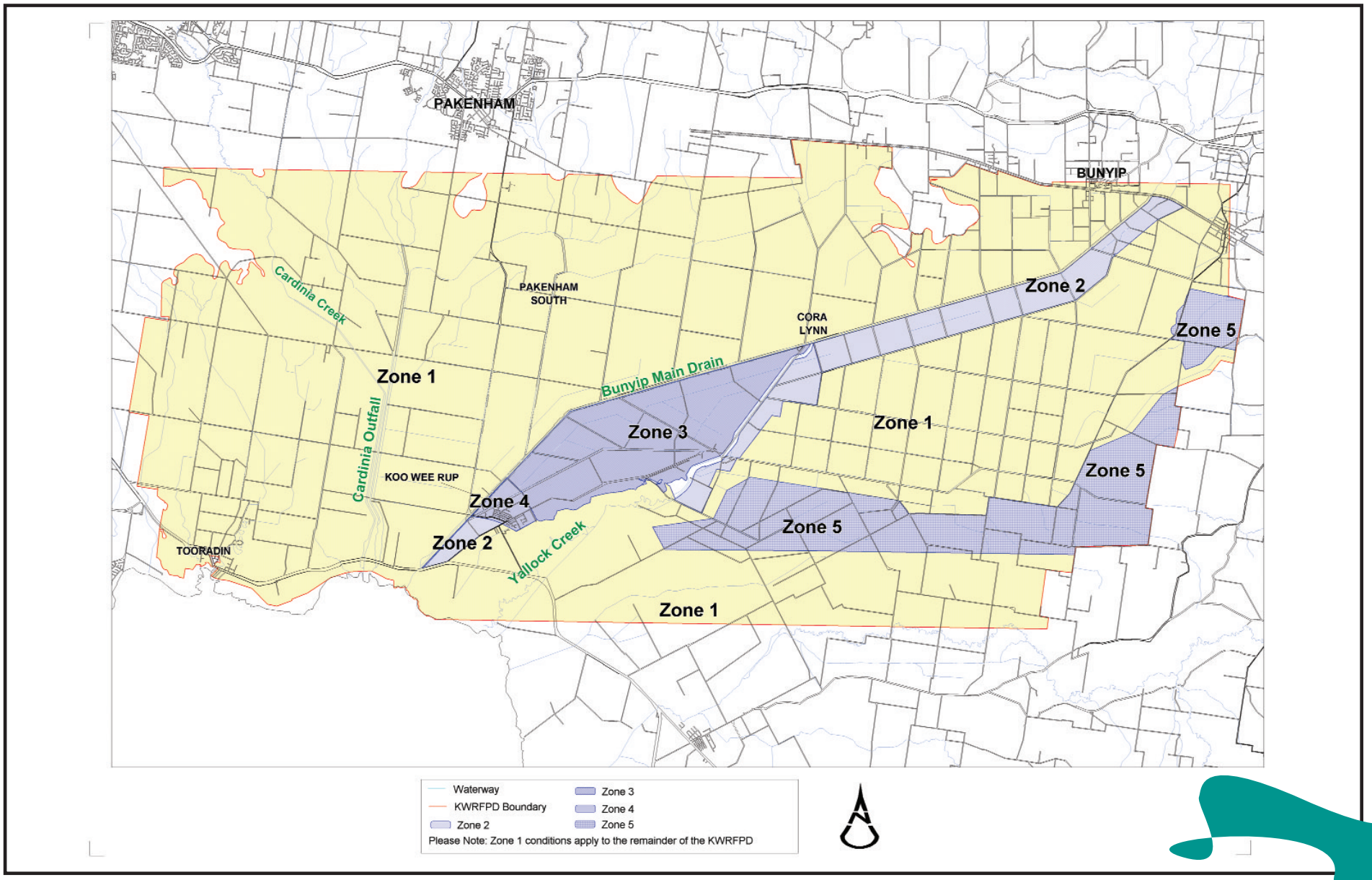
- A fill pad is required that covers the entire building envelope; and
- If a building envelope is not specified then the Plan of Subdivision should include this envelope.

Please note: The requirement for 450mm freeboard for subdivision referrals is to ensure that the minimum floor level requirements will be met upon the construction of any new dwelling; that is, a house constructed as a slab on ground (150mm slab) will achieve the freeboard requirement of 600mm.

3.2.3 Access

All developments should aim to provide access from the property that is no more than 350mm deep, the product of velocity x depth is no more than 0.35 and which otherwise complies with the requirements of Melbourne Water's *Floodway Safety Criteria Guidelines*.

ATTACHMENT A -
Flooding Zones within KWRFPD



ATTACHMENT B - Summary Guidlines KWRFPD

ZONE	Approximate flood depth	Remarks	Subdivision			Building permits		
			Lots smaller than 800m² in built-up areas	**Lots smaller than 1 hectare**	**Lots greater than 1 hectare**	**Dwellings**	**Outbuildings**	**Extensions**
1	300mm	Liable to overland flooding due to overflows from drains	Filling required. Consider flood impacts.	A fill pad that covers the entire building envelope at 450mm above flood level	A fill pad at least 1000m² in area and a minimum of 450mm above the applicable flood level	Dwellings are to be constructed with finished floor levels a minimum of 600mm above the flood level on a fill pad that extends a minimum of 5m from the building and a minimum of 150mm above flood level.	Outbuildings are to be constructed with floor levels a minimum of 300mm above flood level for concrete floors and 150mm above flood levels for earthen floors. Please see conditions for milking sheds and poultry farms	Refer to Guidelines for Development in Flood-Prone Areas
2	700mm	Liable to deep flooding as a result of concentrated overflows from a major drain Filling/building may be refused.	Filling required. Consider flood impacts.	A fill pad that covers the entire building envelope at 450mm above flood level	A fill pad at least 1000m² in area and a minimum of 450mm above the applicable flood level	Dwellings are to be constructed with finished floor levels a minimum of 600mm above the flood level on a fill pad that extends a minimum of 5m from the building and a minimum of 150mm above flood level.	Outbuildings are to be constructed with floor levels a minimum of 300mm above flood level for concrete floors and 150mm above flood levels for earthen floors. Please see conditions for milking sheds and poultry farms	Refer to Guidelines for Development in Flood-Prone Areas
3	150mm	This area has a high level of protection from the Bunyip River floodwaters because of the Yallock Outfall and the Bunyip River levee banks. Liable to flooding from local drainage and from minor overflows of the main levee bank system	Filling required. Consider flood impacts.	No fill pad required	No fill pad required	Dwellings are to be constructed with finished floor levels a minimum of 300mm above the flood level.	Outbuildings are to be constructed with floor levels a minimum of 300m above flood level for concrete floors and 150m above flood levels for earthen floors. Please see conditions for milking sheds and poultry farms	Refer to Guidelines for Development in Flood-Prone Areas
4	Koo Wee Rup Township designated flood level	The Township of Koo Wee Rup is liable to flooding from the local floodwaters and minor overflows of Bunyip River floodwaters from the main levee system	Filling required. Consider flood impacts.	A fill pad that covers the entire building envelope at 450mm above flood level	A fill pad at least 1000m² in area and a minimum of 450mm above the applicable flood level	Dwellings are to be constructed with finished floor levels a minimum of 300mm above the flood level. Where lot sizes are greater than 800m² the dwelling is to be constructed on a fill pad that extends a minimum of 5m from the building and a minimum of 150mm above flood level.	Outbuildings are to be constructed with floor levels a minimum of 300mm above flood level for concrete floors and 150mm above flood levels for earthen floors. Please see conditions for milking sheds and poultry farms	Refer to Guidelines for Development in Flood-Prone Areas
5	150mm	This area is not affected by overflows from any of the main creeks. Parts of the area are liable to flooding from local catchments and need to be addressed.	Filling required. Consider flood impacts.	No fill pad required	No fill pad required	Dwellings are to be constructed with finished floor levels a minimum of 300mm above the flood level.	Outbuildings are to be constructed with floor levels a minimum of 300mm above flood level for concrete floors and 150mm above flood levels for earthen floors. Please see conditions for milking sheds and poultry farms	Refer to Guidelines for Development in Flood-Prone Areas

Melbourne Water Charter

Melbourne Water is owned by the Victorian Government. We manage Melbourne's water supply catchments, remove and treat most of Melbourne's sewage, and manage waterways and major drainage systems.

Our drinking water is highly regarded by the community. It comes from protected mountain ash forest catchments high up in the Yarra Ranges east of Melbourne. We are committed to conserving this vital resource, and to protecting and improving our waterways, bays and the marine environment. We recognise our important role in planning for future generations.

Our vision is to show leadership in water cycle management, through effective sustainable and forward-looking management of the community resources we oversee. We are a progressive organisation that applies technology and innovation to achieve environmentally sustainable outcomes.

The business objectives established to realise our vision are to:

- provide excellent customer service
- operate as a successful commercial business
- manage Melbourne's water resources and the environment in a sustainable manner
- maintain the trust and respect of the community.

We also appreciate that achievements occur through the contribution of our people and through our values. We are people who:

- recognise that we achieve more by working with others
- feel privileged to be the custodians of our water resources
- behave with integrity
- attain excellence through creativity and innovation
- celebrate our achievements and learn from our experiences.

At Melbourne Water, we understand that engaging our stakeholders is the key to achieving our vision of leadership in water cycle management.

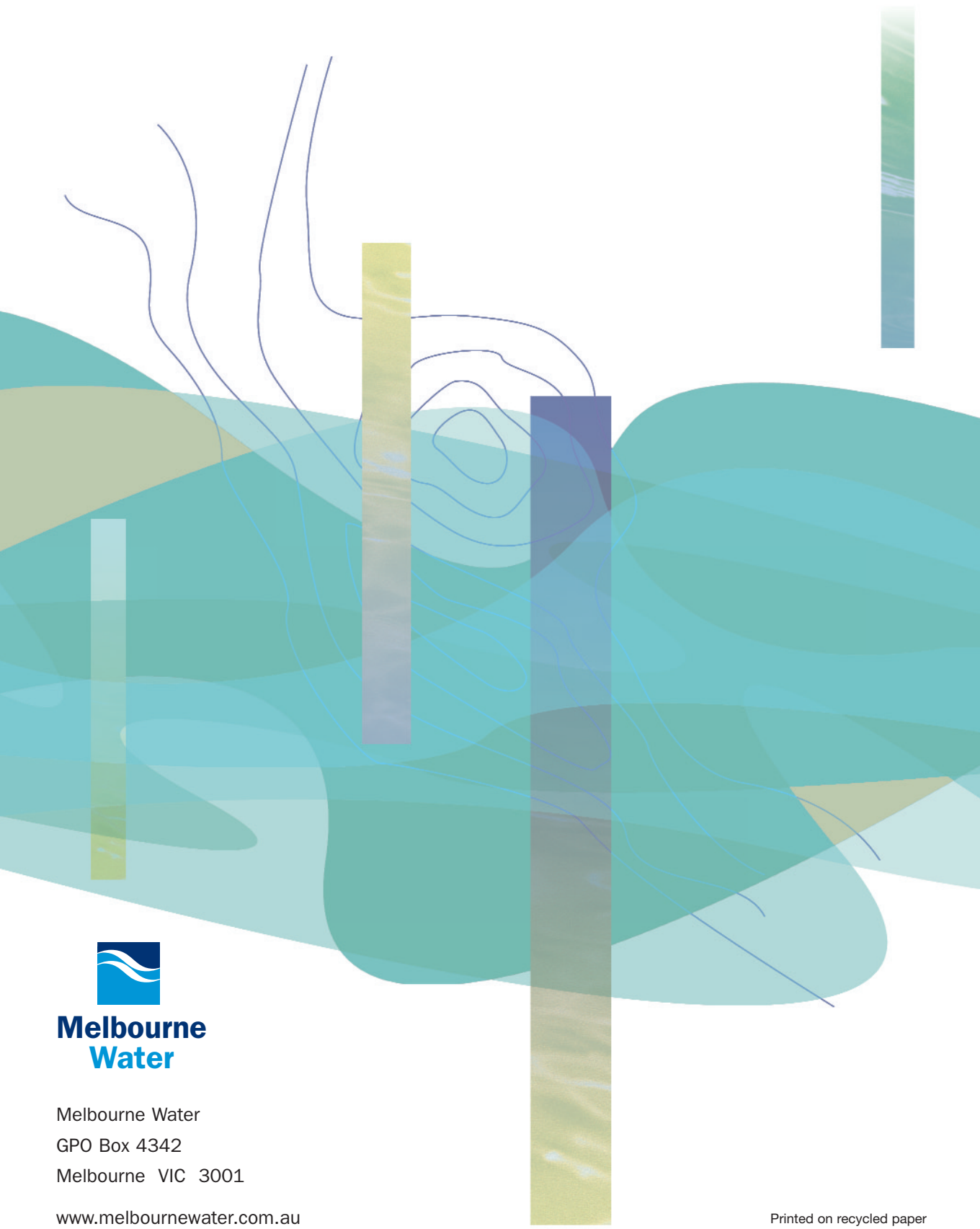
Reference Committee

Chairperson:

Gordon McFarlane, Manager, Yarra Maribyrnong Catchment Planning - Planning Group.

Committee Members:

Ian Gauntlett	Manager Floodplain Management Department of Natural Resources and Environment
Russell Mein	Director, CRC - Catchment Hydrology
Paul Jerome	State Emergency Service
Colin McBurney	Building Control Commission
Shaan Jones	City of Maribyrnong
Neil Craigie	Development Consultant
Michael Ellis	General Manager Assets and Service Cardinia Shire Council
John Glossop	Glossop Town Planning



Melbourne Water

Melbourne Water
GPO Box 4342
Melbourne VIC 3001

www.melbournewater.com.au

Printed on recycled paper

Appendix B

Melbourne Water Correspondence

Melbourne Water

Melbourne Water Corporation
ABN 81 945 386 953
100 Wellington Parade
East Melbourne 3002 Victoria
PO Box 4342
Melbourne 3001 Victoria
Telephone 131 722
Facsimile 03 9235 7200
www.melbournewater.com.au

Dated 8-03-2006
Terry Dexter
Senior Engineer- Regional Strategies
VIC Roads
12 Lakeside Drive
Burwood East 3149

Dear Terry

Re: Healesville-Koo Wee Rup Road Pakenham Bypass to South Gippsland Highway.

Thank you about your letter dated 18th January 2006 seeking information about the waterways and drains along the Koo Wee Rup Road.The area within and surrounding the KooWeep Rup Flood Protection District (KWRFPD) forms one Melbourne's largest and most unique flood plains. The district is split into five zones based on the average depth of flooding for a 100-year ARI event.

The proposed road works are located within Zone 1 and 2. Zone 1 is described as flooding due to overland flows from drains. The 100-year ARI flood depth is generally **300mm** above the general surrounding ground level. Similarly Zone 2 is described as a deep flooding as a result of concentrated overland flows from the major the drains. The 100-year flood depth is generally **700mm** above the general surrounding ground levels. The attached plan shows boundaries of Zones.

The following table shows flows and flood levels of the creeks and drains adjacent to Koo Wee Rup Road.

S.No:	Name of Creek or Drain	Flows cumecs	Location	Flood Levels	Location
1	Deep Creek	98 (100-yr)	~~Bald Hill Rd~~	8.0m AHD	U/S Watson Rd mel:ref: page14Q15
2	Bunyip River MD	570(100-yr) 385(50-yr) 260(20-yr)	Railway Line page18Q17	* 4.76m AHD	Railway Line
3	Koo Wee Rup South Drain	100(100-yr)	Sybella Avenue west of Koo Wee Rup Rd		
4	North West Catch Drain	38.5(5-yr)	7 Mile Rd(Koo Wee Rup North Nar Nar Goon Rd)		
5	McDonald Catch Drain	87(100-yr)	Junction of McDoald Rd and Koo Wee Rup Rd	6.79m AHD	Junction of McDoald Rd and Koo Wee Rup Rd
6	McGregors Drain	No info available			
7	Southern Boundary Main Drain	63(100-yr) **	Railway Line		

*Note that flood level is for section contained between levees. These do not contain Q100 and flows will also be in the northern flood plain.
** Note that the flow is calculated on basis of rational method
Further to above information the attached plan shows the flood levels of different drains running adjacent to Koo Wee Rup Road.

There are a number of the drains and creeks crossing or adjacent to the proposed duplication road and bypass as described above and we recommend as follow.

- The finished level of duplicated road should be set no higher than the existing road finished levels to ensure there will be no an increase in flood level. If this are not possible additional bridging may be required to ensure U/S flood levels is not increased.
- The flood plains are low-lying areas adjacent to rivers, creeks and earth drains and studies may be required to demonstrate no increase in upstream flood levels.
- Any new crossover should be referred to Melbourne Water prior to final designs.

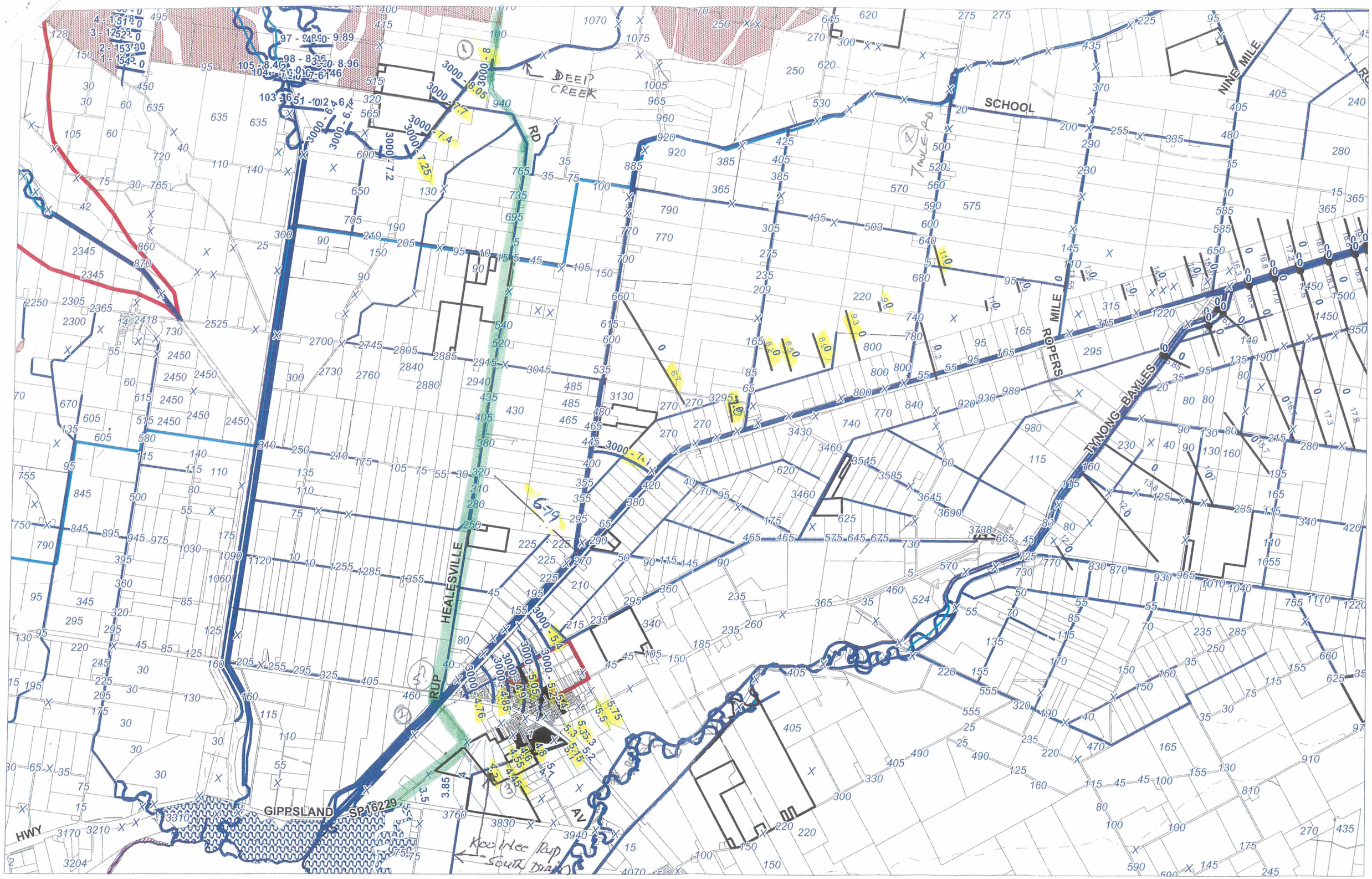
If you require any further information please call me on 9235 7187 or e-mail aijaz.memon@melbournewater.com.au .

Your's Sincerely

Aijaz Memon
Development Planner
Investigation and Survey Team
Flood Plain Services, Waterways

C.C: Keith Boniface Team Leader Investigation & Survey Team.

Copy to Kerrie Parnell of Roads Design on 17/5/06



Drain Alignment
Natural Waterway
Water Main
Channel Drain
Sewer Main
Flood Plain

MGA55

Koo Wee Rup Road Flood Level

Scale 1:50,000
8/3/2006

Flood levels
Alignment of Koo Wee Rup Road

Melbourne Water

ZONE 1

ZONE 2

Whilst all due skill and attention has been used Melbourne Water Corporation shall not be liabe in anyway for loss of any kind including, damages, costs, interest, loss of profits or special loss or damage, arising from any error, inaccuracy, incompleteness or other defect in this information. By receiving and accepting this information the recipient acknowledges that Melbourne Water Corporation makes no representations as to the accuracy or completeness of this information and ought carry out its own investigations if appropriate.

Drain Alignment
Natural Waterway
Water Main
Channel Drain
Sewer Main
Flood Plain

MGA55

Scale 1:50,000
6/3/2006

Melbourne Water

"Aijaz Memon" <aijaz.memon@melbournewater.com.au>
09/05/2006 04:16 PM

To <Corinne.Thomas@ghd.com.au>
cc
bcc
Subject RE: Healesville-Koo Wee Rup Road Duplication Project - Preliminary Drainage Investigation for VicRoads

Hi Corinne,

In the response of your e-mail dated 30th August 06 seeking information about Melbourne Water' s drains running along the alignment of the Koo Wee Rup Road from Pakenham Bypass to South Gippsland. Our comments are as under. (Comments are in the order of questions as you asked).

1: The tide level of the Western Port Bay at the outlet of the drains is 2.7m AHD. We consider 2.7m AHD tide level as a 100-year flood level of the drains at the outlet.

2: We adopt the tide level as a design standard for calculating the flood levels in this case.

3: Our recommendations for construction of the road are as mentioned in our letter to VIC Road dated 8th March 06 (You have already got the copy of this letter). All development should be constructed according to the "Guideline for the development within the Koo Wee Rup floodplain". Besides that, the road should be constructed according to the **WSRD** method.

4: Unfortunately we have no the 100-year flow information of the McGregors Drain and North West Catch Drain. The flow information and flood level information of the Bunyip Main Drain are available at Melbourne Water is based on the RORB model and MIKE 11. A preliminary RORB model was prepared to model the entire catchment to Westernport Bay in 1994 and then it was modified in 1996. Modification of existing RORB model was done up to Iona.

5: We have no flood level information of the McGregors and North West Catch Drain.

6: This is the best information available at Melbourne Water so far about these drains.

7: No

8: Melbourne Water would not object to the merging all channels in one channel or into couple of channels subject to satisfying the all hydraulics issues, such as there would be no increase in flood levels, velocities, depth and velocity ratios and there would be no any significant impact upon the environments. Besides that, hydraulic modelling will be required to demonstrate how above requirements are achieved.

9: We have a RORB models for the main outfall drains, Bunyip and Deep Creek (which flows in parallel to the Cardinia creek but possibly only paper plans as the modelling was done a long time ago). Smaller drains needs to additional analysis.

10: The only HEC RAS modelling is available on Bunyip Main Drain, which you should have.

11: Our general conditions for construction of the road are already mentioned in the para no: 3 and para no 8. Filling will be allowed to subject to no increase of flood level on the U/S and D/S.

12: The flow of Deep Creek at the Pakenham Bypass is in the order of 98 m3 /s. The calculated flow is based on the study that was done by the Water Technology for the Pakenham Bypass in March 2005. The 100-year flow of the McDonald Catch Drain at the Fechner Rd in the order of 87 m3 /s. Previously the location of this flow was mentioned at junction of the McDonald Drain and Koo Wee Rup Road which is incorrect. However we provided the copy of the plan to Vic Road showing the 100-year flood level of drains running together at McDonald Drain Road and Fechner Road. I guess they may have provided that to you.

13: Yes.

If you have any question please feel free to ask me.

Regards.

Aijaz Memon
Development Planner
Investigation & Survey Team
Waterways
Melbourne Water
Ph:No: (03) 9235 7187
aijaz.memon@melbournewater.com.au

> -----Original Message-----
> **From:** Corinne.Thomas@ghd.com.au [mailto:Corinne.Thomas@ghd.com.au]
> **Sent:** Wednesday, 30 August 2006 10:02 AM
> **To:** Aijaz Memon
> **Subject:** Healesville-Koo Wee Rup Road Duplication Project - Preliminary Drainage Investigation for VicRoads
> **Importance:** High
>
> Aijaz,
>
> Further to our phone conversation this morning, the following is a copy of the questions that I have started putting together that I wanted to talk to Melbourne Water about. They cover a range of issues and as I have indicated on the phone, some of them may not have answers to them at this

stage in the process, however that at least will point us to the need to consider it further in future studies.

If after considering these questions it seems like we may not need to meet to discuss them then that is fine. If we do need to meet, good days for me are this Friday and next Tuesday. I will not be in the office today or tomorrow, however I can access my email any time so if you need to contact me feel free to email me.

Thanks for your time and assistance,

Regards,

Corinne Thomas

GHD Pty Ltd
Level 8, 180 Lonsdale Street
Melbourne VIC 3000

ph 8687 8375
fax 8687 8111

MW Meeting ? Notes on issues to address

- What dictates the d/s flood level, is it the outlet into the ocean? (I know it is very flat there, but I?m figuring the sea level in Western Port Bay probably is dictating some of the behaviour)
- What is the "design standard" sea level in Western Port Bay?
- Obviously there is very low lying area in that whole region, does MW have any special requirements for any form of road construction in this area? We are aware of the document ?Guidelines for Development within the Koo Wee Rup Flood Plain?.
- The flows available in the vicinity of the works are not a complete set, is there further information available? (specifically for the McGregors Drain, and a 100 year ARI flow for the North West Catch Drain). How were these flows determined? (ie. RORB or flow gauged or other modelling types?) How old is the information?
- Would there be additional flood level information also? (specifically for the McGregors Drain, the North West Catch Drain, Koo Wee Rup South Drain and Southern Boundary Main Drain). We have been assuming the 100 year flood level will be the ultimate flood level to design for.
- What confidence does MW have in the information that has been provided? Do you see it as definitive or do you feel like further studies should be undergone before this is adopted as the ?standard??
- Are MW planning on doing additional studies in the vicinity of these works some time in the next few years?
- What would be the chance of allowing the channels around the Bunyip MD near the outlet, to be merged into one (or a couple) of very large channels? Is this able to be considered? This area is one that will be quite critical to VicRoads because

of the type of crossing over all the channels that will be required.

- Can we have a catchment plan of the main drains crossing in the area of this drain? (or for adjacent catchments)
- The flood level information provided by MW looks like it was produced in a HEC-RAS program or similar, does this mean if the drainage criteria were of a lesser standard than 100 year that the models could be obtained or re-run with the differing flow instead?
- In terms of long term planning and road construction, does MW have particular design criteria that must be adhered to, ie. filling in of the flood plain concerns, ultimate development flow provisions, afflux criteria to be met, flood level ARI?s to accommodate? It should be noted that this road may one day become freeway standard.
- There are some ambiguities in the locations of some flows in the March 2006 letter to Vic Roads, define locations for Deep Creek, McDonald Catch Drain;
- Can we attach a copy of the MW document ?Guidelines for Development within the Koo Wee Rup Flood Protection District? in our report (copyright implications).

This e-mail has been scanned for viruses by MessageLabs.

"Aijaz Memon" <aijaz.memon@melbournewater.com.au>
02/10/2006 09:30 AM

To <Corinne.Thomas@ghd.com.au>
cc
bcc
Subject RE: Healesville-Koo Wee Rup Road Duplication Project - Preliminary Drainage Investigation for VicRoads

Hi Corinne,

Thanks for seeking information regarding above subject.
The freeboard requirements for a **bridges and crossing** are as follow.
Underside of a bridge requires to be set 600mm above the 100-year flood level.
An Adequate open space requires to be opened above the Creek for maintenance purposes.

For Culverts

The proposed design should not be overtopped during the 1 in 5 year ARI event and should meet Melbourne Water V ´ D Safety Criteria for the 1 in 100 ARI year event.Where velocity (V) must not be higher than 1.5m /s ,Depth (D) must not be higher than 0.35m and DxV ratio must not be higher than 0.35 sq m/s.
It is recommended that post development flood levels for all storm events up to and including the 100 year ARI are no higher than pre development flood levels.
The construction of any crossing structure at this location must not cause the diversion or redirection of 100 year ARI flows.
Minimal disturbance to bed and banks of the watercourse and appropriate waterway protection at, and immediately upstream and downstream of the crossing. In this regard rock beaching of the waterway bed and banks is required to protect against scouring and erosion.

Regards

Aijaz Memon

-----Original Message-----
From: Corinne.Thomas@ghd.com.au [mailto:Corinne.Thomas@ghd.com.au]
Sent: Saturday, 30 September 2006 3:13 PM
To: Aijaz Memon
Subject: RE: Healesville-Koo Wee Rup Road Duplication Project - Preliminary Drainage Investigation for VicRoads

Hi Aijaz,

Thanks very much for your response earlier this month to my email, your comments certainly helped clarify the issues raised.

One further question we wanted to ask was that of freeboard, what type of freeboard requirements would be expected for any bridges or crossings constructed over the main drains for this project? I understand that 300 mm is considered the minimum usually.

Regards,

Corinne

GHD Pty Ltd
Level 8, 180 Lonsdale Street
Melbourne VIC 3000

ph 8687 8375
fax 8687 8111

-----"Aijaz Memon" <aijaz.memon@melbournewater.com.au> wrote: -----

To: <Corinne.Thomas@ghd.com.au>
From: "Aijaz Memon" <aijaz.memon@melbournewater.com.au>
Date: 09/05/2006 04:16PM
Subject: RE: Healesville-Koo Wee Rup Road Duplication Project - Preliminary Drainage Investigation for VicRoads

Hi Corinne,

In the response of your e-mail dated 30th August 06 seeking information about Melbourne Water?s drains running along the alignment of the Koo Wee Rup Road from Pakenham Bypass to South Gippsland. Our comments are as under. (Comments are in the order of questions as you asked).

1: The tide level of the Western Port Bay at the outlet of the drains is 2.7m AHD. We consider 2.7m AHD tide level as a 100-year flood level of the drains at the outlet.

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5: We have no flood level information of the McGregors and North West Catch Drain.

6: This is the best information available at Melbourne Water so far about these drains.

7: No

Appendix C

Assignment Task Brief

3.02 ASSIGNMENT TASK BRIEF

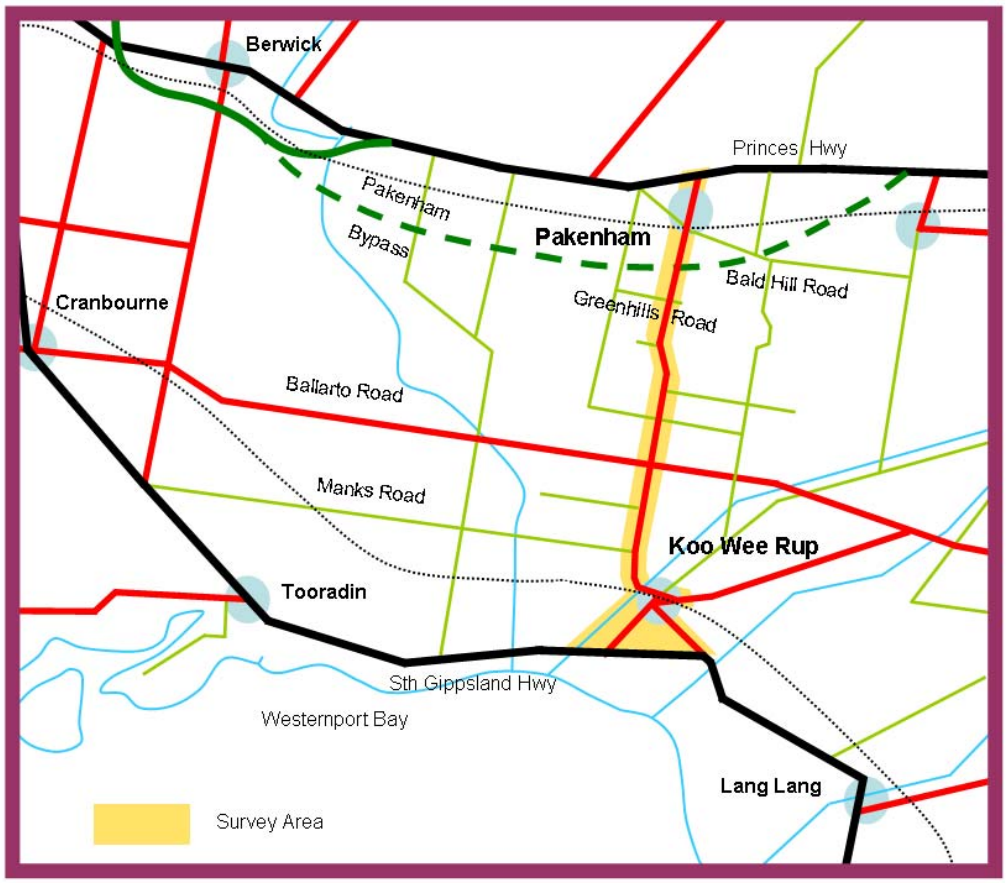
3.02.1 Purpose

The purpose of this study is to provide information on existing waterways and to assess the likely impact of road upgrading on the waterways and the adjacent areas. This will assist VicRoads to ensure that the planning is undertaken in a manner that considers the impact on waterways and the adjacent areas.

3.02.2 Background

A planning study is being undertaken to determine options for the future upgrading of the Healesville - Koo Wee Rup Road generally along its current alignment, (refer Figure C1). It is expected that the development of Healesville - Koo Wee Rup Road will consist of the duplication of the existing road between the Pakenham Bypass and McDonalds Drain. At the southern end it is proposed to construct a bypass of Koo Wee Rup on a new alignment to the west of the township between McDonalds Drain and the South Gippsland Highway.

Figure C1 Healesville – Koo Wee Rup Road, Princes Highway to South Gippsland Highway



3.02.03 Services to be Provided by the Consultant

Standard Requirements

a) VicRoads' Environment Strategy

The VicRoads' Environment Strategy sets the environment policy framework within which VicRoads operates and consultants should be familiar with the Strategy.

Permits

The Consultant shall ensure that they have all necessary permits for undertaking the investigations and that all work be carried out in accordance with these permits.

Survey Tasks

Field work, collation of data and reporting as set out in the Proposal.

The consultant shall:

- Identify all main waterways, as classified and provided by Melbourne Water, which may impact the approximate proposed alignment of the proposed road upgrade;
- List flows and flood levels at potential main waterway crossing locations where these data are provided;
- Assess and describe the potential impact of the road upgrade on adjacent areas to the road;
- For the main waterways, list the types of crossings, with approximate bridge and culvert sizes (only for crossings where flow rates are provided by Melbourne Water), that will be required for the proposed road upgrade where it intersects the main drains; and
- Identify the future issues for further investigation on the drainage and waterways associated with the road upgrade.

The study for the survey shall include:

- The existing road reservation for Healesville-Koo Wee Rup Road between the Pakenham Bypass and McDonald's Drain, and a 100 m wide strip each side of the reservation boundary; and
- The area bounded by McDonalds Drain (Bunyip River), South Gippsland Highway and Sybella Avenue plus a 100 m wide strip along the north-west edge of McDonalds Drain (Bunyip River).

3.02.04 Information to be Supplied by Corporation to Consultant

VicRoads will provide copies of correspondence and plans supplied by Melbourne Water and other relevant information.

VicRoads will provide available aerial photos (if required) and plans showing the corridors.

Whilst not expected to be required, VicRoads will arrange, as far as possible, access to private property or will inform the consultant where access is not available or of any known special requirements for access. The Consultant will be fully responsible for contacting all owners prior to entering their property.

VicRoads will co-ordinate liaison with other specialist consultants as required.

3.02.05 Information to be Provided by the Consultant to the Corporation

The consultant shall supply VicRoads with the deliverables, as set out in 3.02.08, Deliverables.

HP It is anticipated that the survey will be completed within 6 (six) weeks of awarding the contract. A draft report will be presented to VicRoads within two (2) days. VicRoads will review the report and within two (2) weeks accept, reject or suggest amendments to it for inclusion into the final report. A final report shall then be submitted within two (2) weeks from the date of receipt of VicRoads response to the draft report.

3.02.06 Methodology

a) General

The Consultant shall conduct the Assignment in accordance with the methodology submitted to and approved by VicRoads, prior to the commencement of the survey.

b) Liaison with VicRoads

On all contractual matters, the Consultant shall liaise only with the Superintendent or the Superintendent's Representative.

The VicRoads Superintendent's Representative for the assignment will be Mr Terry Dexter. The contact details are as follows:

Phone: (03) 9881 8937

Email: terry.dexter@roads.vic.gov.au

3.02.07 Reporting

The Consultant shall notify VicRoads immediately on the commencement and completion of any field work or discovery of any significant issues which arise as a result of the investigations and notify VicRoads immediately of any other issues that VicRoads should be made aware of.

3.02.08 Deliverables

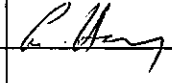
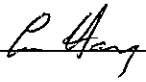
Draft and Final Reports

- One bound copy and one unbound copy of the Draft Report should be presented to VicRoads for comment and review;
- Six bound and one unbound copy of the Final Report should be presented to VicRoads including colour plans as deemed required;
- An electronic copy of the Final Report should be provided to VicRoads on a disc in Microsoft Word format and in Adobe Portable Document File (pdf) format;
- All reports shall contain an executive summary;
- All reports shall contain a copy of the Consultant Task Brief as an Appendix (i.e. Section 3.02 of this contract);
- All reports shall conform to the following requirements:
  - Binding margin: 25 mm;
  - Open margin: 10 mm;
  - In practical terms, provide the 25 mm margin on both sides of each page so that VicRoads can produce double-sided documents;
  - Top margin: 10 mm;
  - Bottom margin: 10 mm;
  - Start each section on the right hand page;
  - Have fonts generally no smaller than 12 point;
  - Start Chapter 1 on the right hand page. Start all other chapters as they occur;
  - First page of Chapter 1 is Page 1;
  - All preceding pages to be in Roman numerals;
  - Odd numbered pages to be right hand pages;
  - Be consistent with style. Use Commonwealth Style manual or similar;
  - Minimise use of colour figures and photographs. Colour figures should be capable of being reproduced in black and white;
  - Supply clean artwork (not photography);
  - Supply unfolded plans if greater than A4 size;
  - Supply loose photographic prints; and
  - Where continuous alignment drawings are broken down to A3 size drawings, all annotation and text shown on the continuous alignment drawings must be self contained within each A3 drawing.

GHD Pty Ltd ABN 39 008 488 373

180 Lonsdale Street
Melbourne, Victoria 3000
T: (03) 8687 8000 F: (03) 8687 8111 E: melmail@ghd.com.au

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft	C Thomas	G Hay	* GCH	G Hay	* GCH	12/9/06
0	C Thomas	G Hay	* GCH	G Hay	* GCH	13/10/06
1	C Thomas	G Hay		G Hay		15/11/06

* denotes signature on original