FIVE D PTY LIMITED

DA 2009/1866, PROPOSED SHOPPING COMPLEX, GLOUCESTER

FLOODING ASSESSMENT

REPORT

June 2010

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1. INTRODUCTION

Five D Pty Limited is proposing a shopping complex and supermarket development with an associated car park near the intersection of Hume Street and Church Street, Gloucester.

Figure 1 illustrates the subject site on an aerial photograph, while Figure 2 shows the cadastral boundaries and the available ground survey.

The current proposal involves:

- construction of a supermarket development with a gross floor area of about 2,400 sq metres;
- the net lettable floor area is in the order of 2,200 sq metres;
- an associated car park covering some 3,460 sq metres, providing 119 car spaces.

The footprint of the proposed development is illustrated on Figure 3.

The floor level of the building is set at RL 95.1 m AHD, providing a flooding immunity up to the design one percent annual exceedence probability (AEP) flood (once in 100 year average recurrence interval (ARI)).

Freeboard against flooding in the design 1% AEP flood is being provided by moveable barriers to be constructed within the building.

The existing ground levels beneath the building footprint are about RL 92.5 m AHD. Thus, the building floor will be elevated by some 2.5 metres.

The car park area is to be filled to a maximum level of RL 94.9 m AHD and graded up to the building floor level to provide pedestrian access.

Access to the subject development site will be provided off Church Street and off Denison Lane.

The rear of the subject property (away from Church Street) abuts a small watercourse, known as "The Billabong".

Gloucester has a history of irregular flooding, with the largest historical event being recorded in 1929. In the 1929 flood, flood waters would have flowed from west to east along The Billabong and along Church Street, before joining the Gloucester River downstream of Thunderbolts Way. Church Street itself near its intersection with Queen Street would have been inundated by up to one metre, while the photographic evidence of flood damage indicates relatively high velocity flows. Contemporary reports of the 1929 flood indicate at least one person was swept from their feet and drowned.

In 1929, the flood waters flowing along The Billabong were sourced overflows from the Gloucester River, some three kilometres south (upstream) of the development site.

Given the nature of flooding at the development site, the proposed development has the potential to change flood behaviour around the site, principally due to:

- the relatively high flood flow velocities in the general area; and
- the intrusion into the flood liable areas for the filled car park (given the building will essentially be elevated on columns).

This report has been prepared to:

- identify any potential changes to flood behaviour;
- identify which of such changes are "significant";
- identify any mitigation measures that may be required.

2. INVESTIGATIONS UNDERTAKEN

2.1 Flood Information

A number of flood studies have been undertaken at Gloucester since the early 1970's. The most recent, "Gloucester Flood Study, Supplementary Report", addressed:

- historical flood levels through Gloucester in the major floods of 1929, 1955, 1956, 1963, 1976 and 1978;
- set up a mathematical model of the Gloucester, Avon and Barrington Rivers from Forbesdale (on the Gloucester River, some 9 kilometres south of the site) to a point some 6 kilometres downstream of the confluence of the Gloucester and Barrington Rivers. The MIKE-11 software package was used for this work.
- The MIKE-11 model was verified against the 1929, 1976 and 1978 floods, using the available historical data;
- Provided predicted design flood levels at the subject site, as given in Table 1 below.
- Predicted flood flow velocities in The Billabong of 1.5 to 1.7 m/sec.

Table 1

Design Flood Levels, Five D Site
(Source: MIKE-11 Model, "Gloucester Flood Study, Supplementary Report")

Frequency (% AEP)	Return Period (ARI years)	Flood Level (m AHD)	
		Upstream Site Boundary	Downstream Site Boundary
1	100	95.21	95.05
2	50	94.97	94.81
5	20	94.61	94.48
10	10	94.32	94.19

Typically, ground levels beneath the building footprint range from RL 92.4 m AHD to RL 92.8 m AHD, while Church Street (near the subject site) varies between RL 93.7 m AHD and RL 95.9 m AHD.

2.2 Additional Hydrodynamic Models

The established MIKE-11 model was not established at a level of detail to enable flood levels and flow velocities to be determined locally around the subject site. Accordingly, a more complex two-dimensional model of the Gloucester River at Gloucester was developed using TUFLOW software.

The principal data required for the two-dimensional model covers:

- topography through a digital elevation model;
- hydraulic boundary conditions comprising of upstream hydrographs and downstream water flow level controls.

A digital elevation model of the Gloucester River floodplain was developed using the ground survey developed for the Gloucester Flood Study and augmented by various surveys of Gloucester by Gloucester Shire Council. The ground survey of the site (as shown on Figure 2) was also incorporated into the digital elevation model for a better representation of the site.

Figure 4 presents a pictorial representation of the digital elevation model, as displayed through a geographical information system (GIS).

The TUFLOW model was established using:

- one dimensional channels for the Gloucester River, Avon River and The Billabong; and
- two dimensional models split into a larger 20 m grid area with a small 2.5 m grid area near The Billabong.

The locations of the 20 m grid area and 2.5 m grid area are also illustrated on Figure 4.

Boundary conditions for the TUFLOW model were derived from the MIKE-11 model established in the Gloucester Flood Study (Reference 1) and comprise:

- inflow hydrographs at the upstream points of the TUFLOW model for the Gloucester River and Avon River; and
- water level versus time hydrographs at the downstream end of the TUFLOW model for the Gloucester River.

Boundary conditions were derived for the 100, 50, 20, 10 and 5 year ARI design flood events.

The investigation is primarily concerned with changes to flood behaviour. Thus, the frictional resistance in the TUFLOW model was adjusted such that the TUFLOW model produced similar flood levels as the Gloucester Flood Study throughout the model area. This approach was taken as opposed to the alternative

of re-calibration of the whole model against the historical flood levels, which would have involved significantly greater effort, which is not justified, given the end use of the investigation and the ground level data available.

Table 2 below presents design flood levels at the Five D site derived from the TUFLOW model for comparison against the Gloucester Flood Study levels quoted in Table 1.

Table 2

Design Flood Levels, TUFLOW Model, Five D Site

Frequency (% AEP)	Return Period (ARI years)	Flood Level (m AHD)	
		Upstream Site Boundary	Downstream Site Boundary
1	100	94.99	94.97
5	20	94.57	94.56
10	10	94.36	94.35

The TUFLOW model indicates the flow velocities across the site as typically

- 0.3 metres per second (m/sec) over the floodplain at the site;
- 0.2 m/sec along Church Street near the site.

2.3 Changes to Flood Behaviour, Post Development

Design flood levels vary near the site. Comparison between existing design flood levels and "after this development" flood levels (identified as "proposed") provides an indication of the changes caused by the development.

The existing and "proposed" flood levels for the 1% AEP flood are given in Table 3 below, while Figure 5 provides the flood levels for the design 10%, 2% and 1% AEP events.

Table 3

Design 1% AEP Flood Levels

Location	Existing Flood Level (m AHD)	Proposed Flood Level (m AHD)
Intersections:		
Denison Street / Billabong Lane	93.66	93.66
King Street / Billabong Lane	94.42	94.42
Hume Street / Billabong Lane	94.89	94.89
Points:		
Downstream site boundary	94.96	94.96
Upstream site boundary	94.991 [1]	94.993 [1]

Notes: 1. Flood levels given to three decimal places to indicate change in flood levels

The flood level values in Table 3 and Figure 5 show no measurable change in flood levels if the proposed development were to proceed.

Further, Figure 5 shows the flood discharge down Denison Lane is expected to fall by about 2 cu m/sec following development.

Figure 6 presents an illustration of the changes in the 1% AEP flood levels and flow velocities after the proposed development.

With regard to design flood levels and Figure 6, it is noted:

- flood levels at the existing buildings are not increased;
- an increase in flood levels of 100 millimetres is indicated on Church Street at the proposed entry to the development, however, this increase dissipates to less than 25 millimetres at the Hume Street / Church Street intersection;
- an increase of 140 millimetres occurs at one locality at the upstream side of the proposed car park, but this reduces to less than 13 millimetres at the upstream boundary of the site.

The existing flood flow velocities at the site are typically:

- 0.3 metres per second (m/sec) over the floodplain at the site;
- 0.2 m/sec along Church Street near the site.

It is clear from the TUFLOW model that higher flood flow velocities occur along "The Billabong" and downstream of the site.

With regard to design flood velocities and Figure 6, it is noted that:

- flow velocity increases are less than 0.15 metres per second adjacent to the car park and down Church Street;

- flow velocity changes outside the site are negligible (less than 0.05 m/sec);

- the velocity increases do not raise the existing flood velocities to a point where erosion potential or damage potential would be of concern.

3. CONCLUSIONS

This report identifies the changes in flood behaviour at the site of a proposed shopping complex near the intersection of Church Street and Hume Street, Gloucester. The changes in flood behaviour have been modelled by establishment of a two-dimensional model of the Gloucester River at Gloucester.

The TUFLOW model uses ground levels and boundary conditions derived from the Gloucester River Flood Study. Additional ground survey from the development site has been incorporated into the TUFLOW model.

The preliminary hydraulic hazard of the site is "High Hazard", while Gloucester Shire Council has adopted a "Low Hazard" category in this area.

The development is located in a "High Hazard" area.

The TUFLOW model shows the proposed development:

- will not change the flood hazard in the area;
- will not affect surrounding buildings to any measurable extent;
- will increase flood flow velocities on the site, but such increases do not propagate beyond the site excepting along Church Street at the entry / exit point to the development.

Whilst the flow velocities along Church Street are increased, the absolute velocities are not sufficient to increase flood damage or erosion potential.

The modelling suggests that the proposed development and associated car park force some additional flood flows onto Church Street. This behaviour could be prevented if the upstream boundary of the car park were elevated to match the building floor level or a low wall installed such that flood flow is diverted to "The Billabong", not Church Street.

The building floor level has been set at RL 95.1 m AHD, equivalent to the design 1% AEP flood level as derived from the Gloucester Flood Study (Ref. 1). Freeboard is to be provided by a series of moveable barriers to prevent flood water entering the building. The TUFLOW model provides a more detailed flood level estimate than Reference 1 at this particular site and thus, it would be acceptable to construct the building floor level to RL 95.0 with freeboard provided by moveable barriers.

REFERENCES

1. Paterson Consultants "Gloucester Flood Study, Supplementary Report", April 2003

FIGURES

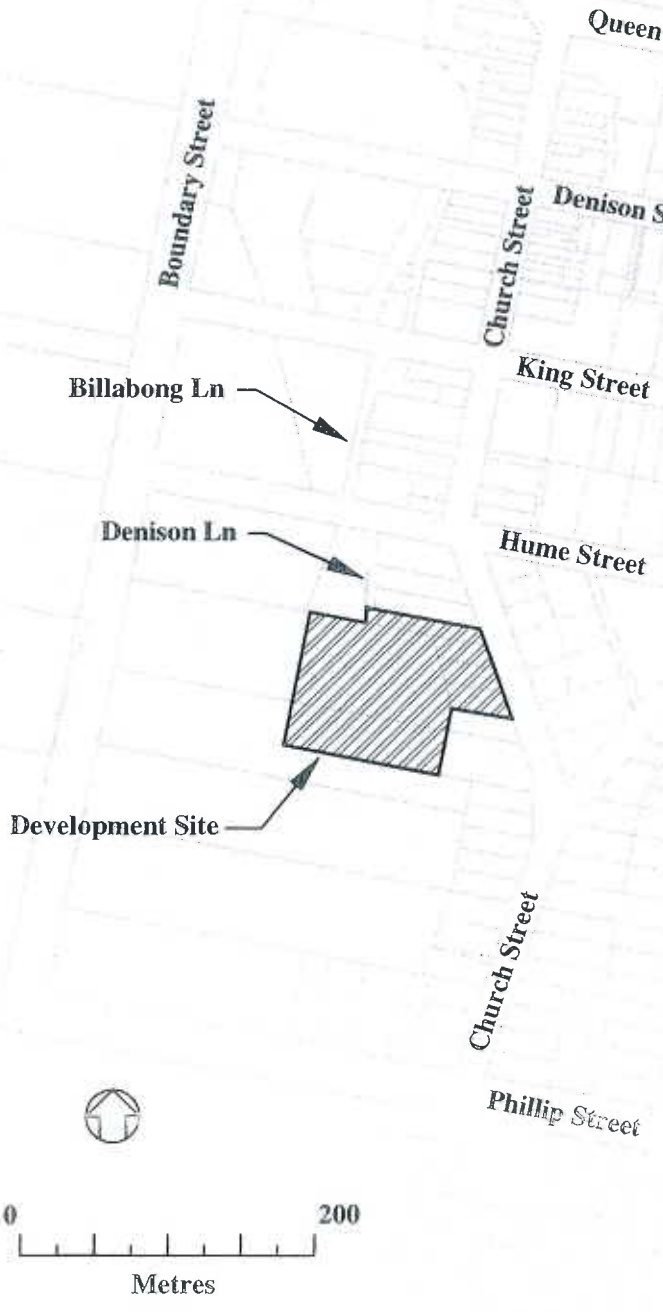
FIVE D PTY LIMITED
DA 2009/1866, PROPOSED SHOPPING COMPLEX, GLOUCESTER
FLOODING ASSESSMENT

0 250

Metres

DATE: 8 JUNE 2010
DISK REF: 09-027
FILE REF: 09027_1_SUBJECT_SITE_AERIAL_V1

FIGURE 1
SUBJECT SITE - AERIAL



DATE: 8 JUNE 2010
DISK REF: 09-027
FILE REF: 09027_2_SUBJECT_SITE_CADASTRE_V1

FIGURE 2
SUBJECT SITE - CADASTRE

FIVE D PTY LIMITED
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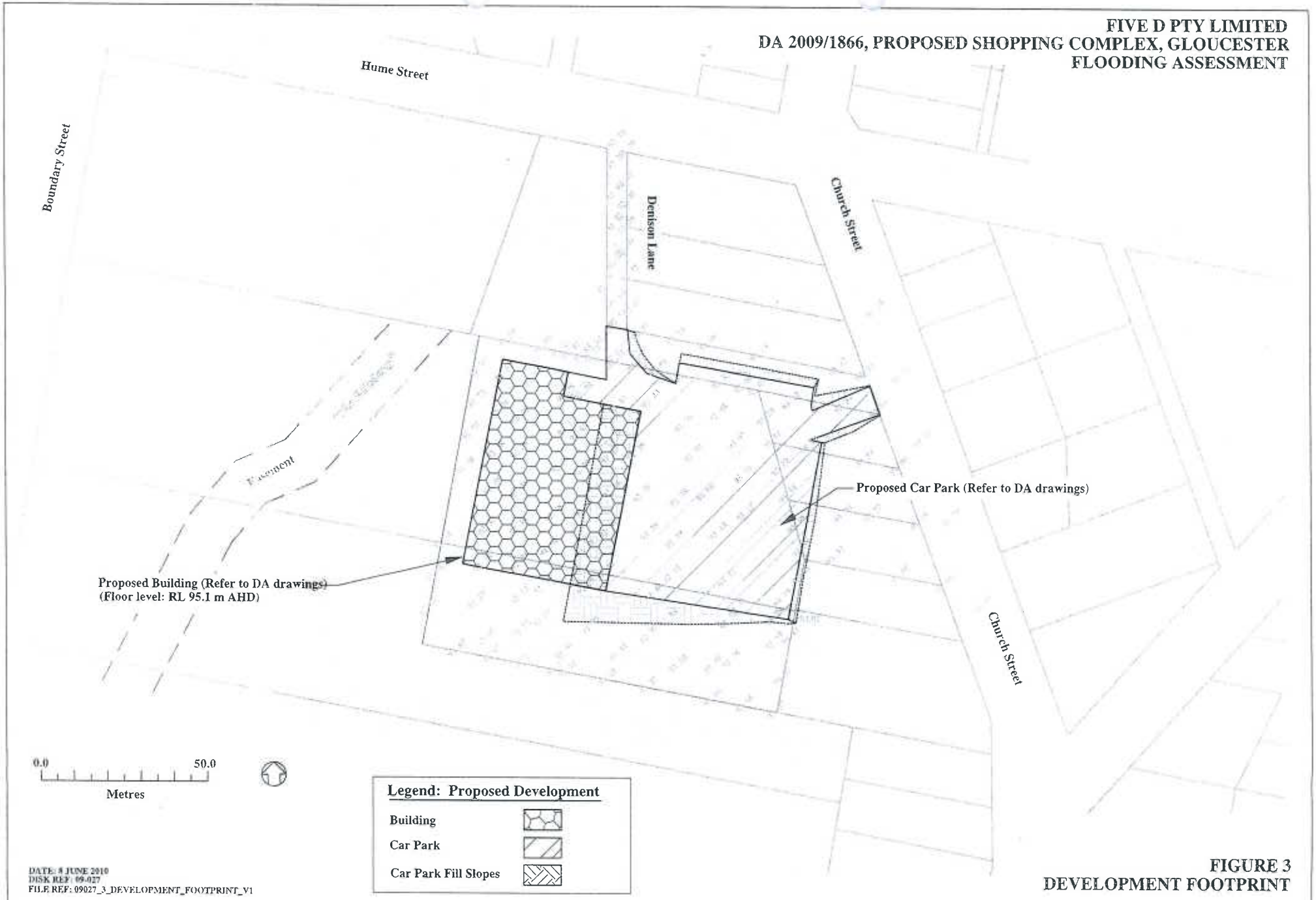
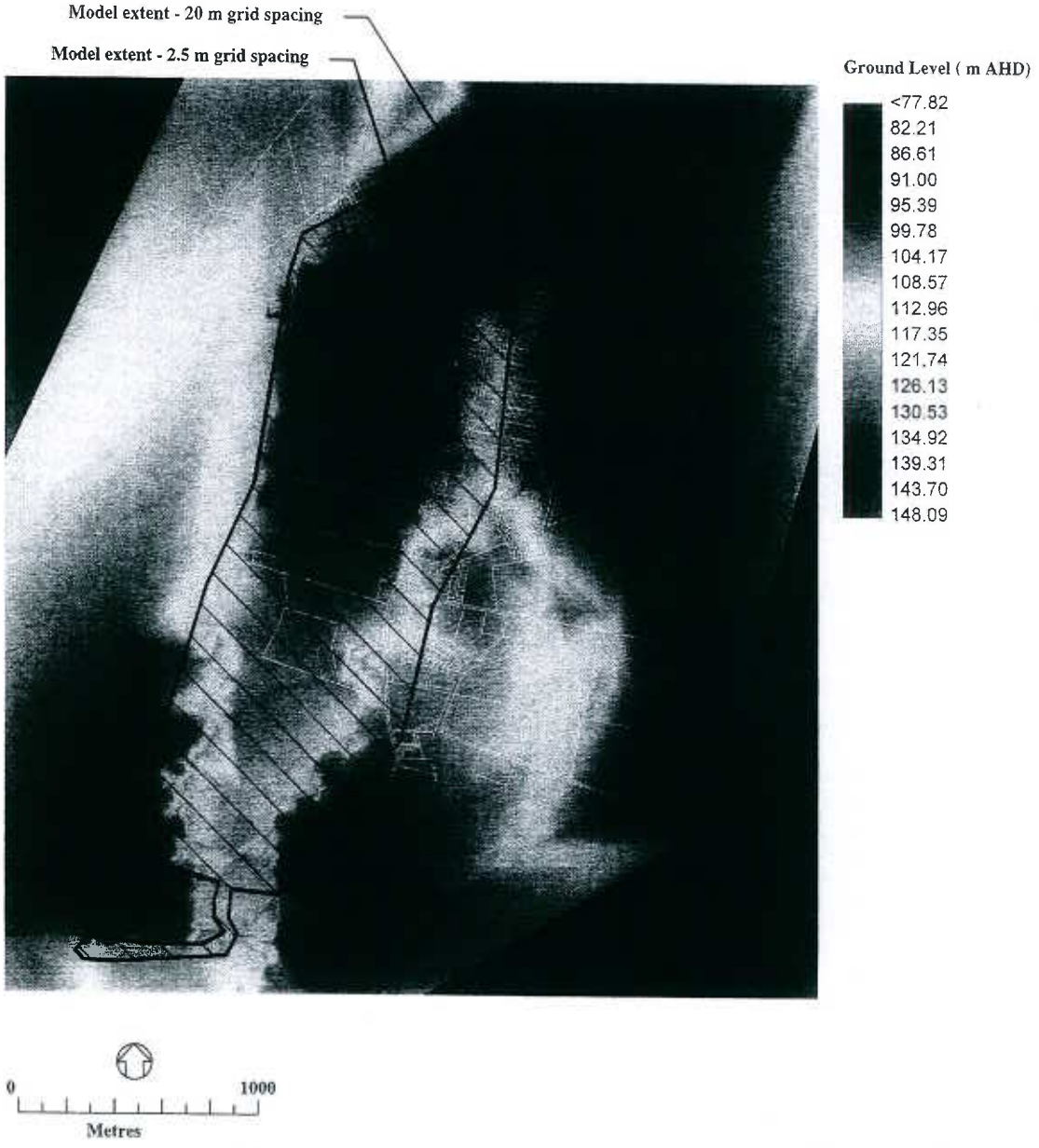
FLOODING ASSESSMENT



DATE: 8 JUNE 2010
DISK REF: 09-027
FILE REF: 09027_3_DEVELOPMENT_FOOTPRINT_V1

FIGURE 3
DEVELOPMENT FOOTPRINT



DATE: 5 JUNE 2010
DISK REF: 09-027
FILE REF: 09027_4_Digital elevation model_V1

FIGURE 4
DIGITAL ELEVATION MODEL

Calculated Flood levels

Return Period		Existing	Proposed
AEP (%)	ARI (yrs)	(m AHD)	(m AHD)
1	100	93.66	93.66
2	20	93.05	93.06
10	10	92.86	92.87

Calculated Flood levels

Return Period		Existing	Proposed
AEP (%)	ARI (yrs)	(m AHD)	(m AHD)
1	100	94.42	94.42
2	20	94.08	94.08
10	10	93.89	93.89

Calculated Flood levels

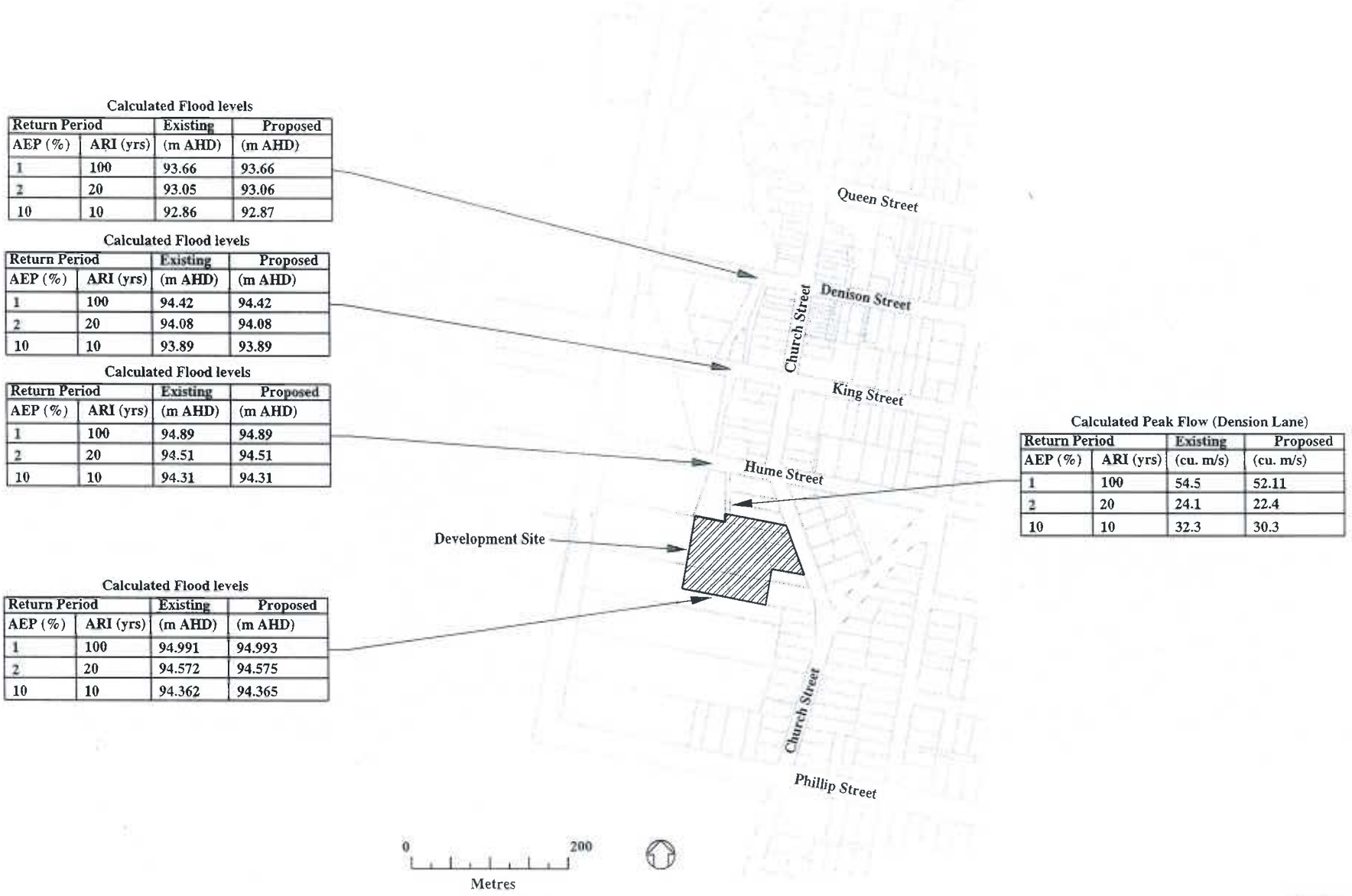
Return Period		Existing	Proposed
AEP (%)	ARI (yrs)	(m AHD)	(m AHD)
1	100	94.89	94.89
2	20	94.51	94.51
10	10	94.31	94.31

Calculated Flood levels

Return Period		Existing	Proposed
AEP (%)	ARI (yrs)	(m AHD)	(m AHD)
1	100	94.991	94.993
2	20	94.572	94.575
10	10	94.362	94.365

Calculated Peak Flow (Dension Lane)

Return Period		Existing	Proposed
AEP (%)	ARI (yrs)	(cu. m/s)	(cu. m/s)
1	100	54.5	52.11
2	20	24.1	22.4
10	10	32.3	30.3

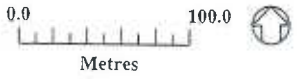


DATE: 8 JUNE 2010
DISK REF: 09-027
FILE REF: 09027_5_CHANGES IN 1%AEP FLOOD_CONDITIONS AT REFERENCE POINTS_V1

FIGURE 5
CHANGES IN 1% AEP FLOOD CONDITIONS
(AT REFERENCE POINTS)

Changes in 1% AEP flood levels

Changes in 1% AEP flood velocities



DATE: 8 June 2010
DISK REF: 09-027
FILE REF: 09-027_6_Changes in 1% AEP Flood_Conditions_V1

FIGURE 6
CHANGES IN 1% AEP FLOOD CONDITIONS