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FLOODPLAIN MANAGEMENT STUDY FOR WYOMING, WINGELLO AND BRADYS GULLY CREEKS

FINAL REPORT

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DISCLAIMER

The sole purpose of the services perfomed by Kinhill and of this report is to estimate flood levels and prepare a management plan for Wyoming, Wingello and Bradys Gully Creeks in Gosford, New South Wales, in accordance with the scope of services set out in the contract between Kinhill Engineers Pty Ltd ("Kinhill") and Gosford City Council ("the Client"). That scope of services was defined by the requests of the Client, the time and budgetary constraints imposed by the Client, and the availability of access to the site.

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FOREWORD

The New South Wales Government's flood policy is directed at providing solutions to existing flooding problems in developed areas, as well as ensuring that new development is compatible with the flood hazard, and that it does not create additional flooding problems in other areas.

Under the policy, the management of flood liable land remains the responsibility of local government. The State government subsidizes flood mitigation works to alleviate existing problems, providing specialist technical advice to assist councils in the discharge of their floodplain management responsibilities.

The flood policy provides for technical and financial support by the government through the following four sequential stages:

- Flood study: Determines the nature and extent of the flood problem;
- Floodplain management study: Evaluates management options for the channel in respect of both existing and proposed development;
- Floodplain management plan: Involves formal adoption by council of a plan of management for the channel;
- Implementation of the plan: Involves construction of flood mitigation works to protect existing development. Also, use of local environmental plans to ensure new development is compatible with the flood hazard.

The Wyoming, Wingello and Bradys Gully Creeks Floodplain Management Study constitutes the second phase of the management process for the three creeks, and has been prepared for Gosford City Council to evaluate the management options.

SUMMARY

The Wyoming, Wingello and Bradys Gully Creeks Floodplain Management Study has been undertaken to formulate a management plan that provides appropriate levels of flood protection to existing and future development. The study area extends from the Pacific Highway outlets, upstream along each creek to the catchment boundary.

The flood standard adopted by Gosford City Council is the 1% annual exceedance probability (AEP) flood event, and this has been used to prepare the management plan. The proposed plan examines a range of mitigation options.

A proposed prioritization of works within the management plan has been prepared to facilitate a staged implementation of the plan consistent with available funding.

Design flood profiles are given for each of the creeks, with recommendations of the works that should be undertaken.

For Wyoming Creek, this study recommends the following works:

- Upgrading the Pacific Highway culvert.
- Lining of the creek from the Pacific Highway to about 50 metres upstream of Glencoe Avenue.
- Removal of all obstructions in the existing Bourbon Street to Day Street concrete channel.
- Conversion of the existing piped Chamberlain Road culvert to twin cells 3.6 metres wide x 1.5 m deep box culverts incorporating a 'U' shaped concrete approach channel.
- Construction of an energy dissipator in Alan Davidson Park.
- Bank protection works at bends and confluences.

For Wingello Creek, this study recommends the following works:

- Removal of obstructions in the Reptile Park reach.
- Lining and straightening of the existing creek from Jarrett Street up to and including the Rainforest Reserve reach.

- Formalization of the existing creek from Roselands Avenue to Warrawilla Road into a grassed trapezoidal waterway with concrete low flow channel.

- Construction of an emergency spillway and weir for the existing Pecan Close detention basin.

- Appropriate bank protection works at bends and confluences.

For Bradys Gully Creek, this study recommends the following works:

- Lining the creek from Pacific Highway to Henry Parry Drive and thence to Cary Street.

- Augmentation of the Henry Parry Drive culvert.

- Completion of the on-going channel works from Glennie Street to Compton Street being undertaken by Council.

- Upgrading the Kirkness Avenue culvert.

This study only deals with the catchment in its existing state of development. Any future development would need to incorporate local detention facilities to maintain the existing discharges.

1 INTRODUCTION

1.1 GENERAL

Wyoming, Wingello and Bradys Gully creeks are tributaries of Narara Creek. They drain the areas to the east of the Pacific Highway at Gosford, as shown in Figure 1.1.

The Lower Narara Creek Floodplain Management Study, undertaken by Kinhill Engineers Pty Ltd (Kinhill 1991a), established coarse hydrologic and hydraulic models for the three catchments and the downstream tailwater levels. The recent Flood Study for Wyoming, Wingello and Bradys Gully creeks (Kinhill 1991b) established refined hydrological and hydraulic models and design flood profiles for the study area based on these tailwater levels.

Between 8 February and 10 February 1992, a major flood was recorded in Narara Creek. In some sections of lower Narara Creek, flood levels exceeded those predicted for the 1% Annual Exceedence Probability (AEP) event by over 700 mm. Flooding was also recorded in the tributaries of Narara Creek. Following this flood, the hydraulic modelling for lower Narara Creek was reviewed (Kinhill 1993) and the design flood levels amended. These new flood levels resulted in minor amendments to the design flood levels in the downstream reaches of Wyoming, Wingello and Bradys Gully creeks.

This report documents the floodplain management study undertaken for Wyoming, Wingello and Bradys Gully creeks based on these revised design flood levels.

The principal aims of this floodplain management study have been to:

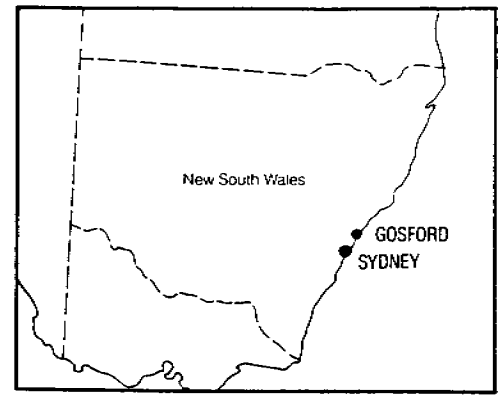
- establish a cost-effective flood management plan
- recommend staged implementation of the management plan.

The detailed studies of each of the three creeks are presented in Sections 3, 4 and 5, and include the following:

- evaluation of flood management options
- recommended flood management plans
- priority ranking of recommendations
- estimated costs of management options.

Generally, the management options have been discussed under two headings:

- Immediate flood management proposals
- Long-term flood management proposals.



LOCALITY PLAN

OURIMBAH
DOG TRAP ROAD
SYDNEY-NEWCASTLE FREEWAY
Narara Creek
Narara Creek
LISAROW
NIAGARA PARK
Branch
PACIFIC HIGHWAY
Park
Nagara
MAIN NORTHERN RAILWAY
Berrys Head
DEANE STREET
HANLAN ST
FOUNTAINS ROAD
CARRINGTON ST
REEVES ROAD
Fountain Creek
ARARA
Wyoming Creek
WYOMING
Wingello Creek
MAIDENS BRUSH ROAD
Gavenlock Oval
MANNS ROAD
DELL ROAD
Freshwater Creek
Narara Creek
Gosford Golf Course
SHOWGROUND ROAD
NORTH GOSFORD
Bradys Gully Creek
Pipeline
Gosford Racecourse
GOSFORD
PACIFIC HIGHWAY
Fagans Bay
Corrumbine Creek
BRISBANE WATER DRIVE
POINT CLARE
Brisbane Water
250
200
150
100
50

N

0 0.5 1km

Legend

- Catchment boundary
- Flood Plain Management Study Area

Figure 1.1
STUDY AREA

WYOMING CREEK, WINGELLO CREEK & BRADYS GULLY CREEK
FLOOD PLAIN MANAGEMENT STUDY

The measures recommended as immediate flood management proposals that will not affect the creek downstream of the Pacific Highway culverts should all be implemented as soon as practicable. For immediate proposals that may affect the creeks downstream of Pacific Highway, such as the augmentation of culverts under the Pacific Highway and the lining of the immediate upstream sections, works should only commence when the downstream improvement works recommended in the lower Narara Creek floodplain management study reports (Kinhill 1991a and Kinhill 1993) have been implemented.

Gosford City Council has adopted the 1% AEP flood event as the appropriate design standard for flood management and mitigation works. For this study, a range of floods was considered: the 1%, 2%, 5%, 20% and 2 x 1% AEP events. The latter corresponds to a flood with a discharge equal to two times the 1% AEP discharge and is assumed equivalent to an extreme flood.

1.2 STUDY AREA

The catchment areas of Wyoming Creek, Wingello Creek and Bradys Gully Creek upstream of the culverts under the Pacific Highway are 2.5 km^2, 5.0 km^2 and 2.2 km^2 respectively. The upper reaches of these catchments are mainly covered by natural bushland, while the lower reaches are almost fully urbanized. Ground elevations through the catchment vary between 3 m Australian Height Datum (AHD) and 160 m AHD. The watercourse slopes vary between 0.5% and 3% and are predominantly small naturally eroded streams except at one short section of Wyoming Creek, between Day Street and Alan Davidson Park, which is concrete lined. A few other locations of Bradys Gully Creek are piped.

1.3 PREVIOUS STUDIES AND DATA BASE

1.3.1 PREVIOUS STUDIES

Narara Creek has been the subject of several flood studies. The most recent study was documented in the Lower Narara Creek Floodplain Management Study (Kinhill 1991a) and the Review of Lower Narara Creek Floodplain Management Study (Kinhill 1993).

Previous studies for Wyoming Creek and Wingello Creek were carried out by Willing & Partners Pty Ltd in 1979. The Wyoming, Wingello and Bradys Gully creeks were the subject of a more recent flood investigation (Kinhill 1991b).

1.3.2 TOPOGRAPHIC DATA

The catchment and floodplain of the creeks are covered by the 1988 (2nd edition) 1:25,000 Gosford topographic map. Also used during various stages of this study were 1:4,000 and 1:2,000 orthophoto maps.

A specific ground survey was carried out by J.T.S. Ryan Firth & Co. under the instruction of Kinhill. This survey included:

- thirty-five channel and overbank cross-sections
- flood heights identified by resident interviews for the 7 February 1990 storm
- floor levels of buildings likely to be affected by floods
- cross-sections to determine culvert details.

1.3.3 RECORDED RAINFALL DATA

Details of the rainfall for historical flooding have been documented in the Flood Study for Wyoming, Wingello and Bradys Gully creeks (Kinhill 1991b).

1.3.4 FLOOD LEVELS

During recent years, the Public Works Department has installed a number of peak flood level indicators in the study area and some of the records obtained from these were used for this study. In addition, resident interviews were conducted during June 1990 to help determine peak flood levels along the creeks. This provided a significant amount of additional information to facilitate verification of flood behaviour.

In addition to the flood heights identified during the resident interviews, Gosford City Council had made available further information on flood levels obtained soon after the February 1990 storm.

Details of the flood level data are given in the Flood Study for Wyoming, Wingello and Bradys Gully creeks (Kinhill 1991b).

1.3.5 URBAN DEVELOPMENT OF CATCHMENT

The catchment areas of Wyoming Creek and Bradys Gully Creek, from the Pacific Highway culvert, are approximately two-thirds developed, whereas the Wingello Creek catchment is about half developed. Development in the catchments over the last twenty-five years has resulted in an increase in runoff. In accordance with the modelling in the Lower Narara Floodplain Management Study, the catchments have been considered in their existing condition, to the level of development experienced at the time of this study. The future estimations of flood impact on the catchments have been modelled using estimated maximum development in each catchment in accordance with Council's zoning maps.

1.3.6 DESIGN RAINFALL DATA

Design rainfall data were extracted from *Australian rainfall and runoff: A guide to flood estimation* Vol. 2 (Institution of Engineers, Australia 1987), which has been adopted by Gosford City Council for design purposes.

1.4 STUDY METHODOLOGY

The adopted study approach involved:

- collection of flood and rainfall data for the February 1990 flood event;
- calibration of the mathematical hydrologic and hydraulic models;
- establishment of design flood profiles for full urbanization, consistent with current zonings;
- evaluation of flood management options.

The first three items were presented in the Flood Study for Wyoming, Wingello and Bradys Gully creeks (Kinhill 1991b). The adopted mathematical modelling approach involved the use of a hydrologic model to determine design flows into the study area, and then to use a hydraulic model to determine peak flood levels in the study area.

1.4.1 RORB HYDROLOGIC MODEL

The runoff routing model for the Wyoming, Wingello and Bradys Gully creek catchments was based on the modelling procedures recommended in *User's manual: RORB Version 3—Runoff Routing Program* (Laurenson and Mein 1985).

The two relevant catchment response parameters were the catchment storage parameter k_c and the storage linear exponent 'm'. The parameter m was set at 0.8, which is the commonly accepted value, while the parameter k_c was varied to provide the best estimates of flow rates. The actual value of k_c was varied during the calibration process until the 'best fit' was obtained from the combined hydrologic and hydraulic modelling, and the historical flood levels.

1.4.2 HEC-2 HYDRAULIC MODEL

Hydraulic models were used to determine flow patterns, flood levels and velocities within the study area. Flood behaviour was assessed by calculating flow conditions throughout the channels and overbank areas.

In order to model flood behaviour during a storm event, the HEC-2 computer program developed by the Hydrologic Engineering Centre of the US Army Corps of Engineers was used in this study. It employs the standard step method procedure for computing of water profiles.

The hydraulic model was calibrated principally by adjusting the Manning 'n' roughness coefficients and the bridge parameters in the special bridge routine.

The steps involved in the calibration process for this study were as follows:

- fixing Manning 'n' roughness coefficients in the hydraulic model from field inspections;

- adjustment of the parameters for both the models to produce the best representation of the flood profile for the February 1990 event;
- adoption of one set of model parameters to be used for hydraulic model verification and design flood estimation.

2 FLOODPLAIN MANAGEMENT OPTIONS

2.1 GENERAL

The study areas for Wyoming Creek, Wingello Creek and Bradys Gully Creek have been subdivided into various distinct areas.

The purpose of a floodplain management plan is to reduce the potential for damage to a flood liable area by any cost-effective means. This could involve either reducing the flood hazard and allowing properties to be evacuated during flood times, or removing flood liable properties from the area. An alternative would be to provide flood-proofing that would not adversely affect other flood liable areas or create any new flood hazards.

A floodplain management study should evaluate the benefits of floodplain management measures to the community. In some instances, it may be necessary to take measures that, while adversely affecting local areas, would benefit the community as a whole.

Both structural and non-structural measures were evaluated for inclusion in the floodplain management scheme. These are outlined below.

2.2 STRUCTURAL MEASURES

The structural measures evaluated for possible inclusion in the floodplain management plan included:

- construction of detention basins at the upper reaches of the creek system;
- channel improvement works, such as construction of a grassed waterway, or concrete or rock lining of an existing creek;
- creek realignment;
- culvert modifications and amplifications;
- concrete paving of flood liable car parks;
- removal of channel obstruction;
- stabilization of eroding banks.

The channel improvements considered in this study have generally been assumed to be concrete-lined channels. However, stacked rock correctly laid to form a similar cross-section may be a preferred option. Stacked rock is available locally and could be considered environmentally preferable at a low cost. This technique has already been successfully used in Alan Davidson Park, Wyoming.

However, the increase in the Manning 'n' for stacked rock (0.03) compared to concrete lining (0.013) could create a greater risk of flooding due to a marginal increase in water levels. The merits of either type of lining would need to be considered for each circumstance at the time of final design. Typical channel cross-sections are shown in Figure 2.1.

The bank stabilization options considered include concrete trapezoidal channels, gabion and reno-mattress, lining or stacked rock lining. Gabion or reno-mattress lining have been adopted in this study, but the low cost of stacked rock may be considered a viable alternative.

An assessment of the relative effectiveness of possible structural measures for the creeks was undertaken, evaluating the hydraulic, economic, ecologic and social benefits of each of the proposed works. Following this assessment it was determined that a combination of measures would be the most appropriate solution.

A summary of the structural options and their assessed features is given in Table 2.1.

2.3 NON-STRUCTURAL MEASURES

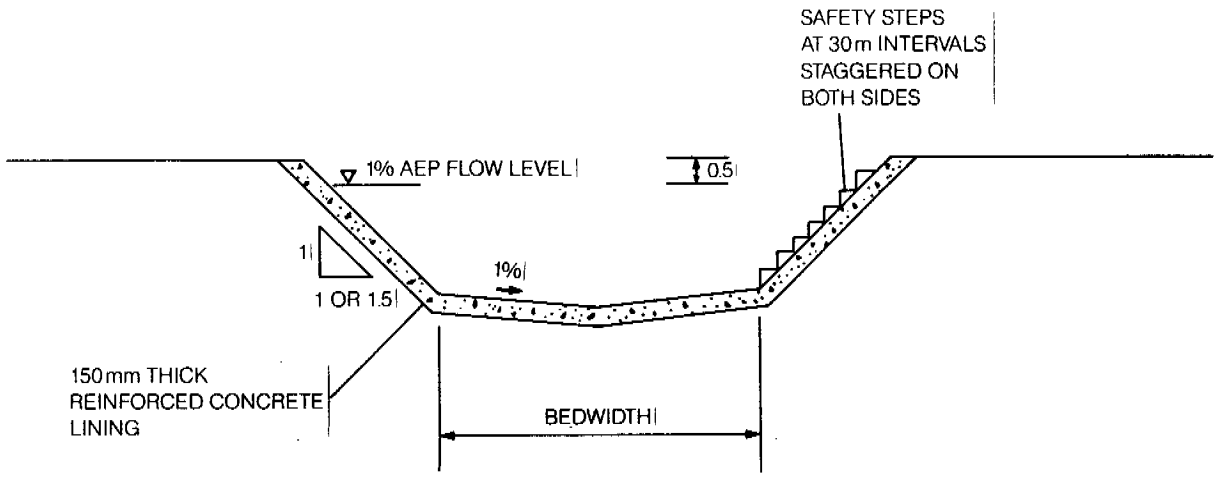
The non-structural measures evaluated for possible inclusion in the floodplain management plan were:

- flood warning
- flood education
- voluntary purchase (sale) of residential property.

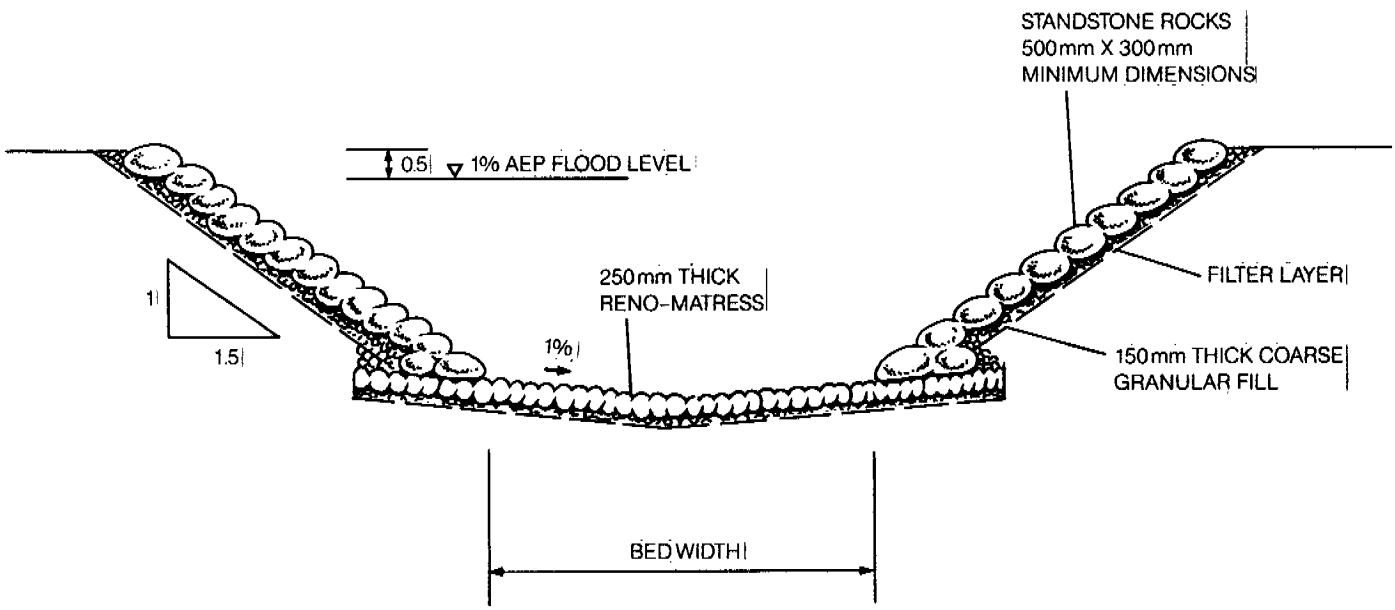
Flood warning was not considered a viable management measure on its own because it would not actually prevent significant flood damage from occurring. In addition, the warning time available to residents would be minimal due to the rapid response of the catchment to rainfalls. Thus there would be insufficient time to facilitate orderly evacuation and preparation.

Flood evacuation education was not considered viable for the residential area because of the lack of opportunity to enable effective evacuation. However, education with regard to the flood management options could be useful.

One of the options for the flood liable houses is the voluntary purchase (sale) of residential property, with the subsequent implementation of restricted landuse to prevent other types of development in floodways. However, this option is not favoured because of the potential social disruption to the community.



CONCRETE LINED CHANNEL CROSS-SECTION



STACKED ROCK LINED CHANNEL CROSS-SECTION

Note: *Sections are only schematic and should not be used for construction.*

Figure 2.1
TYPICAL CHANNEL CROSS-SECTIONS

Table 2.1 **Structural management measures**

Option	Comments	Ecological impact	Flood mitigation impact	Social impact	Further consideration
Construction of detention basins at upper reaches of creek systems	Minimal suitable land available	Minimal	Minimal for extreme flood—needs to be very large for effective mitigation	Minimal	No
Channel improvement works	Concrete lining is the most efficient measure as a mean to improve channel capacity	Depends upon location	Efficient	Aesthetically unpleasing	Yes
	Stacked rock walls are less efficient but are low cost and environmentally preferred	Depends on location	Less efficient when compared to concrete lining	Aesthetically pleasing	Yes
Creek realignment	Applicable in Wingello Creek upstream of Jarrett Street	Appropriate design and construction will minimize the impact	Significant reductions in flood levels achieved	Minimal	Yes
Culvert amplification	Would provide improved road access	Minimal	Minimal	Minimal	Yes
Removal of channel obstructions	Many channel obstructions such as low level crossings, simple timber footings and fences were erected for access, security or privacy reasons and their removal may face objections from the owners	None	Significant reductions in flood levels achieved	Disruptive to the community	Yes
Concrete paving of flood liable car park	Does not solve flooding problem but prevent costly damages	None	None	Minimal	No
Stabilization of eroding banks	Prevent siltation of downstream reaches and undermining of nearby structures. An effective soil conservation measure	Minimal	Minimal	Minimal	Yes

3 WYOMING CREEK MANAGEMENT OPTIONS

3.1 GENERAL

Wyoming Creek was divided into five distinct areas for the preparation of the floodplain management plan, as follows:

- Renwick Street and Glencoe Avenue floodway and channel improvement area—Pacific Highway to Glencoe Avenue;
- Alan Davidson Park floodway and dissipator area—Glencoe Avenue to Bourbon Street;
- Bourbon Street and Day Street floodway and channel improvement area;
- Chamberlain Road floodway and channel improvement area—Day Street to Chamberlain Road;
- Giselle Avenue floodway and channel improvement area—upstream to Chamberlain Road.

These areas are shown schematically in Figure 3.1.

3.2 IMMEDIATE FLOOD MITIGATION OPTIONS

Eight houses have been identified as being flood liable in a 1% AEP event: four in Renwick Street, one in Giselle Avenue and three in Bourbon Street. These houses are listed in Appendix A. In addition, the Pacific Highway, Day Street and Chamberlain Road are all overtopped during the 1% AEP event. However, only works required to make the houses flood free and to prevent excessive scour and erosion of the creek have been identified as being high priority.

3.2.1 RENWICK STREET AND GLENCOE AVENUE FLOODWAY AND CHANNEL IMPROVEMENT AREA—PACIFIC HIGHWAY TO GLENCOE AVENUE

The section of creek comprises an incised channel that passes along the back of the properties in Renwick Street and Glencoe Avenue.

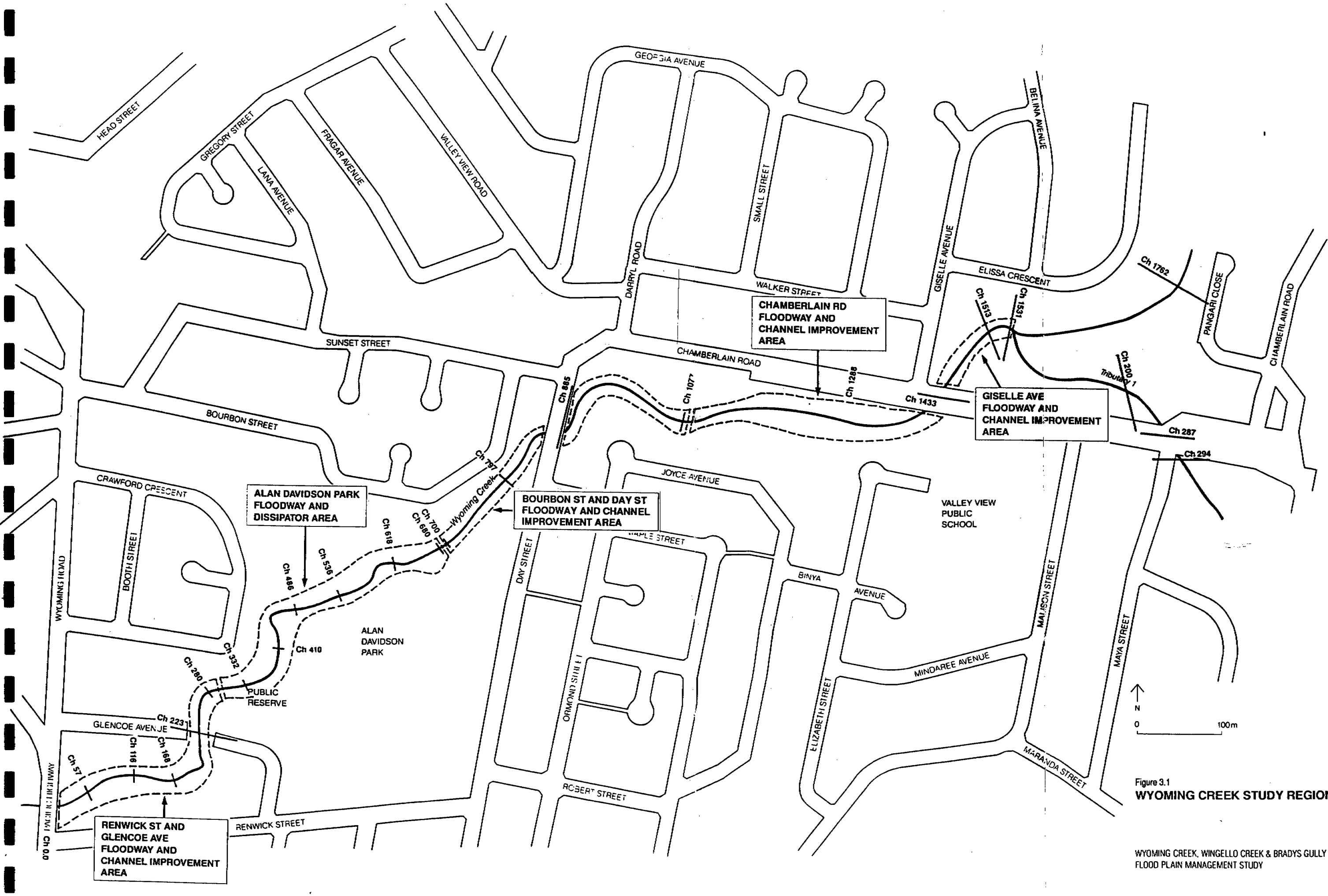


Figure 3.1
WYOMING CREEK STUDY REGIONS

Some sections of the creek have been lined with concrete blocks to prevent scour and erosion; however, some of these blocks have moved and slipped into the creek bed. There is no dedicated drainage easement in the area and four properties are flood liable.

Deepening and lining the creek upstream of the Pacific Highway would result in a lower water profile, as indicated by Profiles 3A, 3B and 3C in Figure 3.2. This would also protect the properties near Glencoe Avenue against inundation.

Profiles 3B and 3C differ from Profile 3A in that the culverts under the Pacific Highway were assumed to be doubled in capacity. For Profiles 3B and 3A, the invert of the new channel was regraded to be in line with the channel upstream of Chainage 488. However, this would require the costly diversion of three sewer mains crossing the creek and so the invert of Profile 3C was designed to avoid diversion of the sewers. This is the preferred option.

The existing twin cell 2.1m by 2.1m box culvert under the Pacific Highway overtops by 800 mm in a 1% AEP event. This culvert is undersized for the 1% AEP discharge, a problem that is exacerbated by the high tailwater level in Narara Creek. The addition of two further cells, 2.1 m by 2.1 m, would improve the situation, as shown by Profiles 3B and 3C in Figure 3.2.

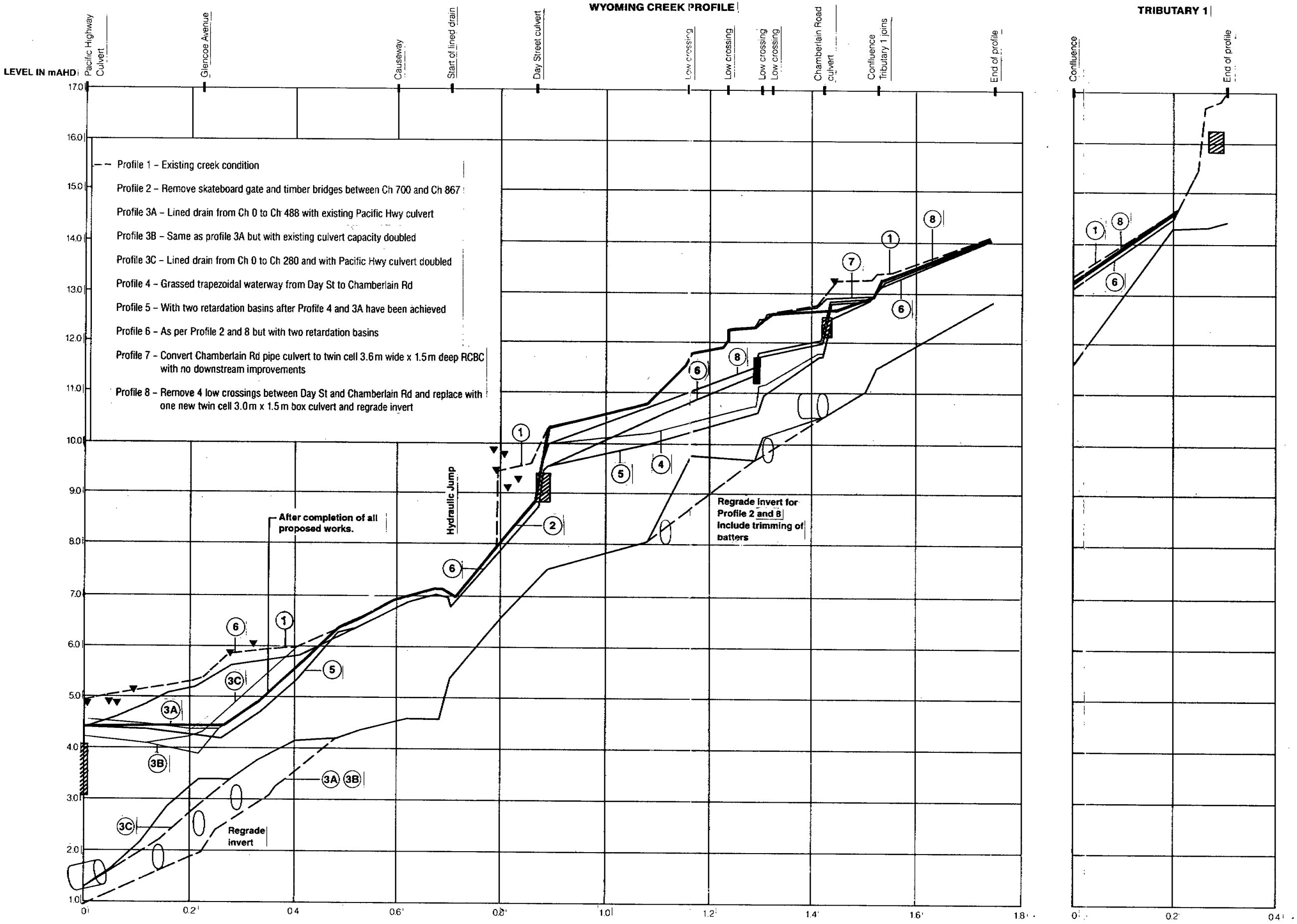
The Profile 3C option is recommended because the Pacific Highway would only be overtopped by about 250 mm in a 1% AEP flood with coincident peak flows. Adoption of Profile 3C would also limit the extent of inundation of the adjoining properties.

However, the advantages of this culvert amplification could not be fully realized unless the section of Wyoming Creek downstream of the Pacific Highway was improved. Under the Lower Narara Creek Floodplain Management Plan, it has been recommended that the creek be realigned and a more direct floodway be created between the Pacific Highway and the railway line. These works would lower the flood levels significantly in this section of the creek.

Typical proposed cross-sections for the lining work are shown in Figure 3.3. Concrete is the preferred lining material due to the restrictions in available land. The batter for the proposed concrete channel would be approximately 1:1.5 vertical–horizontal. Escape stairways should be incorporated in the channel walls at safe intervals.

The backyards of some properties located between the Pacific Highway and Glencoe Avenue are low lying. Consequently, even with the completion of the lined channel, a 1% AEP event would flood some property unless levee banks were built. However, a detailed assessment of the viability of constructing levees should be undertaken if they are required at a later stage as they could cause problems to local drainage.

Both the amplification of the Pacific Highway culvert and the lining of creek from the Pacific Highway are recommended as being high priorities due to the potential benefits of making properties flood free. However, these works would need to be carried out in conjunction with the proposed creek mitigation works downstream of the Pacific Highway as well as the proposed upgrade of the Pacific Highway.



Note: Do not scale off this drawing. Refer to tabulated flood levels.

Figure 3.2

1% AEP DESIGN WATER PROFILES AFTER VARIOUS MITIGATION OPTIONS FOR WYOMING CREEK

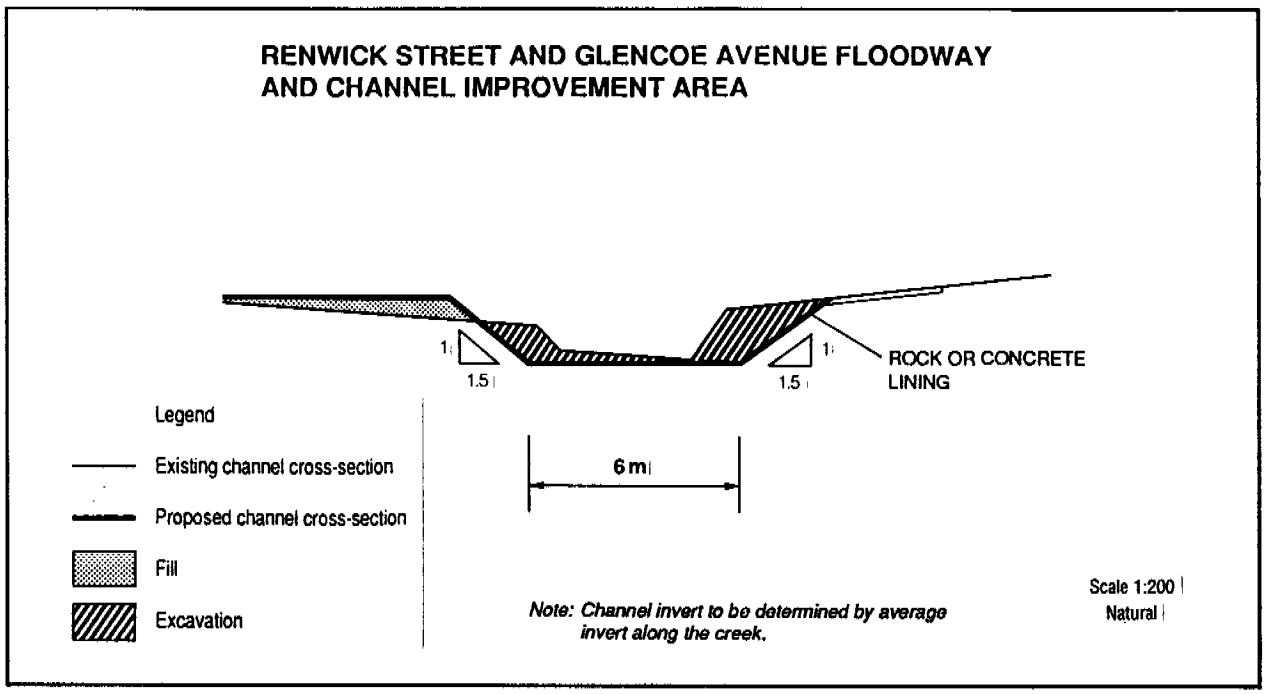


Figure 3.3
TYPICAL CROSS-SECTION FOR WYOMING CREEK

3.2.2 BOURBON STREET AND DAY STREET FLOODWAY AND CHANNEL IMPROVEMENT AREA

Upstream of Alan Davidson Park and downstream of Day Street, Wyoming Creek is contained in a concrete channel. Several footbridges and an access bridge span the channel, which is sometimes used for skateboarding.

The blockage caused by washed away bridges lodging at the skateboard ramp at Chainage 797 was the major cause of the flooding in February 1990 of properties adjoining the channel. Three houses adjoining the lined drain would be liable to flooding in a 1% AEP event if the obstruction reoccurred. Using the Manning formula, it was found that the lined drain would be able to convey the 1% AEP discharge of 44 m^3/s under supercritical flow with minimal freeboard. (Profile 2 in Figure 3.2 shows the supercritical flood level.) However, for this to happen, the channel must be free of any obstructions or likely blockages during periods of high flow.

It is therefore recommended that the skateboard ramp at Chainage 797 be maintained so that it either provides minimal flow resistance or is removed entirely. Any footbridges designed in the future should be subjected to a rigorous hydraulic analysis. Currently, each of the lots adjoining the drain has a simply supported timber bridge that provides access to the opposite bank. If local residents demand that a crossing be provided, it must be specially designed to have a minimum clearance of 500 mm above the 1% AEP flood level and be a single span structure.

The 1% AEP supercritical velocity in the channel is around 6 m/s. Because of this, care must be exercised to prevent any person falling into the drain. One option is to completely fence the full length of the drain on both banks, with only one properly designed and safe crossing at Chainage 797. However, this option is not recommended due to the inconvenience of removing the individual access bridges.

The most permanent remedial measure would be to augment the lined drain so that a minimum of 500 mm of freeboard was achieved in the channel during a 1% AEP event. However, as the lined drain is actually within a developed area, this option is not recommended.

No works are recommended for the existing box culvert at Day Street, which is approximately 6.4 m wide. This is because the immediate downstream section is a 6 m wide trapezoidal channel, and any culvert widening would be ineffective.

3.2.3 CHAMBERLAIN ROAD FLOODWAY CHANNEL IMPROVEMENT AREA

Upstream of Day Street, Wyoming Creek meanders through a public reserve up to Chainage 1077 before passing through the frontage of some properties on Chamberlain Road. Between Chainage 885 and Chainage 1077 the creek is overgrown and ill defined, and there are some sections where bank erosion is undermining the property boundaries.

As a high priority for this section of creek, it is recommended that localized bank protection be provided to prevent further scouring.

Upstream of Chainage 1077, the creek passes through private properties. However, the floodplain has been well maintained and is generally short grass. A proposal for this section of the creek involves formalization of the creek between Chainage 1077 and Chamberlain Road. The resultant water levels are shown as Profile 4 in Figure 3.2. A concrete low-flow channel could be incorporated into the grassed channel for ease of maintenance. As shown in Figure 3.2, this option has the significant effect of lowering the design water levels. Consequently it is expected that Chamberlain Road would not be overtopped in a 1% AEP event with the existing pipe culverts. However, the implementation of other recommended works would have a similar effect and this, together with the complication of maintaining rights of ways and establishing drainage easements, has resulted in this option not being considered further.

An analysis was also undertaken for a situation where the four existing low bridge crossings were removed and replaced with one crossing near Chainage 1288. This crossing was assumed to consist of a two cell 3.0 m by 1.5 m box culvert. A road would then be needed on the bank to provide access to the properties originally served by the four crossings. In addition, it would be necessary to regrade the invert of the creek, as shown in Figure 3.2, and to trim the batters. The water profile that would result (Profile 8) is shown in Figure 3.2.

Under Profile 8, the proposed twin cell box culvert would be overtopped in a 1% AEP event. This would be unavoidable because of the high tailwater level created by the Day Street crossing. The depth of the box culvert would have to be a minimum of 2.4 m to allow free flow.

One difficulty associated with Profile 8 would be that the owners of the existing four low crossings could object to the idea of sharing one common crossing. In view of this, another analysis was undertaken to assess the effect of replacing the four low crossings with twin cell, 3.0 m by 1.5 m box culverts at each of the original four crossing locations. The results of this analysis indicated that there would be very little reduction in the design water level.

Without formalization of the existing narrow creek, water would overtop all the new box culverts. Hence the option of replacing the four existing box culverts is not recommended. This is further justified by the possibility that during floods the properties may be accessed from Joyce Avenue.

3.2.4 GISELLE AVENUE FLOODWAY CHANNEL IMPROVEMENT AREA

The house immediately upstream of the Chamberlain Road culvert is liable to flood in a 1% AEP event under existing conditions. This is because of:

- high tailwater levels downstream of the Chamberlain Road culvert;
- the capacity of the culvert being reduced by a tree on the western bank, immediately upstream of the culvert;
- the already restricted culvert entrance.

As a high priority, it is recommended that the tree on the western bank be felled and that the entrance section be made into a 7.5 m wide concrete 'U' section, incorporating a new head wall. This U section should be extended a distance upstream, before transitioning back to the natural cross-section.

The owner of the lot upstream of the culvert has fenced the property and, in doing so, has created a restriction for the overflowing water, thus increasing the flood level. The vehicular guard rail and mesh railing over the culvert are also potential obstructions to flows and should be replaced with railings that offer minimal obstruction.

In order to reduce flood levels further, an option would be for the pipes to be replaced with two 3.6 m by 1.5 m box culverts. The widening of the upstream creek would involve some loss of land in the private lot upstream of the culvert. The guard-rail would still need to be replaced. However, this would probably be acceptable to the owner because, in return, the house would be inundated less frequently. With this proposal the 1% AEP flood level at the upstream side of the culvert would be at reduced level (RL) 12.87 m AHD, which would be 280 mm below the sunken floor level of no. 1 Giselle Avenue. This proposal is shown as Profile 7 in Figure 3.2 and is recommended for immediate implementation.

The next option evaluated would involve the purchase of the affected house and convert the land to an open reserve. However, under this option the road and the surrounding areas would still be flooded and the road impassable to traffic during significant floods. Therefore this option was not considered further.

Upstream of the Chamberlain Road culvert, up to Chainage 1531, bank erosion is gradually undermining property boundaries. Selected bank protection is therefore recommended for immediate implementation.

3.3 LONG-TERM OPTIONS

3.3.1 ALAN DAVIDSON PARK FLOODWAY AND DISSIPATOR AREA

Wyoming Creek passes through Alan Davidson Park, between Day Street and Glencoe Avenue. The park is a large passive and active recreation area with short, well maintained grass cover. The grassed banks form a natural floodplain and therefore no channel formalization is recommended. However, sections of the creek are eroding on the outside of the bends and bank protection works would be required there.

Just downstream of the concrete channel, at Chainage 696, the creek flow regime changes from supercritical to subcritical flow. This transition has caused erosion and scour, and it is thus recommended that an energy dissipation structure be built in this section.

3.3.2 DETENTION BASINS

To further alleviate flooding, two detention basins could be constructed in the upper reaches of Wyoming Creek, near Chainages 1531 and 1762: one excavated and the other at natural surface level. The excavated material could serve as fill for the embankments for both basins. These basins could also be designed as silt traps to reduce downstream pollution.

The proposed stage–storage and discharge–storage relationships for the basins are presented in Table 3.1.

Table 3.1 **Stage-storage and discharge-storage relationship for detention basins in Wyoming Creek**

Basin	Stage (m)	Discharge (m^3/s)	Storage (m^3)
Excavated basin	0.0	0.0	0
(near Chainage 1531)	0.43	0.8	940
Stage 0 m = RL 11.52 m AHD	0.85	3.0	3,650
Outlet: 3 Nos 1.0 m dia RCP	1.07	4.2	5,190
Emergency weir level = 13.70 m AHD	1.28	5.5	6,650
	1.49	7.2	8,170
	1.71	8.0	10,700
	1.92	8.7	13,200
	2.13	9.3	15,700
	2.24	10.1	17,000
	2.35	12.1	18,300
	2.45	34.9	19,500
Basin at natural surface level	0	0	0
(near Chainage 1762)	0.55	0.3	230
Stage 0 m = RL 15.27 m AHD	1.67	1.5	700
Outlet: 2 Nos 1.0 dia RCP	1.93	1.9	800
Emergency weir level = 17.81 m AHD	2.07	3.1	2,150
	2.26	5.1	3,950
	2.44	6.0	5,740
	2.63	6.8	7,530
	2.68	7.1	7,970
	2.72	8.6	8,420
	2.77	30.1	8,870

The resultant water profiles, nos 5 and 6, are shown in Figure 3.2. These profiles assume that the previously discussed channel improvement works have already been implemented. A comparison of discharges at strategic points for various events is presented in Table 3.2.

It should be noted that this detention basin option is not recommended as it would have little effect on the design water levels.

Table 3.2 **Comparison of discharges for different conditions in Wyoming Creek (m^3/s)**

Location	Existing state of development			Possible future development
	7 February 1990	1% AEP	1% AEP	1% AEP
Basin 1				
Inflow	No basin	No basin	18.8	No basin
Outflow			15.8	
Top water level (m AHD)			18.0	
Chainage 1531	12.0	18.8		30.3
Tributary 1	7.2	9.7		18.3
Basin 2				
Inflow	No basin	No basin	25.5	No basin
Outflow			20.8	
Top water level (m AHD)			13.9	
Chainage 1288	18.4	23.3	19.5	42.1
Chainage 885	25.0	33.8	23.4	49.5
Day Street culvert				
Existing lined drain	31.5	44.2	34.0	58.4
Pacific Highway	38.2	48.5	40.0	60.7

3.4 FUTURE DEVELOPMENT

This report deals only with the catchment in its existing state of development. Any future development would need to incorporate local detention facilities so that the peak discharge value did not exceed the current peak value. The resulting hydrograph from these detention facilities would need to be checked against the established RORB model to avoid synchronization of peak discharges. A discussion of future detention facilities is presented in Section 6.

The future developed situation, assuming maximum development under the current Council zoning has been modelled and the results of the modelling are shown in Table 3.2.

3.5 CONCLUSIONS

A summary of the mitigation works considered, their priority and estimated costs is presented in Table 3.3. The flood levels that would occur following completion of all the works are given in Table 3.4. Flood levels under different scenarios, in accordance with their priority ranking, are tabulated in Appendix C. The recommended works are identified in Figure 3.4 and the design flood levels for Wyoming Creek at the completion of these works are shown in Figure 3.5. The flood contours at the completion of the works are shown in Figure 3.6.

Table 3.3 **Recommended works and priority ranking for Wyoming Creek**

Location	Description	Profile No	Recommendation	No of houses threatened/ roads flooded	Cost	Priority
	No works	1	Not recommended	Eight, Pacific Highway, Day St and Chamberlain Rd flooded		
Renwick St and Glencoe Ave floodway & channel improvement area (Ch0 To Ch280)	Lined channel from Ch0 to Ch486	3A	Not recommended	None, Pacific Highway, Day St and Chamberlain Rd flooded	$800,000	–
	Lined channel from Ch0 to Ch486, with Pacific Highway culvert doubled	3B	Not recommended	None, Day St and Chamberlain Rd flooded	$890,000	–
	Lined channel from Ch0 to Ch280	3C	Immediate recommendation	None, Pacific Highway, Day St and Chamberlain Rd flooded	$430,000	3
	Pacific Highway culvert doubled	3C	Immediate recommendation	None, Pacific Highway, Day St and Chamberlain Rd flooded	$90,000	2
Alan Davidson Park floodway and dissipator area (Ch280 To Ch690)	Energy dissipator downstream of concrete channel in Alan Davidson Park	–	Long term recommendation	–	$140,000	6
	Selective bank protection between Ch280 to Ch690	–	Long term recommendation	–	$20,000	5
Bourbon St and Day St floodway and channel (Ch700 To Ch867)	Remove skateboard ramp and timber bridges in lined drain and raise footbridges and access bridges	2	Immediate recommendation	None, Pacific Highway, Day St flooded	$40,000	Completed 1992
Chamberlain Rd floodway and channel improvement area (Ch885 To Ch1418)	Selective bank protection between Ch885 to Ch1077	–	Immediate recommendation	–	$59,000	4
	Grassed waterway with low flow channel from Ch885 to Ch1418 and replace 4 crossings by one high level crossing	4	Not recommended	Three, Pacific Highway, Day St and Chamberlain Rd flooded	$500,000	–

Table 3.3 (cont) **Recommended works and priority ranking for Wyoming Creek**

Location	Description	Profile No	Recommendation	No of houses threatened/ roads flooded	Cost	Priority
Chamberlain Rd floodway and channel improvement area (Ch885 To Ch1418)	Remove 4 low level crossings between Day St and Chamberlain Rd	8	Not recommended	–		
Giselle Ave floodway and channel inmprovement area (Ch1432 To Ch1531)	Convert Chamberlain Rd pipe culvert to twin cell RCBC Construct new headwalls upstream and downstream to Chamberlain Road culvert and channel protection works to Ch1513	7	Immediate recommendation	Two, Pacific Highway, Day St and Chamberlain Rd flooded	$243,000	1
	Buy No 1 Giselle Ave	–	Not recommended	–	$120,000	–
	Construct two detention basins near Ch1531 and Ch1762 after long term channel works between Ch0 to Ch280 and Ch885 to Ch1418	5	Not recommended	None, Pacific Highway, Day St flooded	$500,000	–
	Construct two detention basins near Ch1531 and Ch1762 after channel works between Ch680 and Ch885	6	Not recommended	–	$500,000	–

Table 3.4 **Design flood levels at completion of recommended works for Wyoming Creek**

Cross section	Existing conditions 1%AEP	After completion of works				
		1%AEP	2%AEP	5%AEP	20%AEP	2*1%AEP
0.0	4.95	4.37	4.18	3.86	3.33	5.88
57.0	5.07	4.37	4.18	3.86	3.33	5.91
116.0	5.19	4.37	4.18	3.86	3.33	5.91
168.0	5.37	4.37	4.18	3.86	3.33	5.91
223.0	5.38	4.56	4.43	4.31	4.06	5.91
260.0		4.90	4.81	4.72	4.36	5.91
280.0	5.80	5.13	5.05	4.96	4.77	5.91
332.0	5.86	5.66	5.58	5.48	5.23	6.11
410.0	5.97	5.90	5.80	5.70	5.47	6.51
486.0	6.36	6.43	6.31	6.17	6.02	7.04
536.0	6.61	6.62	6.51	6.27	6.17	7.08
618.0	6.99	6.98	6.92	6.88	6.57	7.38
680.0	7.20	7.20	7.12	7.05	6.79	7.70
696.0	7.11	7.11	7.04	6.97	6.73	7.42
700.0	7.75	7.18	7.06	6.91	6.66	7.98
797.0	9.52	8.68	8.66	8.63	8.36	9.23
860.0	9.67	Not included in model				
867.7	9.69	8.95	8.74	8.60	8.37	10.21
885.0	10.39	10.39	10.22	10.03	9.67	11.58
888.0	10.39	Not included in model				
1077.0	10.80	10.81	10.73	10.62	10.32	11.50
1155.0	11.52	11.52	11.44	11.37	11.23	11.97
1159.0	11.77	11.76	11.67	11.58	11.40	12.44
1233.0	11.88	11.88	11.79	11.69	11.51	12.52
1237.0	12.23	12.23	12.11	11.99	11.76	13.10
1288.0	12.26	12.26	12.14	12.02	11.79	13.12
1293.0	12.26	12.26	12.14	12.02	11.79	13.12
1299.0	12.43	12.43	12.33	12.24	12.04	13.20
1301.0	12.43	12.43	12.34	12.24	12.04	13.20
1305.0	12.52	12.52	12.43	12.34	12.17	13.27
1360.0	12.53	12.53	12.44	12.35	12.18	13.28
1414.0	12.60	12.60	12.52	12.43	12.25	13.31
1418.0	12.59	12.60	12.52	12.43	12.26	13.28
1433.0	13.25	12.65	12.60	12.54	12.32	13.29
1438.0	13.25	12.65	12.60	12.54	12.32	13.30
1443.0		12.65	12.60	12.54	12.32	13.30
1513.0	13.23	12.89	12.87	12.81	12.67	13.30
1531.0	13.35	13.29	13.22	13.15	13.01	13.68
1762.0	14.17	14.18	14.12	14.06	13.94	14.64
-1531.0	13.35	13.29	13.22	13.15	13.01	13.68
200.0	14.56	14.56	14.54	14.52	14.47	14.87
250.0	15.46					
260.0	15.58	Not included in model				
287.0	15.59					
294.0	15.56					

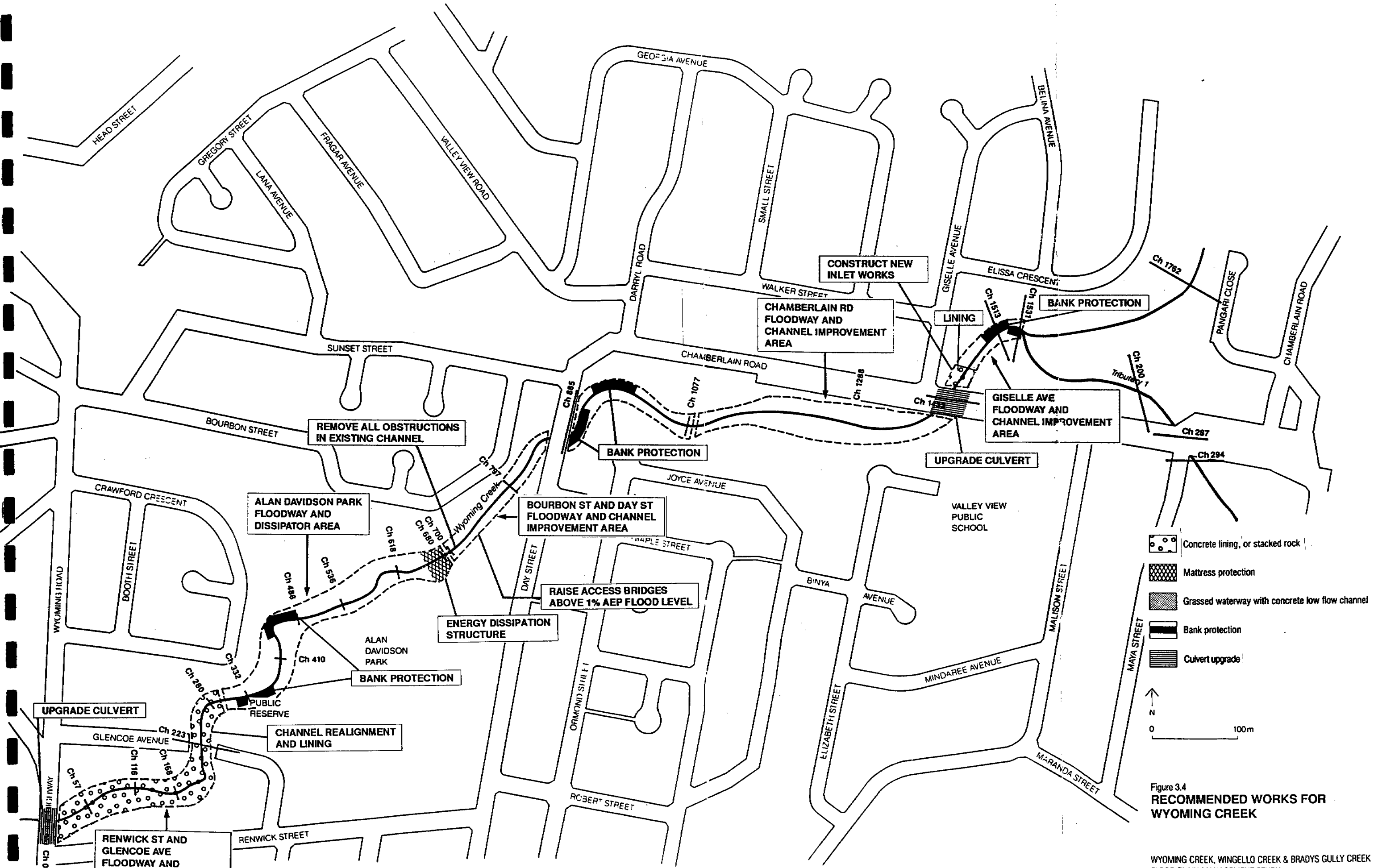
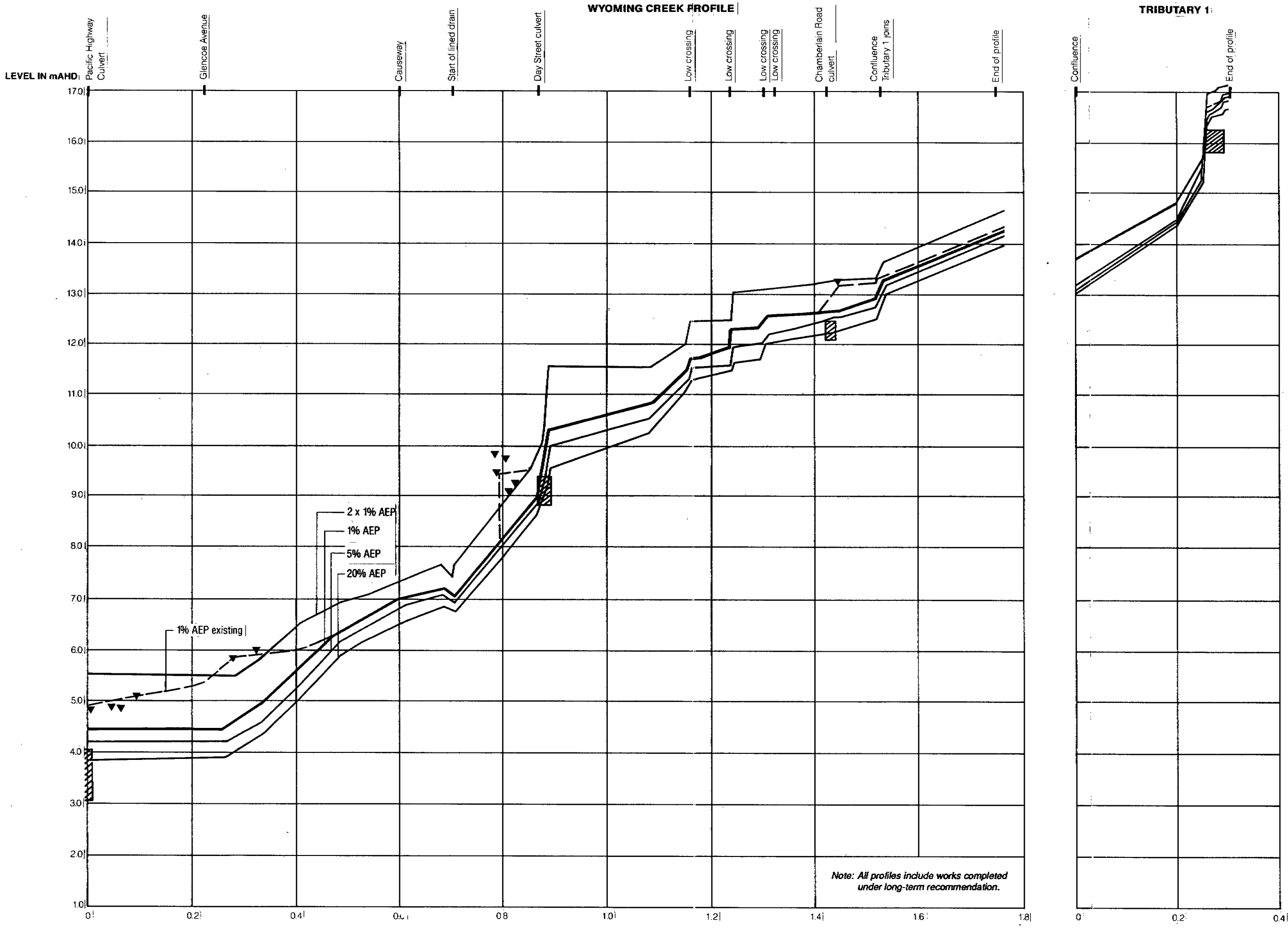


Figure 3.4
RECOMMENDED WORKS FOR WYOMING CREEK



Note: Do not scale off this drawing. Refer to tabulated flood levels.

Figure 3.5

20%, 5%, 1% AND 2 x 1% AEP FLOOD PROFILES WITH RECOMMENDED WORKS FOR WYOMING CREEK

WYOMING CREEK, WINGELLO CREEK & BRADYS GULLY CREEK FLOOD PLAIN MANAGEMENT STUDY

GOSFORD CITY COUNCIL

NOTES

1. FLOOD LEVELS HAVE BEEN CALCULATED AT CROSS SECTION LOCATIONS ONLY.
2. FLOOD LEVELS AND FLOOD CONTOURS BETWEEN CROSS SECTIONS HAVE BEEN LINEARLY INTERPOLATED.
3. FLOOD CONTOURS DEPICT APPROXIMATE WIDTHS OF FLOODING ONLY. FLOOD LIABILITY SHOULD BE VERIFIED BY GROUND SURVEY.
4. FLOOD LEVELS ARE GIVEN IN METRES TO AUSTRALIAN HEIGHT DATUM.
5. SIZES SHOWN ON THIS PLAN ARE APPROXIMATE ONLY AND DETAILS SHOULD NOT BE SCALED FROM THIS DRAWING FOR DETAILED DESIGN PURPOSES.

LEGEND

- 1% AEP flood extent
- CS520 — Flood contour at survey cross section
- 6.5 — Flood contour interpolated between cross sections
- 5.93 — House floor levels

212A	212B	213A
212C	212D	213C
228A	228B	229A
228C	228D	229C

KEY TO ADJOINING SHEETS

Central Mapping Authority Map Reference: GOSFORD U2797 - 24

40 20 0 40 80 120 160 200m

FLOODPLAIN MANAGEMENT PLAN OVERLAY

Produced for
GOSFORD CITY COUNCIL - Revised January 1993
Consulting Engineers - KINHILL ENGINEERS
Consulting Surveyors - JTS RYAN FIRTH & CO

FLOODPLAIN MANAGEMENT STUDY FOR WYOMING, WINGELLO AND BRADYS GULLY CREEKS

FLOOD CONTOURS AT COMPLETION OF PROPOSED WORKS FOR WYOMING CREEK

SHEET 1 of 2 Figure 3.6

GOSFORD CITY COUNCIL DRAWING NUMBER 4/110/A1

GOSFORD CITY COUNCIL

NOTES

1. FLOOD LEVELS HAVE BEEN CALCULATED AT CROSS SECTION LOCATIONS ONLY.
2. FLOOD LEVELS AND FLOOD CONTOURS BETWEEN CROSS SECTIONS HAVE BEEN LINEARLY INTERPOLATED.
3. FLOOD CONTOURS DEPICT APPROXIMATE EXTENT OF FLOODING ONLY. FLOOD LIABILITY SHOULD BE VERIFIED BY GROUND SURVEY
4. FLOOD LEVELS ARE GIVEN IN METRES TO AUSTRALIAN HEIGHT DATUM.
5. SIZES SHOWN ON THIS PLAN ARE APPROXIMATE ONLY AND DETAILS SHOULD NOT BE SCALED FROM THIS DRAWING FOR DETAILED DESIGN PURPOSES.

LEGEND

- 1% AEP flood extent
- CS 520
- 6.5 Flood contour at survey cross section
- 6.6 Flood contour interpolated between cross sections
- House floor levels

212A	212B	213A
212C		
228A		
228C		229C

KEY TO ADJOINING SHEETS

Central Mapping Authority Map Reference: GOSFORD U2797 - 33

40 20 0 40 80 120 160 200m

FLOODPLAIN MANAGEMENT PLAN OVERLAY

Produced for
GOSFORD CITY COUNCIL - Revised January 1993
Consulting Engineers - KINHILL ENGINEERS
Consulting Surveyors - JTS RYAN FIRTH & CO

FLOODPLAIN MANAGEMENT STUDY FOR WYOMING, WINGELLO AND BRADYS GULLY CREEKS

FLOOD CONTOURS AT COMPLETION OF PROPOSED WORKS FOR WYOMING CREEK

SHEET 2 of 2 Figure 3.6

GOSFORD CITY COUNCIL DRAWING NUMBER 4/111/A1

4 WINGELLO CREEK MANAGEMENT OPTIONS

4.1 GENERAL

Wingello Creek was divided into seven distinct areas for the preparation of the floodplain management plan, as follows:

- Reptile Park Reach—Pacific Highway to Jarrett Street;
- Jarrett Street to Rainforest Reserve lining area—Jarrett Street to Roselands Avenue;
- Roselands Avenue to Warrawilla Road grassed waterway area;
- Existing Pecan Close detention basin;
- Blackbutt Street Public Reserve;
- Tributary 1 area—upstream of Warrawilla Road and downstream of Maidens Brush Road;
- Tributary 2 Area—Rainforest Road.

These areas are shown schematically in Figure 4.1.

4.2 IMMEDIATE FLOOD MITIGATION OPTIONS

Two homes in Pecan Close have been identified as being flood liable in a 1% AEP event. These houses are listed in Appendix A. In addition, the Pacific Highway, Jarrett Street, Warrawilla Road and Maidens Bush Road are all overtopped during a 1% AEP event. However, only works required to make the houses flood free and to prevent excessive scour and erosion of the creek have been identified as being high priority.

4.2.1 REPTILE PARK REACH—PACIFIC HIGHWAY TO JARRETT STREET

Wingello Creek, between the Pacific Highway and Jarrett Street, is influenced by the water level at the Pacific Highway. The two 3.05 m by 2.67 m box culverts under the highway overtop by 400 mm in a 1% AEP event. Flood levels upstream of the culverts are controlled by the high water levels in Narara Creek and not the capacity of the culverts, which is greater than the 1% AEP discharge. Therefore the widening of the

Figure 4.1
WINGELLO CREEK STUDY REGIONS

WYOMING CREEK, WINGELLO CREEK & BRADYS GULLY CREEK
FLOOD PLAIN MANAGEMENT STUDY

culverts would not have a significant impact on flood levels, and accordingly upgrading of the Pacific Highway culverts is not recommended.

The proposed works for Wingello Creek downstream of the Pacific Highway have been designed to lower flood levels up to the 5% AEP storm event. The effect of these works on the 1% AEP flood levels will be marginal and it is unlikely any effect will be transferred upstream. The works referred to downstream of the Pacific Highway culverts are described in the Lower Narara Floodplain Management Plan.

Between the Pacific Highway and Jarrett Street, the creek meanders through the Reptile Park where it is used as a feature. Just downstream of the Jarrett Street culverts, large fence gates have been placed across the creek to prevent animals from escaping. These are hinged so theoretically in flood flows they rise and do not impede flows. In addition, there is a concrete weir set at RL3.7 m AHD to create a permanent pond as well as a low-level steel access bridge. All these structures impede the flow and have thus increased flood levels upstream. The removal of these structures would alleviate the situation, as illustrated by Profile 2 in Figure 4.2. However, if regular maintenance of the fence gates were undertaken, they would operate effectively and could thus be retained.

4.2.2 JARRETT STREET TO RAINFOREST RESERVE LINING AREA

Chainage 275 to Chainage 435

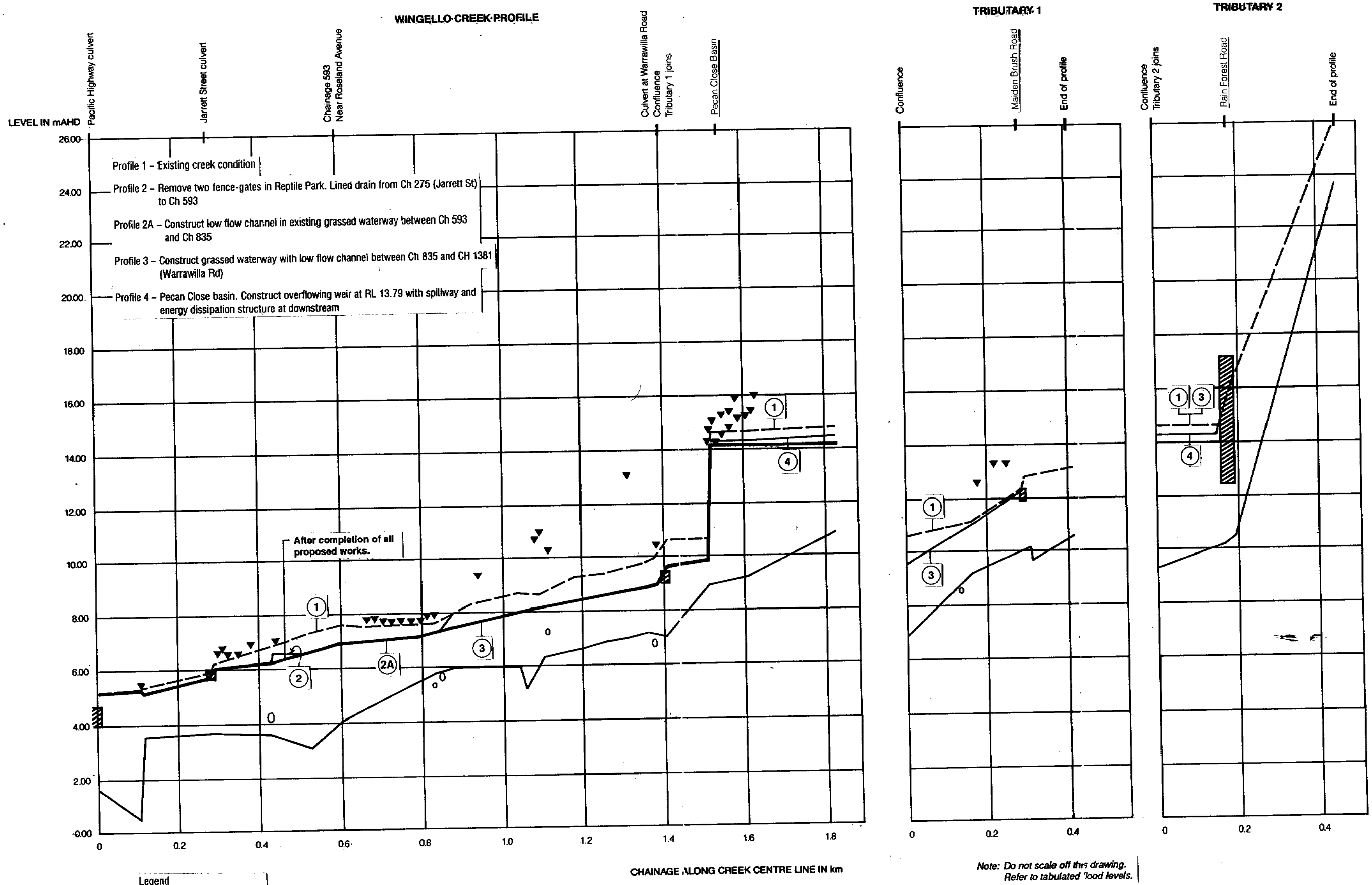
Upstream of the Jarrett Street culverts, Wingello Creek passes through several sharp bends. Owing to severe bank erosion and scour, there is the potential to undermine the foundations of nearby houses. While no houses are flood liable in a 1% AEP event, three have a minimum freeboard.

It is recommended that this section of the creek be straightened and lined. A survey has been undertaken as part of this study to examine the feasibility of improvement works. It is proposed that a trapezoidal channel be constructed from Chainage 275 to Chainage 435, as shown in the drawing in Appendix B. The resultant water level after this improvement would be as shown in Profile 2, Figure 4.2. After completion of these works, as well as the works proposed in the Reptile Park, the three houses in Adnamira Close would have a greater freeboard in a 1% AEP event. This channel has been assumed to be concrete lined, but a channel of stacked rock of an equivalent conveyance may be considered more acceptable.

The typical channel cross-sections are shown in Figure 4.3. These cross-sections have been designed to avoid excess cut and land-take, and would not fully contain a 1% AEP flow. However, the more frequent flood events would be contained within the channel.

Chainage 435 to Chainage 593

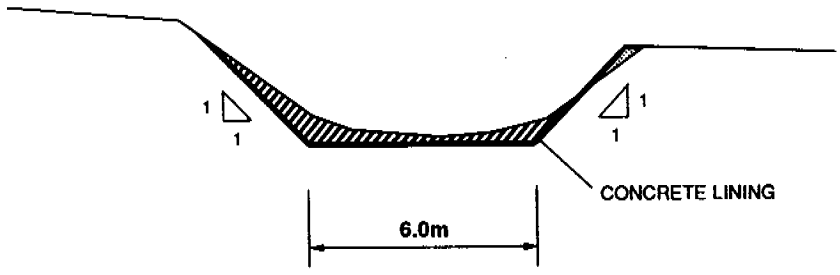
This section of the creek flows through a natural reserve with a dense growth of rainforest trees on both banks. The existing natural channel has several sharp bends, and haphazard rock protection has been laid on some of these bends to prevent scour and erosion. As a result of the dense undergrowth, flood levels are high along this section

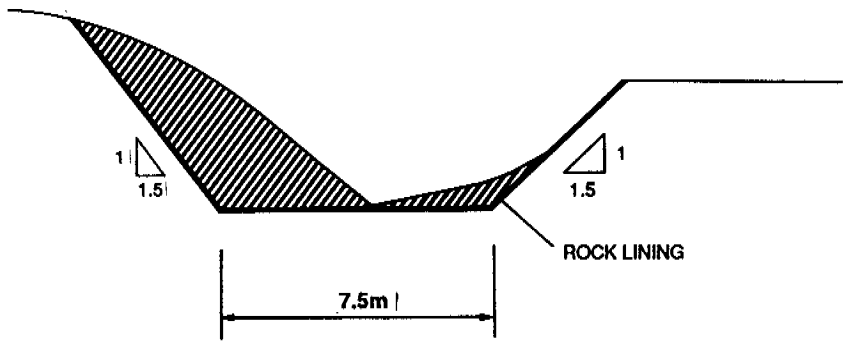


Note: Do not scale off this drawing. Refer to tabulated flood levels.

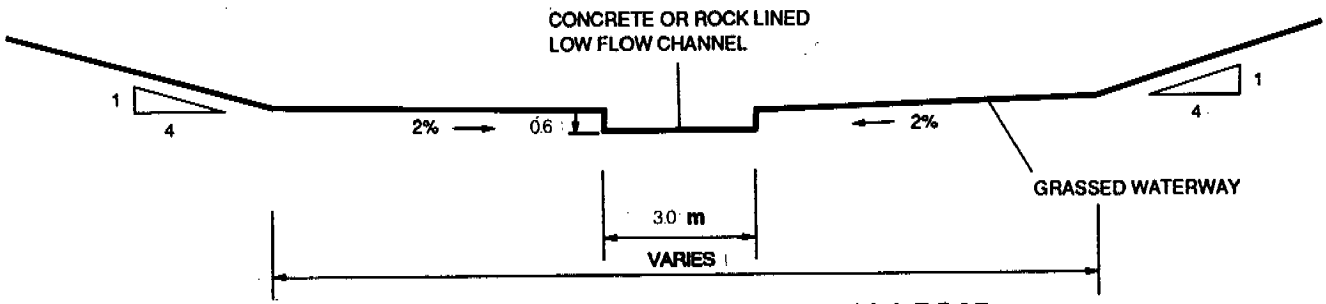
Figure 4.2

1% AEP DESIGN WATER PROFILES AFTER VARIOUS MITIGATION OPTIONS FOR WINGELLO CREEK





JARRETT STREET TO RAINFOREST RESERVE LINING AREA



ROSELANDS AVENUE AND WARRAWILLA ROAD GRASSED WATERWAY AREA

Legend

- Existing channel cross-section
- Proposed channel cross-section
- Fill
- Excavation

Note: Channel invert to be determined by average invert along the creek.

Figure 4.3

TYPICAL CROSS-SECTIONS FOR WINGELLO CREEK

of creek, and this could affect the upstream subdivision along Roselands Avenue, as indicated by Profile 1 in Figure 4.2.

At present, there is only 50–100 mm of freeboard above the 1% AEP for several houses in Roselands Avenue. In order to increase this freeboard and reduce the amount of scour and bank erosion, it is proposed to line the channel between Chainages 435–593. The resultant water profile, after concrete lining, is shown in Profile 2, Figure 4.2.

Concrete lining of this reach would result in about 500 mm of freeboard for the existing Roselands Avenue subdivision, while only about 250 mm of freeboard would be available if this reach were lined with rock. Typical creek cross-sections are shown in Figure 4.3.

This section of natural reserve is classified as 'urban bushland'. Consequently, any works carried out within the reserve would require an environmental review, which would need to be put on public exhibition. A detailed survey and study would therefore be needed to identify a channel alignment that would necessitate the removal of as few trees as possible, would be hydraulically effective and would blend with the surrounding environment.

There is an exposed sewer, which is 450 mm in diameter, near Chainage 425. Ideally, this sewer should be removed and diverted to enable unobstructed flow. However, as shown in Profile 2, Figure 4.2, with the lining of the creek from Chainage 275 to Chainage 593 the head loss created by the exposed sewer could be tolerated.

Owing to the severe scour and bank erosion along sections of Wingello Creek, it is considered that these channel lining works be undertaken as a high priority.

4.2.3 TRIBUTARY 1

Downstream of Maidens Brush Road

Severe bank erosion has occurred just downstream of the culverts under Maidens Brush Road. It is recommended, as a long-term option, that rock protection be placed on the outlet of the culvert to prevent further scour.

4.2.4 ROSELANDS AVENUE TO WARRAWILLA ROAD GRASSED WATERWAY AREA

Chainage 835 to Chainage 1381

Upstream of the Roselands Avenue subdivision, Wingello Creek meanders across a wide open floodplain. Opposite Fuschia Avenue a tributary joins the main creek from the south, resulting in some bank erosion.

It is recommended that the grassed waterway between Chainage 593 and Chainage 835 be extended up to Warrawilla Road, between Chainage 835 and Chainage 1381. The improved water profile is shown in Profile 3, Figure 4.2. Additional rock protection should be provided where the tributary joins the main creek flow.

4.2.5 EXISTING PECAN CLOSE DETENTION BASIN

The existing basin north of Pecan Close is unexcavated, and has been created by a broad earth embankment across the valley. The crest of the embankment is approximately 14.30 m AHD and this is higher than two of the house floor levels in Pecan Close. During major floods, these houses are inundated before the basin overtops.

Two pipes, 1,200 mm in diameter and approximately 90 m in length, pass under the basin. These pipes can carry flows up to a 5% AEP event. For the less frequent events (e.g. 1% AEP), the creek overflows into the basin. The stage–storage and discharge–storage relationship for this basin is presented in Table 4.1. Storage volumes for the basin were estimated from the 1:4,000 orthophoto map and detailed field survey at the basin outlet.

Table 4.1 **Stage–storage and discharge–storage relationship for existing detention basin at Pecan Close**

Stage (m AHD)	Storage (m^3)	Discharge (m^3/s)
9.23	0	0
10.00	4700	2.0
12.00	17,120	8.2
14.00	91,680	12.3
14.29	95,000*	12.8
14.59	97,000*	36.0**

– *Overtopping level at RL14.29 m AHD.*
* *Extrapolated.*
** *Assuming 70 m long weir.*

In order to reduce the flooding of the houses in Pecan Close, it is recommended that the level of the downstream embankment be reduced and that a properly designed weir be constructed to safely pass the 1% AEP and the 2 x 1% AEP flows.

A preliminary design indicates that a 40 m long weir at RL13.75 m AHD would be able to pass the 1% AEP flow. The calculated 1% AEP top water level is RL14.04 m AHD, which is below the average side embankment level of RL14.4 m AHD. The 2 x 1% AEP top water level is RL14.41 m AHD.

It is recommended that a more specific and detailed design be undertaken separately to produce a final design. In addition, the detailed design should incorporate a concrete spillway with training walls on the downstream batter and a dissipation zone at the bottom of the batter.

4.3 LONG-TERM OPTIONS

4.3.1 ROSELANDS AVENUE TO WARRAWILLA ROAD GRASSED WATERWAY AREA

Chainage 593 to Chainage 835

The creek between Chainage 593 and Chainage 835 was previously formalized into a trapezoidal grassed waterway as part of the works for the Roselands Avenue subdivision. This waterway passes through a drainage easement between Roselands Avenue and Dalton Street. A low-flow pipe system was planned for construction under the grass waterway, but was omitted due to the risks of blockage. Bed scour has since severely eroded the trapezoidal grassed waterway.

It is recommended that a low-flow channel (3.0 m wide by 0.6 m deep) be constructed to improve the flow condition and to control erosion. This low-flow channel could be either concrete lined or stacked rock. During construction of the channel, the silt deposited in the bed of the creek should be removed and the waterway cross-section re-established. A typical cross-section is shown in Figure 4.3.

Warrawilla Road culvert

The existing six cell culvert is undersized and poorly configured due to the two major tributaries joining at its upstream side. This is compounded by the flow paths not being streamlined towards the culvert entrance. In addition, the excessive number of intermediate piers creates an unnecessarily high head loss. It is also evident that siltation has rendered some of the flow area ineffective.

The problems could be solved by replacement of the existing cells with an adequately sized bridge and streamlining of the two major flow paths into the bridge entrance. Alternatively, the confluence could be shifted to the downstream side of the culvert by the construction of two separate box culverts, one for each of the branches, thereby eliminating the headloss caused by the converging flows.

Despite the above comments, these works are not recommended because no houses are affected by flooding in a 1% AEP event and because the occasional overtopping of Warrawilla Road is tolerable.

Detention basin at Dalton Street

It would be possible to lower flood levels adjoining the Roselands Avenue subdivision by the construction of a detention basin adjacent to Dalton Street. However, the available storage was found to be only 24,000 m^3 , which would result in a marginal 5% reduction in the outflow. Hence this option would not be cost effective and was not considered further.

4.3.2 TRIBUTARY 1 AREA

Upstream of Warrawilla Road

Upstream of Warrawilla Road, the main creek flow is joined by a tributary from the south (Tributary 1). This tributary flows parallel to Maidens Brush Road before turning through two 90° bends and passing under Warrawilla Road. Significant scour has occurred on the bend adjacent to Maidens Brush Road.

It is recommended that the creek be realigned along this section to remove one of the bends and that rock protection be placed to prevent further scour.

4.3.3 BLACKBUTT STREET PUBLIC RESERVE

This section of the creek forms part of the storage reach for the Pecan Close detention basin. It is in its natural state, with thick growth of rainforest trees. There are no houses nearby that would be endangered by the temporary impounding of water in the basin. No problems are expected in this region.

4.3.4 TRIBUTARY 2 AREA

This section is a natural reach with steep banks. There appears to be no danger of any adjoining properties flooding, although the lower portion of the reach would be drowned by the temporary impoundment of floodwater in the Pecan Close basin. No problems are expected in this region.

4.4 FUTURE DEVELOPMENT

The preceding parts of this section consider the catchment in its existing state of development (i.e. about 50% developed). The zoning plan shows that there is little scope for further development, as most of the presently undeveloped lands are zoned 'pristine'.

However, future developed conditions were simulated using the RORB model, for which it was assumed that most of the natural channels would be formalized into grassed waterways. The 1% AEP discharges at various points, according to the model, are presented in Table 4.2. Discharges for the 7 February 1990 event and a 1% AEP event under existing conditions are also shown in the same table for comparison.

Table 4.2 shows that the 1% AEP discharges for the future conditions are significantly greater than for existing conditions, indicating that the present creek system would be inadequate if there were further development. The only way to solve the problem would be to make it a mandatory development condition for detention facilities to be designed and constructed as part of any future urbanization works. Otherwise, the existing creek and the various culverts all the way downstream to Narara Creek would have to be augmented to convey the increased runoff.

Nevertheless, for the design of future detention facilities, a flood routing analysis should be undertaken and the resultant hydrographs checked against the established RORB model. This would avoid synchronization of flood peaks, which may create undesirable

peak discharges that exceed the existing peak value at some downstream drainage facilities. A discussion of this topic is presented in Section 6.

Table 4.2 **Comparison of discharges for different conditions in Wingello Creek (m^3/s)**

Location	Existing state of development		Possible future development
	7 February 1990	1% AEP	1% AEP
Chainage 1611	30.9	47.2	59.9
Tributary 2	5.3	14.0	18
Pecan Close Basin:			
• Inflow	36.1	54.6	70.3
• Outflow	12.7	27.7	34.8
Chainage 1392	30.1	34.9	78.7
Tributary 1 Chainage 300	26.9	36.6	48.8
Chainage 1392	29.7	39.3	52.6
Chainage 1088	42.2	49.9	67.0
Chainage 835	49.4	56.7	72.0
Pacific Highway	54.6	62.3	78.1

4.5 CONCLUSIONS

A summary of the mitigation works considered, their priority and estimated costs is presented in Table 4.3. The flood levels that would occur following completion of all the works are tabulated in Table 4.4, and flood levels under different scenarios, in accordance with their priority ranking, are tabulated in Appendix D. The recommended works are identified in Figure 4.4, and the design flood levels for Wingello Creek at the completion of these works are shown in Figure 4.5. The flood contours at the completion of the works are shown in Figure 4.6.

Table 4.3 **Recommended works and priority ranking for Wingello Creek**

Location	Description	Profile No	Recommendation	No of houses threatened/ roads flooded	Cost	Priority
–	No works	1	Not recommended	Two, Pacific Highway, Jarrett St, Warrawilla Rd and Maidens Brush Rd flooded	–	–
Reptile Park Reach (Ch0 to Ch275)	Remove obstructions in Reptile Park and lower weir	2	Immediate recommendation	Two, Pacific Highway, Jarrett St, Warrawilla Rd and Maidens Brush Rd flooded	$2,000	Completed 1992
Jarrett St to Rain Forest Reserve lining area (Ch275 to Ch593)	Lined channel from Ch275 to Ch593	2	Immediate recommendation	Two, Pacific Highway, Jarrett St, Warrawilla Rd and Maidens Brush Rd flooded	$590,000	1
Roselands Ave to Warrawilla Rd grassed waterway area (Ch593 to Ch1381)	Construct low flow channel for existing grassed channel from Ch593 to Ch875 to improve flow conditions and prevent erosion	2A	Long term recommendation	Two, Pacific Highway, Jarrett St, Warrawilla Rd and Maidens Brush Rd flooded	$150,000	4
	Construct grass waterway from Ch875 to Ch1381 with low flow channel including bank protection for side creek	3	Immediate recommendation	Two, Pacific Highway, Jarrett St, Warrawilla Rd and Maidens Brush Rd flooded	$680,000	2
Existing Pecan Close detention basin (Ch1391 to Ch1611)	Construct emergency weir for existing Pecan Close basin incorporating concrete spillway, training walls and dissipation structures	4	Immediate recommendation	None, Pacific Highway, Jarrett St, Warrawilla Rd and Maidens Brush Rd flooded	$120,000	3
	Lay one more pipe for Pecan Close basin	4A	Not recommended	–	$65,000	–
Tributary 1 area	Localised bank protection on northern bank downstream of Maiden Brush Rd	–	Immediate recommendation	–	$39,000	Completed 1992
	Localised bank protection on southern bank upstream of Warrawilla Road		Long term recommendation	–	$50,000	5

Table 4.4 **Design flood levels at completion of recommended works for Wingello Creek**

Cross Section	Existing conditions 1%AEP	After completion of works 1%AEP	2%AEP	5%AEP	20%AEP	2*1%AEP
0.0	5.00	5.00	4.94	4.87	4.71	6.15
100.0	5.06	5.07	5.00	4.92	4.75	6.18
115.0	5.09	5.07	5.00	4.92	4.75	6.18
257.7	5.73	5.68	5.60	5.50	5.33	6.36
262.7	5.71	5.65	5.57	5.49	5.32	6.28
275.0	6.11	6.13	6.01	5.81	5.48	6.70
280.0	6.14	Not included in model				
425.0	6.83	6.13	6.01	5.81	5.50	6.81
435.0		Not included in model				
520.0	7.23	6.60	6.49	6.35	6.06	7.41
593.0	7.40	6.80	6.66	6.50	6.18	7.81
656.0	7.42	6.80	6.66	6.50	6.18	7.81
718.0	7.45	6.86	6.72	6.56	6.26	7.89
778.0	7.49	6.97	6.85	6.70	6.44	7.96
835.0	7.53	7.19	7.08	6.95	6.75	8.01
875.0	7.85	7.31	7.22	6.92	6.92	8.07
930.0	8.19					
1038.0	8.55	Not included in model				
1051.0	8.54					
1088.0	8.44	8.12	8.04	7.96	7.81	8.61
1186.0	9.19					
1245.0	9.34	Not included in model				
1317.0	9.59					
1351.0	9.71	8.78	8.69	8.60	8.45	9.25
1375.0	10.03	Not included in model				
1381.0	9.95	8.85	8.76	8.66	8.50	9.35
1391.0	10.15	9.63	9.34	9.07	8.51	11.37
1392.0	10.17	9.63	9.33	9.07	8.51	11.36
1500.0	10.25	9.93	9.81	9.73	9.61	11.39
1506.0	10.25	9.97	9.88	9.80	9.70	11.40
1611.0	14.48	14.04	13.85	11.80	11.14	14.41
1821.0	14.50	14.06	13.86	11.99	11.46	14.48
-1392.0	10.17	9.63	9.33	9.07	8.51	11.36
160.0	11.09	11.09	11.00	10.92	10.75	11.73
290.0	12.39	12.39	12.28	12.16	11.93	13.20
291.0	12.21	12.21	12.13	12.03	11.85	12.85
300.0	12.62	12.62	12.59	12.55	12.44	13.59
305.0	12.71	12.71	12.66	12.59	12.45	13.73
410.0	12.93	12.91	12.84	12.76	12.59	13.78
-1611.0	14.48	14.04	13.85	11.80	11.14	14.41
164.2	14.49	14.05	13.86	12.04	11.77	14.45
169.2	14.49	14.05	13.85	12.04	11.78	14.43
190.0	15.95	15.51	15.02	12.02	11.78	17.53
195.0	15.95	15.51	15.02	12.07	11.80	17.54
450.0	25.79	25.79	25.74	25.69	25.57	26.23

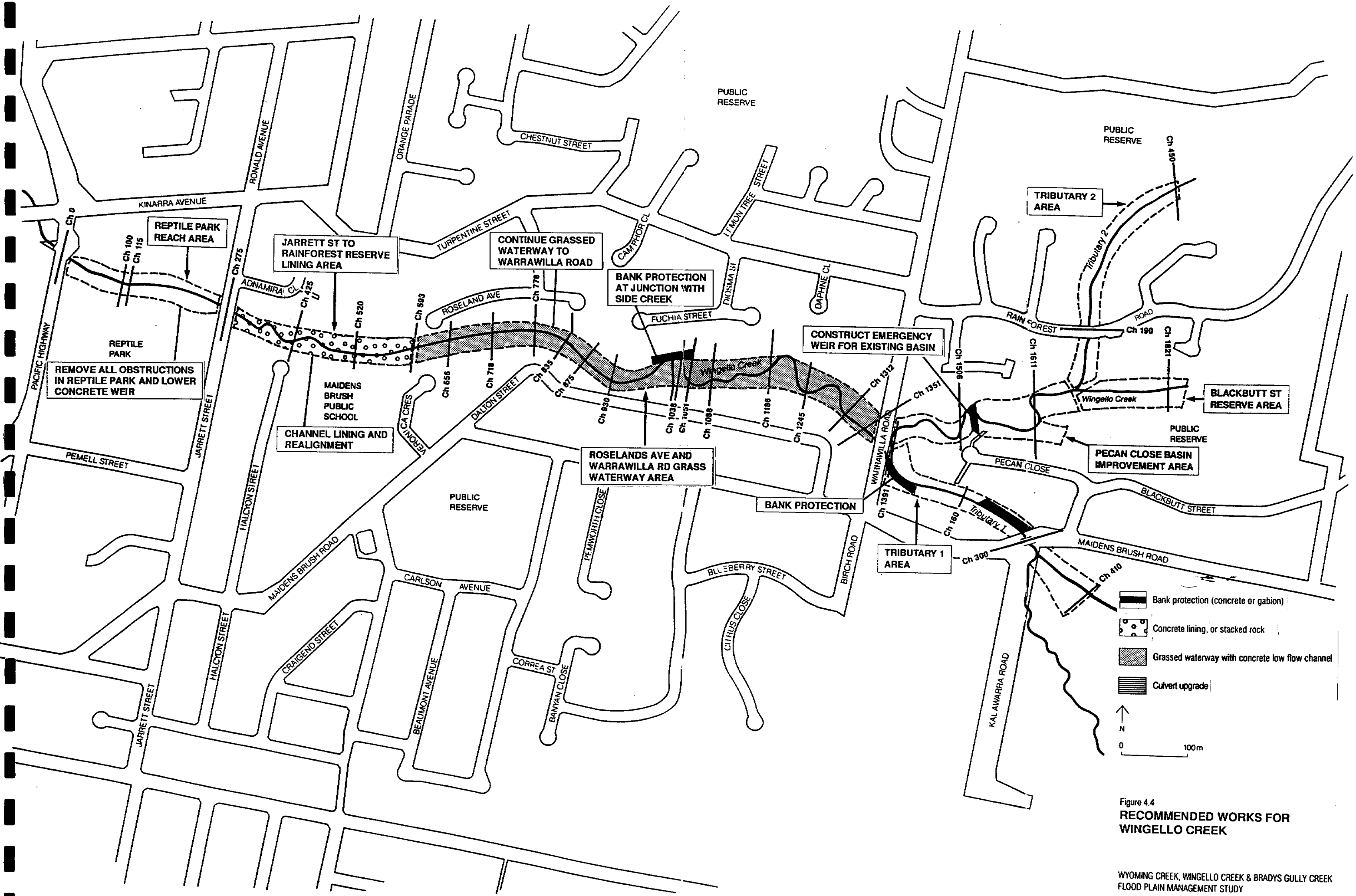
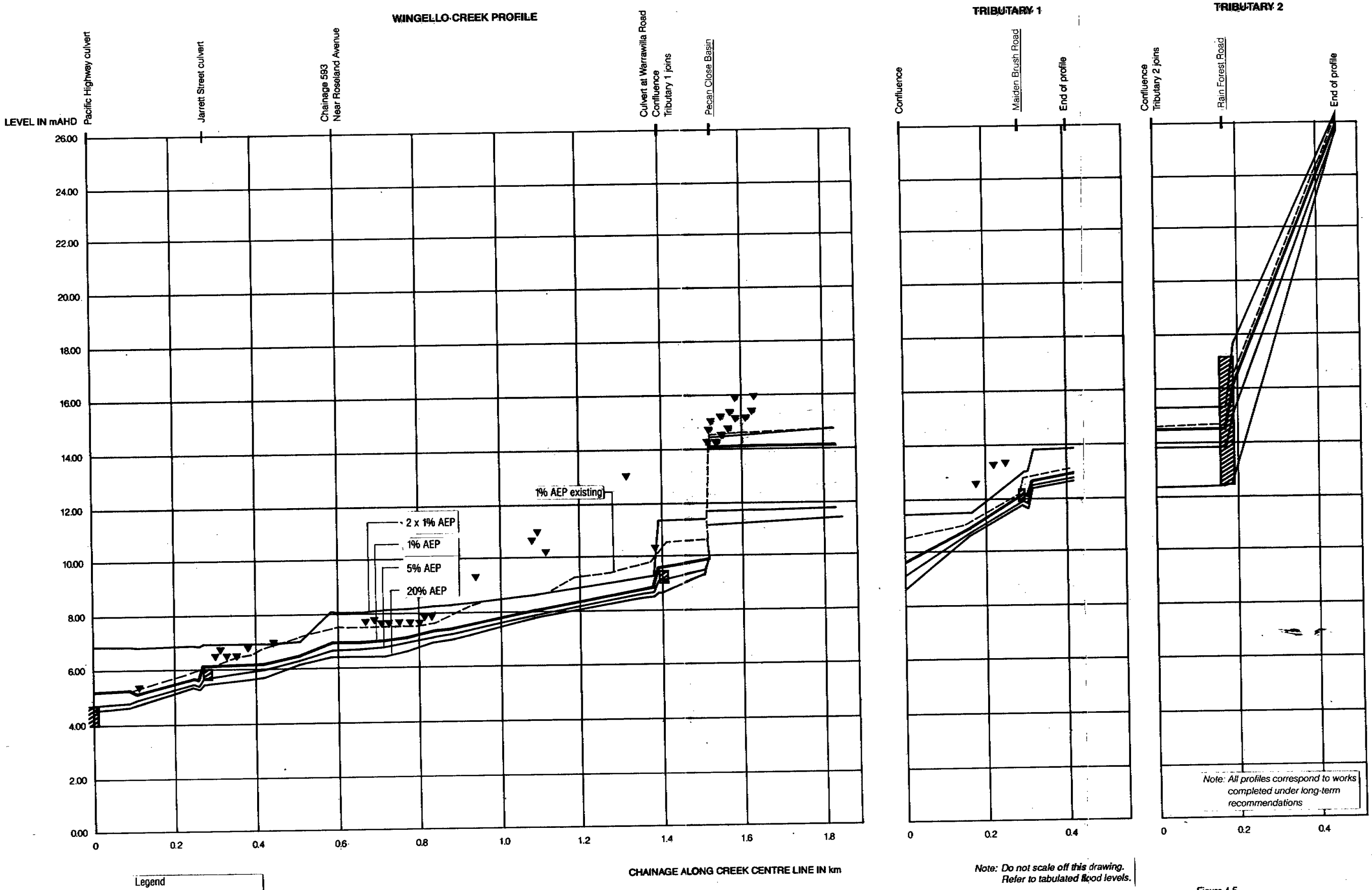


Figure 4.4
RECOMMENDED WORKS FOR WINGELLO CREEK



Note: Do not scale off this drawing. Refer to tabulated flood levels.

Figure 4.5

20%, 5%, 1% and 2 x 1% AEP FLOOD PROFILES WITH RECOMMENDED WORKS FOR WINGELLO CREEK

GOSFORD CITY COUNCIL

NOTES

1. FLOOD LEVELS HAVE BEEN CALCULATED AT CROSS SECTION LOCATIONS ONLY.
2. FLOOD LEVELS AND FLOOD CONTOURS BETWEEN CROSS SECTIONS HAVE BEEN LINEARLY INTERPOLATED.
3. FLOOD CONTOURS DEPICT APPROXIMATE WIDTHS OF FLOODING ONLY. FLOOD LIABILITY SHOULD BE VERIFIED BY GROUND SURVEY
4. FLOOD LEVELS ARE GIVEN IN METRES TO AUSTRALIAN HEIGHT DATUM.
5. SIZES SHOWN ON THIS PLAN ARE APPROXIMATE ONLY AND DETAILS SHOULD NOT BE SCALED FROM THIS DRAWING FOR DETAILED DESIGN PURPOSES.

LEGEND

- 1% AEP flood extent
- CS 520 — Flood contour at survey cross section
- 6.6 — Flood contour interpolated between cross sections
- 6.6 — House floor levels

212A	212B	213A
212C	212D	213C
228A	228B	229A
228C	228D	229C

KEY TO ADJOINING SHEETS

Central Mapping Authority Map Reference: GOSFORD U2797 - 52

40 20 0 40 80 120 160 200m

FLOODPLAIN MANAGEMENT PLAN OVERLAY

Produced for
GOSFORD CITY COUNCIL - Revised January 1993
Consulting Engineers - KINHILL ENGINEERS
Consulting Surveyors - JTS RYAN FIRTH & CO

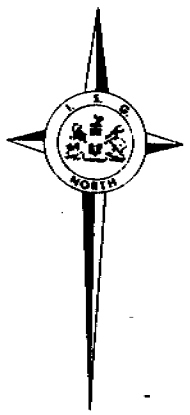
FLOODPLAIN MANAGEMENT STUDY FOR WYOMING, WINGELLO AND BRADYS GULLY CREEKS

FLOOD CONTOURS AT COMPLETION OF PROPOSED WORKS FOR WINGELLO CREEK

SHEET 1 of 2 Figure 4.6

GOSFORD CITY COUNCIL DRAWING NUMBER 4/114/A1

GOSFORD CITY COUNCIL



NOTES

1. FLOOD LEVELS HAVE BEEN CALCULATED AT CROSS SECTION LOCATIONS ONLY.
2. FLOOD LEVELS AND FLOOD CONTOURS BETWEEN CROSS SECTIONS HAVE BEEN LINEARLY INTERPOLATED.
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4. FLOOD LEVELS ARE GIVEN IN METRES TO AUSTRALIAN HEIGHT DATUM.
5. SIZES SHOWN ON THIS PLAN ARE APPROXIMATE ONLY AND DETAILS SHOULD NOT BE SCALED FROM THIS DRAWING FOR DETAILED DESIGN PURPOSES.

LEGEND

- 1% AEP flood extent
- CS 520 — 6.5 — Flood contour at survey cross section
- 6.6 — Flood contour interpolated between cross sections
- 5.99 ● House floor levels

212A	212B	213A
212C	212D	213C
228A	228B	229A
228C	228D	229C

KEY TO ADJOINING SHEETS

Central Mapping Authority Map Reference: GOSFORD U2797 - 61

40 20 0 40 80 120 160 200m

FLOODPLAIN MANAGEMENT PLAN OVERLAY

Produced for
GOSFORD CITY COUNCIL - Revised January 1993
Consulting Engineers - KINHILL ENGINEERS
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FLOODPLAIN MANAGEMENT STUDY FOR WYOMING, WINGELLO AND BRADYS GULLY CREEKS

FLOOD CONTOURS AT COMPLETION OF PROPOSED WORKS FOR WINGELLO CREEK

SHEET 2 of 2 — Figure 4.6

GOSFORD CITY COUNCIL DRAWING NUMBER 4/115/A1

5 BRADYS GULLY CREEK MANAGEMENT OPTIONS

5.1 GENERAL

Bradys Gully Creek was divided into six areas for the preparation of the floodplain management plan, as follows:

- Laycock Street lining area—Pacific Highway to Henry Parry Drive
- Cary Street reach—Henry Parry Drive to Cary Street
- Catholic School pipeline—Cary Street to Glennie Street
- Jarrett Street channel—Glennie Street to Bradys Gully road
- Stachon Road channel—upstream of Bradys Gully Road
- Kirkness Avenue creek.

These are shown schematically in Figure 5.1.

5.2 IMMEDIATE FLOOD MITIGATION OPTIONS

Six houses have been identified as being flood liable in a 1% AEP event: one in Henry Parry Drive and five in Compton Street. These houses are listed in Appendix A. In addition, the Pacific Highway, Henry Parry Drive, Cary Street, Bradys Gully Road and Kirkness Avenue are all overtopped during a 1% AEP event. However, only works required to make the houses flood free have been identified as being high priority.

5.2.1 LAYCOCK STREET LINING AREA—PACIFIC HIGHWAY TO HENRY PARRY DRIVE

This reach presently consists of a natural earth channel with thick vegetation along the banks. There is no existing drainage easement for the creek between the Pacific Highway and Henry Parry Drive. The creek passes through the backs of the properties in Laycock Street, dividing some in two. Over the years, the alignment of the creek has been altered by some of the property owners to maximize land availability. This is shown by excessive amounts of debris along the bed, suggesting that the area might have been filled. The loosely compacted debris is now slowly being exposed and washed down due to bank and bed erosion.

Some of the sections of the creek have been severely eroded, and bank protection works have been undertaken, consisting of sandstone blocks laid on the banks. In places these rocks have been dislodged and have fallen on to the channel bed. There is an existing access bridge across Bradys Gully Creek on Lot 33, Laycock Street and downstream of the bridge the sandstone blocks are in good condition and the creek is of a reasonable size. Upstream of the bridge the creek is narrow, as it has been restricted by

Figure 5.1
BRADYS GULLY CREEK STUDY REGIONS

development along Laycock Street. There is a steep grade along this section of creek, falling 2 m from Henry Parry Drive to the Pacific Highway, which has resulted in supercritical flow along sections of the creek. This has in turn exacerbated the problems of scour and erosion. Owing to the roughness of the reach, the water profile in a 1% AEP event is high, as indicated by Profile 1, Figure 5.2. Fortunately, all house levels along this reach are above the 1% AEP flood level but, as a result of the high tailwater level in the Henry Parry Drive culvert, one house at the upstream end of the culvert is flood liable.

It is recommended that this section of the creek be fully lined from the Pacific Highway to Henry Parry Drive. The improvement is shown in Profile 2, Figure 5.2. This profile is for a concrete-lined channel, which is considered more appropriate in order to reduce the required waterway area. Downstream of the access bridge, on Lot 33, Laycock Street, stacked rock lining may be more acceptable as there is less restriction of available land.

A typical cross-section for the creek between Henry Parry Drive and the Pacific Highway is shown in Figure 5.3.

It is also possible that, in the formalization of the creek, the alignment may be adjusted to minimize the loss of land to property owners in Laycock Street. The status of the land could then be formalized and a drainage easement or reserve obtained. This would be in accordance with Gosford City Council's existing setback policy. The exact alignment and channel size should be determined after a detailed ground survey of the area.

The existing twin-cell 2.14 m by 2.14 m box culverts overtop in a 1% AEP event by approximately 300 mm. Flood levels upstream of the culverts are controlled by the high tailwater levels in Narara Creek, and widening of the culverts would not have a significant impact on flood levels. The capacity of these culverts is approximately 38 m^3/s before they overtop, which is equivalent to a 5% AEP discharge but due to the downstream water levels the culverts marginally overtop for the 5% AEP event. If there was a reduction in the tailwater level because of downstream channel works or a less critical storm occurring in the Narara Creek catchment, the culverts would not overtop in a 5% AEP event and probably only marginally overtop for the 1% AEP event. The steep grade between the Pacific Highway and Henry Parry Drive also negates any minor backing up at the Pacific Highway culvert. Therefore upgrading of the Pacific Highway culverts is not recommended.

5.2.2 CARY STREET REACH—HENRY PARRY DRIVE TO CARY STREET

Between Henry Parry Drive and Cary Street, Bradys Gully Creek is narrow and heavily vegetated. It turns through a sharp 90° bend before passing under Cary Street. The Henry Parry Drive culverts are undersized and the road regularly overtops. One house is flood liable during a 1% AEP event and two more are potentially threatened. A 1% AEP flood would overtop Henry Parry Drive by 600–700 mm. It is proposed to reduce the incidence of flooding by adding one more cell to the existing Henry Parry Drive culvert, after the lining of the downstream section from the Pacific Highway to Henry Parry Drive. The improved situation is shown in Profile 3, Figure 5.2.

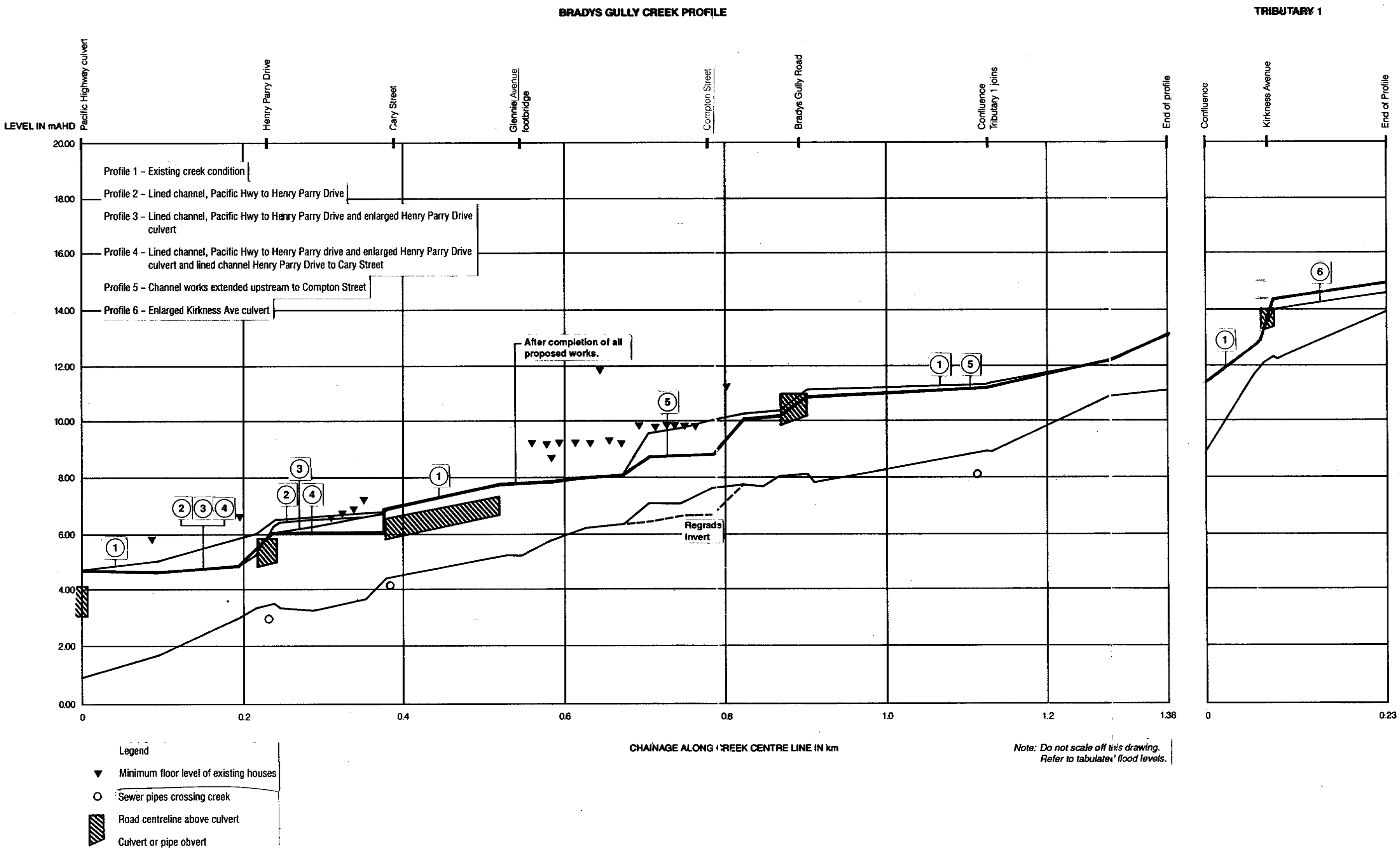
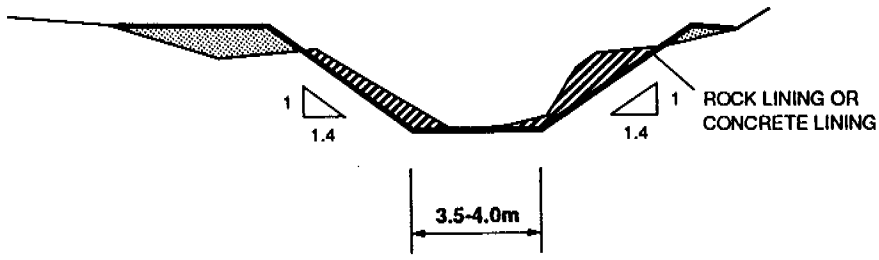
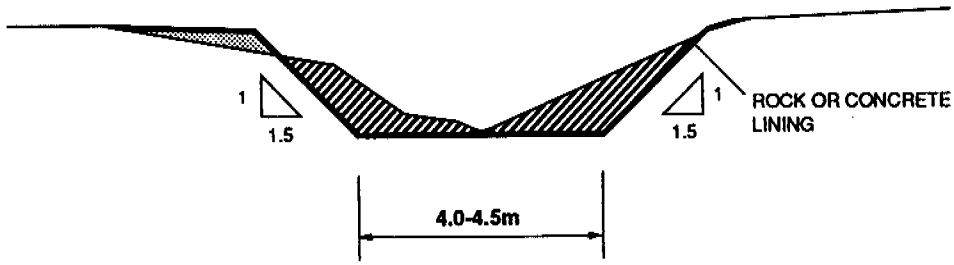


Figure 5.2

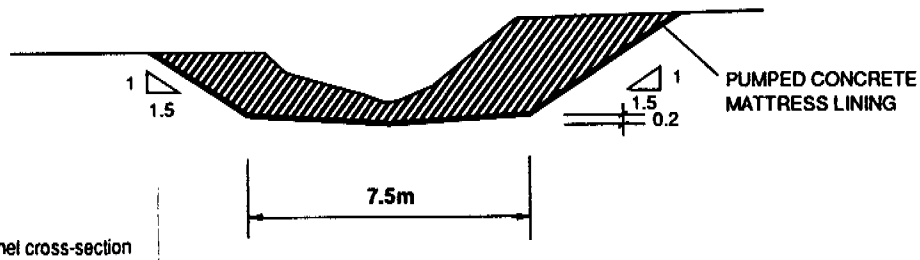
1% AEP DESIGN WATER PROFILES AFTER VARIOUS MITIGATION OPTIONS FOR BRADYS GULLY CREEK



LAYCOCK STREET LINING AREA



CARY STREET REACH



JARRETT STREET CHANNEL

Legend

Existing channel cross-section

Proposed channel cross-section

Fill

Excavation

Note: Channel invert to be determined by average invert along reach.

Scale 1:200
Natural

Figure 5.3
TYPICAL CROSS-SECTIONS FOR BRADYS GULLY CREEK

To further reduce flood levels and to improve the situation, the creek from Henry Parry Drive to Cary Street should be lined. This is shown in Profile 4, Figure 5.2. This proposal would also significantly reduce the tailwater depth in the Cary Street culvert, which in turn would increase the flow capacity of the existing three 1,500 mm diameter pipelines between Cary Street and Glennie Street. Profile 4 is for a rock-lined channel, which is considered the most appropriate for this section of creek. Near Cary Street, there is a drainage easement between Lots 11, 12, 13 and 14 in Deposited Plan 528705, and the alignment and formalization of the creek should be such that it is contained within this easement. However, in the construction of the access track adjacent to the line channel, provision should be made to allow the overland flow from upstream of Cary Street to pass back into Bradys Creek.

A typical cross-section of the creek between Henry Parry Drive and Cary Street is shown in Figure 5.3.

The effect of these works would be to reduce the flood levels so that houses along Henry Parry Drive were not flood liable. It is therefore recommended that they be carried out.

5.2.3 JARRETT STREET CHANNEL—GLENNIE STREET TO BRADYS GULLY ROAD

Bradys Gully Creek, between Glennie Street and Bradys Gully Road, has already been formalized from the existing foot-bridge under Glennie Street up to Compton Street. The majority of the channel is a pumped concrete mattress on the creek invert and part way up the channel sides. However, a major sewer main, which is parallel to Jarrett Street, has meant that some sections have had to be concrete lined. Similarly, just upstream of the Glennie Street foot-bridge, the channel turns through two 90° bends before passing under the bridge. Realignment of this section of channel is not possible because of the water main that runs along Glennie Street.

Upstream of this formalized channel, the creek reverts back to its natural, heavily vegetated state. Five units in Compton street are flood prone due to the high water levels created by this undersized section of the creek. As soon as the remaining channel formalization is completed—between Compton Street and Bradys Gully Road—the water profile in a 1% AEP event would be lowered as indicated by Profile 5 in Figure 5.2.

A typical cross-section of this new section of creek is shown in Figure 5.3. It is recommended that the pumped concrete mattress lining be continued up to Bradys Gully Road, although at the culverts stacked rock would be more suitable for when Bradys Gully Road overtopped.

The lining shown in Figure 5.3 extends the full height of the channel side slopes. Where bank stability is not a problem, it may be considered more acceptable to only line partway to the bank. In this situation, the channel side slope should be suitably battered back.

5.3 LONG-TERM OPTIONS

5.3.1 CATHOLIC SCHOOL PIPELINES—CARY STREET TO GLENNIE STREET

Downstream of the Glennie Street foot-bridge, Bradys Gully Creek is confined to three 1,500 mm diameter pipes passing under the Catholic School. The pipes discharge into an open pit before passing under Cary Street through two 2.4 m by 1.5 m box culverts. During floods, flows overtop the channel upstream of the Glennie Street foot-bridge. This combined with the overflow from the pipelines, inundates the school car park and playing fields. Significant damage has occurred to the car park fences during recent flood events due to flows backing up against these fences. The overland flow returns to the creek downstream of the Cary Street culverts.

As shown by Profile 1 in Figure 5.2, the tailwater level of the pipes is above the culvert, resulting in a reduction in flow capacity in the pipes. Analysis shows that the existing pipelines convey 36% of the total 1% AEP discharge 40 m^3/s, which means a significant amount of water is overtopping the pipelines.

As a result of the works recommended for immediate implementation, the tailwater at Cary Street culvert would be lowered to the obvert of the pipe and the total flow capacity of the three pipes would be increased to 19 m^3/s, with an overland flow of approximately 21 m^3/s.

In order to fully pipe the 1% AEP flow of 40 m^3/s, a total of seven 1,500 mm diameter pipes would be required, assuming that the works recommended for immediate implementation were completed. Alternatively, the pipelines could be reverted to a concrete trapezoidal channel with a bed width of 1.0 m, a top width of 8.8 m, a depth of 2.8 m (includes 0.5 m of freeboard) and a bed slope of 0.35%.

Another option would involve raising the car park or relocating it to higher ground, and allowing overtopping to occur during severe rainstorms. This would prevent pavement damage and hence would reduce damage costs to the school.

The final, preferred, option would be to leave the three pipes and to tolerate overland flow during a major flood event. However, the fences around the car park should be made flood compatible and cause minimal resistance to flows. In addition, provision should be made to ensure that the overland flows return to the creek unimpeded. This should be taken into account during construction of the lining of the creek downstream of Cary Street and the formation of an access track.

In addition, significant scour has occurred at the inlet to the pipes due to the two 90° bends in the creek. A stacked rock transition section should be constructed between the pipe inlets and the existing formalized channel to prevent further scouring.

It is recommended that these works be undertaken as a long-term option, but that they be carried out before any significant scour or erosion occurs to undermine any properties upstream of the pipelines.

5.3.2 JARRETT STREET CHANNEL—GLENNIE STREET TO BRADYS GULLY ROAD

As indicated by Profile 1 in Figure 5.2, Bradys Gully Road would be overtopped in a 1% AEP event. However, with the completion of the recommended channel works downstream of Bradys Gully Road, the 1% AEP flow would not overtop the road, as shown by Profile 5, Figure 5.2. Since no houses upstream of Bradys Gully Road would be affected by flooding, no works are recommended for the culvert.

5.3.3 KIRKNESS AVENUE CREEK—TRIBUTARY ADJACENT TO KIRKNESS AVENUE

As indicated by Profile 1 in Figure 5.2, the Kirkness Avenue culvert is undersized for a 1% AEP flow. To avoid overtopping, two additional 1200 mm diameter pipes could be laid beside the existing pipe. The improvement is shown in Profile 6, Figure 5.2. No houses are presently flooded in the vicinity of this culvert and therefore this work is recommended as a long-term option in order to reduce the frequency of inundation of Kirkness Avenue.

5.3.4 STACHON ROAD CHANNEL—UPSTREAM OF BRADYS GULLY ROAD

Although the two piped sections at Stachon Street and Yuroka Close–Marangani Avenue are not required to be included in this study, it is considered that there could be potential flooding problems there. It is thus recommended that the details of the pipe sections be surveyed and subsequently analysed to determine their flow capacity under appropriate tailwater conditions in a 1% AEP event. Alternatively, a review could be made of their approved original design calculations so as to ascertain the validity of the design principles recommended in *Australian rainfall and runoff: A guide to flood estimation* Vol. 1 (Institution of Engineers, Australia 1987).

5.4 FUTURE DEVELOPMENT

The previous sections concerning Bradys Gully Creek assess the catchment in its existing state of development (i.e. about 60–70% developed), although there is scope for further development within the catchment. Future fully developed conditions were simulated using the RORB model, and the computed 1% AEP discharges at various points are presented in Table 5.1. Discharges for the 7 February 1990 flood and 1% AEP events under existing conditions are also shown in Table 5.1.

Table 5.1 shows that 1% AEP discharges with further development would be slightly greater than for existing conditions. This indicates that some form of flow detention would be needed so that the flow capacity of the downstream drainage facilities would not be exceeded. The design of future detention structures should be carefully evaluated against the RORB model to avoid increased discharges downstream.

A discussion of some design principles for future detention facilities is presented in Section 6.

Table 5.1 **Comparison of discharges for different conditions in Bradys Gully Creek (m^3/s)**

Location	Existing catchment conditions		Possible future development
	7 February 1990	1% AEP	1% AEP
Chainage 1280	10.4	13.6	13.6
Chainage 1125	11.4	13.5	15.5
Kirkness Avenue Tributary	6.3	8.5	8.5
Bradys Gully Road	17.5	20.8	23.7
Chainage 685	25.3	36.1	43.2
Henry Parry Drive	29.8	39.6	46.2
Pacific Highway	35.9	49.0	54.8

5.5 CONCLUSIONS

A summary of the mitigation works considered, their priority and estimated costs is presented in Table 5.2. The flood levels that would occur following completion of all the works are shown in Table 5.3 and flood levels under different scenarios, in accordance with their priority ranking, are tabulated in Appendix E. The recommended works are identified in Figure 5.4, and the design flood levels for Bradys Gully Creek at the completion of these works are shown in Figure 5.5. The flood contours at completion of the works are shown in Figure 5.6.

Table 5.2 **Recommended works and priority ranking for Bradys Gully Creek**

Location	Description	Profile No	Recommendation	No of houses threatened/ roads flooded	Cost	Priority
	No works	1	Not recommended	Six, Pacific Highway, Henry Parry Drive, Cary St, Bradys Gully Rd and Kirkness Ave flooded	–	–
Laycock St lining area (Ch7 to Ch240)	Lined channel between Ch7 and Ch240	2	Immediate recommendation	One, Pacific Highway, Henry Parry Drive, Cary St and Kirkness Ave flooded	$340,000	2
Cary St reach (Ch240 to Ch375)	Add a new culvert to the Henry Parry Drive culvert, after completion of Laycock St lining	3	Immediate recommendation	One, Pacific Highway, Henry Parry Drive, Cary St and Kirkness Ave flooded	$55,000	3
	Lined channel between Ch240 and Ch375 after completion of Laycock St lining and upgrade of Henry Parry Drive culvert	4	Immediate recommendation	Five, Pacific Highway, Henry Parry Drive, Cary St and Kirkness Ave flooded	$210,000	4
Catholic St pipeline Ch375 to Ch551)	Improve overland flowpath and line inlet to pipes	–	Long term recommendation	–	$10,000	5
Jarrett St channel (Ch551 to Ch900)	Continue planned channel works up to Ch900	5	Immediate recommendation	Two, Pacific Highway, Henry Parry Drive, Cary St and Kirkness Ave flooded	$110,000	1
Kirkness Ave creek – Tributary No 1	Upgrade the Kirkness Ave culvert	6	Long term recommendation	–	$76,000	6

Table 5.3 **Design flood levels at completion of recommended works for Bradys Gully Creek**

Cross section	Existing conditions 1%AEP	After completion of works 1%AEP	2%AEP	5%AEP	20%AEP	2*1%AEP
0.0	4.42	4.40	4.34	4.27	3.88	5.81
100.0	5.20	4.40	4.34	4.27	3.88	5.81
200.1	5.88	4.83	4.71	4.58	4.33	5.81
220.2	6.10	5.44	5.29	5.13	4.82	6.72
240.3	6.54	6.10	5.91	5.63	4.84	7.09
245.4	6.54	6.10	5.91	5.63	4.84	7.09
285.0	6.62	6.10	5.91	5.63	5.03	7.09
355.1	6.78	6.10	5.91	5.63	5.03	7.09
375.2	6.83	6.10	5.93	5.67	5.03	7.09
375.3	6.95	6.95	6.93	6.95	5.78	7.11
520.4	7.67	7.67	7.66	7.61	7.63	7.89
521.5	7.79	7.79	7.76	7.75	7.69	7.81
530.6	7.80	7.80	7.77	7.75	7.69	7.89
545.0	7.83	7.83	7.79	7.77	7.70	8.00
551.2	7.84	7.84	7.80	7.78	7.71	8.03
565.0	7.80	7.84	7.80	7.78	7.71	8.03
571.9	7.85	7.85	7.81	7.78	7.71	8.35
575.0	7.87	7.87	7.83	7.79	7.72	8.43
585.0	7.92	7.92	7.87	7.83	7.74	8.55
595.0	7.97	7.97	7.91	7.86	7.75	8.61
605.0	8.06	8.06	7.99	7.92	7.79	8.72
615.0	8.06	8.06	7.99	7.92	7.79	8.72
625.0	8.03	8.06	7.99	7.92	7.78	8.72
635.0	8.13	8.13	8.05	7.97	7.82	8.82
638.4	8.16	8.16	8.07	7.99	7.84	8.86
655.0	8.15	8.16	8.07	7.99	7.85	8.86
675.0	8.14	8.16	8.07	7.99	7.85	9.00
685.0	9.05	8.71	8.55	8.39	8.08	9.75
694.0	9.50	Not included in model				
705.0	9.56	8.79	8.63	8.47	8.15	9.84
715.0	9.63	Not included in model				
725.0	9.73	8.80	8.64	8.48	8.16	9.85
745.0	9.76	8.81	8.66	8.49	8.18	9.86
765.0	9.81	8.83	8.67	8.51	8.20	9.87
785.0	10.03	8.84	8.69	8.53	8.22	9.89
805.0	10.08	9.46	9.34	9.22	8.98	10.09
825.0	10.26	10.05	9.93	9.80	9.53	10.87
845.1	10.33	10.13	10.00	9.88	9.59	11.01
869.2	10.36	10.17	10.05	9.92	9.64	11.05
870.3	10.02	10.17	10.05	9.92	9.64	11.52
900.4	10.23	10.17	10.05	9.92	9.64	11.75
901.5	11.12	10.93	10.63	10.36	9.97	11.79
905.6	11.12	10.93	10.63	10.36	9.97	11.79
1125.0	11.28	11.15	10.91	10.70	10.44	11.97
1130.0	11.37	11.30	11.20	11.07	10.72	12.02
1280.0	12.12	12.11	12.07	12.02	11.94	12.40
1380.0	13.11	13.12	13.04	12.94	12.74	13.53
-1125.0	11.28	11.15	10.91	10.70	10.44	11.97
1185.1	12.96	12.97	12.85	12.74	12.59	13.41
1195.2	13.23	12.99	12.98	12.90	12.74	13.37
1196.0	14.17	Not included in model				
1208.4	14.31	14.06	13.85	13.85	13.54	14.32
1210.0	14.40	Not included in model				
1214.6	14.41	14.06	13.88	13.87	13.55	14.32
1354.0	15.12	15.13	15.07	15.00	14.91	15.27

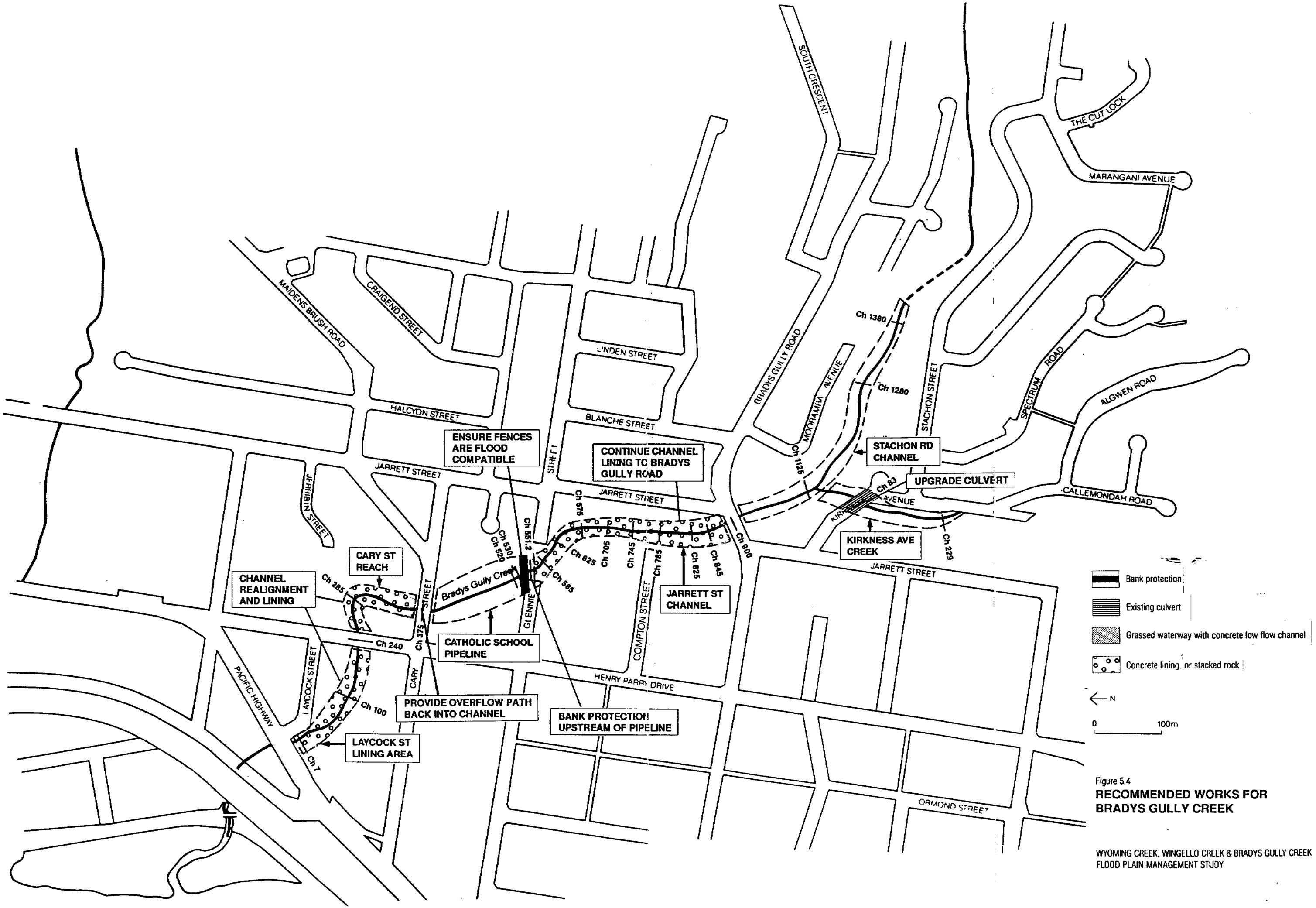


Figure 5.4
RECOMMENDED WORKS FOR BRADYS GULLY CREEK

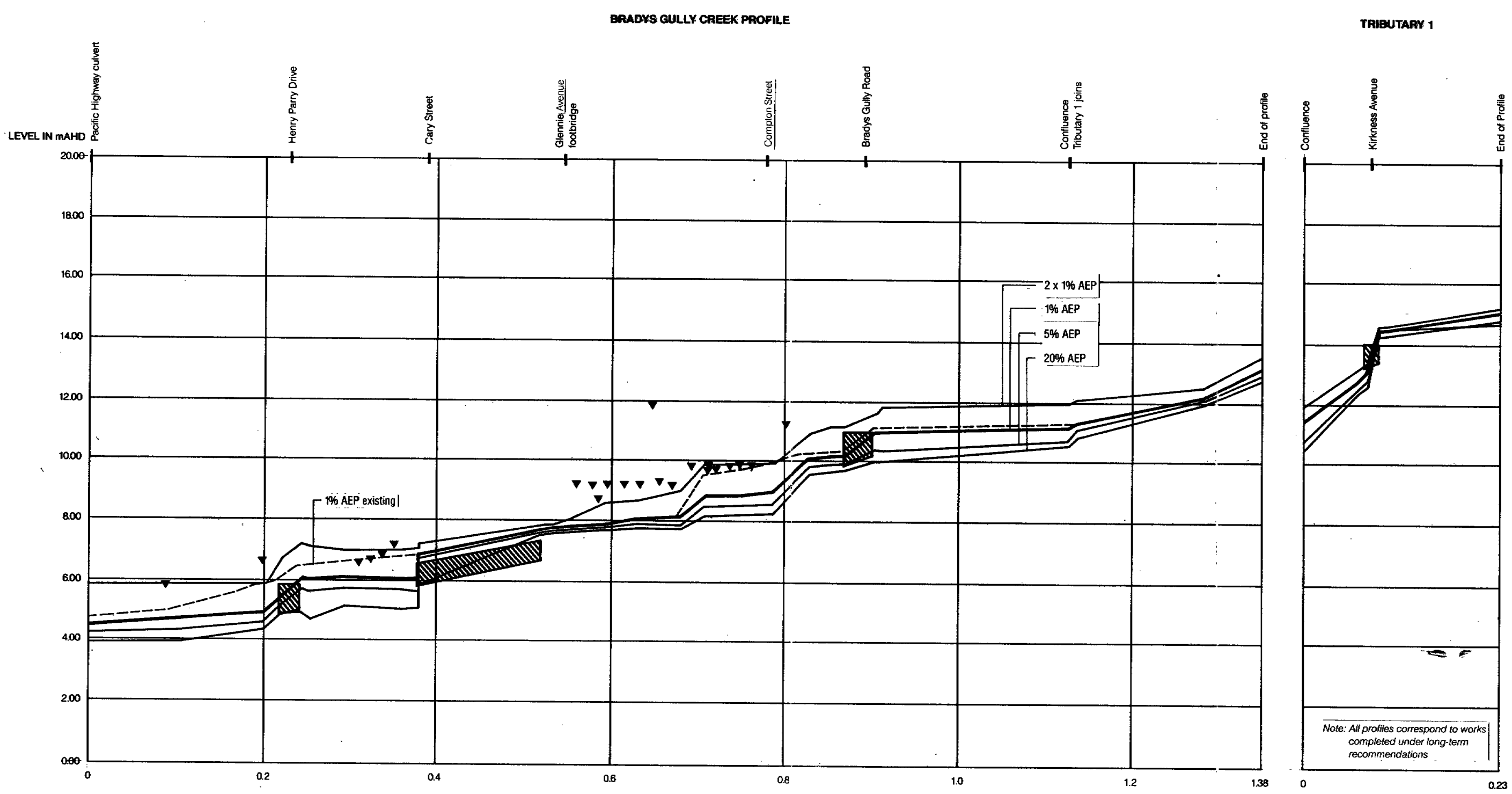


Figure 5.5
20%, 5%, 1% and 2 x 1% AEP FLOOD PROFILES WITH RECOMMENDED WORKS FOR BRADYS GULLY CREEK

GOSFORD CITY COUNCIL

NOTES

1. FLOOD LEVELS HAVE BEEN CALCULATED AT CROSS SECTION LOCATIONS ONLY.
2. FLOOD LEVELS AND FLOOD CONTOURS BETWEEN CROSS SECTIONS HAVE BEEN LINEARLY INTERPOLATED.
3. FLOOD CONTOURS DEPICT APPROXIMATE WIDTHS OF FLOODING ONLY. FLOOD LIABILITY SHOULD BE VERIFIED BY GROUND SURVEY
4. FLOOD LEVELS ARE GIVEN IN METRES TO AUSTRALIAN HEIGHT DATUM
5. SIZES SHOWN ON THIS PLAN ARE APPROXIMATE ONLY AND DETAILS SHOULD NOT BE SCALED FROM THIS DRAWING FOR DETAILED DESIGN PURPOSES.

LEGEND

- 1% AEP flood extent
- CS 520 — Flood contour at survey cross section
- 6.5 — Flood contour at survey cross section
- 6.6 — Flood contour interpolated between cross sections
- 519 — House floor levels

212A	212B	219A
212C	212D	219C
228A	228B	229A
228C	228D	229C

KEY TO ADJOINING SHEETS

Central Mapping Authority Map Reference: GOSFORD U2797 - 52

40 20 0 40 80 120 160 200m

FLOODPLAIN MANAGEMENT PLAN OVERLAY

Produced for
GOSFORD CITY COUNCIL - Revised January 1993
Consulting Engineers - KINHILL ENGINEERS
Consulting Surveyors - JTS RYAN FIRTH & CO

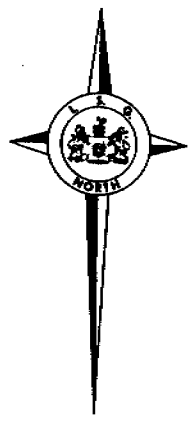
FLOODPLAIN MANAGEMENT STUDY FOR WYOMING, WINGELLO AND BRADYS GULLY CREEKS

FLOOD CONTOURS AT COMPLETION OF PROPOSED WORKS FOR BRADYS GULLY CREEK

SHEET 1 of 2 Figure 5.6

GOSFORD CITY COUNCIL DRAWING NUMBER 4/118/A1

GOSFORD CITY COUNCIL



NOTES

1. FLOOD LEVELS HAVE BEEN CALCULATED AT CROSS SECTION LOCATIONS ONLY.
2. FLOOD LEVELS AND FLOOD CONTOURS BETWEEN CROSS SECTIONS HAVE BEEN LINEARLY INTERPOLATED.
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LEGEND

- 1% AEP flood extent
- CS 520 — 6.5 — Flood contour at survey cross section
- 6.8 — Flood contour interpolated between cross sections
- 5.97 — House floor levels

212A	212B	213A
212C	212D	213C
228A	228B	229A
228C	228D	229C

KEY TO ADJOINING SHEETS

Central Mapping Authority Map Reference: GOSFORD U2797 - 64

40 20 0 40 80 120 160 200m

FLOODPLAIN MANAGEMENT PLAN OVERLAY

Produced for
GOSFORD CITY COUNCIL - Revised January 1993
Consulting Engineers - KINHILL ENGINEERS
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FLOODPLAIN MANAGEMENT STUDY FOR WYOMING, WINGELLO AND BRADYS GULLY CREEKS

FLOOD CONTOURS AT COMPLETION OF PROPOSED WORKS FOR BRADYS GULLY CREEK

SHEET 2 of 2 Figure 5.6

GOSFORD CITY COUNCIL DRAWING NUMBER 4/119/A1

6 DESIGN OF FUTURE DETENTION FACILITIES

The present creek systems cannot cope with any major development of the catchments in the future. The areas zoned as future residential and permanent natural catchment areas are shown in Figure 6.1. Possible basin locations are shown in Figure 6.2. There are, however, some problems with these locations due to the steep valleys, which necessitate a high embankment wall to create sufficient storage. According to the Australian National Committee on Large Dams (1986), embankment walls higher than 5 m would be classified as dams and would thus require rigorous analysis. This would mean a higher cost for design and construction.

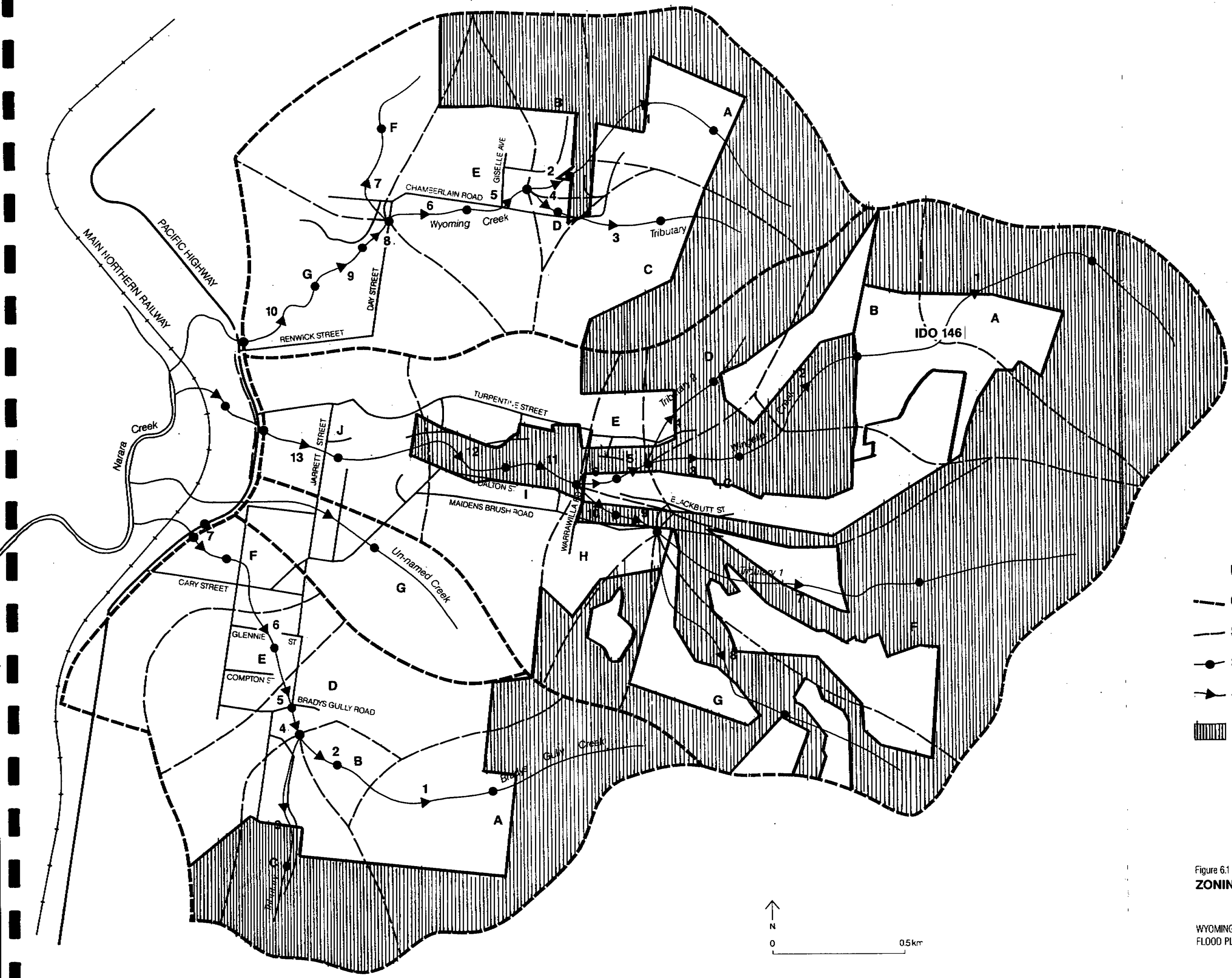
Nevertheless the design of future detention facilities to offset further development should satisfy the following conditions under new development:

- The rising limb of the attenuated hydrograph at the basin location must not be steeper than the rising limb under existing conditions.

- The peak value of the attenuated hydrograph must not be greater than the existing peak value, and should preferably be lower.

- The above conditions are to be checked against an appropriate range of storm durations to ensure that the attenuated hydrographs would not overload any downstream drainage facilities.

The design of detention facilities requires input of the stage–storage–discharge relationship into an overall established hydrologic model for the whole creek system. The normal method of stipulating that the peak developed discharge must not exceed the pre-developed discharge may not be entirely applicable for all cases as it does not take into consideration the effect of time. Also, depending on the complexity of the network of basins in a catchment, the positive effects of one basin may be partially or completely neutralized by another basin instead of complementing each other. It is recommended that detention facilities be designed by experienced hydrologic and hydraulic professionals in order to realize the full benefit of a network of basins within a catchment.



Legend

- Catchment boundary
- Sub-catchment boundary
- Sub-area inflow
- Storage network
- Areas zoned as pristine catchment unless rezoned by council

Figure 6.1

ZONING PLAN OF CATCHMENTS

WYOMING CREEK, WINGELLO CREEK & BRADYS GULLY CREEK FLOOD PLAIN MANAGEMENT STUDY

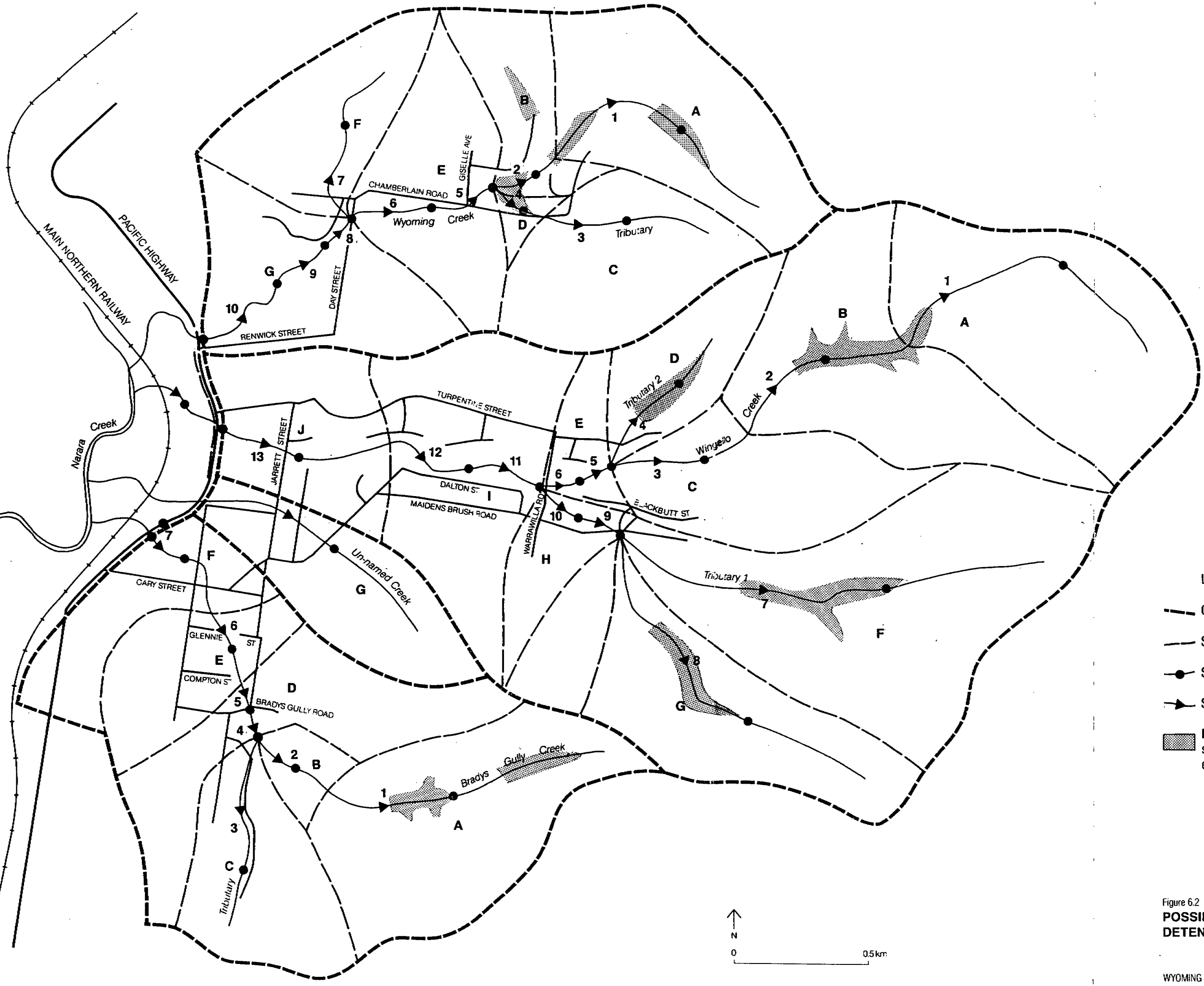


Figure 6.2

POSSIBLE LOCATIONS OF FUTURE DETENTION STORAGE BASINS

7 FORMULATION OF DRAFT FLOODPLAIN MANAGEMENT PLANS

The floodplain management plans, contained in three separate documents, were prepared for each of the three tributary creeks following evaluation of the management options. The plans incorporate the preferred works options.

Formulation of the management plan was undertaken by:

- identifying possible flood mitigation measures;
- reviewing the measures to identify a range of feasible options. The review was based on hydraulic, social, ecologic, economic and hazard criteria;
- hydraulic modelling to determine the effects of the proposed works;
- costing of the works;
- a benefit–cost analysis, assessing the cost effectiveness of the proposed works;
- preparation of a draft plan (preliminary);
- public comment on the draft plan;
- preparation of the final plan.

8 CONCLUSIONS

Many of the conclusions for each of the creek studies have already been discussed in the relevant sections. Other issues relevant to the whole study are put forward here.

Concrete lining was generally adopted for channel improvement works, although this is recognized as the most expensive and least aesthetic material. Gabions, rock mattress or locally available stacked rock could be acceptable alternatives.

Lining using large stacked sandstone rocks would be effective if correctly laid to give a channel cross-section of equivalent conveyance to that of a concrete channel. This low cost option may be considered the environmentally preferred alternative. Stacked rock may be a viable alternative for bank stabilization.

Also, although this study gave a priority ranking for the recommended works, works of sequential priority could be executed at the same time to accelerate the flood and bank protection objectives. In terms of environmental impact, most of the recommended works would not be wholly compatible with existing conditions. However, if proper and careful landscaping were carried out after completion of the works, the constructed drainage structures would be able to blend more naturally into the environment, thus minimizing their impact.

Full concrete lining of existing channels, or construction of a concrete low-flow channel, would have the effect of reducing the ongoing groundwater recharge along the existing creek bed. However, no attempts have been made to quantify the extent of this effect.

This study and the derived design flood profiles have been based on the assumption that the waterway areas within all the creeks are regularly maintained. Some creeks are overgrown and, where no mitigation works are recommended, a maintenance programme should be undertaken to re-establish these waterway areas.

Appendix A

HOUSES AFFECTED BY A 1% AEP FLOOD BEFORE AND AFTER MITIGATION WORKS

Appendix A

HOUSES AFFECTED BY 1% AEP FLOOD BEFORE AND AFTER ALL TERM MITIGATION WORKS

Table A.1 **Wyoming Creek**

House	Approximate chainage (m)	House floor level (m AHD)	Flood level (m AHD)	
			Before mitigation	After mitigation
Lot 27, corner of Pacific Highway and Renwick Street	10	4.82	4.95*	4.37
8 Renwick Street	57	4.898	5.07*	4.37
10 Renwick Street	77	4.748	5.11*	4.37
12 Renwick Street	116	5.148	5.19*	4.37
16 Glencoe Avenue	250	5.798	5.58	4.81
49 Crawford Crescent	332	6.048	5.86	5.60
60 Bourbon Street	797	9.46	9.52*	8.68
62A Bourbon Street	860	9.16	9.67*	8.92
64 Bourbon Street	860	9.28	9.67*	8.92
1 Giselle Avenue	1,433	13.15**	13.25*	12.65

* *Flood level higher than house floor level.*
** *Level of sunken lounge.*

Table A.2 **Wingello Creek**

House	Approximate chainage (m)	House floor level (m AHD)	Flood level (m AHD)	
			Before mitigation	After mitigation
7 Adnamira Close	322	6.42	6.34	6.13
9 Adnamira Close	344	6.77	6.44	6.13
11A Adnamira Close	425	6.99	6.83	6.13
37 Roselands Avenue	718	7.62	7.45	6.86
35 Roselands Avenue	728	7.60	7.43	6.88
33 Roselands Avenue	758	7.62	7.44	6.93
31 Roselands Avenue	785	7.71	7.49	6.99
29 Roselands Avenue	798	7.75	7.50	7.00
22 Pecan Close	1,536	14.05	14.48*	14.04
18 Pecan Close	1,556	14.30	14.48*	14.04
16 Pecan Close	1,571	14.72	14.48	14.04
12 Bottlebrush Crescent	1,506	14.56	14.48	14.04

* *Flood level higher than house floor level.*

Table A.3 **Bradys Gully Creek**

House	Approximate chainage (m)	House floor level (m AHD)	Flood level (m AHD)	
			Before works	After mitigation
287 Henry Parry Drive	310	6.51	6.68*	6.06
285 Henry Parry Drive	325	6.74	6.72	6.06
283 Henry Parry Drive	340	6.86	6.77	6.06
Villa 6/14 Compton Street	745	9.76	9.76*	8.81
Villa 7/14 Compton Street	745	9.76	9.76*	8.81
Villa 8/14 Compton Street	745	9.75	9.76*	8.81
Villa 9/14 Compton Street	745	9.77	9.76*	8.81
Villa 10/14 Compton Street	745	9.75	9.76*	8.81

* *Flood level higher than house floor level.*

Appendix B

ENGINEERING PLAN (1:250) FOR PROPOSED CONCRETE LINING OF WINGELLO CREEK, FROM JARRETT STREET TO RAINFOREST RESERVE

ALIGNMENT ALTERNATIVE

ADNAMIRA CLOSE

STREET

JARRETT

WINGELLO

CREEK

HALCYON STREET

D. P. 238914

D. P. 559456

D. P. 596138

D. P. 230152

D. P. 22435

D. P. 247765

No. 1 TWO STOREY BRICK & FIBRO TILE ROOF GND. F.L. 6·47

No. 3 FIBRO RESIDENCE METAL ROOF F.L. 6·81

No. 5 FIBRO RESIDENCE METAL ROOF F.L. 8·63

No. 7 TWO STOREY BRICK RESIDENCE TILE ROOF GND. F.L. 6·42 1ST FLOOR VER. 6·34

No. 9 TWO STOREY BRICK RESIDENCE TILE ROOF GND. F.L. 6·77 GAR. F.L. 6·02 1ST FLOOR VER. 5·98

No. 11 BRICK RESIDENCE TILE ROOF F.L. 7·35

No. 11A BRICK RESIDENCE TILE ROOF F.L. 6·99 CARPORT

No. 11S TWO STOREY TIMBER & CLAD RES. TILE ROOF GND. F.L. 6·44 CLAD GARAGE 6·42 F.L.

No. 51 BRICK RESIDENCE TILE ROOF F.L. 7·57 GAR. F.L. 6·50 PORCH

No. 50 BRICK RESIDENCE TILE ROOF F.L. 9·05 PORCH

BM ▲ ON HEADWALL R.L. 6·16

EASEMENT TO DRAIN

RETAINING WALL

ROCK RETAINING WALL

CLAD GARAGE

CARPORT

PAVED AREA

DENSE RAIN FOREST

CHAIN WIRE FENCE

PALING FENCE

TIMBER FENCE

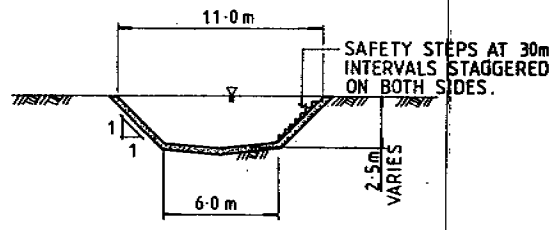
METAL FENCE

BRICK FENCE

INDICATES ALTERNATIVE ALIGNMENT

18·29 WIDE VARIABLE

NOTE: THE POSITION OF FEATURES SHOWN IS SUBJECT TO A BOUNDARY SURVEY.



TYPICAL CROSS-SECTION (N.T.S)

REDUCTION RATIO 1:250

5 2·5 0 5 10 15 20 25

DATUM: A.H.D

ORIGIN OF LEVELS: BM ▲ ON HEADWALL EASTERN SIDE OF JARRETT STREET 36m NORTH OF PEMMEL ST. R.L. 6·165 (CONVERTED FROM 106·215 GOSFORD WYONG REGIONAL SEWER DATUM)

ENGINEERING PLAN FOR PROPOSED CONCRETE LINING OF WINGELLO CREEK FROM JARRET ST. TO RAIN FOREST RESERVE.

WYOMING CREEK, WINGELLO CREEK AND BRADYS GULLY CREEK FLOODPLAIN MANAGEMENT STUDY

PLAN SHOWING LEVELS AND DETAILS OVER PART LOTS 8, 10, 11, 12, 13 & 14 IN D.P. 238914, PART LOT 1 D.P. 559456, PART LOTS 15 & 16 D.P. 596138 AND PART LOTS 3, 4 & 8 D.P. 247765 AT WYOMING.

SHEET 1 OF 1 SHEETS

Ref. P4294

BY:
FIRTH & CO
SULTING SURVEYORS
OORE AVENUE
NDFIELD
3328
5314

: SEPTEMBER 1990

Appendix C

DESIGN FLOOD LEVELS FOR WYOMING CREEK

Appendix C **1%AEP design flood levels for Wyoming Creek**

Cross section	Existing conditions	Completed 1992	Priority 1 completed	Priority 2* completed	Priority 3* completed	Completion* of d/s works
0.0	4.95	4.95	4.95	4.82	4.86	4.37
57.0	5.07	5.07	5.07	4.81	4.86	4.35
116.0	5.19	5.19	5.19	4.65	4.84	4.31
168.0	5.37	5.37	5.37	4.74	4.83	4.26
223.0	5.38	5.38	5.38	5.38	4.55	4.56
260.0	Not included in model				4.90	4.90
280.0	5.80	5.80	5.80	5.80	5.13	5.13
332.0	5.86	5.86	5.86	5.86	5.66	5.66
410.0	5.97	5.97	5.97	5.97	5.90	5.90
486.0	6.36	6.36	6.36	6.36	6.43	6.43
536.0	6.61	6.61	6.61	6.61	6.62	6.62
618.0	6.99	6.99	6.99	6.99	6.98	6.98
680.0	7.20	7.20	7.20	7.20	7.20	7.20
696.0	7.11	7.11	7.11	7.11	7.11	7.11
700.0	7.75	7.18	7.18	7.18	7.18	7.18
797.0	9.52	8.68	8.68	8.68	8.68	8.68
860.0	9.67	Not included in model				
867.7	9.69	8.95	8.95	8.95	8.95	8.95
885.0	10.39	10.39	10.39	10.39	10.39	10.39
888.0	10.39	Not included in model				
1077.0	10.80	10.81	11.52	11.52	11.52	11.52
1155.0	11.52	Not included in model				
1159.0	11.77	11.76	11.76	11.76	11.76	11.76
1233.0	11.88	11.88	11.88	11.88	11.88	11.88
1237.0	12.23	12.23	12.23	12.23	12.23	12.23
1288.0	12.26	12.26	12.26	12.26	12.26	12.26
1292.0	12.26	12.26	12.26	12.26	12.26	12.26
1296.0	12.43	12.43	12.43	12.43	12.43	12.43
1301.0	12.43	12.43	12.43	12.43	12.43	12.43
1305.0	12.52	12.52	12.52	12.52	12.52	12.52
1360.0	12.53	12.53	12.53	12.53	12.53	12.53
1414.0	12.60	12.60	12.60	12.60	12.60	12.60
1418.0	12.59	12.59	12.59	12.59	12.59	12.59
1433.0	13.25	13.25	12.65	12.65	12.65	12.65
1438.0	13.25	13.25	12.65	12.65	12.65	12.65
1443.0	Not included in model		12.64	12.64	12.64	12.64
1513.0	13.23	13.23	12.89	12.89	12.89	12.89
1531.0	13.35	13.35	13.29	13.29	13.29	13.29
1762.0	14.17	14.17	14.18	14.18	14.18	14.18
–1531.0	13.35	13.35	13.29	13.29	13.29	13.29
200.0	14.56	14.56	14.56	14.56	14.56	14.56
250.0	15.46	15.46	15.46	15.46	15.46	15.46
260.0	15.58	15.58	15.58	15.58	15.58	15.58
287.0	15.59	15.59	15.59	15.59	15.59	15.59
294.0	15.56	15.56	15.56	15.56	15.56	15.56

**Note: assumes that all the works of ahigher priority have been constructed*

Appendix D

DESIGN FLOOD LEVELS FOR WINGELLO CREEK

Appendix D **1%AEP design flood levels for Wingello Creek**

Cross section	Existing conditions	Completed 1992	Priority 1 completed	Priority 2* completed	Priority 3* completed	Priority 4 & 5* completed	Completion* of d/s works
0.0	5.00	5.00	5.00	5.00	5.00	5.00	5.00
100.0	5.06	5.07	5.07	5.07	5.07	5.07	5.07
115.0	5.09	5.07	5.07	5.07	5.07	5.07	5.07
257.7	5.73	5.68	5.68	5.68	5.68	5.68	5.68
262.7	5.73	5.68	5.68	5.68	5.68	5.68	5.68
275.0	6.11	6.06	6.13	6.13	6.13	6.13	6.13
280.0	6.14	6.10	Not included in model				
425.0	6.83	6.83	6.13	6.13	6.13	6.10	6.13
520.0	7.23	7.23	6.60	6.60	6.60	6.60	6.60
593.0	7.40	7.40	6.80	6.80	6.80	6.80	6.80
656.0	7.42	7.41	6.77	6.77	6.77	6.77	6.77
718.0	7.45	7.45	6.86	6.86	6.86	6.86	6.86
778.0	7.49	7.49	6.97	6.97	6.97	6.97	6.97
835.0	7.53	7.53	7.19	7.19	7.19	7.19	7.19
875.0	7.85	7.85	7.83	7.31	7.31	7.31	7.31
930.0	8.19	8.19	8.21				
1038.0	8.55	8.55	8.55	Not included in model			
1051.0	8.54	8.54	8.54				
1088.0	8.44	8.44	8.44	8.12	8.12	8.12	8.12
1186.0	9.19	9.19	9.19				
1245.0	9.34	9.34	9.34	Not included in model			
1317.0	9.59	9.59	9.59				
1351.0	9.71	9.71	9.71	8.78	8.78	8.78	8.78
1375.0	10.03	10.03	10.03				
1381.0	10.03	10.03	10.03	8.85	8.85	8.85	8.85
1391.0	10.15	10.15	10.15	9.53	9.63	9.63	9.63
1392.0	10.17	10.17	10.17	9.53	9.63	9.63	9.63
1506.0	10.25	10.25	10.25	9.83	9.93	9.93	9.93
1506.1	10.25	10.25	10.25	9.84	9.97	9.97	9.97
1611.0	14.48	14.48	14.48	14.47	14.04	14.04	14.04
1821.0	14.50	14.50	14.50	14.49	14.06	14.06	14.06
–1392.0	10.17	10.17	10.17	9.52	9.63	9.63	9.63
160.0	11.09	11.09	11.09	11.09	11.09	11.09	11.09
290.0	12.39	12.39	12.39	12.39	12.39	12.39	12.39
291.0	12.21	12.21	12.21	12.21	12.21	12.21	12.21
300.0	12.62	12.62	12.62	12.62	12.62	12.62	12.62
305.0	12.71	12.71	12.71	12.71	12.71	12.71	12.71
410.0	12.93	12.93	12.93	12.93	12.93	12.91	12.91
–1611.0	14.48	14.48	14.48	14.48	14.04	14.04	14.04
164.2	14.49	14.49	14.49	14.49	14.05	14.05	14.05
169.2	14.49	14.49	14.49	14.49	14.05	14.05	14.05
190.0	15.95	15.95	15.95	15.95	15.51	15.51	15.51
195.0	15.95	15.95	15.95	15.95	15.51	15.51	15.51
450.0	25.79	25.79	25.79	25.79	25.79	25.79	25.79

**Note: assumes that all the works of a higher priority have been constructed*

Appendix E

DESIGN FLOOD LEVELS FOR BRADYS GULLY CREEK

Appendix E 1%AEP design flood levels for Bradys Gully Creek

Cross section	Existing conditions	Priority 1 completed	Priority 2* completed	Priority 3* completed	Priority 4 & 5* completed	Priority 6* completed	Completion* of d/s works
7.0	4.42	4.42	4.39	4.39	4.39	4.39	4.38
100.0	5.20	5.20	4.39	4.39	4.39	4.20	4.38
200.1	5.88	5.88	4.83	4.83	4.83	4.83	4.83
220.2	6.10	6.10	5.43	5.43	5.43	5.43	5.43
240.3	6.54	6.54	6.36	6.10	6.10	6.10	6.10
245.4	6.54	6.54	6.36	6.10	6.10	6.02	6.10
285.0	6.62	6.62	6.50	6.33	6.10	6.06	6.10
355.1	6.78	6.78	6.70	6.61	6.10	6.04	6.10
375.2	6.82	6.82	6.75	6.67	6.10	6.08	6.10
375.3	6.95	6.95	6.95	6.95	6.95	6.95	6.95
520.4	7.67	7.67	7.67	7.67	7.67	7.67	7.67
521.5	7.79	7.79	7.79	7.79	7.79	7.79	7.79
530.6	7.80	7.80	7.80	7.80	7.80	7.80	7.80
545.0	7.83	7.83	7.83	7.83	7.83	7.83	7.83
551.2	7.84	7.84	7.84	7.84	7.84	7.84	7.84
565.0	7.84	7.84	7.84	7.84	7.84	7.80	7.84
571.9	7.85	7.85	7.85	7.85	7.85	7.85	7.85
575.0	7.87	7.87	7.87	7.87	7.87	7.87	7.87
585.0	7.92	7.92	7.92	7.92	7.92	7.92	7.92
595.0	7.97	7.97	7.97	7.97	7.97	7.97	7.97
605.0	8.06	8.06	8.06	8.06	8.06	8.06	8.06
615.0	8.06	8.06	8.06	8.06	8.06	8.06	8.06
625.0	8.06	8.06	8.06	8.06	8.06	8.03	8.06
635.0	8.13	8.13	8.13	8.13	8.13	8.13	8.13
638.4	8.16	8.16	8.16	8.16	8.16	8.16	8.16
655.0	8.16	8.16	8.16	8.16	8.16	8.16	8.16
675.0	8.16	8.16	8.16	8.16	8.16	8.16	8.16
685.0	9.05	8.71	8.71	8.71	8.71	8.71	8.71
693.6	9.50	Not included in model					
705.0	9.56	8.79	8.79	8.79	8.79	8.79	8.79
715.0	9.63	Not included in model					
725.0	9.73	8.80	8.80	8.80	8.80	8.80	8.80
745.0	9.76	8.81	8.81	8.81	8.81	8.81	8.81
765.0	9.81	8.83	8.83	8.83	8.83	8.83	8.83
785.0	10.03	8.84	8.84	8.84	8.84	8.84	8.84
805.0	10.08	9.46	9.46	9.46	9.46	9.46	9.46
825.0	10.26	10.05	10.05	10.05	10.05	10.05	10.05
845.1	10.33	10.13	10.13	10.13	10.13	10.13	10.13
869.2	10.36	10.17	10.17	10.17	10.17	10.17	10.17
870.3	10.36	10.17	10.17	10.17	10.17	9.85	10.17
900.4	10.36	10.17	10.17	10.17	10.17	10.05	10.17
901.5	11.12	10.93	10.93	10.93	10.93	10.93	10.93
905.6	11.12	10.93	10.93	10.93	10.93	10.93	10.93
1125.0	11.28	11.15	11.15	11.15	11.15	11.15	11.15
1130.0	11.37	11.30	11.30	11.30	11.30	11.30	11.30
1280.0	12.12	12.11	12.11	12.11	12.11	12.11	12.11
1380.0	13.11	13.12	13.12	13.12	13.12	13.12	13.12
-1125.0	11.28	11.15	11.15	11.15	11.15	11.15	11.15
1185.1	12.96	12.97	12.97	12.97	12.97	12.97	12.97
1195.2	13.23	13.23	13.23	13.23	13.23	12.99	12.99
1196.3	14.17	14.17	14.17	14.17	14.17	14.06	14.06
1208.4	14.31	14.31	14.31	14.31	14.31	14.06	14.06
1209.5	14.40	14.40	14.40	14.40	14.40	Not included in model	
1214.6	14.41	14.41	14.41	14.41	14.41		
1354.0	15.12	15.12	15.12	15.12	15.12	15.13	15.13

**Note: assumes that all the works of a higher priority have been constructed*

Appendix F

PUBLIC SUBMISSIONS AND RESPONSES

Appendix F

PUBLIC SUBMISSIONS AND RESPONSES

F1 PUBLIC SUBMISSIONS

FLOOD STUDY-WYOMING CK-CMNTS

64 Bourbon Street,
WYOMING. NSW. 2250

April 10, 1991

E Mieluk
02 72

10.04.91
15.APR1991 091412

FILE 920.25.01
HILL R R

City Manager,
P.O. Box 21,
GOSFORD. NSW. 2250

Dear Sir,

RE:- EXHIBITION OF THE DRAFT PRELIMINARY FLOODPLAN MANAGEMENT STUDY AND MANAGEMENT PLAN FOR WYOMING, WINGELLO AND BRADYS GULLY CREEK SYSTEM. Dated .... April 9, 1991 GOSFORD STAR.

My first awareness of this proposal was evening of April 9th, and was very surprised I had not received a direct personal letter as in the past programme, from the City Council.

It is imperative, we keep this bridge, as it is the only Vehicle Access to the property and garage, with the cars.

If the intended proposal is to increase the height of the drain to counter-act flooding and control flow of water, and at Council's expense heighten the existing single span vehicle concrete bridge onto our property; which Council originally provided over the structure and built at their expense, 1981 Works Programme, then we would welcome your interest and concern re flooding into our garage and have no objection to the intended proposal; but would request adequate notice of future intended proposals before implementation.

My daughter called at Gosford Shire Council this morning and spoke with 2 very obliging gentlemen, Mr. Ed Mieluk "Flood Mit Engineer" Gosford Council, and Mr. Tyson, was advised to submit a letter immediately regarding my viewpoint.

Thank -you very much for past help and advice you have shown us concerning this problem and would appreciate an early reply as to the intended work programme, It has been very worrying over past flooding into our property.

Awaiting your reply,

Yours sincerely,

Rita R Hill

RITA R. HILL

JOAN GUNNING (daughter) Joan E. Gunning
GWEN HILL (daughter) ..... Notification of contents given
Detective/Sergeant Neville Hill..... Notification of contents given.

SUBMISSION NO. 1

,TION OF THE DRAFT PRELIMINARY FLOODPLAIN MANAGEMENT JDY AND MANAGEMENT PLAN FOR WYOMING, WINGELLO AND BRADYS GULLY CREEK SYSTEM

Draft Floodplain Management Study and Management Plans for the abovementioned creek systems will be placed on ,tion on the Ground Floor of Council's Administration Building, 49 Mann Street, Gosford from Tuesday, 26 March to Monday, ,ril 1991. During that period, Council welcomes written responses from individual property owners, organisations and resident ,oups commenting on the exhibited study and plans.

All submissions should be made in writing and addressed to the City Manager and clearly marked "Submission on the Draft Preliminary Floodplain Management Study and Management Plan for Wyoming, Wingello and Bradys Gully Creek System". Submissions should be received by Council before 5pm on Monday, 7 April 1991.

AMENDED DUAL OCCUPANCIES — NORTH AVOCA
AMENDED RESIDENTIAL FLAT BUILDING — ERINA

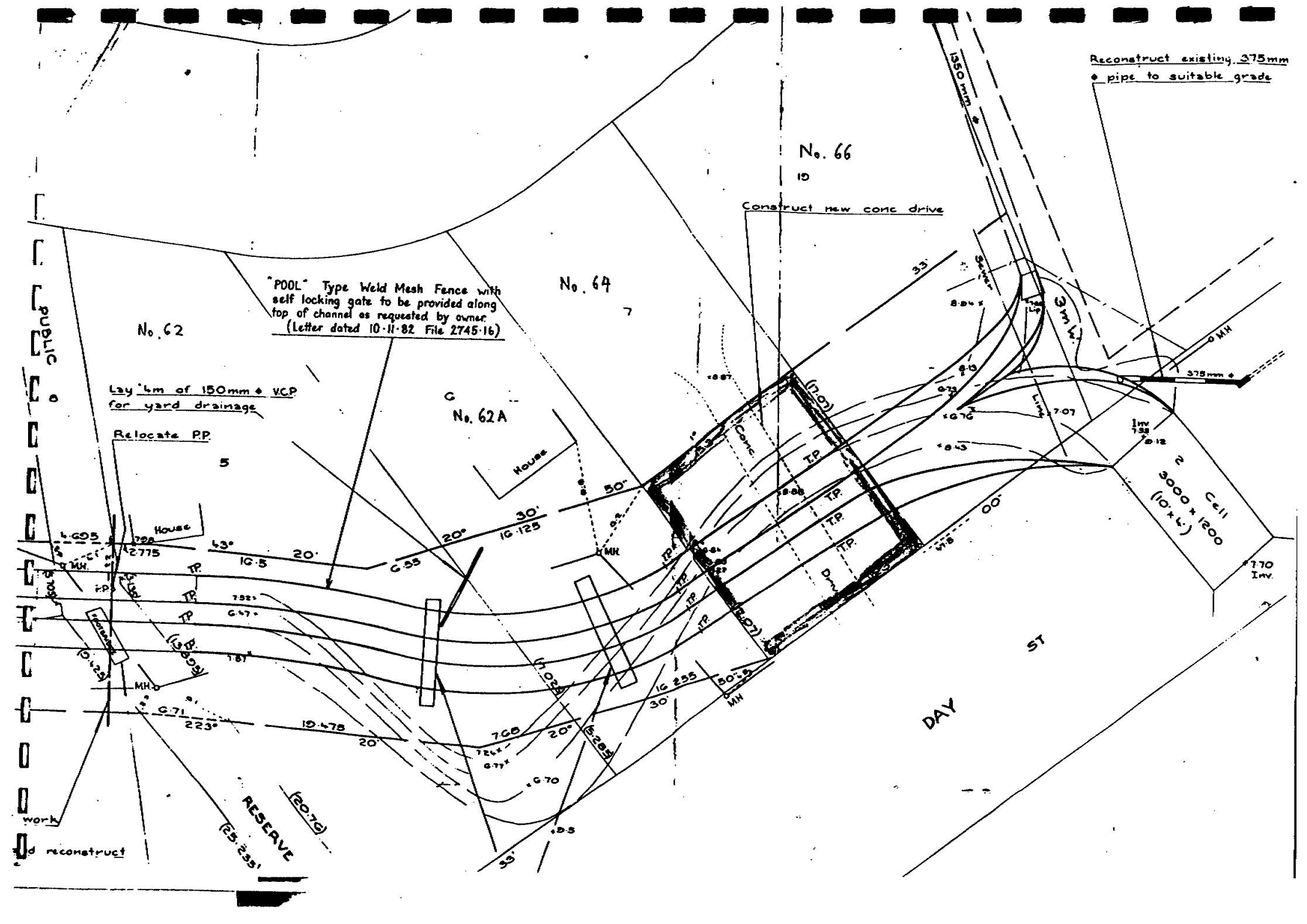
In pursuance of Council Policy and Clause 14 of the Miscellaneous Acts (Planning) Savings and Transitional Provisions Regulations 1980, notice is hereby given that Council has received amended applications for proposed developments as set out in the Schedule below.

The applications and amended plans relating to the developments to which this notice refers may be viewed at the Ground Floor Enquiry Counter of this office between 8.38am and 5.00pm Mondays to Fridays (public holidays excepted) for the period of twenty-one (21) days from 9 April 1991 to 1 May 1991.

Any written submissions on the developments should be addressed to the Town Clerk, quoting the relevant reference numbers and lodged with the Council within twenty-one days from 9 April 1991.

SCHEDULE

1. Eight (8) Unit Residential Flat Building on both Lot E DP 400928 and Lot 6 DP 558907 Nos 50-52 Karalta Road, Erina. DA No.13998.
2. Dual Occupancy on Proposed Lot 70 in approved subdivision of Lot 132 DP 7978 No.16 Coast Road, North Avoca. DA No.13013.
3. Dual Occupancy on Proposed Lot 71 in approved subdivision of Lot 132 DP 7978 No.16 Coast Road, North Avoca. DA No.13004.


No. 66
No. 64
No. 62
No. 62A
"POOL" Type Weld Mesh Fence with self locking gate to be provided along top of channel as requested by owner (Letter dated 10-11-82 File 2745-16)
Lay 4m of 150mm ϕ VCP for yard drainage
Relocate PP
Construct new conc drive
Reconstruct existing 375mm ϕ pipe to suitable grade
1350 mm ϕ
375mm ϕ
House
Garage
Sewer
MH
TP
Cells
3000 x 1200 (10' x 4')
PUBLIC
DAY
ST
RESERVE
work
reconstruct

WYOMING FLOOD MGMT STUDY - CMNTS

66 Bourbon St
Wyoming

8.4.91

E Mieluk

City Manager
Gosford City Council

Dear Sir,

I am writing to you about the Preliminary Floodplain Management Study and Management Plan for Wyoming. My letter is a day late as the exhibition stated that all individuals affected would be contacted which hasn't happened.

The drain which council constructed in 1984 goes through our property. Council put a bridge across the drain to provide a link to all of our block & to provide my family access.

That bridge is the reason I am writing to you. I understand that the study is suggesting the removal of the bridges because they are contributing to the flooding which periodically occurs. The bridges do not inhibit the floodwater as this just passes over the top carrying all the debris with it. The cause of the flooding is the culvert under Day St which has been placed at the wrong angle to the rest of the creek/drain. The water coming down the creek from the other side of Day St builds up at the culvert until it eventually flows over the road. Then

SUBMISSION NO. 2

up with all the water being carried through the easement which comes down along our side fence. In times of torrential rain there is a massive volume of water meeting at right angle which results in the flooding.

In the exhibition on display at comm photographs were on display showing beautification of the existing drain. They were photographs of the work we have done determined to hide the ugliness of an open drain system. To maintain our work we need our bridge to allow us access to our property on the other side of the drain. Without the bridge we would have no way of getting a lawn mower or gardening tools to the other side. Since our bridge has been installed council has never been required to do any mowing or maintenance work at the back of our property.

The bridge is used daily by my family as a safe exit from our property to school & work. My younger children who need to cross Day St can do so safely with a clear view of the very busy street. If the bridge were not there they would have to cross Day St at the corner of Sunset & Day which hides many speeding cars.

As our rates assessment is made on our entire block it would be wrong for council

remove our access to the back of our property.

I would ask you Sir, to take all of the above points into consideration before action on the recommendations of the study and management plan.

Yours faithfully
Mrs E. Loadsman
66 Bourbon St
Wyoming 2250

THE FOLLOWING DOCUMENT HAS BEEN SCANNED AT THE BEST POSSIBLE RESOLUTION.

ORIGINAL PRINT QUALITY IS POOR.

52A Bourbon Street,
Wyoming, 2250.
May 2nd, 1991.

City Manager,
Gosford City Council,
Mann Street,
GOSFORD.

Ed Mialuk

COUNCIL DEPT 02
02·05·91
07.MAY1991 093127
920·25·01
Flood Plain Management Plans
ABRAMS R INFO I

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Submission on Preliminary Flood Plain Management Plans:
Wyoming Creek

With regard to the Bourbon and Day Streets channel area, I note in the draft report one option is to remove the skateboard gate. This gate serves two purposes:

a) safety - should someone (more likely a child) get swept into the channnel during a storm. There have been well-publicised instances of this happening in Sydney in very recent times.

FLOOD STDY CMMTS WYOMING CRK

b) privacy. Some of the local children regard the lined channel as the neighbourhood skateboard ramp / velodrome. The gate does provide some measure of discouragement from trespass through the four properties upstream of the gate. The sign erected by the Council at the downstream end of the lined channel was of no practical deterrent value whatever.

I ask you to keep both aspects in mind while coming to a decision.

Yours faithfully,

(Ms R ABRAMS)

SUBMISSION NO. 3

(4)5

COPY

30 April 1991

Mr K Dedden
City Manager
Gosford City Council
P O Box 21
GOSFORD NSW 2250

Dear Sir,

WYOMING CREEK ACTION GROUP

Following the release of Document No. 3 Management Plan for Wyoming Creek prepared for Gosford City Council by Kinhill Engineers Pty. Limited, February 1991, the Wyoming Creek Action Committee was formed and we now attach submission indicating landowners' remarks, reservations and recommendations in the proposed submission for Council's attention.

The Committee can be contacted as follows:

C/- Mr Glen Watts
11 Glencoe Avenue
Wyoming NSW 2250

Phone: (02) 630 5311 (business)
(043) 28 5469 (after hours)

Please acknowledge receipt of this submission.

Yours faithfully,

per:

WYOMING CREEK ACTION COMMITTEE

cc: Mr P Wilson
Director of Works

SUBMISSION NO. 4

5.6 FLOOD MANAGEMENT PLAN - WYOMING CREEK

5.6.2 Renwick Street and Glencoe Avenue Floodway and Channel Improvement Area

The Committee:

- agrees with recommendation of second option and subsequent conditions noted on page 34
- requires more detailed information on construction methods and extent of works as this could lead to the resumption of small parcels of affected land
- requires information in regard to reimbursement for any said resumption
- requires detailed information on the localised effect west of the Main Northern Railway Line due to the increased capacity of the Pacific Highway culvert
- fencing for this particular section of waterway is critical due to presence of children i.e. as has been supplied by Council in the Day Street reconstruction
- landowners preference is to maintain the natural aesthetics of the area in reconstruction of this section of waterway.

5.6.3 Alan Davidson Floodway and Dissipator Area

The Committee makes the following points:

- agrees with the final option of a grassed waterway with concrete low flow channel incorporating localised gabion, sandstone or concrete retaining walls at the affected sections and a gabion energy dissipation structure at the discharge point of the concrete channel
- requests details of the proposed counter weir on figure 5.6 sheet 1 of 2 due to concern regarding water retention in weir and the safety of small children
- landowners express concern over the unknown timing of works in relation to erosion control within this area and also request confirmation that the above works be completed once instigated.

...../2

5.6.4 Bourbon and Day Street Floodway and Channel

The Committee makes the following points:

- agrees with the recommendation, however disagrees with the conditions regarding access bridges and service crossings
- as Council originally built and erected all access bridges, Council is requested to take necessary action to eliminate the separation of these bridges from foundations
- all relevant landowners are adamant that individual bridges are required in their existing positions and that as recommended, two lots sharing a single access, will definitely not be acceptable
- all new or relocated access bridges should have allowance made for any necessary service to transverse waterway i.e. power and water
- landowners recommend that Council consider a secondary flow path under Day Street at approximately 45 degrees to existing culvert, thus straightening path of waterway.

5.6.5 Day Street and Chamberlain Road Floodway and Channel Improvement Area

The Committee agrees with recommendation and conditions.

5.6.6 Chamberlain Road Floodway and Channel Improvement Area

The Committee agrees with the recommendation and raises the issue that Council should do remedial works in regard to erosion on both northern and southern banks and the surrounding affected areas adjacent to existing low level crossings.

...../3

5.6.7 Giselle Avenue and Channel Improvement Area

The Committee makes the following points:

- agrees with the recommendations with the following conditions:

  (i) close consultation with affected landowners is critical

  (ii) new twin cell RCBC (3.6 x 1.5) should be located in a position that will not adversely affect the natural course of waterway and create future problems to landowners

  (iii) landowners require future information on land acquisition required to carry out recommendations

  (iv) landowners of property at corner of Chamberlain Road and Giselle Avenue require Council to supply access (walkway) across waterway. Fencing for this particular section of waterway is critical due to presence of children i.e. as has been supplied by Council in the Day Street reconstruction

  (v) landowners preference is to maintain the natural aesthetics of the area in reconstruction of this section of waterway

  (vi) any new or relocated access bridges should have allowance be made for any necessary service to transverse waterway i.e. power and water

GENERAL POINTS

The Committee makes the following points:

- the lack of annual and post-flood maintenance for the Wyoming Creek waterway has created concern and needs to be addressed for the proposed upgrading

- the future re-zoning of upstream areas in relation to future housing development needs to be addressed as this will undoubtedly affect the effectiveness of the proposed upgrading.

1.

Ed Mialuk

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920·28·01

12 Kahibah Rd.
Umina
2257

1 May 91.

Re ; Draft Preliminary Floodplain Management Study for Wyoming, Wingello and Bradys Gully Creek System.

Having viewed the documents available at council I am compelled to respond in the negative to the bulk of the recomendations.
Particularly the use of concrete linings in preference to rehabilitation of the creeks to a more 'natural' condition.

In part 3 Wingello Creek. 6.6.3. contemplates concrete lining in a rainforest reserve. This is environmentally and aestheticly unacceptable, the durability, performance and ease of maintainance of concrete is not relevant to considerations of the treatment of our creek systems and goes against the recomendations of the State Polution Control Commission.

The principles espoused in the concept of Total Catchment Management should be applied and no further flood'transference' (concrete) devices constructed in Gosford City.

Concrete lining of creeks flies in the face of public attitudes accepted universally and recognised by governments at all levels ie. N.S.W. Governments recent Coast Policy.

In concluding this submission I also regester my opposition to the use of Kinhill Engineering given the recent publicity this company has recieved it would appear Kinhill is unable to give objective advice.
If Kinhill is merely responding to councils brief i believe that the terms of reference issued by Council should be published and available for the public to make comment on.

Yours Sincerly

FLOOD STDY CMMT-WINGL/WYOM/BRD

Bryan Ellis.

Arrived late
No reply sent.
LMcS/C

SUBMISSION NO. 5

WINGELLO

Ed Mieluk

CREEK

FLOOD STDY-CMMTS DRAFT REPORT

MANAGEMENT

PLAN

DRAFT REPORT

NCKC

CONTACTS Doug FORD 136 Showground Road
Narara 23-2456

Garrie WATT 9 Adnamira Close
Wyoming 29-1075

SUBMISSION NO. 6

WINGELLO CREEK MANAGEMENT PLAN - DRAFT REPORT

GENERAL

THE INTENDED MITIGATION WORKS,AS DESCRIBED IN THE MANAGEMENT PLAN,GENERALLY MEET WITH THE APPROVAL OF RESIDENTS IN THE AFFECTED AREA.HOWEVER,CONCERN HAS BEEN EXPRESSED ON SEVERAL ISSUES RELATED TO THESE WORKS.THESE ISSUES ARE:

SILTATION of lower reaches,during both the construction and bank-stabilisation phases

APPEARANCE of the completed works in the Rainforest Reserve lining area from Jarrett Street to Roselands Avenue

DAMAGE to the Rainforest Reserve during construction

PRIORITY of the works along this creek and others in the Wyoming District

PROJECTED starting date of the works.This is particularly important for the following reasons.

1.Ongoing damage to property by bank erosion
2.Flooding of properties
3.Flooding of habital spaces,garages & workshops
4.On going siltation of lower reaches of creek
5.Predicted increases in water flow due to up stream development
6.Personal stress and hardship

REPTILE PARK REACH

The two recommended solutions - lowering the wier and removing the fences and bridges - are fully supported by residents upstream.These works should be commenced immediately,prior to otherworks upstream.Residents upstreamof Jarrett Street will benefit immediately,without the risk of increased flooding from flow-improvements upstream.The works here should be commenced immediately.

JARRETT STREET TO RAINFOREST RESERVE LINING AREA

The primary alleviation option - straightening and concrete-lining this section - is considered by residents to be effective,but must be performed with the following provisos:

1. All works must be performed with an absolute minimum of damage to the rainforest vegetation.
2. Areas where damage is unavoidabledue to reallignment of the creek,must be replanted with the same species
3. Before commencement of the works the residents are to be advised of the width of the concrete lining.
4. Will the Council be responsible for clearing the waterway in the dry season of any obstructions such as logs, trolleys etc

The 450mm sewerage pipe must be either raised,or buried under the concrete canal lining unless the creek bed is significantly lowered by the lining works.The current clearance between the pipe and the creek bed in inadequate.

PROPERTY RIGHTS AND PURCHASES

Recompense for loss of land - will the residents be compensated for any of their land acquired by the council for the construction of the concrete lining.

Replacement of any damaged fences etc. - who will pay for the replacement of any fences,gates etc. damaged during the construction of the concrete lining.

Replacement of trees,schrubs etc. removed during construction - will they be replaced with species of the same size and value.

ROSELAND AVENUE TO WARRAWILLA ROAD GRASSED WATERWAY

The grassed waterway with concrete low-flow channel is fully supported by residents.However,it is vital that the works conclude with the improvements to the appearance of the area.Selected areas must be replanted with native species,spaced from the creek to avoid later creek obstruction from fsllen limbs.All works must be finished in a manner which leaves no exposed soil or debris.Siltation must be minimal during all phases of construction.The possibility of the grassed area being undermined when the water level rises above the height of the concrete low-flow channel must be fully investigated prior to commencement of the works.

The recommendations in the Management Plan for the PECAN CLOSE DETENTION BASIN,BLACKBUTT STREET PUBLIC RESERVE TRIBUTARY 1: MAIDENS BRUSH RESERVE and TRIBUTARY 2: RAIN FOREST ROAD appear to be suitable.

SECONDARY CREEK AT PEMMEL CREEK

What happens to secondary creek at Pemmel Street when roundabout is installed at Henry Parry Drive ?.Will roundabout works affect this creek ?.Will the creek be cleaned and/or modified.

TRIBUTARY AT FUSCHIA/ROSELANDS - Has it been piped ?.Not shown on map.

Whilst the residents appreciate that the proposed works may not be commenced for some time in the future due to the availability of funds and the priority of other works to be completed by the Council there are a couple of alternative suggestions that the Council might consider to alleviate the problem faced by some residents in times of prolonged periods of rain.

These are, 1. Removing the existing dog leg in the creek between Nos 5 & 7 Adnamira Close so as to allow a straighter passage for the water to flow.

This dog leg IS NOT SHOWN on the plan,however a site inspection by Council officers would show this to be a problem area.

2. A committment by Council to cleaning the creek at least twice per year of any debris likely to block the free flow of water in times of prolonged periods of rain.

It has been suggested by some residents that the concrete lining will upset the current abundance of Flora and Fauna within the creek.As an alternative perhaps the Council might consider lining the sides of the creek with large concrete or stone blocks suitable reinforced and leaving the creek bed in its natural state.

We trust the foregoing will assist the Council in its decision and should any further information be required please contact Mr.Doug FORD on 23-2456 or Mr.Garrie WATT on 29-1075

02 Ed Mialuk

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RAVI B I

B & J Ravi
13 Dogwood Close
Wyoming
NSW 2250

6 May 1991

FLOOD STDY SUBMISSN·BRADYS GLY

Officer-in-Charge
Engineering Section
Gosford City Council
GOSFORD 2250

RE : Flood Management Plan & Proposed Works
BRADYS GULLY CREEK

Dear Sir/Madam

We would like to submit this letter as a response to the plans that were displayed by council recently.

Our property is 287 Henry Parry Drive and is the last property before the water course runs under H.P.Drive. The section that concerns us is the "Cary Street Reach" of the water course.

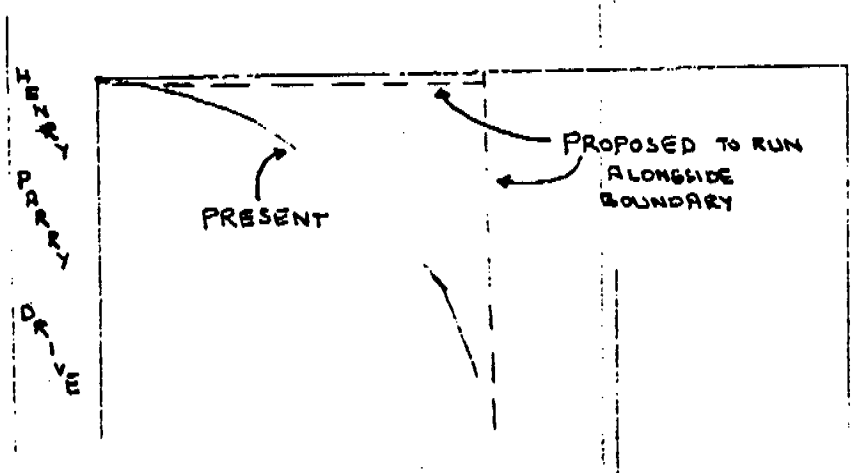
1. The extra cell to be added to on to the Henry Parry Drive Culvert; Will this be before or after the bridge on H.P.Drive?

2. Our property is dissected in two by the water course. Access to the property beyond the water course via a bridge which accomodates both pedestrian and vehicular traffic would be paramount in our minds.

3. The report mentions that at least 2 houses are presently affected by the water course. Would completion of the works mean that the houses would no longer be affected?

4. Lining of the water course from Cary Street to H.P.Drive would involve
   a. What time frame and when
   b. What kind of access by Council through properties

5. The water course runs at an angle through our property. Would it be possible to straighten it during the course of the works?



SUBMISSION NO. 7

6. Does Council have a specific date as to the commencement and completion of the works?

We are looking forward to the works that will be undertaken by the Council to alleviate "flooding problems"

Living in hope

Yours faithfully

6/5/91

B & J Ravi

N.C.R.C.

NARARA CREEK RESTORATION COMMITTEE

C/- 134 Showground Road

NARARA 2250

Ed Mielcik

30th April 1991

FLOOD WKS NARARA-PRECEDE WYNGE

The City Manager
Mr Keith Dedden

Dear Sir
The N.C.R.C. supports the recommendations put forward by the Wyoming resident-action groups on the Wyoming, Wingello and Bradys' Gully Flood Management Studies.

The N.C.R.C. must, however, insist that the works planned for these creeks be performed AFTER the aquisitions and flood-mitigation works intended for the Lower Narara Creek are implemented. These works must take priority for two reasons:

1/- The works on the tributaries will inherently increase their ability to rapidly discharge water into the Narara Creek. This will result in higher flood peaks in Narara Creek, and more frequent lower-level flooding during short-duration rainfalls.

2/- The works on the tributaries will inevitably cause disturbance to the creek banks and topsoil; the resulting silt will just as inevitably find its way into the Narara Creek system due to the increased drainage efficiency of these tributaries.

As always, we are prepared to discuss aspects of our submission with the relevant Council officers.

Yours sincerely,

Chris Holstein

GOSFORD DISTRICT ENVIRONMENT FOUNDATION

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GOSFORD ENVIRONMENT I
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• Copy 920.26
• Copy 920.28

Tel.: 60.1024

230 Scenic Road,
KILLCARE HEIGHTS, 2257.

24 April, 1991.

The City Manager,
GOSFORD CITY COUNCIL.

FLOOD STDY WYOMNG/WINGLLO/BRAD

Dear Sir:

DRAFT PRELIMINARY FLOODPLAIN MANAGEMENT STUDY AND MANAGEMENT PLAN FOR WYOMING, WINGELLOW AND BRADYS GULLY CREEKS SYSTEMS.

Our perusals of the papers and the pictorial material made available for inspection, left us with the impression that stormwater could be delivered more rapidly down the drainage lines than at present if the works proposed by the consultants were implemented. Assuming that the consultants subjected their proposals to test models, we have to accept as stated in the papers, that flooding or threat of flooding in the named creek systems would either not occur or be of minor significance.

It seems to the Foundation however, that the problems to be resolved by a Management Plan for the named creek systems, misses the real issue and must therefore, be ancillary to and integrated with, a Master Plan for the whole Narara Creek Valley and the catchment thereof. The assumption must be that the consultants were not provided with parameters appropriate to producing a comprehensive study or with the opportunity to link up with previous studies known to have been produced.

The Foundation expects there will be at least two consequences of that position:

> firstly, during storm events large volumes of water will be rapidly delivered to the point of tidal limit, and depending upon the height of the tide and allied matters associated with a particular storm event, cause back-up of flood waters on the lower flood plain of Narara Creek; and
>
> secondly, further denigrate the environmental sensitivity of the Wyoming, Wingellow and Bradys Gully Valleys by replace ment of the remnant of the *Systems* with concrete (or whatever) drains, and the removal of the meandering features and vegetation along the creeks.

The most notable feature of the comment in the reports exhibited was the lack of reference to *Total Catchment Management*, to no comment on measures to deal with the nutrient factor in Urban Runoff [see the *Pollution Control Manual for Urban Stormwater (SPCC)*] and to very limited comment on decelerating ponds and silt traps.

By way of contrast, the papers give the impression that the *sine qua non* of the exercise is to pack more people on to the catchment of the Narara Creek Valley. The Foundation believes that Council must accept that planning (or the lack of it) which fails to recognise density of landuse as a cause of flood problems, cannot expect engineering to correct them without affecting the environment. (*Environment* as defined in s.5 of the EPA Act).

[cont'd on p.2.]

Pressure to accommodate more and more people into areas possessing doubtful urban capabilities is producing the massive costs now estimated by Council to correct flooding. This is a charge upon the community as a whole and to the extent that the problem is created by a policy of growth at any cost, grossly immoral. The fact that the growth is sponsored by the State Government does not absolve the Council's participation.

If it is to cost $54m. to construct works and drains, the City could well be better off to use a substantial part of that amount to remove all landuse in flood areas in order to provide drainage reserves and floodways free of structures.

The total catchment of Narara Creek ends up in the Brisbane Water Estuary. The Foundation knows little about the true condition of this waterbody for the simple reason that if detailed studies have been executed, the unpleasant truths have so far escaped publicity. Notwithstanding, it must be evident that if the Hawkesbury River and arms of Broken Bay can be shown to be experiencing algal blooms and the presence of blue-green algae, the bitter truth about Brisbane Water must soon cause administrative embarrassment given the opportunity for public participation.

Summary

The papers presented for public exhibition provide machinery leading to the quicker disposal of water into the main watercourse of Narara Creek and will probably reduce flooding in the *Systems* studied.

The Foundation is brave enough to expect that the final Management Plan for Narara Valley will do much more than that. It should hold landuse on the entire catchment to its present density and indeed, seek ways to reduce that density; it should set imaginative plans to implement controls on flow times and silt transfer; and it should ensure that the waters discharged into the Brisbane Water will not exacerbate eutrophication of that waterway.

If Council succeeds in those endeavours, the future will be the better and the costs to the present generation will be well spent. The landuse philosophy and the technology is available .. the will to implement rests with today.

Yours sincerely,

Allen A. Strom,
SECRETARY.

F2 RESPONSES TO PUBLIC SUBMISSIONS

F.2.1 INTRODUCTION

The following are the responses from Council and the Consultant for each of the submissions. The submissions were received as a result of placing the Wyoming Creek, Wingello Creek and Bradys Gully Creek Floodplain Management Plan on public display.

Submission No.1—R. Hill of 64 Bourbon Street, Wyoming

The residents of the above property are concerned about flooding of their garage. The existing single span concrete bridge is the only vehicular access to the property and is built directly over the concrete channel. The 1% AEP flood profile is expected to be up to the soffit of the bridge.

The proposal would be to raise the existing bridge so that it has a deck level 0.5 m higher than the 1% AEP level. This bridge would be safer and also accessible during extreme rainfall events.

As part of the raising works, ramps would need to be constructed for smooth vehicular movement. The ramps should be kept as far away from the banks as practicable. This work would not be funded with government assistance.

Submission No. 2—Mrs E Loadsman of 66 Bourbon Street, Wyoming

Mrs Loadsman is a resident of the first house downstream of the Day Street culvert. Concern was expressed that the existing footbridge would be removed without any replacement.

During periods of high flow water would overtop the Day Street culvert, and the footbridge at No. 66 Bourbon Street. While the bridge may not have been washed away during the February 90 event, it is still possible that under a 1% AEP event, the bridge could be washed away.

It is proposed within the recommended Management Plans that a bridge with a deck level of 0.5 m higher than the 1% AEP level be constructed. This bridge would be expected to have concrete footings and the chances of failure would be significantly reduced.

The Management Plan also suggested that in order to minimize expenditure, two adjoining lots could share a single footbridge at their common boundary.

It is understood that Council originally constructed some of these bridges and would need to fund replacement of any originally built by Council.

Concern was also expressed that the alignment of the Day Street culvert was the main reason for flooding downstream of the culvert. However, the culvert alignment controls floodlevels upstream of the culvert and not downstream.

Submission No. 3—Ms R Abrams of 62A Bourbon Street, Wyoming

This submission considered that the skateboard gate should be retained in order to maintain privacy and safety.

Removal of the skateboard gate would lower the 1% AEP flood levels upstream of it and would make the upstream land flood free up to the 1% AEP event.

All decisions about flood mitigation measures to be implemented are under the jurisdiction of Council, and the community must weigh up safety and privacy versus flood protection when considering this work.

An alternate option to complete removal of the gate would be to redesign it to be less of a hydraulic restriction.

Submission No. 4—Wyoming Creek Action Committee (WCAC)

The WCAC generally supports the recommendations presented in the Management Plan, however, several issues were raised.

The reimbursement for the resumption of land if any resumption is undertaken, is an issue that needs to be considered by Council. Mitigation works for the areas downstream of the Pacific Highway have been identified under the Lower Narara Creek Floodplain Management Plan. Works in Wyoming Creek that may affect the downstream areas would only commence after the works recommended by the Lower Narara Creek Floodplain Management Plan have been completed.

Safety facilities such as escape stairways in lined drains, fences along banks, removal of unsafe timber crossings and non-obstructive railings for culverts have been discussed in the Management Plan and Floodplain Management Study.

The natural aesthetics of the watercourse would have to be examined at certain reaches of the creek. Maintenance of the natural creek condition has to be evaluated against the provision of an effective drain and determining the most appropriate works option. The final decision would also take into consideration the desires of the residents along the watercourse.

The problems of erosion had been identified in the Management Plan. Services crossings would be acceptable as long as their impact on the flow conditions are minimal. Otherwise, specially designed crossings may be needed.

The Day Street culvert alignment and the replacement of the existing crossings had been discussed in the preceeding response to Submission Number 2.

The future rezoning of the upstream areas and the maintenance of the waterways would be appropriately controlled and managed by Council.

Submission No. 5—Mr B Ellis of 12 Kahibah road, Umina

Mr Ellis is concerned about the environmental impact of the recommended drainage works on the rainforest reserve.

It is acknowledged that concrete lining in a rainforest reserve is aesthetically not pleasing. Other suitable materials such as grassed waterway or a stone lined channel would require a wider creek and a greater number of trees to be removed.

The final decision on what measures are to be taken would be influenced by the desires of local residents who would be endangered by flood and is being addressed by Council since the public display of the Draft Floodplan Management plans.

Submission No. 6—Mr D Ford and Mr G Watt of 136 Showground Road and 9 Adnamira Close, Wyoming respectively

The submission generally supported the recommendations discussed in the Wingello Creek Management Plan. However several questions were raised and the responses are described below.

Flood mitigation works funding is subject to approval by the State Government and the availability of Council finance. Once finance is available Council would construct a suitable timetable of works. An overall priority of works is shown in the Floodplain Management Study.

All construction work would be undertaken with the necessary erosion control measures in place, and the utmost care would be taken to ensure, within the limits of practicality, that damage to the surrounding environment would be minimal.

Any fences and trees that are within the floodway area and affect the hydraulic efficiency of the floodway would be removed. Fences not within this category would be reinstated should they be damaged. Vegetation that is damaged would be replanted with the same species.

Should the existing creek be realigned and concrete lined, some localised land take would be required. It is unlikely residents would be financially compensated due to the added protection against floods.

The submission also identified the undesirable obstruction created by the exposed 450 mm diameter sewer pipe in the creek near Halcyon Street. The analysis undertaken in this study indicated that the obstruction due to the pipe itself is tolerable if the creek is fully concrete lined. However, if significant amounts of forest debris and fallen trees were to occur, then the houses upstream of it could be flooded during periods of heavy rain. Regular cleaning of the creek is required.

Concern was expressed about the stability of the proposed grassed waterway with a concrete low flow channel under high flow conditions. High flows occur infrequently and once the grass on the gentle batters is fully established, it would be able to resist erosion. In addition, the concrete low flow channel would prevent scouring of the base of the batters under normal flow conditions. Care would need to be exercised in the design to ensure that grass adjoining the low flow channel does appropriately stablise.

The Pemmel Creek, which is a very minor watercourse, mentioned in the submission was not included in the scope of this study. The Fushia Street tributary was also not included.

The existing 'dog-leg' in the creek between No's 5 and 7 Adnamira Close would disappear once the creek is re-aligned and straightened.

The suggestion of using large concrete blocks or stone blocks to line the sides of the creek, while leaving the bed in its natural, state is recognized as a possible alternative and will be assessed for suitability prior to detail design.

However the concrete or stone blocks would need to be appropriately interlocked to prevent undermining. It should be noted that this suggestion would not achieve the hydraulic performance achieved by the full lining option.

The submission raises the question of providing regular creek clearing and maintenance in an effort to reduce obstructions and erosion. A regular maintenance program is presently carried out by Council in the Gosford area.

Submission No. 7—B&J Ravi of 13 Dogwood Close, Wyoming

The submission from B&J Ravi raises a few points for the Cary Street to Henry Parry Drive Reach.

The extra cell to be added to Henry Parry Drive culvert will be alongside the existing cells under Henry Parry Drive.

The proposed works would reduce flood levels so as to make 287 and 285 Henry Parry Drive flood free up to the 1% AEP event.

All flood mitigation works funding is subject to approval by the New South Wales State Government and the availability of Council finance. Work can commence once this funding is available. It would be anticipated that lining the watercourse from Cary Street to Harry Parry Drive would take several months to complete. The duration is subject to variations because of uncertainties such as weather conditions. Access for the works would have to be maintained at the time of construction. Council would consult the views of affected residents as regards to such access.

The submission also proposed that the creek be realigned alongside the lot boundary thus forming a 90° turn at the lot corner. This is highly undesirable. The alignment of the proposed lining would follow the present water course alignment.

Submission No. 8—Narara Creek Restoration Committee

The Floodplain Management plans for Wyoming, Wingello and Bradys Gully Creeks recommend that works that would affect Narara Creek should only commence after mitigation works within Narara Creek, identified under the Lower Narara Creek Floodplain Management Plan, are in place.

Furthermore all completed mitigation measures within the tributaries would minimize sediment transport into Narara Creek. A significant portion of the recommended mitigation works includes bank stabilization and other forms of erosion control measures. All construction works would only be commenced after suitable temporary erosion control measures are in place.

Submission No. 9—Gosford District Environment Foundation (GDEF)

The GDEF in their submission made the following points:

- there would be a quicker disposal of stormwater from the studied creek systems into the main watercourse of Narara Creek;
- the stormwater from the studied creek systems would cause backing up of water onto the lower floodplain of Narara Creek;
- the removal of meandering features and lining of natural creeks should not proceed;
- the lack of reference to 'Total Catchment Management' philosophy and probable exacerbation of eutrophication of the waterbody;
- the flood problem, as a result of intense land use on the floodplain, should not be solved by engineering methods as such methods are usually not compatible with natural environment;
- the cost for mitigation works should instead be utilized for removal of all properties and structures that are within the drainage reserves and floodways;
- the water quality in the Brisbane Water Estuary.

The first two points had been appropriately considered in the management study for both the Lower Narara Creek Floodplain Management Study and this study. All works that may affect Narara Creek would not commence until the mitigation works identified for Narara Creek are in place. The mitigation works for Narara Creek had been appropriately designed to accommodate the future developed runoffs from the studied creek systems.

The remaining points are issues that need to be considered under a total catchment management concept. The scope of this study is however limited to hydrologic and hydraulic investigation for the three creek systems.

The GEDF's proposal of complete removal of all properties and structure within floodway would be difficult to implement and is not considered practical.

Appendix G

REFERENCES

Appendix G
REFERENCES

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End of Report