

EWY CREEK MANAGEMENT PLAN

prepared for

Sutherland Shire Council

by

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ACKNOWLEDGEMENTS

The Study Team gratefully acknowledges the role and contribution of all those persons and authorities who provided assistance in compiling this Management Plan.

In particular, the team wish to thank the Council Staff from the Environmental Services Department and Technical Services, especially David Lake, Mike Rogers, Des Hewitt, Raymond Wong and Rod Logan, and attendees at the two Community Liaison Meetings including Jean Baluk, Yvette Graf, Janet Grey, Brian Guthrie, Steve Edge, Trevor McDonald, Connie McPherson, Ian Tetley, Col Wilconson, Victor Wilmott and Mark Wilson.

Other organisations, statutory bodies and government departments who also assisted include staff and officers of the Roads and Traffic Authority, City Rail, The Water Board, Greening Australia, The Department of Water Resources, Department of Sport and Recreation, NSW Public Works Department, Scout Association.

EXECUTIVE SUMMARY

Urban Context

Ewey Creek is a waterway that is typical of the many urbanized sub-catchments which feed into Port Hacking on metropolitan Sydney's southern boundary.

The Creek lies near the centre of Sutherland Shire. It is less than 2km long and drains an area of approximately 167 hectares, extending from around Gympie railway station in the west, through Miranda, to Yowie Bay.

Landuse within the catchment has intensified over recent years, and in view of the increasing density of residential and commercial activity planned, both Council and the community agree that the creek's remnant natural characteristics deserve recognition and careful management.

Management Objectives, Problems and Issues

The creek's appearance and natural systems indicators have led to concern about further impact from development, and a desire to rehabilitate the waterway in line with the objectives set for this study:

- To transform a degraded creek system into a valuable passive open space corridor
- To control drainage with a view to minimizing erosion and flooding risks
- To retain the natural appearance of the creek as far as is practical
- To protect the viability of the creek as a natural system for vegetation and wildlife conservation
- To control water pollution and upgrade the aquatic environment to meet EPA standards.

To address these objectives the study has involved

- Analysis by the Study Team and Council Officers of the area's resources, as well as the anticipated effects of impacts on the creek catchment
- Liaison with representatives of the local community in determining issues in the creek that are of concern, and the options available to deal with them
- Investigation of Authorities' interests, standards, State guidelines and sources of assistance available in relation to Council's management responsibility

Management Plan Proposals

As a result of these considerations a *Concept Plan* for Ewey Creek is proposed and a range of *Strategies* for its orderly, long term implementation are suggested.

The Concept Plan is centred on re-establishing the creek as a viable natural system and valued component of its urban setting. It seeks to rehabilitate the vegetation cover, primarily with littoral rainforest species, integrated with water quality control measures, and low key passive recreation developments in existing open space reserves. Elements of the Plan include:

- Two gross pollutant traps recommended for construction at Klah Place and the Old Quarry site north of President Avenue, with the addition of artificial wetlands to augment the effects of the traps in improving water quality.
- The establishment of a linked system of open space and landscape upgrading along the creek in a corridor of minimum 20 metres width is considered desirable, but will only be achieved as redevelopment occurs and dedication of the necessary land is effected in the long term.
- Similar incremental improvements to creek bank profiles, and the design of walls and pathways within the corridor are proposed, both to alleviate the effects of flooding and to create a more natural character along the waterway.
- An important component of the Plan is the concerted promotion of the Strategies by Council, and an education and awareness programme being mounted within the wider community. People's lifestyles and activities directly effect water quality and urban bushland, and this responsibility must be understood and acknowledged in order to improve the creek environment.

The Strategies for creek management and rehabilitation fall into three categories, and some key elements of each are:

- *Water, Conservation and Open Space Management*
 - improvement to water quality in Ewey Creek by installing water management devices and reducing degrading factors within its catchment
 - use of local stone in erosion control measures
 - pipe sections of the creek in narrow reaches
 - extend street sweeping programme
 - engage in bush regeneration and weed eradication programmes
- *Landscape Character and Visual Appreciation*
 - enhance character and access to existing open space reserves
 - encourage views into creek corridor from surrounding high land
 - undertake a tree planting programme to emphasise the creek location
 - better identify park entrances and improve appearance
 - ensure security and safety in new park extensions

- *Landuse, Access and Recreation*

- adopt draft Development Control Plans (DCP's) for the creek environs with amendments arising from this Plan
- extend the open space corridor by dedications from related development sites
- increase recreational range consistent with passive character of the corridor
- facilitate access for better waterway management and pedestrian convenience
- encourage disabled user and pram access to open space system

Implementation

The realization of the proposed Concept Plan will depend on the continued application of good detail design, as well as major initiatives in creek rehabilitation.

A range of typical construction details, suitable materials and plant species are provided to assist this ongoing process.

The capital cost involved in developing aspects of the plan may be substantial in relation to Council's overall budget responsibilities. The Kiah Place GPT, for example, is estimated at \$340,000, while park enhancement and bush regeneration of the Old Quarry site is estimated at \$370,000. Other examples of project costs are included to assist Council in determining the relative value in its works programme for the Shire.

It is stressed, however, that capital costs are not the only aspects that should be considered in evaluating the creeks rehabilitation. Public health benefits, improved safety and recreational values are some of the less tangible, or more far reaching factors that must also be weighed in determining the implementation stage.

To assist with the programming of the Management Plan, two levels of priority are identified for the bulk of the strategies, with a further indication of the ease of implementation for each. The GPT at Kiah Place, for example, is both high priority and considered suitable for short term implementation. Other initiatives, such as land dedication and some detailed DCP's for the catchment, are indicated as long term elements on the Plan.

A schedule of possible sources of additional funds is provided as an aid to Council's budgeting and implementation programme.

1 INTRODUCTION

1.1 BACKGROUND

Sutherland Shire has developed into an area of marked contrasts, containing as it does substantial tracts of generally undisturbed bushland and dramatic estuarine creeks, yet having at its populated heart a highly urbanised infrastructure that has, in places, all but obscured the evidence of its rich original natural landscape.

Ewey Creek lying almost at the geographical centre of the Shire (see figures 1 and 2) provides the very evidence of the latter stages of the impacts of that process of urbanisation, displaying many of the signs that hint at an advanced stage of natural systems degradation.

The principal evidence of these impacts may be seen in:

Water quality: Poor water quality due to minimal pollution and siltation control within the catchment.

Tree canopy changes: Loss of native species in the canopy and lack of canopy continuity, owing to growth of weed species trees.

Bank erosion: Undercutting due to uncontrolled stormwater at peak flows.

Construction features: Visually disruptive elements within the creek, mostly evident from inappropriate construction design for stormwater features.

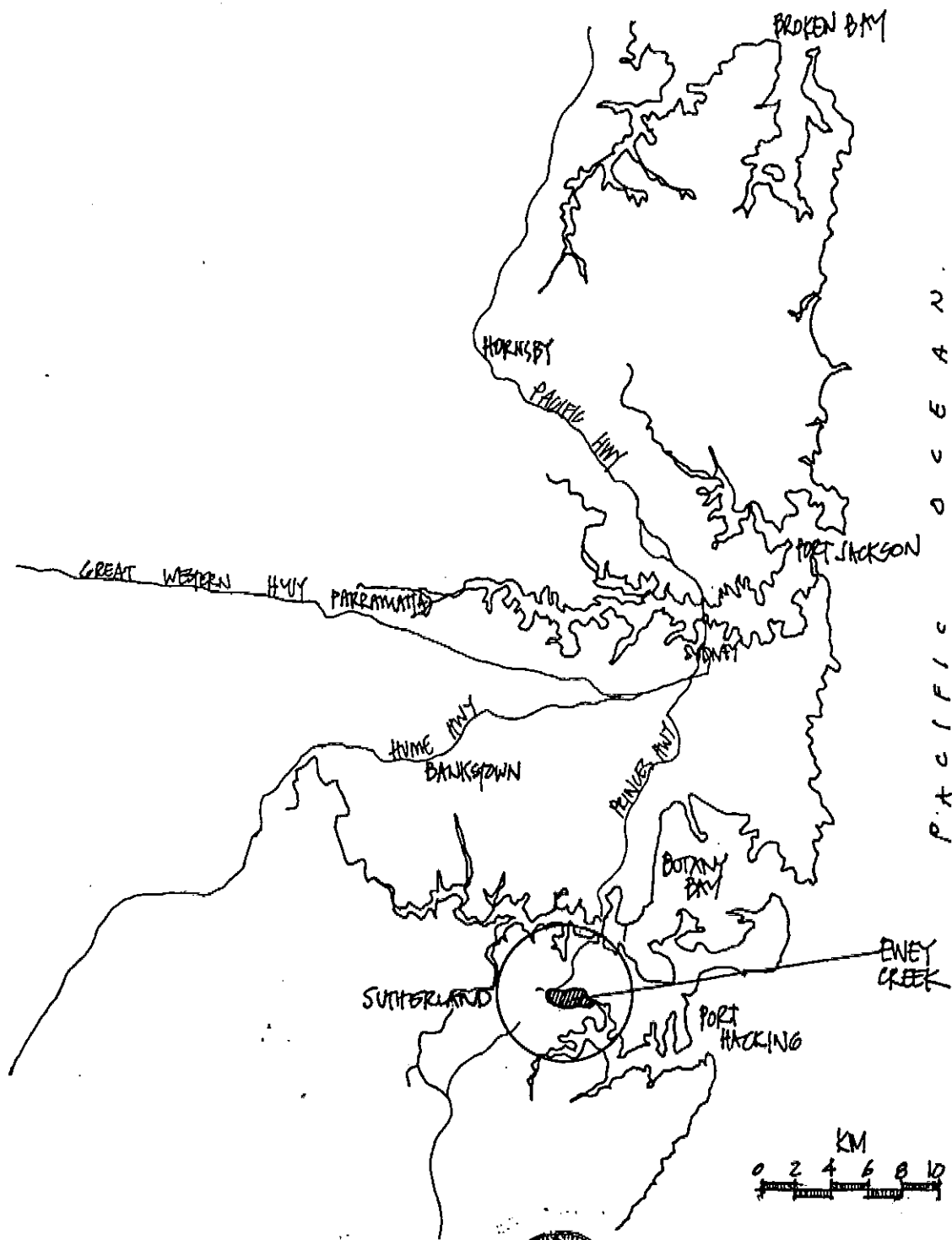
Weed invasion: Substantial loss of native shrub and field layer owing to the invasion of exotic weed species and lack of adequate and appropriate maintenance.

Dumping: Depositing of garden and other waste within the public land.

Recreation: Limited access and opportunity due to unstructured nature of the open space components of Ewey Creek.

Yet despite these continued threats the creek corridor retains many attractive natural features that suggest that the process of revival is by no means beyond the realm of practical and affordable strategies.

Underlying the many threats that face Ewey Creek are the three key impacts of urbanisation that are common to many of the built landscapes in Sutherland and indeed throughout metropolitan Sydney; strategies that appropriately address *water management, vegetation management and community involvement* in the care and control of Ewey Creek will ultimately lead to a revival of the Creek to a healthy and attractive resource that can once more be a source of pride and enjoyment for the local community.



EWHEY CREEK MANAGEMENT PLAN

Figure 1

REGIONAL CONTEXT

1.2 THE NEED FOR A MANAGEMENT PLAN

Both the Council and the local community have been aware for some time of the impacts and threats to Ewey Creek and have adopted specific initiatives from time to time to attempt to address such issues.

Nonetheless, the inter-related and often complex nature of many of the threats to the health of the Creek require a co-ordinated approach to the assessment of the source of those impacts (and their consequences) and provide coherent strategies to reverse or halt the negative processes.

A Management Plan is the appropriate mechanism for such an approach, bringing together the substantial body of information that exists on the creek's natural systems and water management, assessing the inter-relationship of contributing impacts and recreation opportunities, evaluating community attitudes and setting out clear cut strategies with priorities for action and their implicit costs.

The completed Management Plan then provides a practical working tool for future planning within the catchment, guidelines for community involvement and the approaches to be adopted in developing detailed designs for recommended projects within the Creek.

In undertaking this Study and preparing the Plan, the specific objectives set by Council have been important considerations. The five objectives summarised in the brief require that an overall concept and management strategies be proposed:

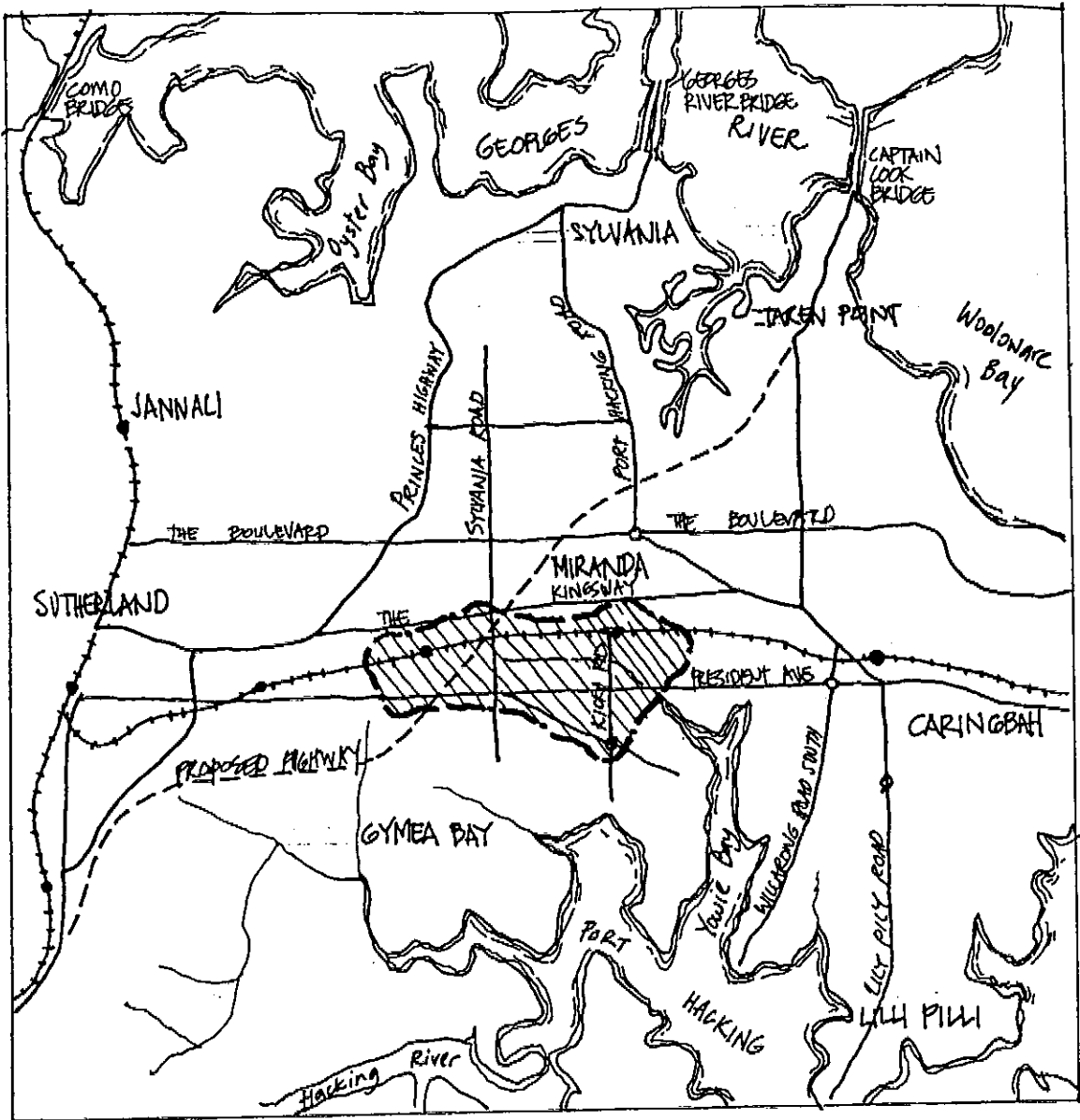
- to transform a degraded creek system into a valuable passive open space corridor
- to control drainage with a view to minimising erosion and flooding risks
- to retain the natural appearance of the creek as far as is practical
- to protect the viability of the creek as a natural system for vegetation and wildlife conservation
- to control water pollution and upgrade the aquatic environment to meet EPA standards

1.3 THE PLANNING CONTEXT

The existing Miranda Centre Draft Development Control Plan (DCP) which contains the Ewey Creek corridor permits and encourages the development of medium density housing on the properties adjoining and surrounding Ewey Creek. Council is thus currently considering a number of applications for medium density development adjoining the Creek corridor.

With the expected residential intensification of the area, there must inevitably be further pressure placed on Ewey Creek, both in terms of its availability for public enjoyment and in relation to the impacts on the Creek's natural systems.

Council have prepared two Draft Development Plans (numbers 15 and 22) for precincts within the draft Miranda DCP with plans for further precincts that adjoin Ewey Creek.



EWEY CREEK MANAGEMENT PLAN

Figure 2

LOCAL CONTEXT

Whilst the DCPs for these precincts (and the development consents that result) must necessarily be compatible with the aims and strategies developed for this Management Plan, it is intended that the Ewey Creek corridor be considered a separate Management Area (No. 4); the purpose of this Management Plan being to inform the decision making process for that discrete Management Area.

14 METHODOLOGY AND FORMAT OF THE PLAN

The following brief summary sets out the approach and methodology adopted to achieve the objectives of the Plan and sets out the chosen format. This involved four key stages as follows.

1.4.1 DATA COLLECTION AND SURVEY

This involved the consultant team in site specific document research on flora and fauna data, water quality and maintenance practices. The information was supported by field checks, (including visual character appraisal) and discussion with Council officers, the RTA and the SRA. Council also provided base information such as survey plans and undertook hydraulic modelling of the Creek to determine flood levels. It should be noted that Council was denied access onto the property of No. 2 Gosby Avenue. Survey work and consequently flood data information could not, therefore, be determined for this property.

1.4.2 COMMUNITY LIAISON AND ISSUES ANALYSIS

Following Council's evaluation of responses to a pre-study questionnaire of residents whose properties adjoin Ewey Creek, the consultant team co-ordinated two meetings with representative landowners/residents; the first meeting was spent in detailed discussions of matters of concern to the residents and the follow up meeting was used to discuss draft strategies compiled by the consultant team in response to those concerns in concert with the findings of the detailed evaluation and analysis of the issues that affect the creek corridor.

1.4.3 CONCEPT PLAN OPTION AND STRATEGY DEVELOPMENT

In analysing the numerous issues that affect the Creek and after evaluation of Council objectives and community concerns, the team considered a number of options before identifying a broad co-ordinated concept for the entire creek corridor.

Following on from the preferred option the team has then defined a series of detailed strategies that address the key issues, providing clear guidelines for the future design, implementation and management of specific projects. The strategies are provided in both a written and drawn form.

1.4.4 PRIORITIES AND COSTS

In tandem with the assessment of various options and the subsequent development of preferred options and detailed strategies, the team has assessed the cost benefit of all practical alternatives.

In arriving at final strategies the Plan sets out not only the anticipated costs but identifies priorities for staging the works. Appended to the priorities is an assessment of "achievability" of given projects, by which Council may assess the relative ease with which a strategy may be implemented (e.g. without need to acquire land etc) to a clear cost benefit.

Finally, the Plan provides details of suitable funding sources for various projects from State and Federal agencies.

2 ISSUES ANALYSIS

This section describes the Aims, Issues and Principles relating to areas of specific detailed study.

Each study is presented in a consistent format as follows:

- A statement of the Aims
- A summary of the major Issues for quick reference
- A fuller discussion of each topic with background and references to the Issues as well as options considered where appropriate.
- A statement of the principles for use in the plan.

The detailed studies are as follows:

- 2.1 Urban Context, landuse and ownership
- 2.2 Use and Access
- 2.3 Water Management
- 2.4 Landscape character
- 2.5 Conservation and Management of Native Vegetation
- 2.6 Recreation
- 2.7 Open Space Management

Refer to Figure 3 for a summary of the Analysis.

2.1 URBAN CONTEXT, LANDUSE AND OWNERSHIP

AIMS

To increase and optimise public ownership and enjoyment of land adjacent to Ewey Creek to an extent that is compatible with community expectations and in a manner that can absorb and adapt to change in demands from adjoining development.

ISSUES SUMMARY

Existing ownership of land adjacent to Ewey Creek is predominantly private limiting the potential for establishing larger areas of public open space to those occasions when sites are redeveloped.

The locality is undergoing considerable change with the emergence of the Miranda Centre as a major retail outlet. This has been facilitated by zonings which also aim to increase housing densities in the vicinity of the Centre. Increased densities will place greater pressure on public open space with particular emphasis on the Ewey Creek corridor in providing future opportunity for additional open space.

There is a need to optimise and rationalize the present and future allocation of open space in order to achieve a balanced and logical system which provides maximum benefit for community use in both the short and long term.

2.1.1 DISCUSSION

Initial residential development of the Ewey Creek catchment did not respect the Creek as an important feature in the subdivision layout. At best, the Creek alignment forms the boundary between private blocks. Invariably, however, the Creek dissects individual blocks bearing little relationship to topography or other natural features and limiting its potential value as a more significant community resource.

Existing controls on the Creek where it runs through private property are limited to drainage easement rights.

The Catchment area of Ewey Creek is dominated by well established residential development and is characterized by low density attached housing. Increasingly, however, medium to high density development is occurring in parallel with the growth of the nearby Miranda Centre and the convenience of public transport that the Centre offers.

Increased densities are being encouraged by present zonings and a draft DCP for the Miranda Centre which identifies considerable areas north of Ewey Creek for "... future consideration to maximise residential densities ...". Much of the remainder is also favoured for an increase of present residential densities.

Urban consolidation in this regard will have considerable impact on the present areas of open space. An increase in population combined with a loss of private open space will greatly increase pressure and demand for larger and more diverse areas of open space and recreational opportunity. Inevitably, Ewey Creek will be called on to fulfil some of these opportunities.

Figure 3
Analysis

To offset this pressure, the DCP's indicate allocations of open space be made along the Ewey Creek corridor forming, over the long term, a linked open space route from Chapman Street South in the west to President Avenue in the east. Accordingly, three precincts within the DCP areas of Miranda and Gynea which fall along the creek corridor have been prepared showing preferred dedication/allocation of land for public open space. The DCP's have also set controls on site redevelopment in terms of building set-backs controls of building height and materials, and provision of buffer zones and public access routes (refer to Appendices E, F, G, H)

This approach by Council appears broadly compatible with the aims of this management plan for Ewey Creek. An extension of this approach over the remaining precincts along the Ewey Creek corridor will provide a greatly enhanced open space system that will be beneficial to the local community over the long term.

It is acknowledged, however, that Council's objective to increase public access along the Creek corridor may have some negative implications. Serious concerns of vandalism and security risks have been expressed by residents along the Creek and it is clear that these problems cannot be overlooked when considering strategies to increase public enjoyment of Ewey Creek.

Several specific issues of land ownership and use are worthy of more detailed discussion:

- ***RTA Land***

The current allocation of public open space zoned for recreation within the Ewey Creek catchment is not a true reflection of the actual area of public land that is potentially available for some degree of public use.

Much of this open space falls within a broad corridor owned by the RTA which is earmarked for a future freeway route. At present, the RTA discourages use of these areas from the public even though they remain idle and do not serve any interim purpose to the RTA. Furthermore, the size, proximity and existing vegetative cover of these areas, particularly in relationship to the Ewey Creek corridor, highlights the value of these landscapes as important visual, recreational and natural resources. Opportunity clearly exists here for a change in the RTA policy to enhance the landuse and landscape values of the areas while not compromising long term roadworks or the present level of management undertaken by the RTA. Council liaison with the RTA will establish the degree to which increased public access to and use of the land may be had, even in the short term.

- ***Scout Hall Site***

The local Scout Group which occupies a Hall and land adjacent to the RTA corridor generates a considerable level of activity on its site and which benefits greatly from this undeveloped setting. Consideration for enhancing RTA land in this vicinity should, therefore, carefully consider the value of the area to the Scout Group in association with other potential community uses.

- ***Land adjoining President Avenue***

Two blocks of land flanking Ewey Creek south of President Avenue have been identified for redevelopment. These are significant sites because of their visual prominence along President Avenue as well as their physical relationship with the Creek.

The western block (No. 154 President Avenue) is privately owned. A Development Application has been received by Council for sub-division with the portion adjacent to the Creek proposed for acquisition. This appears to be a practical compromise for site redevelopment although conditions regarding the height of new buildings may need to consider adjacent residences and avoid significant visual impact on the Creek corridor.

The eastern block (No. 112 Matson Crescent) is Council owned and is under review for sale to rationalize Council assets.

Existing recreational use of the site is negligible, inhibited by steep grades and thick vegetative cover of weeds. While these are not attributes favouring retention the land provides an important visual link with the reserve opposite President Avenue and if returned to a natural state, would provide an extension to this key visual resource. Retention of the block will also allow potential for pedestrian access to be made available from Matson Crescent to Clifford Road and Yowie Bay.

2.1.2 PRINCIPLES

- Optimise links of public open space along the Creek which respect the privacy and amenity of existing residents.
- Undertake additional precinct DCP's along the entire length of Ewey Creek following the objectives and standards recommended in the existing draft proposals, modified as necessary by this management plan.
- Incorporate planting strategies for street trees and conditions of development which enhance the indigenous vegetation character.
- Increase landscape and landuse potential of RTA owned land but respecting the long term freeway proposals.
- Approve the subdivision of No. 154 President Avenue which provides for acquisition of open space by Council as proposed.
- Retain Council owned land at No. 112 Matson Crescent and incorporate landscape rejuvenation programme as discussed in Section 2.6.

22 USE AND ACCESS

Aims

To optimise pedestrian access into and through key areas of the Ewey Creek corridor and to allow controlled vehicular access for management. Ensure access is provided in a manner which has cognizance with the needs and expectations of local residents.

Issues Summary

Current use levels of the Creek corridor suggest that individual public reserves experience low levels of visitor use and that a significant number of these appear to be used for transitory purposes where through routes for pedestrians are available. Any change to existing reserves to improve public access, however, must account for concern by residents for increased problems of vandalism and public risk from undesirable users of the parks. There must also be consideration given to the key role of the Creek as a water management device, particularly with respect to risk to safety during flooding and the need to ensure adequate access for maintenance vehicles.

2.2.1 DISCUSSION

As a user survey was not carried out for this study, information is based on feedback from local residents through the two Community Liaison Meetings held by the Project Team, information forwarded by Council and observations made by the Team during field work.

Circulation and use of the Ewey Creek corridor is presently dictated by the isolated and discontinuous nature of its public reserves. As a consequence, recreation in each is self centred and generally attracts only a small number of users from a very local catchment. For much of the time, many areas appear to be little more than ancillary open spaces to adjoining properties.

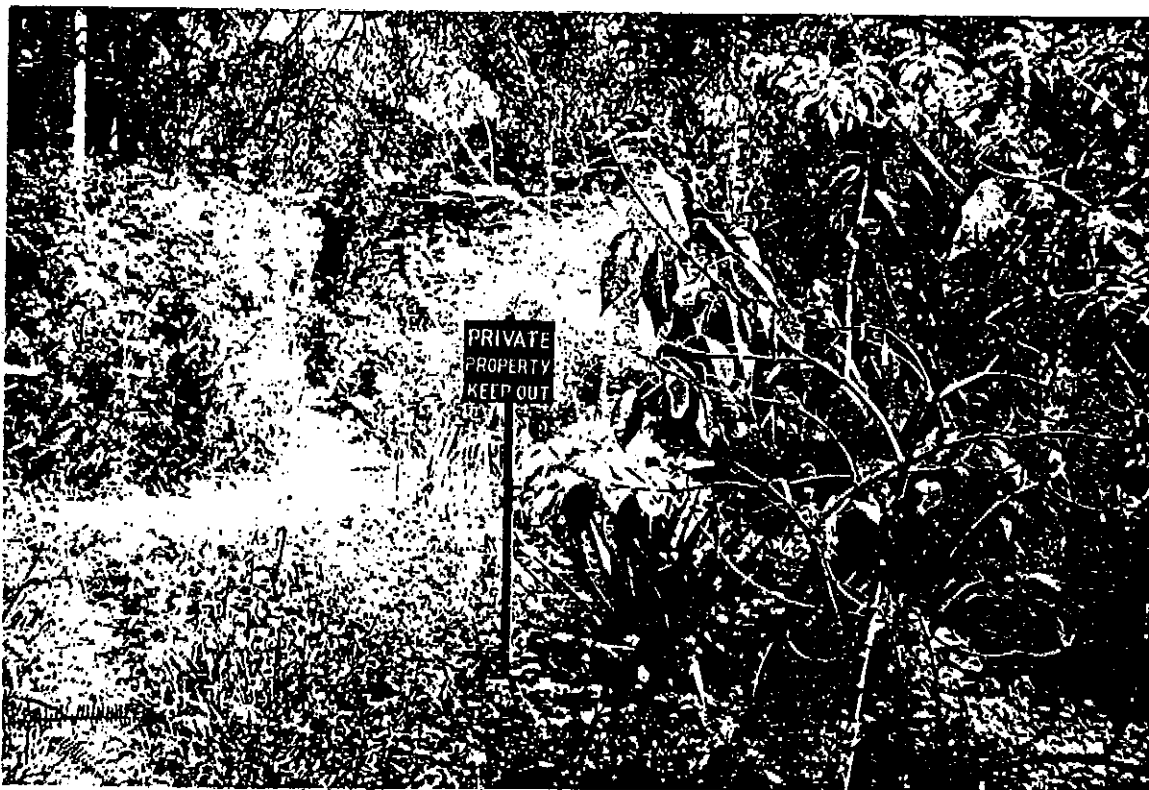
Additional reasons for their limited use may also be attributable to a lack of attractive visual qualities and recreation focus in each. In most instances, the Creek itself is inaccessible from view or is visually isolated because of steep embankments or infestation of weed. Where the water is visible, it is often unattractive in appearance because of poor water quality, proliferation of litter or inappropriate bankside treatments.

Transitory use of the quarry site attracts relatively high use levels as it allows a convenient through route for pedestrians north to Miranda Railway Station and shopping centre. This is facilitated with bitumen paths and steps that follow a fairly direct route parallel to President Avenue and NW to Kirkby Place, running close to the end of Partridge Avenue. A minor access route is also available to the lower levels of the quarry via steps and a ramp.

Access into other public reserves is frequently available from adjacent residential streets. However in many situations, access terminates at the end of reserves rather than providing a through route and this has created deadends and areas not favoured for recreation. This is particularly so where reserves are long and narrow such as the open space corridor east of the Kiah Place Reserve and the Kiora Road Reserve.



The absence of formal public access into the disused quarry site has left the area isolated from public attention and exposed to vandalism.



Much of the Creek corridor is privately owned locking its potential for public access until redevelopment over the longer term. The sentiment of local residents must be sought before any extension to pedestrian routes is considered.

Potential for linking public reserves over the longer term would increase the through route function of existing reserves and allow wider use. Nonetheless, this is complicated by:

- present extent and nature of private ownership requiring long term dedication of open space when available through development consents.
- concern by residents that increasing public access would be matched by greater problems of vandalism and public risk.
- Difficulty in achieving physical links along corridor as the Creek crosses a series of Streets which separate sections of the Creek from each other.

These constraints imply that the establishment of a continuous public link for the full length of the Ewey Creek corridor will be difficult to achieve in the short to a medium term and may indeed not necessarily be appropriate or desirable. Strategies to optimise public access may therefore be most appropriately directed at creating and enhancing those links that serve to limit dead-end routes and that fulfil a clearly identified and justifiable access or recreational role.

It will be important to discourage access of undesirable users of the creek corridor where appropriate e.g. non-maintenance vehicles. Limited and controlled access points will be appropriate. Continued vehicular access will however be required to the Scout Hall adjacent to the RTA reserve.

The encouragement of access into and through RTA owned land will be desirable to maximise available open space. Access and recreation types and design will need to be developed with the approval and in collaboration with the RTA.

Cycle routes are a common consideration along linear public parks such as creeklines. The nature of the Ewey Creek corridor, however, does not readily lend itself to the creation of extensive cycle paths, nor indeed is this generally a compatible activity. Thus whilst particular crossings of the creek corridor may be able to accommodate to joint cycle and footpaths, the emphasis should be clearly placed on priority and safety for pedestrians.

Access for the disabled is also an important consideration. At present the proliferation of steep paths limits wheelchair access. Both the short and long term planning of open space in Ewey Creek should provide, where topography permits, optimum wheelchair access and should avoid links that do not clearly indicate suitability or otherwise for the disabled.

Increased use and access by pedestrians must be mindful of the potential dangers of flooding, requiring that where such incidents occur, path locations and design do not create 'traps' that prevent easy escape.

2.2.2 PRINCIPLES

- Encourage greater pedestrian access and circulation into and within public reservations to optimise the enjoyment and generate recreation opportunity in relatively isolated areas.
- Strengthen physical and visual links between public reservations to enhance recreation opportunity generated by a continual system.
- Provide convenient access for maintenance vehicles into Reserves but which does not detract from visual and recreation amenity.
- Ensure continuous public safety from water management hazards and risk from flash flooding.
- Discourage access into reservations of public vehicles and recreation users which are non compatible with the preferred recreation mode.
- Design and layout of all paths and reserves should seek to optimise ready access for the disabled.
- Ensure provision of additional through routes is compatible with consensus of local sentiment.

23 WATER MANAGEMENT

Aims

To reduce the effects of flooding and to improve water quality and bank stability along the creekline.

Issues Summary

To establish appropriate water quality controls a series of models were run. The preferred option derived from these models provides for the removal of phosphorus and sediment equally. This option entails the installation of a Water Pollution Control Pond and two Gross Pollutant Traps (one major, one minor) at specified points along the Creek. A further WPCP may be considered for the quarry site if monitoring of water quality after installation of the initial components warrants further controls.

Creek bank stabilisation will be required at various locations to minimise bank undercutting. The use of local stone for the construction will give an appropriate appearance to these structures.

Further survey work will be required to establish the extent of flooding potential prior to establishing appropriate development guidelines and controls.

2.3.1 DISCUSSION

Where ever development occurs, be it agricultural or urban, additional loads are placed on the creek system in the form of increased stormwater runoff sediment eroded from land surfaces and other pollutants including (nutrients, trace metals, toxic organics and residual chemicals). All of these pollutants can markedly affect the stability of the creek and its water quality.

The visual evidence of this phenomenon in the Ewey Creek catchment has been a loss of native vegetation along the creek corridor and significant alluvial deposits collecting at the head of Yowie Bay. Although the catchment is well established, a significant amount of both new and redevelopment is occurring with the potential to further exacerbate water quality problems and give rise to further siltation in Yowie Bay.

This aspect of the catchment management study addresses the issues of key pollutant export loads being generated in the catchment (phosphorus and sediment) and their effect on the physical condition of Ewey Creek and the quality of its waters. The control of stream erosion is also considered and brief comments are provided on the management of the increased runoff arising from development of the catchment.

- **Creek Morphology**

Ewey Creek is currently in a relatively static condition owing to a combination of natural bedrock outcrops stabilising the bed grade, while with a few exceptions, the banks have stabilised due to the scour resistance of naturally occurring bank material, the binding cover of vegetation (including weed species) or in many cases the construction of artificial retaining walls.

Based on an interpretation of the limited amount of historical data available and the current condition of the creek it would appear that Ewey Creek has a similar history to many other small urban streams. Survey plans dating from last century indicate a creek with a low meander ratio which is indicative of a young active stream. However, prior to development, it is likely to have been a generally dry gully with flows occurring only after significant rainfalls. The presence of a healthy vegetative cover on the banks and riparian verges would have provided a good degree of erosion protection with erosion occurring only with high flows following intense storms.

The effect of clearing of the land has been to de-stabilize the banks and to a lesser extent the bed of the creek by the combined effect of an increase in the peak flows and volume of runoff and a simultaneous loss of bank vegetation. The natural response of the creek to these introduced instabilities has been to deepen and widen the original gully. The creek has now reached a new longitudinal bed profile which is controlled by numerous rock outcrops. The process has been that the banks have been undermined thus allowing the creek to expand laterally.

Although the creek is deeply incised in places it appears to have reached a stable longitudinal profile owing to the existence of rock outcrops which are providing a natural defence against further bed degradation. However as further and more intense building development continues to reduce the extent of previous areas within the catchment and further to increase peak flow rates and volume of stormwater runoff, these flows will continue to stress the capacity of the creek and lead to lateral erosion at pressure points. This is particularly evident on the outside of creek bends and where the natural earthen bank remains and covering vegetation is sparse.

In the few remaining sections of natural creek bank, no evidence of bank piling failures was observed and it is concluded that this mechanism is unlikely to have been involved in the erosion of the creek.

The valley is generally steep and barring future artificial interference is likely to remain. Therefore, the sediment carrying capacity of the stream will continue to exceed the rate of sediment supply. Evidence of this behaviour is the lack of sediment deposits within the stream. The few deposits observed are either located at culvert outlets or wherever plunge pools have developed downstream of an abrupt change in the bed grade. The deposits generally consist of coarse material which is being gradually flushed into Yowie Bay under high flow conditions and being replaced by fresh material. Virtually all medium and fine sediments are carried directly to Yowie Bay.

Creek Stability (Bed and Bank Erosion)

During two field inspections, the water level was fairly low. The water was clear and the creek bed was clearly visible at all locations which were inspected. Most evidence of past creek bank movement is either anecdotal or circumstantial and rates of erosion can only be estimated from the size of the alluvial deposits at the head of Yowie Bay. The frequency of artificial bank armoring indicates areas of past active bank erosion and it can therefore only be surmised that historically a significant proportion of the silt now in Yowie Bay has been derived from the creek channel. Notwithstanding this historical erosion, the erosion in the main creek channel appears to have slowed considerably as evidenced by the presence of vegetation, albeit thin on most portions of the remaining earthen bank sections. The principle source of sediment would now appear to be derived from both point sources, eg. construction sites, and non-point sources within the catchment although erosion along the creek will still occur under conditions of high flow.

In many instances, the artificial bank works, which are usually some form of masonry construction, have been provided to either limit the bank erosion encroaching onto private lands and/or to confine creek flows to a narrow corridor. While these works appear generally stable notwithstanding minor undercutting, regular monitoring is recommended as sudden bank failure during high flows may lead to culvert blockages and higher than expected flood levels.

Owing to the existence of both natural rock outcrops in the creek bed and the use of masonry bank armouring, improved creek stabilisation works could be implemented over many years providing the existing works are closely monitored to ensure their continued structural integrity. At the same time, it is recommended practice for river engineers/authorities to conduct a regular maintenance reporting on the status of river works to ensure their continued effectiveness and the safety for river/creek users.

Creek Stabilisation; Options analysis

The development of strategies to remove constrictions to creek flow, involving appropriate creek bank treatments will assist in stabilising the creek.

Rock stabilisation techniques which have been used successfully on many eastern Australian streams are considered suitable for Ewey Creek. It is envisaged that the bank treatment would comprise large rock boulders interspersed with correctly sized rip-rap and reed beds combined with generally flatter bank slopes (refer Section 5.2.3). A filter layer of either crushed rock or a suitable geofabric is recommended under all rock work and a geomat should be used to stabilise any reed beds.

The individual rock boulders would need to be angular, of sound stone and have an equivalent minimum spherical diameter of 800mm. Rip-rap is not recommended on the outside of creek bends owing to the high flood velocities but may be used elsewhere providing it conforms to an appropriate size and grading. An indicative rip-rap size for a 15° slope would be:

- (i) D₅₀ grading from 150mm dia. near the top of bank to 650mm at the toe of the bank; and
- (ii) Not more than 20% (by weight) of rock smaller than 0.35D₅₀ size.

Note: D₅₀ is the median rock diameter of the rock mixture. The rock diameter being defined as the representative equivalent spherical dimension.

These sizes are intended as a guide only and should not be used for detailed design without a rigorous check of the expected flow velocities, depth of flow and bank slope.

In order to maintain a creek appearance consistent with the geology of the area it is recommended that, if at all possible, rock used in bank stabilisation works be won from a local source such as the old quarry immediately upstream of President Avenue. Initial estimates indicate that approximately 3000m³ of rock will be required to stabilise the full length of the open creek. This would provide sufficient volume to create a wetland in the quarry area but one which would not have an appreciable effect on downstream water quality. An estimated 5400m³ of rock needs to be removed to create the minimum sized WPCP included in the water quality modelling described elsewhere in this report.



Above: Improved water management of Ewey Creek needs to be undertaken by public authorities and local residents if the level of pollution entering the Creek system is to be significantly reduced.



Right: Filling and terracing has constricted sections of the creekline modifying its flow and flooding characteristics.

Rock filled gabions are a realistic option for bank stabilisation at culvert transitions. In some instances crib walling may be suitable but a much higher quality foundation would be required which may be difficult to achieve given that excavation would be in the creek bed.

No creek bed grade control structures such as check weirs or chutes are considered necessary for stabilisation purposes. Devices to lower creek velocities will, in the main, only be effective at low flows and cannot be justified on current evidence of erosion occurring during low flows. Nevertheless they could be safely incorporated to provide aesthetic variations in bed levels providing that they are designed to withstand the expected flood flows.

Tributary Drains

Tributary drains entering the open sections of Ewey Creek may be treated in the manner illustrated in Section 5.2.8. A guide to the type of outlet arrangement necessary to control the flow direction and velocity are indicated in Appendix 2.

Water Quality Modelling and Options

A more detailed discussion of the causes and impacts of poor water quality are to be found in Section 2.5. What follows is a discussion of the various options for control measures that have been considered suitable for further detailed consideration.

Water quality modelling was carried out using the AQUALM-XP model. AQUALM-XP is a water quality modelling package which includes a suite of modules for runoff, non-point source and point source pollutant export, and pollutant transport and routing. The software suite includes:

- (i) daily rainfall/runoff model,
- (ii) a non-point source export model,
- (iii) a gross pollutant trap model,
- (iv) a water pollution control pond model,
- (v) a lake loading model,
- (vi) a river quality and loading model.

Pollutant export relations were established using available parameters for similar developed catchments in the Sydney region. These relations were used to estimate non-point source pollutant loads. The pollutants modelled for this study were:

- E.coli
- Sediment
- Suspended solids
- Total phosphorus

Four sites along the creek were investigated as potential sites for pollution control devices. These sites included:

- (i) the RTA land at corner of Houston Street and Manchester Road.
- (ii) the reserve adjacent to Kiah Place.
- (iii) the old sandstone quarry site upstream of President Avenue, and
- (iv) the creek valley upstream of Clifford Road and the head of Yowie Bay.

The permanent pollution control devices which were investigated included:

- (i) Minor and Major Gross Pollutant Traps.
- (ii) Water Pollution Control Ponds.
- (iii) Wetlands.
- (iv) "Wet" Retarding Basins.

Wet Retarding Basins were only briefly considered as no suitable sites exist along the creek except for the reach downstream of President Avenue and within the head of Yowie Bay. Sufficient storage capacity could only be created by either inundating large tracts of private property or by being visually intrusive. A further issue was the problem with constructing a wet basin while the status of water frontage rights to Yowie Bay and title boundaries extend to include part or all of the creek at many locations.

Wetlands were investigated as an alternative to Water Pollution Control Ponds (WPCP's) due to their greater efficiency for pollutant retention for a given detention time. The greater efficiency of wetlands is considered to result from the proportionally greater biomass in the water body where water depths are limited to about 200 to 250mm compared to the water depth of a WPCP which may be considered. However in the case of Ewey Creek the greater efficiency was insufficient to offset the reduced storm runoff detention time possible in a wetland due to restrictions on the area available for wetland development. The maximum runoff detention time available using wetlands was about 12 hours which was insufficient to achieve appreciable reductions in either E. coli or total phosphorus levels.

Given the space restrictions along the creek corridor and the need to reduce both phosphorus and sediment levels along the creek as well as Yowie Bay it was concluded that GPT's and WPCP's would provide the only feasible means of reducing the key pollutant levels within the creek system.

Thirteen combinations of WPCP's and GPT's at the four nominated sites were analysed using the AQUALM-XP model. The combinations ranged from "do nothing" to 3 GPT's and 2 WPCP's as listed in Option 7.

The pollutant levels in the creek resulting from the control device combinations listed below appear in Tables.

Option 1

Do nothing.

Option 2

Minor GPT below ground level at Kiah Place plus Major GPT at Old Quarry Site

Estimated capital cost \$290,000.

Option 3a

Minor GPT below ground level and WPCP (0.36ha water surface area) at Kiah Place

Estimated capital cost \$600,000.

Option 3b

Minor GPT below ground level and WPCP (0.29ha water surface area) at Kiah Place

Estimated capital cost \$550,000.

Option 3c

Minor GPT below ground level and WPCP (0.22ha water surface area) at Kiah Place

Estimated capital cost \$430,000.

Option 3d

Minor GPT below ground level and WPCP (0.22ha water surface area) at Kiah Place plus a Major GPT at Old Quarry Site.

Estimated capital cost \$630,000

Option 4a

As for Option 3a plus Major GPT and WPCP at the Old Quarry site.

Estimated capital cost \$1,250,000 (Incl. \$225,000 for rock used for creek stabilisation).

Option 4b

As for Option 3b plus Major GPT and WPCP at the Old Quarry site.

Estimated capital cost \$1,200,000 (Incl. \$225,000 for rock used for creek stabilisation).

Option 4c

As for Option 3c plus Major GPT and WPCP at the Old Quarry site.

Estimated capital cost \$1,080,000 (Incl. \$225,000 for rock used for creek stabilisation).

Option 4d

As for Option 3c plus a Major GPT only at the Old Quarry site.

Estimated capital cost \$630,000.

Option 5

Minor GPT only at Kiah Place plus Major GPT and WPCP at the Old Quarry site.

Estimated capital cost \$740,000 (Incl. \$225,000 for rock used for creek stabilisation).

Option 6

Minor GPT and WPCP on RTA land at Houston Street plus a Major GPT and WPCP at the Old Quarry site.

Estimated capital cost \$1,150,000.

Option 7

As per Option 4c plus a Minor GPT and WPCP on RTA land at Houston Street.

Estimated capital cost \$1,670,000 (Incl. \$225,000 for rock used for creek stabilisation).

Option 8

Minor GPT and Wetland at Kiah Place plus a Major GPT and WPCP at the Old Quarry site.

Estimated capital cost \$990,000 (Incl. \$225,000 for rock used for creek stabilisation).

Cost Effectiveness

A cost benefit analysis based on removal rates for Sediment and Total Phosphorus was used to assess seven of the listed options and is included as Table 1. Results indicated that the most cost effective removal is achieved with a single installation comprising a major GPT and WPCP at either the Old Quarry site or at Yowie Bay. However no benefit to the creek is gained for an installation at the Old Quarry site. It is about 10% of the open creek benefits from a single installation at the Old Quarry site. It is therefore recommended that a minor GPT and WPCP be constructed at Kiah Place and a major GPT be constructed immediately upstream of the Old Quarry.

A WPCP at the old quarry site would primarily benefit Yowie Bay and should only be constructed as a result of excavating rock from the quarry for other purposes or following a detailed cost/benefit study based on an extended period of water quality monitoring to gauge the effectiveness of the installed control devices and any temporary on-site controls which may be required as part of future planning and building development approvals.

The cost of the WPCP at the Old Quarry would not, on the basis of evidence at hand, be justified in terms of the benefits likely to be realised. Its creation is seen as a result of either reopening the quarry for sale of the rock on a commercial basis or using the rock as the creek bank stabilising material. In the later case the water filled depression created would only be sufficiently large to be developed as a wetland and as such would have negligible benefit on water quality.

A representative selection of the identified options were subjected to a cost/benefit analysis. The analyses considered the Sediment and Total Phosphorus captured. The results were expressed in terms of the mass of pollutant captured over a 50 year period per dollar spent on both capital and recurrent costs during that time. The assumptions used in the analysis are:

- (i) Both the GPT's and WPCP's have a design life of 50 years.
- (ii) The Inflation rate for determining cleaning costs is 3% p.a.
- (iii) No allowance has been made for repairs or capital depreciation.
- (iv) Cleaning costs for a minor GPT are \$70/m³ based on historical ACT costs.
- (v) Cleaning costs for a major GPT are \$30/m³ based on historical ACT costs.
- (vi) Cleaning and macrophyte harvesting in a WPCP is costed at \$10,000 per operation.
- (vii) Cleaning of a WPCP required once every 10 years.
- (viii) Pollutant capture is determined at the Old Quarry site.
- (ix) The capital cost of a WPCP at the Old Quarry site has been discounted by \$225,000 which is the estimated cost of extracting 3000m³ of rock for use in stabilizing the creek banks.

It is therefore considered that Option 4 (c) would be the most suitable alternative, but that it allow for a staged implementation. This option involved the construction of a Minor GPT below ground level and WPCP (0.22 ha water surface area) at Kiah Place; plus a Major GPT and WPCP at the Old Quarry site north of President Avenue and west of Partridge Avenue. Specifically, it would be appropriate that the WPCP at the Old Quarry site not proceed until a detailed assessment of the effect of the other creek devices and catchment source controls has been evaluated. Under the recommended part implementation arrangement the cost efficiency is calculated as:

Table Economic Efficiency of Options

Option	Sediment Removal Rate (kg/\$)	Phosphorus Removal Rate (gm/\$)
2	15.9	-
3a	6.0	1.9
3b	6.2	1.8
3c	8.9	1.4
4b	9.2	1.5
4c	11.2	1.2
5	12.9	2.2

Water Quality; selected options

A reduction in both sediment and phosphorus loads is viewed as being equally important to creek water quality. Therefore while GPT's alone provide the greatest efficiencies in sediment removal there is unlikely to be any effective reduction in phosphorus, hence Option 2 was rejected. A similar argument applies to Option 5 in which only the lower 10% of the creek system will benefit from a reduction in phosphorus levels.

Of the various options considered for water quality strategy the most effective option appears to be to partially implement Option 4 (c).

This option comprises the smallest feasible Water Pollution Control Pond at Kiah Place together with a minor Gross Pollutant Trap located at the head of the WPCP. A second GPT (major) is proposed immediately upstream of the Old Quarry. Development of a second WPCP at the quarry would proceed only following a monitoring programme to determine whether a further expenditure to improve water quality was justified. A WPCP at this site would have direct benefit to Yowie Bay and therefore funding sources outside of Council's own resources should be considered.

The cost of the WPCP at the old quarry site may also be offset against other creek projects if rock for use in the creek stabilisation and landscaping is excavated from the quarry.

Flood Management Options

Options for flood mitigation measures are limited to schemes involving either works to increase the hydraulic capacity of the creek or clearing of the floodplain of inappropriate building development. There are no suitable available sites within the catchment where an effective stormwater retarding basin could be constructed.

Works to Increase the Hydraulic Capacity of Ewey Creek

There are currently several sections of creek where the hydraulic capacity is significantly less than the rest of the creek and in a few cases there is significant flooding of private land. The recommended creek stabilisation works (refer Appendix C) have taken into account the narrow sections of the creek channel by proposing a flatter bank slope and in some cases are accompanied by an increase in the creek bed width. These works will provide an improvement in the hydraulic capacity of these sections but flooding problems will persist upstream of the main road culverts. In particular, the culvert at Wandella Avenue is causing flooding immediately upstream of the crossing. However there is only one property, No. 2 Mawarra Road where habitable rooms are subjected to flooding during the 100 year ARI event. The lowest habitable room floor level of the two adjacent properties is above the calculated 1 in 100 year ARI event flood level. Under these circumstances it would be difficult to justify implementing expensive flood mitigation works. Some lowering of the flood level may be achieved by improving the hydraulic performance of the culvert by the addition of flared wingwalls and bevelled entrances to the culvert cells.

Other strategies which may be worthy of consideration following a cost benefit study could include:

- Do nothing and accept the occasional cost on the community.
- Flood proofing of dwellings to a level 500mm above the calculated 100 year ARI event flood level.
- Installation of a flood wall or levee with either flood gates installed on local drains or pumping from an on site drainage pit.
- Requirement for future significant extensions/upgrading to include provision for flood proofing all habitable rooms. In this regard strict conditions and approval procedures must be adopted by Council and any other relevant authorities to avoid redevelopment by stealth.
- Encourage privately funded replacement of non conforming dwellings. In this regard any redevelopment application should give careful consideration to the location and type of fencing that may be required. Any fencing should be designed to allow the free passage of flood waters with due allowance made for blockages. Minor dwelling encroachments onto the flood plain should be discouraged. This should apply even where the sub floor area is allowed to remain open due to the tendency to illegally enclose such areas and use them for storage. Attention should also be given to landscape screen planting which may have an adverse impact on flooding.

Non Structural Floodplain Works

Historical development has allowed both subdivision and building development to generally confine the creek to the narrowest possible corridor. Proposals to widen the creek corridor and return as much of the riparian land to public ownership as practical may readily be designed to incorporate flood alleviation measures. Strategies involving voluntary purchase of flood prone lands by the relevant drainage authority have been successfully applied in similar urbanised catchments. Typically these strategies place riparian lands in 1 of 3 categories according to the severity of flooding, viz:

Category A	Not subject to flooding from the 1% Annual Exceedance Probability (AEP) flood.
Category B	Land subject to flooding but all habitable rooms of dwelling are more than 500mm above the 1% AEP flood level.
Category C	Floor levels of habitable rooms are less than 500mm above 1% AEP flood level and include those below the 1% AEP flood level.

In the case of Ewey Creek only two Category C properties have been identified and neither are considered to be at sufficient risk to warrant purchase on the basis of flooding alone.

However where purchase of these or other flood affected private properties is deemed desirable for environmental or public access purposes then their purchase would provide an opportunity to demolish any non-conforming buildings. The cost of any purchase and subsequent demolition may be partly offset by resale of surplus land for building development consistent with the flood plain management strategy.

Flood Mitigation: selected options

Significant flood control works do not appear to be justified based on the extent and depth of flooding from both the 1 in 100 year ARI and 1 in 10 year ARI floods. Creek stabilisation works involving flattening the creek banks together with the use of flared wingwalls at the culvert approaches may provide some local improvement in flood protection. Based on the known flooding evidence currently available it is recommended that the extent of flooding be reassessed following the preparation of a functional design for the creek stabilisation and landscaping works which should be subjected to a rigorous hydraulic analysis. A cost benefit study using results from the hydraulic analysis of the functional design will then provide the basis for an informed decision regarding the need further flood mitigation/minimisation works.

Clearly, the design and construction of new developments proposed for flood prone areas must take account of these factors.

2.3.2 PRINCIPLES

- **Creek stabilisation:** Develop bank stabilisation treatments that are compatible with the natural appearance of the creek, preferably by the use of local stone material.
- **Water Quality:** Implement devices, structures and features that give equal emphasis to removal of sediment and phosphorous loads. Consider further water quality control measures at the quarry site only if monitoring of effectiveness of initial strategies indicates the necessity.
- **Flood Mitigation:** Assess requirements for flood control measures only when more detailed analytical data is available and following preparation of functional designs for the creek stabilisation and landscape measures. Consider controls on future development in flood prone areas identified during the analysis of the functional design to take account for this factor.

2.4 LANDSCAPE CHARACTER

Alms

To establish a visual identity for the creek that emphasises its natural characteristics.

To improve the identity of the creekline with respect to its suburban context.

To provide opportunities for the public to appreciate the visual qualities of the creek from within and without the corridor.

Issues Summary

Suburban development of the Ewey Creek catchment has progressively eroded the physical and visual definition of the Creek. While pockets of the original landscape remain, the majority of the Creek has been modified to accommodate housing and urban infrastructure to the extent that the Creek is now barely recognisable from the surrounding urban environment.

In order to re-address the Creek's significance as both a contextual and local landscape feature, a co-ordinated approach to upgrading its visual character is required. While much of this effort can be focussed on the pockets of public open space along the Creek corridor, it is essential that private landowners also contribute so that the Creek can be identified in its entirety over the short and long term.

Regeneration and revegetation strategies for both the public and private domain will need to be the key components in proposals for visual enhancement of the creek.

2.4.1 DISCUSSION

The built form character of the Ewey Creek catchment is typical low density residential which is not readily distinguishable from neighbouring areas.

The landscape is not substantially enhanced by its vegetation cover which consists of scattered canopy tree within private landholdings, inconsistent street trees avenues, and a mostly continuous but mixed canopy of trees following the creek course. Species are mixed throughout although native species generally predominate. Fragmentation of this vegetation, particularly as a result of mixing exotic with natives species dilutes the image of a retained natural creek system. This is most noticeable along the creekline where the inconsistency of tree species has greatly weakened what otherwise could be a strong visual statement.

The creekline is well defined by the sharp land form variation across the catchment. This helps focus attention toward the creek from either side which is most noticeable along the series of streets which cross it. The grid pattern of the streets, however, has been determined without respect for the landform and, in consequence, the creek. The frequent creek crossings may provide public views of the creek, but in their present form they tend to alienate each of the sections of the creek.

The area of greatest visual significance worthy of note is the reserve encompassing the disused quarry north of President Avenue. The relatively natural state of the existing and regenerating vegetation, together with the escarpment created by the quarry and the series of foot trails all form a strong visual impression with potential for integration into the creek corridor.



Above: The visual identity of the creek as a landscape feature has been lost to suburban development. The absence of a strong landscape framework either within the street environments or private landholdings is largely responsible for this lack of identity.



Left: Modification of the creek profile, weed growth and garden infrastructure characterizes the middle and upper reaches of the creekline.

Sandstone outcrops and the dynamic quality of the Creek here has produced an interesting, though highly under-utilized public open space.

Weed trees and some littering and dumping of garden refuse has spoilt its amenity as elsewhere along the creek. Nonetheless, the area displays sufficient potential to indicate that with limited intervention and improved management the reserve can provide a feature of considerable visual, educational and recreational merit.

The character of the creekline itself varies from a relatively natural and attractive feature such as its course through the quarry site to a rather utilitarian drainage line consisting of pipes and culverts which occurs in several sections of the middle and upper reaches of the creek. Other variations to its character occur in consequence to bank stabilization treatment which has required modification to the creek profile, usually with concrete, stone or block walls to reduce the risk of erosion. Terracing and retaining walls have also been constructed to achieve level platforms for gardens or buildings, thereby reducing the otherwise natural characteristics of the creek.

Attitudes of private landowners vary from those who incorporate the creek as a key element in the garden layout to those who ignore the creek almost totally. Most treatment is for aesthetic improvement with stone edging, bridges and the planting of various exotic and native species being the common features. At the other extreme, however, the Creek has been ignored altogether and is screened from view with fences and planting. The creek in these instances takes on the appearance of an unkempt channel infested with weed.

Opportunity exists along the creek and throughout its catchment to improve the quality of visual character. Such an undertaking, however, is complicated by the mixed ownership patterns, the rapidly changing urban density and the commitment of all landowners, public and private, to provide an appropriate and continual level of input.

Proposals for visual enhancement must necessarily be mindful of the implications of other strategies that will govern the future good management of the creek. Nonetheless, major considerations concerning the landscape character of the creekline must address the need to strengthen the overall identity of the creek.

Visual enhancement of the creek can be achieved by strengthening its tree canopy with the judicious planting of indigenous species to provide a continual and recognisable feature in the landscape. This would need to be undertaken on private properties as well as within the public domain, many of the public reserves being already well-endowed with trees. Assistance, guidance and education of the local community by Council is the only course that will achieve this aim in a co-ordinated manner.

This action would also generate public awareness for the need to restore the Creek's natural characteristics by:

- reducing visually incompatible plant material and constructed landscape elements such as excessive masonry, levelling and filling.
- increasing the interest level of those residents who currently make minimal contribution toward its visual character. This may help reduce levels of weed infestation and reduce activities that lead to the Creek's degradation.

The upper catchment of the creek above Manchester Road consists of two minor tributaries which may require more substantial treatment to improve their visual character. Here, the creeklines bisect gardens and have raised concern among some residents that they harbour vermin and are a safety risk. Piping them would alleviate these problems and have little effect on the overall integrity of the Creek. The routes should still be planted with indigenous vegetation as elsewhere to maintain the physical reference of the creek's course.

The enhancement of landscape character in public reserves would be relatively easily achieved given the ability of Council directly to implement strategies and also because of the substantial resource of high quality landscape elements which already exist in many public reserves. Much of this work need only strengthen and develop the existing usually natural features.

Opportunity also exists to generate greater visual impact of Ewey Creek along street reservations and beyond the immediate curtilage of the creek corridor throughout its catchment. Street tree planting reflecting the original tree canopy could be undertaken without significant cost and this would greatly improve the amenity of the suburban environment. Species which reflect creekline vegetation in contrast with other street tree planting could be implemented at the creek crossings to highlight these transition points.

One specific issue related to the visual aspects of street tree planting should also be given further consideration:

- As part of the draft DCP for the Miranda Centre, a pavement and street planting programme is proposed. This is clearly a positive initiative that will improve the amenity of streets. However, the recommended species of street trees which cross Ewey Creek will miss an opportunity to enhance the visual significance of the Creek. The use of indigenous trees to emphasise the natural occurrence of species (e.g. sclerophyll species along the slopes and rainforest species of the 'wetter' creek crossing) would achieve a much more appropriate and bolder statement.
- A similar gradation of species could be encouraged for use in the specific controls set out for precinct plans. This could involve a comprehensive species list to cover requirements of site design such as screening, shade, and aesthetics. Techniques for establishing and managing new natural areas of vegetation are discussed in Section 2.5 of the report.

2.4.2 PRINCIPLES

- Strengthen the visual identity of Ewey Creek as a prominent landscape feature by undertaking a judicious planting programme along its route and within its catchment.
- Minimise the fragmented nature of the Creek system by strengthening the links between the existing isolated sections. Use recreational and educational opportunities to reinstate contextual character.
- Introduce a consistent vocabulary of construction materials common to all elements of the Creek system.
- Improve park address points at Klah Place, the disused quarry site and Clifford Road.

25 CONSERVATION AND MANAGEMENT OF NATIVE VEGETATION

Alms

To protect and manage remnant native vegetation whilst maximising natural regeneration capability of sites within the catchment.

To reduce impacts on native vegetation and re-establish appropriate native vegetation on sites where natural conditions have been significantly altered.

Issues Summary

The influences of urban development in the Ewey Creek catchment have substantially modified the extant native vegetation both by the various processes of fragmentation and soil modifications.

The substantial modifications to the status and nature of the original soils has lead to conditions that are more conducive to weed invasion and less suitable for regeneration of the original native plants. The absence of the natural incidence of fire within the creek corridor has increased opportunities for the proliferation of species that are otherwise fire-sensitive.

The processes required to reverse this situation should rely predominantly on strategies for regeneration, supplemented as required by revegetation. Long term weed control will be an important strategy, given that the modified soils are unlikely to be returned to their former status.

The awareness and involvement of the local community, both in the reduction of negative impacts on the creek such as garden waste dumping, encroachment of lawnmowing etc and also in the regeneration and revegetation of the creek will be practical and economical strategies.

All proposals for protection, management and enhancement of the native vegetation within the creek should follow the guidelines set out in SEPP 19.

2.5.1 DISCUSSION

- **Extent of Original Native Vegetation**

The geology of the catchment is predominantly Hawkesbury Sandstone with a shale capping along the main east-west ridgeline (Benson et al. 1990, p.138)¹. Benson (1990) notes that the clay ridgelines were dominated by forests of Blackbutt (*Eucalyptus pilularis*) and Grey Ironbark (*Eucalyptus paniculata*) though Turpentine (*Syncarpia glomulifera*), Red Mahogany (*Eucalyptus resinifera*), and White Stringybark (*Eucalyptus globoides*) were also present. Shrub and understorey species included *Polyscias sambucifolia*, *Dodonaea triquetra*, *Acacia parramattensis*, *Glochidion ferdinandi*, *Breytia oblongifolia*, *Bursaria spinosa* and *Pittosporum undulatum*. A transition from shale to sandstone geology occurs between the elevated ridgeline and Port Hacking. Sandstone vegetation would have dominated the majority of the lower catchment.

¹ Benson, D.H. & Howell, J. (1990). *Taken for Granted - the bushland of Sydney and its suburbs*. The Royal Botanic Gardens, Sydney.

Soils derived from Hawkesbury Sandstone are strongly acid. They are characteristically low in phosphate and often locally deficient in nitrogen (Chapman et al. 1989, p.155)². Subsequently, natural woodlands and open forest on sandstone were characterised by species adapted to low soil nutrient levels. Benson (1990) notes that woodlands of Scribbly Gum (*Eucalyptus haemastoma*), *Banksia serrata*, and Red Bloodwood (*Eucalyptus gummifera*) with a diversity of shrubs - *Doryanthes excelsa*, *Leptospermum attenuatum*, *Ricinocarpos pinifolius*, species of *Grevillea*, *Hakea*, *Boronia*, *Eriostemon*, *Acacia*, *Dillwynia*, grasses sedges and some ferns would have been characteristic in the area. On the more sheltered south and east facing slopes, along drainage lines (such as Ewey Creek) and where deeper soils had accumulated, open forest replaced woodland. Blackbutt (*Eucalyptus pilularis*), Black She-oak (*Allocasuarina littoralis*), Christmas Bush (*Ceratopetalum gummiferum*) and Blueberry Ash (*Elaeocarpus reticulatus*) were characteristic with Sydney Peppermints (*Eucalyptus piperita*) and Sydney Red Gum (*Angophora costata*) fringed the rocky outcrops along Port Hacking.

The estuarine and intertidal zones of Yowle Bay are dominated by Grey Mangrove (*Avicennia marina*), River Mangrove (*Aegiceras corniculatum*) with saltmarsh communities, including Samphire (*Sarcocornia quinqueflora*), and Creeping Brook Weed (*Samolus repens*). Common reed (*Phragmites australis*), Swamp Oak (*Casuarina glauca*) and Coastal Banksia (*Banksia integrifolia*) dominate areas immediately above the tidal limit.

• **Status of Remnant Native Plant Communities**

The majority of native plant communities present in the catchment have been removed over the last few decades as the extent and density of residential land use has increased. Except for isolated stands in parks/utility corridors and individual trees in residential properties, all of the shale based vegetation has been cleared.

Isolated remnants of sandstone woodland and open forest occur in the lower catchment (particularly towards Port Hacking), being mainly restricted to public reserves. One major remnant was identified on the public reserve adjoining President Ave. and the sandstone quarry. This remnant still retains a representative structure and floristic composition of the original plant community. Elsewhere along Ewey Creek, smaller remnants survive however these have been significantly modified or degraded. Isolated remnant trees survive in residential properties.

The estuarine and intertidal vegetation communities of Yowle Bay remain relatively intact. Degradation of the plant communities immediately above the tidal limit has occurred, primarily through weed invasion.

In total, 91 species of indigenous native plants were identified in the area. No rare or endangered species were recorded. A complete species listing is provided in Appendix D.

All remnant plant communities are suffering from various forms of degradation and require management if they are to be re-established, regenerated or retained in a natural condition.

² Chapman, G.A. and Murphy, C.L. (1989). *Soil Landscapes of the Sydney 1:100,000 sheet*. Soil Conservation Service of NSW. Sydney.

- **Fragmentation**

The fragmentation, or breaking-up, of bushland areas into small remnants affects bushland in a number of ways:

- Increases edge to surface area ratio of remnants resulting in increased susceptibility of these areas to weed invasion. Particularly in urban areas where weed seed sources are prolific, fragmentation increases the length of remnant edge exposed to weed propagules and decreases the surface area of bushland that can remain resilient to weed invasion. Consequently, weed invasion is accelerated.
- modification of internal remnant microclimatic conditions, including increased solar /UV radiation levels, wind speed, and water status can modify both the flora and faunal species composition (Hobbs et al. 1991)³. In smaller remnants such as those found in the Ewey Creek catchment, these changes will almost certainly be detrimental.

Fragmentation can occur in a number of ways:

Direct Fragmentation

- Fragmentation resulting from direct human actions. Fragmentation is rapid and clearly visible.
- Some examples include:
 - encroachment of lawnmowing into bushland
 - the clearing of bushland as a perceived improvement or for access purposes
 - construction of facilities in bushland remnants
 - construction of services through bushland e.g. stormwater.

Indirect Fragmentation

- Fragmentation resulting indirectly from human actions. Fragmentation is slow and often not immediately discernible.
- Some examples include:
 - decline of native species and increase in weed species associated with nutrient enrichment along creeklines. The internal fragmentation of the remnant vegetation occurs as a result of external influences.
 - repeated burning of selected areas within a remnant e.g. fire breaks. This reduces soil seed bank of fire sensitive species, creating a more simplified vegetation type dominated by fire tolerant species. The resulting vegetation is less resilient to weed invasion.

³ Hobbs, R.J., Margules, C.R., & Saunders D.A. 1991. *Biological Consequences of Ecosystem Fragmentation: a review*. Conservation Biology, Vol. 5, No. 1.
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Factors contributing to direct fragmentation can be avoided through appropriate design and location of facilities and services in/through bushland remnants and the rehabilitation of disturbed sites after works. Adequate training of maintenance staff and public education is also required.

The mitigation of indirect fragmentation relies upon modifying contributing factors within the catchment e.g. stormwater control and nutrient enrichment, and through the adoption of sound on-site management practices.

• **Modification of Soil pH, Nutrient Level and Moisture Content**

The urbanisation of a catchment will directly modify the natural conditions of the catchment. Consequently, any natural bushland remaining after urbanisation will be subject to these changed conditions. The degree to which these bushland remnants survive in their natural condition will rely particularly on their resilience to the changing soil environment. Changes in soil pH, nutrient level and moisture content are three somewhat related factors which are recognised as significant contributors to the decline and modification of sandstone bushland in urban areas.

Soil pH

Sandstone based woodland and open forest communities in Sydney generally occur on acidic soils with a background pH of 4.5 to 5.5. At this level, the availability of macronutrients such as nitrogen, phosphorus and potassium are relatively low. Consequently, the woodland species have developed complex mycorrhizal associations which assist these species in obtaining soil nutrients⁴.

The importation of urban construction materials into catchments can significantly modify soil pH levels downslope/downstream. Soil pH testing of sites within sandstone bushland adjoining netball courts in northern Sydney indicated an increasing soil pH (alkaline) immediately adjoining the site. Soil pH gradually declined to background levels below the development.⁵

The increasing soil pH associated with urban development has a number of implications:

- Increasing soil pH will increase the direct availability of macronutrients in the soil. The greater availability of nutrients will assist the establishment of weed species.
- Mycorrhizal fungi are sensitive to increasing soil nutrient levels. Consequently a decline in mycorrhizal associations associated with soil pH change will probably result in the decline in vigour of native sclerophyll species. Research in the United States indicates that many weed species do not require mycorrhizal associations and as such are at a greater advantage when competing with native plants which either lack or have reduced levels of mycorrhizal fungi⁶.

⁴ Mycorrhizal associations are thought to exist between most native sclerophyll plant species. It is a symbiotic relationship between the host plant and various species of fungi in the soil which enable the plant to gain access to fixed soil nutrients in return for acting as a host for the fungi. The associations also assist in protecting the host species from disease causing fungi.

⁵ Buchanan, R.A. 1989. *Bush Regeneration - Recovering Australian Landscapes*. TAFE Publications, Sydney.

⁶ St. John, T.V. 1984. *Mycorrhizal Fungi and Revegetation* in proceedings from Native Plant Revegetation Symposium. 15 December, 1982. San Diego, California.

At this stage there is no feasible way of modifying soil pH levels on an urban catchment scale of the nature of Ewey Creek.

Soil Nutrient and Moisture Levels

In native sandstone plant communities there is a generally a gradational decrease in soil nutrient and moisture levels upslope from creeklines. Accordingly, species adapted to higher nutrient and moisture levels (mesic species) would characterise creekbanks. An upslope transition to species more adapted to dry, poorer soils (sclerophyll species) would occur on the sideslopes.

However, soil nutrient and moisture levels increase in bushland adjoining urban development. The degree and extent of influence varies depending on topographic factors, density of development, and time since development.

Of particular relevance to bushland management is the increase in phosphate levels from urban development. Background levels of soil phosphorus for sandstone bushland is generally considered to be between 25 - 60 ppm. However, phosphorus levels 40 ppm higher than background levels have been recorded in urban bushland below housing⁷. Furthermore, soil phosphorus levels associated with stormwater discharges have been recorded at 10 times background levels. Wright (1988) recorded soil phosphate levels 30 m below an urban stormwater outlet (of about 20 year standing) of 190 to 250 ppm, and on a floodplain 1.5 km from major urban inputs (50 years standing) levels of 625 ppm were recorded⁸.

The sources of nutrients, particularly phosphorus, are varied:

- Sewer discharges within the catchment;
- Leachate from imported building materials;
- Dumped organic garden wastes;
- Detergents;
- Leached fertilisers from gardens and lawns;
- Pets. It has been estimated that phosphorus input from pets is on average 2 kg phosphorus/ha./year.
- Stormwater run-off from roads.

Phosphorus generally occurs in the environment in an insoluble form - adhering to clay particles and organic matter. As such it moves slowly in the environment, and therefore the input of phosphorus from urban areas usually results in a gradual accumulation in the soil. The diffuse movement of this phosphorus downslope from urban areas into bushland remnants will promote considerable change in sandstone vegetation.

⁷ Lelshman, M. 1986. *The distribution of soil phosphorus within urban bushland in the area of Ku-ring-gal, Sydney*. Bsc (Hon) Report, Macquarie University.

⁸ Wright, H. Dr. 1988. *The longterm threat to bushland from urban run-off - minimising the damage*. Unpublished. State Pollution Control Commission, Sydney.

Natural vegetation along the creekline has often been replaced by weed and mesic species which thrive under the highly modified growing conditions. Of particular concern is the highly invasive Madelra vine which is difficult to control and, as seen here, creates a further threat to remnant trees.



Changes associated with increasing soil nutrients and moisture levels include:

- Decline in sandstone woodland/open forest species. This probably occurs as a result of increased competition with weeds and native mesic species, and a decline in mycorrhizal activity.
- Increase in weed establishment. The combined action of soil pH change, nutrient and moisture increases creates soil conditions conducive to the establishment of weed species. The close proximity of urban development, with its associated weed propagule sources, accelerates the process.
- Increased frequency and extent of native mesic species. Native species which under normal conditions would be mainly found on moist, higher nutrient sites (such as creeklines) are now able to extend their range upslope due to the changed soil conditions. This change in distribution and abundance of mesic species is particularly evident with Sweet Pittosporum (*Pittosporum undulatum*) and Blueberry Ash (*Elaeocarpus reticulatus*). This change is further accelerated when fire events are removed from the system (as is the case in most urban bushland remnants). Mesic species tend to be fire sensitive particularly at an early age and are usually killed by fire.

The net result of these changes in soil conditions is that many sites which once supported dry sclerophyll species can no longer support this community in a self-perpetuating condition.

The removal of soil nutrients from the system is a complex and difficult task. In recent years various strategies have been implemented to reduce the impact of soil nutrients:

- Education of residents living in the catchment;
- Construction of gross pollutant and nutrient traps/wetlands in an effort to harvest nutrients along watercourses. This approach does not however reduce the impact on bushland from adjoining diffuse sources.
- Annual burning of vegetation to remove nutrients in the biomass. This will reduce the species diversity in the long term and is generally unacceptable for small bushland remnants.
- Harvesting and removal of plant biomass (and subsequent removal of nutrients). Whilst some harvesting of plant biomass would assist in removing nutrients from the site, the annual input of nutrients will in most cases will be higher than that which can be feasibly removed.

• **Fire Management**

Fire is an important natural influence on species distribution and diversity in sandstone bushland. It is an essential factor which needs to be incorporated into the management of urban bushland. However the frequency, intensity and extent of fire events in urban bushland needs to be controlled to ensure that maximum diversity of species and animal habitat is maintained.

Sandstone plant species have varying responses to fire. Some species, for example Flannel Flower (*Actinotus helianthi*), are most abundant in the first few years after fire, gradually declining in abundance until the next fire event. Other species are more fire sensitive and achieve levels of abundance some years after a fire event. If maximum species diversity is to be achieved, fire events need to be controlled on a mosaic pattern across a remnant over a number of years. This will maximise the potential for both fire sensitive and fire responsive species to fulfil their reproductive cycles, and thus provide for maximum diversity of faunal habitat and food sources.

Fire is also important in reducing the susceptibility of dry, sandstone communities being invaded by fire sensitive mesic species e.g. Sweet Pittosporum (*Pittosporum undulatum*) and Blueberry Ash (*Elaeocarpus reticulatis*). This is a common occurrence in urban bushland where fire has been excluded. However, in planning for the use of fire, a detailed fire history plan and future strategy must be developed to ensure that a carefully planned approach is used and that fire sensitive areas are excluded.

Recent changes to air quality statutes require that consent from the Environment Protection Authority be granted prior to undertaking control burning of urban bushland.

In the context of Ewey Creek the practical application of fire management strategies must inevitably be tempered by both the configuration and urban context of the creek and the resultant concerns regarding safety that are likely to be evident in the community.

• **Natural Regeneration and Revegetation**

The ability of a bushland remnant to naturally regenerate will be dependent on a number of factors:

- Availability of native seed and propagules, either from adjoining sites or within the soil seed bank.
- Degree of fragmentation of the remnant.
- Degree of change in soil pH, nutrient and moisture availability.
- Level of competition from weed species.

Furthermore, the ability of a bushland remnant to naturally regenerate in perpetuity will depend upon:

- The degree to which degrading causal factors are removed.
- The extent to which altered site conditions can be reversed to acceptable limits for desired vegetation.
- The degree to which natural processes and rates of change can be re-introduced.

In most areas of urban bushland it is not possible to fully reintroduce natural processes and rates of change or to fully remove causal factors. The extent of these issues are enormous and interwoven with the fabric of urban society. However there is scope for reducing degrading causal factors and adopting appropriate strategies for managing the accelerated rates of change.

Remnant vegetation along Ewey Creek ranges from largely unmodified to significantly modified/absent. Correspondingly the degree of weed infestation reflects the degree of site modification, being greater in sites where foreign soil material has been deposited or where urban runoff is greatest.

Most of these site changes are beyond economic and physical reversibility e.g. the removal of imported fill to re-expose natural soil material, and therefore need to be accepted as the new "natural" conditions arising from our urban presence. Accordingly, a new range of native species may be more appropriate to use in the revegetation of significantly modified sites. Some impacts can be reduced through public awareness and education.

Significantly modified sites will have a reduced capacity to naturally regenerate the original native plant communities. Given an enormous level of resource input, a representative sandstone plant community could be re-introduced using revegetation techniques, however this reconstructed community would require continual and probably increasing levels of funding and labour input to maintain.

Sites which are largely unmodified will have the greatest capacity to naturally regenerate. These are areas where modification of soil conditions have been slower (for varying reasons) than significantly modified sites. Accordingly, given that impacts are reduced and the rate of change can be reduced further these sites can be managed using bushland regeneration techniques to minimise long term resource input and to maximise species diversity.

Nevertheless, in approaching sites along Ewey Creek with the aim of re-introducing native plant communities, preference should be given to encouraging natural regeneration where possible. On significantly modified sites, revegetation should proceed in conjunction with regeneration where regeneration rates are not sufficiently high to provide adequate native plant cover or diversity. This will be the most cost-effective means of re-establishing native vegetation on these sites. Assessment of individual sites by skilled and experienced bushland regeneration practitioners is required.

Irrespective of whether a revegetation or regeneration strategy is chosen for a site long term weed control will always be required, particularly along the creeklines which are significantly modified and have higher soil phosphorus levels. Research indicates that weed species are able to take greater advantage of high soil phosphorus than even native mesic/rainforest species⁵. Therefore weeds are likely to always be at a competitive advantage on nutrient enriched soils on sandstone.

- **State Environmental Planning Policy (SEPP) 19 - Bushland in Urban Areas**

State Environmental Planning Policy (SEPP) 19 - Bushland in Urban Areas was introduced by the NSW Department of Planning in 1986. The broad aim of the policy is to protect and encourage sympathetic management of urban bushland remnants which occur on, or adjoining, public open space in the Sydney region.

SEPP19 recognises that urban bushland is an important urban resource due to:

- Its value to community as part of the natural heritage
- Its aesthetic value; and
- Its value as a recreational, educational and scientific resource.

More specifically, the policy aims to:

- retain bushland in parcels of size and configuration which enable bushland to survive in long term
- protect rare and endangered flora and fauna
- protect habitats for native flora and fauna
- protect wildlife corridors and links to nearby bushland
- to promote the management of bushland in a manner which protects and enhances the quality of the bushland and facilitates public enjoyment of the bushland compatible with its conservation.

The implementation of SEPP 19 is the statutory responsibility of Local Government under the Environmental Planning and Assessment Act (1979). The policy only applies to areas of native vegetation which are representative of the structure and floristics of the natural vegetation. Along Ewey Creek, SEPP 19 will technically apply only to largely unmodified sites. Nonetheless, the application of SEPP 19 to remnant vegetation should aim to be applied liberally rather than restrictively⁹.

In areas identified as urban bushland under SEPP 19, the following constraints and management guidelines must be applied:

- Bushland cannot be disturbed without council consent, except where for bushfire hazard reduction, recreation use in accordance with a Plan of Management for the bushland, or for services / main road construction.
- In granting consent to disturb bushland, council must consider the aims and objectives of SEPP19.
- If disturbance is necessary and there are no feasible alternatives, bushland must be restored after disturbance.
- The effect of a proposed development (on adjoining land - public or private) on bushland (on or adjoining public open space) must be considered prior to granting development consent.

⁹ Department of Environment and Planning (1986) *Circular No. 114*.
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Right: Sites of significantly modified vegetation have a low capacity to naturally regenerate and as with this reserve off Kiora Road require substantial management input and revegetation to reinstate the natural floristic cover.



Below: A major remnant of sandstone woodland remains in the public reserve adjacent to President Avenue. The vegetation here is, however, fragmented by various degrading factors and requires improved management to ensure the retention of the natural plant communities.



2.5.2 PRINCIPLES

Management of largely unmodified sites to be consistent with the aims and objectives of SEPP19 - statutory requirement of Council under EPA Act.

- **Fragmentation**

Reduce fragmentation of remnants through:

- Reduction in extent of mowing in and around reserves
- Ensure that location of tracks, trails, facilities and service lines/pipes are located to minimise further fragmentation. Ensure that disturbed sites are restored after construction/installation.
- Remove dumped garden wastes from bushland and prevent further dumping.
- Ensure that stormwater discharges are piped through, rather than discharge into bushland remnants.

- **Modification of Soil pH, Nutrient level and Moisture Content**

Reduce nutrient inputs (particularly diffuse sources) through:

- Education
 - encourage residents to reduce fertiliser use
 - encourage residents to wash vehicles on lawns rather than streets
 - reduce garden waste dumping along creekline
- Integration of plant harvesting into long term vegetation management
- Regular sweeping of street gutters in catchment will remove fine soil particles which contain high nutrients
- Ensure sewer manholes do not discharge in catchment.
- Encourage on-site retention of stormwater in urban areas of catchment.

- **Fire Management**

Develop a fire management program for remnant dry sandstone vegetation based on:

- Fire history of sites
- 10-15 year rotation cycle of burn sites
- Use of small spot burns in rotation to ensure a mosaic pattern is achieved.

Moist, mesic based vegetation will require significantly longer periods between burns than dry sclerophyll vegetation.

- **Natural Regeneration and Revegetation**

Encourage the potential for natural regeneration of native vegetation through:

- Reduction of impacts such as rubbish dumping and nutrient enrichment.
- Reduce occurrences of weed species on private land within catchment.

Where potential for natural regeneration is low, revegetate sites with appropriate native species.

Initially consolidate areas of largely unmodified vegetation in conjunction with control of highly invasive weed species.

- **Water and Open Space Management**

Weed control along Ewey creek will be closely integrated with Regeneration / Revegetation strategies for each site. However, there are overall priorities which should be considered when approaching weed control in the catchment:

- Priority should be given to stabilising, consolidating and weeding largely unmodified bushland remnants. These areas contain the greatest diversity of native plant species and will form important nuclei for extending the range of native species in the catchment.
- Priority should also be given to the control of highly invasive vine species, such as Madlera Vine (*Anredera cordifolia*) and Morning Glory (*Ipomea indica*). Madlera vine, in particular, is highly invasive and now occurs in isolated patches along the creekline. Vine species pose a major threat to vegetation management in urban areas since they are capable of smothering remnant native trees and other canopy species. Given minor weed control, canopy species can be established on sites which have a weed understorey however it is extremely difficult to establish and maintain canopy species in competition with aggressive exotic vines. Control techniques for vines must take into account their reproductive cycles and mechanisms. Bush regeneration weed control techniques are most appropriate.
- Secondary priority should be given to the progressive re-establishment of native canopy species along the creekline and gradual removal of exotic canopy species once native species are established. This gradual removal will assist in maintaining the visual character of the creekline corridor. In many situations along the creek, weed trees also help stabilize creek banks and should not be removed until replacement vegetation provides a similar level of protection. The re-establishment of native groundcover species can be undertaken in conjunction with this process. The rate of native plant re-introduction and weed removal will be dependent on the level and commitment of financial resources and labour.

- **Regeneration / Revegetation Strategies**

Three classes of vegetation have been identified within the Ewey Creek catchment. Those on:

- Largely Unmodified Sites
- Significantly Modified Sites
- Adjoining Private Land.

Each of these classes requires a different strategy for managing vegetation.

- **Largely Unmodified Sites**

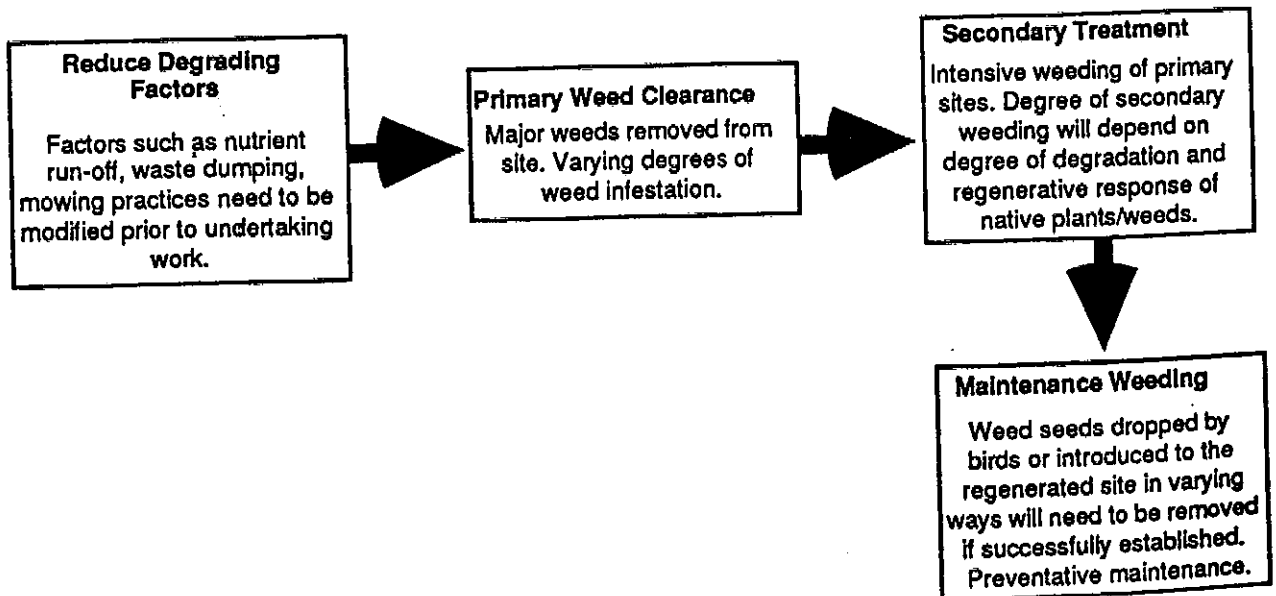
Areas where the dominant vegetation cover is indigenous or where practical re-establishment of indigenous vegetation cover is likely using bushland regeneration techniques.

Principle locations

- Remnant bushland around quarry and public reserve north of President Ave.
- Remnant bushland in public reserve and fringing Yowle Bay, south of President Ave.
- Remnant trees with mown native understorey on Roads and Traffic Authority land west of Thacker St.

Bushland regeneration techniques most appropriate for managing largely unmodified sites.

Bushland Regeneration Process



- Remnants should be consolidated.
- Regeneration work should be undertaken only by trained and experienced regenerators or under supervision by trained regenerators. This is important since many decisions which need to be made in undertaking bush regeneration work on a range of sites can only be adequately made by skilled, perceptive practitioners.
- All weed material should be removed from site and disposed of appropriately.
- Revegetation work may be necessary on bushland / urban boundaries to provide buffering.
- Implement a fire management program based on mosaic 10-15 year cycles on dry sites. Implement a monitoring program of burnt areas to assess effectiveness of strategy. Weed control after control burns is normally required.

Significantly Modified Sites

Areas where significant modification to natural site conditions has occurred resulting in a significant decline or alteration in native vegetation cover and regenerative capability. Vegetation cover is usually dominantly exotic. Re-establishment of native vegetation through bushland regeneration techniques will be limited.

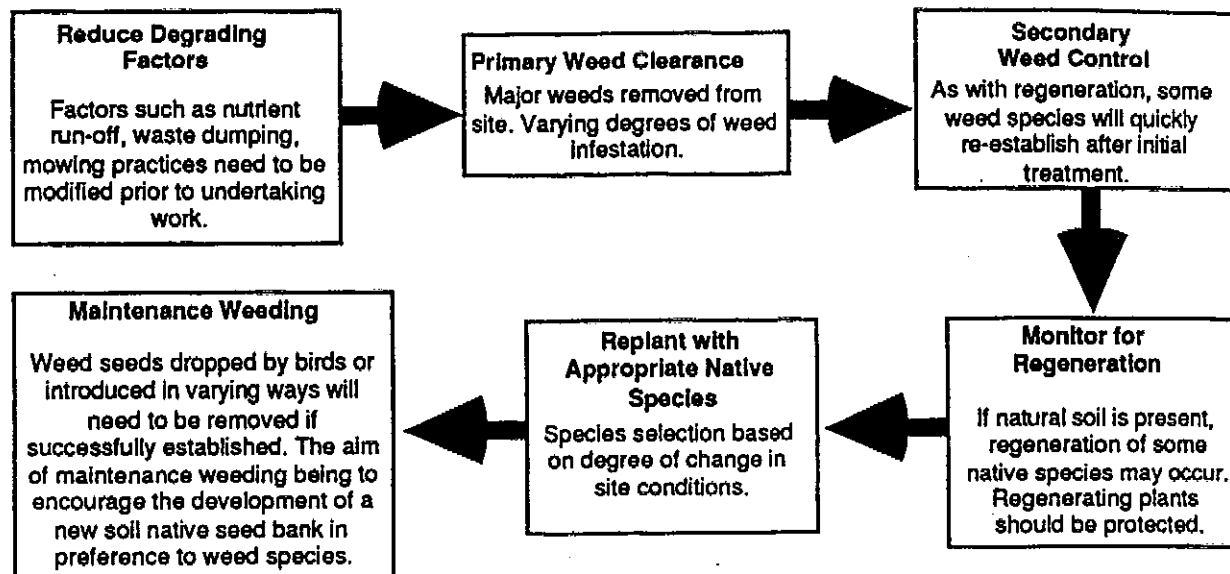
Principle Locations

- Most areas upstream of sandstone quarry at President Ave.
- Particularly modified where creekline corridor is reduced in width.

Revegetation techniques most applicable to managing vegetation on significantly modified sites.

Note: Some small areas of remnant native vegetation may occur on these sites. These should be initially be treated with regeneration techniques then revegetated if required.

Revegetation Process



- Bushland weed control techniques should be used to remove weeds from these areas. A range of these techniques have been developed to maximise long term effective control as practised by National Trust weed eradication teams, Australian Trust for Conservation Volunteers and other agencies and consultants.
- Remove large weed trees (e.g. Camphor Laurels) when native canopy species reach sufficient height to reduce visual impact and provide bank stability following weed tree removal.
- Revegetate sites using species suited to higher soil nutrient and moisture levels. A representative list is attached.
- For revegetation work, use species propagated from nearest naturally occurring source. Council's nursery would be ideal for this role.
- Establish canopy species first, or if resources permit both native canopy and understorey species can be established concurrently.
- Installation of erosion control matting (e.g. coconut fibre) may be necessary on steep, filled sites. This should only be installed after total weed control has been achieved.
- Harvesting of mesic species (e.g. *Pitosporum undulatum*) over the long term may assist in reducing nutrient load in these areas.
- Burning of vegetation will be of little benefit. Burning in these areas would be primarily for nutrient removal and stimulation of sclerophyll natural regeneration. However, burning of the small volume of vegetation on these sites will probably not reduce nutrient levels below the tolerance level of the original vegetation. Secondly, due to the significant changes in soil in these areas (e.g. dumping of fill and garden wastes) it is unlikely that a viable seed bank of sclerophyll species still exists in most places.

Adjoining Private Land

- *areas where natural vegetation has been either totally removed or if still present consisting mainly of remnant mature trees.*

Principle Locations

- Dominant land use in catchment
- A landscaping approach is most appropriate for these sites.
- Residents should be encouraged to replant with species indigenous to the area. Species suitable include those associated with sandstone and shale based woodlands/open forests in the region. Due to the reduced concentration of impacts away from the creekline these species are likely to survive to maturity. This will assist in maintaining a natural landscape character representative of the region. A representative species selection would include those listed for "dry, elevated sites" on the attached species list.
- Residents should be encouraged to remove significant weed species from their properties in the long term. Significant urban tree weed species include Camphor Laurel (*Cinnamomum camphora*), Small Leaf Privet (*Ligustrum sinense*) and Large Leaf Privet (*Ligustrum lucidum*).

Encouragement in this regard can be achieved by increasing public awareness of the negative effects of weed species through education programmes. This may also be facilitated by removing weed tree species from the list of trees protected from removal under Tree Preservation Orders.

26 RECREATION

Alms

Enhance recreation opportunities within public reserves along Ewey Creek which are compatible with the low key, passive nature of the resource and the sentiment of local residents.

Issues summary

Present recreational use within the Ewey Creek corridor is very low key, catering generally to the sporadic demands of its surrounding residents and the specific requirements of interest groups, such as the Scout Association. This is largely a product of the fragmented nature of open spaces along the Creek, which occur either as public reserves or vacant lots. The lack of identity, recreation focus and structured access in these areas highlights the missed opportunity for optimising them as key recreational resources. The same problems have led to indiscriminate dumping and vandalism, particularly in areas which are hidden from public view; thereby further degrading the resource. The potential, for these open spaces, however, may now be realized with the opportunities that may arise as a result of progressive residential redevelopment of the area to higher density dwellings.

In particular there are opportunities to combine passive recreation uses associated with water management features along the corridor. Opportunities exist to enhance recreation potential at a number of individual sites along the Creek.

2.6.1 DISCUSSION

The Catchment consists of series of unrelated public open spaces none catering for any particular recreation opportunity.

There is a distinct lack of recreational facilities within the Corridor, most recreation potential depending on the enthusiasm and imagination of users in creating opportunity. This is a desirable situation particularly where the natural qualities of the resource are highly valued and low key recreational use is favoured.

Despite the obvious existing and potential attractions of a natural creek system there are no water oriented features of significant relevance to the Creek; weed infestation usually precludes access or attraction to the creek.

All reserves appear to provide for local demand only and in the main this is of an unstructured passive nature with little if any concession even to minimal features such as seating.

The topographic nature of the site tends to preclude any recreational activity that requires significant areas of level clear ground. Even where these exist, such as the 'kickabout' area bounded by Houston Street and Manchester Road, the slopes limit their potential. Clearly the creek corridor is of such a nature that substantial orientation to active recreation activities is unlikely to be appropriate. Nonetheless, where opportunities exist to accommodate the needs of the young community in particular for low key active facilities, without compromise to the visual integrity or otherwise quiet enjoyment of the creek, such opportunities should be exploited.

Movement-oriented recreation opportunities within the corridor, such as walking, jogging and cycling are limited by the discontinuous nature of the open space system.

It cannot be expected that this situation will change dramatically in the short term. Nonetheless, and when further links are established along the creek corridor, such opportunities may increase and should be encouraged.

• **Site specific Recreation Issues**

A number of recreation issues arise with respect to specific locations within the corridor. The following is an analysis of those sites and issues.

Scout Hall Site

Recreation opportunity on this site is mostly generated by activity of the Scout group, who utilize their space frequently and intensively. The group would not be significantly affected by the RTA freeway proposal because they have secured a right of way to Manchester Road.

The Scouts would welcome greater opportunity for use of the RTA area for outdoor activities - campfires, barbeques etc. Currently, the RTA policy discourages any trespassing of their properties. This reduces the legitimate recreation use of area and encourages vandalism which has been apparent on the Scout Hall.

The remoteness and isolation of this space also creates a security risk and weakens recreation opportunity.

Because of the temporary nature of the RTA site, options for enhancing recreational use are necessarily limited. Funding of works would receive a low priority in consequence. However, work may dovetail with weed control, bank stabilization and water quality works, particularly related to improving planting and site access.

Kiah Place Reserve

This is a relatively large area of well cut grass and scattered trees offering greatest scope for a combination of active/passive recreation. In its present form it appears to offer little attraction for considerable use. Though well maintained, the area is divided by terracing of land which precludes use of the higher, southern areas of the park. Lack of provision of even minor facilities further weakens the attraction of the park. The quietness and relatively large size of the area suggests potential for a more attractive setting for local use for several types of activity, the good visual access across the area also enhances safety considerations.

Options for increased recreation on this site will depend greatly on water management devices which will inevitably influence character of space. Better availability and access to more level spaces would greatly enhance the areas recreation potential.

Given the potential for the site to fulfil a water management role the opportunity to integrate water-oriented recreation facilities should not be missed.



Left: Retention of the natural bushland character in reserves of the lower creek catchment are highly conducive to passive recreation requiring only minimal amenity provision.

Below: The public reserve at Kiah Place is a highly under-utilized resource with few visual or physical attributes to provide an attractive recreational setting.



RTA Corridor

This is a linear reserve, only recently made available to public with adjacent development of DHA housing. It presently acts only as a link from a footbridge at the eastern end to Klah Place Park.

There is no provision at present for recreation except for walking access along southern bank.

The adjoining DHA development has a significant proportion of young mothers and thus demand for recreation suitable for this group must be considered desirable.

This corridor has good access to the Creek and also has high potential for quiet passive recreation given improved treatment.

Improved recreational opportunity would also exist to the east if the site was linked with the adjacent street.

Klora Road

This is a small reserve, heavily treed which creates a total canopy over the area. The trees create a sense of enclosure and the area is quiet and relatively sheltered from the street. The site is conducive to being explored yet no through route or circular path provides such opportunity.

The area is close to medium/high density developments and thus has high use potential by local residents. At present there are no facilities catering for these adjoining properties.

Local residents have expressed concerns that options to increase access through the park may create security problems. Klora Road provides an arterial vehicular access and is also a commonly used route for pedestrians to the station, shops and clubs etc; the latter causing some problems at night.

Quarry Site

The derelict quarry site is a dramatic physical feature in a semi-natural setting with the open faces of the quarry wall still apparent and sporadic re-growth of native vegetation in clear evidence. The existing path system and stairs provide ready pedestrian access through the site, being well used for walking and giving good views from the higher ground.

The proximity of President Avenue and its attendant noise does, however, reduce amenity and the presence of litter and broken glass emphasises the current 'wasteland' character of the site.

The adjoining creek, the steep nature of the area (lending good views over and beyond the site) and the substantial size of the site suggest considerable recreational opportunity with links to the rest of the creek corridor to the north west and southeast. Again, the opportunity for the site to fulfil a water management role suggests a potential for water-oriented facilities.

The site provides undoubted potential for passive recreation activities, particularly of natural systems interpretive and educational nature.

Yowie Bay

The lower end of the creek issuing into the bay has a very distinct character with an enclosed 'natural' impression created by the steep sides and substantial tree cover that overly the waterpools and outcropping stone of the creek bed.

Whilst the topography limits easy access and substantial recreational activity is inevitably limited the area has particular attractions that lend themselves to quiet low key pathway links between President Avenue and Clifford Avenue reserve when and if such opportunities arise.

Private Areas

Recreation activity within properties adjoining the creek varies from intensive gardening incorporating the Creek as a feature to complete isolation of the Creek with fences, heavy weed infestation and bank stabilization methods which produce a highly negative impact. Increased awareness of the Creek for its passive recreational qualities may increase respect for its worth and reduce problems caused by inappropriate garden management.

• Overview

It is evident from the discussion of the issues and description of sites that recreation along the Ewey Creek corridor consists primarily of low key, unorganised recreation. There is generally no provision of facilities to enhance recreational experiences, except for some pedestrian access allowing transitory use, but little else.

While it may be seen as desirable to maintain local character, it is questionable that the present level of recreation is achieving its full potential as a local reserve. Existing local sentiment suggests that the public greatly value these public resources although expectations are minimal.

Careful development/enhancement/planning with compatible strategies could embrace this sentiment and give greater recognition of these areas. This could be achieved without compromising local quality and potentially reduce undesirable use of parks, which presently weakens the amenity of many parts of Ewey Creek.

2.6.2 PRINCIPLES

In order to optimise recreation use of the Ewey Creek corridor, the following principles are offered to enhance recreational experience in the reservations:

- Generally facilitate greater recreation opportunity in public reserves along the Ewey Creek corridor by developing compatible facilities. Discourage active recreation in areas identified for passive use.
- Optimise potential of particular reserves by developing opportunities arising from existing physical characteristics or future water management devices if appropriate.

- Achieve this by adopting following site specific principles:
 - RTA/Scout site
Encourage active recreational use of the site and provide temporary facilities which are compatible with present use of the area by Scouts. Review RTA's current management.
 - Klah Place
Incorporate recreational opportunity into future wetland ; Cater for appropriate recreational use with provision for some low key active use of the area and develop a local education and interpretative resource.
 - RTA corridor
Encourage greater use levels/opportunity for passive recreation along creek. Discourage active uses.
 - Klora Road
Enhance existing passive recreational use of park.
 - Quarry site
Optimise future water management devices for recreation. Incorporate existing under-used physical elements for greater public appreciation, interpretation and enjoyment. Discourage active recreational use except for areas which are isolated from key passive use areas.
 - Yowle Bay
Encourage passive use of site which is compatible with its natural characteristics. Discourage active recreation in any form. Improve visual links with Yowle Bay and access public path which does not compromise privacy of adjacent landowners.

27 MANAGEMENT

Aims

To maintain public land in a manner which sustains and enhances the dominance of natural bushland enabling an appropriate level of recreational use and the servicing of water management devices.

Issues Summary

Maintenance of public reserves throughout the Ewey Creek catchment is generally adequate in keeping them in a tidy condition. With some modification to their layouts and landscape treatments, together with the input of local volunteers to assist with maintenance and management, the standard and character of these reserves could improve considerably. These may require changes to the tasks and routines of maintenance staff but should not greatly affect their overall level of input.

2.7.1 DISCUSSION

Maintenance of public areas throughout the catchment varies according to the priorities and procedures established by different authorities.

The majority of public land falls under the responsibility of the Sutherland Shire Council through its Recreation Facilities and Buildings Department. The Department has allocated a labour force of four to five men to carry out the maintenance of reserves in the catchment as well as other specified areas in the Shire. Tasks are dominated by grass cutting which is undertaken approximately every four to five weeks using tractors at the Kiah Place reserve, and ride-on or standard push mowers at the other reserves. Other tasks include brushcutting, minor weeding and spraying of non-residual chemicals to control Lantana and grass growth around the edges.

Weed control is one task that is evidently inadequate and is only undertaken in an ad-hoc fashion, usually in response to pressure from local residents. The lack of follow up treatment and expertise in carrying out this work, therefore, results in only marginal or even questionable long term improvement to weed infested areas.

Council also employ staff specifically to address the regeneration of bushland. However, the vast area of bushland requiring attention throughout the Shire has resulted in little activity occurring in bushland areas within the Ewey Creek catchment.

Other potential sources of maintenance assistance, primarily through 527 committees, have yet to be organised for Ewey Creek reserves. Interest from residents is growing, however, and the formation of such a group should be encouraged in the near future.

The Council also undertakes regular street sweeping as part of its routine maintenance work. This is only carried out on major roads such as Gympie Bay Road, Kingsway and President Avenue and in streets around shopping centres. No sweeping is carried out in suburban streets unless specifically requested by the local community.

However, recent changes in practices have been implemented. For instance suction of material is now the only method used; flushing is no longer carried out because of negative environmental implications. These are very positive initiatives which should be encouraged in the development of strategies for the Ewey Creek catchment.

The State Rail Authority (SRA) undertake regular maintenance of verges and perilite along the line which passes through the north of the catchment. This work involves spraying of noxious weeds twice yearly in winter using residual chemicals; in summer with a knock down spray. The SRA employs an agronomist to ensure appropriate chemicals and applications procedures are followed in accordance with current legislation. The agronomist also prepares a specification if the work is to be carried out by contractors. Slashing of vegetation is carried out twice yearly and this is to be increased in regularity. Burning is not undertaken as a maintenance procedure. Increased security measures are also being installed along sections of the railway line. This may involve improved fencing and modification to locks to reduce access and vandalism.

The RTA provide low-key maintenance to the freeway corridor. Mostly consisting of grass cutting, undertaken by a contractor. Again, where required additional maintenance tasks are usually only carried out in response to local residents' requests.

From all of the above it is evident that there is little if any clear cut strategy for management and maintenance of vegetation along Ewey Creek, the principal emphasis being on grass cutting, minimal containment of weed and removal of nuisance when requested.

Strategies developed to co-ordinate management and maintenance of Ewey Creek must therefore seek to achieve a common goal and agreed methodology between all the authorities concerned.

A detailed discussion of the issues that relate to vegetation management in the creek may be found in Section 2.5.

2.7.2 PRINCIPLES

- Review emphasis of Council maintenance staff procedures in the Ewey Creek corridor to match best practice for regeneration of native vegetation.
- Continue and improve appropriate street cleaning strategies to minimise impacts on the creek.
- Encourage the establishment of, and provide technical support for local involvement in the management of the creek corridor.
- Encourage the RTA and SRA to adopt appropriate maintenance procedures that will enhance the regeneration of native vegetation.

3 CONCEPT PLAN

By adopting design and planning principles identified through the analysis of the Ewey Creek catchment above, a detailed Plan can be developed that accurately reflects both immediate opportunities and long term responsibilities in the rehabilitation of the creek.

Although the area of the creek catchment is relatively small, the diversity and extent of the principles that must be respected in its management underline the complexity of such systems. This is particularly problematic when they are located in urban surroundings. It is necessary, and helpful, in such cases to express the intent of the Management Plan as a simple concept prior to considering the strategies required to bring it into effect.

The *Concept Plan* for Ewey Creek envisages a central corridor of rehabilitated bushland, made visible and accessible amidst the domestic character of its surroundings. The creek should regain its value as natural asset in an urbanized catchment and cease to be seen as merely a drainage facility and a problem area.

While there are limited opportunities to develop recreational activities in the creek corridor, the Concept Plan maximises connections to the larger public reserves where toddlers play, seating, casual leisure and interpretive facilities are focused. Safe, weather pathways will link the corridor as redevelopment and practicality permit.

The concept promotes more efficient long term management by allowing maintenance and emergency access along the creekline in a flood free, public reserve. At key locations within the catchment, pollution control traps and artificial wetlands are integrated in the open space to improve water quality in the creek, and in Yowie Bay.

Beyond the creek corridor the Plan relies on planting, waste and water runoff management, community education and development control to complement the direct strategies for rehabilitation.

In all of this, the Concept Plan is seen as a considered balance of three fundamental criteria in planning, namely

- Feasibility
- Desirability
- Affordability

but remains a challenging and exciting proposal that will contribute to the image and urban design quality of the district (refer figure 4).

Figure 4
Concept Plan.

4 STRATEGIES

The following section describes in detail the strategies that are derived from the preferred concept for Ewey Creek.

The strategies are intended to provide clear guidelines for the future planning, design and management of the creek.

The strategies are collated under three common headings and should be read in conjunction with the corresponding three drawings:

- *Water, Conservation and Open Space Management* (refer figure 5)
- *Landscape Character and Visual Appreciation* (refer figure 6)
- *Landuse, Access and Recreation* (refer figure 7)

Under each heading the specific strategies are documented in detail, with a corresponding indication of the parties that should be responsible for further development or implementation.

4.1 WATER, CONSERVATION AND OPEN SPACE MANAGEMENT

• *Water Management devices*

Construct the following water management devices to improve the water quality of Ewey Creek:

- **Klah Place Reserve**
Install a Minor Gross Pollutant Trap (GPT) below ground level and Water Pollution Control Pond (WPCP) with a water surface area of 0.22 Hectares in the existing public reserve at Klah Place. SSC
Technical Services
- **Old Standstone Quarry**
Install a major GPT within the creekline in the north-west corner of the public reserve. SSC
Technical Services
- **Old Quarry**
Install a WPCP to encompass the existing creek and the western portion of the old quarry floor within the lower area of the reserve. Proceed with construction only after installation of the GPT's and the WPCP as described above and only if subsequent water monitoring suggests the need and justification of this additional device. SSC
Technical Services
- **Prior to the construction of the WPCP at the quarry site, consideration should also be given to the use of the area as a landing site for any anticipated dredging operation of Yowle Bay and Port Hacking. Note that this operation is beyond the scope of this study and will be subject to further detailed analysis.** SSC
Technical Services

• *Creek stabilization*

Install creek stabilization treatments which are compatible with improved flood mitigation measures and the natural appearance of the creek. Consideration should be given to the use of rock won from construction of the WPCP at the old quarry site. Install in the following locations:

- **Klah Place**
Between the weir of the WPCP east to the end of the public reserve.
- **Klora Road Reserve**
The entire section of the creekline running through the reserve. SSC
Technical Services
- **Private Landholdings**
Install this treatment along the creekline of existing private landholdings over the longer term when acquired or dedicated for public ownership in association with site re-development. The relevant landowners will be totally responsible for this work at the time of redevelopment. Land Owners

- **Replace open drain**

Install pipes along the creek drainage easement replacing the existing open gully for all sections upstream of Manchester Road. This will improve visual amenity and safety of the creekline to residents and remove habitat for vermin. Relevant landowners will be totally responsible for this work at the time of redevelopment.

Land Owners

- **Stormwater pipe extension**

Install stormwater pipes to provide a continual controlled drain extending from existing drainage outlets in the two public reserves north and south of President Avenue. Landowners will be totally responsible for this work as part of any redevelopment of the adjacent land.

SSC
Technical Services
Land Owners

- **Information and Management Advice**

Undertake a community liaison programme informing residents of the need to reduce nutrient inputs into the stormwater and creek system by encouraging them to:

SSC
Technical Services

reduce fertilizer use

wash vehicles on lawns rather than streets

stop garden waste dumping along the Creekline.

Furthermore, inform residents of the prevalence of weed species throughout the catchment and their degrading effects on natural systems, particularly Ewey Creek. Recommend the progressive removal of these species with priority on those which are highly invasive. Provide a list of preferred replacement species which follows the recommended list for wetland rainforest and dry sites outlined in Sections 5.2.5 and 5.2.6.

SSC
Technical Services

- **Street sweeping**

Extend the programme of sweeping street gutters to include all streets in the catchment so that accumulated nutrient rich material is removed before entering the natural drainage system.

SSC
Technical Services

- **Sewer discharge**

Undertake regular monitoring of sewer manholes to check for discharges. Inform the relevant authority of the need for any maintenance works if discharges are detected.

SSC
Technical Services
Water Board

- **On-site Stormwater Detention**

Ensure that new development applications to Council comply with the Interim Standards for on-site detention of stormwater discharge.

SSC
Technical Services

• **Pollution Monitoring**

Undertake an on-going programme of monitoring possible sources of pollution entering the stormwater system from locations within the catchment likely to generate contaminated run-off. Consideration should be given to commercial areas, the railway corridor, new building sites and public carparks. Undertake environmental audits of business premises to identify possible sources of pollution and educate owners about pollutant disposal.

SSC
Health Services

• **Bush Regeneration**

Undertake a bush *regeneration* programme involving weed removal and on-going maintenance in areas along the creekline where the native bush cover is relatively intact. Consideration should be given to the establishment of a 527 Committee in association with Council to assist with the regeneration programme. Note that bush regeneration should not be undertaken in isolation from other strategies recommended for the same area, particularly regarding park enhancement and water management measures. Ensure that all work is carried out under the supervision of an appropriately qualified bush regeneration specialist. Areas favoured for this treatment include:

SSC
Technical Services
527 Committee

- Remnant bushland around the old quarry and public reserve north of President Avenue.
- Remnant bushland in public reserve and fringing Yowie Bay, south of President Avenue.
- Remnant trees with mown native understorey on Roads and Traffic Authority land west of Thacker Street.

• **Bush Revegetation**

Undertake a bush revegetation programme for highly modified areas and sites requiring substantial reconstruction. Ensure revegetation is undertaken with similar stipulations to the bush regeneration programme outlined above and follow the recommended species list for wetlands, rainforest and dry sites outlined in Sections 5.2.5 and 5.2.6.

SSC
Technical Services

- Kiora Road reserve
- Planting associated with the recommended water management devices at Klah Place and the Old Sandstone quarry site.
- Planting associated with park enhancement in all public reserves not identified for regeneration work.
- The creek corridor currently under private ownership. This work will need to be carried out progressively following acquisition/dedication of the corridor for public open space in consequence to site redevelopment (refer Section 5.1). Relevant landowners will be totally responsible for this work at the time of redevelopment.

Land Owners

- **Fire Management**

As part of the bushland regeneration strategy, liaise with residents and the Fire Brigade to determine the potential for undertaking a fire management programme specifically for bushland areas in reserves adjacent to Ewey Creek or either side of President Avenue. Consideration should be given to the positive implications of the procedures in achieving and maintaining an indigenous bushland community and in controlling undesirable plant species. Review this strategy annually.

SSC
Technical Services
Fire Brigade
Local Residents

- **Water quality monitoring**

Undertake an on-going water monitor programme in Ewey Creek to gauge the success of the water quality devices and to determine whether the construction of the WPCP at the old quarry site is justified. Recommended locations for monitoring are:

SSC
Technical Services
Community groups
Health Services

- Upstream of Klah Place WPCP
- Immediately downstream of the Klah Place WPCP
- Immediately downstream of the Major GPT near Taylor Close
- Downstream of President Avenue

Consideration should be given to liaising with community groups such as local schools to assist with the programme.

- **Management Officer**

Identify an officer to oversee the implementation of strategies for a fixed period to ensure that momentum for this work is maintained and to facilitate community liaison. Consideration should be given to extending the role of the officer to include the co-ordination of other similar projects throughout the Shire.

SSC
Technical Services

- **Water quality and park interpretation**

Install a co-ordinated and discrete system of signs and other appropriate interpretive measures explaining strategies being undertaken to improve the environmental conditions of Ewey Creek and the vulnerability of the natural system to mismanagement and unsympathetic activities among the community.

SSC
Technical Services

Figure 5

Strategies

Water Conservation +

Open Space Management.

4.2 LANDSCAPE CHARACTER AND VISUAL APPRECIATION

• *Enhancement of Major Public Open Space*

Redevelop existing and amalgamated public reserves to optimise on existing landscape features and proposed water improvement devices to create a series of distinctive landscape settings which combine to generally enhance the visual significance of the creek corridor. In this regard, redevelopment should follow a theme which emphasises the natural qualities of the creek environment. All enhancement measures to be developed in concurrence with strategies described in Section 4.1 including bank stabilization treatments, revegetation and regeneration programmes. Redevelopment of specific sites are:

- *Kiah Place*

Redevelop the reserve incorporating the Water Pollution Control Pond (WPCP) as its main aesthetic feature. Design the pond as a semi-natural water body with a variety of edge profiles and treatments including rock outcropping, a shallow gravel beach and native vegetation. Species should reflect a natural progression of plants from aquatic emergent species to climax communities which will encourage habitat for native fauna and increase visual and educational interest.

SSC
Technical Services

Provide areas within the reserve which allow active play and quiet seating to co-exist and incorporate a sympathetically designed playground to be installed in a physically separate part of the site.

Facilitate the use of the reserve as an educational resource with amenities such as boardwalks, viewing tower, and interpretive signs.

Enclose the reserve with a vegetative screen to protect the privacy of adjacent residents.

- *Disused Sandstone Quarry (Lower Level -prior to construction of WPCP)*

Optimise the geological, educational and visual attributes of the quarry by installing paths, seating, interpretive signs and viewing points that highlight features of the site that will be of interest to the public. Replace weed growth from fissures in the quarry floor and wall with indigenous species. Ensure that the GPT is sensitively located within the north-west corner of the reserve and that it is adequately screen planted to obscure view's from both within the reserve and residential areas around it. Consideration in the enhancement of the site should be given to the potential installation of the WPCP and its use as a landing site for dredging of Yowie Bay and Port Hacking.

SSC
Technical Services

- **Disused Sandstone Quarry (Lower Level - Incorporating WPCP)**
 Incorporate the proposed WPCP within the reserve as a semi-natural feature to compliment the education and visual attributes offered by the quarry. Utilize the characteristics of the sandstone to determine the alignment and form of the pond edge. Vary the edge profiles whenever possible to accommodate a range of Indigenous wetland/aquatic plant communities. Consideration in this regard should be given to creating a perched wetland edge to maintain water levels and, therefore growing conditions in isolation from varying water levels of the pond itself (refer Section 5.2.2). Provide site infrastructure in addition to features previously installed including boardwalks, seating and interpretive trails. Also install a focus of interpretation and site information where views of the quarry wall and pond can be best appreciated.

SSC
Technical Services

- **Disused Sandstone Quarry (Upper Level)**
 Optimise the easy street access, isolation and relatively level surface of this area with the installation of a playground structure. Provide an area of mown grass adjacent to the playground to facilitate active play. Contain the grass area within the path system to prevent invasion into adjacent bushland and remove all other areas of grass for the regeneration of the native bushland cover.

SSC
Technical Services

Remove all other areas of mown grass and reinstate the natural bushland. Ensure that this treatment along the top of the quarry wall is successful in screening the nearby security fence and strengthens the visual continuity of the ridgeline.

- **North of President Avenue**
 Enhance the natural quality of this part of the reserve by removing the areas of mown grass and other degrading elements through strategies for bush regeneration in Section 4.1. Provide some additional discrete seating throughout the reserve and replace the piperail barrier along a section of the path running close to the President Avenue with a structure which is more sympathetic with the setting.

SSC
Technical Services

- **Yowie Bay**
 Redevelop the separate portions of this area to establish one large integrated reserve which encapsulates the tranquil enclosed qualities it has to offer. Re-establish a native vegetative cover over the longer term to compliment the bushland north of President Avenue but optimising the potential for a lush plant community. Provide discrete seating and access routes to presently inaccessible parts of the reserve, particularly adjacent to the creek.
 SSC
Technical Services

- **Viewing Platforms**

Open up and promote views of significant features and settings by constructing viewing platforms at prominent vantage points. Consideration should be given to the character of their intended setting with a view to ensuring compatible siting, design and use of materials. Appropriate locations for these structures include:

SSC
Technical Services

- The top of the quarry face adjacent to Partridge Avenue to provide panoramic views and an interpretation point over the quarry and water body below.
- A new entrance point off President Avenue into the eastern side of the Yowie Bay reserve to provide an incidental viewing point over the tree canopy and steps to provide access to the reserve below.
- The end of Clifford Road to optimize on the views of Yowie Bay and provide steps for access to the waters edge.
- A simple freestanding structure within the Kiah Place reserve to enhance the appreciation of the water body and provide the reserve with a visual focus.

- **Street tree planting**

Instigate a tree planting and management programme for streets in the Creek catchment to generally increase the visual presence of vegetation in the catchment and improve the amenity of the streets. Species should be indigenous to the area with sclerophyll species predominating. Rainforest species should be planted, however, along cul de sacs and sections of streets crossing the Creek. This will help define the creek within its setting and similar planting which is recommended along the creek corridor.

SSC
Technical Services

The Programme should involve a review of the vigour, visual character and consistency of any existing avenue trees. Infill gaps if appropriate or undertake a replacement programme with new species as described.

• ***Creek Corridor Enhancement (short-term)***

Promote Ewey Creek as a prominent natural feature in the landscape by liaising with property owners to undertake an on-going programme of replacing inappropriate vegetation with indigenous species and incorporating natural materials for other structural treatments. Develop these measures in concurrence with strategies described in Section 4.1 including bank stabilization and revegetation treatments.

SSC
Technical Services

• ***Creek Corridor Enhancement (long term)***

Council to develop a co-ordinated enhancement programme for the Creek Corridor if and when areas become available for acquisition or dedication through redevelopment. The programme should be phased to ensure that high priority is given to revegetation work while the incorporation of embellishments including paths, footbridges, lighting and seating is carried out with cognizance of local residents. Consideration should be given to modifying the finish of existing retaining walls by cladding or sandblasting to reduce their visual impact. All work should incorporate strategies described in Sections 4.1 and 4.3. Relevant landowners will be totally responsible for this work at the time of redevelopment.

Land Owners

• ***Enhancement of Secondary Parks***

Strengthen the character of secondary parks to increase their visual and recreational appeal. Achieve this by generally improving the standard to the reserves with minor provision of amenities, weed removal, native tree revegetation and increased maintenance input. All enhancement measures to be developed in concurrence with strategies described in Section 4.1 including bank stabilization treatments, revegetation and regeneration programmes. Appropriate parks for enhancement include:

- **Klora Road Reserve**
Modify the present character of the reserve with the long-term replacement of the weed cover and native vegetation. Ensure that the shade and intimate quality currently afforded by the reserve is maintained.
SSC
Technical Services
- **RTA reserve off Houston Street**
Undertake improvement work with the concurrence of the Authority.
SSC
Technical Services
- **Corridor east of Kiah Place Reserve**
Ensure that park improvements here are linked and incorporated within the layout of the proposed redevelopment of Kiah Place Reserve.
SSC
Technical Services

- **Park Infrastructure**

Develop a co-ordinated pallet of park furniture, pavement details, steps, signage and stone walling treatments to be used in all new development works along the creek corridor.

SSC
Technical Services

- **Bollard Lighting**

Improve visibility and safety of all pedestrian paths through public reserves with the installation of bollard lighting. Design and character of lights should be compatible with other park furniture and be sufficiently durable to withstand vandalism. Consideration should be given to installing bollard lights to public footpaths along the Ewey Creek corridor if and when additional sections are acquired or dedicated through site redevelopment. Relevant landowners will be totally responsible for this work in the creek corridor at the time of redevelopment.

SSC
Technical Services
Land Owners

- **Park Entrances**

Highlight the entrance into parks with a series of co-ordinated gateway features including accent planting, stone walling, steps interpretive signs and lighting. Appropriate locations for these features include:

SSC
Technical Services

- Corner of Sylvania Road and Klah Place (for Klah Place reserve)
- Verge adjacent to Kloro Road reserve
- Verge at the end of Partridge Avenue (for the old Quarry reserve)
- Verge at the end of Kirkby Place (for the old Quarry reserve)
- Verge at the end of Clifford Road (for the Yowie Bay reserve)

- **New parapets**

Replace pipe-rail fences at Creek crossings with parapets which use natural materials such as local stone and timber to enhance the integrity of the creek. Appropriate streets for this treatment are:

SSC
Technical Services

- Wandella Road
- Kloro Road (west side only)
- President Avenue

Figure 6
Strategies
Landscape Character +
Visual Appreciation

Figure 7
Strategies
Landuse Access +
Recreation

4.3 LANDUSE, ACCESS AND RECREATION

- **Draft development Control Plans (DCP's)**

Adopt principles developed in draft Miranda DCPs for precincts 15 and 22 for the remainder of the Ewey Creek corridor. Modify to suit strategies developed in this Management Plan.

SSC
Planning

- **Extend the DCP programme**

Prepare DCP's for the remaining precincts along the creek corridor adopting similar principles to the draft DCP's already prepared and following strategies developed in this Management Plan. Matters for consideration in the assessment of a development application may include any of the following criteria:

SSC
Planning

- Height, scale and relationship with adjacent buildings.
- Setbacks from creek boundaries.
- Extent of vegetation to be cleared.
- Siting design and materials to be used.
- Extent of earthworks required.
- Finished levels above the 100 year flood line.
- Extent of proposed open space.
- Proposed vegetation species.
- Dedication of land along the creek corridor to Council.
- Orientation of dwellings towards the creek.
- Fencing adjoining the creek to be open-type in character.

Appropriate precincts for this strategy occur within the Miranda Centre DCP Precinct No's P3, P13, P26, P27B, P28, P29, P31, P33 and P34.

- **Redevelopment of Existing Properties**

Ensure that all forms of redevelopment for existing properties along the creekline including subdivisions, dual occupancies or building renovations comply with the principles set out in the Management Plan. This includes orientation of dwellings towards the creek to increase the creeks visibility.

- **154 President Avenue**

Give consent to the Development Application to this property which proposes the acquisition of land by Council along its north-eastern boundary for incorporation into the Yowie Bay reserve adjacent to it. Ensure that the application also allows public access into the reserve from President Avenue on the western side of the Ewey Creek bridge.

SSC
Planning

- **112 Matson Crescent**

Retain this block of land within Council ownership because of its visual prominence on the corner of President Avenue and the eastern bank of Ewey Creek. Redevelop the site in association with the adjacent reserve to create a bolder visual and recreational resource as discussed under section 4.2 Landscape Character and Visual Appreciation.

SSC
Properties

• **Recreation**

Improve the recreational potential of all public reserves by enhancing their landscape character to generate greater attractiveness for use, and modifying layouts to cater for a wider range of recreational pursuits. As a rule, only passive non-organised pursuits should be encouraged with some facility for active recreation if the reserve can accommodate them in a compatible way. Incorporate proposed Water Pollution Control Ponds (WPCP's) in a manner which will facilitate and enrich recreational interest. Undertake the following site specific strategies:

- **Klah Place**
 Optimise on the tranquil water setting proposed for the reserve with the provision of seating, board-walks and walking trails in appropriate locations throughout the site. Incorporate open grass clearings on the existing elevated terraces to retain active play as minor recreation pursuit. A playground structure to cater for young children should also be installed at the eastern end of the reserve where interference with quieter parts of the reserve will be minimal.

SSC
Technical Services

- **Old Quarry**
 Provide low key recreational features throughout the reserve to reflect the natural and educational qualities of the resource. In particular, develop the quarry site and proposed WPCP as key landscape features. Encourage attention to their significance with improved pedestrian trails to create a circuit and to optimise on the under-utilized public access routes off Kirkby Place and Partridge Avenue.

SSC
Technical Services

- **RTA Reserve**
 Liaise with RTA to seek concurrence for changes to their present policy of discouraging public access onto the reserve. Encourage recreational use with improved access across the creek, and more attractive open space with additional native planting and weed removal.

SSC
Technical Services
RTA

Footbridges

Improve pedestrian access and increase recreation opportunity within open space reserves by incorporating new pedestrian bridges across the creek and steps down steep grades. Install bridges in association with landscape enhancement strategies for major and secondary parks as described in Section 4.2. Consideration should be given to ensuring compatibility of design with the surrounding landscape in terms of siting and use of materials. All bridges to be designed to clear the 100 year flood level including piers and other structural components. Appropriate locations and structures include:

RTA Reserve

Replace the existing damaged crossing with a simple plank and handrail construction for pedestrian access. Improve the approaches to the bridge with a graded path. Consider a similar structure and treatment in the eastern end of the reserve to create a pedestrian circuit.

SSC
Technical Services

Klora Road Reserve

Install a timber footbridge at the western end of the park to create an internal circuit.

SSC
Technical Services

Old Quarry

Install two timber footbridges in the quarry site-one in the north-western corner of the reserve in association with the development of the WPCP linking it with a presently under-utilized footway to Kirkby Place; the other, linking existing pedestrian trails in the south western corner of the reserve with the footpath along President Avenue.

SSC
Technical Services

Yowie Bay

Provide a footbridge over Ewey Creek linking the presently under-utilized eastern reserve with the area of dedicated open space on the western side.

SSC
Technical Services

KIRKBY PLACE

PRESIDENT AVENUE

- **Maintenance Access**

Ensure access is readily and easily available for maintenance vehicles to service water management devices and public reserves generally for the following locations:

SSC
Technical Services
Land Owners

- **Klah Place**
Direct access to service the GPT is made available from Klah Place.

Access into the WPCP is made available via a ramp at an appropriate gradient off Klah Place through the GPT apron for periodic dredging of the pond floor.

- **Disused Sandstone Quarry**
Access to the old quarry floor for maintenance of the GPT and WPCP is provided by utilizing the existing ramp off Partridge Avenue and following the route of the proposed path into the area. Ensure that the route is sufficiently clear and graded for maintenance vehicles without excessive impact on the character of the setting.

- **Creek Corridor**
Ensure access for maintenance vehicles is provided along the creek corridor when areas are dedicated or acquired for open space. Routes need to be designed with sufficient clearance of vegetation and gradients. Refer to Section 5.1.

Access points into the corridor for maintenance vehicles to be made available over the longer term off adjacent streets or existing public reserves. Relevant landowners will be totally responsible for provision of maintenance access at the time of redevelopment.

- **Access for the disabled**

Install paths leading into major reserves to allow access for the disabled.

SSC
Technical Services

Provide separate accommodation for disabled carparking close to the the entrances into reserves and provide appropriate kerb crossings nearby.

Provide carparks and ramps in the following locations:

- Klah Place (western end)
- Partridge Avenue (western end)
- Clifford Road (eastern end)

5 IMPLEMENTATION

This section sets out a range of ways and means for pursuing the strategies for creek rehabilitation and management. It suggests the priorities for a work programme and indicates the financial implications of developing the preferred concept.

- 5.1 *Corridor Controls.* Suggested boundaries and zones for landuse management along the creek line.
- 5.2 *Design and Material Guidelines.* Typical details and construction techniques for use in rehabilitation works.
- 5.3 *Priorities.* Recommended priorities for specific project implementation.
- 5.4 *Costing.* A guide to the relative costs for specific projects and rates for general treatments throughout the creek catchment.
- 5.5 *Funding Alternatives.* Summary of grants available from State and Local Government, statutory authorities and other agencies that may be sought to assist with projects development arising from this Plan.

5.1 CORRIDOR CONTROLS

Following from the Strategies, there will be several design and creek management initiatives that apply along the whole length of the waterway, particularly where these have a direct relationship to water levels, or the need for management access, for example.

Illustrated on Figures 8 and 9 are Corridor Controls that should be pursued in the long term to establish the

- **Creek Corridor** - preferred minimum widths

Set at the 1 in a 100 year flood line but not less than 20 metres in any open section of the creek corridor. The Building setback (see below) will ensure buildings are clear of the 100 year flood.

In piped sections this corridor width should be set at any existing easement width, but not less than 3 metres, for access purposes.

- **Landscape Buffer** - Species selection guidelines

A 10 metre wide strip adjacent to the creek corridor in which canopy tree planting is particularly encouraged, and any vegetation introduced is limited to those native plant species recommended in Section 5.2.5 and 5.2.6 of this study. Boundary fences are to be open-type in form.

- **Building Setback** - Visual and shadow impact

In the first 5 metres of the Landscape Buffer on both sides of the creek development should not be permitted. The rear 5 metres of the Buffer zone may be developed in line with other DCP conditions of site coverage, side boundary set backs etc, but to a maximum height of one storey on the northern bank and two storeys on the southern bank of the creek. Building envelope controls in the DCPs would apply to the rest of the site.

Figure 8
Consider Controls
Plan

Figure 9
Consider Controls
Creek Profile

5.2 DESIGN AND MATERIAL GUIDELINES

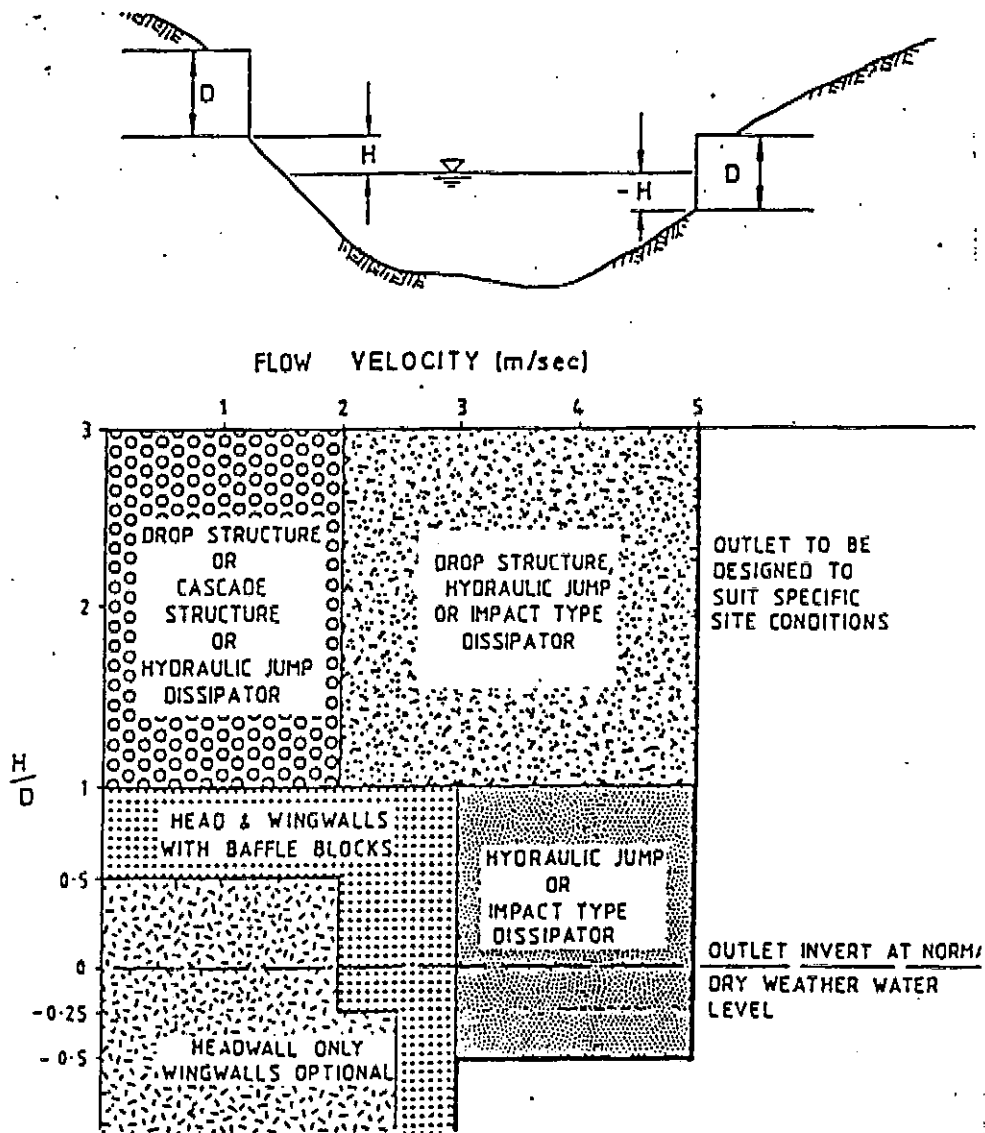
Continuing management of the creek, and development along the corridor should aim for a higher standard of appearance and aesthetic control in all construction. To this end, the following guidelines suggest materials, techniques and details that are suitable for Ewey Creek bank treatments, structures, planting and pollution control measures.

Reference to Appendix C for further information is also recommended.

It should be noted, however, that these details are only guidelines and cannot be applied without specific site investigation and detailed design. They are intended to demonstrate the scale, character and relative impact/costs of appropriate treatments.

Following this section, Detail Plans have been prepared to demonstrate the application of Strategies (refer Figure 10). These have been undertaken for the Klah Place, Old Quarry and Yowle Bay reserves which are the key public open spaces along the creekline. The layouts show a notional arrangement of landscape and recreational elements focussing on proposed water management devices as key site features. The Plans are Indicative only and should only be considered for discussion purposes.

5.2.1 SELECTION OF TRIBUTARY DRAIN OUTLET WORKS

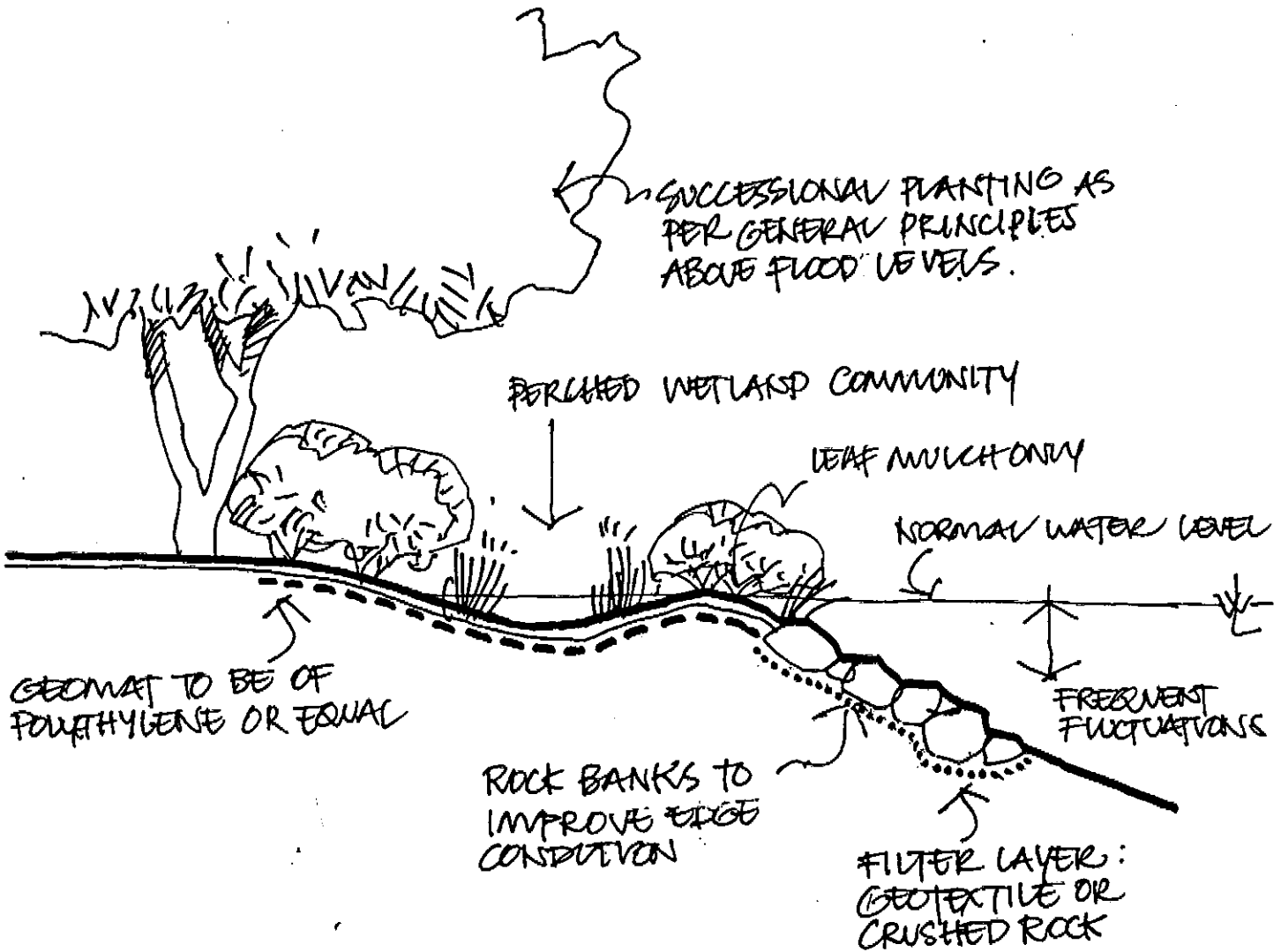


Note 1. It is strongly recommended that whenever $H > 1.0$ m that H/D is assumed to be greater than 1.0 for the purposes of selecting the outlet type.

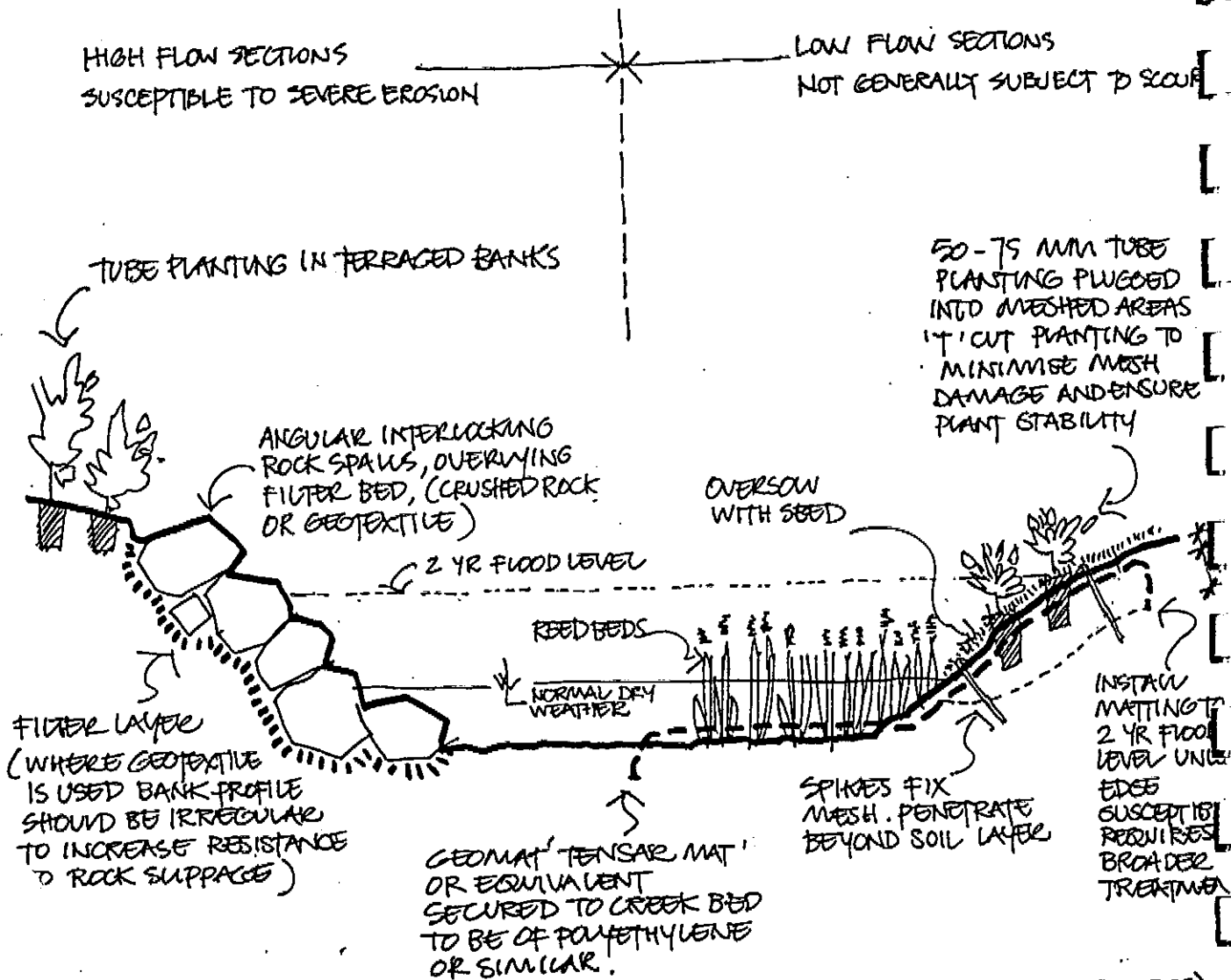
Note 2. Stilling Ponds may be used where $H/D < 1.0$ and outlet velocities are less than 5 m/sec.

Note 3. For $H/D > 3$ a drop chamber, cascade or chute structure with dissipator would normally be adopted within the appropriate velocity range. However specific model studies may be required and extreme care should be exercised in selecting the appropriate outlet type.

5.2.2 EDGE PROFILE OF PONDS

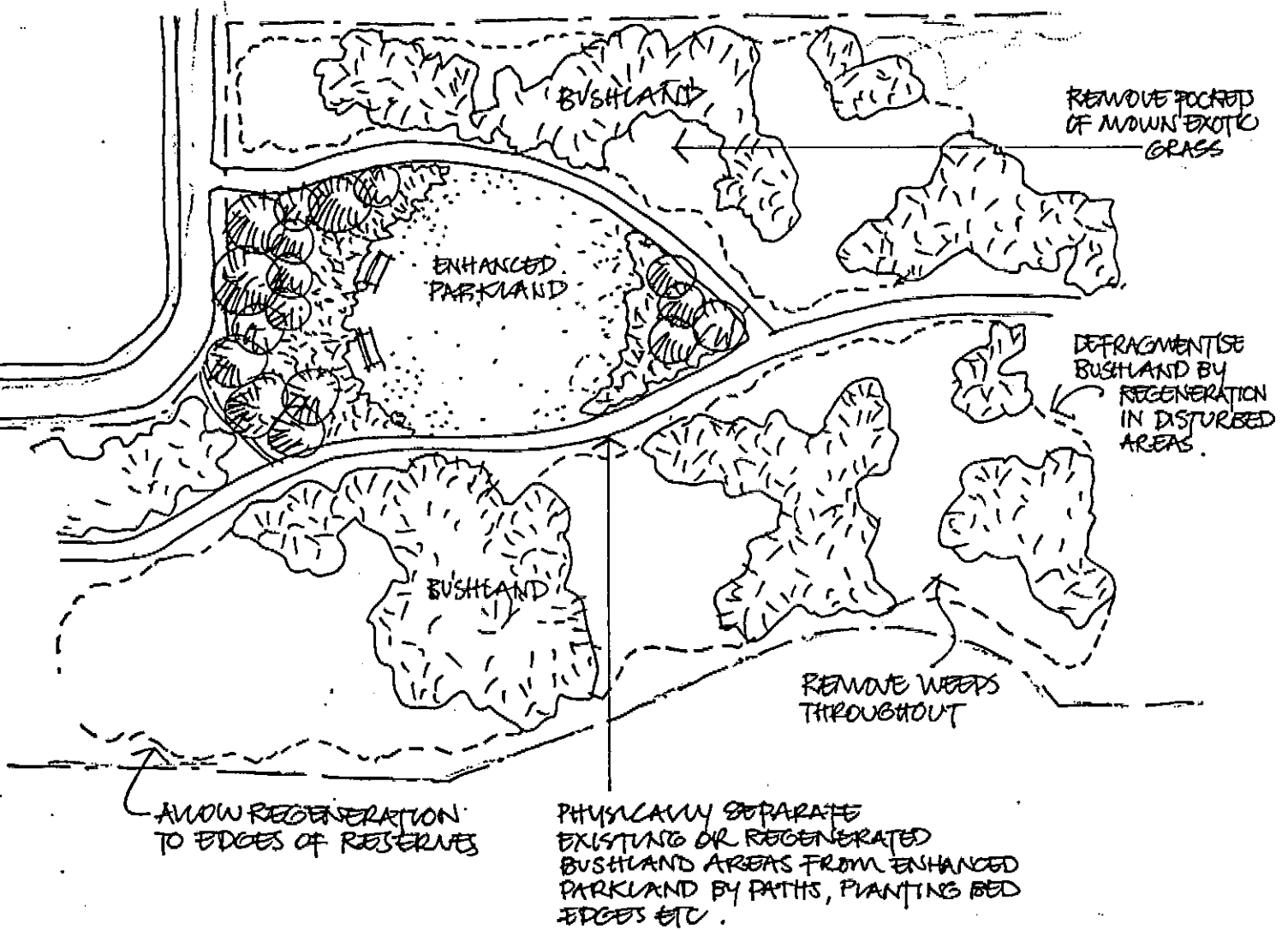


5.2.3 STABILIZATION TREATMENT OF CREEK BANKS



* GENERAL NOTE = FOR UPSLOPE PLANTING WEED CONTROL (FOLLOW REVEGETATION PROCESS) IF GREATER THAN 1:4 USE COCONUT MAT OTHERWISE LEAF MULCH, WITH TUBESTOCK PREFERABLY.
 ALL BANK STABILIZATION TREATMENTS ARE SUBJECT TO DETAILED INVESTIGATION AND DESIGN

5.2.4 PRINCIPLES FOR DEFRAGMENTIZING NATIVE BUSHLAND



5.2.5 SPECIES LIST FOR WETLAND SUCCESSIONAL PLANTING AND DRY ELEVATED SITES

Species selection based on known occurrence in region or suitability for introduction (particularly wetland species)

		Aquatic Sites	Fringe aquatic/terrestrial sites	Dry, elevated sites - Catchment above President Ave.	Dry, elevated sites - below President Ave.
Trees					
<i>Acacia mearnsii</i>	Black Wattle			•	
<i>Acmena smithii</i>	Lilly-Pilly			•	
<i>Allocasuarina littoralis</i>	Black She-Oak			•	
<i>A. torulosa</i>	Forest Oak			•	
<i>Angophora costata</i>	Sydney Red Gum			•	•
<i>Banksia integrifolia</i>	Coast Banksia				•
<i>Casuarina glauca</i>	Swamp She-Oak				
<i>Ceratopetalum gummiferum</i>	Christmas Bush			•	
<i>Elaeocarpus reticulatis</i>	Blueberry Ash			•	
<i>Eucalyptus gummifera</i>	Red Bloodwood			•	
<i>E. pilularis</i>	Blackbutt			•	•
<i>E. piperita</i>	Sydney Peppermint			•	•
<i>E. punctata</i>	Grey Gum			•	
<i>E. resinifera</i>	Red Mahogany			•	•
<i>Exocarpus cupressiformis</i>	Native Cherry			•	•
<i>Glochidion ferdinandii</i>	Cheese Tree			•	
<i>Melaleuca linariifolia</i>	Snow In Summer			•	
<i>M. nodosa</i>	Ball Honeymyrtle			•	
Shrubs					
<i>Acacia longifolia</i>	Sydney Golden Wattle			•	•
<i>A. suaveolens</i>	Sweet Scented Wattle			•	•
<i>A. terminalis</i>	Sunshine Wattle			•	•
<i>A. ulicifolia</i>	Prickly Moses			•	•
<i>Banksia spinulosa</i>	Hairpin Banksia			•	•
<i>Bursaria spinosa</i>	Blackthorn			•	
<i>Dadonea triquetra</i>	Common Hop Bush			•	•
<i>Goodenia ovata</i>	Hop-leaved Goodenia			•	
<i>Hakea salicifolia</i>	Willow-leaved Hakea			•	•
<i>H. sericea</i>	Bushy Needlebush			•	•
<i>Kunzea ambigua</i>	Tickbush			•	•
<i>Leptospermum polygallifolium</i>	Lemon-scented Tea Tree			•	•
<i>Lomatia silaifolia</i>	Crinkle Bush			•	•
<i>Notolaea longifolia</i>	Native Olive			•	•
<i>Omalanthus populifolius</i>	Bleeding Heart			•	•
<i>Petrophile sessilis</i>				•	•
<i>Phyllanthus gastroemil</i>	Blunt Spurge			•	•
<i>Platylobium formosum</i>	Handsome Flat-Pea			•	•
<i>Polyscias sambucifolia</i>	Elderberry Panax			•	•

		Aquatic Sites	Fringe aquatic/terrestrial sites	Dry, elevated sites - Catchment above President Ave.	Dry, elevated sites - below President Ave.
Grasses / Sedges					
<i>Cyperus polystachyos</i>			•		
<i>Elaeocharis sphacelata</i>		•			
<i>Gahnia clarkel</i>			•		
<i>G. erythrocarpa</i>			•		
<i>G. sieberana</i>			•		
<i>Phragmites australis</i>			•		
<i>Juncus usitatus</i>	Common rush		•	•	
<i>Lomandra longifolia</i>			•	•	•
<i>Microlaena stipoides</i>	Weeping Meadow Grass		•	•	•
<i>Paspalum distichum</i>	Water Couch	•	•		
<i>Schoenoplectus validus</i>	River Club-rush	•			
Herbs					
<i>Allisma plantago-aquatica</i>	Water Plantain	•			
<i>Persicaria decipiens</i>	Spotted Knotweed		•		
<i>P. lapathifolium</i>			•		
<i>Phyllidrum lanuginosum</i>	Frogmouth		•		
<i>Triglochin procerum</i>	Water Ribbons	•			
Other Monocotyledons					
<i>Isolepis inundatus</i>		•	•		
<i>Typha orientalis</i>		•	•		
<i>Vallisneria spiralis</i>	Ribbon Weed	•			

5.2.6 SPECIES LIST FOR SIGNIFICANTLY MODIFIED SITES

Species selection based on recorded occurrences within the Royal National Park and gullies in the Sutherland Shire of species tolerant of higher soil nutrient and moisture levels.

Trees

<i>Acmena smithii</i>	Lilly Pilly
<i>Backhousia myrtifolia</i>	Grey Myrtle
<i>Callitriche serratifolia</i>	Black Wattle
<i>Ceratopetalum apetalum</i>	Coachwood
<i>C. gummiferum</i>	Christmas bush
<i>Cryptocarya glaucescens</i>	Brown Beech
<i>Elaeocarpus reticulatus</i>	Blueberry Ash
<i>Ficus coronata</i>	Sandpaper Fig
<i>F. rubiginosa</i>	Port Jackson Fig
<i>Guloa semiglauca</i>	Guloa
<i>Pittosporum revolutum</i>	
<i>Rapanea howittiana</i>	Brush Muttonwood
<i>R. variabilis</i>	Muttonwood
<i>Schizomeria ovata</i>	Crab Apple
<i>Stenocarpus salignus</i>	Scrub Beefwood
<i>Syncarpha glomulifera</i>	Turpentine
<i>Synoum glandulosum</i>	Scentless Rosewood
<i>Syzigium australe</i>	Brush Cherry
<i>S. oleosum</i>	Blue Lillypilly
<i>Toona ciliata</i>	Red Cedar
<i>Tristanlopsis laurina</i>	Water Gum

Shrubs

<i>Acronychia oblongifolia</i>	
<i>Breynia oblongifolia</i>	
<i>Clerodendrum tomentosum</i>	
<i>Hymenanthera dentata</i>	Tree Violet
<i>Melicope microeocca</i> (syn. <i>Euodia micrococca</i>)	
<i>Notolaea venosa</i>	
<i>Omalanthus populifolius</i>	
<i>Trema aspera</i>	Native Peach
<i>Zieria smithii</i>	Sandfly Zieria

Groundcovers

<i>Commelina cyanea</i>	
<i>Dichondra repens</i>	Kidney weed
<i>Pseuderanthemum variabile</i>	
<i>Viola hederacea</i>	Native Violet

Ferns

<i>Adiantum aethiopicum</i>	Common Maiden Hair
<i>Blechnum watslii</i>	Rough Water Fern
<i>Calochlaena dubia</i> (syn. <i>Culcita dubia</i>)	False Bracken Fern
<i>Cyathea australis</i>	Rough Tree Fern
<i>Doodia aspera</i>	Rasp fern
<i>Histiopteris incisa</i>	Batwing Fern
<i>Todea barbara</i>	King fern

Palms

<i>Livistona australis</i>	Cabbage Tree Palm
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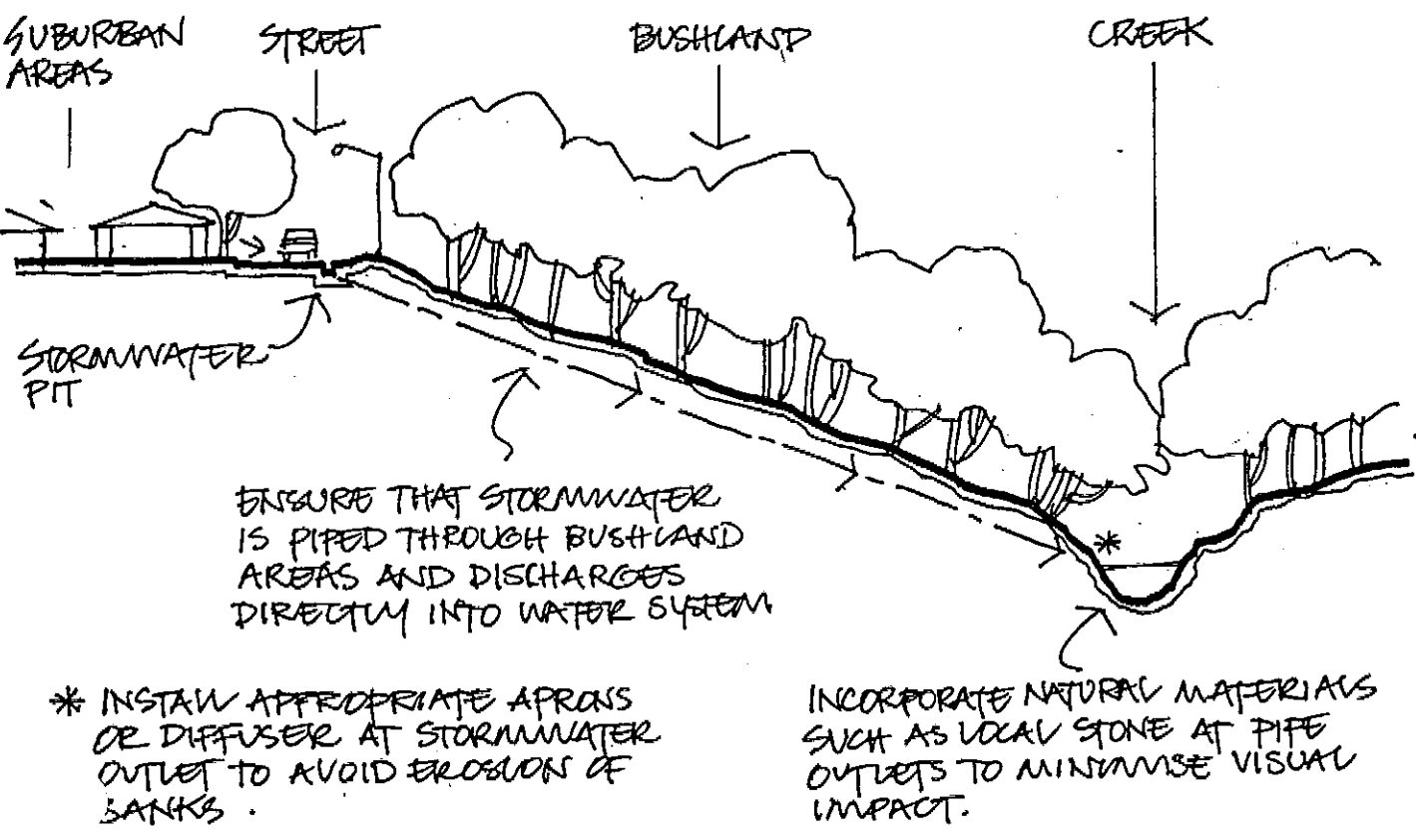
Grasses

<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Meadow Grass
<i>Opismenus aemulus</i>	Basket Grass
<i>O. imbecillis</i>	Basket Grass

Other Monocotyledons

<i>Dianella caerulea</i>	
<i>Lomandra longifolia</i>	Mat rush

5.2.7 STORMWATER DIVERSION FROM NATIVE BUSHLAND

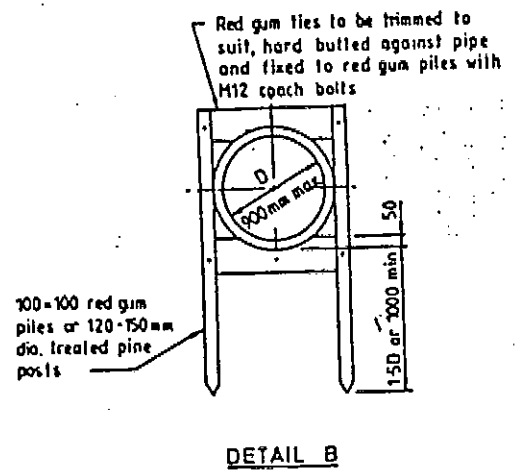
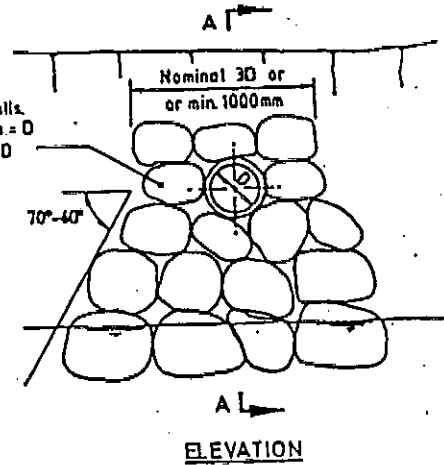
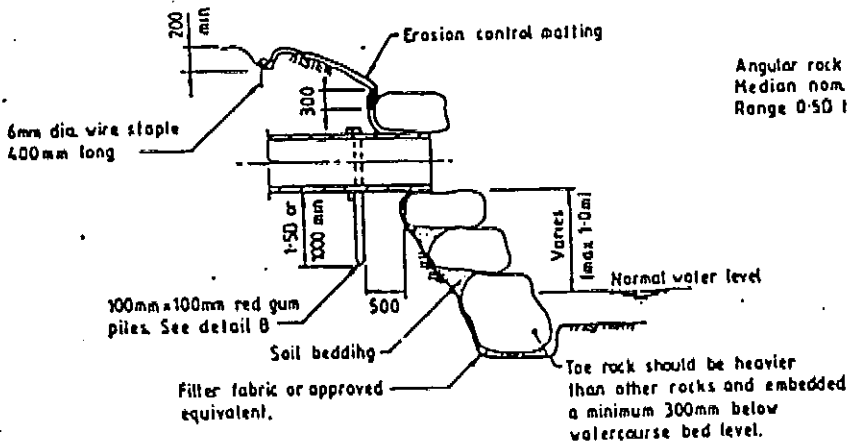


ENSURE THAT STORMWATER IS PIPED THROUGH BUSHLAND AREAS AND DISCHARGES DIRECTLY INTO WATER SYSTEM

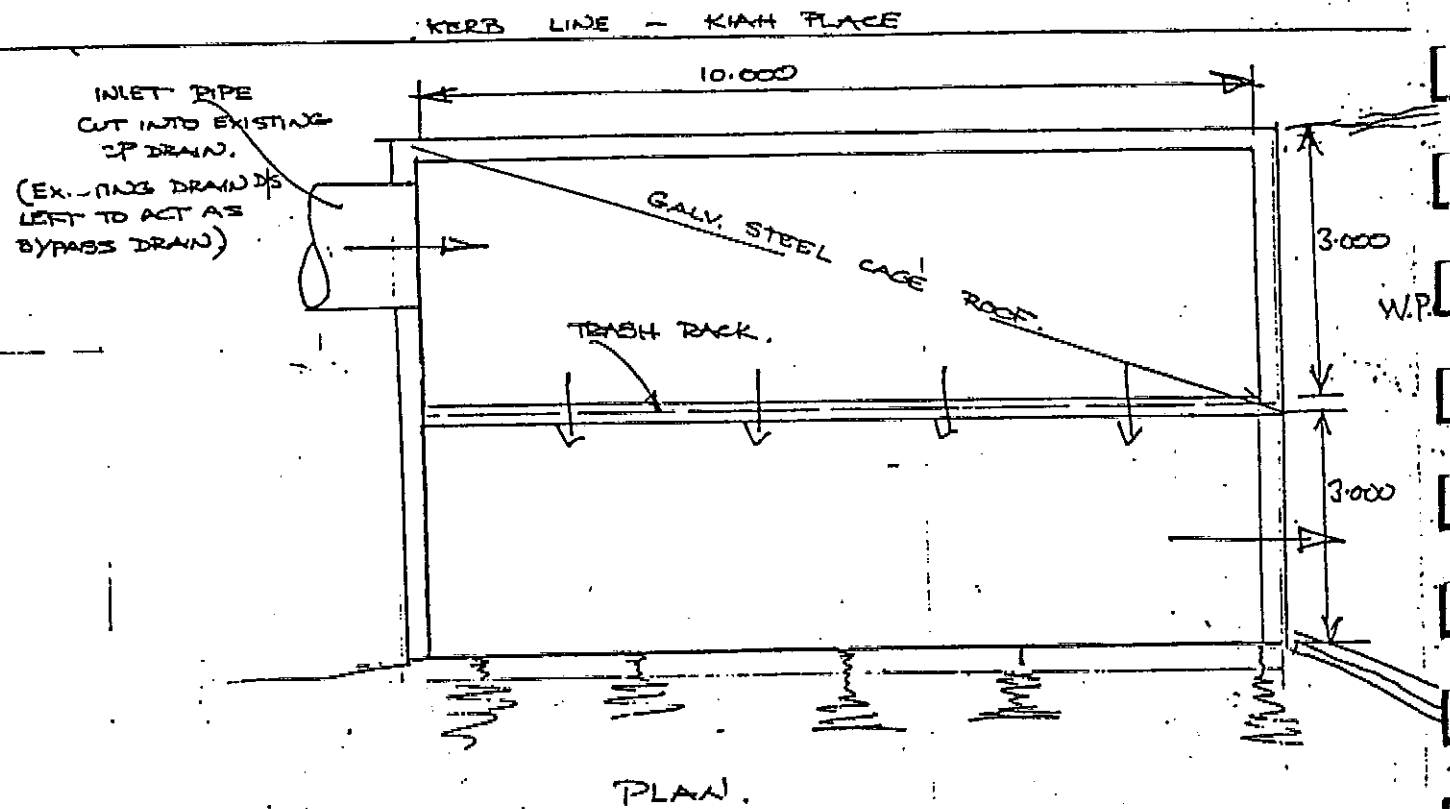
* INSTALL APPROPRIATE APRONS OR DIFFUSER AT STORMWATER OUTLET TO AVOID EROSION OF BANKS.

INCORPORATE NATURAL MATERIALS SUCH AS LOCAL STONE AT PIPE OUTLETS TO MINIMISE VISUAL IMPACT.

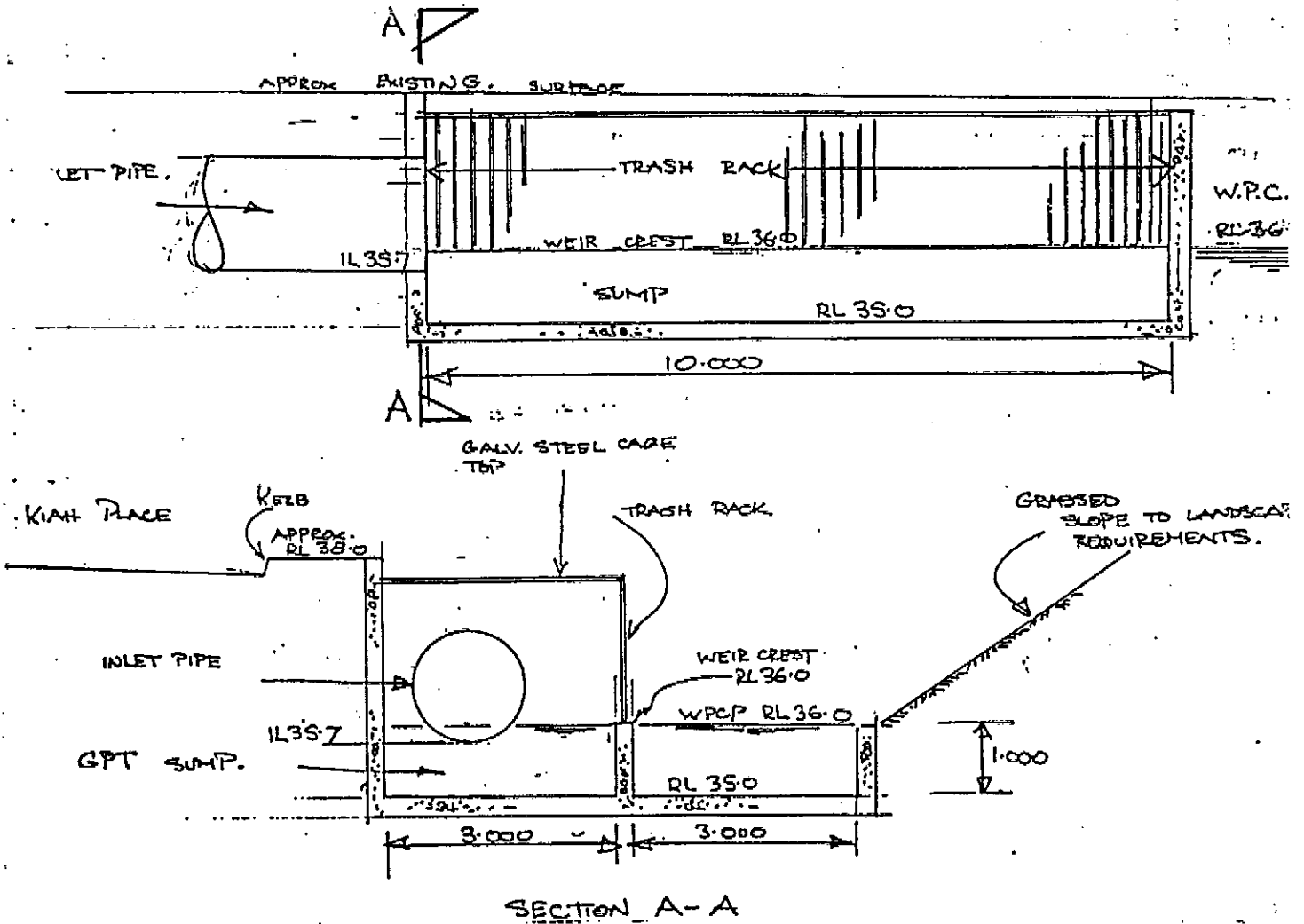
5.2.8 SELECTION OF TRIBUTORY DRAIN OUTLET WORKS



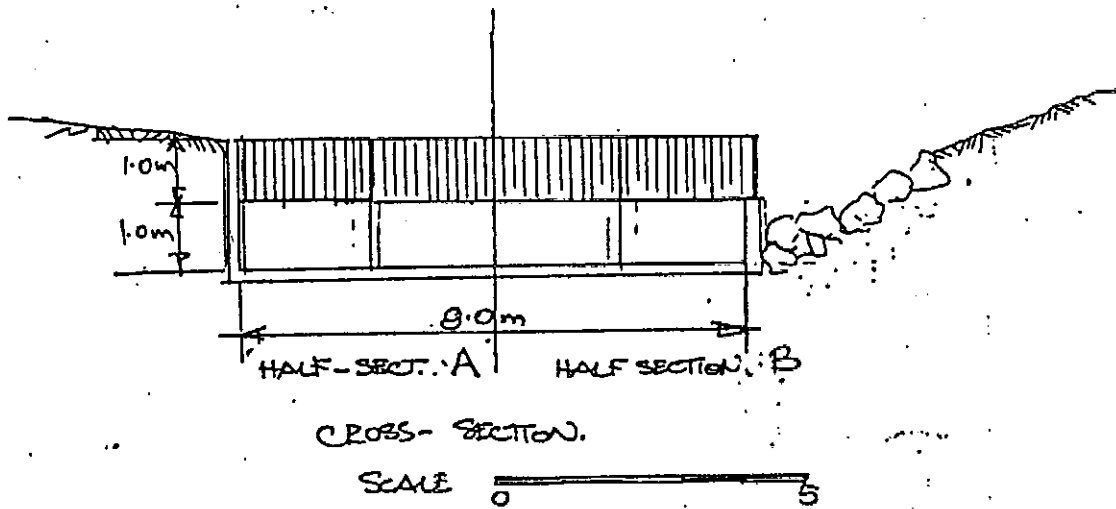
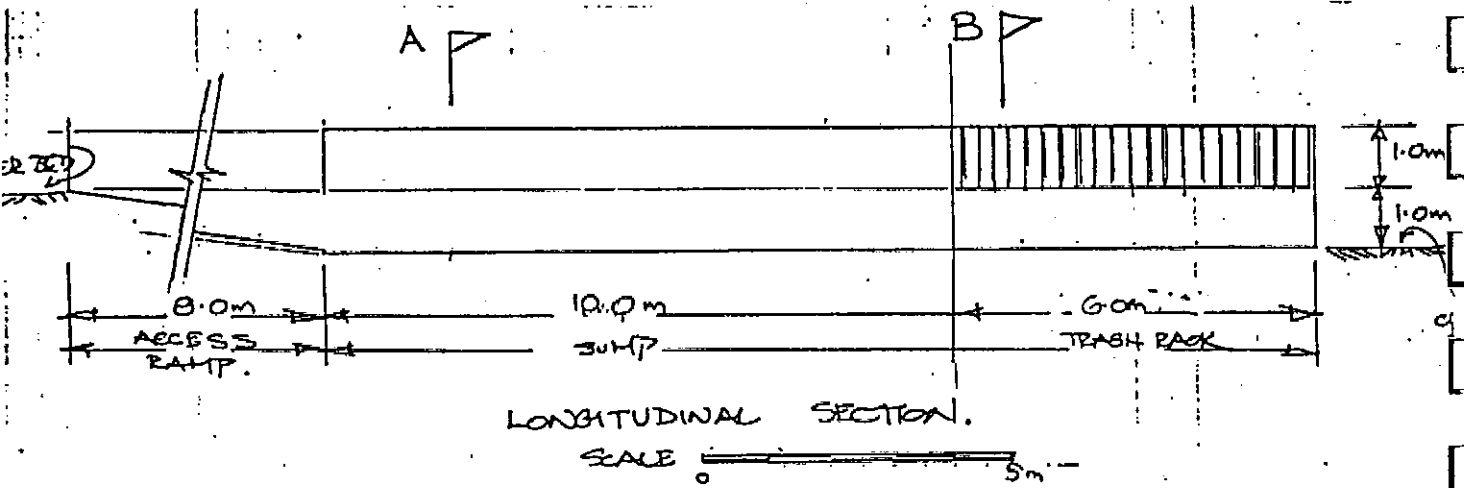
5.2.9 CONCEPT DESIGN FOR MINOR GROSS POLLUTANT TRAP AT KIAH PLACE (AFTER WILLING & PARTNERS PTY LTD, 1991)



5.2.10 CONCEPT DESIGN FOR MINOR GROSS POLLUTANT TRAP AT KIAH PLACE (AFTER WILLING & PARTNERS PTY LTD, 1991)



5.2.11 CONCEPT DESIGN FOR MAJOR GROSS POLLUTANT TRAP AT OLD QUARRY SITE
(AFTER WILLING & PARTNERS PTY LTD, 1991)



5.2.12 CONCEPT DESIGN FOR MAJOR GROSS POLLUTANT TRAP AT OLD QUARRY SITE
(AFTER WILLING & PARTNERS PTY LTD, 1991)

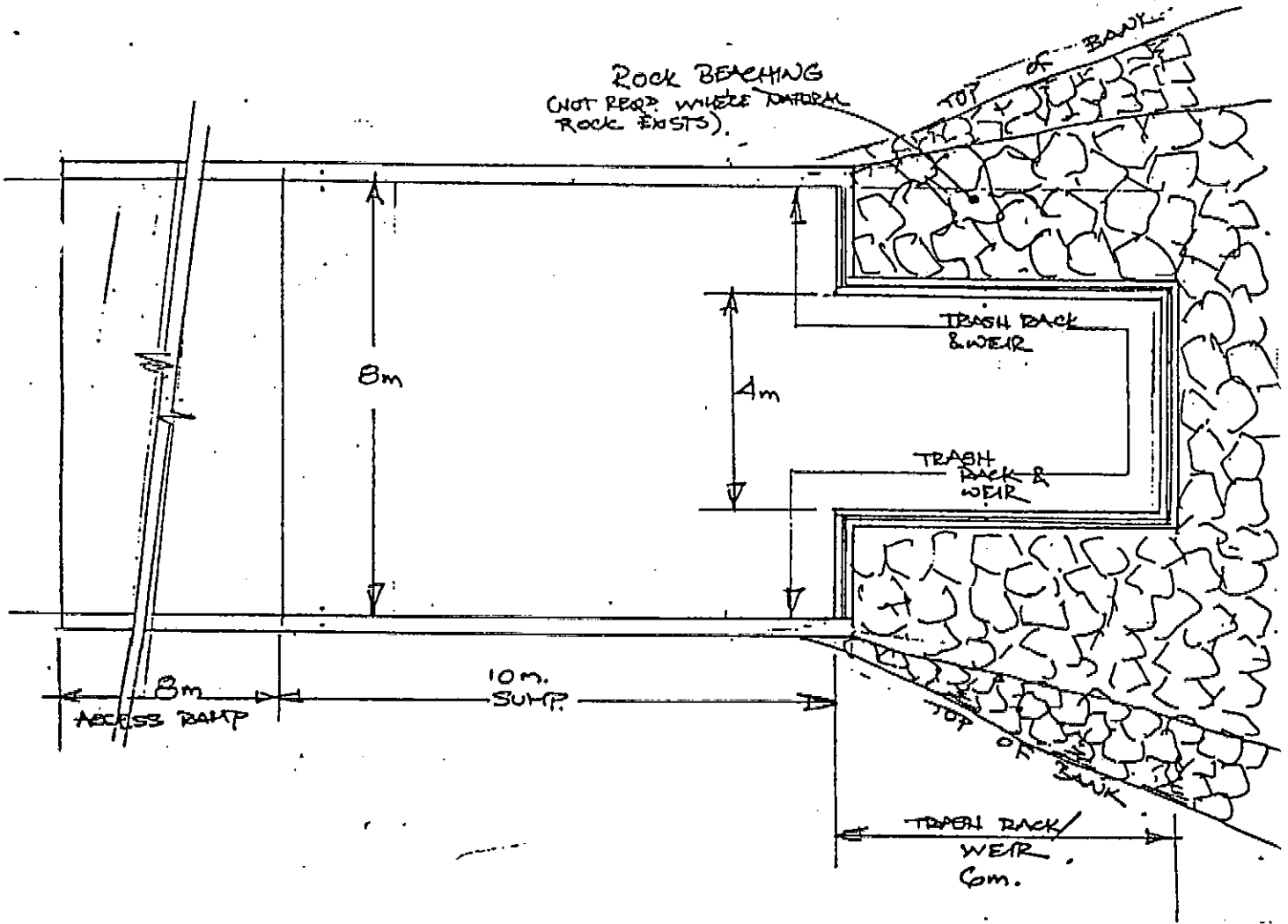


Figure 10

Detail Plans

5.3 PRIORITIES

The rate at which strategies for rehabilitation of Ewey Creek are implemented will depend on many factors, including - Council's resources, community awareness and preferences, rate of development and landuse change in the catchment, availability of funding assistance, and the Imperatives of good management, amongst others.

In light of this, the Study has sought to encourage balanced responses to the various needs within the creek catchment and the community. The resource information, strategies and detail guidelines underline this intent.

It is, nevertheless, important that the programme of improvements responds to critical needs and immediate opportunities in the system where these have been identified. To this end a suggested implementation programme is illustrated in Figure 8 for the bulk of the strategies that comprise the Plan. These are divided with two broad groups for short term action, or alternative resolution in the longer time frame.

Council should carefully consider not only the dollar cost of works but also the ongoing management implications, and lifecycle costs, in determining its final programme of action. Composing the relative costs in choosing to adopt a strategy or doing nothing in specific cases, can be an enlightening exercise.

5.4 COSTING

The following cost estimate has been prepared as a guide only in order to assist Council with budgeting. It must be noted that a more accurate estimate for works will be necessary in association with design development. Costs do not account for Professional Fees or Inflation.

Costing for bank stabilization work and the extraction of stone from the quarry site for construction of the WPCP has been determined separately. It is likely that costs for both projects would be reduced significantly if rock won from the quarry was saleable or if it was re-used for bank stabilization.

ITEM

Minor Gross Pollutant Trap Klah Place	\$90,000
Water Pollution Control Pond Klah Place	\$340,000
Major Gross Pollution Trap Old Quarry Site	\$200,000
Water Pollution Control Pond Old Quarry Site	\$450,000
Klah Place Reserve Park enhancement, bush revegetation and creek bank stabilization	\$340,000
Old Quarry Site Park enhancement and bush revegetation To be undertaken in association with construction of WPCP	\$370,000

Figure 11
Implementation
Priorities

Old Quarry Site Involving works unaffected and outside the area associated with the WPCP, principally the bushland area north of President Avenue. Park enhancement and bush regeneration	\$115,000
Yowle Bay Reserve Park enhancement and bush regeneration	\$200,000
Klora Road Reserve Park enhancement, bush revegetation and creek bank stabilization	\$150,000
RTA Reserve Minor park enhancement, bush regeneration and creek bank stabilization	\$95,000
Street Tree Planting Individual trees	\$40/tree
Total tree planting for all streets within and including President Avenue north to Karimbla Road and South Street; Gynea Bay Road east to Mooki Street. Clifford Road is also included. Street trees are measured at 8 metre centres and assumes absence of existing trees.	\$70,000
Creek corridor Enhancement, bush revegetation and creek bank stabilization at a linear metre rate for a 25 metre wide corridor (average)	\$1,300/m
Piping Replace existing open creek gullies upstream of Manchester Road with piping, including planting of a 13 metre wide corridor.	\$85,000

5.5 ALTERNATIVE FUNDING SOURCES

To assist in the funding of works involved in the management plan there are a range of Commonwealth Government, and State Government Grants available. These Funds are usually only for capital works which may include professional planning and documentation fees and Grants usually have to be matched by Council, with a commitment to carry out ongoing maintenance of constructed works.

Commonwealth Grants are now all amalgamated under the National Landcare Programme. State Government grants are listed in "Guide for Grants for Local Government 1991" booklet produced by the NSW Department of Local Government. Relevant Grants are listed below in the following table with a brief description and where appropriate, possible applications.

Limited funding is available for re-current works, however agencies such as Greening Australia can provide assistance in setting up Community Groups willing to participate in ongoing bushland management.

NAME OF GRANT	PURPOSE	ADMINISTRATING AGENCY	SCOPE AND LIMITS OF ASSISTANCE
1. National Landcare Programme Save the Bush	Remnant bushland management, revegetation, establishment of faunal corridors.	National parks and Wildlife Service	Bushland revegetation of the lower catchment above President Avenue. Typical grant \$1,000 - \$5,000 occasionally up to \$10,000. Must be broad community support for the project.
2. National Landcare Programme One Billion Trees	Standard re-vegetation strategies	Greening Australia	Typical grant approx. \$1,000. Total \$180,000 for NSW.
3. National Landcare Programme National Soil Conservation Programme	Works directed at soil management	Department of Conservation and Land Management	Maybe of limited applications in Ewey Creek but worth investigating. Granted directed specifically at combating soil erosion. Dollar for dollar grant. Max \$30-\$40,000. Total grants \$200,000.
4. Metropolitan Green Space Programme	Assistance to planning and development of open space that can be completed within 12 months	Department of Planning	Applies to regional open space but has been used in some instances for local parks. Typical grant \$30,000 dollar for dollar.
5. Special Environmental Levy Funding	Assistance in bush regeneration and installation of gross pollutant traps	Waterboard of NSW	Installation of litter interception devices and assistance in Bushland Regeneration providing Council commitment to long term on-going maintenance. An approved grant could amount to a substantial proportion of capital works costs, particularly if Council provides a monetary commitment.
6. Noxious Plants Control Programme	Financial assistance for control of declared noxious weeds	NSW Agriculture and Fisheries	Dollar for dollar grant for weed removal of declared noxious weeds only. Council must have a weeds inspector, and a weed management programme.
7. Estuary Management Programme	Improvement of Estuaries and Estuarine Waters	Public Works Department of NSW Coasts and Rivers Branch	Dollar for Dollar funding of lower catchment works that protect the estuarine waters of Yowle Bay such as the gross pollutant traps, and water pollution control ponds. Approved grant could amount of 50% of cost of these facilities.

NAME OF GRANT	PURPOSE	ADMINISTRATING AGENCY	SCOPE AND LIMITS OF ASSISTANCE
8. NSW Waterways Infrastructure Development Programme	Foreshore Improvements and construction of boat ramps and foreshore access	Public Works Department of NSW Coasts and Rivers Branch	Foreshore Improvement works and access to Yowle Bay. Up to 50% of capital cost of project to \$10,000 - \$15,000. Total allocation \$4.2m
9. Capital Assistance Programme	Construction and Improvement of Public sporting and recreational facilities	Department of Sport and Racing and Recreation	Possible application for some funding under this programme as a dollar for dollar grant. Up to 50% of capital costs. Typically \$8,000 - \$10,000. Total allocation \$4m.
10. Job Skills	Over 21 year old trained labour for re-vegetation work.	Department of Employment and Training	Labour to assist in documented revegetation work. Job skills programme already in place with the Council. A new programme could be established specifically for work and projects on Ewey Creek. Grant covers funding for a co-ordinator and approx. 20 trainee staff for about 26 weeks.
11. Landcare and the Environment Action Programme (LEAP)	Under 21 year old trained labour for re-vegetation work	Department of Employment and Training.	Same as Job Skills, except no programmes are yet in place with Council.
12. Special Projects	Funding for specific projects related to the Job Skills Programme.	Department of Employment and Training.	Grant to \$20,000 to supplement the Job Skills programme. Must be matched by Council. Be of community benefit and endorsed by the unions.

6 APPENDICES

APPENDIX A

A.1 COST ESTIMATES

A.1.1 Creek Rock Armouring

Trim bank to place rock.

Place filter layer of geotextile or crushed rock. (\$3/m²)

Place 3000 m³ rock and compact soil and seed

Assumes 4 m³ rock /lineal metre of creek treated

Based on rates for similar projects all inclusive cost

for above work, is \$900/lineal metre

700m of creek @ \$900/m

Gabions at Wandella Road culvert approaches

\$	675000.00
\$	25000.00

TOTAL	\$	700000.00
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A.1.2 Water Pollution Control Pond at Old Quarry Site

Pond water surface area = 0.38ha

Pond volume = 6000 m³

TWL = RL17.3

Pond bed elevation = RL 15.0

Excavation in solid rock = 5430 m³ at \$75/m³

3000 m³ of excavated rock to be used for creek armouring.

(Value \$225000.00)

Gablon or Rock Fill spillway for WPCP

Safety fencing at \$90/m

Miscellaneous

\$	407250.00
\$	20000.00
\$	7000.00
\$	15750.00

TOTAL	\$	450000.00
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A.1.3 Major Gross Pollutant Trap at Old Quarry Site

GPT size 8m long plus approach apron, weir length 14m, height 1m.

Based on unit area rates for GPTs constructed in ACT the estimated cost would be \$200000.

A.1.4 Minor Gross Pollutant Trap at Klah Place Reserve

GPT size 3m wide plus 3m weir apron, weir length 10m, height 1m.

Based on unit area rates for minor GPT's constructed in ACT \$90000.

A.1.5 Water Pollution Control Pond (WPCP) at Klah Place - Option (a)

This option requires aquisition of part of Lot 22 Klah Pl and part of 172 Kalimba Road.

Pond water surface area = 0.36ha

Pond volume = 7900 m³

TWL = RL36.0

Pond bed elevation = RL 33.0

Excavated volume = 9,200 m³

Assuming 40% in soil: 3,680m ³ @ \$20/m ³	\$	73600.00
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Assuming 40% in soft rock: 3,680m ³ @ \$47.5/m ³	\$	174800.00
--	----	-----------

Assuming 20% in hard rock: 1,840m ³ @ \$75/m ³	\$	138000.00
--	----	-----------

Gablon or other rock fill spillway	\$	20000.00
------------------------------------	----	----------

Heavy Duty Conc. Crib R. Wall 200m ² @ \$330m ²	\$	66000.00
---	----	----------

Safety fencing 250m @ \$90/m	\$	22500.00
------------------------------	----	----------

Miscellaneous	\$	15100.00
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TOTAL	\$	510000.00
--------------	----	------------------

Note cost of land aquisition must be added to the above construction cost.

A.1.6 Water Pollution Control Pond at Kiah Place - Option B

This option requires the existing creek encroachment into Lot 22 to be maintained.
The estimate does not include any land acquisition costs.

Pond water surface area = 0.29ha

Pond volume = 6100 m³

TWL = RL36.0

Pond bed elevation = RL 33.0

Excavated volume = 8,000 m ³		
Assuming 40% in soil: 3,200m ³ @ \$20/m ³	\$	64000.00
Assuming 40% in soft rock: 3,200m ³ @ \$47.5/m ³	\$	152000.00
Assuming 20% in hard rock: 1,600m ³ @ \$75/m ³	\$	120000.00
Gablon or other rocks fill spillway	\$	20000.00
Heavy Duty Conc. Crib R. Wall 200m ² @ \$330m ²	\$	66000.00
Safety fencing 250m @ \$90/m	\$	22500.00
Miscellaneous	\$	15500.00
		<hr/>
TOTAL	\$	460000.00
		<hr/>

Water Pollution Control Pond at Kiah Place - Option C

This option requires the existing creek encroachment onto Lot 22 to be maintained.
The estimate does not include any land acquisition costs.

Pond water surface area = 0.22ha

Pond volume = 4,300 m³

TWL = RL 36.0

Pond bed elevation = RL 33.0

Excavated volume = 6,000 m ³		
Assuming 40% in soil: 2,400m ³ @ \$20/m ³	\$	48000.00
Assuming 40% in soft rock: 2,400m ³ @ \$47.5/m ³	\$	114000.00
Assuming 20% in hard rock: 1,200m ³ @ \$75/m ³	\$	90000.00
Gablon or other rock fill spillway	\$	20000.00
Heavy Duty Conc. Crib R. Wall 75m ² @ \$330m ²	\$	24750.00
Safety fencing 250m @ \$90/m	\$	22500.00
Miscellaneous	\$	20750.00
		<hr/>
TOTAL	\$	340000.00
		<hr/>



APPENDIX B

Table B.1 Predicted Annual Pollutant Exports at Various Locations

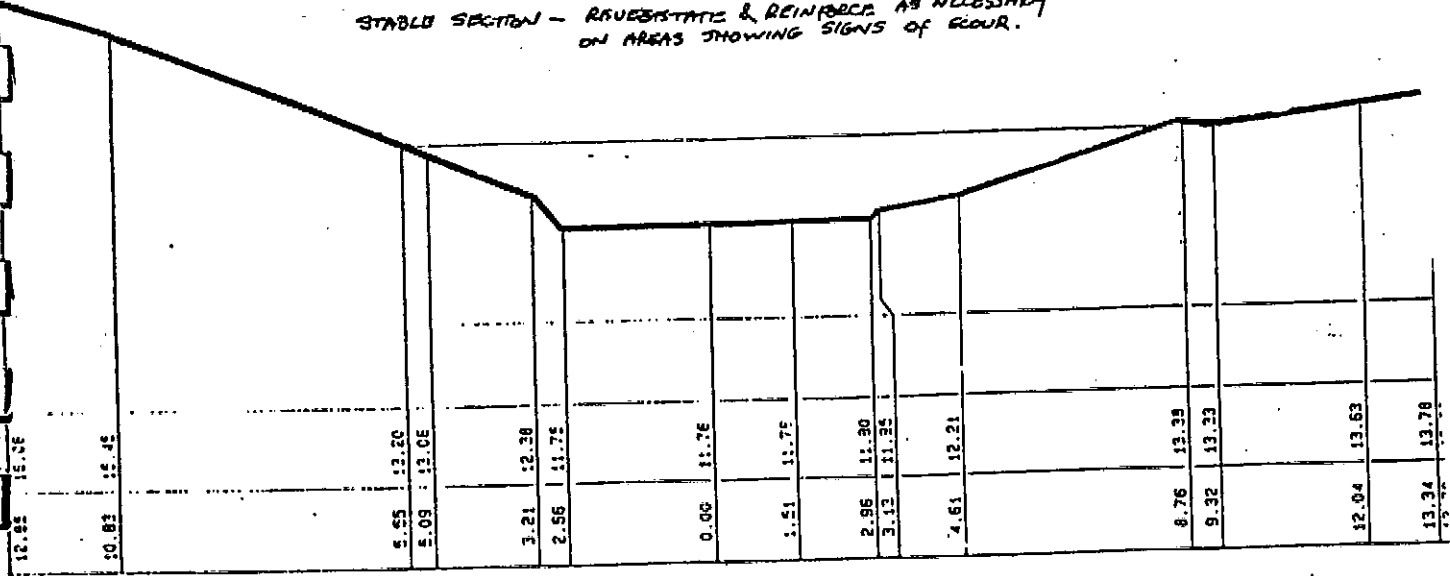
LOCATION	OPTION	E coli x 10 ¹³	SEDIMENT x10 ⁵ kg	S. SOLIDS x10 ⁴ kg	TP kg
Houston St. (RTA Reserve)	1	1.9	2.1	1.0	62
	2	1.9	2.1	1.0	62
	3a	1.9	2.1	1.0	62
	3b	1.9	2.1	1.0	62
	3c	1.9	2.1	1.0	62
	4b	1.9	2.1	1.0	62
	4c	1.9	2.1	1.0	62
Klah Place Reserve	5	1.9	2.1	1.0	62
	6	0.56	0.18	0.44	35
	7	0.56	1.3	0.44	35
	1	3.6	4.0	2.0	120
	2	3.6	2.5	2.0	120
	3a	1.1	0.45	0.89	71
	3b	1.2	0.48	0.95	76
3c	1.3	0.53	1.0	81	
4b	1.3	0.48	0.95	76	
4c	1.3	0.53	1.0	81	
Partial 4c	1.3	0.53	1.0	81	
5	3.6	2.5	2.0	120	
6	2.3	2.1	1.4	93	
7	0.87	0.39	0.75	66	
GF2	1	6.1	6.9	3.4	200
	2	6.1	5.4	3.4	200
	3a	3.7	3.3	2.3	160
	3b	3.8	3.3	2.4	160
	3c	3.9	3.4	2.5	170
	4b	3.8	3.3	2.4	160
	4c	3.9	3.4	2.5	170
Partial 4c	3.8	3.4	2.5	170	
5	6.1	5.4	3.4	200	
6	4.8	5.0	2.8	180	
7	3.4	3.2	2.2	150	

LOCATION	OPTION	E coll x 10 ¹³	SEDIMENT x 10 ⁵ Kg	S.SOLIDS x 10 ⁴ Kg	T. P. Kg
Old Quarry Site	1	8.5	9.5	4.8	280
	2	8.5	5.5	4.8	280
	3a	6.0	6.0	3.7	240
	3b	6.2	6.0	3.7	240
	3c	6.2	6.0	3.8	240
	4b	6.1	3.8	3.7	240
	4c	4.9	1.1	2.2	180
	Partial 4c	6.2	3.9	3.8	240
	5	6.6	1.2	2.7	210
	6	5.6	1.1	2.4	190
Clifford Road (Yowie Bay)	7	4.5	1.0	2.0	170
	1	9.9	11.0	5.6	330
	2	9.9	7.1	5.6	330
	3a	7.4	7.5	4.4	280
	3b	7.5	7.6	4.5	290
	3c	7.6	7.6	4.6	290
	4b	6.2	2.6	2.9	230
	4c	6.3	2.0	3.0	230
	Partial 4c	7.6	5.4	4.6	290
	5	7.9	2.8	3.5	250
6	7.0	2.7	3.2	240	
7	5.9	1.9	2.8	220	

APPENDIX C

POSSIBLE CREEK BANK STABILIZATION TREATMENTS

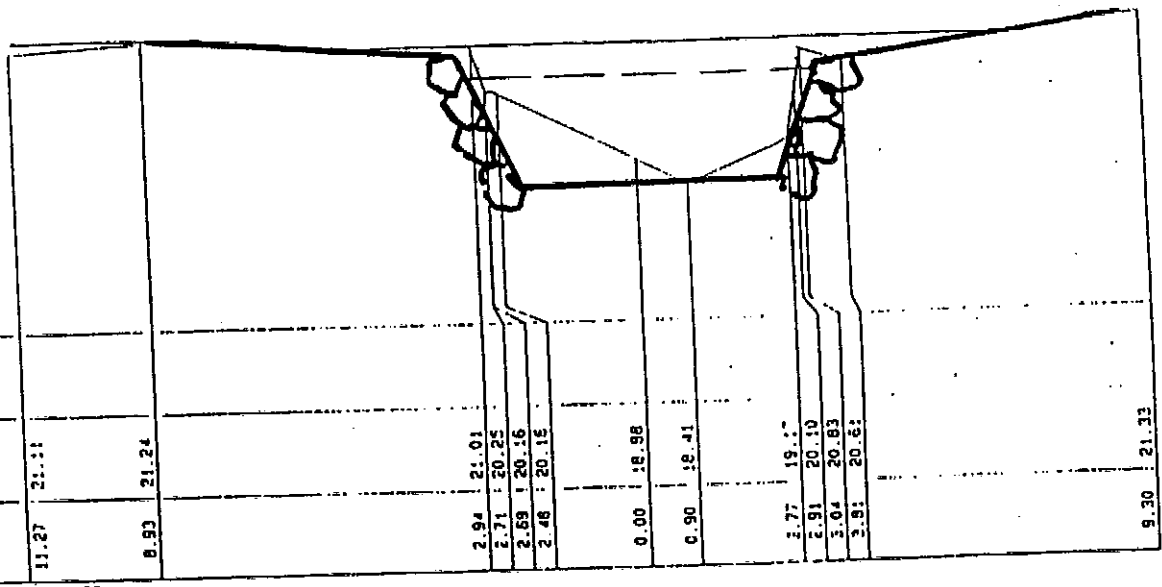
STABLE SECTION - REVEGETATE & REINFORCE AS NECESSARY ON AREAS SHOWING SIGNS OF EROSION.



1752.833

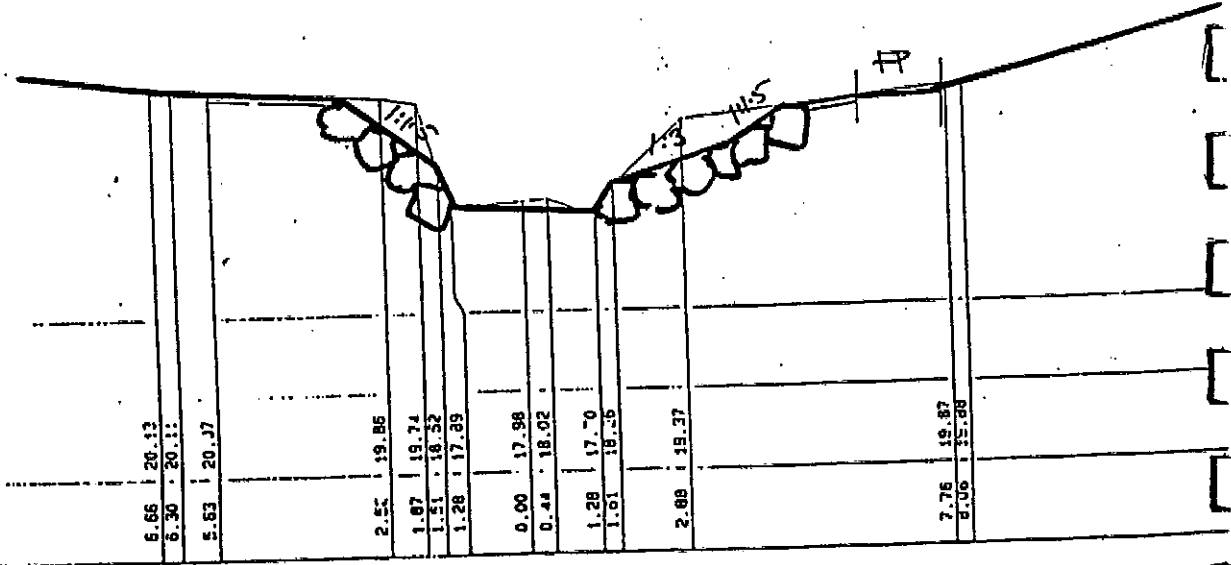
LEGEND:

- 100 YR ARI FLOW (EXISTING).
- - 100 YR ARI FLOW (WITH CHANNEL WIDENING, ROCK ARMOURING, PLANTING AND IMPROVEMENT TO WANDELLA RD CULVERT ENTRANCE)



Scales Horizontal 1: 100
Vertical 1: 100

1480.000

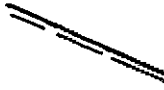


1520.000

LEGEND



Interlocking angular rock spalls with a typical representative diameter of 800mm. All rock spalls to overlap a filter bed of graded crushed rock or a non woven polyester geotextile. (Typical Manning's $n = 0.04$)



Reinforced grass or reed beds. (Reinforcing mesh to be a polyethylene product suitably pegged to the bank material). (Typical Manning's $n =$ as for grass/reeds).

LEGEND

Interlocking angular rock spalls with a typical representative diameter of 800mm. All rock spalls to overlie a filler bed of graded crushed rock or a non woven polyester geotextile. (Typical Manning's $n = 0.04$)



Reinforced grass or reed beds. (Reinforcing mesh to be a polyethylene product suitably pegged to the bank material). (Typical Manning's $n =$ as for grass/reeds).

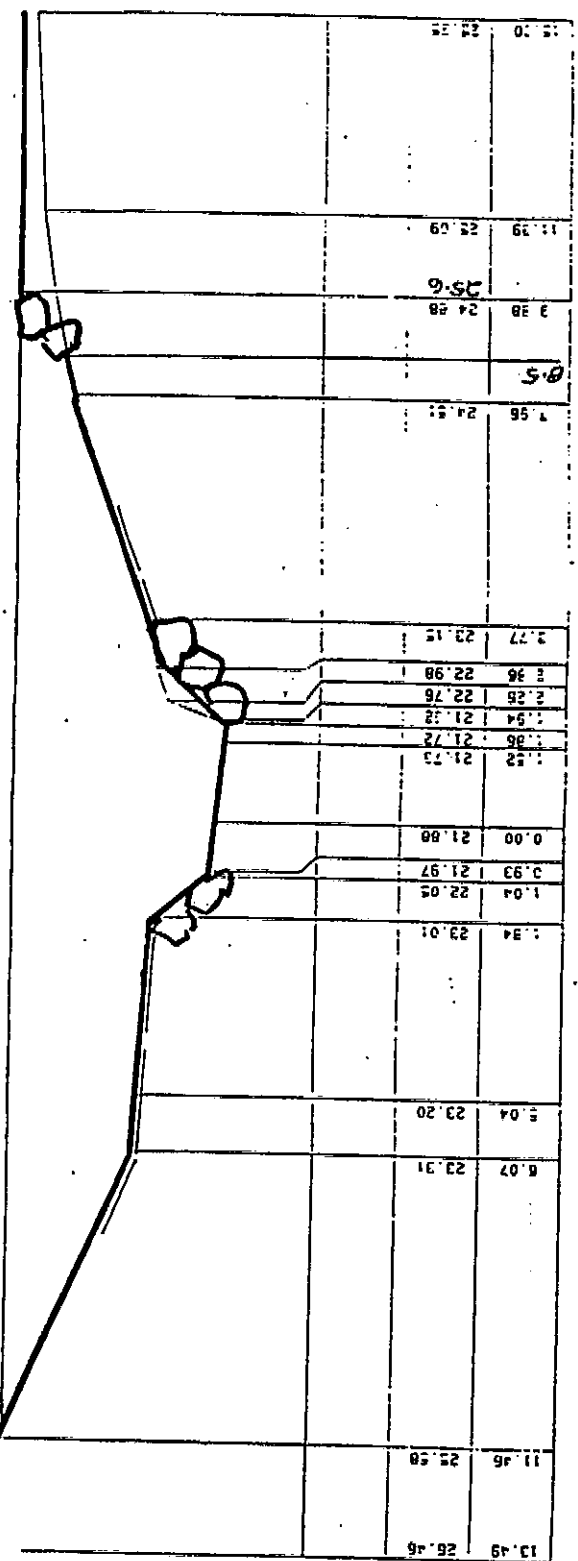
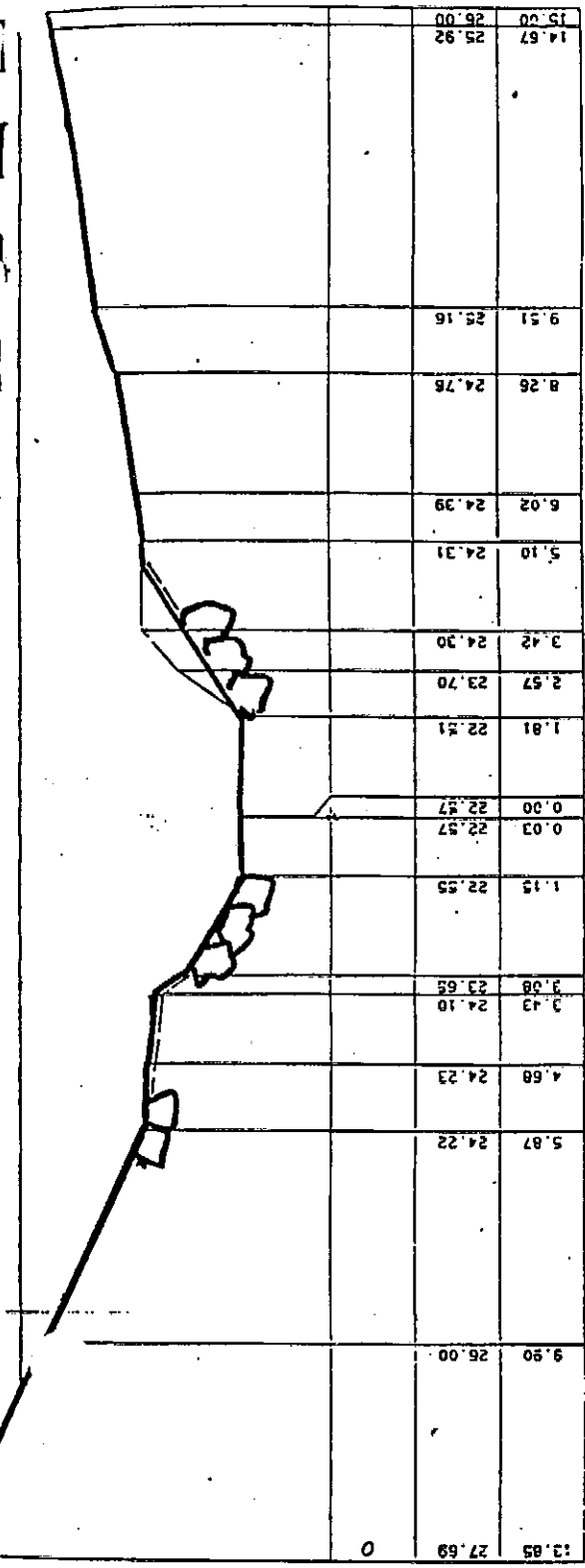


21.000

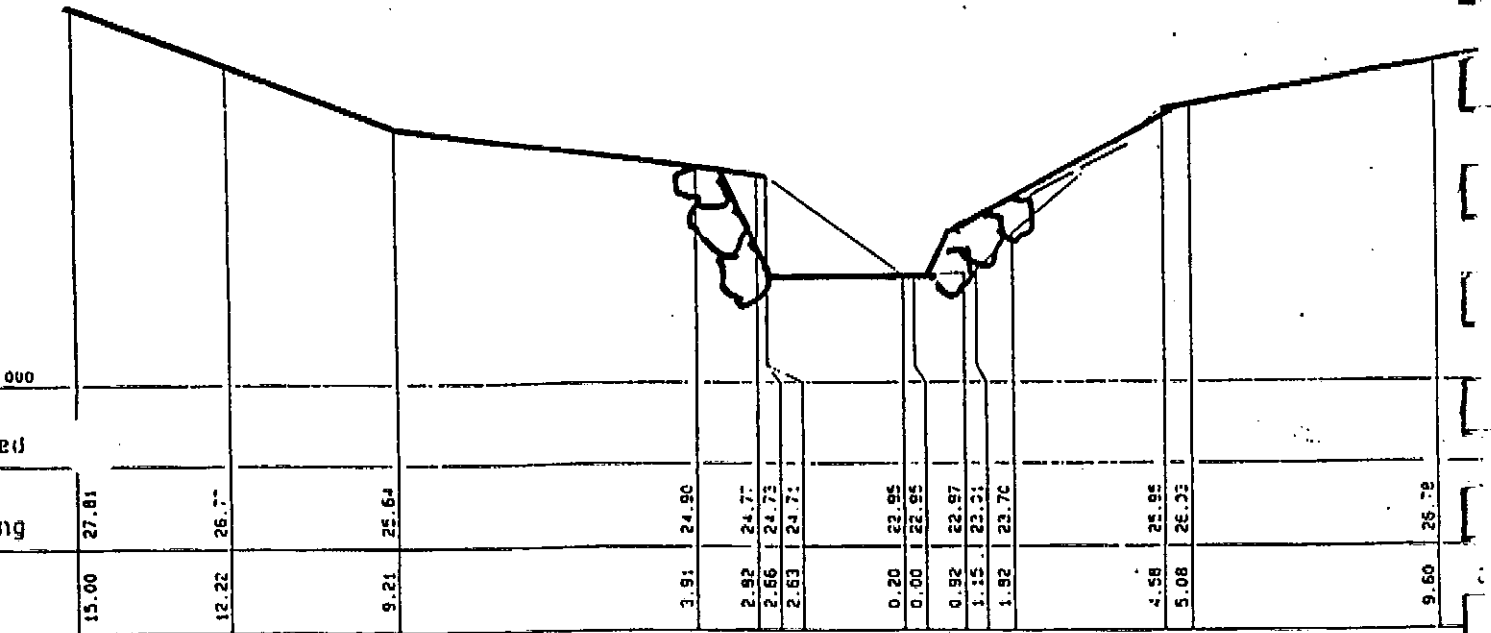
1260.000

20.000

1320.000



100 YR ARI



Horizontal : 100
Vertical : 100

1200.000

14.67	29.89	14.23	29.63
4.76	29.22	3.37	24.81
1.94	24.25	0.85	24.19
0.00	24.22	0.76	24.25
5.47	26.34	6.37	26.74
7.29	26.79	15.00	27.12

22.000

1140.000

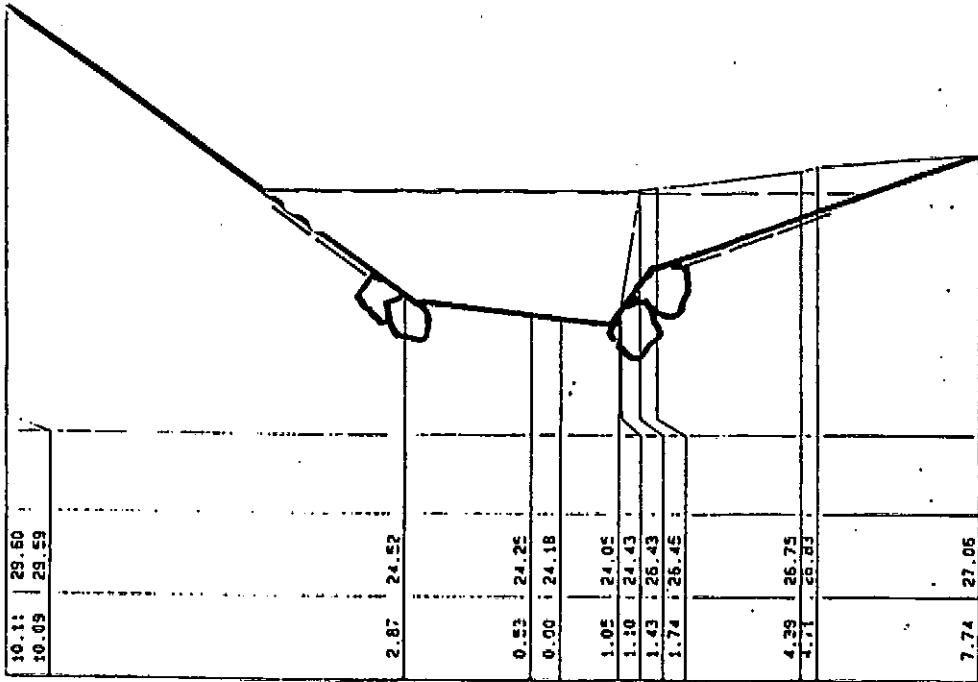
13.66	27.74	12.11	27.53
7.25	27.22	6.20	26.74
3.69	24.50	2.13	23.43
0.55	23.26	0.33	23.42
0.66	23.26	1.23	23.70
2.43	24.60	2.72	24.75
5.20	25.17	7.89	25.59
8.21	25.66	9.46	26.08
15.30	28.04		

21.000

1180

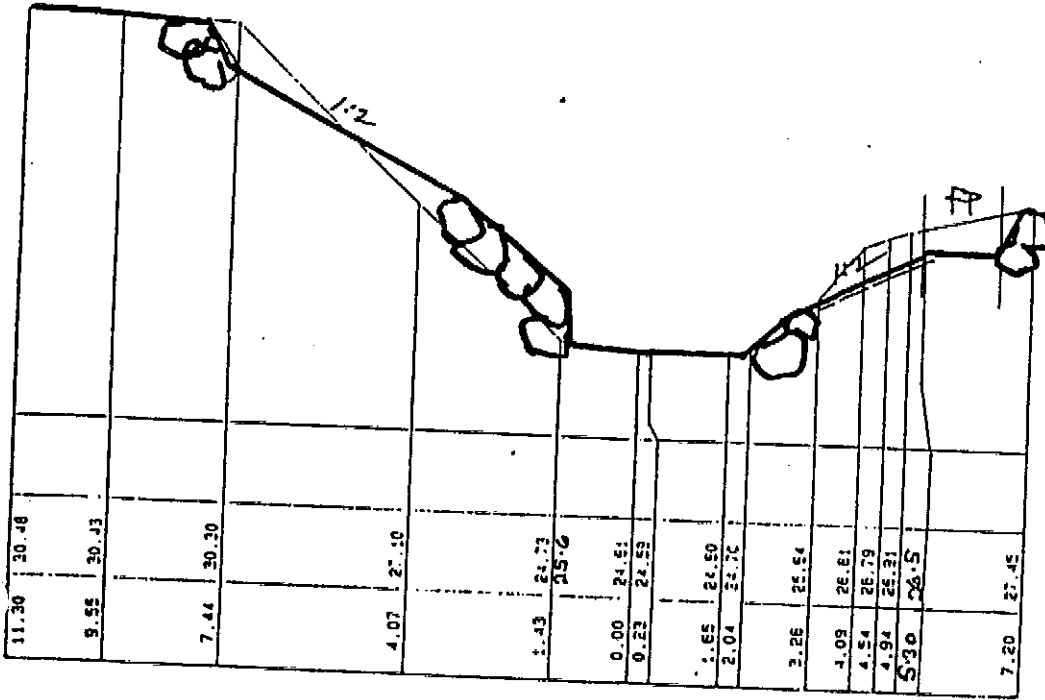
100YRARI

22.000



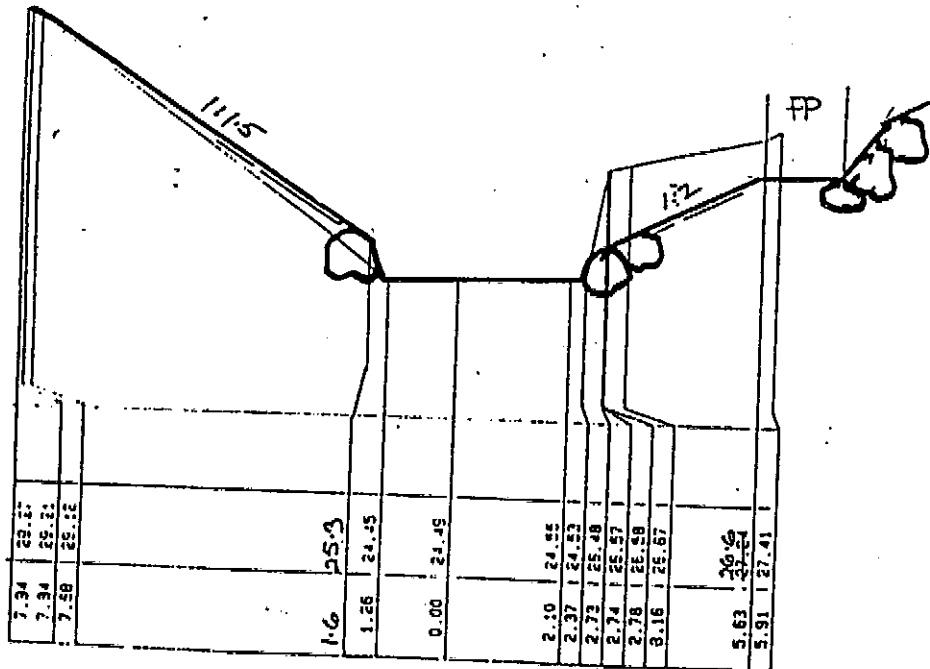
1120.000

100 YR ARI



23.000

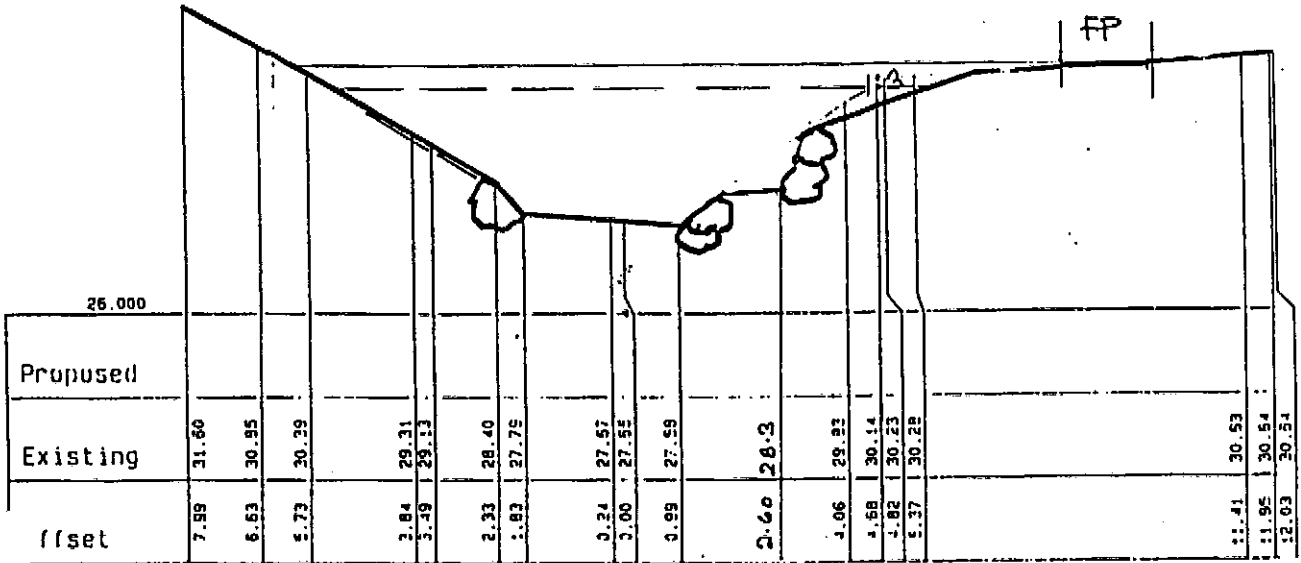
1080.000



22.000

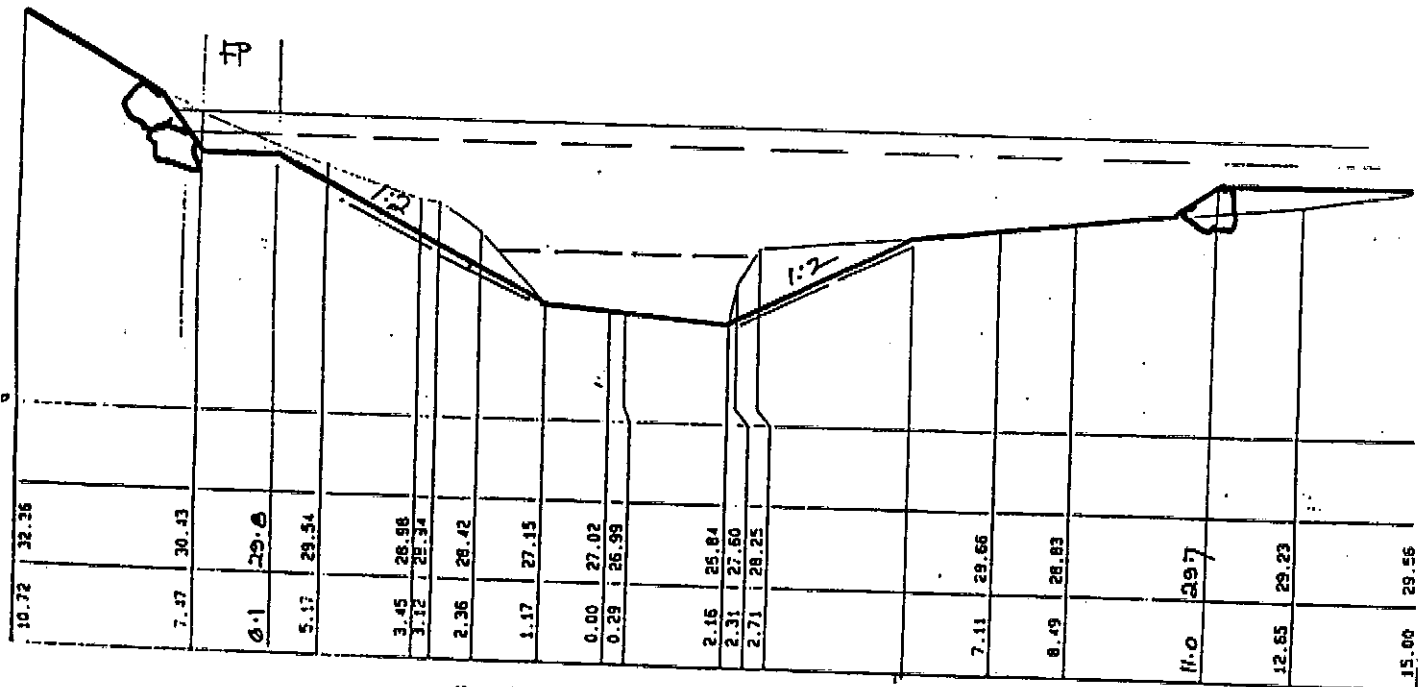
1100.000

100 YR ARI

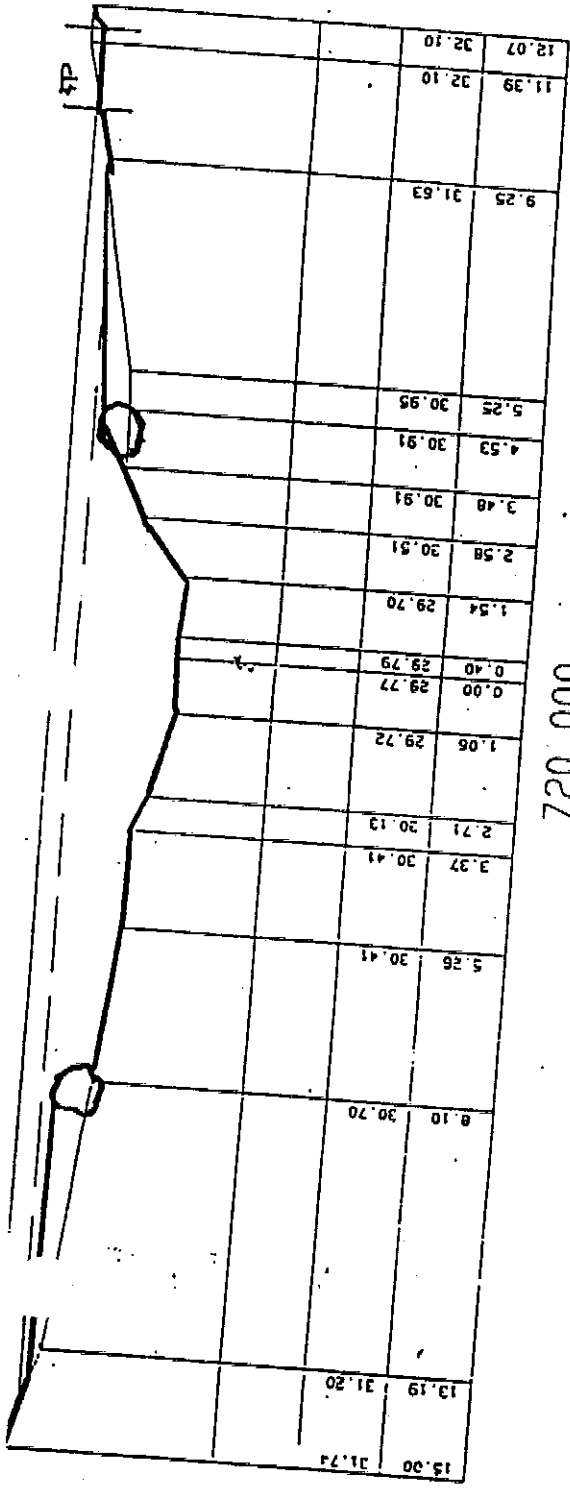


Scales Horizontal 1: 100
Vertical 1: 100

880.000



940.000



28.000

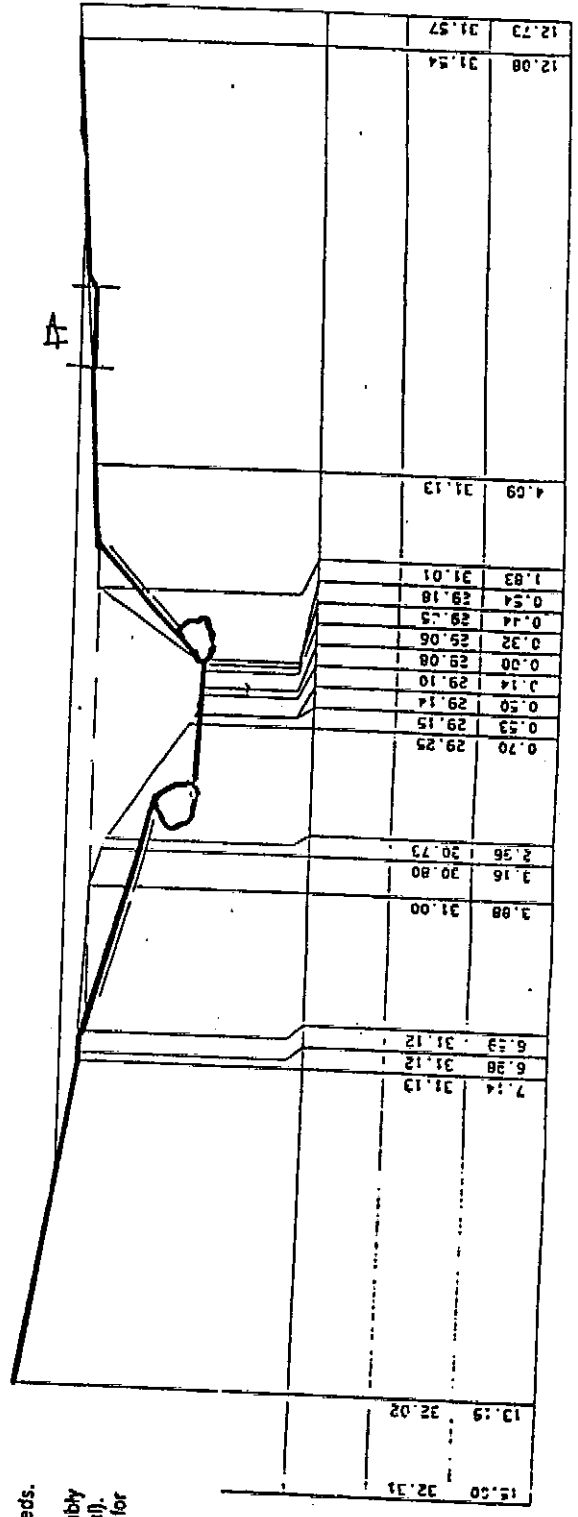
720.000

LEGEND

Interlocking angular rock spalls with a typical representative diameter of 800mm. All rock spalls to overlie a filter bed of graded crushed rock or a non woven polyester geotextile. (Typical Manning's $n = 0.04$)



Reinforced grass or reed beds. (Reinforcing mesh to be a polyethylene product suitably pegged to the bank material). (Typical Manning's $n =$ as for grass/reeds).



27.000

740.000

APPENDIX D

Native Plant Species Identified during Survey of Ewey Creek.

Ian Perkins, November 1992.

Species	Common Name	Sites			Notes
		1	2	3	
Trees					
<i>Acacia mearnsii</i>	Black Wattle	.	.		
<i>Acmena smithii</i>	Lilly-Pilly	.			
<i>Allocasuarina littoralis</i>	Black She-Oak	.	.		
<i>A. torulosa</i>	Forest Oak		.		
<i>Angophora costata</i>	Sydney Red Gum	.	.	.	
<i>Banksia integrifolia</i>	Coast Banksia	.	.		
<i>Casuarina glauca</i>	Swamp She-Oak	.			
<i>Ceratopetalum gummiiferum</i>	Christmas Bush		.		
<i>Elaeocarpus reticulatis</i>	Blueberry Ash		.		
<i>Eucalyptus gummifera</i>	Red Bloodwood		.		
<i>E. pilularis</i>	Blackbutt	.	.		
<i>E. piperita</i>	Sydney Peppermint	.	.		
<i>E. punctata</i>	Grey Gum	.	.		
<i>E. resinifera</i>	Red Mahogany		.		
<i>Exocarpus cupressiformis</i>	Native Cherry		.		
<i>Ficus rubiginosa</i>	Port Jackson Fig		.		
<i>Glochidion ferdinandi</i>	Cheese Tree	.	.		
<i>Melaleuca linariifolia</i>	Snow In Summer		.		
<i>M. nodosa</i>	Ball Honey Myrtle		.		
<i>Pittosporum undulatum</i>	Sweet Pittosporum	.	.		

Shrubs

<i>Acacia longifolia</i>	Sydney Golden Wattle	• •
<i>A. suaveolens</i>	Sweet Scented Wattle	•
<i>A. terminalis</i>	Sunshine Wattle	•
<i>A. ulicifolia</i>	Prickly Moses	•
<i>Banksia spinulosa</i>	Halpin Banksia	•
<i>Bursaria spinosa</i>	Blackthorn	•
<i>Dodonea triquetra</i>	Common Hop Bush	• •
<i>Epacris longiflora</i>	Native Fuchsia	•
<i>Goodenia ovata</i>	Hop-leaved Goodenia	•
<i>Grevillea sericea</i>	Pink Spider Flower	•
<i>Hakea salicifolia</i>	Willow-leaved Hakea	• •
<i>H. sericea</i>	Bushy Needlebush	•
<i>Helichrysum diosmifolium</i>	Pill flower	•
<i>Isopogon anemonifolius</i>		•
<i>Kunzea ambigua</i>	Tickbush	•
<i>Leptospermum polygallifolium</i>	Lemon-scented Tea Tree	•
<i>L. sp.</i>		•
<i>Lomatta silatfolia</i>	Crinkle Bush	•
<i>Notolaea longifolia</i>	Native Olive	•
<i>Omalanthus populifolius</i>	Bleeding Heart	•
<i>Petrophile sessilis</i>		•
<i>Persoonia levis</i>	Smooth Geebung	•
<i>P. linearis</i>	Narrow-leaved Geebung	•
<i>Phyllanthus gastroemil</i>	Blunt Spurge	• •
<i>Pimelea linifolia ssp. linifolia</i>	Rice Flower	•
<i>Platylobium formosum</i>	Handsome Flat-Pea	•
<i>Polyscias sambucifolia</i>	Elderberry Panax	•
<i>Zieria pilosa</i>		•
<i>Z. smithii</i>	Sandfly Zieria	•

Herbs

<i>Actinotus helianthi</i>	Flannel Flower	.
<i>Sarcocoma quinqueflora</i>	Sapphire	.
<i>Samolus repens</i>	Creeping Brookweed	.
<i>Styidium</i> sp.	Trigger Plant	.
<i>Trachymene incisa</i> ssp. <i>incisa</i>		.
<i>Wahlenbergia gracilis</i>	Native Bluebell	.
<i>Xanthosia pilosa</i>	Wooly Xanthosia	.
<i>X. tridentata</i>	Rock Xanthosia	.

Climbers/Twiners

<i>Billardiera scandens</i>	Apple Berry	.
<i>Cassytha</i> sp.	Devils Twine	.
<i>Eustrephus latifolius</i>	Wombat Berry	.
<i>Glycine tabacina</i>	Love Creeper	.
<i>Hardenbergia violacea</i>	False Sarsaparilla	.
<i>Hibbertia dentata</i>	Twining Guinea Flower	.
<i>Kennedia rubicunda</i>	Running Postman	.
<i>Pandorea pandorana</i>	Wonga Wonga Vine	.
<i>Smilax glycyphylla</i>	Native Sarsaparilla	.

Grasses

<i>Cymbopogon refractus</i>	Barbed-Wire Grass	.
<i>Danthonia</i> sp.	Wallaby Grass	.
<i>Echinopogon caespitosus</i>	Tufted Hedgehog Grass	.
<i>Entolasia stricta</i>	Wiry Panic Grass	.
<i>E.</i> sp.	Panic Grass	.
<i>Imperata cylindrica</i>	Blady Grass	.
<i>Microaena stipoides</i>	Weeping Meadow Grass	.
<i>Opilsmenus imbecillis</i>	Basket Grass	.
<i>Themeda triandra</i>	Kangaroo Grass	.

Ferns

<i>Adiantum aethiopicum</i>	Malden Hair	.
<i>Blechnum watslii</i>	Hard Water-fern	.
<i>Calochlaena dubia</i>	False Bracken	• • •
<i>Cheilanthes sieberi</i>	Mulga fern	.
<i>Gleichenia dicarpa</i>	Pouched Coral Fern	.
<i>Undsaea microphylla</i>	Lacy Wedge-fern	.
<i>Pteridium esculentum</i>	Bracken	• •

Other Monocotyledons

<i>Dianella caerulea var. caerulea</i>		• •
<i>D. revoluta</i>	Mauve Flax Lily	.
<i>Gahnia clarkii</i>		.
<i>Lepidosperma laterale</i>	Variable Sword-sedge	.
<i>Lomandra longifolia</i>	Mat rush	• •
<i>L. obliqua</i>	Fish Bones	.
<i>Pterostylis sp.</i>	Greenhood Orchid	.
<i>Typha orientalis</i>	Bullrush	.
<i>Xanthorrhoea arborea</i>	Broadleaf Grass-tree	.

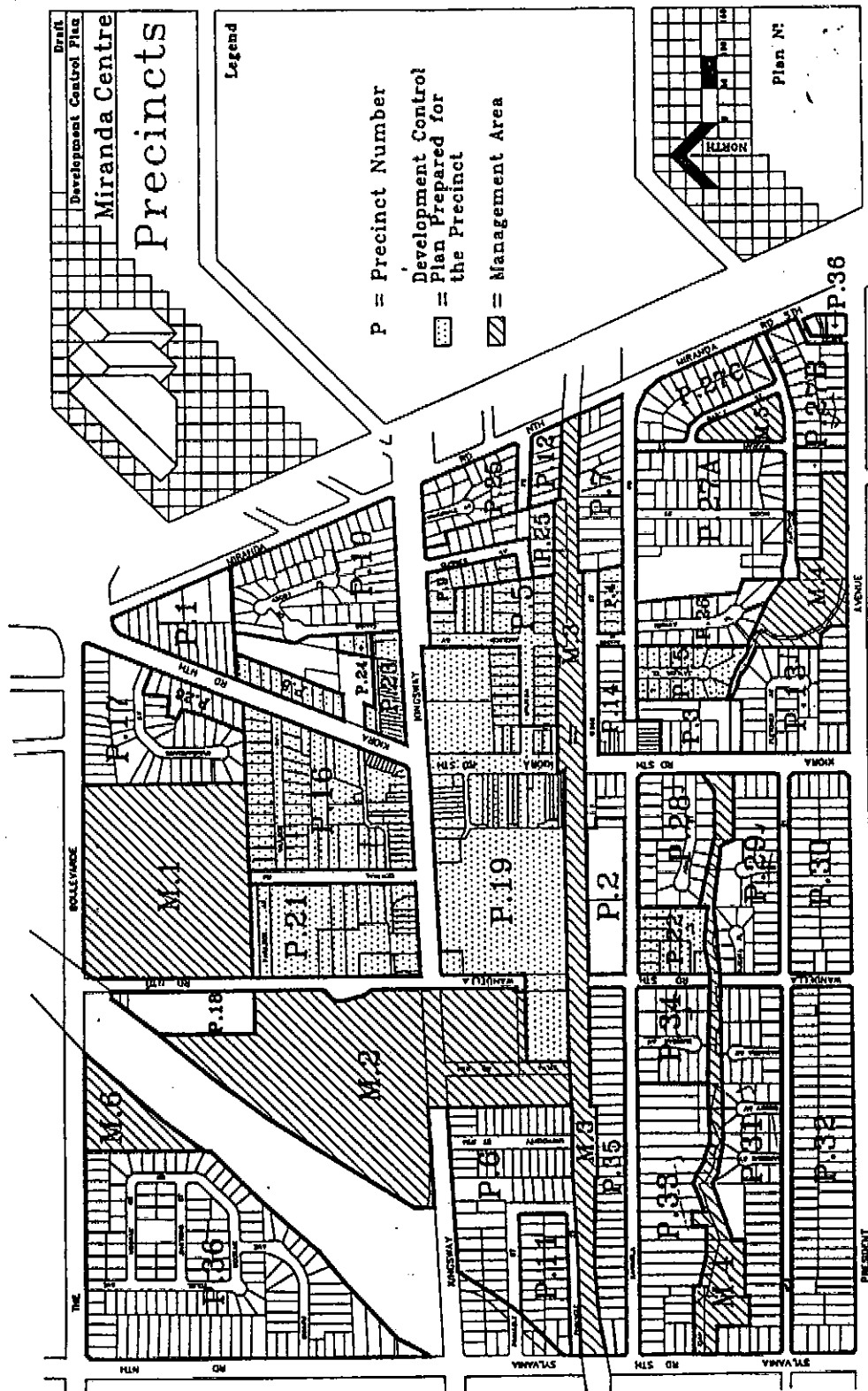
Site 1 - Public Reserve and foreshore areas of Yowle Bay, south of President Ave.

Site 2 - Public Reserve and surrounds of Quarry, north of President Ave.

Site 3 - Creekline upstream of Quarry, particularly between Klora Rd. and Manchester Rd.

APPENDIX E

DRAFT DEVELOPMENT CONTROL PLAN MIRANDA CENTRE, PRECINCTS



APPENDIX F

DRAFT DEVELOPMENT CONTROL PLAN MIRANDA PRECINCT 15

Miranda Precinct 15

4) On redevelopment of sites abutting Ewey Creek, the creek is to be maintained as an open channel and landscaped or creek treatment works undertaken as determined by Council.

Background Statement
This precinct has recently been rezoned to allow for development of townhouses and villas. Provisions exist in Ewey Creek to be provided on redevelopment of Site 3 and the Creek must be maintained in its natural state. Council will negotiate with adjoining owners to secure pedestrian access from Kira Road to the Creek.

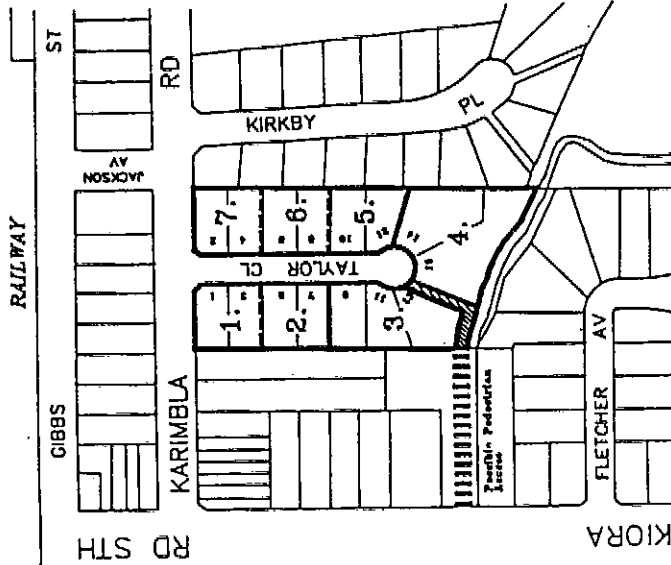
- Objectives**
- a) Enable redevelopment of the precinct in townhouses or villas.
 - b) Provide access to Ewey Creek from Taylor Close and Kira Road.
 - c) Ewey Creek maintained in its natural state.

Standards

- 1) Sites are to be redeveloped as indicated on the Plan prior to redevelopment.

2) Sites 1, 2, 3, 6 and 7 may be varied subject to an application for a variation.

3) On redevelopment of Site 3 an open space area equivalent to 10% of the site is to be dedicated as indicated on the Plan and physically constructed. Pedestrian access is to be provided between Taylor Close and Ewey Creek.



▨ Dedicated Open Space

ENVIRONMENTAL PLANNING AND ASSESSMENT ACT, 1979
SUTHERLAND
DRAFT DEVELOPMENT CONTROL PLAN
MIRANDA PRECINCT 15
Parent Plan: SUTHERLAND PLANNING SCHEME

RATIO 1:2000
0 20 40 60
LEGEND
▨ UNALLOTTED DEVELOPMENT SITE
▨ EXISTING PUBLIC OPEN SPACE
▨ PROPOSED PUBLIC OPEN SPACE
1 Identified

AMENDMENTS	
No.	Detail
1	
2	
3	
4	
5	

ACTION	Amendments						
	Original	1	2	3	4	5	6
Resolution to Prepare							
Notice of Intention							
Adopt Draft Plan							
Advertise Draft Plan							
Adopt Final Plan							

APPENDIX G

DRAFT DEVELOPMENT CONTROL PLAN MIRANDA PRECINCT 22

Miranda Precinct 22

Background Statement

This is a high density residential precinct with good access to transport, shopping and community facilities. The development must be designed to maintain any adverse impacts on the adjoining housing areas. This can be achieved by ensuring the building heights and setbacks. The large site will allow for innovative design at high density.

Vehicular access to the site must be controlled to maintain the conflict with other Crown traffic. By amalgamating the site, access can be provided at the corner of the Precinct, away from the intersection of Wandella Rd and Karimbla Rd.

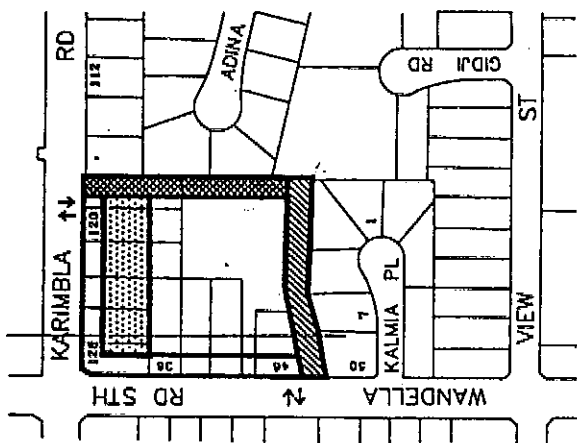
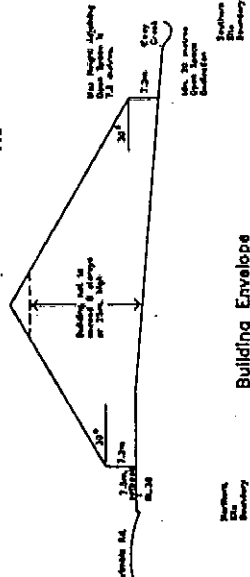
Open space can be dedicated to Council upon redevelopment to form part of the overall system along Eway Creek.

Objectives

- 1) Outline overall redevelopment of the Precinct.
- 2) Development at street level to cater for adjoining housing.
- 3) Development designed to minimise overshadowing and oversteering of adjoining housing.
- 4) Complementary design features and facilities throughout the Centre.

- 5) Safe and convenient access to the site.
 - 6) Access to public open space.
- Standards
- 1) All proposals shown in the precinct must be amalgamated prior to redevelopment.
 - 2) A density 200 persons per hectare will be permitted if the amalgamation and design guidelines are achieved.
 - 3) Building setbacks of 7.2 metres apply to the Karimbla Road and Wandella Road frontages.
 - 4) A minimum setback of 6 metres applies to the eastern boundary which must be increased where necessary to minimise overshadowing impacts on adjoining properties.

- 5) The eastern boundary setback must be barely landscaped to provide a dense screen buffer to adjoining lots. All large existing trees in the area of No. 118 Karimbla Road are to be retained.
- 6) An area with a minimum width of 20 metres from the southern boundary of the site is to be dedicated for open space.
- 7) Development must be within the building envelope created by:
 - i) a 7.2 m height along the public open space and the streets at the required setback
 - ii) a building plane of 30° taken from any point along the 7.2 m height along the public open space and the Karimbla Road frontage; and
 - iii) a maximum height of 8 storeys or 25 metres.



- 8) Vehicular access must be at the southern end of the site on Wandella Rd or the eastern end on Karimbla Rd, or both as shown on the Plan.
- 9) The development must incorporate the urban design elements of this Plan. External finishes must be consistent with the Miranda Centre - Colour Scheme.
- 10) Street planting and pavement treatment must be provided as indicated on the street planting and pavement plan.

- Open Space/Drainage Zoning
Min. 20m. wide
- Minimum 6m. Landscape Buffer
- 2 Storey maximum
- Vehicular Access Points

ENVIRONMENTAL PLANNING AND ASSESSMENT ACT, 1979

SUTHERLAND

DRAFT DEVELOPMENT CONTROL PLAN

MIRANDA PRECINCT 22

Parent Plan: SUTHERLAND PLANNING SCHEME

Plan Number 6.1/22/1

RATIO 1:2000

LEGEND

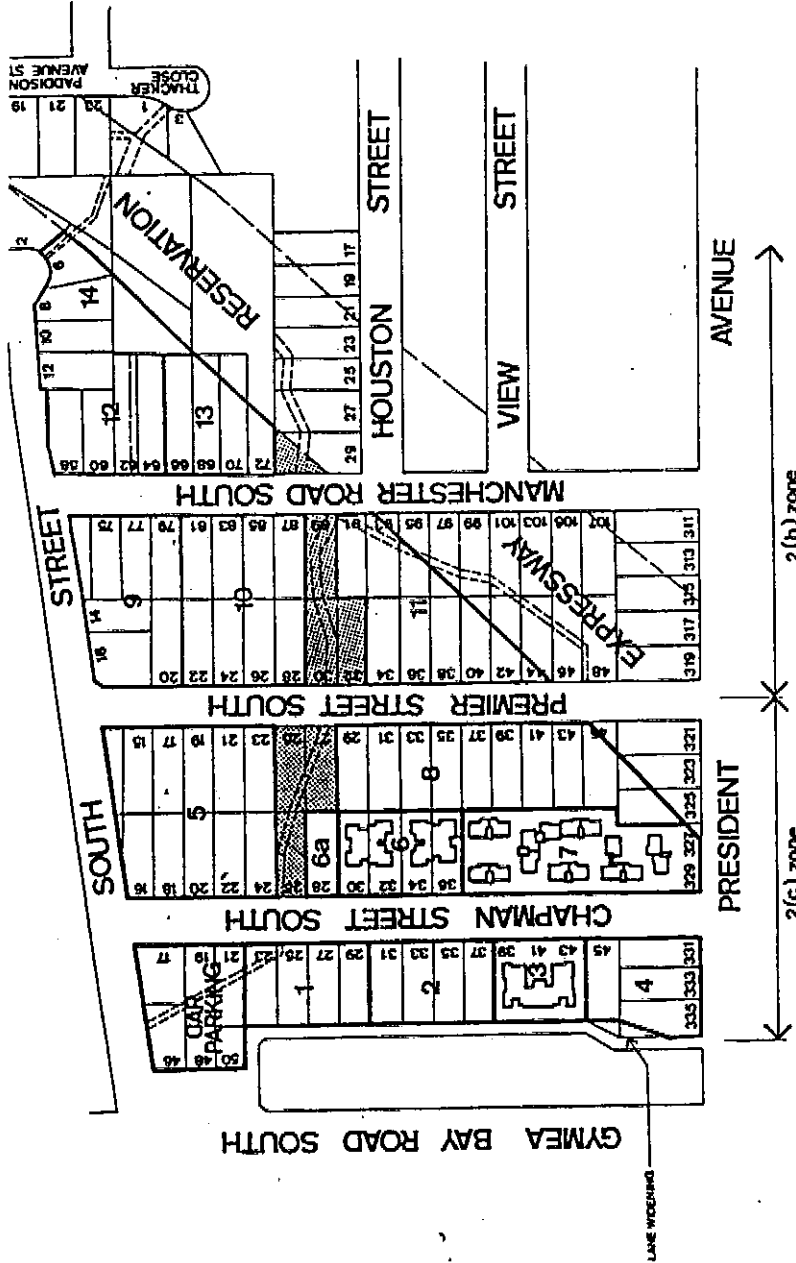
- AMALGAMATED DEVELOPMENT SITE
- EXISTING PUBLIC OPEN SPACE
- PROPOSED PUBLIC OPEN SPACE
- Admitted
- Notified by letter
- Meeting of Owners

AMENDMENTS	
No.	Detail
1	
2	
3	
4	
5	
6	

ACTION	Amendments						
	Original	1	2	3	4	5	6
Resolution to Prepare							
Notice of Intention							
Adopt Draft Plan							
Advertise Draft Plan							
Adopt Final Plan							
Notice of Adoption							

APPENDIX H

DRAFT DEVELOPMENT CONTROL PLAN GYMEA PRECINCT 2



ENVIRONMENTAL PLANNING AND ASSESSMENT ACT, 1979

SUTHERLAND

DEVELOPMENT CONTROL PLAN

GYMEA PRECINCT 2

SUTHERLAND PLANNING

Parent Plan Scheme

Plan Number 02/2/1

RATIO

LEGEND

- PROPOSED OPEN SPACE
- EXISTING OPEN SPACE
- L - LITTER
- M - PUBLIC MEETING

AMENDMENTS

No.	Date	Description
1		PUBLIC MEETINGS - NOT TO PROCEED WITH DETAILED PLANNING
2		ANAL. ON WEST SIDE OF CHAPMAN AVENUE
3		ROOM FOR LANE WIDENING FROM 225 PRESIDENT AVE
4		23-24 CHAPMAN ST SOUTH NOT TO BE DEV. SEPARATELY
5		
6		

ACTION	Date		Amendments					
	Original	Amendment	1	2	3	4	5	6
Resolution to Prepare	-	1.12.80	-	-	-	-	-	-
Notice of Intention	-	1.12.80	-	-	-	-	-	-
Adopt Draft Plan	-	10.8.74	-	-	-	-	-	-
Advertise Draft Plan	-	2.1.75	-	-	-	-	-	-
Adopt Final Plan	-	20.8.84	20.8.84	20.11.84	24.11.84	24.11.84	24.11.84	24.11.84
Notice of Adoption	-	1.5.84	1.5.84	1.5.84	1.5.84	1.5.84	1.5.84	1.5.84

7 BIBLIOGRAPHY

Technical Services Division, Sutherland Shire Council, 1990. **Sutherland Shire Urban Bushland. Plan of Management.**

Richard H. Riggs, March 1992. Ewey Creek. **Bushland Regeneration Study.**

Sutherland Shire Council, May 1992. **Code for Subdivision Edition 6** (amended in line with Sutherland Local Environment Plan).

Minister for Planning, March 1992. **Sutherland Local Environment Plan Government Gazette 40.**

8 REFERENCES

1. Willing & Partners Pty Ltd (1991) Gross Pollutant Traps Design. Manual prepared for Sutherland Shire Council, Sydney.
2. Standing Committee on Rivers and Catchments, Victoria. "Guidelines for Stabilising Waterways (1991).
3. S.P.C.C. Pollution Control Manual for Urban Stormwater.
4. Willing & Partners Pty Ltd "Design Guidelines for Gross Pollutant Traps" prepared for ACT Planning Authority 1992.