



Best Practice Guidelines for Greener Subdivisions

Western Sydney



An outcome of the

Keep the Soil on the Site: Greener Subdivisions Project

Prepared by

Hawkesbury/Nepean Landscape Unit
Sydney South Coast Region
NSW Department of Land and Water Conservation

Project funded by

NSW Stormwater Trust

Acknowledgments

Blacktown City Council (lead agency for the project)

Contributions also from:

Baulkham Hills Shire Council
Camden Council
Liverpool City Council
Penrith City Council
Department of Land and Water Conservation
Landcom
Civil Contractors Federation
Urban Development Institute of Australia

Published by:

Sydney South Coast Region
NSW Department of Land and Water Conservation
68 Mileham Street
Windsor NSW 2756
March 2002
©NSW Government
ISBN 0 7347 5268 7
HO nn/02

Contents

List of Figures	v
Chapter One - Introduction	1
Chapter Two - Regulatory Framework	5
2.1 Environmental Planning and Assessment Act 1979	5
2.2 Legislation requiring permits or approvals	5
2.3 Other relevant legislation, policies and guidelines	7
Chapter Three - Water	11
3.1 Stormwater management	11
3.1.1 Stormwater management plans	13
3.1.2 Guidelines for development control plans	13
3.1.3 Reference documents	16
3.2 Erosion and sediment and control	16
3.2.1 Guidelines for development control plans	18
3.2.2 Reference documents	19
3.3 Soil and salinity	19
3.3.1 Guidelines for development control plans	22
3.3.2 Reference documents	22
3.4 Floodplain management	23
3.4.1 Floodplain management plans	23
3.4.2 Guidelines for development control plans	24
3.4.3 Reference documents	24
Chapter Four - Biodiversity	25
4.1 Vegetation	25
4.1.1 Vegetation management plans	26
4.1.2 Riparian vegetation	28
4.1.3 Guidelines for development control plans	29
4.1.4 Reference documents	30
4.2 Native fauna	31
4.2.1 Guidelines for development control plans	32
4.2.2 Reference documents	32

Contents

Chapter Five - Built Environment	33
5.1 Housing design and lot size	33
5.1.1 Guidelines for development control plans	35
5.1.2 Reference documents	35
5.2 Roads and infrastructure	35
5.2.1 Guidelines for development control plans	36
5.2.2 Reference documents	36
5.3 Visual amenity	36
5.3.1 Guidelines for development control plans	37
5.3.2 Reference documents	37
Chapter Six - References	41
Appendix One	
Site Assessment Checklist	41
Appendix Two	
Assessment of Stormwater Management Plans	42
Appendix Three	
Contacts List	43
Appendix Four	
Native Plant Landscaping Units for Western Sydney Councils	45
Appendix Five	
Alternate Floor Construction Cost Comparison	55

List of Figures

1. Areas applicable to the Best Practice Guidelines for Greener Subdivisions: Western Sydney.	3
2. Subdivided lots facing onto watercourse with riparian zone preserved	12
3. Protecting the natural creekline (Source: NSW EPA 1996)	15
4. Incorporation of stormwater management measures into the open space network (Source: NSW EPA 1996)	15
5. Residential dwelling (Source: NSW EPA 1996)	16
6. Sediment control measures on a construction site	18
7. Causes of urban salinity in Western Sydney (Source: DLWC 2000)	20
(a) Salinity can occur at the base of a slope where water accumulates and the soil becomes waterlogged	
(b) A perched water table can give rise to seepage on slopes	
(c) Wall structures can act as a wick through which salt can move and concentrate.	
8. Effects of salinity	21
(a) Crumbling of mortar and bricks show the effects of salinity	
(b) Piers affected by salinity	
9. Riparian vegetation (Source: NSW EPA 1996)	29
10. Caddies Creek, a riparian corridor which provides a habitat for native fauna	31
11. Diversity of lots on an unconstrained site (Source: NSW EPA 1996)	33
12. A split level design on a sloping block	34
13. A connected street pattern (Source: NSW DUAP 2000)	36

In response to Sydney's population growth, there has been an ever increasing demand for new housing within the Sydney metropolitan area. With land availability limited in areas close to the central business district, the constant demand for new housing has seen the development of new residential subdivisions in numerous areas on Sydney's urban fringe. Notably, one of the highest growth areas is that of Western Sydney, which is undergoing rapid subdivision through development of its greenfield sites.

Greenfield developments are large sites where houses are built on land that was formerly 'green fields' (i.e. rural land). The principles of Greenfield development can also be applied to new housing proposed on major land holdings that were formerly used for other purposes (e.g. industrial, commercial or extraction).

As is the case with any proposed activity, planning and development of a subdivision should be done in a way that seeks to minimise, or where possible, negate the impact on the environment. In achieving this aim, it needs to be recognised that each proposed subdivision site has its own unique environmental attributes, existing impediments and merits that require further investigation and discussion with key government stakeholders to ensure outcomes are satisfactorily achieved.

This document has been produced as part of the Keep the Soil on the Site: Greener Subdivisions project. The project, led by Blacktown City Council, was initiated by the Hawkesbury-Nepean Catchment Management Trust, which was subsequently incorporated into the Department of Land and Water Conservation (DLWC). The project builds upon the original Keep the Soil on the Site project, which targeted builders in raising awareness in the use of appropriate soil erosion and sediment control techniques on building sites.

While this initial project has been successful in educating on-site contractors, it was observed that significant improvements in management practices could be made at the planning stage to maximise the environmental sustainability of subdivision developments in Western Sydney.

Poor land management practices in the Hawkesbury/Nepean catchment have the potential to cause significant environmental harm. Given the large size of many subdivisions in Western Sydney (within the Hawkesbury - Nepean catchment), if not managed properly these developments can have a substantial impact on a range of environmental issues, including water quality, salinity, biodiversity and erosion and sediment control.

The *Draft Hawkesbury Lower Nepean Blueprint* (DLWC, 2002) identifies the environmental impacts of greenfields development as a key land use issue in the catchment. The preparation of this document has specifically aimed to complement the objectives and targets of the Blueprint. In particular, this document satisfies Land Use Priority Action No 4 of the Blueprint, which requires the following:

"Develop and apply best practice guidelines for sustainable greenfields and rural residential development, which includes assessment prior to identification of Urban Development Program additions and rural residential areas in planning strategies and instruments."

This document does not seek to summarise and replace the many guidelines and policies referenced within, or to be the sole reference for natural resource management in urban development. It seeks to play a role as a guide to allow the planner, designer and developer to be better informed of the need to incorporate sustainable practices in subdivision planning to ensure sustainable outcomes on the ground.

These guidelines have been prepared specifically for Western Sydney local government areas within the Hawkesbury/Nepean catchment which have substantial greenfield developments, including Blacktown City Council, Baulkham Hills Shire Council, Penrith City Council, Liverpool City Council, Camden Council and Hawkesbury City Council, as shown in Figure 1.

1

The aims of these guidelines are to:

- achieve the best possible environmental outcomes from greenfield developments through the provision of best practice land subdivision guidelines for council officers, developers and consultants;
- encourage improved design and environmental management and provide a basis for consistency between council consent conditions;
- provide ideas for the formulation of environmentally sustainable guidelines in development control plans or local environmental plans as they relate to greenfield subdivisions;
- promote the importance of pre-development site assessment, exhibiting the integrated nature of assessment for each aspect of the environment;
- promote development that conserves biodiversity, maintains natural flows in watercourses and maintains the natural contours of the land;
- provide examples where some of the practices suggested have been implemented by councils;
- look at constraints to the uptake of sustainable practices, and design concepts that contribute to such practices. Best practice should consider the package of planning, urban design, engineering and environmental considerations to come up with the best solution for a site. The regulatory framework within which decisions have to be made must also be considered;
- improve the level of certainty for land owners, developers and their consultants in progressing conceptual frameworks or masterplans for proposed subdivision; and
- streamline the approval process through the incorporation and adoption of the best management practices in this guideline.

These guidelines have been formulated to be used as a practical tool for all people involved in the subdivision development industry, including:

- council officers who prepare consent conditions for subdivisions or who strategically plan for greenfield developments;
- land owners and developers who develop greenfield sites and their consultants; and
- state government officers involved in land planning and development.

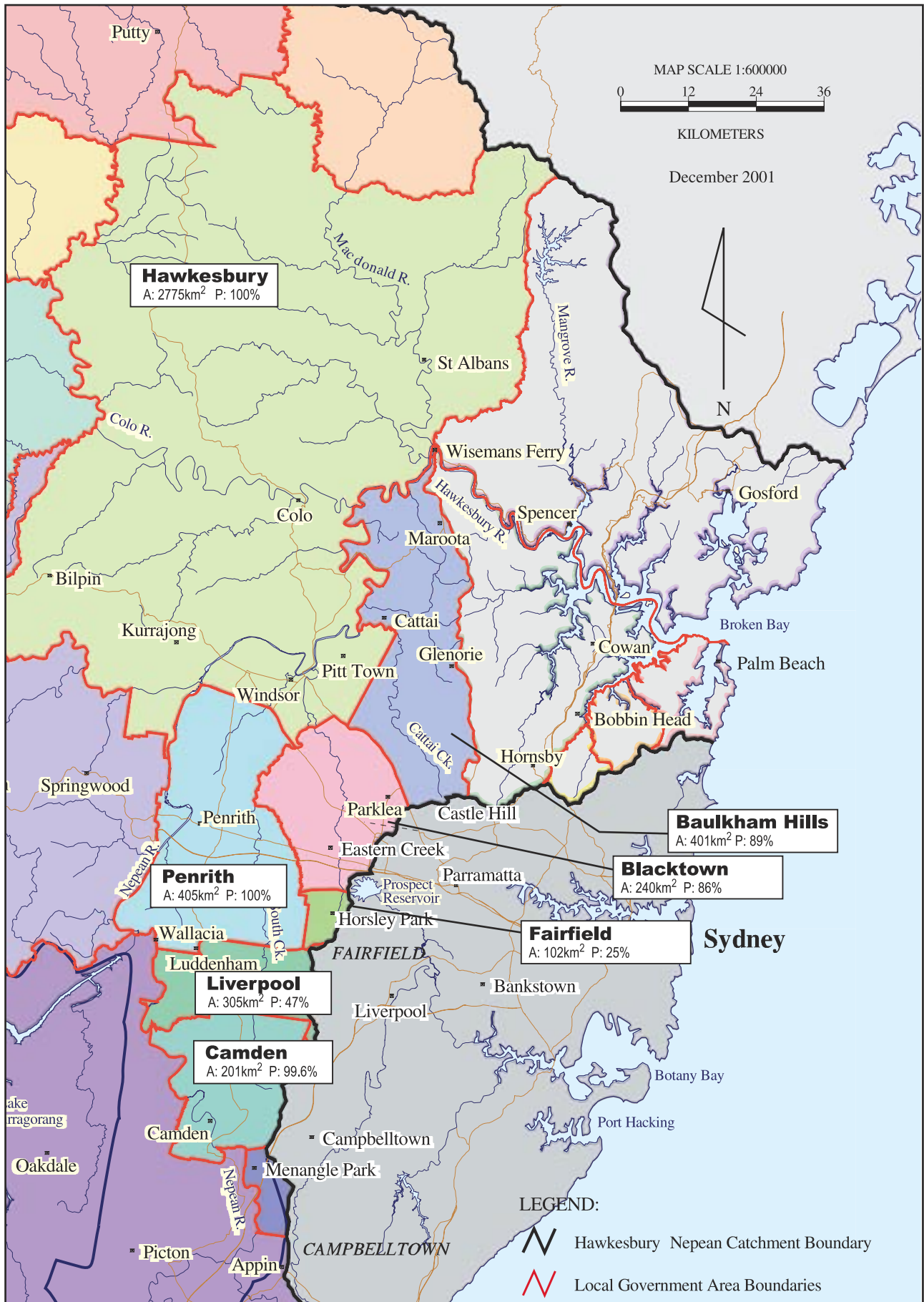


Figure 1. Areas applicable to the Best Practice Guidelines for Greener Subdivisions: Western Sydney.

Regulatory Framework

Development of land is subject to a range of legislation, policies, strategies and plans across Federal, State and Local jurisdictions. The following is a list and brief overview of relevant legislation that may apply to the development of greenfield sites. It should be noted that the list is not exhaustive, and hence it is recommended that relevant federal, state and local government agencies be consulted to determine the applicability of legislation and other planning instruments administered by the respective agencies.

2.1 Environmental Planning and Assessment Act

The *Environmental Planning and Assessment Act 1979* (EP&A Act) provides a broad legal framework for planning and assessing development in NSW. The Act aims to promote social and economic welfare and a better environment by encouraging the proper management, development and conservation of natural and man-made resources.

Under the EP&A Act, responsibility for planning and assessment is shared between state and local government. Planning instruments available at a state level currently include State Environmental Planning Policies (SEPPs) and Regional Environmental Plans (REPs). Local councils are responsible for local planning issues under the EP&A Act through development of local environmental plans (LEPs) and development control plans (DCPs). Local planning instruments should be consistent with state planning instruments.

Through their role as regulatory authorities, government agencies and councils should be proactive in providing a clear direction as to what issues, performance criteria and control mechanisms are to be addressed as part of a subdivision application. By identifying these requirements (e.g. erosion and sediment controls, stormwater management controls, water quality goals, vegetation management plans etc) up front in relevant planning instruments and

guidelines, the applicant is then responsible for implementing the various requirements during the planning phase. This subsequently reduces the need to impose a large number of consent conditions in determining an application.

The White Paper released by the Department of Urban Affairs and Planning, entitled *planFIRST* (2001), proposes amendments to the planning system whereby all current LEPs and DCPs within a local council area will be replaced by one plan which will include all the planning controls within that local government area. The local plan would be required to reflect the intent of the regional plan.

Section 94 of the EP&A Act enables consent authorities to impose conditions of consent which levy monetary contributions from developers towards the cost of, for example, stormwater works needed as a consequence of a particular development.

Sydney Regional Environmental Plan No 20 - Hawkesbury-Nepean River (No 2 - 1997) aims to protect the environment of the Hawkesbury-Nepean River system by ensuring that the impacts of future land uses are considered in a regional context. Under this statutory plan, the general planning considerations, policies and strategies (as set out within the Plan) must be taken into consideration by a consent authority when determining a development application, or in the preparation of an environmental planning instrument or DCP.

2.2 Legislation requiring permits or approvals

- The *Threatened Species Conservation Act 1995* protects all threatened plants and animals native to NSW. The Act provides for the identification, conservation and recovery of threatened species and their populations and communities. It also aims to minimise the threats faced by those species. The introduction of the Act included amendments to the EP&A Act (s.5A) which

2

require assessment using the 8-part test for developments or activities which may have an impact upon any threatened species or ecological community. If the 8-part test concludes that a proposed development or activity is likely to have a significant effect on threatened biota, a species impact statement must be prepared.

- The *Rivers and Foreshores Improvement Act 1948* (RFI Act) will remain in force until the regulations of the *Water Management Act 2000* are prepared (expected late 2002 or early 2003). The RFI Act applies to 'protected land', which includes the bank, shore or bed of protected waters and those areas within 40m of the top of the bank or shore. The Act also applies to natural and artificially modified watercourses and water bodies, which are known as 'protected waters', including permanent and intermittent streams, and any lakes connected to them.

The Act requires that a Part 3A permit be obtained from DLWC for any excavation on, in or under 'protected land', or removal of material from protected land or for any activity that may obstruct or detrimentally affect the flow of 'protected waters'.

In assessing Part 3A permit applications, DLWC will consider the proposal's consistency with the aims and objectives of the *NSW State Rivers and Estuaries Policy 1992* and other relevant State Government policies, strategies and guidelines. The Act also contains provisions for conditions relating to protection of the environment to be attached to 3A permits. In this instance, DLWC frequently promotes development setbacks from watercourses and in some cases, the establishment of vegetated riparian zones. It should be noted that the Act is only applicable to areas of freehold land (i.e. the Act does not apply to Crown land).

- The *Water Management Act 2000* introduces controlled activity approvals for 'waterfront land' which includes the beds, banks and

foreshores of rivers, estuarine and coastal water bodies. Controlled activity approvals will come into effect following the preparation of the regulations accompanying the new Act, which will replace existing licences, approvals and permits under the *Water Act 1912* and the *Rivers and Foreshores Improvement Act 1948*. The Act also introduces the concept of an 'aquifer interference regime' which refers to:

- the penetration of an aquifer; or
- the interference with water in an aquifer; or
- the obstruction of the flow of water in an aquifer.

A controlled activity approval will be required for these activities.

- The *Native Vegetation Conservation Act 1997* is administered by the Department of Land and Water Conservation. The Act provides the framework for the conservation and sustainable management of native vegetation in NSW. Within the Sydney metropolitan area, there are a number of local government areas (LGAs) that are partially excluded from the Act (including Baulkham Hills, Blacktown, Camden, Fairfield, Hawkesbury, Penrith and Liverpool). In these areas, the Act only applies to areas of 'state protected land' which are not otherwise exempt or excluded from the Act. State protected land is defined across three categories, namely:
 - mapped land that is generally in excess of 18° slope (Category A);
 - land within, or within 20m of, the bed or bank of a prescribed stream (Category B); and
 - mapped land that is defined as environmentally sensitive (Category C).

Category A lands within the Hawkesbury-Nepean catchment are shown on maps available from DLWC offices. A list of prescribed streams (Category B) is also available from DLWC.

At the time of writing, there were no gazetted areas of Category C land within the Hawkesbury-Nepean Catchment.

Subdivision developments that propose to clear vegetation from state protected land may require consent from the Minister for Land and Water Conservation under the Act. Proponents and councils should consult early with their local DLWC office regarding subdivisions in areas that may be affected by the Act.

- The *Fisheries Management Act 1994* was introduced to conserve, develop and share the fisheries resources of the State for present and future generations. Under the Act, a permit must be obtained from NSW Fisheries for any dredging or reclamation activities that may be harmful to fish or fish habitats.

To support this legislation, NSW Fisheries have developed a policy and guideline document entitled *Aquatic Habitat Management and Fish Conservation* (1999 update). While the document is applicable to all forms of development within or adjacent to aquatic habitats, the guidelines contained in section 5.25 are particularly relevant to Western Sydney subdivisions, which recommend (amongst other actions) a minimum foreshore or river frontage buffer of 50m.

In November 2001, the NSW Minister for Fisheries listed a new key threatening process under Schedule 6 of the *Fisheries Management Act 1994* that is likely to affect the clearing of vegetation on greenfield lands. The new key threatening process is 'the degradation of native riparian vegetation along NSW watercourses'. NSW Fisheries will prepare a threat abatement plan for the key threatening process, in close consultation with the community, local councils and other government departments.

- The *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* provides a framework for the environmental assessment and approval of actions that have, will have, or are likely to have a significant impact on a matter of 'national environmental significance'. Such matters include world heritage properties, Ramsar wetlands, internationally protected migratory species and nationally threatened animal and plant species and ecological communities (e.g. Cumberland Plain Woodlands, Shale/Sandstone Transition Forest). An action that is likely to have a significant effect on the above may require approval from the Commonwealth Minister for the Environment.

2.3 Other relevant legislation, policies and guidelines

- The *Protection of the Environment Operations Act (POEO)* came into effect on 1 July 1999 and has consolidated the following earlier Acts:
 - ◆ Clean Waters Act 1970
 - ◆ Clean Air Act 1961
 - ◆ Noise Control Act 1975
 - ◆ Pollution Control Act 1970
 - ◆ Environmental Offences and Penalties Act 1989
 - ◆ Regulatory sections of Waste Minimisation and Management Act 1995

The POEO Act focuses on environmental management. Since 1 July 1999 local councils hold increased powers in relation to environmental management in their local area.

These changes mean that owner-builders, builders, landscapers or land managers in general are directly responsible for preventing sediment and construction wastewater leaving a construction site. While the EPA monitored land development actions in

2

the past, now councils have the power and responsibility to monitor the industry and issue infringement notices.

Under the POEO Act, **on-the-spot fines can be imposed on builders, owner/occupiers or landscapers** of land where pollution has the potential to, or has entered gutters, drains and waterways. On top of this fine an administration fee may be charged.

Supervisors need to take reasonable and practical steps to ensure workers under their control on the site (e.g. sub-contractors) do not breach environmental laws.

The law does not recognise:

- ◆ Whether or not the site is difficult
- ◆ Problems that might be encountered in implementing the plan
- ◆ Whether or not there is a familiarity with good soil and water management standards

Note that workers aware of significant environmental harm in association with their work, e.g. a major loss of sediment from their site, have a legal duty under the POEO Act to notify their employer.

Local councils may issue the following notices:

- ◆ Clean up notices
 - ◆ Prevention notices
 - ◆ Penalty infringement notices
 - ◆ Compliance cost notices
 - ◆ Noise control notices
 - ◆ Noise abatement notices
- The *Draft Hawkesbury Lower Nepean Catchment Blueprint 2002* describes a plan for natural resource management in the Hawkesbury Lower Nepean and outlines how strategic investment and action will improve the current state of natural resource management. It is a ten year plan which recognises the importance of adaptive

management supported by concerted action, cooperative effort and ongoing improvement in management actions. Successful implementation of the Blueprint will result in:

- ◆ better river health by improving stormwater and sewage management to reduce pollutants and
 - ◆ sediments entering waterways, by implementing a program for environmental flows and by caring for riparian vegetation;
 - ◆ conservation of most at-risk areas of native vegetation and aquatic habitat;
 - ◆ closer alignment of biophysical capabilities of the land and its use by improved management of urban and rural development; and
 - ◆ A more involved community contributing to improved catchment health.
- Under Section 12 of the *Protection of the Environment Administration Act 1991* the NSW Environment Protection Authority requires councils to prepare stormwater management plans for urban areas within specified catchments, districts or local government areas. Stormwater management plans within the Hawkesbury/Nepean catchment currently exist for the catchments of South Creek, Cowan Creek, Cattai Creek, Berowra Creek and for both the Upper and Middle Hawkesbury/Nepean. Stormwater controls on subdivisions should be consistent with stormwater management plans for the sub-catchment.
 - The *NSW State Rivers and Estuaries Policy 1992* provides objectives and principles for the management of the State's rivers, estuaries, wetlands and adjacent riverine plains. Development within and adjacent to watercourses should be designed and implemented so as to reduce, and where possible halt:
 - ◆ declining water quality;
 - ◆ loss of riparian vegetation;

- ◆ damage to riverbanks and channels;
- ◆ declining natural productivity;
- ◆ loss of biological diversity; and
- ◆ declining natural flood mitigation

The primary objectives of the policy are to manage the rivers and estuaries of NSW in ways which:

- ◆ slow, halt or reverse the overall rate of degradation in their systems;
- ◆ ensure the long term sustainability of their essential biophysical functions; and
- ◆ maintain the beneficial use of these resources.

In preparing a development proposal, applicants should ensure that their proposal is consistent with the policy.

- The *NSW Wetlands Management Policy 1996* was introduced in an effort to halt, or where possible reverse degradation of the State's wetlands. In addressing this issue, the policy encourages projects and activities which will restore the quality of the State's wetlands, such as:
 - ◆ rehabilitating wetlands;
 - ◆ re-establishing vegetation buffer zones around wetlands; and
 - ◆ ensuring adequate water to restore wetland habitats.

If a proposed greenfield site contains any wetlands (as defined by the policy), applicants should ensure that their proposal is consistent with the policy.

- The *NSW Biodiversity Strategy* applies to all areas across the state. The goal of the strategy is to protect the native biological diversity of NSW and maintain the ecological processes and systems. One of the core objectives of the strategy is to identify, prevent or attack at-source the threats to biodiversity through timely implementation of targeted actions. Importantly, the strategy builds on the principles of Ecologically Sustainable Development (ESD) as defined in the *Protection of the Environment Administration Act 1991*.
- The *Draft Native Vegetation Conservation Strategy* for New South Wales has been prepared by the Native Vegetation Advisory Council (NSW). The strategy includes measurable targets and actions as part of six primary outcomes for the improvement, conservation and sustainable management of native vegetation across the state. Further, the strategy recognises the need for partnerships across a wide variety of groups, including government and non-government organisations and individuals, to ensure these targets are met.

Water

The effective management of water related issues are critical in minimising impacts associated with subdivision development. In order to achieve this outcome, existing site characteristics and any associated constraints need to be identified early in the planning process. Aspects to be considered include:

- stormwater control;
- design and implementation of effective sediment and erosion control measures;
- identification of potential salinity hazard areas;
- the biophysical stability of watercourses and the characteristics of natural channels;
- connectivity of waterway systems, overland flows and natural drainage lines;
- the need for watercourse ecosystems to be managed for sustainable outcomes; and
- flood hazard and flood behaviour

While each of these factors is individually significant, the relationship between them can often be complex. Therefore, to maximise sustainable outcomes, it is important that an integrated approach be used when considering the above elements during the **initial site assessment**. Site assessment is an important component of pre-development planning. The importance of this planning aspect is highlighted throughout other sections of this document, and provides a key theme to sustainability.

3.1 Stormwater Management

As part of the **initial subdivision planning process**, a land capability assessment should be undertaken to determine if the proposed site is broadly suitable for urban development (see Appendix 1). This assessment should also identify any potential landform constraints present at the site. The *Draft Managing Urban Stormwater: Source Control* (NSW Environment

Protection Authority, 1998) outlines the framework and steps involved in conducting a land capability assessment.

The information collected from these initial studies can then be incorporated into the development of a stormwater control framework, based on ecologically sustainable development (ESD) and appropriate water sensitive urban design (WSUD) principles.

The overall goals of WSUD are:

- preservation of existing topographic and natural features such as watercourses;
- protection of surface water and groundwater resources; and
- integration of public open space with drainage corridors.

The principles of WSUD include minimising impervious areas and the use of pipes and encouraging infiltration (where appropriate) and stormwater reuse. Such principles are based on minimising the impacts of development on the total water cycle and maximising the multiple use benefits of a stormwater system.

It is important however that implementation of WSUD techniques considers the potential impact on the local salinity hazard. Indeed, the principles of WSUD may need to be revised in areas where saline affected soils are an issue. Therefore, this component of the guidelines should be read in conjunction with Section 3.3 (Soil and Salinity) of this document. To reduce uncertainty with regard to the implementation of WSUD techniques and salinity issues, Council needs to investigate the relationship of these aspects at the LEP stage to develop a framework for WSUD at the DCP level.

Water sensitive urban design principles can be adopted at a range of development scales from an entire greenfield subdivision down to an individual lot. Potential water sensitive design techniques include:

3

- integrate major above ground water features with positive features of a development, for example, having houses facing, rather than backing on to watercourses and water bodies (e.g. Highlands Ridge Estate, Baulkham Hills Shire Council; Stanhope Gardens Neighbourhood , Blacktown City Council);
- locate stormwater treatment structures off-line of watercourses/waterbodies, and outside riparian zones to ensure appropriate water quality improvement prior to discharge into natural drainage lines;
- configuration and sizing of lots should maximise communal open space and stormwater drainage areas e.g. Lemongrove Estate, Parklea, Blacktown City Council. Specifically, larger blocks should be located in areas where vegetation is to be conserved;
- include natural habitats, such as watercourses, within open space areas of the development;
- provide buffer zones adjacent to watercourses e.g. Caddies Creek, Highlands Ridge Estate, Rouse Hill, Baulkham Hills Shire Council. The Department of Land and Water Conservation is able to assist with expected requirements;
- reduce road pavement widths and use vegetated swales in place of kerb and gutter where problems with salinity and groundwater are unlikely to occur;
- develop the perimeter road network to divert runoff into stormwater treatment ponds;
- reduce impervious surfaces in carparks by using pavers or reinforced grass where salinity will not be affected; and
- re-use stormwater, for example, in watering playing fields or by watering gardens from a rainwater tank or using in a grey water system. This should be reinforced by a drainage strategy.

These design techniques are examples of recommended current practice and should be looked at in an



Figure 2. Subdivided lots facing onto watercourse with riparian zone preserved

integrated manner. They need to be site specific and looked at in context with regard to other site aspects, including soil properties and geotechnical stability. For example, construction of water bodies (i.e. permanent detention basins) can increase the local salinity hazard through excess infiltration. Also, standing water can lead to mosquito problems and subsequent health hazards. It is therefore important that a complex variety of native vegetation be established in association with the waterbody to promote healthy predator/prey relationships to reduce this risk.

An example of recommended current practice Water Sensitive Urban Design is Highlands Ridge Estate at Rouse Hill (Figure 2). The perimeter road network has been designed to pass between the subdivided lots and the adjacent watercourse (Caddies Creek). This results in houses being constructed in an orientation that faces onto the watercourse, promoting community stewardship of Caddies Creek and its associated riparian zone. The road layout also allows for the capture of stormwater and diversion to off-line water quality control ponds.

3.1.1 Stormwater management plans

The preparation of broad based stormwater management plans (SMPs) provides an opportunity to incorporate water sensitive urban design principles into stormwater management practices within each catchment. The objectives of a stormwater management strategy for any new urban development should be integrated and consistent with any stormwater management plan for the catchment in which the development is located. A stormwater management plan should contain the following:

- a) A brief description of the catchment, including climate, topography, water quality, streamflow, aquatic ecosystems and habitats, riparian vegetation, point sources of pollution, flood characteristics, major sewer overflows and urban bushland areas;
- b) Identification of stormwater management problems and issues;

- c) An evaluation of potential stormwater management practices to address the identified problems and issues;
- d) Clearly defined stormwater management performance objectives for both existing and proposed urban areas. i.e. what pollutants are the stormwater treatment structures trying to control (e.g. coarse sediments, fine sediments, oils and greases, fertilisers/nutrients etc);
- e) An implementation strategy;
- f) A monitoring program, including a clear identification of responsibilities;
- g) A mechanism for reporting the effectiveness of the plan (are performance objectives being met?);
- h) A program for revising the plan and linking its review to council state of the environment reporting and council management planning;
- i) Variations for particular site conditions such as salinity prone areas

In certain circumstances, a proponent may be unable to apply aspects of the SMP due to site specific matters or characteristics. In such cases, the developer may need to devise an alternative solution to that provided in the SMP for managing stormwater on the subdivision. The focus however, needs to remain on the performance of the system in relation to water quality outcomes and operation under a range of rainfall/flood events.

Appendix 2 assesses the features of the various SMPs for the Hawkesbury/Nepean catchment.

3.1.2 Guidelines for development control plans

The objectives of SMPs can be supported by the inclusion of appropriate guidelines and considerations in development control plans such as those listed below. Development of such plans must also address cumulative impact issues associated with stormwater management.

1. *Sediment basins* may be incorporated in projects which result in over 0.25 hectares of disturbed area

3

and which can be drained to one location. Such structures can function as permanent *wet and/or dry detention basins* and, if of sufficient size, as *water quality control ponds and urban lakes*. However, the provision of such features requires careful planning and design, involving a comprehensive environmental and performance assessment. Such structures are not to be located 'on-line' of any watercourse or waterbody.

Review of these structures should also examine the *environmental flow characteristics* of the receiving waters and where the structure fits in the context of council's trunk drainage management strategy. The design and location of basins/control ponds should also consider maintenance access requirements and possible recreation use. See *Managing Stormwater: Soils and Construction* (NSW Department of Housing, 1998) for further detail.

2. Urban stormwater is an adverse impact associated with subdivision development. It is therefore essential that this issue be managed on urban lands, and not within areas required for environmental protection and conservation. (e.g. outside of riparian areas).

3. Where appropriate, roads and driveways may be designed to incorporate vegetated swales adjacent to the pavement area instead of kerb and guttering to facilitate infiltration and water quality treatment, depending on soil type and location (NB: extra maintenance by council may be required).

4. Parking lot storage of stormwater run off may also be accommodated in vegetated swales or other appropriate landscape structures.

5. *Rainwater tanks* may be provided to store roof water on site for re-use purposes such as flushing toilets, washing vehicles and garden irrigation, but not for human consumption. This practice can reduce ongoing costs associated with water use. In addition rainwater tanks can assist in reducing the size of large stormwater detention structures.

6. Limiting the extent of hardstand surfaces such as roads, driveways and carparking areas can assist maintenance of the pre-development flow regime.

7. Open car-parking areas and internal driveways should encourage infiltration by the use of *porous pavements and modular paving*, wherever soils are suitable.

8. *Drainage reserve areas* should retain watercourses, recharge areas and areas of indigenous vegetation as natural site features integrated into the public open space network.

9. *Minimising the area of hard surfaces and using permeable surfaces* wherever soils are suitable, encourages infiltration and reduces surface water run off.

10. Natural watercourses and their associated riparian zones should be maintained and rehabilitated wherever possible. Piping, filling, relocation or any other activity that otherwise detrimentally affects watercourses are strongly discouraged. For management of watercourses and their associated riparian zones, consideration should be given to the following criteria:

- actual or potential biodiversity and habitat;
- the ecological connectivity role of the watercourse in supporting the local and regional biological network
- the actual or potential ability of the watercourse to enhance water quality;
- the actual or potential visual/aesthetic character of the watercourse;
- the actual or potential passive recreational value of the watercourse;
- the impact of a proposed development on the continuing function of the watercourse for the benefit of future generations (including cumulative impacts);
- the issue of flood hazard in relation to life and property;
- the issue of soil salinity in relation to watercourses and their associated riparian zones;
- the adequacy of riparian buffer zones; and
- cost/benefit ratio and practicality assessment.



Figure 3. Protecting the natural creekline (Source: NSW EPA 1996)

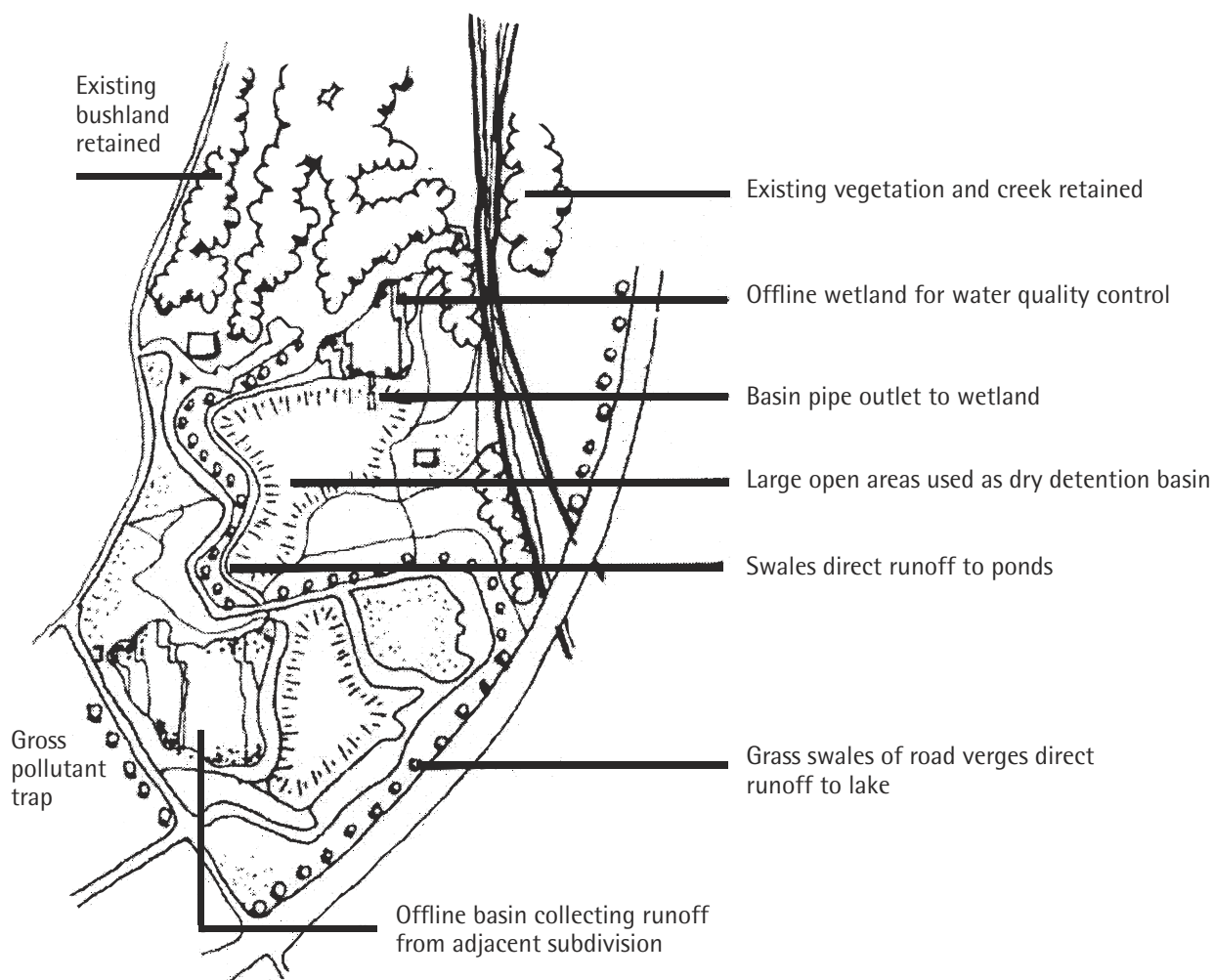


Figure 4. Incorporation of stormwater management measures into the open space network (Source: NSW EPA 1996)

Example: Stanhope Gardens Neighbourhood 1, Blacktown City Council; Glenwood Park Estate, Blacktown City Council.

3

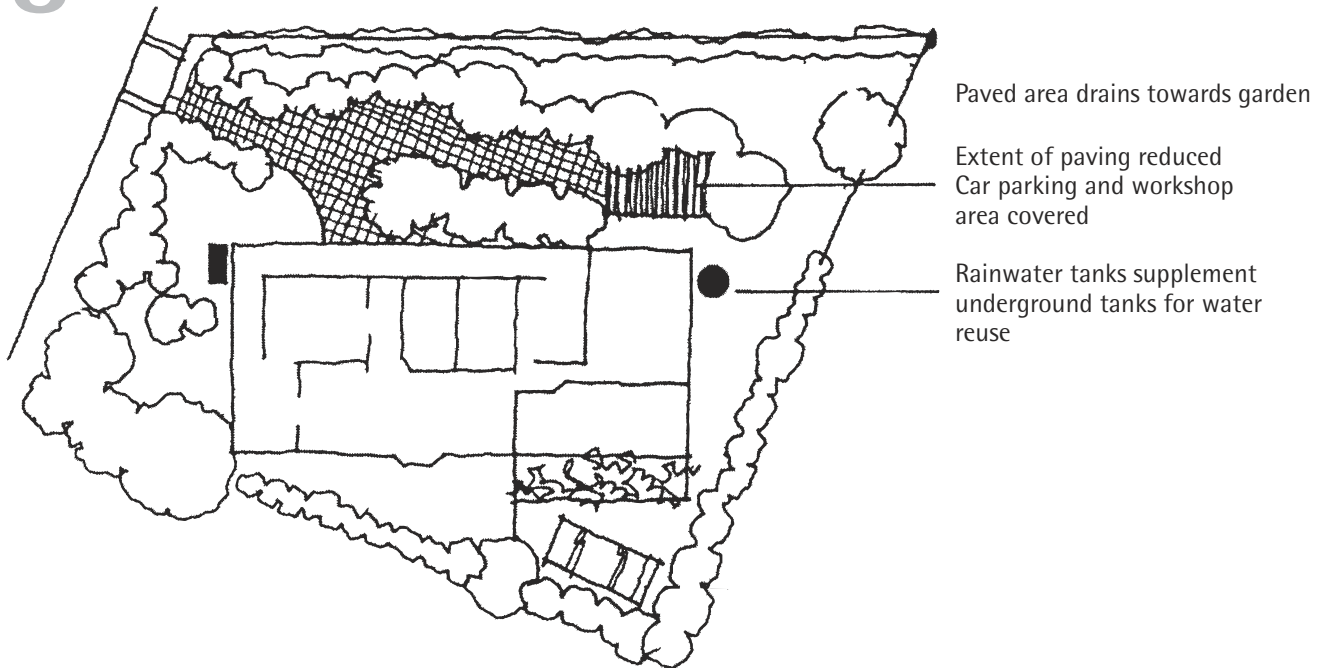


Figure 5. Residential dwelling (Source: NSW EPA 1996)

Examples of subdivision layouts that incorporate the principles of water sensitive urban design are shown in Figures 3, 4 and 5. Further examples are shown in Liverpool City Council's *Development Control Plan No. 8 Natural Assets* (1999) and Hornsby Shire Council's *Sustainable Water Development Control Plan* (1998).

Examples include Carnes Hill, Liverpool City Council; Caddies Creek, Highland Ridge, Rouse Hill, Baulkham Hills Shire Council; Stanhope Gardens, Neighbourhood 1, Blacktown City Council.

3.1.3 Reference documents

Hornsby Shire Council 1999 *Berowra Creek Stormwater Management Plan*

Penrith City Council and Blacktown City Council 2000, *South Creek Stormwater Management Plan*

Penrith City Council 2000 *Middle Nepean Hawkesbury Stormwater Management Plan*

Camden Council et al. 2000 *Upper Nepean River Catchment Stormwater Management Plan*

Baulkham Hills Shire Council and Blacktown City Council 2000 *Cattai Stormwater Management Plan*

Hornsby Shire Council et al. 1999 *Cowan Creek Stormwater Management Plan*

NSW Environment Protection Authority 1998 *Managing Urban Stormwater: Source Control* (Draft)

NSW Department of Housing 1998 *Managing Urban Stormwater: Soils and Construction*.

3.2 Erosion and Sediment control

Development of a subdivision site commonly involves substantial disturbance to the ground surface for the provision of utilities, earthworks and road construction. Given the large areas associated with many subdivisions, these developments present a significant erosion hazard. If not managed adequately, soil erosion and off-site movement of sediment can have a severe impact on natural environments and ecosystems. Such impacts may not be immediately evident, however the cumulative impact over many years can result in significant restoration costs (NSW Department of Housing, 1998).

The State Government endorsed publication, *Managing Urban Stormwater: Soils and Construction* (NSW Department of Housing, 1998) (NB: currently under review) is the principal manual used for the planning and management of erosion and sediment control

issues across NSW. The manual (commonly referred to as the 'Blue Book'), provides comprehensive guidelines to assist applicants in the preparation of Erosion and Sediment Control Plans (ESCPs) and Soil and Water Management Plans (SWMPs). Notably, the Blue Book:

- identifies the importance of site assessment and analysis in initial subdivision planning;
- provides guidance on the appropriate use, and limitations of best management practice erosion and sediment control measures to apply on-site;
- emphasises the importance of soil type identification in developing an effective ESCP/SWMP;
- recognises the need to incorporate ESD principles, including:
 - ◆ creation of buffer zones between areas of development and remnant habitats;
 - ◆ interception and management of stormwater before discharge into natural watercourses;
 - ◆ identification and protection of threatened species, habitat areas and remnant vegetation;
- promotes the need to monitor the effectiveness of the ESCP/SWMP and revise as necessary;
- acknowledges that best management practices change, and that both government and industry should follow such changes; and
- includes a Model Code of Practice for Soil and Water Management and a list of standard conditions of consent.

ESCPs/SWMPs should include scaled drawings and detailed specifications that are easily understood by supervisory staff. It is strongly recommended that the Blue Book be consulted in the preparation of an ESCP/SWMP to ensure that the plan is consistent with the manual. Preparation of an erosion and sediment control strategy also satisfies Policy 3, Strategy (f) of *Sydney Regional Environmental Plan (SREP) No. 20 Hawkesbury-Nepean* (1997), which promotes the

need for an ESCP where 'the development concerned involves the disturbance of soil'.

Items to be included on the plan should include:

- locality of the site, a north point and a scale bar;
- existing and final contours, including catchment area boundaries and indications of direction of fall;
- location and description of existing vegetation;
- diversion of uncontaminated up-slope runoff around the disturbed site;
- location of significant natural areas requiring special planning or management, including watercourses, floodplains, seasonally wet areas, areas prone to ponding/waterlogging, unstable slopes etc;
- nature and extent of earthworks, including cut and fill and roadworks;
- location of all stockpiles;
- location of site access, proposed roads and other impervious areas;
- existing and proposed drainage patterns;
- location and type of proposed erosion and sediment control methods;
- site rehabilitation proposals, including final contours;
- maintenance schedule;
- soil and water management plans (SWMPs) should also show the location and sizing calculations for sedimentation basins; and
- a clear program showing staging of works.

Additional information may be required for larger scale proposals to address the long term impacts of the development. Such information may include an assessment of the acid sulfate and salinity potential of the subject site. Figure 6 illustrates common sediment and erosion control measures used on a development site.

3

3.2.1 Guidelines for development control plans

1. *Sediment and erosion controls* should be installed prior to any ground disturbance.
2. All components of the ESCP/SWMP are to be in accordance with the state government endorsed guidelines *Managing Urban Stormwater: Soils and Construction* (Department of Housing, 1998).
3. *Uncontaminated runoff* should be intercepted upslope and diverted around all disturbed areas and other areas likely to be disturbed. Runoff diversions are to be adequately stabilised to prevent erosion from concentrated flow. Any diversion outlet into a watercourse is to be provided with appropriate scourprotection using a 'soft - engineering' approach.
4. *Topsoil* should only be stripped from approved areas and should be stockpiled for re-use during site rehabilitation and landscaping. Where possible, topsoil stockpiles should be no greater than 1m in height to

maintain the viability of soil micro-organisms and the topsoil seedbank.

5. *Stockpiles* of topsoil, sand, aggregate or other material should be stored clear of any drainage line or easement, footpath, kerb or road surface and be protected by appropriate erosion and sediment controls.
6. Areas of *sodic/saline soils* should be identified prior to the commencement of works. Disturbance of these areas should be minimised to reduce exposure of these soils.
7. Design, sizing, location and operation of any *sediment basin(s)* is to be in accordance with *Managing Urban Stormwater: Soils and Construction* (Department of Housing, 1998).
8. *Site access controls*, such as shaker pads are to be installed before the commencement of works to prevent site vehicles tracking sediment and other pollutants onto any sealed roads serving the development.



Figure 6. Sediment control measures on a construction site

9. Any conditions imposed in permits issued under the *Rivers and Foreshores Improvement Act 1948* must be complied with, and carried into conditions of consent where required. This Act requires that approval be obtained from the DLWC for any excavation or activity (on freehold land) that may detrimentally affect water flow, in or within, 40 metres of the top of the bank of a watercourse.

10. Drainage from sites should reflect pre-existing or natural conditions in terms of location, quantity, quality, frequency and velocity. Uncontrolled discharge of water to adjoining lands should be minimised whilst the rate of overland flow to natural drainage systems should not be altered (e.g. through the use of on-site detention systems).

11. *Soil landscapes and dispersibility*: The occurrence of dispersible soils should be identified prior to the commencement of works. The selection of appropriate erosion and sediment control measures, particularly the sizing of sediment basins will be strongly influenced by the presence of dispersible soils.

12. Steep land areas (slopes greater than 20%) usually have a high soil erosion hazard. Subdivision proposals within these areas should be accompanied by:

- a drainage strategy;
- a geotechnical report;
- a detailed site survey;
- a landform specific soil and water management plan;
- a schedule of proposed cut and fill operations; and
- details of appropriate construction techniques.

13. All soil and erosion techniques are to be maintained throughout development works.

14. All earthworks in completed areas should be grassed/seeded and maintained until each lot is redeveloped.

3.2.2 Reference documents

NSW Department of Housing 1998 *Managing Urban Stormwater: Soils and Construction*

Blacktown City Council 1998 *Soil erosion and sediment control policy*

Hawkesbury City Council 1997 *Soil erosion sediment control Development Control Plan*

Camden Council 1995 Local Approvals Policy No. 2, *Erosion and sediment control policy and code of practice*

Penrith City Council 1999 *Erosion and sediment control Development Control Plan and code of practice*

Liverpool City Council 2000 *Sediment and erosion control*

NSW Department of Urban Affairs and Planning 1997 *Sydney Regional Environmental Plan No. 20: Hawkesbury-Nepean*.

3.3 Soil and salinity

Emerging saline effects within the Hawkesbury/Nepean catchment have occurred in areas underlain by Wianamatta shales. Possible causes of urban salinity in Western Sydney are shown in Figures 7(a) and 7(b). The increased occurrence of salinity is related to:

- a decrease in deep rooted vegetation;
- over irrigation of crops, improved pastures and private gardens and lawns;
- alteration of natural drainage patterns by the construction of houses, roads, railways, channels etc;
- creation of wet zones of waterlogged soil by impeded drainage;
- leakage of standing water bodies, pools, lakes and service pipes;
- exposure of susceptible soils; and
- irrigation of sports grounds, golf courses, parks and gardens.

3

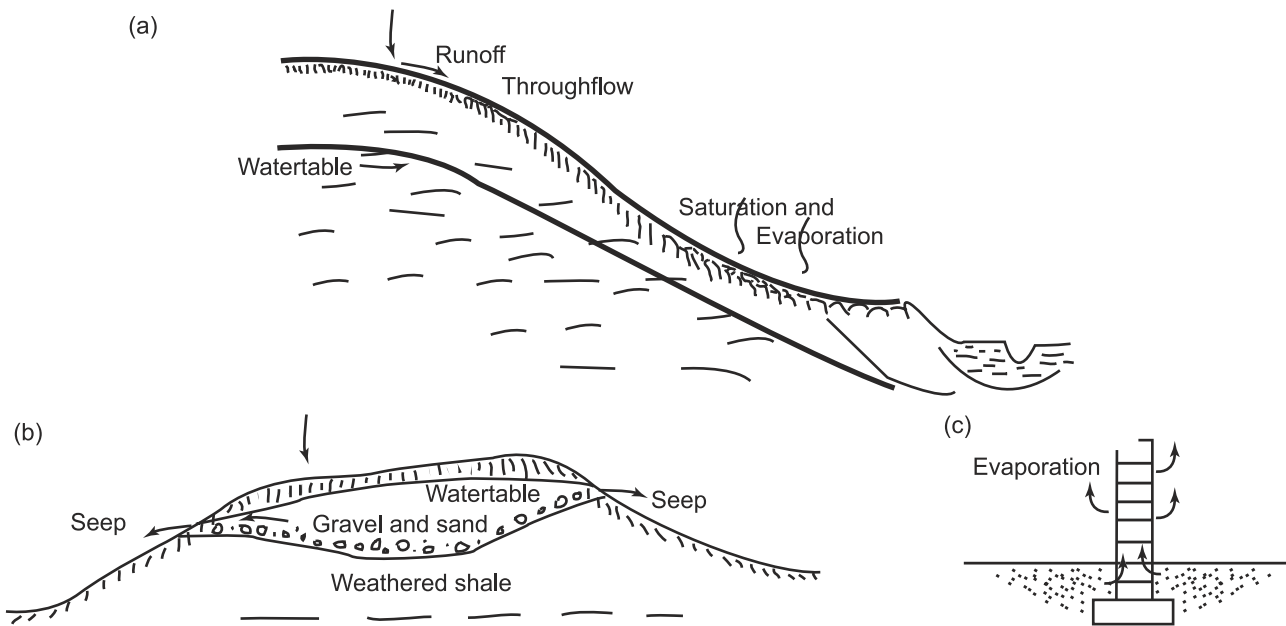


Figure 7. Causes of urban salinity in Western Sydney (a) Salinity can occur at the base of a slope where water accumulates and the soil becomes waterlogged (b) A perched water table can give rise to seepage on slopes (c) Wall structures can act as a wick through which salt can move and concentrate. (Source: DLWC 2000)

Salts are present in the soil profile as a result of weathering of soil and rock materials, marine deposition and from the ocean via wind a rain. Surface groundwater can mobilise these salts, resulting in concentration of salts that can affect plant growth, soil structure, and reduce the lifespan of materials and products such as concrete, metal, roads and buildings.

To assist in the identification and management of salinity prone areas, the DLWC has produced the *Draft Salinity Hazard Map for Western Sydney* (2000), which differentiates between areas of known salinity, areas of potential salinity and areas of no known hazard.

The draft map should be used in conjunction with the Draft Guidelines to accompany *Draft Salinity Hazard Mapping for Western Sydney* (2000). Both the map and the guidelines are available for viewing at local councils and DLWC offices (see Appendix 3). At present the map covers an area from Windsor/Richmond in the north, to Catherine Field in the south, and from Glenbrook in the west to Mays Hill in the east. The mapping is currently being extended to include other areas to the north, south and east of the current map boundaries. The DLWC Urban Salinity Team is also

currently producing (2002) various booklets for local government. These will include information on broad scale and site specific salinity investigations, building in saline environments and identifying urban salinity.

The *Draft Salinity Code of Practice* (Western Sydney Regional Organisation of Councils, 2002) is currently being developed as a management tool to assist Local Government and State agencies in addressing salinity issues in Western Sydney. Primarily, the Code of Practice aims to:

- provide information on the current best practice in salinity management for Western Sydney;
- facilitate a pro-active, coordinated and cooperative approach to salinity management; and
- ensure salinity is considered as a land management issue throughout the land development process.

It is envisaged that the Code of Practice will help councils in the identification of salinity issues and associated hazards within their Local Government

Areas, eventually leading to the development of Salinity Management Strategies for their respective LGAs. It is recommended that the Code of Practice be consulted for advice on salinity investigations and procedures for dealing with salinity in Western Sydney.

In determining development applications, councils should also consider the policies and strategies of *SREP No. 20 Hawkesbury-Nepean* (1997), notably that of Policy 4, Strategy (d) which states that consent authorities '*Consider the impact of development on the level and quality of the water table.*' Further, *SREP No. 30: St Marys 2000* details in Clause 49, Part 7, section 51(1) that '*the consent authority must not grant consent to the development of any land unless it has considered a detailed soil assessment which indicates whether the land is at risk from salinity or contains soils which are highly erodible.*'

In developing land, both proponents and infrastructure providers have an obligation to future landowners (including council where land may be dedicated) in ensuring that the development is within the limits of the land capability of the area. Therefore, in considering salinity issues, it is essential that the integrity of all aspects of a subdivision (i.e. both

planning and construction) be reliable in the long term. In this regard, it is important to consider the effect of development on soil and water processes in the landscape, as well as the affect of these processes on the development.

Indicators of severe salinity problems within an urban environment include:

- a white crust of salt on brickwork and, in advanced situations, crumbling mortar and bricks (Fig. 8(a));
- cracked or collapsed pavements, drives and driveways;
- effects on building footings (Fig 8(b));
- corrosion of water, gas and sewage pipes and metal fence posts;
- concrete drains may show seepage of salt in cracks and deterioration of concrete and steel reinforcing;
- roads may display cracking and salt 'halos' around cracks; and
- water logging / persistent 'rising damp'.



Figure 8. Effects of salinity (a) Crumbling of mortar and bricks show the effects of salinity (b) Piers affected by salinity

3

It is important to address salinity issues early in the assessment process to ensure that the existing hazard is not exacerbated as a result of development.

Planning, design, construction and maintenance of structures should include consideration of:

- groundwater and subsurface flows; and
- concentration and composition of salts in the soil profile, groundwater and surface waters.

There are a number of activities that can be taken to reduce the impacts of salinity. The principles to remember are

- minimise water application to ground;
- maintain good drainage; and
- prevent damage to infrastructure.

3.3.1 Guidelines for development control plans

1. The *salinity hazard* needs to be investigated as a part of the initial site assessment.
2. *New houses, buildings or infrastructure* in current or potentially salt affected areas may need to be built to withstand the effects of salinity. In badly affected areas, consideration should be given to rehabilitating salt affected land, building above ground or not building at all.
3. Avoid impeding waterflow in the subsoil (e.g. cuts and retaining walls, or compaction of roads).
4. Promote the retention and establishment of *deep-rooted vegetation* in new urban development areas.
5. Develop *native landscaping and gardens* to reduce over irrigation and water usage.
6. Use *smart irrigation systems* linked to soil moisture for irrigation activities or for large garden areas.
7. Minimise use of infiltration and detention of stormwater in hazard areas, consider lining of detention systems to prevent infiltration (i.e. reconsider WSUD implications in relation to salinity management).

8. Limit the application of extra salt through water recycling programs or irrigation of saline groundwater.

9. Maintain effective site drainage.

10. Identify and manage sodic soils (NB: These soils commonly occur near drainage lines and/or lower slope areas. They are usually very hard, with a dense soil structure and low permeability. Sub-surface sodic soils have low permeability in the B horizon leading to mobilisation and redistribution of soluble salts in the A horizon and, thus, to seepage salinity).

11. Consider the use of salt protected services, e.g. salt resistant drainage pipes, casing of underground services.

12. Maintain/re-establish effective vegetated riparian buffer zones.

13. Proponents should clearly demonstrate what measures have been employed to ensure the salinity hazard does not increase (both on site and on adjoining land) as a result of a development.

3.3.2 Reference documents

Western Sydney Regional Organisation of Councils
2002 *Draft Salinity Code of Practice*

NSW Department of Land and Water Conservation
2000 *Draft Salinity Hazard Map for Western Sydney*

NSW Department of Land and Water Conservation
2000 *Draft Guidelines to accompany Draft Salinity Hazard Mapping for Western Sydney*

NSW Department of Land and Water Conservation (in prep) *Urban Salinity Information Booklets*

Baulkham Hills Shire Council 2000 *Interim salinity policy*

NSW Department of Urban Affairs and Planning
1997 *Sydney Regional Environmental Plan No. 20: Hawkesbury-Nepean*

NSW Department of Urban Affairs and Planning 2000
Sydney Regional Environmental Plan No. 30: St Marys

Wagga Wagga City Council 1998 *The investigation of salinity risk for rezoning applications*. This policy requires that an assessment of current salinity status be included as part of the environmental study accompanying a rezoning application. The assessment must also show what effect the change in land use will have on the salinity status. The types of investigations required are also listed in the policy.

Wagga Wagga City Council 1999 *Building in a saline environment: Urban salinity prevention*. This document provides advice on building materials and techniques that are likely to reduce the impacts of salinity on buildings and can be downloaded at: www.wagga.nsw.gov.au

Dubbo City Council 1997 *Local Environmental Plan - Rural Areas* requires the preparation of a dryland salinity impact assessment for any new development. The assessment must include information on whether the subsequent loss of vegetation will potentially result in increasing soil salinity and any mitigation measures proposed to be undertaken. In determining applications, council must consider the potential of a development to cause or exacerbate any outbreaks of salinity.

3.4 Floodplain management

Floodplain risk management planning is primarily the responsibility of Local Government. It is the role of councils to develop and implement Floodplain Risk Management Plans (FRMPs) consistent with the *Floodplain Management Manual: the management of flood liable land* (NSW Government, 2001). The manual provides a guideline for the approach to be taken to ensure consistency of the planning and development process with the State Government's *Flood Prone Land Policy 2001*.

In most urban areas subject to flooding, councils have developed and adopted FRMPs, summarising council's strategy for managing existing, future and continuing flood risks. In greenfield areas, councils and floodplain management committees (with assistance from PlanningNSW and DLWC) should be developing FRMPs prior to the rezoning process to ensure that

new development is consistent with the objectives and principles of floodplain and stream related Government policies (e.g. *Flood Prone Land Policy 2001* and *NSW State Rivers and Estuaries Policy 1992*).

Both councils and PlanningNSW need to consider and integrate s.117 direction G25 - Flood Liable Land (under the *Environmental Planning and Assessment Act 1979*) with regard to local environmental studies supporting draft LEPs, to ensure that high hazard floodways are zoned for special uses to avoid future flood risks. As high hazard floodways are often aligned with natural watercourses, opportunities arise for councils and Planning NSW to zone these lands for environmental protection and/or conservation. This approach then avoids future conflicts and unrealistic expectations that the land could be made suitable for development.

If decision makers for development do not make decisions in a manner consistent with the principles and objectives of the *Floodplain Management Manual*, council officers and decision makers for the development may not be afforded the indemnity that is afforded under section 733 of the *Local Government Act 1993*. In such circumstances, council officers and decision makers may need to seek their own legal advice regarding liability should flood related litigation arise in the future.

3.4.1 Floodplain management plans

The fundamental principle of the *Floodplain Management Manual* is that consideration of flood risks and flood related development policies should be within the context of the FRMP rather than on an ad-hoc basis.

The FRMP must consider a range of flood related issues. At a fundamental level, there is a need to consider:

- the impact of flooding on development;
- the impact of development on flood behaviour; and
- the impact of flooding on people / occupants.

These considerations are required for the full range of flood events up to the probable maximum flood (PMF), so that flood liability and flood losses are not

3

exacerbated. To ensure that ad-hoc decisions are avoided in the future, councils should consider and integrate cumulative impacts into its Floodplain Management Plan. The *Floodplain Management Manual* also emphasises the need to maintain and enhance riverine and floodplain environments so that the implementation of flood policy objectives does not compromise other relevant policies seeking to conserve and enhance the environment.

Therefore it is critical that those preparing FRMPs (or other studies that feed into the strategic floodplain management process of Council), ensure that investigations consider not only existing conditions, but also future conditions of the floodplain/riverine environment. As stream management in new subdivisions will be required to conserve and enhance the biophysical characteristics of the watercourses through the site, it is important that appropriate parameters such as changes to catchment hydrology and channel roughness are integrated into the hydrologic and hydraulic models. It is important for designers of new subdivisions to undertake suitable hydraulic-geomorphic assessments to satisfy themselves that watercourse and floodway designs are appropriate.

Local and State agencies need to carefully consider the most appropriate approach to facilitate the integration of flood risk management planning and riparian corridor management planning to ensure consistency of approach. These considerations need to occur both at the subdivision site as well as the relationship to the broader catchment. An integrated process achieves the best results when there is appropriately qualified experts from both council and DLWC (both riverine and flood management) feeding into the early stages of the design and analysis process. It is extremely important that issues relevant to each site are identified for consideration as early in the process as possible to avoid unnecessary delays if left unconsidered up to the development approval process.

3.4.2 Guidelines for development control plans

1. A Floodplain Risk Management Plan should be developed by council and relevant floodplain

management committees (in consultation with PlanningNSW and DLWC) for any proposed subdivision, prior to the rezoning process.

The plan should be consistent with the *Floodplain Management Manual: the management of flood liable land* (NSW Government, 2001) and other existing legislation, policy and planning instruments.

2. Assessment of flood related impacts must consider the full range of flood events up to and including the Probable Maximum Flood.
3. Explore opportunities to zone high hazard floodway areas as special uses, environmental protection and/or conservation as appropriate.
4. Following the preparation of a Floodplain Risk Management Plan, subdivision planning and development must be consistent with the plan.

3.4.3 Reference documents

NSW Government 2001 *Floodplain Management Manual: the management of flood liable land*

NSW State Rivers and Estuaries Policy 1992

PlanningNSW (in prep) *Draft Riparian Corridor Policy*

NSW Department of Land and Water Conservation (in prep) *Hawkesbury Nepean Regional Floodplain Risk Management Study* (Incorporating a series of Best Practice Guidelines)

Land and Water Resources Research and Development Corporation 1999 *Riparian Land Management Technical Guidelines - Vol 1&2*. (Prepared by Lovatt, S. & Price, P.)

Land and Water Resources Research and Development Corporation 2000 *A Rehabilitation Manual for Australian Streams - Vol 1&2*. (Prepared by Rutherford, I., Jerie, K, & Marsh, N.)

NSW Department of Water Resources 1993 *Riverwise Guidelines for Stream Management*

Brisbane City Council 2000 *Natural Channel Design Guidelines*

4.1 Vegetation

Since European settlement, land use pressures from agricultural pursuits and urban development have resulted in the clearance of 87 percent of the original Cumberland Plain vegetation (NSW National Parks and Wildlife Service, 2001a). In this regard, preservation of native vegetation is often viewed as a competing interest to urban development. However, a balance between environmental, social and economic issues can be achieved through the careful integration of these aspects during the initial stages of the planning process.

The vegetation of the Cumberland Plain consists of 12 different ecological communities. Of these, 9 have been listed as 'endangered' under Schedule 1 of the *Threatened Species Conservation Act 1995* by the NSW Scientific Committee. Further, the 'clearing of native vegetation' has been listed as a Key Threatening Processes under Schedule 3 of the Act. As a consequence of these listings, the NSW National Parks and Wildlife Service (NPWS) is currently preparing a preliminary draft of the *Cumberland Plain Recovery Plan* to ensure the recovery of each of the Endangered Ecological Communities (EECs) (NPWS, 2001b).

The aim of the draft plan is to '*halt the loss and achieve a net gain in the extent and condition of bush on the Cumberland Plain*'. As part of its long term vision, NPWS has set a goal to '*bring back the bush of the Cumberland Plain so that at least 30% of the landscape is vegetated with protected bushland*'. The initial development of the plan has involved the mapping (at 1:25000 scale) of all remnant native vegetation of the Cumberland Plain to compile a comprehensive information base describing the characteristics, distribution and condition of the EECs (NPWS, 2001b). The final maps, which partially include the six local government areas applicable to these guidelines, are available in both hard copy and electronic format from NPWS. It is expected that a preliminary draft of the recovery plan will be exhibited in 2002.

The introduction of the *Threatened Species Conservation Act 1995* included amendments to the

Environmental Planning and Assessment Act 1979 requiring the application of the '8-part test' for developments or activities which may impact upon threatened species or ecological communities. In light of the recent determination of several Cumberland Plain EECs, and the objectives of the recovery plan (in prep), it is recommended that **initial site assessments** include a comprehensive flora survey to identify the presence of any EECs (or other threatened species).

Developments seeking to clear areas of Cumberland Plain Woodland may also trigger the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Should a proposed development have the potential to impact upon any threatened species or EEC, it is recommended that the applicant contact their local council to ascertain their responsibilities under the Act.

In response to the continuing reduction of remnant bushland and decline of biodiversity across metropolitan Sydney, the Sydney Regional Organisation of Councils (SROC) have developed the *Green Web - Sydney* (1997). This document targets local government in encouraging the formulation of policies for the conservation, enhancement and re-establishment of local flora and fauna on public and private land. Specifically, the document provides direction for the establishment of habitat corridors which link fragmented patches of bushland.

As part of the plan, all remnant native vegetation and proposed revegetation sites across the Sydney metropolitan area has been mapped at 1:30000 scale. It is envisaged that these maps will then be used by local government in implementing the *Green Web - Sydney* Action Plan for their respective LGAs.

As discussed in Chapter 2, the *Native Vegetation Conservation Act 1997* applies to state protected lands within the six local government areas applicable to these guidelines. Developments that propose to clear vegetation on these areas may require consent from DLWC. It should be noted that such consents do not

4

form part of the integrated development process. It is therefore recommended that proponents contact DLWC prior to the lodgement of a development application to determine if a consent to clear vegetation may be required under the Act.

4.1.1 Vegetation management plans

Sustainable management of vegetation in Western Sydney requires a coordinated approach from a variety of natural resource managers, users and stakeholders. In order to achieve this outcome, the effective management of vegetation must occur over regional, local and site specific scales. The formulation of a regional framework has already been completed through the development of the *Green Web - Sydney* (SROC, 1997).

The processes involved in the implementation of the document at a local level are described in the *Action Plan for Councils* (Part 1). The action plan relies on local government to develop new (or modify existing) policies, planning strategies, development controls and management practices for the conservation and re-establishment of native vegetation within their respective LGAs (SROC, 1997).

Some of the principal components of the *Green Web - Sydney* action plan include:

- zoning of all remnant vegetation (including Cumberland Plain) on public land as *conservation zones*;
- adoption of a *Vegetation and Habitat Protection Order* for the protection of remnant indigenous plants and plant communities (including threatened species endangered ecological communities), which applies to public and private land;
- preparation of *Development Control Plans* for the protection and enhancement of indigenous flora and fauna, including controls for the retention of indigenous trees, understorey and groundcovers. DCPs should also prevent the fragmentation of habitat by conserving compact, continuous areas rather than smaller, thin areas;

- *review and revision* of open space strategies and park plans of management to identify areas of remnant bushland as conservation zones;
- *connection of fragmented bushland* areas to create larger habitat areas to support more species and larger populations which are more self sustaining;
- incorporation of *habitat requirements* in landscape design controls to protect, enhance and create habitat in public and future private open space areas in new developments; and
- preparation of a *biodiversity management manual* for council staff that includes guidelines for the management of indigenous vegetation and habitat.

The development of a vegetation management framework at both regional and local levels provides an information base for the preparation of site specific vegetation management plans (VMPs). Given the large areas associated with many subdivisions, it is strongly recommended that a VMP be prepared as a component of any new subdivision development application. Vegetation management plans for subdivision areas should ideally be formulated for the entire site and be consistent with any larger plan or planning instruments applicable to the area. In particular, applicants should clearly demonstrate how the VMP satisfies the recommendations and strategies of the *Green Web-Sydney* (SROC, 1997) and existing NPWS Recovery Plans prepared under the *Threatened Species Conservation Act 1995*.

Proponents should take greater responsibility in promoting biological connectivity through linkages with biological reserves both on and off site. The effective integration of existing and proposed features of a development is fundamental in ensuring the sustainability of biological networks at a local and regional scale. Further, the plan should seek to achieve a level of robustness against urban impacts such as weed invasion, trampling and edge effects. Indeed, vegetation management and connectivity should be

promoted as a feature of a development, rather than being viewed as a site constraint.

The suggested steps for the preparation of a VMP are as follows:

1. *Identify the implications* of any National Parks and Wildlife Service Recovery Plans, or any areas identified as part of the *Green Web - Sydney*

2. *Assess the site and determine constraints:* flora and fauna (previous studies, endangered species & ecological communities/existing vegetation communities, etc.); habitat and corridor values; frost areas; fire issues; salinity, roads and pathways, service infrastructure (water, sewerage, gas, electricity, communications); shadow zones; drainage; topography (slope, aspect, soils, geology, erosion, deposition); weeds and weed sources, public safety issues, etc

3. *Define and evaluate threats to areas of vegetation* (both remnant and proposed), including the cost of protecting such areas and buffers required.

4. *Describe each task necessary for the implementation of the plan:* describe each task necessary for the implementation of the plan, how each task will be done, the duration and priority order of each task, and the responsible party for each task.

5. *Prepare a workplan:* showing the implementation timetable for each component of the plan.

6. *Liaise* with local council, State agencies and landcare/bushcare groups for any additional requirements.

7. *Provide details on seed collection and propagation:* only local native species are to be used - identify local native seed sources, check on any licences required.

8. *Prepare maps/diagrams and plant species lists:* describe existing vegetation, constraints, vegetation and natural features to be retained, proposed vegetation (species/communities, zonation from water to land, corridors/linkages, spacings, tubestock/cells/ long stems/direct seeding), sediment and erosion control, stabilisation works, etc. Consider the need for salt tolerant species. Consultation with NPWS should

be undertaken for areas associated with threatened species and/or endangered ecological communities.

9. *Provide details on site preparation, including:*

- protection of plants to be retained
- installation of sediment and erosion control devices
- completion of any site works (if any)
- weed control (techniques and sequences of removal)
- application of herbicides
- storage of topsoil and organic litter
- soil remediation
- surface preparation (levelling, deep ripping, scarifying, mulching etc.)
- surface stabilisation - (needs to be suitable for the site/vegetation - erosion matting, mulch, brushmatting, sterile cover crops, binding sprays, etc.)
- site drainage

10. *Describe the planting program and method (if necessary):* detail how it will be done, staging and also consider the installation of weed mats, mulch, stakes & ties, tree guards etc.

11. *Describe site and vegetation maintenance:* sediment and erosion control, watering, replacement of plant losses, weed control, disease and insect control, mulch, etc.

12. *Describe the monitoring and review process:* include a method of performance evaluation, assessing the need for replacing plant losses, addressing deficiencies and six-monthly reporting.

13. *Address other issues including:* signage, relevant legislation, planning instruments/guidelines, OH&S, community involvement, liaison with relevant government agencies. The plan should also detail how it complements any other existing vegetation management plans.

14. *Prepare a costing:* Calculate the cost of the implementing all stages and all components of the

4

plan - show details on unit cost, materials, labour, monitoring, maintenance and reporting.

For subdivision areas covering multiple environments (e.g. ridgecrests, riparian areas), or which contain significant or threatened vegetation (e.g. endangered ecological communities), a sub-set of landform specific VMPs may need to be prepared.

4.1.2 Riparian vegetation

Identification of watercourses and associated riparian vegetation is a critical component of **initial site assessment**. The role of the riparian zone is often described as providing a buffer between watercourses/foreshores and the terrestrial environment (and associated pressures). However, the riparian zone should be considered as an intrinsic element of the riverine system which requires its own protection. To ensure that the environmental values of riparian areas are adequately conserved, provision of 'buffer' zones should be located beyond the riparian zone. Therefore, in determining the riparian management objectives for each site, applicants should recognise and incorporate both riparian zones and buffer zones adjacent to all watercourses.

The benefits of riparian vegetation (Figure 9) include:

- **Bank stabilisation:** Riparian vegetation stabilises channel banks and floodplains. This reduces bank erosion, floodplain stripping, alteration to channel geometry and alignment, and reduces sediment loads.
- **Habitat:** Riparian zones provide a habitat for terrestrial fauna, including birds, mammals, reptiles, frogs, worms and soil microfauna. Such areas also provide links to other flora zones and larger habitat areas. Riparian vegetation is also an important habitat and food source for terrestrial insects, which in turn can be a food source for fish. Additionally, riparian vegetation provides camouflage for a variety of terrestrial and aquatic fauna. Tree roots can also provide a habitat for fish and invertebrates.

- **Connectivity:** Riparian zones assist in biodiversity conservation by linking areas of remnant vegetation (e.g. between water sources and areas outside the site). These linkages provide habitat corridors between larger bushland areas, which facilitate faunal movement.

- **Water quality:** The presence of a fully structured and diverse vegetated riparian zone can assist in the capture and breakdown of pollutants such as oils and greases and insecticides. In addition, provision of a vegetated riparian zone will support communities of aquatic organisms, which play an important role in water quality improvement. However, it should be noted that these characteristics are only passive elements of water quality control. As discussed in Section 3.1.2, stormwater treatment should be managed on urban lands, outside riparian areas prior to discharge.

- **Weed control:** Riparian vegetation inhibits the growth of exotic species by reducing light penetration to the ground surface.

- **Salinity management:** Drainage lines often have a higher salinity hazard than other parts of the landscape. Retention/re-establishment of riparian vegetation in these areas can assist in reducing salinity impacts through groundwater suppression.

A riparian zone of local native vegetation should be maintained wherever possible adjacent to rivers, estuaries and lakes. Where necessary, the restoration/re-establishment of riparian vegetation should aim to achieve a fully structured community of indigenous trees, shrubs and grasses e.g. Voyager Point, Liverpool City Council; Stanhope Gardens Neighbourhood 1, Blacktown City Council. A diversity of species is recommended to provide resistance to stresses, and to encourage terrestrial and aquatic biodiversity.

In determining appropriate riparian and buffer zone widths, a range of factors needs to be considered, including channel and floodplain geometry, vegetation

characteristics (existing and potential), habitat values, fauna movement potential and corridor linkages/extension. Determination of widths should aim to achieve sustainability of these aspects in the long term.

When addressing issues relating to riparian management, a number of regulatory planning instruments may be applicable to the site. For any proposed works involving excavation in or within 40 metres of a watercourse or foreshore, it may be necessary to obtain a permit under Part 3A of the *Rivers and Foreshores Improvement Act 1948* from DLWC prior to the commencement of works. The Act contains provisions for conditions relating to protection of the environment to be attached to 3A permits. In this regard, the preparation of a riparian vegetation management plan (i.e. a sub-plan of a vegetation management plan) is often required as a condition of a 3A permit.

It is recommended that the Department of Land and Water Conservation be consulted for advice regarding

the preparation of riparian vegetation management plans, Part 3A permits or determination of riparian and buffer zone widths. As stated in Section 4.1, should a proposed development have the potential to impact upon any vegetation (including riparian vegetation), it is recommended that the applicant contact the relevant local Council during the initial planning phase to ascertain their responsibilities under the *Threatened Species Conservation Act 1995*.

4.1.3 Guidelines for development control plans

1. A *vegetation management plan* should be prepared by a suitably qualified person and submitted to council for approval as part of the development application for subdivision. Vegetation management plans should be formulated for the entire site and be consistent with any larger plan or planning instruments applicable to

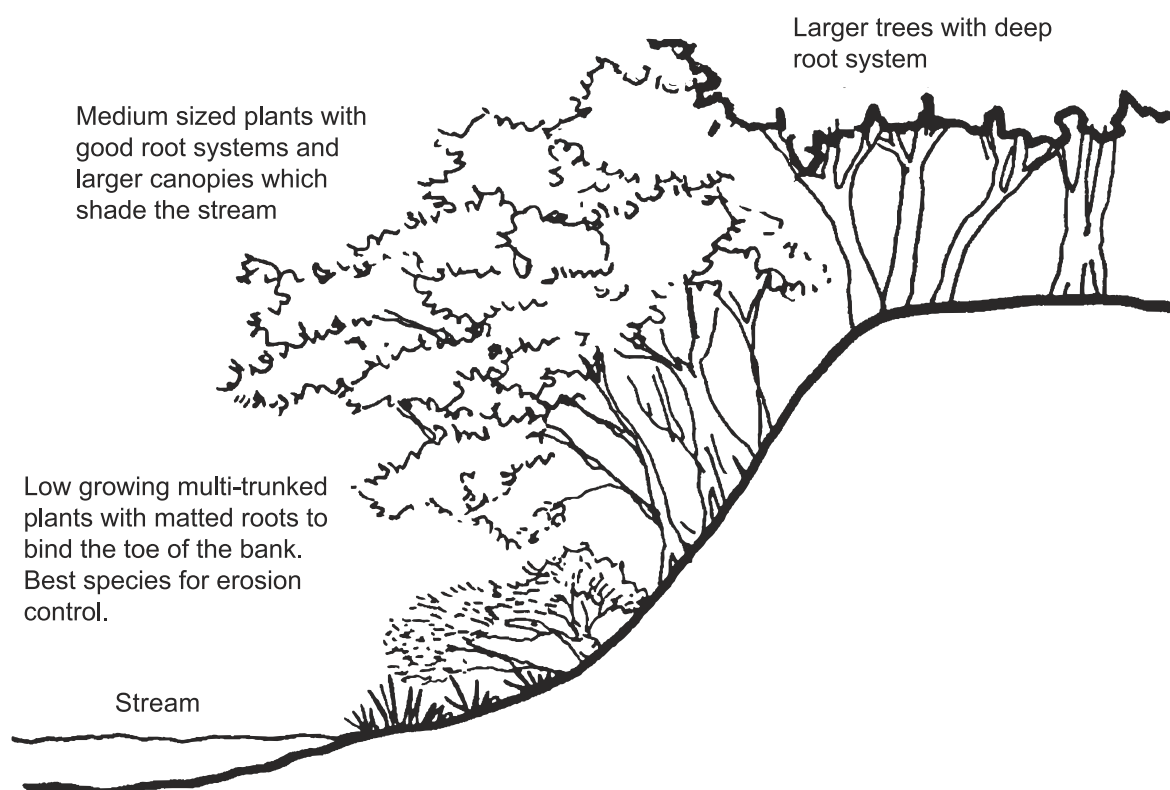


Figure 9. Riparian vegetation (Source: NSW EPA 1996)

4

the area. (e.g. Green-Web – Sydney (SROC, 1997) or NPWS Recovery Plans).

2. Consider the need for additional *vegetation management sub-plans* for subdivision sites that contain multiple environments, or which contain significant or threatened vegetation (e.g. riparian zones, endangered ecological communities).

3. In terms of maintaining biological diversity, resilience, ecological connectivity, sustainable habitat, improving aesthetics and increasing desirability for prospective residents it is recommended that:

- all *existing and significant native vegetation* on site be retained and protected.
- Specific recommendations be made for the *conservation of viable remnant vegetation* into the future in a sustainable manner;
- a *native revegetation/regeneration program* be incorporated within the development to prevent the spread of weeds into existing remnant vegetation and to minimise the fragmentation of native vegetation by the development. Plants chosen should be native to the local area (see Appendix 4);
- an *adequate buffer* be retained between the edge of remnant vegetation and urban development;
- a *seed collection/plant relocation program* be in place to collect seed from native trees/understorey species that are to be removed to assist in maintaining the local gene pool;
- *grassing* with invasive species (e.g. kikuyu) should not be permitted near bushland and riparian areas;

4. *Bonds* may be considered as part of the vegetation management plan. For example, a general bond per lot may be applied as part of the approval process. Special bonds (per tree) may be applied to ensure protection of significant trees or habitats during the development phase. This is only refunded when the subdivision is released by Council.

DLWC commonly requires a bond as a condition of a 3A permit for the rehabilitation of riparian zones. The bond is progressively released upon satisfactory completion of each stage of the vegetation management plan.

5. *Lot layout and subdivision design* should maximise the retention of existing vegetation. The opportunity should be taken to retain or establish deep-rooted vegetation.

6. Where necessary, the need for salt tolerant native species should be considered.

Reference documents

Sydney Regional Organisation of Councils 1997 *Green Web-Sydney, A Vegetation Management Plan for the Sydney Region*

NSW State Rivers and Estuaries Policy 1992

NSW National Parks and Wildlife Service 1997a *Urban Bushland Biodiversity Survey: Native Flora in Western Sydney*

NSW National Parks and Wildlife Service 2001 *Biodiversity Planning Guide for NSW Local Government*

NSW National Parks and Wildlife Service (in prep) *Cumberland Plain Recovery Plan*

Baulkham Hills Shire Council 2000 *Kellyville/Rouse Hill Residential DCP No. 200*

Liverpool City Council 1999 *Development Control Plan No. 8 Natural Assets*

Threatened Species Conservation Act 1995

Environment Protection and Biodiversity Conservation Act 1999 (Cth)

Land and Water Resources Research and Development Corporation 1999 *Riparian Land Management Technical Guidelines - Vol 1&2*. (Prepared by Lovatt, S. & Price, P.)

Land and Water Resources Research and Development Corporation 2000 *A Rehabilitation Manual for Australian Streams - Vol 1&2*. (Prepared by Rutherford, I., Jerie, K, & Marsh, N.)

NSW Department of Water Resources 1993 *Riverwise Guidelines for Stream Management*

Brisbane City Council 2000 *Natural Channel Design Guidelines*

In assessing the management needs of native fauna, a comprehensive fauna survey should be carried out as part of the **initial site assessment**. The survey should cover all forms of faunal biota that may potentially occur on site in both terrestrial and aquatic environments, including fish, amphibians, mammals, reptiles, birds and macroinvertebrates. Particular emphasis should be placed upon the conservation requirements of threatened fauna that may inhabit



Figure 10. Caddies Creek, a riparian corridor which provides a habitat for native fauna

4.2 Native Fauna

Consideration of native fauna issues is an important aspect of subdivision planning. Given the inherent relationship between flora and fauna, it is important that both aspects be considered concurrently in addressing biodiversity management of a site. As discussed above, the retention/restoration of native vegetation is critical in providing adequate and functional habitat, corridors and linkages for native fauna.

a site, as well as the presence of critical habitat. It is recommended that NPWS and NSW Fisheries be consulted early in the planning process to determine the management requirements for terrestrial and aquatic fauna issues under the *Threatened Species Conservation Act 1995* and *Fisheries Management Act 1994*.

During the planning phase of the subdivision development process, priority should be given to retention of remnant native vegetation on site to

4

maximise the area of faunal habitat. In addition, subdivision design should maintain, or where necessary establish corridor links between existing habitat areas located both on and off site. It is recommended that the *Green Web - Sydney* (SROC, 1997) be consulted to assist in the identification of existing, and establishment of future fauna habitat areas and corridor linkages.

Development of the Highlands Ridge Estate (Baulkham Hills Shire Council) provides an example of the benefits associated with the retention of riparian vegetation (Figure 10). Protection of riparian vegetation along Caddies Creek has also served to retain faunal habitat and movement potential.

4.2.1 Guidelines for development control plans

1. *Locate important habitat areas* for example, remnant vegetation, riparian zones, mature trees, dense understorey, exposed rock, logs and leaf litter within the area to be developed.
2. *Identify potential wildlife sanctuary areas* and earmark for retention.
3. *Identify species* likely to utilise corridors and then assess the optimal width of corridors.
4. *Link remnant areas* with a fully structured vegetated corridor of trees, shrubs and grasses of appropriate species diversity to increase shelter and foraging sites, particularly for small insectivorous birds.
5. For potential sanctuary areas, plan *major weed removal* outside the main bird breeding season.
6. *Assess vegetation.* For example, where pied currawongs are a problem, restrict the number of fruit bearing species; where noisy miners are a problem, use insect rather than bird pollinated plants when carrying out bush regeneration.

7. *Replace logs, rocks and leaf litter whenever possible* to provide shelter and foraging and breeding sites for lizards and invertebrates.

8. *Significant flora and fauna species, populations and ecological communities should be preserved.* Development should ideally be designed to retain existing bushland and fauna habitats, including identifiable corridors and linkages.

9. *Carry out bush regeneration and/or appropriate plantings* to establish or enlarge habitat areas for native fauna.

10. Implement a *monitoring program* to measure the effectiveness of newly established habitat areas and corridors in attracting native fauna.

4.2.2 Reference documents

Sydney Regional Organisation of Councils 1997 *Green Web-Sydney, A Vegetation Management Plan for the Sydney Region*

NSW National Parks and Wildlife Service 1997b *Urban Bushland Biodiversity Survey: Native Fauna in Western Sydney*

NSW National Parks and Wildlife Service 2001 *Biodiversity Planning Guide for NSW Local Government*

Threatened Species Conservation Act 1995

Environment Protection and Biodiversity Conservation Act 1999 (Cth)

5.1 Housing design and lot size

The built environment can reinforce environmental actions in the subdivision development stage to create an attractive, functional and environmentally sound development. This section looks at environmentally sustainable initiatives at the built form stage of development.

The current planning regime suggests a mix of apartments, townhouses, courtyard houses and large detached houses is often needed to meet the lifestyle and economic needs of a diverse and sustainable society. A range of lots makes it possible to achieve the transport advantages of a more compact community while also providing people with a choice of housing type and cost options (e.g. Stanhope Gardens, Blacktown City Council via Stanhope Gardens Masterplan, *Stanhope Gardens DCP* (Part J of the Blacktown DCP 1992); Smart Growth, Liverpool City Council). It should be noted however, the smaller the lot size, the higher the quality of architectural design required to achieve privacy, prevent overshadowing, create reasonably sized backyards and attractive street frontages. Further, stormwater management controls must adequately provide for the increased runoff associated with smaller lot sizes due to the higher proportion of impervious surfaces.

Baulkham Hills Shire Council in its *Kellyville/Rouse Hill DCP No. 200* sets out four building density zones which are based on an analysis of location to surrounding and topographic and vegetation constraints. The four zones are fringe density (5 dwellings/hectare); cluster density (10 dwellings/net hectare); local centre density (15 dwellings/net hectare) and town centre density (30 dwellings/net hectare). Development density should reflect the characteristics of the site and the overall environmental considerations. Figure 11 shows a diversity of lots.

The Residential Subdivision publication by the NSW Department of Urban Affairs and Planning, Urban Design Advisory Service (2000) provides advice in designing and planning a neighbourhood.

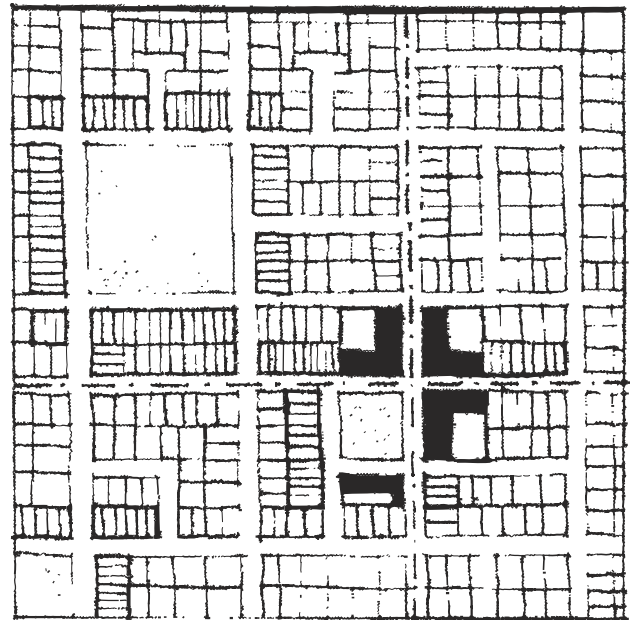


Figure 11. Diversity of lots on an unconstrained site (Source: NSW DUAP 2000)

15 dwellings/ha achieved by subdividing into a range of lot sizes, so that all options from apartments through to large lots are offered. The proportion of larger lots (>700 sq. m) is increased. Denser forms of housing are located at transport nodes, town centres or fronting parks.

5

House design should have regard to the site, rather than modification of the site to suit the dwelling. This can result in less cut and fill and subsequently less soil erosion and disruption to drainage patterns on site, ultimately improving stormwater quality.

The use of alternative housing designs can greatly reduce the environmental impacts associated with conventional building techniques. Figure 12 illustrates the multiple benefits of alternative design, namely:

1. Minimal interruption of natural drainage.
2. Pier and beam construction retains natural slope of the land and can decrease potential salinity impacts.
3. Deep rooted vegetation can decrease the impact of salinity.
4. Maintenance of natural features leads to an increase in visual amenity, biodiversity and connectivity.

5. Rainwater tank saves water for garden usage.

Integration of alternative design techniques which minimise salinity impacts will potentially decrease the costs associated with the repair of salt affected public and private infrastructure (e.g. roads, drainage pipes, building footings etc). In this regard, any additional capital expenditure in development of the subdivision may lead to a net cost saving in the longer term.

The construction of a piered suspended slab, as an alternative to the traditional 'slab on ground' method can be cost effective on sloping land after taking into account the additional excavation costs associated with slab on ground techniques. Appendix 5 provides a schedule of cost comparisons between suspended floor and slab on ground construction methods.



Figure 12. A split level design on a sloping block

5.1.1 Guidelines for development control plans

1. *Design* of subdivision and lot layout to account for:
 - remnant vegetation, fauna habitat and wildlife corridors (existing and future)
 - overland drainage
 - salinity and groundwater interception
2. *Smaller lots* should utilise flat treeless sites, as this reduces the likelihood of cut and fill and vegetation removal.
3. Where there is *hilly topography* or stands of remnant vegetation, lots should be larger to minimise vegetation clearance.
4. Council should develop an *appropriate basal footprint ratio* relative to the block.
5. *Road layout and lot shape/orientation* should be designed to minimise cut and fill and disturbance to natural drainage and vegetation.
6. *Site design* should seek to minimise the proportion of impervious surfaces on each lot.
7. Ancillary works required for a dwelling (e.g. retaining walls, steep driveways etc.) should be undertaken in conjunction with the building construction. (NB. Blacktown City Council is investigating this option as a draft standard condition). A certifier is then required to assess the entire development.
8. *Cut and fill* could be prevented within a specified distance (e.g. 2m) from the boundary of each lot.
9. Lots should be oriented to maximise solar access to future dwellings.
10. Encourage the establishment of vegetation corridors along adjoining blocks and streetscape areas where space permits.
11. In areas of high density housing, provide opportunities to retain or establish deep rooted vegetation in public areas such as in the streets, parks or access pathways (NB. a minimum 2-2.5 m width

from kerbs to footpaths is needed for deep-rooted trees).

5.1.2 Reference documents

Baulkham Hills Shire Council 2000 *Kellyville/Rouse Hill Development Control Plan No. 200*

Blacktown City Council 1992 *Blacktown Development Control Plan Part J Stanhope Gardens*

NSW Department of Urban Affairs and Planning 2000 *Residential Subdivision - A handbook for the design and planning of new neighbourhoods* (Compiled by the Urban Design Advisory Service)

5.2 Roads and infrastructure

The street network should be developed with regard to environmental constraints. Development of the road network needs to consider a number of factors including, terrain, watercourse crossings and impacts associated with cut and fill. Where possible, roads should be constructed to follow the natural contours of the land to reduce stormwater velocities (Figure 13). Perimeter roads can also serve a water quality control function by collecting road runoff and diverting it to stormwater treatment structures.

Development of the road layout should seek to orientate lots to face onto reserves, remnant vegetation and riparian areas to provide passive surveillance by the community to reduce bushfire risk and the occurrence of dumping. Integration of the road layout and lot orientation with natural features will have a positive effect on property values.

Streets are not just conduits for cars - they create an address, a sense of place, determine property values, as well as offering a place to walk, meet and to cycle. A wide street reserve can include overland drainage, grass and street trees. Street reserves of this type usually follow a gentle topography and are ideal for cycle ways.

Refer to the UDAS handbook *Residential Subdivision* (2000) for further information.

5

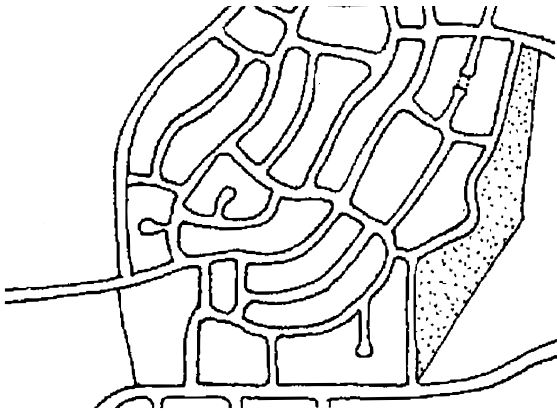


Figure 13. A connected street pattern (Source: NSW DUAP 2000)

On-street parking can satisfy a portion of the town, neighbourhood or village centre's carparking requirements. Joint use of carparking where public facilities are located together reduces land take and creates safer, more compact centres.

5.2.1 Guidelines for development control plans

1. The *street alignment* should be determined by the natural topography of the land, curving in response to contours and natural features (e.g. remnant vegetation) of the site.

2. *Road design* should seek to:

- minimise cut and fill and impacts.
- follow contours to reduce stormwater velocities and allow for swales.
- avoid transgression of habitat and fauna movement corridors.
- provide perimeter roads adjacent to remnant native vegetation and riparian areas to provide passive surveillance from houses and passers-by.
- reduce the need for kerb and gutter while allowing runoff to be directed to stormwater treatment measures.
- minimise disturbance to water flow and drainage.

- consider the need for salinity resistant techniques and materials.

3. The use of bridges with piered approaches is preferred for *watercourse crossings*. Design should aim to maximise light penetration to support vegetation growth beneath the structure. This can be achieved through the use of grated road surfaces or light wells in median strips.

4. *Bus routes* should be within acceptable walking distance of all dwellings. Where possible, residential properties should be within 400 metres of a bus stop.

5. The *design and appearance of roads* should be considered as part of the overall subdivision design. The use of non-standard materials, finishes, pavement and landscape treatments where appropriate is encouraged.

6. Roads should be designed to highlight the *entry and arrival points* of a neighbourhood.

7. *Road reserves* should be designed to provide *interest and variety* in the streetscape through curves, native landscaping and paving treatments, for example, Voyager Point, Liverpool City Council, Stanhope Gardens, Blacktown City Council.

5.2.2 Reference documents

NSW Department of Urban Affairs and Planning 2000 *Residential Subdivision - A handbook for the design and planning of new neighbourhoods* (Compiled by the Urban Design Advisory Service)

5.3 Visual amenity

Urban development should consider building form and siting, building heights and setbacks. Any proposed development should contribute to an attractive residential environment with clear character and identity. Early planning will assist in achieving an appealing visual amenity, however this is ultimately dependent on the built form.

Extensive cut and fill can lead to a decline in visual amenity through the need to construct extensive

retaining walls and elevated fences. It can also impede surface and ground water flow and increase areas of water logging, which can increase the salinity hazard. Provision of native vegetation as part of the streetscape can significantly contribute to the visual amenity of a suburb by attracting wildlife (e.g. birds) and providing shade in pedestrian and parking areas.

5.3.1 Guidelines for development control plans

1. A *subdivision proposal* should be:

- designed to have minimal impact on significant views and vistas; and
- compatible with the cultural and landscape characteristics of the locality or region

2. Consider using building construction principles that *address site constraints*, such as split level homes, use of drop edge beams to negate the need for soil retention by retaining walls, and dwellings erected on suspended floors. Many construction sites with steep frontages and driveway access may be better suited to a design that incorporates a garage below the house. Other forms of construction will be considered on their merits, for example, Camden Council's *Local Policy No. 7 Cut and fill on residential land*.

3. *Restrict residential development* of all lots with a grade of 6% or greater to ensure the erection of any dwelling thereon is of a design which does not involve cut and fill on site (e.g. split level, suspended floor construction, drop edge slab construction).

4. The *use of drop edge beams* for concrete slab edge support may be required in situations where the method of construction is not appropriate to the amenity of the existing area.

5. Cut and fill should be prevented from taking place within a specified distance e.g. 2 metres from any boundary. This would prohibit the construction of retaining walls on boundaries.

6. Cut and fill proposals should be submitted with the development application to Council, supported by adequate details to justify the variation of Council's

requirements. Details should include drainage design, engineering details, stabilisation details, erosion and sediment control details, visual aspects and the impact on the amenity of adjoining land. Refer to Camden Council's Local Policy No. 7 Cut and fill on residential land.

7. Depending on the soil type and drainage characteristics at each site (as determined following **initial site assessment**), the extent of cut of any allotment of land shall be minimised (NB: a minimum should be determined by each local government area e.g. 500mm).

8. Depending on the soil type and drainage characteristics at each site (as determined following *initial site assessment*), the extent of fill of any allotment of land shall be minimised (NB: a minimum should be determined by each local government area e.g. 500mm).

9. *Landscaping* should be sensitive to streetscape character, natural features of the site and views.

10. The applicant will be responsible for any development works on the site, (e.g. buildings, retaining walls, cutting, surface water drainage, fences etc). The total cost of the development can then be determined upfront at the development application stage. This should also contribute to the visual amenity of the completed form and streetscape generally.

5.3.2 Reference documents

Camden Council 1997 *Local Policy No. 7 Cut and fill on residential land*

- Baulkham Hills Shire Council 2000 *Development Control Plan No. 3 Residential*
- Baulkham Hills Shire Council 2000 *Kellyville/Rouse Hill Residential Development Control Plan No. 200*
- Baulkham Hills Shire Council and Blacktown City Council 2000 *Cattai Stormwater Management Plan*
- Baulkham Hills Shire Council 2000 *Interim salinity policy*
- Blacktown City Council 1992 *Blacktown Development Control Plan Part J Stanhope Gardens*
- Blacktown City Council 1998 *Soil erosion and sediment control policy*
- Brisbane City Council 2000 *Natural Channel Design Guidelines*
- Camden Council 1995 *Local Approvals Policy No. 2, Erosion and sediment control policy and code of practice*
- Camden Council 1996 *Camden Development Control Plan No. 87, The Cascades, Mount Annan*
- Camden Council 1997 *Local Policy No. 7 Cut and fill on residential land*
- Camden Council 2000 *Upper Nepean River Stormwater Management Plan*
- Cowan Stormwater Management Plan Committee 1999 *Cowan Creek Stormwater Management Plan*
- Dubbo City Council 1997 *Dubbo Local Environmental Plan 1997 Rural Areas*
- Hawkesbury City Council 2001 *Hawkesbury Development Control Plan*
- Hawkesbury City Council, 1997 *Soil erosion sediment control Development Control Plan*
- Hawkesbury Nepean Catchment Management Trust 1995 *Erosion and sediment control policy*
- Hornsby Shire Council 1998 *Sustainable Water Development Control Plan*
- Hornsby Shire Council 1995 *Residential Subdivision Development Control Plan*
- Hornsby Shire Council 1999 *Berowra Creek Catchment Stormwater Management Plan*
- Hornsby Shire Council et al. 1999 *Cowan Creek Stormwater Management Plan*
- Land and Water Resources Research and Development Corporation 1999 *Riparian Land Management Technical Guidelines - Vol 1&2.* (Prepared by Lovatt, S. & Price, P.)
- Land and Water Resources Research and Development Corporation 2000 *A Rehabilitation Manual for Australian Streams - Vol 1&2.* (Prepared by Rutherford, I., Jerie, K, & Marsh, N.)
- Liverpool City Council 1997 *Development Control Plan No. 4 Environmentally responsive residential development*
- Liverpool City Council 1999 *Development Control Plan No. 8 Natural Assets*
- Liverpool City Council 2000 *Sediment and erosion control*
- Middle Nepean Hawkesbury Stormwater Management Plan Committee 2000 *Middle Nepean Hawkesbury Stormwater Management Plan*
- Native Vegetation Advisory Council 2000 *Draft Vegetation Conservation Strategy for New South Wales*
- NSW Department of Housing 1998 *Managing Urban Stormwater Soils and Construction*
- NSW Department of Land and Water Conservation 2000 *Draft Guidelines to accompany Draft Salinity Hazard Mapping for Western Sydney.*
- NSW Department of Land and Water Conservation (in prep) *Hawkesbury Nepean Regional Floodplain Risk Management Study* (Incorporating a series of Best Practice Guidelines)
- NSW Department of Land and Water Conservation 2000 *Draft Salinity Hazard Map for Western Sydney*

- NSW Department of Land and Water Conservation 2002 *Draft Hawkesbury Lower Nepean Blueprint*
- NSW Department of Land and Water Conservation (in prep) *Urban Salinity Information Booklets*
- NSW Department of Urban Affairs and Planning 2000 *Residential Subdivision - A handbook for the design and planning of new neighbourhoods* (Compiled by the Urban Design Advisory Service)
- NSW Department of Urban Affairs and Planning 2000 *Sydney Regional Environmental Plan No. 30: St Marys*
- NSW Department of Urban Affairs and Planning 2000 *planFIRST: review of plan making in New South Wales*
- NSW Department of Water Resources 1993 *Riverwise Guidelines for Stream Management*
- NSW Environment Protection Authority 1996 *Managing Urban Stormwater: Strategic Framework* (Draft)
- NSW Environment Protection Authority 1998 *Managing Urban Stormwater: Source Control* (Draft)
- NSW Fisheries 1999 *Aquatic Habitat Management and Fish Conservation*
- NSW Government 2001 *Floodplain Management Manual: the management of flood liable land*
- NSW National Parks and Wildlife Service 1997a *Urban Bushland Biodiversity Survey: Native Flora in Western Sydney*
- NSW National Parks and Wildlife Service 1997b *Urban Bushland Biodiversity Survey: Native Fauna in Western Sydney*
- NSW National Parks and Wildlife Service 1999 *NSW Biodiversity Strategy*
- NSW National Parks and Wildlife Service 2001 *Biodiversity Planning Guide for NSW Local Government*
- NSW National Parks and Wildlife Service 2001a *Cumberland Plain Recovery Plan Information Sheet* http://www.npws.nsw.gov.au/news/recovery_plans/cumb_plain_plan.html
- NSW National Parks and Wildlife Service 2001b *Cumberland Plain Recovery Plan and Vegetation Mapping Information Sheet* http://www.npws.nsw.gov.au/science/vegmap/cumb_vegmap.html
- NSW National Parks and Wildlife Service (in prep) *Cumberland Plain Recovery Plan*
- Penrith City Council 1996 *Erosion and sediment control development control plan and code of practice*
- Penrith City Council 1999 *Penrith Development Control Plan Residential Construction Works*
- Penrith City Council 2000 *Middle Nepean Hawkesbury Stormwater Management Plan*
- Penrith City Council and Blacktown City Council 2000 *South Creek Stormwater Management Plan*
- PlanningNSW (in prep) *Draft Riparian Corridor Policy*
- Skelsey, M., (2001) 'Mandatory tanks in home of the future' *The Daily Telegraph* 1 June 1
- Sydney Regional Organisation of Councils 1997 *Green Web-Sydney, A Vegetation Management Plan for the Sydney Region*
- Upper Nepean Stormwater Plan Committee 2000 *Upper Nepean River Catchment Stormwater Management Plan*
- Wagga Wagga City Council 1996 *Building in a saline environment: Urban salinity prevention*
- Western Sydney Regional Organisation of Councils 2002 *Draft Salinity Code of Practice*

Site Assessment Checklist

Appendix One

Feature	Consult with/ refer to
Land capability	PlanningNSW/DLWC/EPA
Soil landscape analysis (dispersibility; structure; sodicity etc)	DLWC
Erosion and sediment control	Local Council/DLWC/ EPA/'Blue Book'
Salinity investigation	Local Govt/DLWC
Watercourses and water bodies (permanent and ephemeral)	DLWC/NSW Fisheries
Water quality management and monitoring	EPA
Flow characteristics and flood behaviour	DLWC
Aquatic health (macroinvertebrates and fish)	NSW Fisheries
Site vegetation and connectivity (on and off site): <ul style="list-style-type: none"> • threatened species and endangered ecological communities; • riparian vegetation; • existing high quality or significant remnant vegetation; • areas suited to restoration and/or regeneration; • potential habitat corridor links with other council areas. 	Local Govt/NSW Fisheries/ NPWS/Environment Australia DLWC/Local Govt/ NPWS/Green Web Local Govt/Green Web/NPWS Local Govt/Green Web/NPWS Local Govt /NPWS/ Green Web
Site fauna and connectivity (on and off site): <ul style="list-style-type: none"> • threatened species; • habitat and corridor management for native species. 	Local Govt/NSW Fisheries/ NPWS/ Environment Australia Local Govt/NPWS

Assessment of stormwater management plans

Appendix Two

Features		Middle Nepean -Hawkesbury	Cattai Ck	Cowan Ck	Upper Parramatta	Berowra	Upper Nepean	South Ck
Description of catchment	Climate	***	***	**	**	**	**	**
	Topography	***	**	**	**	**	***	**
	Water quality	***	***	***	***	**	**	***
	Streamflow	***	***	-	***	***	***	***
	Aquatic ecosystems and habitats	***	-	**	***	**	**	***
	Riparian vegetation	***	**	**	**	**	***	***
	Point sources of pollution	**	*	***	**	*	***	*
	Major sewer overflows	***	***	*	***	*	***	***
	Urban bushland areas	***	-	**	***	**	**	***
	Existing urban areas	**	**	**	**	**	**	**
Clearly defined stormwater management objectives	Proposed urban areas	**	***	-	**	-	**	**
		**	**	**	**	**	**	**
Identification of stormwater management issues and problems		yes	yes	yes	yes	yes	yes	yes
Evaluation of potential stormwater management practices to address the identified problems and issues		yes	yes	yes	yes	yes	yes	yes
An implementation strategy		**	***	**	**	*	***	**
A monitoring program		yes	yes	yes	yes	yes	yes	yes
A mechanism for reporting the effectiveness of the plan		yes	yes	yes	yes	yes	yes	yes
A program for revising the plan and linking its review to council SOE reporting and council management planning		yes	yes	yes	yes	yes	yes	yes

KEY: - not included; 'yes' included; * briefly covered; ** well covered; *** high level of detail.

For information on	Contact		Phone
<ul style="list-style-type: none"> Rivers and Foreshores Improvement Act 1948 – Part 3A Permits Water Act 1912 (These two Acts will be incorporated into the Water Management Act 2000 from early 2003)	DLWC	Parramatta Office	9895 7503
	DLWC	Parramatta Office	9895 7503
	DLWC	Parramatta Office	9895 7503
<ul style="list-style-type: none"> Threatened Species Conservation Act 1995 	NPWS – Conservation Programs and Planning Division		9585 6678
<ul style="list-style-type: none"> Environmental Planning and Assessment Act 1979 	PlanningNSW or your local council – see contacts below		9762 8000
<ul style="list-style-type: none"> Protection of the Environment Operations (POEO) Act 1997 Protection of the Environment Administration (POEA) Act 1991 	EPA – POEO Service Centre		133 372
	EPA – POEO Service Centre		133 372
<ul style="list-style-type: none"> Soil and water management / erosion and sediment control 	Local Government – see contacts below. See also 'Managing Urban Stormwater: Soils and Construction' – the Blue Book (Dept of Housing – phone 9821 6092)		
<ul style="list-style-type: none"> Council Planning Controls 	Baulkham Hills Shire Council		9843 0555
	Blacktown City Council		9839 6000
	Camden City Council		4655 2455
	Campbelltown City Council		4620 1510
	Hawkesbury City Council		4560 4444
	Liverpool City Council		9601 2566
	Parramatta City Council		9806 5000
	Penrith City Council		4732 7777
For contact details of other NSW Councils go to the Local Government and Shires Association web page http://www.lgsa.org.au/gov/councils.cfm			
<ul style="list-style-type: none"> Draft Salinity Code of Practice 	WSROC		9671 4333

For information on	Contact	Phone
<ul style="list-style-type: none"> Landscaping and native plant species supply services 	Landscape Contractors Association (for details of LCA members)	9790 5151
	Australian Association of Bush Regenerators	0407 002 921
	Office of Sydney Harbour Manager – 9338 9391 or go to http://bearings.nsw.gov.au/resource/planting_vegetation.html for lists of plant species by suburb and contact details for nurseries / suppliers	
<ul style="list-style-type: none"> Environmental Consultants 	Look under the following headings in the Yellow Pages: <ul style="list-style-type: none"> - Environmental and/or Pollution Consultants - Erosion Control and Soil Stabilisation - Natural Resources Consultants - Geotechnical Engineers and/or Consultants 	
<ul style="list-style-type: none"> Builders and Construction Companies 	Master Builders Association www.mbansw.asn.au	8586 3555
	Housing Industry Association www.buildingonline.com.au	8878 0400

Native Plant Landscaping Units for Western Sydney Councils

Appendix Four

BAULKHAM HILLS SHIRE COUNCIL		Soil Type				Landscape Use			Plant Characteristics					
Botanical Name	Common Name	Sandstone	Clay	Riparian	Coastal & estuarine	Tertiary Alluvium	Shade tolerant	Screening	Bird attracting	Showy flowers	Interesting fruit/seed pods	Rare/uncommon	Height - metres	Width - metres
Trees														
<i>Allocasuarina littoralis</i>	Black She Oak	*	*			*		*	*		*		4-6	3-3
<i>Allocasuarina torulosa</i>	Forest Oak	*						*	*		*		5-8	2-3
<i>Angophora bakeri</i>	Narrow Leaved Apple	*				*		*		*			3-6	2-4
<i>Angophora costata</i>	Smooth Barked Apple	*							*	*			8-20	3-10
<i>Angophora floribunda</i>	Rough Barked Apple	*	*						*	*	*		8-20	4-10
<i>Backhousia myrtifolia</i>	Grey Myrtle	*	*	*						*	*		3-4	
<i>Callicoma serratifolia</i>	Black Wattle	*		*			*			*			3-5	2-3
<i>Corymbia eximia</i>	Yellow Bloodwood	*												
<i>Corymbia gummifera</i>	Red Bloodwood	*							*	*	*		3-15	3-10
<i>Elaeocarpus reticulatus</i>	Blueberry Ash	*					*	*	*	*	*		4-8	2-4
<i>Eucalyptus amplifolia</i>	Cabbage Gum		*	*					*				10-20	4-8
<i>Eucalyptus fibrosa</i>	Broad-leaved Ironbark		*			*							35	5-10
<i>Eucalyptus paniculata</i>	Grey Ironbark	*	*						*				15-30	8-15
<i>Eucalyptus pilularis</i>	Blackbutt	*							*				15-30	8-10
<i>Eucalyptus punctata</i>	Grey Gum	*	*						*				10-25	5-8
<i>Eucalyptus saligna</i>	Sydney Blue Gum	*	*	*					*		*		15-30	5-12
<i>Glochidion ferdinandi</i>	Cheese Tree	*		*			*				*		5-10	4-8
<i>Melaleuca lineariifolia</i>	Snow in Summer	*	*			*		*		*			4-8	2-4
<i>Tristaniopsis laurina</i>	Water Gum	*		*			*	*		*			3-10	3-5
Shrubs														
<i>Acacia falcata</i>			*						*		*		1.5-3	1-2
<i>Acacia floribunda</i>	White Sallow Wattle	*	*				*	*	*	*	*		2-4	2-3
<i>Acacia limifolia</i>	Flax Leaved Wattle	*	*						*		*		2-3	1-2
<i>Acacia limifolia</i>	Flax Leaved Wattle	*	*						*		*		2-3	1-2
<i>Bursaria spinosa</i>	Blackthorn		*	*		*			*				2-3	1

Native Plant Landscaping Units for Western Sydney Councils – Baulkham Hills Shire Council

BAULKHAM HILLS SHIRE COUNCIL		Soil Type				Landscape Use			Plant Characteristics					
Botanical Name	Common Name	Sandstone	Clay	Riparian	Coastal & estuarine	Tertiary Alluvium	Shade tolerant	Screening	Bird attracting	Showy flowers	Interesting fruit/seed pods	Rare/uncommon	Height - metres	Width - metres
<i>Ceratopetalum gummiferum</i>	NSW Christmas Bush	*						*		*			2-4	1-3
<i>Daviesia corymbosa</i>		*								*			1.5	
<i>Epacris pulchella</i>	NSW Coral Heath	*												
<i>Epacris purpurascens</i>		*					*	*		*		*	1-1.5	0.3-0.5
<i>Kunzea ambigua</i>	Tick Bush	*											2-4	2
<i>Leptospermum polygalifolium</i>	Lemon Scented Tea Tree	*	*	*	*	*		*					2	1.5
<i>Ozothamnus diosmifolius</i>	Everlasting	*	*	*	*	*							2	1
<i>Persoonia hirsuta</i>	Geebung	*				*						*	1	
<i>Persoonia linearis</i>	Narrow Leaved Geebung	*	*			*		*	*	*	*		3-5	1
<i>Pimelia linifolia</i>	Rice Flower	*								*			1	1
Ground Covers / Scramblers														
<i>Centella asiatica</i>		*	*				*						0.1	x
<i>Dampiera stricta</i>		*												
<i>Dichondra repens</i>	Kidney Weed	*	*			*	*						0.1	x
<i>Goodenia hederacea</i> var <i>hederacea</i>	Violet Leaved Goodenia	*	*										0.2	0.5
<i>Hardenbergia violacea</i>	False Sardaparilla	*	*	*						*			0.1	2
<i>Pandorea pandorana</i>	Wonga Wonga Vine	*	*	*			*	*		*				
<i>Pratia purpurascens</i>		*	*	*			*	*					0.1	x
<i>Pseuderanthemum variabile</i>	Pastel Flower	*	*				*	*		*			0.1-0.3	0.1
<i>Viola hederacea</i>	Native Violet	*	*	*	*		*	*					0.1	x
Ferns														
<i>Adiantum aethiopicum</i>	Maidenhair Fern	*	*	*			*						0.3	x
<i>Adiantum hispidulum</i>	Rough Maidenhair Fern	*					*						0.15-0.4	x
<i>Cheilanthes sieberi</i> ssp. <i>Sieberi</i>	Mulga Fern	*	*	*			*	*					0.1-0.3	x
<i>Pellaea falcata</i>	Sickle Fern	*					*	*					0.5	x
Grasses / Tufted Plants														
<i>Danthonia tenuior</i>	Wallaby Grass	*	*	*							*		0.5-0.7	0.1

Native Plant Landscaping Units for Western Sydney Councils – Baulkham Hills Shire Council

<i>Dianella caerulea s. lat</i>	Blue Flax Lily	*					*	*	*	*	0.5	0.5
<i>Dianella revoluta</i>	Mauve Flax Lily	*					*	*	*	*	0.5	0.5
<i>Echinopogon caespitosus</i>	Tufted Hedgehog Grass	*				*		*	*		0.3	0.2
<i>Eleocharis sphacelata</i>	Tall Spike Rush	*						*	*		1	x
<i>Juncus usitatus</i>	Common Rush	*				*	*	*	*		0.6	0.5
<i>Lepidosperma laterale</i>		*									0.5-1	0.2
<i>Lomandra longifolia</i>	Spiny Mat Rush	*				*	*	*	*		1	1.5
<i>Lomandra multiflora ssp. multiflora</i>		*				*	*	*	*		0.3	0.2
<i>Opilsimenus aemulus</i>	Basket Grass	*				*	*	*	*		0.3	0.1
<i>Persicaria hydropiper</i>	Water Pepper					*	*	*	*		1	
<i>Themeda australis</i>	Kangaroo Grass.	*				*	*	*	*		0.5	0.5

Botanical Name		Common Name		Soil Type				Landscape Use				Plant Characteristics					
		Sandstone	Clay	Riparian	Coastal & estuarine	Tertiary Alluvium	Shade tolerant	Screening	Bird attracting	Showy flowers	Interesting fruit/seed pods	Rare/uncommon	Height - metres	Width - metres			
Trees																	
<i>Angophora floribunda</i>		*															
<i>Eucalyptus crebra</i>	Rough Barked Apple		*								*				*	8-20	4-10
<i>Eucalyptus fibrosa</i>	Narrow leaved Ironbark		*						*							20-30	
<i>Eucalyptus moluccana</i>	Broad-leaved Ironbark		*				*									35	5-10
<i>Eucalyptus sclerophylla</i>	Grey Box		*				*									20-25	6-8
<i>Eucalyptus tereticornis</i>	Scribbly Gum		*				*								*	15	
<i>Melaleuca decora</i>	Forest Red Gum		*				*									15-35	6-12
Shrubs	White Feather Honeymyrtle		*				*									6-20	5-10
<i>Acacia falcata</i>			*				*										
<i>Bursaria spinosa</i>	Blackthorn		*	*			*			*					*	1.5-3	1-2
<i>Daviesia ulicifolia</i>			*	*			*			*						2-3	1
<i>Dillwynia tenuifolia</i>			*	*			*			*						1.5	0.5
<i>Dodonaea falcata</i>			*	*			*			*					*	0.4-1	
							*			*					*	1.5	

Native Plant Landscaping Units for Western Sydney Councils – Camden City Council

CAMDEN CITY COUNCIL		Soil Type				Landscape Use			Plant Characteristics					
Botanical Name	Common Name	Sandstone	Clay	Riparian	Coastal & estuarine	Tertiary Alluvium	Shade tolerant	Screening	Bird attracting	Showy flowers	Interesting fruit/seed	Rare/uncommon	Height - metres	Width - metres
<i>Eucalyptus bauerana</i>	Blue Box			*									20-30	6-8
<i>Eucalyptus botryoides</i> x <i>saligna</i>				*					*				10-20	4-8
<i>Eucalyptus crebra</i>	Narrow leaved Ironbark		*					*	*				20-30	
<i>Eucalyptus elata</i>	River Peppermint			*				*	*				20-45	
<i>Eucalyptus moluccana</i>	Grey Box		*										20-25	6-8
<i>Eucalyptus viminalis</i>	Ribbon Gum			*				*	*				20-40	
<i>Melaleuca lineariifolia</i>	Snow in Summer	*	*			*		*		*			4-8	2-4
<i>Tristaniopsis laurina</i>	Water Gum	*		*			*	*		*			3-10	3-5
Shrubs														
<i>Acacia implexa</i>	Hickory	*	*				*			*			4-10	
<i>Acacia floribunda</i>	White Sallow Wattle	*	*				*	*	*	*			2-4	2-3
<i>Bursaria spinosa</i>	Blackthorn		*	*		*			*				2-3	1
<i>Indigofera australis</i>	Native Indigo		*				*						1.5	1
Ground Covers / Scramblers														
<i>Dichondra repens</i>	Kidney Weed	*	*			*	*						0.1	x
<i>Dichondra repens</i>	Blue Trumpet	*	*		*	*	*						0.1	x
<i>Pratia purpurascens</i>		*	*	*		*	*						0.1	x
Ferns														
<i>Cheilanthes sieberi</i> ssp. <i>Sieberi</i>	Mulga Fern	*	*			*	*						0.1-0.3	x
Grasses / Tufted Plants														
<i>Cymbopogon refractus</i>	Barbed Wire Grass	*	*								*		0.5	0.5
<i>Danthonia tenuior</i>	Wallaby Grass	*	*								*		0.5-0.7	0.1
<i>Danthonia racemosa</i>	Wallaby Grass		*								*		0.5-0.7	0.1
<i>Oplismenus aemulus</i>	Basket Grass		*	*			*						0.3	0.1
<i>Themeda australis</i>	Kangaroo Grass	*	*	*	*								0.5	0.5

Native Plant Landscaping Units for Western Sydney Councils – Hawkesbury City Council

HAWKESBURY CITY COUNCIL		Soil Type				Landscape Use			Plant Characteristics					
Botanical Name	Common Name	Sandstone	Clay	Riparian	Coastal & estuarine	Tertiary Alluvium	Shade tolerant	Screening	Bird attracting	Showy flowers	Interesting fruit/seed pods	Rare/uncommon	Height - metres	Width - metres
Trees														
<i>Angophora bakeri</i>	Narrow Leaved Apple	*				*		*		*			3-6	2-4
<i>Angophora floribunda</i>	Rough Barked Apple	*	*						*	*		*	8-20	4-10
<i>Angophora subvelutina</i>	Broad Leaved Apple		*	*						*			25	
<i>Backhousia myrtifolia</i>	Grey Myrtle	*	*	*							*		3-4	
<i>Casuarina cunninghamiana</i>	River She Oak		*	*				*					20-35	
<i>Casuarina glauca</i>	Swamp Oak	*	*	*				*	*		*		4-8	3-4
<i>Corymbia eximia</i>	Yellow Bloodwood	*												
<i>Eucalyptus tereticornis</i>	Forest Red Gum		*						*				15-35	6-12
<i>Eucalyptus amplifolia</i>	Cabbage Gum		*	*					*				10-20	4-8
<i>Eucalyptus crebra</i>	Narrow leaved Ironbark		*					*	*				20-30	
<i>Eucalyptus eugenoides</i>	Thin Leaved Stringybark		*						*				12-20	5-10
<i>Eucalyptus fibrosa</i>	Broad-leaved Ironbark		*			*							35	5-10
<i>Eucalyptus moluccana</i>	Grey Box		*										20-25	6-8
<i>Eucalyptus punctata</i>	Grey Gum	*	*						*				10-25	5-8
<i>Eucalyptus sclerophylla</i>	Scribbly Gum					*			*			*	15	
<i>Melaleuca decora</i>	White Feather Honeymyrtle		*				*		*	*			6-20	5-10
<i>Tristaniopsis laurina</i>	Water Gum	*		*			*	*	*				3-10	3-5
Shrubs														
<i>Acacia falcata</i>			*						*		*		1.5-3	1-2
<i>Acacia implexa</i>	Hickory	*	*				*		*	*			4-10	
<i>Acacia floribunda</i>	White Sallow Wattle	*	*				*	*	*	*	*		2-4	2-3
<i>Baeckea virgata</i>	Twiggy Heath Myrtle	*					*			*			2-4	
<i>Banksia ericifolia</i>	Heath Leaved Banksia	*							*	*	*		2-3	2.5
<i>Banksia spinulosa</i>	Hairpin Banksia	*							*	*	*		1.5	1
<i>Bursaria spinosa</i>	Blackthorn		*	*		*			*	*			2-3	1
<i>Ceratopetalum gummiferum</i>	NSW Christmas Bush	*						*	*	*			2-4	1-3

Native Plant Landscaping Units for Western Sydney Councils – Hawkesbury City Council

HAWKESBURY CITY COUNCIL		Soil Type						Landscape Use				Plant Characteristics				
Botanical Name	Common Name	Sandstone	Clay	Riparian	Coastal & estuarine	Tertiary Alluvium	Shade tolerant	Screening	Bird attracting	Showy flowers	Interesting fruit/seed	Rare/uncommon	Height - metres	Width - metres		
<i>Hibbertia diffusa</i>			*	*		*							0.5			
<i>Leptospermum polygalifolium</i>	Lemon Scented Tea Tree	*	*	*		*		*					2	1.5		
<i>Persoonia nutans</i>			*			*							1			
<i>Pimelia linifolia</i>	Rice Flower	*								*			1	1		
<i>Pultanea parviflora</i>			*			*										
<i>Pultanea villosa</i>	Hairy Bush Pea		*						*	*			1-1.5	1		
Ground Covers / Scramblers																
<i>Ajuga australis</i>	Bugle		*													
<i>Brachycome multifida</i>	Cut Leaf Daisy		*							*			0.4			
<i>Brunoniella australis</i>	Blue Trumpet		*	*			*			*			0.1-0.3	x		
<i>Clematis aristata</i>	Old Man's Beard	*	*							*						
<i>Dichondra repens</i>	Kidney Weed	*	*	*		*	*						0.1	x		
<i>Goodenia hederacea</i> var <i>hederacea</i>	Violet Leaved Goodenia	*	*	*									0.2	0.5		
<i>Hardenbergia violacea</i>	False Sardaparilla	*	*	*			*			*			0.1	2		
<i>Viola hederacea</i>	Native Violet	*	*		*		*						0.1	x		
Ferns																
<i>Adiantum aethiopicum</i>	Madenhair Fern	*	*	*			*						0.3	x		
<i>Cheilanthes sieberi</i> ssp. <i>Sieberi</i>	Mulga Fern	*	*	*		*	*						0.1-0.3	x		
Grasses / Tufted Plants																
<i>Cymbopogon refractus</i>	Barbed Wire Grass	*	*								*		0.5	0.5		
<i>Danthonia racemosa</i>	Wallaby Grass		*							*			0.5-0.7	0.1		
<i>Danthonia tenuior</i>	Wallaby Grass	*	*							*			0.5-0.7	0.1		
<i>Dianella revoluta</i>	Mauve Flax Lily	*	*				*		*	*			0.5	0.5		
<i>Eleocharis sphacelata</i>	Tall Spike Rush	*	*						*				1	x		
<i>Juncus usitatus</i>	Common Rush	*	*	*	*	*							0.6	0.5		
<i>Lomandra longifolia</i>	Spiny Mat Rush	*	*	*	*	*	*						1	1.5		
<i>Lomandra multiflora</i> ssp. <i>multiflora</i>		*	*			*							0.3	0.2		
<i>Oplismenus aemulus</i>	Basket Grass		*	*			*						0.3	0.1		
<i>Persicaria hydropiper</i>	Water Pepper		*	*						*	*		1			
<i>Themeda australis</i>	Kangaroo Grass	*	*	*	*								0.5	0.5		

Native Plant Landscaping Units for Western Sydney Councils – Liverpool City Council

LIVERPOOL CITY COUNCIL		Common Name	Soil Type				Landscape Use			Plant Characteristics						
			Sandstone	Clay	Riparian	Coastal & estuarine	Tertiary Alluvium	Shade tolerant	Screening	Bird attracting	Showy flowers	Interesting fruit/seed pods	Rare/uncommon	Height - metres	Width - metres	
Trees																
	<i>Angophora subvelutina</i>	Broad Leaved Apple		*	*										25	
	<i>Casuarina glauca</i>	Swamp Oak	*	*	*			*	*				*		4-8	3-4
	<i>Eucalyptus tereticornis</i>	Forest Red Gum		*											15-35	6-12
	<i>Eucalyptus amplifolia</i>	Cabbage Gum		*	*										10-20	4-8
	<i>Eucalyptus benthamii</i>	Camden White Gum		*										*	20-30	
	<i>Eucalyptus elata</i>	River Peppermint			*			*	*						20-45	
	<i>Eucalyptus fibrosa</i>	Broad-leaved Ironbark		*				*							35	5-10
	<i>Eucalyptus maculata</i>	Spotted Gum		*										*	30	
	<i>Eucalyptus moluccana</i>	Grey Box		*											20-25	6-8
	<i>Eucalyptus sclerophylla</i>	Scribbly Gum						*						*	15	
	<i>Melaleuca decora</i>	White Feather Honeymyrtle		*				*	*					*	6-20	5-10
	<i>Tristaniopsis laurina</i>	Water Gum			*									*	3-10	3-5
Shrubs																
	<i>Bursaria spinosa</i>	Blackthorn		*	*				*						2-3	1
	<i>Dillwynia parvifolia</i>			*										*	0.3-1	0.5
	<i>Dillwynia tenuifolia</i>			*	*			*	*					*	0.4-1	
	<i>Hibbertia diffusa</i>			*	*			*	*						0.5	
	<i>Pultenaea parviflora</i>			*				*	*					*	1	
Ground Covers / Scramblers																
	<i>Dichondra repens</i>	Kidney Weed	*	*				*	*						0.1	x
	<i>Dichondra repens</i>	Blue Trumpet	*	*				*	*						0.1	x
	<i>Pratia purpurascens</i>		*	*	*			*	*						0.1	x
Ferns																
	<i>Cheilanthes sieberi ssp. Sieberi</i>	Mulga Fern	*	*				*	*						0.1-0.3	x
Grasses / Tufted Plants																
	<i>Cymbopogon refractus</i>	Barbed Wire Grass	*	*										*	0.5	0.5

Native Plant Landscaping Units for Western Sydney Councils – Penrith City Council

PENRITH CITY COUNCIL		Soil Type				Landscape Use			Plant Characteristics					
Botanical Name	Common Name	Sandstone	Clay	Riparian	Coastal & estuarine	Tertiary Alluvium	Shade tolerant	Screening	Bird attracting	Showy flowers	Interesting fruit/seed pods	Rare/uncommon	Height - metres	Width - metres
<i>Tristaniopsis laurina</i>	Water Gum	*		*			*	*		*			3-10	3-5
Shrubs														
<i>Acacia falcata</i>											*			
<i>Acacia implexa</i>	Hickory	*	*				*		*	*			1.5-3	1-2
<i>Banksia serrata</i>	Old Man Banksia	*							*	*	*		4-10	
<i>Bursaria spinosa</i>	Blackthorn		*	*		*			*				4-16	2-5
<i>Daviesia genitifolia</i>			*									*	2-3	1
<i>Daviesia ulicifolia</i>			*					*					1-2	
<i>Grevillea juniperina</i>			*			*				*		*	1.5	0.5
<i>Hibbertia diffusa</i>			*	*		*							1-2	
<i>Leptospermum trinervium</i>	Paperbark Tea Tree		*			*			*				0.5	
<i>Persoonia nutans</i>			*			*							2	1.5
Ground Covers / Scramblers														
<i>Brunoniella australis</i>	Blue Trumpet		*	*			*			*			0.1-0.3	x
<i>Clematis aristata</i>	Old Man's Beard		*							*	*			
<i>Dichondra repens</i>	Kidney Weed		*	*		*	*						0.1	x
<i>Goodenia hederacea</i> var. <i>hederacea</i>	Violet Leaved Goodenia		*										0.2	0.5
<i>Pratia purpurascens</i>			*	*		*	*						0.1	x
Ferns														
<i>Adiantum aethiopicum</i>	Madenhair Fern		*	*			*						0.3	x
<i>Cheilanthes sieberi</i> ssp. <i>Sieberi</i>	Mulga Fern		*			*	*						0.1-0.3	x
Grasses / Tufted Plants														
<i>Cymbopogon refractus</i>	Barbed Wire Grass		*								*		0.5	0.5
<i>Danthonia racemosa</i>	Wallaby Grass		*								*		0.5-0.7	0.1
<i>Danthonia tenuior</i>	Wallaby Grass		*								*		0.5-0.7	0.1
<i>Eleocharis sphacelata</i>	Tall Spike Rush		*	*					*				1	x
<i>Juncus usitatus</i>	Common Rush		*	*	*	*	*						0.6	0.5

Native Plant Landscaping Units for Western Sydney Councils – Penrith City Council

PENRITH CITY COUNCIL		Soil Type						Landscape Use			Plant Characteristics				
Botanical Name	Common Name	Sandstone	Clay	Riparian	Coastal & estuarine	Tertiary Alluvium	Shade tolerant	Screening	Bird attracting	Showy flowers	Interesting fruit/seed pods	Rare/uncommon	Height - metres	Width - metres	
<i>Lomandra multiflora</i> ssp. <i>multiflora</i>		*	*			*							0.3	0.2	
<i>Oplismenus aemulus</i>	Basket Grass		*	*			*						0.3	0.1	
<i>Persicaria hydropiper</i>	Water Pepper			*							*	*	1		
<i>Themeda australis</i>	Kangaroo Grass	*	*	*	*								0.5	0.5	

Alternate Floor Construction Comparison

Appendix Five

FLOOR COSTING SHEET

SUPPLY TO BUILDER RATE (10/05/01)

(Source: SMARTSLAB Pty. Ltd.)

System	Item	Building Size	Unit	Cost	Total
		(9.6m x 16.8m)			
"Pod" type Slab on Ground	Site Levelling	1	Job	600	600
	Supply and install pods steel and concrete	161.28	m ²	50	8064
	Piers @ 2400mm ctrs average 1000mm deep	40	m	55	2200
				Total \$/m²	\$10,864 \$67.36
Raft Slab with Drop Edge Beams	Supply and install including excavation.	161.28	m ²	111	17902.08
	Retaining wall treated pine 800mm high	12	m ²	140	1680
				Total \$/m²	\$19,582.08 \$121.42
Smartslab Concrete Raised Floor on Steel Bearers and Joists	Strip Footings, incl excavation, concrete, steel and labour	52	m	45	2340
	Island Piers to 800mm average incl footings 2400 ctrs	18	unit	50	900
	External brick incl engaged piers average height 800mm	52	m	56	2912
	Supply and install frame and concrete mesh and formwork	161.28	m ²	95	15321.6
				Total \$/m²	\$21,473.60 \$133.14

System	Item	Building Size	Unit	Cost	Total
		(9.6m x 16.8m)			
Smartslab Particleboard floor on Steel Bearers and Joists	Strip Footings, incl excavation, concrete, steel and labour	52	m	45	2340
	Island Piers to 800mm average incl footings 2400 ctrs	18	unit	50	900
	External brick incl engaged piers average height 800 mm Piers @ 1800 ctrs	52	m	56	2912
	Supply and install frame and particle board 22 mm incl glue and nails	161.28	m ²	57	9192.96
				Total \$/m²	\$15,344.96 \$95.14
Conventional Timber Bearers and Joists Green Hardwood	Strip Footings, incl excavation, concrete, steel and labour	52	m	45	2340
	Island Piers to 800mm average incl footing 1800 ctrs max	41	unit	50	2050
	External brick incl engaged piers average height 800 mm Piers @ 1200 ctrs	52	m	63	3276
	Supply and install frame and joists 450ctrs Particle board 18mm incl glue and nails	161.28	m ²	35	5644.8
				Total \$/m²	\$13,310.8 \$82.53

The above figures are estimates only and do not include maintenance costs.

