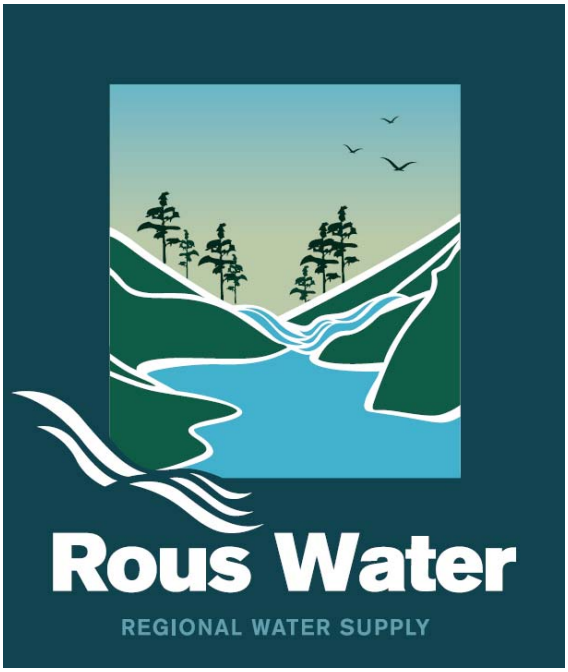
Development Control in the Rous Water Supply Catchment Areas



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1.1 Background

Rous Water is the regional water supply authority supplying water to the whole of the Local Government Areas of Lismore (excluding Nimbin), Ballina (excluding Wardell), Byron (excluding Mullumbimby) and Richmond Valley (excluding land to the west of Coraki).

Rous Water recognises that keeping the catchments healthy is the first step in protecting the quality of the water supply. If the catchments become unhealthy, then water quality in rivers and streams will deteriorate. This endangers the drinking water quality, as well as impacting on activities such as stock watering, irrigation and recreation, and the ecological health of native plants and animals.

The health of a catchment is largely dependent on the changes that man has made to the catchment landscape and the management practices that catchment landholders choose to employ. The choices that landholders make in modifying and managing their properties can therefore have a significant influence on water quality.

Rous Water works across a range of disciplines including the following key activity streams:

- Review and implementation of the regional water supply strategy;
- Planning and construction of major water supply infrastructure including water mains and water treatment facilities;
- Manages, protects, enhances and operates the water catchment areas;
- Manages, protects, enhances and operates the water supply dams;
- Manages and operates the water treatment plants;
- Manages and operates the water distribution systems;
- Implements a comprehensive demand management strategy.

Rous Water has surface water catchment areas associated with the following existing water sources:

- Rocky Creek Dam
- Emigrant Creek Dam
- Wilsons River Source

In addition, Rous Water operates groundwater sources from bores in the Woodburn Sands aquifer and the Alstonville Plateau groundwater source.

An additional future water source will be the proposed Dunoon Dam, which is scheduled for completion between 2016 and 2023 (Rous Water Management Plan 2008-2011).

INTRODUCTION

1

The water resources of the North Coast Region are intensively utilised with opportunities for developing additional supplies limited by environmental, economic and social issues. The continued supply of a safe (meeting required public health standards) and adequate yield from these resources is necessary to provide for the North Coast's existing population and its projected growth over coming years. This growth will result in increased subdivision and development pressures with an associated increase in demand and the potential to adversely affect the quality of the Region's existing and potential new supplies (DWE 2007).

There is a responsibility for local government to ensure the continuation of a sustainable supply from these existing surface water and ground water sources. One of the key mechanisms to protect the quantity and quality produced from these sources is the use of the planning and development assessment processes to help eliminate land practices which result in saltation or pollution of rivers, other water bodies and underlying aquifers (DWE 2007).

In operating the regional water supply system, the current approach adopted by Rous Water in reviewing any development proposal is to protect the water supply by a multiple barrier approach from catchment ecology through to the water treatment process and distribution system. All of these barriers must be protected during the urban development process, and no barrier is considered to be more significant than any other.

However, recent changes in the approach taken by the State Government to reduce the complexity of the planning system and to reduce referrals by Council resulted in draft local environmental plans being prepared without referral clauses. Therefore, Councils must include protecting the water supply in its suite of development controls, and in the assessment of development applications. To do this, there must be appropriate provisions within local planning instruments to give a Council the power to protect the water quality.

In order to ensure that development outcomes within the water catchment areas of Rous Water are compatible with the drinking water catchment values in these locations, Rous Water would like to provide clear advice to both the constituent Councils and proponents of development, regarding Rous Water expectations.

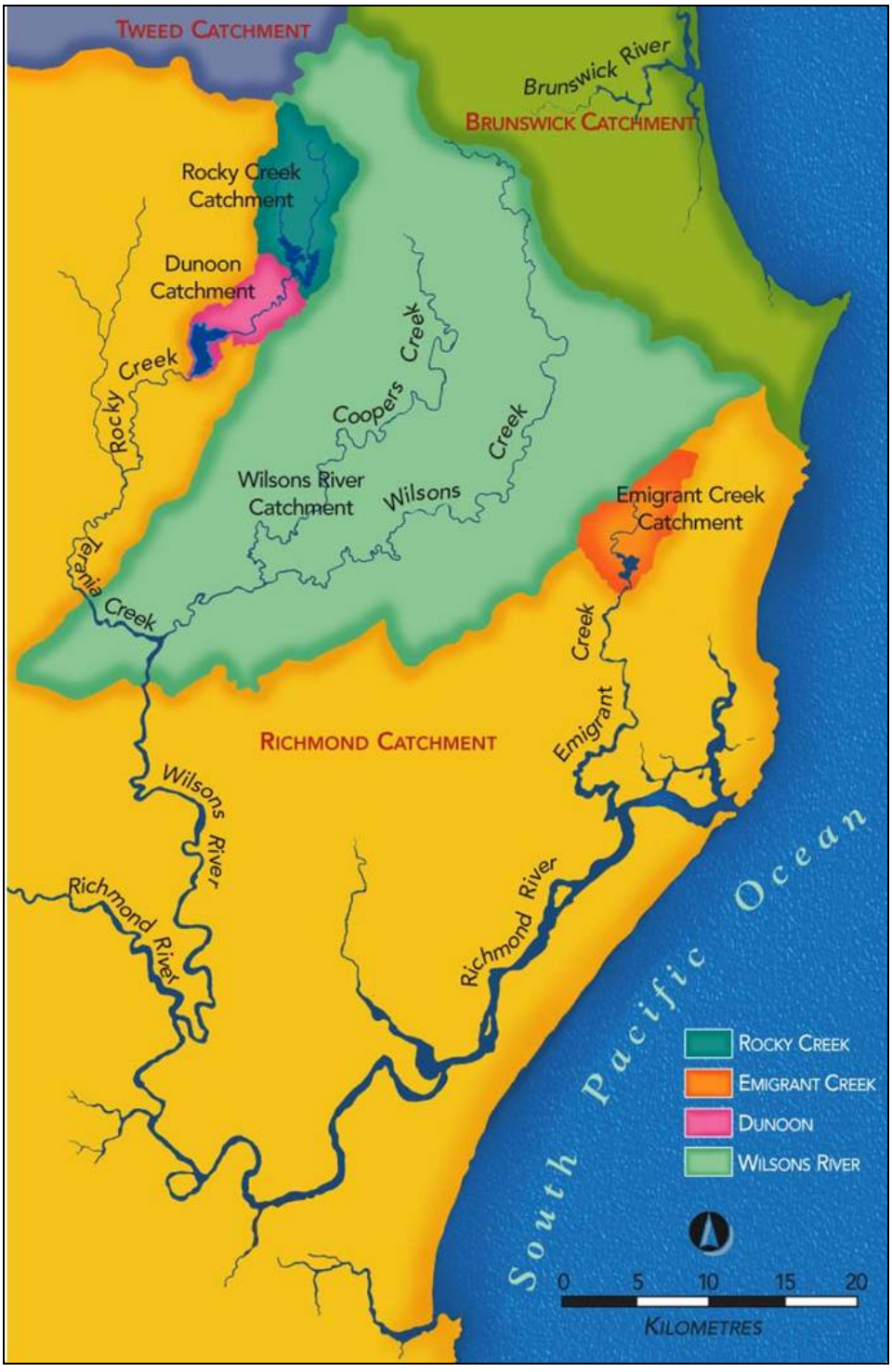

Figure 1. Rous Regional Water Supply (Source: Rous Water).

1.2 Objectives

The objectives of this report, defined in the project brief are as follows:

- To provide a referral clause that requires input from Rous Water in determining certain development applications;
- To provide development guidelines identifying the requirements of Rous Water for all development within the water catchment areas;
- To establish agreed implementation protocols with constituent Councils;
- To establish triggers for potential Rous Water involvement and thresholds for size/location of development for which guidelines would apply;
- To establish a series of conditions of approval that could be applied to certain types of development/issues.

1.3 Scope of Work

The scope of work associated with this review included the following:

1. Identify opportunities to improve planning-related outcomes through the LEP renewal process

(i) Review the Rous Water submission made to the respective constituent Councils regarding the LEP renewal process.

(ii) Other than those mechanisms identified at (2) and (3) below, identify any other opportunities available to improve planning-related outcomes through the LEP renewal process.

2. Conduct background research/review background information and establish effective referral arrangements

(i) Review existing planning schemes that apply in the respective water catchment areas operated by Rous Water (available via relevant constituent Council websites).

(ii) Review any current clause (contained in the existing LEPs) that must be addressed for any development associated with these existing planning schemes in the respective water catchment areas operated by Rous Water (Clause 45 in the Lismore LEP is the only existing clause).

(iii) Review the draft clause originally proposed by the constituent Councils.

(iv) Review the draft clause published by the Department of Water and Energy (DWE).

(v) Conduct research to review the practices adopted in other jurisdictions.

(vi) Review the contributions and comments received from catchment managers in other jurisdictions.

(vii) Based on the background research (and an awareness of the range of issues of interest to Rous Water (refer (3) below), recommend what would

be considered to be 'best practice' in terms of a referral clause or any changes to the existing draft DWE clause.

3. Establish development guidelines issues to be addressed

(i) Conduct review of previous development applications within the catchment areas in order to provide clear understanding of the development pressures occurring.

(ii) Review the background material prepared by Rous Water in relation to a range of key issues of concern. This includes comments made in response to a number of development applications.

(iii) With an awareness of best management practice in relation to the identified issues of concern, prepare qualitative development guidelines identifying the requirements of Rous Water for all development within the water catchment areas. These guidelines should effectively be a guide for developers/constituent Councils as to Rous Water's expectations in relation to key issues of concern, both in terms of the development assessment process and in relation to development outcomes.

(iv) Identify the nature of development to which the guidelines identified in (iii) above refers (i.e. identify any inclusions or exclusions). For example, there may be a 'sliding scale' of requirements – clearly a single dwelling would not need to address as many issues as would a major subdivision.

4. Develop conditions of approval for different categories of development/types of issues

(i) For the different categories of development identified (refer 3 (iii) above) and the different types of issues being addressed, identify a series of conditions of approval that could be used as the basis of a suitable response to these items.

1.4 Structure of the Document

In completing this review, this document is structured as follows:

- Section 1 provides a background to the project and outlines the purposes of the document.
- Section 2 provides an overview of the current planning system and legislative changes in the context of protecting the catchments.
- Section 3 investigates the current planning controls applicable to each of the catchments and details options for providing improved planning controls. It reviews best management practices and recommends a course of direction through the incorporation of a new clause in the Standard Instrument, together with additional DCP controls.
- Section 4 summarises the key issues of concern to Rous Water and identifies how best to address those issues through the development control process.

2 IMPROVING PLANNING OUTCOMES

Objective: Identify opportunities to improve planning-related outcomes through the LEP renewal process.

A Council has many statutory obligations which need to be carefully considered in determining the merit of development applications:

- Section 7(e) of the Local Government Act 1993 (NSW) requires councils, councillors and council employees to have regard to the principles of ecologically sustainable development (ESD) in carrying out their responsibilities.
- Section 3 of the Protection of the Environment Operations Act 1997 (PEOA) (NSW) and Section 6 of the Protection of the Environment Administration Act 1991 (PROTEA) (NSW) also contain reference to ESD and the precautionary principle.
- Section 79C of the Environmental Planning and Assessment Act 1979 sets out the matters for consideration under that act and includes "*the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality*".

The difficulty is in determining the extent to which each matter must be given weight, and providing clear guidance on expectations for development "environmental performance".

Recent precedents set in planning appeals indicate that a development in a water supply catchment needs to be considered both in its own right and in the broader context of incremental development. Decisions made in relation to developments in catchments, and policy decisions made in planning frameworks, are pointing towards a neutral or beneficial effect as being the test against which new developments in water supply catchments should be assessed.

The concept of a "neutral or beneficial effect' was introduced to planning legislation as a result of 1999 Sydney Water contamination event through State Environmental Planning Policy No 58 and subsequently the Drinking Water Catchments Regional Environmental Plan No 1. (Note that as of 1 July 2009, all REP's in NSW have become SEPP's) Since that time councils, developers and the government have struggled to understand what constitutes a "neutral or beneficial effect" and more importantly, how to measure it for development assessment in a practical manner.

A major problem with the neutral or beneficial effect test is that even if a proposal fails to meet contemporary best management practice standards, if the site is currently poorly managed/degraded and would benefit from any intervention no matter how minimal, it can still technically pass the 'test'. Thus the test is biased toward development on poorly managed land.

In addition, climate change has also become an important and relevant planning consideration in development assessment. In *Walker v Minister for Planning [2007] NSWLEC 741*, the Minister's approval of a concept plan for a residential subdivision and retirement development at Sandon Point was found

to be void, due to failure by the Minister to take into account implied mandatory considerations, namely, ESD principles, including whether the flooding impacts of the project would be compounded by climate change.

While an appeal against the decision was allowed in *Minister for Planning v Walker [2008] NSWCA 224,* it was considered that "*Since these aspects of ESD were not addressed by the Minister in giving his approval to the concept plan, in my opinion they will need to be addressed when development approval is sought… I do not think approval of the concept plan should be considered as resolving these matters in favour of the development."*

Clearly, consideration of the impacts of climate change is becoming essential in the development process, moreover a detailed assessment is required rather that conceptual or in-principle. While the above court cases refer to a residential/retirement development, it is also appropriate that non-residential developments consider the impacts of climate change, including the impacts on water availability and supply.

Assessing the potential impact of development on water quantity however enters an area of extreme uncertainty as there is very little information available on existing water availability, particularly on groundwater. Moreover, many of the actions required to ensure improved water quality such as planting vegetated buffers, and reforestation potentially reduces the amount of runoff for a significant period, thus potentially reducing water quantity. Conversely, putting large impervious surfaces can increase water quantity through runoff, but potentially significantly impacts on water quality through transport of pollutants.

The *Far North Coast Strategy* (Department of Planning) states that "In preparing local environmental plans councils will liaise with water and energy providers and make provision for any regional gas, water and electricity infrastructure corridors that may be required." This specifically refers to the provision of infrastructure, however given the Court decisions it could equally apply to the protection of the water resources. A key issue is whether or not potential impacts on water quantity can be assessed for a proposed development. In addition, the *Far North Coast Strategy* states that "Local environmental plans will recognise and protect the regional water supply system through appropriate planning provisions."

There are other pieces of legislation that are considered through the planning assessment process that may impact on water quality such as the Water Management Act 2000, the Native Vegetation Act 2003, Rural Fires Act 1997 and State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004. However these are stand alone documents that must be considered and complied with as appropriate, regardless of any LEP provision.

Through land use zoning and land use permissibility, Councils can control the land uses that are allowed, and where. The way in which the land is used can have a significant effect on the quality of the drinking water supply. The LEP renewal process provides the opportunity for Councils to maintain and improve the quality of water in the catchments.

Clearly the NSW Government's direction is to simplify the planning process, and to avoid duplication of assessments and to minimise State Government involvement in minor DA's. Unfortunately for Councils, this often leads to additional responsibility and work load.

A key purpose of this review is to assist the Constituent Councils in undertaking this work.

2.1 Rous Water Submission to Councils

Objective: Review the Rous Water submission made to the respective constituent Councils regarding the LEP renewal process.

2.1.1 Review of Submission to Constituent Councils

Between February and April 2007, Rous Water wrote to the General Managers of Byron Shire Council, Ballina Shire Council and Lismore City Council regarding renewal of the respective Local Environmental Plans (LEP), with a particular focus on issues of concern in relation to the regional water supply catchment areas (Emigrant Creek, Rocky Creek and the Wilsons River).

In these letters, Rous Water raised the following issues:

- Water supply infrastructure – Rous Water requested that the LEP's continue to make provision for undertaking activities relating to the provision and maintenance of water supply infrastructure within all zones of the LEP.
- Demand management – ideally, the LEP would encourage and support Rous Water's Demand Management Plan, including alternative water sources (rainwater, stormwater, greywater), water recycling, rainwater tank installation, backflow prevention, and reduction of water use.
- Assessment of development proposals - Rous Water believes that a concurrence clause should be included in the LEP renewal with specific reference to all Rous Water water catchment areas. The clause should require any development application pertaining to the specified water catchment areas to be referred to Rous Water for concurrence, with the exception of development for the purpose of a dwelling-house on land that possesses a dwelling entitlement.
- On-site wastewater systems - Rous Water considers that additional controls for on-site systems in the water supply catchment areas will help to control the input of pathogens to the dams and therefore reduce the risk of pathogens being present in the water. Rous Water requested that the constituent Councils consider how the Rous Water guidelines can be best integrated into the LEP renewal process.
- Water sensitive urban design – Rous Water considered that adoption of WSUD principles in all development that occurs within the respective water catchment areas would assist in the protection and improvement of catchment values and is therefore supported.
- Integrated Water Cycle Management Plan – At the time of writing Rous Water was in the process of preparing an IWCM Plan to identify ways to improve the management of water supply, sewerage and stormwater services. Rous Water recommended a review of these

plans to identify whether there are any specific issues that require input into the LEP.

- Implications of the Far North Coast Strategy – Rous Water is concerned that within its regional water supply catchment areas there could potentially be additional development in excess of that identified and mapped in the strategy.

Comment: The response provided to the constituent Council is logical from a total catchment management perspective, and covers the full range of development issues that may occur within the catchments. The comments are particularly useful as overarching principles within which an LEP would be prepared.

Demand and supply varies greatly depending on a range of circumstances outside the development assessment process. In setting out the size and location of zones to facilitate development, the ability to adequately service development is a key consideration. However, it is very difficult to introduce LEP provisions relating to demand management. These processes can however operate alongside the LEP process and are best approached in a strategic and cooperative manner between Councils and the water provider. A key factor for Councils to remember is that its population is drinking the water its development has the potential to pollute. It is in everyone's best interest to ensure good water quality.

With respect to referrals to Rous Water, as discussed above, the State Government has moved away from requiring referrals to the extent it is not allowing such provisions in new LEP's. Regardless of the desire to have significant input, that input has now been limited by the State Government to making a submission as an interested party on exhibited development applications.

The Sydney Catchment Authority, having removed mandatory referrals from the process through replacing State Environmental Planning Policy 58 with the Drinking Water Catchments Regional Environmental Plan No. 1 (both discussed later in this report) advised that regardless of the referral provisions, Councils still prefer to refer development applications for advice on determination rather than undertaking a comprehensive in-house assessment. This was due in part to a lack of expertise or qualifications within the Council, particularly using the computer models often required for complex assessments, and in part due to the lack of adequate guidelines for assessment and poor quality applications.

An alternative to the referral process is to provide a good set of guidelines and to provide training in the use of those guidelines, and also in general water quality protection. Water quality is rarely addressed in planning training courses.

2.2 Improving Planning Outcomes Through the LEP Renewal Process

Objective: Other than those mechanisms identified at (2) and (3) below, identify any other opportunities available to improve planning-related outcomes through the LEP renewal process.

2.2.1 Review of LEP Renewals

Most Councils within NSW are currently reviewing LEP's in accordance with directives from the Department of Planning. The intent of this review is to standardise LEP provisions across NSW. A review of proposed amendments relating to water quality protection was undertaken.

It is understood that all of the constituent Councils have adopted a somewhat similar approach to water supply catchment areas in the LEP renewal process, by establishing an environmental overlay for the subject areas and an accompanying clause that requires consideration and water quality and catchment health considerations. This approach is supported as it provides the opportunity for a consistent set of controls applicable across all catchments. By way of example, the Richmond River Draft LEP contains the following provisions;

5.5A Environmental overlay considerations [local]
(1) Objective
The objectives of this clause are to:
(a) identify environmental constraints on a map or series of maps,
(b) minimise the impact of development on the environment, and
(b) require consideration of the impact of development on identified environmental constraints.

(2) Land to which this clause applies
This clause applies to land identified on the Environmental Overlay Map.

(3) Consideration of environmental constraints
Development consent must not be granted unless consideration has been made of the impacts from that development on environmental constraints and that appropriate measures are proposed, or have been made, to off-set or mitigate those impacts.

(4) Definitions
For the purposes of this clause:
Environmental constraints *are those environmental constraints identified on the Environmental Overlay Map and include such things as wildlife corridors, wetlands, endangered ecological communities (EEC), habitat of threatened or endangered species or populations, environmental hazards, water supply catchments, or the like.*

5.5B Development in water supply catchments [local] - draft
(1) Objective
The objective of this clause is to ensure that development carried out within a water supply catchment does not have an adverse impact on water quality.

(2) Land to which this clause applies
This clause applies to all land within an identified Water Supply Catchment on the Environmental Overlays Map.

(3) Where consent may be granted for development
In addition to those considerations required by clause 5.5A(3), a consent authority must not grant consent to carry out development on land to which this clause applies unless it has considered the following and is satisfied that there will be nil or an acceptable impact of that water supply:

(a) any potential adverse impact that the development may have on water quality within the water supply catchment,
(b) any potential incremental adverse impacts that the development may have on water quality within the water supply catchment, including cumulative impacts,
(c) whether adequate safeguards and other measures are proposed to protect water quality within the water supply catchment, and
(d) any requirements of the relevant water supply authority.

(4) Definitions
For the purposes of this clause and clause 5.5A:
***Water supply catchment** means a water catchment used for the supply of potable water and identified on the Environmental Overlays Map.*

2.2.2 Assessment of Proposed Controls

In principle these provisions appear reasonable, however the Council can still approve development that has a negative impact on water quality if it feels that impact is acceptable. This creates an opportunity for cumulative impact and in essence is contrary to the intent of the provision.

It would also be useful to use terminology that has already been used in the protection of drinking water catchments in NSW and tested over the last ten years or so.

The standard LEP instrument allows a Council to produce individual maps of constrained land and prepare separate clauses that relate specifically to those constraints. Consultation with the Department of Planning in relation to separate mapping of the catchments, and also the provision of a separate clause indicates that it would support the clause proposed in Section 3.4 of this report. Inclusion of a specific clause also provides the opportunity to give force to Development Control Plan provisions to both guide the preparation and assessment of development applications.

At the time of writing all Councils except Richmond Valley have provided their comprehensive draft LEP's to the Department of Planning for review and as such, each Council will need to request an amendment to include the proposed clause. The Department of Planning has indicated a willingness make such an amendment. None has included a specific clause relating to a mapped area and to water quality protection in the drinking water catchments.

3 ESTABLISHMENT OF REFERRAL CLAUSE

Objective: Conduct background research/review background information and establish effective referral clauses/arrangements for proposed development within water catchment areas.

3.1 Existing Planning Schemes/Local Environmental Plans

Objective: Review existing planning schemes that apply in the respective water catchment areas operated by Rous Water.

The purpose of reviewing the existing planning controls that apply to the catchments is to establish a baseline of current controls. Having reviewed the existing controls, informed decisions can be made as to a consistent approach forward for new controls.

3.1.1 Review of Planning Provisions for Existing Water Sources

Rocky Creek Dam

Rocky Creek Dam is Rous Water's principle water source, with a capacity of 14,000ML. It was constructed in the 1950s and is located in the Lismore City Council (LCC) area (Rous Water Management Plan 2008-2011). Its entire water catchment area consists of lands managed by either the Department of Environment and Climate Change or Rous Water, hence there has been no development pressures experienced in this location.

The land in the immediate vicinity of Rocky Creek Dam is zoned 5 – Special Uses Zone under the Lismore Local Environmental Plan 2000. The catchment for Rocky Creek Dam is zoned 1(f) – Forestry Zone. The objectives and development permissibility for these zones are shown below.

65 Zone No 5 (Special Uses Zone)
The following table provides general zoning controls for Zone No 5:

Table
65.1 Objectives of zone
The objectives are:

(a) to designate land which is now used or is intended to be used for particular public or community purposes, and
(b) to ensure the land is used for a purpose appropriate to its location, community needs and economic utilisation.

65.2 Without development consent
Development for the purpose of:

- *bush fire hazard reduction*
- *home occupations*
- *Exempt development*

65.3 Only with development consent
Development for any public purpose

Development for the purpose of:
- *roads*
- *the particular use indicated by black lettering on the map*

65.4 Only with development consent—advertised development
Development not included in item 65.2, 65.3 or 65.5.

65.5 Prohibited
Development for the purpose of:
- *brothels.*

34 Zone No 1 (f) (Forestry Zone)
The following table provides general zoning controls for Zone No 1 (f):

Table
34.1 Objective of zone
The objective is to allow forestry activities carried out by or on behalf of the Forestry Commission.

34.2 Without development consent
Development for the purpose of:
- *agriculture*
- *any building, work, place or land use authorised under the Forestry Act 1916 (including any ordinarily ancillary or incidental development)*
- *bush fire hazard reduction*
- *home occupations*
- *Exempt development*

34.3 Only with development consent
Development for the purpose of:
- *extractive industries*
- *mines*
- *utility installations*

34.4 Only with development consent—advertised development
Nil.

34.5 Prohibited
Development not included in item 34.2, 34.3 or 34.4.

Comment: These provisions make no reference the land as being important for the purposes of water collection for the water supply. The general "community uses" allows for a range of uses and there are no special provisions to ensure water quality is protected. Interestingly, any road, which presumably includes roads or works on roads by a Council, requires development consent.

Emigrant Creek Dam

The Emigrant Creek Dam is located within Ballina Shire, and has a capacity of 820ML (Rous Water Management Plan 2008-2011). The catchment for the Emigrant Creek Dam, including the dam itself, is zoned 7(c) – Environmental Protection – Water Catchment, under the Ballina Local Environmental Plan 1987.

Zone No 7 (c) Environmental Protection (Water Catchment) Zone

1 Objectives of zone

A The primary objective is to prevent development which would adversely affect the quantity or quality of the urban water supply.

B The secondary objective is to regulate the use of land within the zone:

(a) to encourage the productive use of land for agricultural purposes and to permit development which is ancillary to agricultural land uses, except for development which would conflict with the primary objective of the zone, and

(b) to ensure development of the land maintains the rural character of the locality, and

(c) to ensure development of the land does not create unreasonable and uneconomic demands, or both, for the provision or extension of public amenities or services.

C The exception to these objectives is development of public works and services, outside the parameters specified in the primary and secondary objectives, only in cases of demonstrated and overriding public need and subject to the impact on water quality and quantity being minimised as much as is reasonably practical.

2 Without development consent

Agriculture (other than feed lots, piggeries, poultry farms, stock homes and other intensive keeping of animals); bush fire hazard reduction.

3 Only with development consent

Bed and breakfast establishments; childcare centres; dwelling-houses; forestry; helipads; home industries; public utility undertakings; retail plant nurseries; roads; telecommunications facilities; utility installations.

4 Advertised development—only with development consent

Nil.

5 Prohibited development

Any purpose other than a purpose specified in item 2, 3 or 4.

Comment: Objectives A and B are potentially in direct conflict as agriculture has the potential to significantly affect both water quantity and quality. Objective C is incomprehensible.

11 Subdivision of land within Zone No 1 (a1), 1 (a2), 1 (b), 1 (d), 1 (e), 7 (a), 7 (c), 7 (d), 7 (d1), 7 (f), 7 (i) or 7 (l)

(1) The council shall not consent to the subdivision of:

(a) land within Zone No 1 (a1), 1 (a2), 1 (d), 1 (e), 7 (a), 7 (c), 7 (d1), 7 (f), 7 (i) or 7 (l)—except in accordance with this clause, or

(b) land within Zone No 1 (b) or 7 (d)—except in accordance with this clause or clause 13.

(2) Except as provided by subclause (3), the council may consent to the subdivision of land referred to in subclause (1) only where the area of each allotment to be created by the subdivision is not less than:

(a) in the case of land within Zone No 1 (a1) or 7 (i)—20 hectares, and

(b) in the case of land within Zone No 1 (a2), 1 (b), 1 (d), 1 (e), 7 (a), 7 (c), 7 (d), 7 (d1), 7 (f) or 7 (l)—40 hectares.

(3) The council may consent to the subdivision of land referred to in subclause (2) (a) where the area of each allotment to be created by the subdivision is not less than 13 hectares.

(4) In deciding whether to grant consent under subclause (3) the council shall consider:

(a) the area and quality of land and its potential agricultural productivity,

(b) the likely effects, both economic and otherwise, that the proposed subdivision will have on agricultural industries in the area and the resources employed by or in connection with those industries,

(c) the likely effects, both economic and otherwise, that the proposed subdivision will have on the use and development of other land and resources in the area,

(d) whether there are any reasonable alternatives to the proposed subdivision in the circumstances,

(e) the effect of the existence of, or potential to erect, a dwelling,

(f) the cumulative effect of similar proposals if consent is granted, and

(g) the likelihood of the proposed allotments remaining available for agricultural use.

(h) the adequacy of the water supply to the proposed allotments.

(5) Where land within Zone No 1 (a1), 1 (a2), 1 (b), 1 (d), 1 (e), 7 (a), 7 (c), 7 (d), 7 (d1), 7 (f), 7 (i) or 7 (l):

(a) is lawfully used for a purpose other than a dwelling-house, bed and breakfast establishment or agriculture, or

(b) may lawfully be used for a purpose other than a dwelling-house, bed and breakfast establishment or agriculture by reason of a development consent granted in respect of that use,

the council may consent to the excision of that land for that purpose.

(6) Nothing in this clause shall prohibit or restrict a subdivision for any of the following purposes:

(a) the opening or widening of a public road,

(b) minor adjustments to common property boundaries, but only if the council is satisfied that any such adjustment will not lead to:

(i) the creation of any additional allotments or additional dwelling entitlements or both, and

(ii) a substantial change to the land area contained in each allotment or a substantial change to the configuration of each allotment, and

(iii) an increase in the size of an allotment that would provide in the future for the creation of additional allotments or additional dwelling entitlements, and

(iv) an outcome contrary to the terms of any development consent granted in respect of any of the land concerned, and

(v) an increase in the likelihood of potential for land use conflict,

(c) enlarging the area of any existing allotment without reducing the area of any existing allotment, and

(d) rectifying any encroachment upon an existing allotment.

Comment: Despite the objective to protect water quality within a 7(c) zone, there is nothing in the subdivision provisions that requires water quality to be a matter for consideration in the assessment of an application of subdivision.

12 Dwelling-houses within Zone No 1 (a1), 1 (a2), 1 (b), 1 (d), 1 (e), 7 (a), 7 (c), 7 (d), 7 (d1), 7 (f), 7 (i) or 7 (l)

(1) This clause applies to land within Zone No 1 (a1), 1 (a2), 1 (b), 1 (d), 1 (e), 7 (a), 7 (c), 7 (d), 7 (d1), 7 (f), 7 (i) or 7 (l).

(1A) For the purpose of this clause, a reference to a dwelling-house includes a reference to a dwelling-house operated as a bed and breakfast establishment.

(2) The Council shall not consent to the erection of a dwelling-house on land to which this clause applies except in accordance with this clause.

(3) A dwelling-house may, with the consent of the council, be erected on vacant land to which this clause applies only where that land:

(a) has an area of not less than:

(i) in the case of land within Zone No 1 (a1) or 7 (i)—20 hectares,

(ii) in the case of land within Zone No 1 (a2), 1 (b), 1 (d), 1 (e), 7 (a), 7 (c), 7 (d), 7 (d1), 7 (f) or 7 (l)—40 hectares,

(b) is an existing holding,

(c) is an allotment created by subdivision to which development consent has been granted in accordance with clause 11,

(d) is an allotment created by a subdivision to which development consent has been granted in accordance with clause 13 as in force when consent for the subdivision was granted but before the gazettal of Ballina Local Environmental Plan 1987 (Amendment No 36), or

(e) is an allotment created by a subdivision to which development consent was granted before the appointed day, not being a development consent which was granted subject to a condition that a dwelling-house could not be erected on that allotment,

(f) is an allotment not in the 7 (f) zone created on or after the appointed day by a subdivision carried out in accordance with Part 12 of the Local Government Act 1919 where:

(i) the consent of the Council was not required for the subdivision, and

(ii) before the subdivision was carried out, a dwelling-house could have been erected under this clause on the land comprising that allotment.

(3A) Notwithstanding the provisions of subclause (3), the council may consent to the erection of a dwelling-house on an allotment of land that was lawfully created before the appointed day and upon which a dwelling-house could lawfully have been erected immediately prior to the appointed day.

(3B) The council may consent to the erection of a dwelling-house on vacant land to which this clause applies that would have complied with subclause (3) or (3A) but for the fact that part of the land has been acquired by a public authority for a public utility undertaking.

(4) A rural workers' dwelling may, with the consent of the council, be erected on an allotment of land, being an allotment having an area of not less than:

(a) in the case of land within Zone No 1 (a1) or 7 (i)—10 hectares for the first rural workers' dwelling and 30 hectares for each subsequent rural workers' dwelling, and

(b) in the case of land within Zone No 1 (a2), 1 (b), 1 (d), 7 (a), 7 (c), 7 (d), 7 (d1), 7 (f) or 7 (l)—20 hectares for the first rural workers' dwelling and 60 hectares for each subsequent rural workers' dwelling,

if the council is satisfied that:

(c) the erection of each such additional dwelling will not impair the suitability of the land for agriculture,

(d) the needs of existing agriculture genuinely require that rural workers reside on the land, and

(e) any other rural workers' dwellings on the holding are being used by persons substantially engaged in agricultural employment on that land.

(5) Notwithstanding the provisions of subclause (3), the council may consent to the erection of a dwelling-house on Lot 1, DP 575688, No 2 Old Pacific Highway, Newrybar, if the council is satisfied that the disposal of waste water on the land does not adversely affect the water quality in the catchment of Emigrant Creek Dam.

Comment: Water quality is only an issue on the two lots mentioned in subclause 5.

14 Dual occupancy

(1) This clause applies to land within Zone No 1 (a1), 1 (a2), 1 (b), 1 (d), 1 (e), 2 (a), 2 (b), 2 (t), 7 (a), 7 (c), 7 (d), 7 (d1), 7 (f), 7 (i) or 7 (l).

(2) Where, in pursuance of this plan, development for the purposes of a dwelling-house may be carried out on an allotment of land to which this clause applies, a person may, with the consent of the council:

(a) alter or add to a dwelling-house erected on the allotment so as to create 2 dwellings, or

(b) erect 2 attached dwellings on the allotment,

if, but only if, there will be no more than 2 dwellings on the allotment after the development has been carried out (excluding the dwellings of workers engaged in rural activities on the allotment).

(3) A person must not subdivide land on which development has been carried out in pursuance of this clause if the subdivision would permit the separate ownership of each dwelling.

23 Development within Zone No 1 (d), 7 (c), 7 (d), 7 (d1), 7 (f), 7 (i) or 7 (l)

A person shall not, on land within Zone No 1 (d), 7 (c), 7 (d), 7 (d1), 7 (f), 7 (i) or 7 (l):

(a) notwithstanding clause 8 of the Environmental Planning and Assessment Model Provisions 1980, cut down, top, lop or otherwise destroy a tree (other than a tree planted for commercial or landscaping purposes), or

(b) clear, fill or otherwise alter the surface level of land,

without the consent of the council.

24A Development within Zone No 7 (c)

(1) This clause applies to land within Zone No 7 (c).

(2) In determining an application for consent to carry out development on land to which this clause applies, the council must take into consideration the following matters:

(a) any potential adverse impact, including any incremental adverse impact, on the water quality within the catchment that may result from the development,

(b) whether adequate safeguards and other measures have been proposed to protect the water quality,

(c) whether the proposed development would be more suitably undertaken on an alternative site,

(d) any comments that have been provided in relation to the proposed development following consultation with the relevant water supply authority.

Comment: Clause 24A is the only clause that specifically invokes the requirement to protect water quality, and only in the 7(c) zone. This provision should apply to all areas within the catchment.

Wilsons River Source

The Wilsons River Source was completed in 2007. The water catchment area covers 550 square kilometres across the local government areas of Ballina, Byron and Lismore. It is capable of providing 4000ML per annum. Water from this source is extracted above Howards Grass and treated in the Nightcap Water Treatment Plant (Rous Water Management Plan 2008-2011).

In the Lismore LGA, the catchment for the Wilsons River Source includes Wilsons River (LGA boundary), Coopers Creek (LGA boundary), Numulgi Creek and Boomerang Creek. The catchment includes land zoned as:

- 1(a) General Rural Zone
- 1(r) – Riverlands Zone
- 5 – Special Uses Zone
- 8 – National Parks and Nature Reserves

In the Ballina LGA, the catchment for the Wilsons River Source includes Pearces Creek (LGA boundary) and Skinners Creek (LGA boundary). The catchment includes land zoned as:

- 1(a1) – Rural – Plateau Lands Agriculture
- 1(b) – Rural – Secondary Agriculture Land
- 7(d1) – Environmental Protection – Newrybar Scenic/Escarpment

In the Byron LGA, the catchment for the Wilsons River Source includes the Wilsons River (LGA boundary), Skinners Creek (LGA boundary), Coopers Creek (LGA boundary), Bennys Creek, Little Bennys Creek, Stony Creek, Byron Creek, Tinderbox Creek and Opossum Creek. The catchment includes land zoned as:

- 1(a) – General Rural Zone
- 1(ah) – General Rural Zone – refer to Clause 38
- 1(b1) – Agricultural Protection (b1) Zone
- 1(b2) – Agricultural Protection (b2) Zone
- 7(j) – Scientific Zone

Comment: Within the Wilsons River Source there are 12 different zones, in three different local government areas, each with different approach to development control. This is an example of where the water source would benefit from a consistent planning control over the whole catchment.

Woodburn Sands Aquifer

The Woodburn Sands Aquifer is a minor water source, but is valuable during times of drought (Rous Water Management Plan 2008-2011). As an aquifer, it is also sensitive to pollutants entering the system through infiltration.

The current rural zoning makes no reference to the importance of the area for drinking water.

Proposed Dunoon Dam

The proposed Dunoon Dam water catchment area is located in the Lismore City Council area. Completion of the development of this source is planned for between 2016 and 2023. Rous Water is currently in the process of acquiring land for a buffer in the Dunoon Dam water catchment (Rous Water Management Plan 2008-2011).

Clause 45 of the Lismore LEP 2000 **Water catchment and inundation area for proposed dam near Dunoon** states:

> *(1) This clause applies to land near Dunoon shown edged with a heavy black broken line on the map (being the water catchment for the Dunoon dam).*

(2) Consent must not be granted to any development on land to which this clause applies without the concurrence of Rous Water.

(3) Despite subclause (2), the concurrence of Rous Water is not required for development for the purpose of a dwelling-house unless the development is to be carried out on land shown hatched on the map (being the land to be inundated by the Dunoon dam).

(4) In deciding whether to grant concurrence required by this clause, the Rous Water must take into consideration the following matters:

(a) any potential adverse impact on the water quality within the catchment that may result from the development,

(b) any potential incremental adverse impacts on water quality that may result from the development,

(c) whether adequate safeguards and other measures have been proposed to protect the water quality,

(d) whether the proposed development would detrimentally affect the future construction of any dam,

(e) whether the proposed development would be more suitably undertaken on an alternative site.

(5) The owner of land shown hatched on the map and located within the Dunoon dam catchment may, by notice in writing require Rous Water to acquire that land.

(6) On receipt of such a notice, Rous Water must acquire the land to which the notice relates.

This provision will remain in place until such time as the Lismore Council's new local environmental plan is gazetted. Once the new LEP is gazetted the Lismore LEP 2000 will no longer have force, nor will Rous Water have any concurrence role.

It is suggested that the proposed clause at 3.4 of this report be included in the Lismore Draft LEP. In addition Rous Water and Council will need to ensure that subclause 5 and 6 above are also included in the draft LEP to ensure that land is acquired by Rous Water where appropriate.

Unfortunately given the current position of the State Government, Rous Water will have no opportunity under the standard instrument to stop inappropriate development within the Dunoon Dam catchment by utilising its powers to refuse concurrence, thereby forcing Council to refuse the development. The best that can be achieved is that if the land is acquired by Rous Water, or Council and ensures the development has a neutral or beneficial effect in accordance with the proposed clause and the development controls set out in the draft DCP discussed later in this report.

Alstonville Plateau Bores

The Alstonville Plateau bores are spread across an area of around 450km^2 and yield around 22,000ML/yr. The depth to the top of the aquifer is 30m. Land uses across the bores consists of agricultural (primarily grazing), rural residential and the urban towns of Wollongbar and Alstonville.

There is a Water Sharing Plan for the Alstonville Plateau Groundwater Sources 2003 prepared under the Water Management Act 2000, however this only covers the allocation of resources and environmental flows.

There is a history of trace contamination within the bores, identified by NSW Health as originating from both farm animal and human sources, primarily from failing septic tanks and leaking bores. Both these are preventable through management actions and are not directly due to the land use activity.

The land falls within the Ballina Shire LGA and is covered by around 13 different zones, with much of the rural land covered by the 7(c) Water Catchment zone. Whilst the 7(c) zones protect water quality, the other zones make no reference to water quality, despite being on top of the aquifer. There is little known about the recharge areas of the aquifer, however if there is general infiltration from above, this must be taken into consideration for all development whether in the 7(c) zone or another. The contamination issues and the extent of development within the groundwater catchment justify the need for a strong set of controls over the whole area.

3.1.2 Implications for LEP Renewal

Across all the catchment areas the respective zoning within the LEP's should be E2 Environmental Conservation for catchment land within the ownership of the crown or Rous Water (or marked for acquisition), E3 Environmental Management for land within private ownership, or E4 Environmental Living for land on the aquifers or ground water resources.

From the Standard Instrument, the following are the provisions that a Council is to use, and can modify to suit local circumstances. Normally, a council cannot remove objectives, but can add to them.

Zone E2 Environmental Conservation
1 Objectives of zone
• To protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values.
• To prevent development that could destroy, damage or otherwise have an adverse effect on those values.
• To protect and enhance the ecology, hydrology and scenic values of watercourses.
• To protect and enhance biodiversity corridors and areas of remnant indigenous vegetation.
• To allow for low impact passive recreational and ancillary land uses that are consistent with the retention of the natural ecological significance.

2 Permitted without consent
Nil

3 Permitted with consent
Drainage; Earthworks; Environment facilities; Environmental protection works; Flood mitigation works; Public utility undertakings; Recreation areas; Roads

4 Prohibited
Business premises; Hotel or motel accommodation; Industries; Multi dwelling housing; Recreation facilities (major); Residential flat buildings; Retail

premises; Seniors housing; Service stations; Warehouse or distribution centres; Any other development not specified in item 2 or 3

Zone E3 Environmental Management
1 Objectives of zone
• To protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values.
• To provide for a limited range of development that does not have an adverse effect on those values.

2 Permitted without consent
Extensive agriculture; Home occupations

3 Permitted with consent
Agriculture; Building identification signs; Business identification signs; Drainage; Dual occupancies; Dwelling houses; Earthworks; Environment facilities; Environmental protection works; Farm buildings: Farm stay accommodation; Flood mitigation works; Home-based child care; Home businesses; Home industries; Moveable dwellings; Public utility undertakings; Recreation areas; Roads; Roadside stalls; Secondary dwellings; Tourist and visitor accommodation;

4 Prohibited
Aquaculture; Hotel or motel accommodation; Industries; Intensive livestock agriculture; Multi dwelling housing; Residential flat buildings; Retail premises; Seniors housing; Service stations; Serviced apartments; Turf farming; Warehouse or distribution centres; Any other development not specified in item 2 or 3

Zone E4 Environmental Living
1 Objectives of zone
• To provide for low-impact residential development in areas with special ecological, scientific or aesthetic values.
• To ensure that residential development does not have an adverse effect on those values, particularly any aquifers.
• To ensure land uses are compatible with the environmental capabilities of the land.
• To preserve and improve natural resources through appropriate land management practices.

2 Permitted without consent
Home occupations

3 Permitted with consent
Bed and breakfast accommodation; Building identification signs; Business identification signs; Child care centres; Community facilities; Drainage; Dual occupancies; Dwelling houses; Earthworks; Environmental facilities; Environmental protection works; Flood mitigation works; Group homes; Home-based child care; Home businesses; Home industries; Information and education facilities; Moveable dwellings; Places of public worship; Public utility undertakings; Recreation areas; Roads; Schools; Secondary dwellings

4 Prohibited
Industries; Service stations; Warehouse or distribution centres; Any other development not specified in item 2 or 3

Comment: It is likely these permissible and prohibited land uses will need to be refined with community consultation. Ideally the objectives would include

reference to protecting water quality, however Councils are bound by the Department of Planning and it would argue that water quality is implicit in the wording "ecological". There is therefore a need for an additional overlay that deals specifically with the issue of water quality, consistently across all catchments.

3.2 Proposed Referral Clause

Objective: Review the draft clause originally proposed by the constituent Councils. Review the draft clause published by the Department of Water and Energy.

3.2.1 Review of the Department of Water & Energy Referral Clause

The NSW Department of Water and Energy has provided a guideline to North Coast councils on managing the impact of new development within urban drinking water catchments.

The guideline advises that local government authorities, as part of the preparation of new LEPs, include a clause similar to that outlined below.

Suggested Clause to Protect Urban Water Supply Catchments
XX Development within urban water supply catchments

(1) The objective of this clause is to maintain the quantity and quality of surface and groundwater resources accessed for the provision of urban water.

(2) This clause applies to land within the surface drainage catchment of [specify town water supply sources and storages] or land overlying the [specify town water supply aquifer] within the [specify LGA] or {refer to Map Overlay].

(3) The consent authority must not grant consent to development on land to which this clause applies unless the applicant and the consent authority have considered:

(a) the potential for the development to cause or increase:

(i) soil erosion, including erosion caused by vegetation clearing, earthworks, road construction, or any other means,

(ii) contamination of surface and groundwater resources, including contamination caused by use of pesticides, herbicides, fuels and toxic chemicals, intensive horticulture/aquaculture/animal husbandry;

(iii) alterations to surface water flow and/or groundwater recharge rates; and

(iv) any other potential adverse impacts on the water quality and quantity within the catchment.

(b) measures to ameliorate or to avoid any adverse impact, including consideration of alternative locations for the development;

(c) any coastal, estuary, river or catchment action plan applying to the land subject to this clause; and

(d) any requirement of a water supply authority.

(4) The consent authority must not grant consent to development on land subject to this clause unless it is satisfied that the carrying out of the proposed development:

(a) would have a neutral or beneficial effect on surface water and ground water quality and quantity;

(b) will include appropriate controls for the mitigation of any pollution of surface and groundwater (including ongoing responsibility for maintenance

of any works) and for any increase in the sediment content of water flows; and
(c) will not adversely affect the supply of water to the urban water supply or the recharge rate of any aquifer.

Definitions
Urban water supply catchment *means that part of the landscape which drains to a watercourse or storage or recharges an aquifer from which a town water supply is extracted.*
Catchment action plan *has the same meaning as in the Catchment Management Authorities Act 2003. Note. The term is defined as a catchment action plan of an authority that has been approved by the Minister under Part 4 of the Catchment Management Authorities Act 2003.*

Notes
1. The Department of Water and Energy considers that wherever possible the E2 – Environmental Conservation zoning should be placed over lands which overlay significant shallow aquifers.
2. Possible groundwater contaminating activities include but are not limited to:

- *Septic tanks, trenches and transpiration beds*
- *Sewerage treatments works*
- *Effluent irrigation*
- *Animal manure*
- *Graveyards and burial sites*
- *Carcass burial*
- *Storage and use of fuel, pesticides, herbicide or any other hazardous chemicals*
- *Vehicle wash down areas*
- *Landfill and waste management sites*
- *Activities that intercept the water table eg. sand minding.*

3.2.2 Assessment of DWC Referral Clause

It is considered that the majority of this provision is reasonable with the exception of subclause 4(b) and 4(c).

Subclause 4(b) suggests that proposed development should mitigate its pollution of surface or groundwater. This provision is essentially redundant when one considers the principle of a neutral beneficial effect as set out in subclause 4(a). That is, if the development is having a neutral or beneficial effect on water quality then there is either no pollution or all of the effects are mitigated such that the proposed development has no greater impact than the existing.

Subclause 4(c) is logical, however there is no way to do determine the current recharge rates in off aquifers. Indeed there is still very little understanding and knowledge of the behaviour of the aquifers within the catchment other than that they are an important water source. While it is important to protect the aquifers this provision as it stands would result in development not being able to be approved as there is currently no way of demonstrating impact on recharge rates. Therefore it cannot be demonstrated that the development will not adversely affect the recharge rate of an aquifer.

Whilst it is agreed that not only the recharge rates of the aquifers but also water quality must be protected it is considered that a better and more practical way of approaching development is to require detailed and comprehensive site analysis to determine geological characteristics which would then enable an a development to be designed such that those characteristics are considered appropriately with regard to water quality. This approach is more likely to receive support and is also considered to ultimately provide better protection of the aquifers.

3.3 Other Current Practice

Objective: Conduct research to review the practices adopted in other jurisdictions. Review the contributions and comments received from catchment managers in other jurisdictions.

3.3.1 Benalla (Regional Victoria)

The town of Benalla in Victoria is supplied with water by the Ryans Creek catchment. This catchment is a proclaimed Special Water Supply Catchment Area under the *Catchment and Land Protection Act 1994.* The catchment is closed for public access. The Benalla Planning Scheme contains the following clauses:

3.0 Permit requirements

In addition to referring the following permit applications to the Department of Sustainability and Environment and the Goulburn Broken Catchment Management Authority for comment, the following permit applications must be referred to North East Water in accordance with section 55 of the Planning and Environment Act 1987 and Clause 66.02 of the scheme:

- *Subdivision of land creating lots less than 40 hectares in area.*
- *The development of land for intensive agricultural, lot feeding, poultry farming and pig keeping, or any other intensive land use.*
- *Any development that the responsible authority considers may not satisfy the purpose of the zone.*
- *All applications for development of land (other than those types that would clearly have no impact on water quality, e.g. advertising signs, fences, road works or unenclosed buildings and works ancillary to a building).*

Unless it can be demonstrated that a proposed development, including subdivision, would in no way be harmful to the catchment or the quality of the water resource, there will be a presumption against granting a permit for that development.

4.0 Decision guidelines

Before deciding on an application, the responsible authority must consider:

- *The potential for the proposed development to degrade the water quality of the resource.*
- *Whether the environmental objectives of the schedule have been met..*
- *The comments of the Department of Sustainability and Environment, North East Water, and the Goulburn Broken Catchment Management Authority.*

22.07 Development in the Ryan's Creek Catchment

Objectives

- *To protect the water quality of the catchment from inappropriate land use and development, and minimise water diversions from the catchment.*

Policy

It is a policy that:

- *A management plan be prepared as part of an application to prevent the pollution of waterways and manage the consequences of any pollution which does occur from any uses.*
- *Land use planning and development is to support catchment strategies and sustainable natural resource management practices.*
- *When considering an application for the use of land, the responsible authority should consider:*
  - *The potential for the proposed use to degrade water quality or quantity;*
  - *The intensity of the use;*
  - *Appropriate measures to prevent erosion of banks, stream beds and adjoining land and the saltation of watercourses, drains and other features;*
  - *Appropriate measures to prevent pollution, increased nutrient loads and increased turbidity of water in watercourses, drains and other features;*
  - *Appropriate measures to prevent increased surface water run-off or concentration of surface water run-off leading to erosion, saltation, pollution of watercourses, drains and other features;*
  - *Any management plan prepared by the relevant water board or water supply authority; and*
  - *The comments of the Department of Sustainability and Environment, North East Water and the Goulburn Broken Catchment Management Authority.*
- *Any use of development of land should be of a rural nature.*
- *The creation of new point source discharges should be avoided and support the rationalisation of existing discharge points.*
- *Works are to be scheduled for those times of the year where high rainfall events are not experienced.*
- *Works are to be avoided on saturated soil where compaction is likely.*
- *Native vegetation and other significant strands of vegetation are to be protected to prevent land degradation and adverse affect of ground water recharge, maintain water quality and protect the bio-diversity of flora and fauna species.*
- *Applications to remove vegetation are to be accompanied by a plan that includes proposals for maintaining and establishing native vegetation at other locations on the subject land.*
- *A planning permit application for a dwelling should consider the location of effluent disposal methods and the possibility of nutrient leakage to Ryan's Creek.*
- *Land based effluent disposal systems and disposal areas should be located more than 100 metres from the banks of streams including ephemeral streams.*
- *Permits for land use and development may include conditions requiring works to rectify land degradation to offset any potential impact on water quality from the proposed use and development.*
- *Above ground water storage areas should be sites where leakage into the ground water will be minimised or to sites where they are part of farm salinity mitigation works. When considering an application for a ground water storage area, the responsible authority should consider impacts on water yield and regime.*

- *Diversions from Ryan's Creek are to be discouraged and should be either limited or not permitted.*

Comment: The measures proposed above are very prescriptive and yet can be interpreted in many different ways which would still result in the potential to pollute. It is noted that the location of the effluent management systems should be "considered" and then located greater than 100m from the creek, regardless of the design or soil system.

3.3.2 Mount Lofty Ranges (Adelaide, South Australia)

The document *Protecting drinking water quality into the future – Priority areas and land use compatibility in Adelaide's Mt Lofty Ranges Watershed* (EPA South Australia, SA Water & CRC for Water Quality and Treatment 2008) proposes a set of priority areas where each is defined in terms of management objectives.

A risk based approach has been taken by understanding the current risks to the water supply and then defining priority areas of the watershed which have different inherent risks due to their spatial location within the water supply catchment and their biophysical characteristics.

- Priority 1 areas are the immediate hydrological catchments of the primary reservoirs that are directly harvested for drinking water supply. Development would only be permitted if there is a beneficial effect on water quality.
- Priority 2 areas are those within 2km of all secondary water supply reservoirs, land within 100m of perennial watercourses and land in flood prone and high runoff areas. Development would only be permitted if there is a neutral or beneficial effect on water quality.
- Priority 3 areas including all remaining parts of the watershed. Development should only occur where the land use has a negligible, neutral or beneficial impact on water quality.

Feedback from South Australia Water was that putting the emphasis on development assessment officers was dubious because they would not know what the risks would be, without the formal requirement to do a risk assessment.

Comment: The risk based approach is good from a catchment management perspective, however the outcomes generally tend to be too general to be useful at a single DA level, i.e. at macro scale.

3.3.3 Melbourne Water (Melbourne, Victoria)

In correspondence to Rous Water, a representative of Melbourne Water suggested that the water source manager should prepare a risk management plan which identifies:

1. An assessment of current risks to drinking water quality posed by the sources of municipal water supply in the Council area.
2. A demonstration that the risks are currently managed.
3. An evaluation of which types of developments or land use change will impact on the effectiveness of the risk management, and therefore the development of permit and referral requirements (Robert Considine).

Comment: Whilst this is a good direction for overall catchment management, in terms of local planning provisions to control development assessment, it is of little use.

3.3.4 Sydney Catchment Authority (Sydney, NSW)

In response to the *Cryptosporidium* incident affecting Sydney's Drinking Water Catchments in 1998, the NSW Government introduced a State Environmental Planning Policy No 58 (SEPP 58) to deal with (amongst other things) on-site effluent management. SEPP 58 introduced a new concept to the planning assessment system, the requirement to demonstrate a "neutral or beneficial effect on water quality."

The SEPP also contained a referral provision requiring either the concurrence of or notification of the Chief Executive of the Sydney Catchment Authority (SCA). The SEPP provision is below.

SEPP 58

Part 2 Carrying out of development

8 Consent to Schedule 1 or 2 development

A person must not carry out development specified in Schedule 1 or 2 except with the consent of the consent authority.

9 Consent authority

The relevant council is the consent authority for development specified in Schedule 1 or 2, other than State significant development.

10 Matters for consideration

In relation to any development or activity proposed to be carried out on land to which this Policy applies. a consent authority in exercising functions under Part 4 of the Act, a proponent or determining authority in exercising functions under Part 5 of the Act. and the Director-General in exercising functions under this Policy, must consider the following:

(a) whether the development or activity will have a neutral or beneficial effect on the water quality of rivers, streams or groundwater in the hydrological catchment, including ,during periods of wet weather.

(b) whether the water quality management practices proposed to be carried out as part of the development or activity are sustainable over the long term,

(c) whether the development or activity is compatible with relevant environmental objectives and water quality standards for the hydrological catchment when these objectives and standards are established by the Government.

11 Concurrence of Director-General

(1) This clause applies to:

(a) development (other than State 'significant development) specified in Schedule 1 that is proposed to be carried out on any land to which this Policy applies, other than land within the Shoalhaven Catchment as shown on the maps, and

(b) development (other than State significant development) specified in Schedule 1 or 2 that is proposed to be carried out on land within a special area (including the Shoalhaven Special Area).

(2) A consent authority cannot grant consent to a development application to carry out development to which this clause applies, except with the concurrence of the Director-General.

(3) For the purposes of section 30 (3) of the Act. the matters that are to be taken into consideration by the Director-General in deciding whether concurrence should be granted are:

(a) the matters set out in Part 2, and

(b) a water cycle management study relating to the proposed development.

(4) The Director-General may refuse to grant concurrence under this clause in relation to a particular development if the Director-General has not been furnished with:

(a) a water cycle management study prepared in respect of the development that addresses the following matters:

(i) pre-development and post-development run off volumes and pollutant loads from the site of the proposed development,

(ii) the assessment of the proposed development against the matters for consideration specified in clause 10,

(iii) the impacts of the development on receiving waters.

(iv) the water cycle management strategies and best management practices proposed to be employed to address those impacts.

(v) the arrangements to be made for the ongoing maintenance and monitoring of the water cycle management system, and

(b) the results of consultations concerning the proposed development with the Environment Protection Authority, the Department of Land and Water Conservation and other relevant agencies.

12 Notification of Director-General

(1) This clause applies to:

(a) development (other than State significant development) specified in Schedule 1 that is proposed to be carried out on land within the Shoalhaven Catchment as shown on the maps. and

(b) development (other than State significant development) specified in Schedule 2 that is proposed to be carried out on any land to which this Policy applies. other than land within a special area.

(2) A consent authority must. within 2 days after the receipt of a development application for consent to carry out development to which this clause applies. notify the Director-General of the receipt of the application.

(3) The consent authority, in determining whether or not to grant consent to the development application (and. if consent is granted. in determining any conditions to which the consent is to be subject), must take into account any comments made by the Director-General that are received by the consent authority:

(a) within 21 days after the consent authority notified the Director-General of the receipt of the application, or

(b) within such longer period as is advised within the 21-day period referred to in paragraph (a) by the Director-General to the consent authority.

Comment: The issue with the SEPP was that there was very little guidance from the government as to what a neutral or beneficial effect meant. In addition, very little base water quality data was available to determine from which point neutral should be measured. Water quality within watercourses varied considerably dependent on conditions. The scientists took the definition literally and proposed that no development would not have an impact and therefore couldn't be approved.

A further and more serious problem was that the quality of the development applications was so poor, very little if any attention was given by the applicant to water quality. Whilst some applications contained assessments of effluent

movement through soil, the assumptions behind the calculations were more often based on the desired outcome rather than accurate scientific data of such factors of soil type, effluent volume and rainfall.

Subsequently guidelines were developed proposing the edge of the site (property boundary) was to be the point at which impact was measured, therefore if a development could contain its impacts on-site it would have a neutral effect.

The "beneficial" component is a desirable outcome, but is essentially irrelevant in the definition in terms of requirement for approval.

Drinking Water Catchments Regional Environmental Plan No 1

The assessment of development applications in the Sydney Drinking Water Catchments is now conducted under the Drinking Water Catchments Regional Environmental Plan No. 1 (which repealed SEPP 58). Note that as of 1 July 2009, all REP's in NSW have become SEPP's

The REP specifies that consent authorities must not grant consent for development on land within the hydrological catchment unless it has considered whether the proposal has a "neutral or beneficial effect on water quality" (NorBE) and is satisfied that carrying out the development would have a neutral or beneficial effect on water quality.

The consent authority can be satisfied a neutral or beneficial effect on water quality is demonstrated when the proposed development:

- Has no identifiable potential impact on water quality; or
- Will contain any impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site; or
- Will transfer any impact outside the site by treatment in a facility approved by the consent authority – but the consent authority must be satisfied that the treatment will result in water quality of the required standard.

Comment: The key component of the approach taken by the Sydney Catchment Authority in the REP is to have sufficient and suitable information available to both consultants and development assessment staff to prepare and assess development applications. By increasing the quality of applications, the NorBE test is easier to determine.

3.3.5 Application of Best Management Practice

Design of On-site Effluent Management Systems

One of the commonly debated factors relating on-site effluent management and water quality is the standard 100m setback from watercourses for an on-site effluent disposal system. Whilst there is no science to justify the need for a 100m buffer, it seems an arbitrary distance generally acknowledged as being a "safe distance". The Sydney Catchment Authority commenced a research program in 2003 to investigate the movement of pathogens and viruses from an on-site system through and over soils in order to determine appropriate buffer distances to watercourses.

> *Contamination of surface water by human enteric viruses from on-site sewage treatment and disposal systems is a major concern for the protection of public health. Limited information is available on virus concentrations in septic tanks, however, calculations indicate that maximum concentrations could exceed 1010 viruses per litre for short periods when there is an infected resident in the household. Virus removal from wastewater in septic tanks, primarily due to sedimentation with attached particles, is less than one log10. Hence, land application systems and subsequent effluent transport in buffer distances still need to achieve large reductions of viruses to protect water quality.*

(Source: Charles *et al* 2003)

Further research by The Cooperative Research Centre for Water Quality and Treatment resulted in the preparation of a fact sheet for *Pathogen movement and survival in catchments, groundwaters and raw water storages*.

The key research findings for virus movement from on-site land application systems were:

- *All pathogen groups are removed to the highest extent in unsaturated soils followed by saturated soils. Overland flow provides the least removal.*
- *The rate of virus removal during soil transport decreases with distance. Hence laboratory results for transport over short distances cannot be directly extrapolated to field situations.*
- *In Sydney's drinking water catchments, where approximately 70% of properties are connected to centralised sewers, on-site systems have been calculated to discharge approximately the same total load of pathogens and phosphorus to land and waterways within the catchments as centralised sewage treatment plants. For nitrogen, and in worst case scenarios, the discharge from on-site systems is greater. Hence, adequate design of land application systems is required to provide appropriate treatment and reuse of effluent prior to entering waterways.*
- *In terms of water quality protection, the most important factors for on-site systems are:*
  - *Management and maintenance – ensuring that on-site treatment and land application systems perform as designed.*
  - *Density – more systems equates to a greater number of failures.*
  - *Soil and design – ensure that there is adequate unsaturated soil depth.*
  - *Setback distances - ensuring the sewage receives treatment through saturated soil transport or overland flow.*

The implementation recommendations are:

- *Design guidelines for land application systems should be modified to reflect the important role of unsaturated soil transport in the removal of pathogens.*
- *Subsurface irrigation and pressurised subsurface land application systems should be encouraged to maximise transport of sewage in unsaturated soil.*

In addressing riparian management the fact sheet research findings indicate:

- *Laboratory experiments with intact soil blocks showed that 1 metre width of grass vegetation could reduce Cryptosporidium in the surface water runoff by up to 99.99% compared to bare soil alone.*
- *The rate of pathogen removal during surface transport decreases with distance. Hence laboratory results for transport over short distances can not be directly extrapolated to field situations.*
- *Field scale experiments confirmed that grass vegetation was effective at reducing the transport of Cryptosporidium however, viruses (PRD1 bacteriophage) and to a lesser extent bacteria (E. coli) were easily mobilised over at least 10 metre distances.*
- *Vegetation also significantly increases infiltration thus reducing the volume of surface runoff and the potential for erosion and sediment transport.*
- *Steep base slopes and high intensity short duration rainfall represent a high risk of Cryptosporidium oocyst surface transport.*
- *Rain events mobilise significant concentrations of Cryptosporidium and E. coli particularly from fresh faecal material.*
- *Subsequent rainfall events can remobilise Cryptosporidium that have been deposited onto the surface of the soil.*
- *The high concentration of pathogens in faeces means that although significant levels are transported in the runoff, faecal pat materials continue to contribute pathogens for prolonged periods (weeks in summer to months in winter).*

The implementation recommendations are:

- *Plant and maintain appropriate grass vegetation cover in riparian zones and on steep sloped areas.*
- *Encourage animals not to defecate in riparian zones by placing shade trees, watering and feed points as far away from watercourses as possible and by fencing where acceptable.*

The CRC research indicates a number of important things for development control:

- *A high degree of attention should be paid to soil type, saturation and porosity in the design of on-site effluent management systems.*
- *The type of disposal system should be chosen after the site soil tests.*
- *The 100m buffer distance is not necessarily required, but given the variation in land surface vegetation it is probably a good "precautionary" setback distance.*

It is considered therefore that a clear and focussed set of planning controls relating to on-site effluent management and sediment and erosion controls (sediment binding and transporting nutrients) will address the majority of the pollution issues facing the drinking water catchments.

Development Assessment Module (DAM)

In response to some of the research undertaken by the CRC, the SCA developed a computer GIS based model for predicting the transport of effluent through soil. Known as the DAM, the model sits within the SCA's computer program it uses to manage the development assessment process within the drinking water catchments and utilises key GIS layers such as aerial photographs, digital terrain, and derivative soil mapping.

The DAM utilises input variables such as effluent system type, numbers of persons or bedrooms, and disposal method to predict an effluent plume containing faecal coliforms and other contaminants such as nitrogen & phosphorus. The potential for that plume to reach a watercourse can then be readily assessed visually and graphically in a very short time.

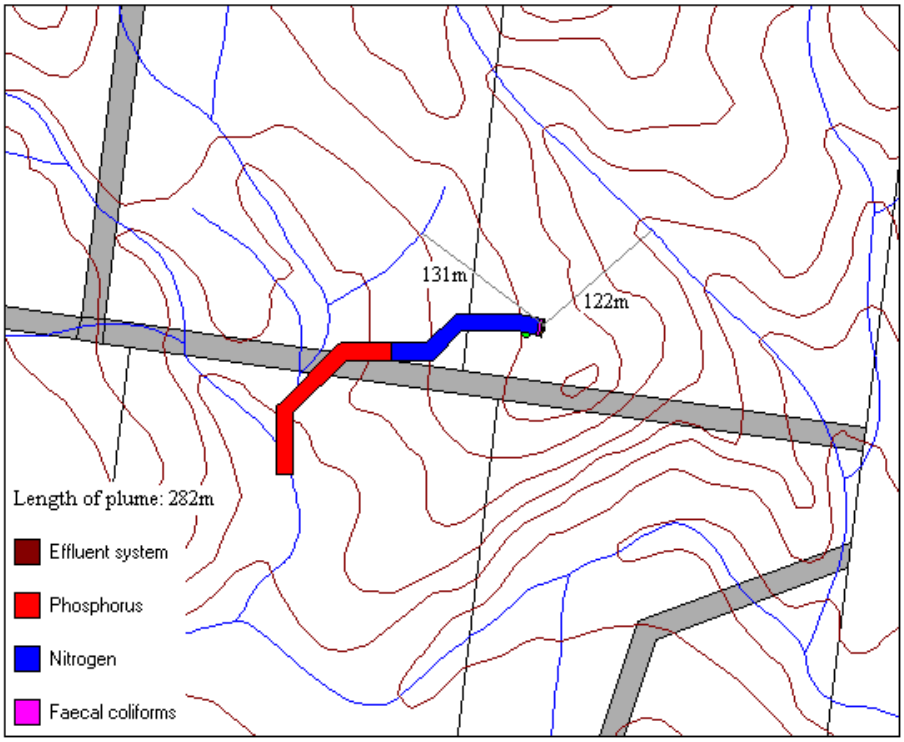

Figure 2 Example of an effluent plume predicted to reach road and waterway

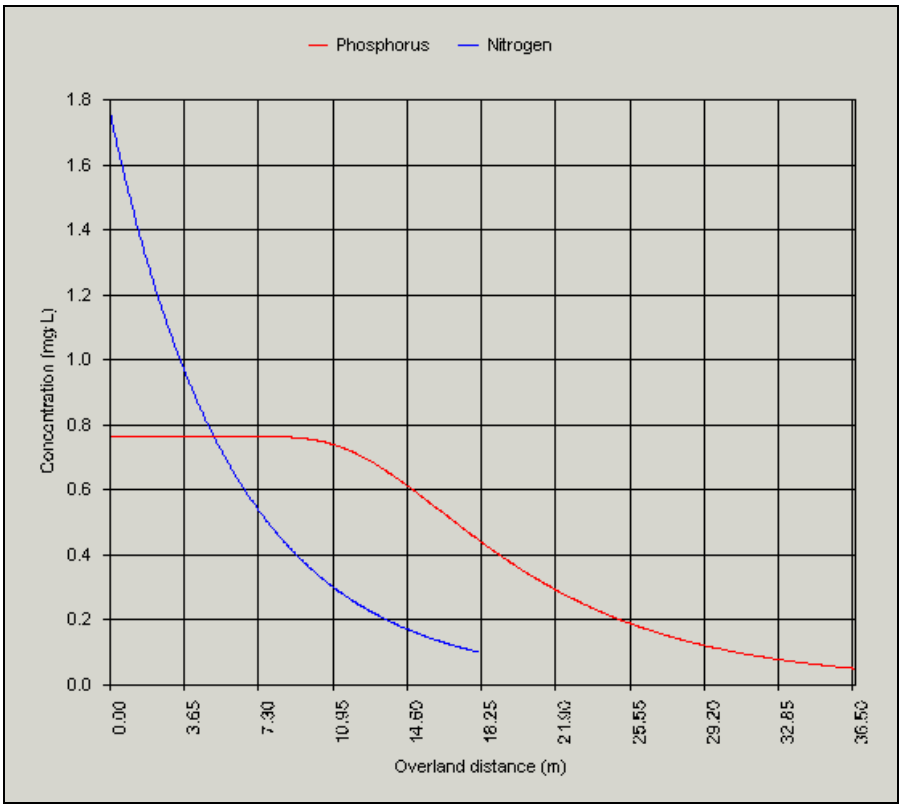

Figure 3 Contaminants profile nitrogen & phosphorus

The SCA stated in its Annual Catchment Management Report 2007-08:

> *The SCA also intends to make its development assessment module (DAM), an effluent plume model, available to councils. This will allow councils to better assess this part of the development applications. Currently, the SCA undertakes this modelling. We have updated the DAM to provide for a more comprehensive assessment of the impacts of onsite systems and to better adapt it for use by councils.*

Unfortunately, the DAM has still not been released to Councils. The DAM is an excellent development assessment tool if the correct data is available to underpin its modeling and Rous Water and constituent Councils should push the SCA for its public release.

3.4 Referral Clause

Objective: Based on the background research (and an awareness of the range of issues of interest to Rous Water, recommend what would be considered to be 'best practice' in terms of a referral clause or any changes to the existing draft DWE clause.

The standard LEP finishes at clause 5 (refer to Section 3.2.1). Discussions with the Grafton office of the NSW Department of Planning indicates the following clause *"would be acceptable to the Department, although there may be some fine tuning by Parliamentary Counsel to suit individual LEP's*."

ESTABLISHMENT OF REFERRAL CLAUSE

Having reviewed the provisions applicable in other similar catchments and examining in detail the operational aspects of the NorBE test within the SCA area of operations, the following clause has been developed to be inserted into the revised LEPs:

6.0 ADDITIONAL LOCAL PROVISIONS

6.1 Development within urban water supply catchments

(1) The objective of this clause is to maintain the quality of surface and groundwater resources accessed for the provision of urban water.

(2) This clause applies to land within the surface drainage catchment of [specify town water supply sources and storages] or land overlying the [specify town water supply aquifer] within the [specify LGA] or [refer to Map Overlay].

(3) The consent authority must not grant consent to development on land to which this clause applies unless the applicant and the consent authority have considered:

a) the potential for the development to cause or increase:

(i) soil erosion, including erosion caused by vegetation clearing, earthworks, road construction, or any other means,

(ii) contamination of surface and groundwater resources, including contamination caused by use of pesticides, herbicides, fuels and toxic chemicals, intensive horticulture/aquaculture/animal husbandry;

(iii) alterations to surface water flow and/or groundwater recharge rates; and

(iv) any other potential adverse impacts on the water quality within the catchment.

b) measures to ameliorate or to avoid any adverse impact, including consideration of alternative locations for the development;

c) any coastal, estuary, river or catchment action plan applying to the land subject to this clause; and

d) any requirement of a water supply authority.

(4) The consent authority must not grant consent to development on land subject to this clause unless it is satisfied that the carrying out of the proposed development would have a neutral or beneficial effect on surface water and ground water quality.

This definition is based on the draft clause provided by the DWE (which was based on the provisions within Drinking Water Catchments Regional Environmental Plan No 1). This proposed clause simplifies the previous clause by deleting the requirement to demonstrate no impact on water quantity, which is in practical terms, difficult to demonstrate and may be counterproductive.

The following definitions should be included to support the clause.

Urban water supply catchment means that part of the landscape which drains to a watercourse or storage or recharges an aquifer from which a town water supply is extracted.

Catchment action plan has the same meaning as in the Catchment Management Authorities Act 2003. Note: The term is defined as a catchment action plan of an authority that has been approved by the Minister under Part 4 of the Catchment Management Authorities Act 2003.

Ground Water means water located beneath the ground surface in soil pore spaces and in the fractures of lithologic formations and includes an aquifer.

An aquifer is a layer of relatively porous substrate that contains and transmits groundwater.

A neutral or beneficial effect on water quality is demonstrated when a proposed development:

- ***Has no identifiable potential impact on water quality; or***
- ***Will contain any impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site; or***
- ***Will transfer any impact outside the site by treatment in a facility approved by the consent authority – but the consent authority must be satisfied that the treatment will result in water quality of the required standard.***
- ***Will improve water quality.***

As several of the Constituent Councils have lodged their draft LEP's with the Department of Planning, an amendment will have to be requested to include the above provision. It is desirable this occurs before the Draft LEP is placed on exhibition as the provision has a significant effect on the way development applications will be prepared and assessed under t he new LEP's.

4 DEVELOPMENT GUIDELINES

Objective: Develop and establish development guidelines for the identified Rous Water key issues of concern (refer section 1.3).

4.1 Review of Development Applications

Objective: Conduct a review of previous development applications within the catchment areas in order to provide a clear understanding of the development pressures occurring.

Requests were made to the local councils for copies of relevant development applications and for an overview of the number and type of applications occurring in the subject areas. Whilst this information was not forthcoming, discussions held with Council development assessment officers indicated that the majority applications within catchment areas are for rural residential subdivision, and single dwellings (utilising on-site effluent management systems).

Whilst there may be other applications that have a potential to have a negative impact on water quality, the issues arising from those applications will be the same: on-site effluent management, nutrient transport, and sediment and erosion.

With regard to existing development that is causing or has the potential to cause pollution, there is very little the development assessment process can do unless there is a development proposed on the subject property. In this case, a Council would have the power to affect change to fix any existing issues.

Existing polluting development is subject to the provisions of the Protection of the Environment Operations Act 1997. In addition, catchment management plans and voluntary agreements with land owners are an effective means of improving water quality. These are outside the development process and the provisions of the Environmental Planning and Assessment Act 1979.

4.2 Key Issues of Concern

Objective: Review the background material prepared by Rous Water in relation to a range of key issues of concern. This includes comments made in response to a number of development applications.

The key issues identified by Rous Water are:

Application of the Australian Drinking Water Guidelines

Comment: The Australian Drinking Water Guidelines are relevant only for assessing the impact for a proposed development on water quality where there is a direct discharge into a watercourse, or for monitoring the broader health of the catchment over a long period of time. For example if a new sewage treatment plant were to be constructed, to assess the impact of introducing a high volume of nutrients into a stream.

In day to day development assessment it is too difficult to assess the impact of a single development on the water quality of a watercourse within a significant sized catchment. At what point would one measure the impact of a residential development on a watercourse, at the point a pollutant might enter, or at some point downstream (and if so at how far)? Full knowledge of every pollutant entering the watercourse (across all weather conditions) is required, and as such, the exercise becomes theoretical.

A better approach, and the one proposed here is to undertake development in a manner whereby no new pollutants reach a watercourse and where possible, the existing pollutants leaving a site are reduced.

Management and Restoration of the Riparian Zone.

***Comment*:** The management and restoration of riparian zones, particularly drainage depressions is critical to be health of drinking water catchments. However there are limited opportunities through the development assessment process to improve riparian zones on major watercourses.

However, if there is a riparian zone (which may include a drainage depression) and the opportunity exists to provide a mitigation or offsetting feature, then that option is relevant to the development assessment process. Conditions may be placed on development consent, however there must be demonstrated nexus between the restoration of a riparian zone and the impact of the proposed development on water quality. For example, in many cases, the re-vegetation of a drainage depression may be more important to water quality than a riparian zone.

Implications for the Provision and Maintenance of Water Supply Infrastructure

Comment: The new structure for local environmental plans leaves very little scope for tailored specific provisions to provide and maintain water supply infrastructure. Infrastructure can be zoned one of the E zones mentioned above, however the only method of providing specific provisions is through the creation of map overlays and subsequent provisions as proposed in this report.

Demand Management Strategies

Comment: Demand management strategies are best addressed through catchment management plans, water sharing plans or operational management plans. There is very limited opportunity in the development assessment process to introduce demand management strategies.

Other Government controls such as the application of BASIX modeling for residential development will contribute to water use efficiency, thus reducing demand.

Water Quality Protection and Improvement Within the Drinking Water Catchment Areas

Comment: It is considered that it is the best to separate water quality protection and water quality improvement within the development assessment process. The principle of the neutral or beneficial effect test is that new development should not result in a further decline in water quality and should at least have a neutral effect.

A desirable outcome is that the proposed development has a beneficial effect on water quality and this outcome is more likely to be negotiated through the approval of development that would otherwise perhaps not be approved. This may involve the restoration of degraded areas on a property which without the proposed development may be unviable to restore, or there is a lack of desire on the part of the land owner.

Planning Controls (suitability of proposed land uses)

***Comment*:** It is proposed that a reasonable range of land uses are possible within the catchments which if designed appropriately based on a comprehensive site analysis of environmental factors will result in improved water quality, or at least no further decline. In most cases, Councils are limiting subdivision within catchment areas which is a desirable outcome.

Relevant Best Management Practice Guidelines

Comment: Current best practice appears to be that which is being undertaken within the Sydney Catchment Authority area of operations. The focus of the SCA through its Regional Plan and development guidelines is to have development based on a far higher degree of site analysis than generally accepted across most local government areas.

In particular requiring high quality development design based on soil structure and capability, highly accurate rainfall data, vegetation cover and accurate pollutant modeling. Accordingly a set of design guidelines based on site analysis in the form of a draft development control plan is proposed.

Another approach would be to have the Department of Planning endorse a set of best practice guidelines for individual land uses across the state, and making those available online. This approach would standardise practices and provide and approach consistent with the application of a Standard Instrument to LEPs. In effect, this has already happened with erosion and sediment control guidelines, on-site effluent management, parking and traffic.

Catchment Health Issues

Comment: Catchment health issues such as water quality vegetation cover and riparian health are relevant in forming a broader catchment base plans and community plans in order to monitor and improve a catchment over a period of time. It is very difficult to incorporate broad scale catchment health issues into individual site related LEP's or development assessment due to the limited science and data available on.

Where an opportunity exists to incorporate measures into a development that will have a significant improvement to catchment health, these should be taken.

Waste Water Management Systems

Comment: The research undertaken by the CRC and discussed above clearly indicates that there are a range of critical factors including soil type, porosity, absorption capacity etc that must be analysed for each individual on-site effluent system. In many cases, a general approach has been taken to the design of systems which has resulted in failure and water pollution.

There is now sufficient justification to require a much greater site analysis and a higher level of design in order to protect water quality. Best practice for design is *On-site Sewage Management for Single Households* ("The Silver Book") and AS/NZS 1547-2000 *On-site Domestic Wastewater Management*. Rous Water has also developed a guide with is based on these two documents. The DAM (SCA's computer model) also provides a high level of assessment and should be made available to constituent Councils and developer consultants.

Soil Contamination Issues

Comment: Soil contamination can result from failing waste water management systems resulting in pathogens and/or nutrients binding to the sediments and being transported to a watercourse. In addition, soil contamination can come from run-off from sealed or paved areas such as roads or car parks, however good design can overcome these through the introduction of pollution control devices.

Where existing developments such as service stations or other contaminating uses are to be altered, the State Environmental Planning Policy (SEPP) 33 - Hazardous and Offensive Development and SEPP 55 – Remediation of Land both apply in respect of assessing a situation and remediating any problems. No additional provisions are required.

Where an on-site effluent management system is being replaced, or where evidence exists of a previous system, the impact of those systems on the capacity of the soil to take additional loads must be considered.

Water Sensitive Urban Design

Comment: Good-quality site analysis and water sensitive urban design will result in development which has a neutral beneficial effect on water quality. There are a number of high-quality design guidelines already in place which set out water sensitive urban design measures and there is little point in repeating or replicating these documents. It is better to reference the documents (as amended) which reduces the opportunity for conflicting standards, particularly if a proposed development ends up in the Land and Environment Court. NSW Landcom's *Soils and Construction: Managing Urban Stormwater* (2004) manual, (the "Blue Book"), is one highly referenced in the Courts.

Potential Storm Water Contamination

Comment: As discussed above, good site analysis and design should result in minimal potential for stormwater contamination. There are numerous similar documents around that set out best practice, the best of which are *Environmental Practice Manual of Rural Sealed and Unsealed Roads* (ARRB Transport Research Ltd. 2002), *Road Runoff & Drainage: Environmental Impacts and Management Options* (Austroads Inc. 2000) and the "blue book".

Integrated Water Cycle Management Planning.

Comment: Integrated water cycle management planning is critical to development design achieving a neutral beneficial effect on water quality. Central to the principle it is to determine upfront and prior to design the capacity of the site, and the environmental constraints.

4.3 Development Guidelines

Objective: With an awareness of best management practice in relation to the identified issues of concern, prepare qualitative development guidelines identifying the requirements of Rous Water for all development within the water catchment areas. These guidelines should effectively be a guide for developers/constituent Councils as to Rous Water's expectations in relation to key issues of concern, both in terms of the development assessment process and in relation to the development outcomes.

Identify the nature of development to which the guidelines identified above refers (i.e. identify any inclusions or exclusions). For example, there may be a 'sliding scale' of requirements – clearly a single dwelling would not need to address as many issues as would a major subdivision.

As discussed above, the guideline proposed is based around requiring a comprehensive site analysis, and ensuring the site analysis justifies the development design.

The issue of thresholds of development for application of the guidelines was raised at the workshop with Councils on 24 March 2009. It is considered a comprehensive site analysis is applicable to any development. The level of detail in the analysis is dependent upon the "site conditions" of the proposed works, and the extent to which the proposed development impacts on the site. For example, if a dwelling were proposed on 10ha then the extent of the site is the entry to the property, driveway and dwelling site. It would be difficult to justify requiring analysis of the site 500m away that is not affected by the proposed development. That said, the location of the proposed dwelling must be justified in the context of the site.

If a subdivision were proposed then the entire site should be investigated, as potential impacts are likely to occur across the site. In addition, degraded areas may be identified to assist in the demonstration of a neutral or beneficial effect.

As such, no thresholds are proposed.

Issues to be addressed in the guidelines relate to critical factors in a site assessment as follows;

Salinity: Salt is a natural element of soil, however certain soil types contain more salt than others. Salt can be brought to the surface through disruption of groundwater flow. This then causes salinity and land degradation. While salinity itself does not necessarily have an adverse impact on water quality, it can inhibit the growth of, and kill vegetation, resulting in exposed soil susceptible to erosion. Developments should be designed so as not to impeded the flow of groundwater in areas prone to salinity. For example, any roads traversing potentially saline areas must not impede groundwater flow.

Vegetation: Vegetation protects soil from erosion, as well as providing a water quality filtering function. Stormwater runoff is slowed by vegetation, allowing increased infiltration of water and settling of particulates and

associated pollutants. The clearing of vegetation increases the risk of soil erosion, particularly in steeper areas.

Design should minimise the clearing of vegetation, or development placed in areas that are already cleared where possible.

Site History: Previous uses of the site need to be considered to determine the potential for any contamination to have occurred. This can be investigated by:

- Enquiring with the Department of Environment and Climate Change for any records of EPA notices of contaminated lands;
- Researching the historical use of the site through the Department of Lands land and property information searches;
- Enquiring with the local Council.

Land uses that indicate potential for contamination include orchards, cattle dips, rubbish tips and intensive agriculture. Contaminated land forms a constraint for development, and may require special treatment in accordance with the provisions of State Environmental Planning Policy (SEPP) 33 - Hazardous and Offensive Development and SEPP 55 – Remediation of Land.

Flood Liable Land: Levels for the 100yr ARI flood should be identified as building envelopes and works should not be located within flood prone lands. This may result in water pollution during a flood event, particularly in the case of effluent management systems.

Bushfire Prone Land: The requirement to provide APZs between buildings and a bushfire hazard is potentially in conflict with the need to preserve vegetation for water quality benefits, as well as ecological reasons. The best way to avoid this is to place building envelopes in areas that are already cleared, and that will not need further clearing for APZ purposes.

Existing Degradation: Existing areas of land degradation such as salinity and erosion may be caused by poor land management practices in the past, or failed erosion and sediment control structures. Such areas should be rehabilitated as part of a development to prevent sediments from reaching watercourses, and to prevent further land degradation. The requirement for rehabilitation may constrain the design because any activity that may exacerbate erosion should be avoided.

The rehabilitation of these areas should not be seen as a negative to the development assessment process as it contributes to the demonstration of “neutral or beneficial effect” and therefore can be of assistance. Any areas requiring rehabilitation or remediation can provide an opportunity to offset any water quality impacts of the development, thereby helping to achieve a neutral or beneficial effect on water quality.

Roads and Access: To avoid undue disturbance to soil, roads should be located so as to minimise cut and fill, minimise vegetation clearing, and minimise length. If there are existing roads on the site, it must be determined whether the best water quality outcomes are obtained by upgrading and using existing roads, or by building new roads. Consider that a new road may cause more disturbance to the soil during construction, but an existing road may not be well placed in terms of other constraints.

Roads should follow ridge lines wherever possible, as this requires less cut and fill than roads on cross-slopes. Where roads follow ridges, energy dissipaters must be used to reduce the velocity of water flowing down gutters and swales, depending on slope.

When determining road configuration, the number of watercourse and drainage depression crossings should be minimised.

Watercourses: When watercourses and drainage depressions exist on site, the following design principles should be addressed:

- A watercourse should not form the boundary between two allotments, as this can create conflict over who is responsible for watercourse and riparian maintenance.
- A lot should not be bisected by a watercourse so as to create large usable areas on each side of the watercourse. This creates a barrier for movement from one side of the property to another (requiring a crossing), especially if the watercourse has been fenced off for rehabilitation.

Building Placement

Disturbance to the soil presents an erosion risk. The erosion risk is greater on steeper slopes. Building envelopes and roads should therefore be planned on flat or gently sloping land wherever possible. Slopes over 20% are a considerable constraint to development, and will generally present a high erosion risk due to the extent of cut and fill required. As a guide, roads should not be constructed on slopes over 20% and building envelopes should be on a 5% slope or less.

Building envelopes should be addressed at subdivision development application stage to avoid water quality issues later. Constraining gradients on the site should be mapped to delineate areas suitable for development from those that are unsuitable.

To avoid undue disturbance to soil, roads should be located so as to minimise cut and fill, and minimise length. Roads on cross slopes require more cut and fill than roads on ridge tops.

On-site Effluent Managment

North facing slopes are better for effluent disposal as the solar access maximises evapotranspiration, as well as providing solar access for the dwelling. The direction of the prevailing wind should also be considered, as wind increase evaporation.

Erosion Control

One of the most important soil properties to consider is rainfall erosivity. Erosion is the wearing away of soil by water and wind. It is a natural process, but some land management practices can increase the rate at which it occurs. The eroded soil may be deposited at some point in the landscape, or may be carried to a watercourse. This increases the suspended sediment in the water, as well as adding pollutants that are attached to the soil particles, thereby degrading water quality.

Some soil types are more susceptible to erosion than others. Sites with highly erodable soils may require special design measures to ensure the protection of water quality. Appropriate design can minimise erosion by avoiding disturbance of steep slopes, avoiding vegetation clearing and observing buffer zones around watercourses.

Lot Layout: Lot layout should be designed around the building envelopes that have already been identified, taking into consideration roads and watercourses or other constraints identified in the site analysis. The lot boundaries should be located to minimise the impact on existing vegetation and in sensitive areas (such as steep land or highly erosive soils).

Stormwater Management: The impacts of development on existing degraded areas, or watercourses should be determined. Increasing stormwater flows may have either a detrimental or beneficial effect. Benefits may include increased vegetation growth providing filters to streams. Impacts which increase salinity or sediment transport will be detrimental.

Attention should be give to the condition of ephemeral drainage lines as collectively, these can transport significant amounts of pollutants to a watercourse.

WATER SENSITIVE DESIGN ELEMENTS

Integrate the Design: All issues that affect the water cycle such as flooding, stream protection, stream flow, water supply, sewerage, drainage, water quality and so forth, should be managed in an integrated manner which allows them to be reconciled with other site planning issues such as biodiversity conservation, scenic and landscape quality and access driveways and roads. This requires a thorough understanding of the site. This will enable the designer to avoid adverse impacts and to utilise measures that achieve multiple objectives.

Accommodate existing soil and water management measures: development will generally result in the modification of natural land and water features. However it is possible to design in a manner which recognises the site constraints and protects natural features and embraces opportunities to restore or reconstruct natural features that have been lost. It is also critical that the design recognises existing soil and water management measures that have been introduced on the site including erosion control works such as contour banks, flumes and sediment dams.

The retention and restoration of natural features and incorporation of existing soil and water management measures into the subdivision design provides for many benefits including:

- Reduced risks from natural hazards
- Maintenance of biodiversity
- Aesthetic benefits
- Protection of water quality

Control watercourse or gully erosion: The modification of natural soil profiles and vegetation cover through the construction of roads, buildings and other impermeable surfaces can cause significant changes to the behaviour of

the landscape. During moderate rainfall events highly erosive water flows may be created following subdivision leading to:

- Gully erosion
- Rapid watercourse widening
- Increase bank and channel erosion
- Sediment deposition
- Loss of natural pool and riffle sequences within watercourses
- Degradation of aquatic habitats.

To counteract these impacts design should endeavour to minimise the likelihood of erosive stormwater flows from the subdivision.

Control erosion and sedimentation on the site: Development has the potential to increase erosion and sedimentation on the site. This occurs through disruption to land surfaces, removal of vegetation and through the importation and stockpiling of materials for construction of roads, buildings and other impervious surfaces. Design should take into consideration erosion risks and avoid disturbance in high risk areas which include steep slopes, erosive soils, and areas in close proximity to drainage lines and watercourses. Design should incorporate the preparation of a Erosion and Sediment Control Plan.

Control stormwater pollution: Some developments have the potential to introduce greater quantities and a broader variety of pollutants to the site. In addition, the replacement of natural ground surfaces and vegetation cover with roads, buildings and other impermeable surfaces may increase the volume of runoff from the site and the potential for pollutants to be transported off site during rainfall events.

Stormwater generated by these rainfall events can be managed by a variety of measures. These measures should be incorporated into a design.

Control effluent pollution: Wastewater management is a major issue associated with development in some parts of the Rous Water catchments. The relatively remote location of some developments means wastewater management will generally be provided through on-site wastewater management systems. The type of system, location within the site and ongoing management are all important considerations in the development design.

Ensure long-term effectiveness of management measures: On-site soil and water management measures serve not only the immediate site, but provide benefits to the downstream catchment. Failure of these measures through lack of maintenance or accidental or deliberate action can lead to significant water quality problems. The design process should ensure that the design integrity and effectiveness of on-site measures should be enduring.

Construction Management: Construction and land disturbance can lead to significant environmental harm when soil exposed by access and clearing is eroded and washed away by stormwater. Valuable topsoil is lost and the potential for regeneration of vegetation is reduced. The eroded material is dumped on downstream environments leading to pollution of downstream creeks and waterways by sedimentation, increased turbidity and releasing nutrients attached to the eroded soil particles. Degradation of water quality

from construction sites can also be attributed to poor management of stockpiles, waste storage areas and the construction site's machinery.

General principles:

- Awareness of the conservation values of a site and manage environmental risks during construction works.
- Minimise the extent of disturbed areas.
- Rapidly revegetating disturbed areas.
- To control erosion, stabilise exposed soil surfaces and divert stormwater away from exposed soil surfaces.
- To intercept, retain and remove water-borne pollutants during construction prior to the discharge of stormwater from the site.
- To minimise exposure and disturbance of sensitive soils such as sodic, saline and dispersive soils.
- To prevent damage to stormwater management measures installed prior to site works such as swales, ponds and contour banks.

Erosion and sediment control measures:

- Prepare and implement an Erosion and Sediment Control Plan (ESCP) for sites with the total disturbed area of less than 2500m^2 such as single dwellings and minor civil infrastructure works.
- Prepare and implement a Soil and Water Management Plan (SWMP) for all works where the total disturbed area is calculated as greater than 2500m^2. The SWMP identifies the constraints about control of soil erosion and pollution from sediments, outline measures during the construction stage and requires consideration as to whether a sediment basin is required.
- Site constraints should be assessed at the concept design stage of the project and should drive the design solutions included in the SWMP. Design development should be managed to integrate the engineering and soil and water management planning as once engineering plans are finalised, integration can be very difficult to achieve.
- Appropriate monitoring and maintenance measures for the management practices should be in place.

The proposed draft Development Control Plan is included as Attachment 1 to this report. It is intended that this DCP be inserted into a Councils city/shire wide Development Control Plan. It may be amended as appropriate by Councils, however the main structure and focus should be retained.

5 IMPLEMENTATION PROTOCOLS

Establish agreed implementation protocols with constituent Councils.

5.1 Consultation Process

Objective: Consult with constituent Councils on how best to apply the Rous Water Guidelines in the context of each Council's LEP and development assessment process.

Conduct a half day workshop with staff from constituent Councils.

Consultation has occurred with all constituent Councils. Letters of invitation to the workshop held on the 24 March 2009 were sent to all Councils. All Councils were represented at that workshop. The letters are included in Attachment 2.

The letter also contained a request for information relating to development applications. Subsequent to that letter, emails were sent following up on the information request. No development applications were provided for review.

In response to not receiving the development application information discussions with Council staff occurred via telephone, and feedback obtained.

5.2 Implementation Protocol

Objective: Establish an agreed implementation protocol to formalise the Rous Water guidelines in the planning and development assessment process.

One of the outcomes of the workshop was the in-principle agreement to the inclusion of the proposed LEP clause in draft LEP's and the preparation of a draft DCP for consideration by Councils for inclusion in each Councils DCP.

The Draft LEP clause was referred to the Department of Planning (Grafton office) and received in-principle support pending review by Parliamentary Counsel.

As several of the Draft LEPs have been completed, but not yet exhibited, each Council will need to request to the Department of Planning that the draft clause be included in its draft LEP. The authors see no reason the State Government would object to the protection of the drinking water catchments.

6 CONDITIONS OF APPROVAL

Objective: Develop conditions of approval for different categories of development/types of issues.

For the different categories of development identified (refer 3(iii) above) and the different types of issue being addressed (refer Section 1.3), identify a series of conditions of approval that could be used as the basis of a suitable response to these items.

A set of draft conditions of approval has been developed based on those used effectively by the Sydney Catchment Authority. In many cases however, the conditions have been amended to remove redundant or duplicate requirements, or conditions that (in the authors view) are likely to be overturned by the Court.

The SCA also requires applies numerous conditions requiring the provision of covenants to ensure ongoing maintenance and management of different areas of a development. Covenants are difficult to manage, and in most cases ineffective. In addition, the Environmental Planning and Assessment Act requires that a condition to be complied with and therefore the provision of a covenant is effectively duplicating a legal requirement.

The draft conditions are included in Attachment 3.

REFERENCES

ARRB Transport Research Ltd (2002), *Environmental Practices Manual for Rural Sealed and Unsealed Roads,* ARRB Transport Research Ltd.

Austroads (2001), *Road Runoff and Drainage: Environmental Impacts and Management Options*, Austroads.

Charles, K., Schijven, J., Ferguson, C., Roser, D., Deere, D. & Ashbolt, N. (2003), *Designing On-site Sewage Disposal Systems to Protect Public Health,* Centre for Water and Waste Technology, University of New South Wales.

Clark, J., *pers. comm.* (2009), email to Robert McGuinness dated 7 July 2009.

Considine, R., *pers. comm.* (2008), email to Anthony Acret dated 11 March 2008.

Cooperative Research Centre for Water Quality and Treatment (undated), *Pathogen movement and survival in catchments, groundwaters and raw water storages – Management implications,* Cooperative Research Centre for Water Quality and Treatment.

Landcom (2004), *The Blue Book – Managing Urban Stormwater: Soils and Construction*, Landcom.

Minister for Planning v Walker [2008] NSWCA 224.

NSW Department of Local Government (1998), *Environment & Health Protection Guidelines – On-site Sewage Management for Single Households,* NSW Department of Local Government.

NSW Department of Planning (2006), *Far North Coast Regional Strategy*, NSW Department of Planning

NSW Department of Water and Energy (2007), *Guidelines for Managing the Impact From Developments in Urban Water Catchments,* NSW Department of Water and Energy.

NSW Government, *Ballina Local Environmental Plan 1987.*

NSW Government, *Byron Local Environmental Plan 1988.*

NSW Government, *Drinking Water Catchments Regional Environmental Plan No 1.*

NSW Government, *Environmental Planning and Assessment Act 1979.*

NSW Government, *Lismore Local Environmental Plan 2000*

NSW Government, *Local Government Act 1993.*

NSW Government, *Native Vegetation Act 2003.*

NSW Government, *Protection of the Environment Adminstration Act 1991.*

NSW Government, *Protection of the Environment Operations Act 1997.*

NSW Government, *Richmond River Local Environmental Plan 1992.*

NSW Government, *Rural Fires Act 1997.*

NSW Government, *Standard Instrument – Principal Local Environmental Plan.*

NSW Government, *State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004.*

NSW Government, *State Environmental Planning Policy No 33 – Hazardous and Offensive Development.*

NSW Government, *State Environmental Planning Policy No 55 – Remediation of Land.*

NSW Government, *State Environmental Planning Policy No 58 – Protecting Sydney's Water Supply* (Repealed).

NSW Government, *Sydney Catchment Authority Catchment Management Report 07-08*.

NSW Government, *Water Management Act 2000.*

NSW Government, *Water Sharing Plan for the Alstonville Plateau Groundwater Sources 2003*

Rous Water (2008), *Rous Water On-site Wastewater Management Guidelines*, Rous Water Regional Water Supply.

Rous Water (undated), *Management Plan 2008-2011,* Rous Water Regional Water Supply.

Sydney Catchment Authority (2006), *Sustaining the Catchments – Neutral or Beneficial Effect on Water Quality Assessment Guidelines,* Sydney Catchment Authority.

SA Water, Catchment Research Centre for Water Quality and Treatment & Environment Protection Authority (2007), *Protecting drinking water quality into the future – priority areas and land use compatibility in Adelaide's Mount Lofty Ranges Watershed,* Environment Protection Authority.

Walker v Minister for Planning [2007] NSWLEC 741.

ATTACHMENT 1 – Draft Development Control Plan

ATTACHMENT 2 – Results Of Consultation

Robert McGuinness

From: Jim Clark [Jim.Clark@planning.nsw.gov.au]
Sent: Tuesday, 7 July 2009 2:27 PM
To: Robert McGuinness
Subject: Re: FW: Rous Water Development Controls

Hi Robert

No I haven't seen this before.
The clause is fine. It will need to have some tweaking by the legal drafting experts, but it would be OK to send to councils as is. Note that all the councils in the Rous area (except Richmond Valley) have already sent their Comprehensive LEPs to us, so they will have to make special submissions now to have the clause included (and they may not want to do that).

cheers.....Jim

Jim Clark
Team Leader Local Planning
Northern Region
NSW Department of Planning
Phone 6641 6604
Fax 6641 6601
0419 605 316

jim.clark@planning.nsw.gov.au

>>> "Robert McGuinness" <robert@innovationplanning.com.au> 6/07/2009 3:23 pm >>>

Hi Jim

Not sure if you received the email below. Could you please have a look and provide some comments as I need to finish the job for Rous Water.

Cheers

Rob

From: Robert McGuinness [mailto:robert@innovationplanning.com.au]
Sent: Monday, 11 May 2009 4:19 PM
To: jim.clark@planning.nsw.gov.au
Subject: Rous Water Development Controls

Hi Jim

Innovation Planning has been engaged by Rous Water to review the development controls to protect drinking water within its catchments.

At a workshop before Easter the proposed controls were discussed with the constituent Councils and agreement in principle reached on some wording. The wording is based on the provision in the Sydney Drinking Water Catchments REP, which is working well.

Would you please review the attached wording and provide me with your opinion as to whether the Department would agree to a clause in the new LEP's to this effect.

Regards

Rob

Robert McGuinness

Director

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ATTACHMENT 3 – Draft Conditions

Proposed Conditions

The following conditions are proposed as standard conditions of consent applying to development within the catchments. Council may adopt all or some of the conditions, and should amend each condition [particularly the words highlighted] to suit the individual development proposed as appropriate.

Wastewater Management Systems.

Amended Soil System

1. The amended soil system must be designed, located and installed in accordance with the recommendations contained within the report prepared by [Consultant & Date of Report] and the manufacturer's specifications, but with the following specific requirements and modifications:
   - the septic tank is to have a minimum volume of 3000 litres and is to be fitted with an outlet filter;
   - the septic tank is to be connected to a pump well with a minimum volume of 2000 litres;
   - the collection well pump is to be set so as to commence operation when the effluent level reaches 65% full and switches off when the holding tank is 50% full, and an alarm system is to be installed that is triggered when the pump fails or when the holding tank is 75% full;
   - the site for the mound must be levelled and built up with the clean topsoil brought in from elsewhere **with minimum cut (no more than 25 cm) into slope**;
   - the mound must be capped with a soil of moderate permeability, e.g. loam to clay loam, to minimise rainfall infiltration and promote evapotranspiration and must be fully turfed prior to occupation of the dwelling;
   - the mound area is to be fenced-off or protected from livestock and vehicles;
   - all run-on and stormwater collected from roofs, access roads and other hard surface areas is to be diverted away from the mound area, e.g. by means of a stabilised bund or drain with provision for energy dissipation at the outlet to prevent scouring or erosion;
2. The wastewater management system is to be maintained according to Section 5 of the guidelines *On-site Sewage Management for Single Households* and AS/NZS 1547-2000 *On-site Domestic Wastewater Management*, and the manufacturers requirements;
3. All effluent must be assimilated within the boundaries of the property;
4. No effluent management areas are to be located within 100 metres of a named river, 100 metres of any perennial or intermittent creek or watercourse, or within 40 metres of a dam or drainage depression.

In this regard it is noted that a [Drainage Depression/Watercourse] is located ZZ metres to the [insert direction] of proposed effluent management area;

5. Water conservation devices that are at least AAA-rated are to be installed in the dwelling to minimise the volume of wastewater produced;

6. These conditions of consent relating to wastewater management must be provided to the installer of the wastewater system.

> *Reason for Conditions X to X – To ensure that the on-site wastewater management and effluent disposal system will have a sustainable neutral or beneficial effect on water quality over the long term.*

7. Effective erosion and sediment controls are to be installed prior to any construction activity, including earthworks for the dwelling and site access. The controls must prevent sediment entering drainage depressions and watercourses and are to be regularly maintained and retained until works have been completed and groundcover established.

> *Reason for Condition X – To manage adverse environmental and water quality impacts during the construction stage of the development and to minimise the risk of erosion, sedimentation and pollution within or from the site during this construction phase.*

Aerated Wastewater System with Irrigation

1. The aerated wastewater treatment system including the effluent irrigation area must be designed, located and installed in accordance with the recommendations in the wastewater report prepared by [Consultant & Date of Report], but with the following specific requirements and modifications:
   - the effluent irrigation area is to have a minimum size of XXXX square metres;
   - the effluent irrigation area is to be located YY metres to the north of that proposed to ensure an adequate buffer to a drainage depression to the south;
   - the irrigation disposal must be either by subsurface means using a wick-based system **or** pressure compensating drip emitters with root barriers, **or** must employ by surface irrigation with **fixed** sprinkler points using quick-coupling valves or similar, with sprinklers to be rotated throughout the irrigation area [amend as appropriate]
   - the irrigation system must be fitted with a series of valves that enable different parts of the irrigation area to be utilised at any one time;

- the effluent irrigation system must be hydraulically designed and tested to ensure there is uniform delivery to all parts of the irrigation areas;
- the effluent irrigation area is to be fenced off from livestock and vehicles;
- The effluent irrigation area is to be mown regularly with grass clippings to be disposed of outside the irrigation area;
- the effluent distribution pipe from the tank to the irrigation area is to be buried at a minimum depth of 300mm and in a manner that provides protection against mechanical damage or deformation;
- a pump with sufficient capacity is to be provided to ensure effective and even delivery of effluent to and throughout the delivery area;
- all run-on and stormwater collected from roofs, access ways and other hard surface areas is to be diverted away from the effluent irrigation area, e.g. by means of a stabilised bund or drain with provision for energy dissipation at the outlet to prevent scouring or erosion;

2. The existing septic tank and absorption trenches are to be decommissioned in accordance with the NSW Health Advisory Note (dated 3-May 2006) for *Destruction, Removal or Reuse of Septic Tanks, Collection Wells, Aerated Wastewater Treatment Systems and Other Sewage Management Facility Vessels*;

3. The wastewater management system must be maintained according to Section 5 of the guidelines *On-site Sewage Management for Single Households* and AS/NZS 1547-2000 *On-site Domestic Wastewater Management*;

4. All effluent must be assimilated within the boundaries of the property;

5. No effluent management areas are to be located within 100 metres of a named river, 100 metres of any perennial or intermittent creek or watercourse, or within 40 metres of a dam or drainage depression. In this regard it is noted that a DD/WC is located ZZ metres to the [insert direction] of proposed effluent management area;

6. Water conservation devices that are at least AAA-rated are to be installed in the dwelling to minimise the volume of wastewater produced;

7. These conditions of consent relating to wastewater management must be provided to the installer of the wastewater and effluent disposal systems.

Reason for Conditions X to Y – To ensure that the on-site wastewater management and effluent disposal system will have a sustainable neutral or beneficial effect on water quality over the long term.

8. Effective erosion and sediment controls are to be installed prior to any construction activity, including earthworks for the dwelling and site access. The controls must prevent sediment entering drainage depressions and watercourses and are to be regularly maintained

and retained until works have been completed and groundcover established.

Reason for Condition X – To manage adverse environmental and water quality impacts during the construction stage of the development and to minimise the risk of erosion, sedimentation and pollution within or from the site during the construction phase.

Composting Toilet & Greywater System

1. The wastewater management system, including the greywater treatment system, is to be designed, located and installed in accordance with the recommendations of the wastewater report prepared by [Consultant & Date of Report], and the principles contained within the guidelines *On-site Sewage Management for Single Households* and AS/NZS 1547-2000 *On-site Domestic Wastewater Management*;

2. The compost shall be buried under clean friable soil at a minimum depth of 150mm below finished ground level for a minimum maturation period of three months. The compost maturation area shall be located within the boundaries of the property in a level area that is not subject to erosion or inundation and is not located within 100 metres of any creek or watercourse, whether perennial or intermittent, or within 40 metres of a dam or drainage depression;

3. No grey water is to be disposed of within 100 metres of a named river, 100 metres of any perennial or intermittent creek or watercourse, or within 40 metres of a dam or drainage depression;

4. The wastewater management system must be maintained according to Section 5 of the guidelines *On-site Sewage Management for Single Households* and AS/NZS 1547-2000 *On-site Domestic Wastewater Management*;

5. Water conservation devices that are at least AAA-rated are to be installed in the dwelling to minimise the volume of wastewater produced;

6. All stormwater collected from roofs and other hard surface areas is to be diverted away from any effluent management area by means of a stabilised bund or drain with provision for energy dissipation at the outlet to prevent scouring or erosion;

7. These conditions of consent relating to wastewater management must be provided to the installer of the wastewater and greywater systems.

Reason for Conditions X to Y – To ensure that the on-site wastewater management and grey water treatment and disposal system will have a sustainable neutral or beneficial effect on water quality over the long term.

8. Effective erosion and sedimentation controls are to be installed prior to any construction activity, including earthworks for the dwelling and site access. The controls must prevent sediment entering drainage depressions and watercourses and are to be regularly maintained and retained until works have been completed and groundcover established.

Reason for Condition X – To manage adverse environmental and water quality impacts during the construction stage of the development and to minimise the risk of erosion, sedimentation and pollution within or from the site during this construction phase.

Pump-out System

1. There is to be no on-site disposal of wastewater effluent, and the property is to be connected to the sewer as soon as it becomes available;
2. All wastewater generated in the new dwelling and bed and breakfast accommodation is to be directed to a new pump-out wastewater system with the following requirements:
   - the pump-out tank is to have a minimum capacity of 4500 litres;
   - the tank and lid are to be designed to have an appropriate weight and/or the tank is to be suitably anchored to ensure that there are no tank buoyancy problems;
   - the tank is to be provided with a visible indicator for wastewater level and an visual alarm for excessive wastewater levels;
   - the alarm is to be triggered when the tank volume exceeds 3000 litres;
   - the tank is to be connected to a pump-out stand fitted with a "Kamlock" (or similar) cover that can be readily accessed by pump-out trucks;
   - the pump-out stand is to be located in a small spillage well with a valve for the collection of any spilt sewage;
   - the applicant is to enter into an agreement with a Council-approved tanker pump out service for regular and "as needs" pumping;
3. The existing tank is to be decommissioned in accordance with the NSW Health Advisory Note (dated 3-May 2006) for *Destruction,*

Removal or Reuse of Septic Tanks, Collection Wells, Aerated Wastewater Treatment Systems and Other Sewage Management Facility Vessels;

4. Water conservation devices that are at least AAA-rated are to be installed in the bed & breakfast and new dwelling;

5. These conditions of consent relating to wastewater management must be provided to the installer of the wastewater and pump-to-sewer systems.

Reason for Conditions X to Y – To ensure that wastewater management will have a sustainable neutral or beneficial effect on water quality over the longer term.

6. Effective erosion and sedimentation controls are to be installed prior to any construction activity, including earthworks for the dwelling and site access. The controls must prevent sediment entering drainage depressions and watercourses and are to be regularly maintained and retained until works have been completed and groundcover established.

Reason for Condition X – To manage adverse environmental and water quality impacts during the construction stage of the development and to minimise the risk of erosion, sedimentation and pollution within or from the site during this construction phase.

Subdivision Conditions

General

1. The lot layout and staging is to be as shown on the proposed Plan of Subdivision prepared by [Consultant & Drawing Numbers & Date].

Reason for Condition 1 - The Council has based its assessment on this version of the proposed subdivision.

Water Cycle Management

2. All management measures as specified in the Water Cycle Management Study prepared by [Consultant & Date of Report], are to be implemented in particular as elaborated or varied in the conditions below.

Reason for Condition 2 – To ensure that a sustainable neutral or beneficial effect on water quality can be achieved over the long term for the development as a whole.

Subdivision Road [and Right-of-Way]

3. The subdivision road is to be paved and otherwise constructed to Council's engineering standards and as specified in the conditions below;

4. The right-of-way through proposed Lot X to provide access to proposed Lot X is to be constructed to Council's engineering standards, is to be consistent with the guidelines *Environmental Practice Manual of Rural Sealed and Unsealed roads* (ARRB Transport Research Ltd. 2002), *Road Runoff & Drainage: Environmental Impacts and Management Options* (Austroads Inc. 2000) and is also to incorporate the requirements identified in the following conditions:

5. The proposed road and right-of-way are to have vegetated swales, as appropriate, for their entire length with appropriately spaced cross drains, level spreaders, sills or mitre drains that divert water onto a stable surface capable of accepting concentrated water flow and provide for efficient sediment trapping and energy dissipation. Where the outlets of swales discharge into drainage depressions or watercourses they must be stabilised by an energy dissipater;

6. All swales, batters and verges associated with the proposed subdivision road and right-of-way are to be vegetated and stabilised with bitumen and jute matting or equivalent as soon as possible after construction. In steeper areas where the slope is in excess of 10%, the swales need to be armoured with coarse gravel, cobbles or rock;

7. All drainage works associated with the proposed subdivision road and right-of-way must be wholly included in the road reserve or have suitably defined easements;

Waterway Crossings

8. The subdivision road and right-of-way crossings of [Insert watercourse name] and waterways near proposed Lots X are to be appropriately sized box culverts consistent with the guidelines *Environmental Practice Manual of Rural Sealed and Unsealed roads* (ARRB Transport Research Ltd. 2002), and are as a minimum to be sealed for 50 metres either side of the waterway crossing. Such crossings are also to be consistent with any requirements for controlled activities under the Water Management Act 2000 issued by the Department of Water & Energy;

Access Ways to Dwelling Sites

9. Access ways to dwelling sites are to be constructed with roadbase (aggregate) and are to be located so as to minimise watercourse or drainage depression crossings, minimise cut and fill, minimise length, avoid the need for vegetation clearing and are not to exceed 10 percent slope, unless they are sealed or armoured and zigzagged up the slope;

10. Any access way crossing of a watercourse or drainage depression is to be a properly engineered concrete causeway, pipe or box culvert crossing consistent with the guidelines *Environmental Practice Manual of Rural Sealed and Unsealed roads* (ARRB Transport Research Ltd. 2002);

11. All access driveways are to have vegetated swales on both sides of their entire length with appropriately spaced level spreaders, sills or

mitre drains that divert water onto a stable surface capable of accepting concentrated water flow and provide for efficient sediment trapping and energy dissipation. Where outlets of swales discharge into drainage depressions or watercourses they must be stabilised by an energy dissipater;

12. All swales, batters and verges associated with the access ways to the lots are to be vegetated and stabilised with bitumen and jute matting or similar as soon as possible after construction. In the steeper areas where the slope is in excess of 10%, the swales need to be armoured with coarse gravel, cobbles or rock.

Reason for Conditions X to Y - To ensure the subdivision road, right-of-way and access ways to dwelling sites and associated drainage works and water quality control measures are appropriately managed and maintained over the longer term to ensure an overall and sustainable neutral or beneficial impact on water quality.

Intra-lot Access

13. There is to be only a single crossing across [Insert watercourse name] in proposed Lot X to provide access to the lot X;

14. The crossing referred to in conditions 13 above are to be properly engineered box culvert crossings consistent with the *Environmental Practices Manual for Rural Sealed and Unsealed roads* (ARRB Transport Research Ltd. 2002), *Road Runoff & Drainage: Environmental Impacts and Management Options* (Austroads Inc. 2000) and any requirements for controlled activities under the Water Management Act 2000 issued by the Department of Water & Energy. The approaches are to be sealed 30 metres on either side of the crossing.

Reason for Conditions X to Y - To ensure all intra-lot access and associated management measures have a minimal impact on water quality that can be maintained over the longer term.

Remnant Native Vegetation, Regrowth and Vegetation Offsets

15. There is to be no clearing of any native vegetation including regrowth other than the minimum clearing required for road construction and any future dwelling, access way construction and fire asset-protection zone purposes. Services such as phone and electricity lines and the like shall be installed along existing cleared areas and/or road access ways without additional clearing of vegetation;

16. All native vegetation, including any regrowth on proposed Lots X forming contiguous areas of X hectare or greater as shown on Figure 7 of the Water Cycle Management Study by [Consultant & Date of Report], are to be fenced out with a stock-proof fence and delineated on the approved Plan of Subdivision as “native vegetation”;

17. A minimum of X hectares of native vegetation is to be planted consistent with section 5.5 of the Water Cycle Management Study prepared by [Consultant & Date of Report]. The new plantings area

shall be fenced out with a stock-proof fence and delineated on the approved Plan of Subdivision as "native vegetation" and:

- the fences around the "native vegetation" areas are to be retained and maintained;
- no livestock grazing is permitted in these fenced-off "native vegetation" areas at any time;
- there be no clearing or harvesting of the vegetation in areas identified as "native vegetation" other than weed management without the written approval of the Council;
- there is to be no clearing of "native vegetation" associated with boundary fencing;

18. The revegetation referred to in Condition X above is to consist of a mixture of locally-native tree and shrub species planted at 3-metre spacings in the proposed revegetated areas. The plants are to be tube stock and staked and protected to ensure a higher survival potential. If 6 months after planting less than 50% of plantings have become established, a further round of planting will be required;

19. A weed control program for the control of blackberry and serrated tussock is to be undertaken for those affected lots as specified in the Water Cycle Management Study by [Consultant & Date of Report];

Protection and Rehabilitation of [insert watercourse name]

20. **[insert watercourse name]** is to be fenced off from livestock at a distance of 20 metres from [insert area]. Where there is existing native vegetation along the Creek the fencing should be located to include this vegetation in the fenced-off riparian zone and;
    - the fences around the "native vegetation" areas are to be retained and maintained;
    - no livestock grazing is permitted in these fenced-off "native vegetation" areas at any time;
    - there be no clearing or harvesting of the vegetation in areas identified as "native vegetation" other than weed management without the written approval of the Council;
    - there is to be no clearing of "native vegetation" associated with boundary fencing;

21. The fenced-off riparian zone is to be replanted with locally native vegetation consisting of a mixture of trees and shrubs at 3-metre spacings. The vegetation is to be planted from tube stock because of their higher survival potential and is to be staked and protected. If six months after planting less than 50% of plantings have become established, a further round of planting will be required;

22. Appropriate signage is to be provided on the fence lines required in Conditions X above identifying that these fenced-off areas are for water quality management and sediment and erosion control, and not available for livestock grazing.

Reason for Conditions X to Y – To ensure that the water quality impacts of the proposed development are minimised and to ensure that appropriate measures are taken to offset the water quality impact of the increased intensity of the proposed development so as to have a

sustainable neutral or beneficial effect on water quality over the long term.

Management of Areas of Active Erosion

23. The gully and rill erosion areas on proposed Lots 7, 8, 9 and 10 as indicated by locations 2, 3, 4 and 5 on Figure 6 of the Water Cycle Management Study prepared by [Consultant & Date of Report] are to be rehabilitated, revegetated and fenced-off with a permanent stock-proof fence as detailed in the report;

Existing Erosion Control Works

24. All existing erosion control works on all lots, consisting of sediment dams, flumes, drop down structures and contour banks and associated fencing, are to be retained and maintained, and in the case of the sediment dam on proposed Lots X is to be restored to its original functionality;

25. There is to be a public positive covenant under Section 88E of the Conveyancing Act 1919, the prescribed authority being the Council, for all lots requiring that all existing soil conservation works, including sediment control dams, flumes, drop down structures and contour banks and associated fencing, are to be retained and maintained and not disturbed without the written consent of the Council.

Reason for Conditions X to Y - To stabilise and manage on-site erosion and associated water quality problems and to retain the functionality of existing erosion and sediment control structures so as to avoid increased water quality problems with the intensification of land use.

Revegetation of Salt-Degraded Areas

26. The salinity-affected area - identified as "Location 1" on Figure X of the Water Cycle Management Study by [Consultant & Date of Report] is to be remediated, revegetated and fenced-off from livestock as specified in the report;

Reason for Conditions X to Y - To stabilise and manage salinity, erosion and associated water quality problems so as to avoid a deterioration in water quality associated with the intensification of land use over the longer term.

Dwelling Sites

27. There is to be a public positive covenant under Section 88E of the Conveyancing Act 1919, the prescribed authority being the Council, placed over each lot requiring that future dwellings are to be located on the lot shown on the approved subdivision plan

Reason for Condition X – To ensure that any water quality impacts of the proposed development are minimised and to ensure that appropriate measures are taken to offset the water quality impact of the increased intensity of proposed development so as to have a sustainable neutral or beneficial effect on water quality over the long term.

Other

28. Any rubbish deposited in gullies on proposed [insert lot if required] is to be removed and deposited in a properly licensed facility.

Reason for Condition X - To ensure that the water quality of runoff from the site is not contaminated by rubbish and to ensure a sustainable overall neutral or beneficial impact on water quality over the longer term.

29. Conditions X to Y and Z above are to be complied with prior to the issuance of a subdivision certificate for the development.

Reason for Condition Y – To ensure there is an overall and sustainable neutral or beneficial impact on water quality during all phases of the proposed development.;

Construction Activities

30. A Soil and Water Management Plan (SWMP) is required for all works proposed or required as part of the subdivision, in particular the subdivision road. It is to be prepared by a person with knowledge and experience in the preparation of such plans and is to meet the requirements outlined in Chapter 2 of the NSW Landcom's *Soils and Construction : Managing Urban Stormwater* (2004) manual - the "Blue Book" and be to the satisfaction of Council;

31. Effective erosion and sediment controls are to be installed prior to any construction activity including earthworks for the subdivision road, watercourse crossing and dwelling site access. The controls must prevent sediment entering drainage depressions and watercourses, and are to be regularly maintained and retained until works have been completed and groundcover established.

Reason for Conditions X & Y – To manage adverse environmental and water quality impacts during the construction stage of the development and to minimise the risk of erosion, sedimentation and pollution within or from the site during this construction phase.

ATTACHMENT 4 – Fact Sheet For Pathogen Movement And Survival In Catchments, Groundwaters And Raw Water Storages

The Cooperative Research Centre for
Water Quality and Treatment

Pathogen movement and survival in catchments, groundwaters and raw water storages

Management implications from the Cooperative Research Centre for Water Quality and Treatment Catchments and Storages Research Program

Fact sheet objective

The new Australian Drinking Water Framework outlines the methodology for providing safe drinking water by managing the complete catchment to tap supply system. This document is achieving global recognition as the best way to manage our drinking waters as we move into the 21st Century and is being incorporated into National and State Health Guidelines.

Understanding the level of risk in our waters is fundamental to the Framework. This allows managers of catchments and urban water utilities to focus their efforts on policies, works and operational practices to not only lower risks to public health but also improve the environmental health of these waters.

While much is known about nutrient and solids transport from land to our waterways, far less is understood about the survival and transport of the major pathogen groups (the viruses, bacteria and protozoa).

These fact sheets present the findings of a major international research program carried out by the Australian Cooperative Research Centre for Water Quality and Treatment into the fate of these pathogens in our catchments, source waters and reservoirs.

Fact sheet contents

These fact sheets are derived from the following CRC for Water Quality and Treatment research projects:

- Pathogen Movement from On-site Systems
- Fate and Transport of Pathogens in Catchments
- Source Water Quality Assessment and the Management of Pathogens in Tributaries and Aquifers
- Hydrodynamic Distribution of Pathogens in Reservoirs
- Investigation of Survival of *Cryptosporidium* in Environmental Waters

Summary of key points

The CRC Research has revealed that viable, infectious pathogens can move readily from faeces and sewage on land surfaces and on-site systems into source waters and even through large reservoirs to water supply offtakes. This ability results from the resistance of pathogens to environmental inactivation, their small size and their tendency to remain as single entities and not attach to particles and surfaces.

The research has identified the risk factors that lead to the highest concentrations of pathogens in source waters as well as providing indicative values for these concentrations in a range of different Australian regions.

Fortunately, the same research has identified that good management practices, largely consistent with those currently promoted for nutrient and sediment management, can greatly reduce the risks posed by pathogens. This demonstrates that good catchment management practices are effective and important preventive measures in multiple barrier water quality management.

An important outcome from the research has been the development of greatly improved protocols for pathogen monitoring and water quality assessment. These tools can be used in studying specific catchments and source waters to gain a better understanding of the risks present as well as in verification of source water quality.

Table of Contents

In Australia, drinking water quality management is undertaken in the context of the Australian Drinking Water Guidelines Framework. In the table below the salient research findings are presented within the Framework to aid in their implementation by the Australian Water Industry.

ADWG Framework Elements		Key research findings and reference to Factsheet No.
Assessment of the Drinking Water Supply System	Water Supply System Analysis	Conceptual Model (see inside back cover)
	Review of Water Quality Data	FS 7. Datasets used for risk assessment estimation of impacts FS 10. Use of faecal sterols to distinguish human and herbivore faecal sources will identify areas for priority in risk assessments
	Hazard Identification and Risk Assessment	FS 3. Juvenile cattle and pigs, and adult and juvenile sheep shed the most *Cryptosporidium* FS 5. *E. coli* are readily mobilised over distances of many metres FS 5. Steep base slopes and high intensity short duration rainfall represent a high risk of *Cryptosporidium* oocyst transport FS 6. *Cryptosporidium* oocysts deposited in catchments are readily transported as single entities FS 6. Viruses appear to be transported as far as run-off moves over vegetated land surface during rain events although this is only important if human sewage sources are present FS 9. In aquifers, separation distances of tens of metres of sand are an effective barrier to protozoan and bacterial transport
		FS 1. Aerated wastewater treatment systems have limited pathogen removal capacity FS 2. Pathogen removal is greatest in unsaturated soils FS 4. Temperature is the most influential factor for *Cryptosporidium* inactivation in soil and faeces

Planning-Preventative Strategies for Drinking Water Quality Management	Multiple Barriers	FS 5.	Intact vegetation increases infiltration, significantly reducing surface runoff, erosion potential and pathogen transport
		FS 8.	Catchment protection is an important barrier to protect water quality from pathogen contamination
		FS 12.	Detention process for reservoirs can be reduced from years to days by short-circuiting during inflow events
	Critical Control Points	FS 2.	Management and maintenance are the most critical factors for ensuring ongoing on-site systems performance
		FS 5.	*Cryptosporidium* in surface water runoff can be reduced by up to 99.99% over 1 metre width of grassy vegetation. The rate of pathogen removal during surface transport decreases with distance.
		FS 8.	Risk management activities should be targeted to wet weather conditions
Verification of Drinking Water Quality	Drinking Water Quality Monitoring	FS 7.	Importance of hydrologically-driven monitoring
		FS 9.	Larger samples volumes improve risk monitoring sensitivity
		FS 11.	ColorSeed^{tm} for *Cryptosporidium* and *Giardia* testing
		FS 11.	Source water monitoring to include quality control techniques
		FS 11.	Source water monitoring programs should incorporate estimates of uncertainty and variability
Research and Development	Investigative Studies and Research Monitoring	FS 8.	Sampling during storm events
		FS 7.	Techniques and strategies for large volume sampling during events
		FS 10.	Monitoring downstream in major tributaries during dry and event conditions can reflect source water health and likely contaminant sources
		FS 10.	Use of faecal sterols and microbial indicators to distinguish human and herbivore faecal sources

Research background

Pathogen movement from on-site systems - FS 1, FS 2

The aim of this project was to develop a methodology to define buffer distances for on-site sewage systems in Sydney´s drinking water catchments.

The work included numerous experiments on effluent quality and the fate and transport of contaminants to support an integrated methodology for virus transport and fate modelling and quantitative microbial risk assessment.

Fate and transport of pathogens in catchments - FS 3, FS 4, FS 5, FS 6

This project was designed to advance the state of knowledge regarding sources, fate and transport of pathogens in catchments. Its principal goal was to provide data to facilitate the development of predictive models to describe pathogen concentrations at critical locations in catchments and reservoirs.

Data from this project will facilitate the development of mathematical models to predict concentrations of pathogens at critical locations in drinking water catchments. The work involved quantifying the sources, fate and transport of pathogens in catchments including: animal pathogen loads, pathogen inactivation and dispersion, and rainfall simulation to measure event-based pathogen land transport.

Source water quality assessment and the management of pathogens in tributaries and aquifers - FS 7, FS 8, FS 9, FS 10, FS 11

The project was designed to collect and analyse the hydrology and a comprehensive set of water quality data from eight systems supplying water to between 10,000 and 100,000 customers. Water quality analyses included pathogens, microbial indicators, biomarkers, physical and chemical quality and particle size. Rainfall and flow information was collected from the six surface and two groundwater systems.

The project aimed to enhance understanding of pathogen behaviour in Australia to improve management at the catchment scale after pathogen mobilisation and export from the land but before reservoir storage.

Hydrodynamic distribution of pathogens in reservoirs & Investigation of survival of *Cryptosporidium* in environmental waters - FS 12

Pathogen breakthrough is most likely to occur when raw water with high pathogen load enters the treatment plant undetected. It is well established that pathogens enter reservoirs during transient elevated flow events, but the fate and transport within the reservoir is less well known. The objectives of this study were to develop, test and verify techniques that will help utilities monitor and predict the dynamic and non-uniform distribution of pathogens in lakes and reservoirs. Two models were developed to meet this aim, improve monitoring and aid in the selection of water harvesting depth.

An associated study is examining the factors that influence the persistence of infectivity or *Cryptosporidium*, a common pathogen of concern. The study has focussed on temperature and light. The results will be integrated into the models mentioned above.

FS 1 On-site sewage treatment system performance

Research Findings

- Thermotolerant coliforms are not sufficient indicators of microbial risk from treated sewage due to lower tolerance than viral and protozoan pathogens to treatment, disinfection and environmental conditions. Additionally, thermotolerant coliforms are larger than viruses, resulting in greater removal in soil.
- On-site sewage systems, particularly older systems (10 years+) and septic tanks, are failing to meet the NSW effluent quality guidelines used as a basis for land application system design. This is likely to be a key factor in the failure of land application systems.

Septic tank effluent quality	SS ($mg.l^{-1}$)	BOD ($mg.l^{-1}$)	TN ($mg.l^{-1}$)	TP ($mg.l^{-1}$)	Thermotolerant coliforms ($cfu.100ml^{-1}$)
Guideline values*	50	150	50-60	10-15	10^5 – 10^7
Equivalent percentile	13%	33%	15-23%	25-40%	32-93%
Average	379	224	160	21	10^6
80th percentile	660	330	250	36	10^6
Number of systems	43	43	45	46	38

* (DLG, 1998) (Expected quality)

- New NSW Aerated Wastewater Treatment System (AWTS) designs performed well, with approximately 50% meeting the guidelines, but AWTS disinfection systems provided limited pathogen removal.

AWTS effluent quality	SS ($mg.l^{-1}$)	BOD ($mg.l^{-1}$)	Thermotolerant coliforms ($cfu.100ml^{-1}$)	Free Chlorine ($mg.l^{-1}$)
Guideline values*	30 (45)**	20 (30)	10 (100)	0.2-2.0
Equivalent percentiles	85% (94)	85% (89)	67% (76)	54-91%
Average	18	11	6 200	0.5
80th percentile	27	15	162	0.5
Number of systems	141	140	140	119

* (NSW Health, 1998); ** Upper limit for grab samples

- Viruses (including Noro-, Reo-, Rota- and Entero-viruses) were detected in 40% of grab samples of septic tank effluent.
- Virus concentrations in sewage from a single household may be as high as 10^{10} per litre for short periods when there is an infected resident in the household. (Therefore, virus reduction before suitable for drinking water is up to 17 $\log_{10}$ [Regli et al., 1991]).
- Virus removal in on-site sewage treatment systems: 75% in septic tanks and 90% in AWTS.
- AWTS with Chlorine or UV disinfection provide an additional 90 to 98% removal of viruses.

Implementation

- Design guidelines for land application systems should be modified to reflect high concentrations of contaminants experienced in sewage from on-site systems.
- Assessment of on-site system suitability and performance should include traditional indicators, additional microbial indicators (to account for viruses and protozoa) and contaminant removal mechanisms.

More Information

Charles, K. J. and Ashbolt, N. J. (2004) Quantitative Microbial Risk Assessment: a catchment management tool to delineate setback distances for septic systems. Young Researchers Conference 2004. P. Lens and R. Stuetz. Wageningen, the Netherlands, IWA.

Charles, K., Ashbolt, N., Ferguson, C., Roser, D., McGuinness, R. and Deere, D. (2003) Centralised versus decentralised sewage systems: a comparison of pathogen and nutrient loads released into Sydney's drinking water catchments. Water Science and Technology 48 (11-12)**:**53-60.

Charles, K. J., Ashbolt, N. J., Deere, D. A. and Roser, D. J. (2003a) Disinfection in Aerated Wastewater Treatment Systems. Ozwater: Innovation in Water, AWA 20th Convention, 6-10 April 2003, Perth.

Charles, K. J., Roser, D. J., Ashbolt, N. J., Deere, D. A. and McGuinnes R. (2003b) "Buffer distances for on-site sewage systems in Sydney's drinking water catchments." Water Science & Technology 47(7-8): 183-189.

Charles, K. J., Schijven, J. F., Ferguson, C., Roser, D. J., Deere D. A. and Ashbolt, N. J. (2003c) Designing on-site sewage disposal systems to protect public health. On-site '03 Future directions for on-site systems: Best management practice, Armidale, Lanfax Labs.

Charles, K., Ashbolt, N. J., Deere, D. A. (2004) Effluent quality from 200 on-site systems: Design values for guidelines, Proc. IWA 6th Specialist Conference on Small Water & Wastewater Systems & 1st International Conference on Onsite Wastewater Treatment & Recycling. 11-13 February 2004 at the Esplanade Hotel Fremantle. Murdoch University, Western Australia, Murdoch. Innovation in Water, AWA 20th Convention, 6-10 April 2003, Perth.

Charles, K. J., Ashbolt, N. J., Roser, D. J., McGuinness, R. and Deere, D. (2004a) Effluent quality from 200 on-site sewage systems: Design values for guidelines. 6th Specialised Conference on Small Water and Wastewater Treatment Plants, Fremantle, February 2004, International Water Association.

Charles, K. J., Schijven, J. F, Roser, D. J., Deere, D. A. and Ashbolt, N. J. (2004b) Transport and fate of nutrients and pathogens during sewage treatment in a mound system. 10th National Symposium on Decentralised Sewage Treatment and Disposal Systems, Sacramento, US.

DLG (1998). Environment and Health Protection Guidelines: On-site Sewage Management for Single Households. Sydney, NSW, Department of Local Government.

NSW Health (1998) Aerated Wastewater Treatment Systems (AWTS) Accreditation Guideline. Sydney, NSW Health Department.

Regli, S., Rose, J. B., Haas, C. N. and Gerba, P. C (1991) "Modelling the risk from Giardia and viruses in drinking water." Journal of American Water Works Association 83(11): 76-84.

FS 2 Virus movement from on-site land application systems

Research Findings

- All pathogen groups are removed to the highest extent in unsaturated soils followed by saturated soils. Overland flow provides the least removal.
- The rate of virus removal during soil transport decreases with distance. Hence laboratory results for transport over short distances can not be directly extrapolated to field situations.
- In Sydney's drinking water catchments, where approximately 70% of properties are connected to centralised sewers, on-site systems have been calculated to discharge approximately the same total load of pathogens and phosphorus to land and waterways within the catchments as centralised sewage treatment plants. For nitrogen, and in worst case scenarios, the discharge from on-site systems is greater. Hence, adequate design of land application systems is required to provide appropriate treatment and reuse of effluent prior to entering waterways.
- In terms of water quality protection, the most important factors for on-site systems are:
    - Management and maintenance – ensuring that on-site treatment and land application systems perform as designed.
    - Density – more systems equates to a greater number of failures.
    - Soil and design – ensure that there is adequate unsaturated soil depth.
    - Setback distances - ensuring the sewage receives treatment through saturated soil transport or overland flow.

Implementation

- Design guidelines for land application systems should be modified to reflect the important role of unsaturated soil transport in the removal of pathogens.
- Subsurface irrigation and pressurised subsurface land application systems should be encouraged to maximise transport of sewage in unsaturated soil.

More information

Charles, K. J. and Ashbolt, N. J. (2004) Quantitative Microbial Risk Assessment: a catchment management tool to delineate setback distances for septic systems. Young Researchers Conference 2004. P. Lens and R. Stuetz. Wageningen, the Netherlands, IWA.

Charles, K. J., Ashbolt, N. J., Ferguson, C., Roser, D. J., McGuinness, R. and Deere, D. A. (2003) "Impacts of centralised versus decentralised sewage systems on water quality in Sydney's drinking water catchments." Water Science & Technology 48(11-12): 53-60.

Charles, K. J., Schijven, J. F., Ferguson, C., Roser, D. J., Deere, D. A. and Ashbolt, N. J.(2003) Designing on-site sewage disposal systems to protect public health. On-site '03 Future directions for on-site systems: Best management practice, ArFS 10. On-site sewage treatment system performance.

FS 3 Animal management

Research Findings

- Improved testing methods were developed for *Cryptosporidium* and *E. coli* and then applied to faeces of adult and juvenile domestic animals (cattle, sheep and pigs) and wild kangaroos.
- Juvenile cattle and pigs, and adult and juvenile sheep shed the most *Cryptosporidium*.
- Adult sheep were shown to be a significant source of *Cryptosporidium*, shedding more than the juveniles.
- Juvenile cattle also shed the highest concentrations of *E. coli*.
- Kangaroos shed lower levels of *E. coli* than all of the domestic animals and low levels of *Cryptosporidium* (similar to adult pigs and adult cattle).

Faecal source	Number of positive samples/Total number of samples	Concentration of Cryptosporidium oocysts g^{-1} dry weight of faeces [a]		
		Median	Mean	Standard Deviation
Cattle (adult)	6/20	0.5	331	1 400
Cattle (juvenile)	22/27	172	40 000	130 000
Sheep (adult)	15/20	51	3 500	13 000
Sheep (juvenile)	13/15	47	888	1 900
Pig (adult)	8/20	0.5	54	119
Pig (juvenile)	12/20	35	1 400	5 200
Kangaroo (adult)	7/25	0.5	754	2 800

[a] adjusted for recovery

Implementation

- Keep all domestic livestock as far away from watercourses as possible, the actual distance required would depend on what pathogens need to be controlled (protozoa require less setback than bacteria) and on the local soil, climate, vegetation and slope factors.
- At the very least, newborn to juvenile animals should be kept separated from watercourses in barns/ stockyards or distant paddocks.
- Collection, stockpiling (away from watercourses) and treatment of manure, particularly from juvenile animals will minimise the land deposition of highly contaminated faeces.
- Stock access to waterways can be limited by fencing off riparian zones and/or supplying alternate sources of water.

More information

Atwill, E. R., Hoar, B., das Gracas Cabral Pereira, M., Tate, K. W., Rulofson, F. and Nader, G. (2003) Improved quantitative estimates of low environmental loading and sporadic periparturient shedding of *Cryptosporidium parvum* in adult beef cattle. Applied & Environmental Microbiology, 69, 4604-4610.

Heitman, T. L., Frederick, L. M., Viste, J. R., Guselle, N. J., Morgan, U. M., Thompson, R. C. A. and Olson, M. E. (2002) Prevalence of Giardia and Cryptosporidium and characterization of Cryptosporidium *spp*. isolated from wildlife, human, and agricultural sources in the North Saskatchewan River Basin in Alberta, Canada. Canadian Journal of Microbiology, 48, 530-541.

FS 4 Inactivation of pathogens in soils and faeces

Research Findings

- Four major factors were investigated for their impact on the inactivation of *Cryptosporidium* and viruses in soils and faeces (temperature, soil type, moisture content and biotic status).
- Temperature was shown to be the most influential factor for *Cryptosporidium* inactivation in both soils and faeces.
- Soil type (texture) also significantly affected inactivation of *Cryptosporidium* oocysts and viruses.
- At low temperatures (4°C) inactivation rates (*K*) for *Cryptosporidium* were very slow, less than 0.0051 per day in a clay loam soil.
- Inactivation rates (*K*) for the virus PRD1 in wet soil at 20°C was 0.023 day $^{-1}$.
- Inactivation rates (*K*) for PRD1 in septic tank effluent at 22°C was 0.034 day $^{-1}$.
- Although the surface of cow pats are significantly drier than the interior there was no significant difference in the rate of *Cryptosporidium* die-off.
- Microcosm studies indicated there was no significant difference between viable oocyst counts in wet or dry faeces except at 4°C, where the differences were not of biological significance (*K* of 0.0002 vs 0.0015 day^{-1}).

Implementation

- Manure storage should aim to increase temperatures to maximise pathogen inactivation.
- When modelling the fate of pathogens in the environment, inactivation rates must be appropriate for the temperature of the climate in question.

More information

Jenkins, M. B., Bowman, D. D., Fogarty, E. A. and Ghiorse, W. C. (2002) *Cryptosporidium parvum* oocyst inactivation in three soil types at various temperatures and water potentials. Soil Biology & Biochemistry 34:1101-1109.

FS 5 Riparian management

Research Findings

- Laboratory experiments with intact soil blocks showed that 1 metre width of grass vegetation could reduce *Cryptosporidium* in the surface water runoff by up to 99.99% compared to bare soil alone.
- The rate of pathogen removal during surface transport decreases with distance. Hence laboratory results for transport over short distances can not be directly extrapolated to field situations.
- Field scale experiments confirmed that grass vegetation was effective at reducing the transport of *Cryptosporidium* however, viruses (PRD1 bacteriophage) and to a lesser extent bacteria (*E. coli*) were easily mobilised over at least 10 metre distances.
- Vegetation also significantly increases infiltration thus reducing the volume of surface runoff and the potential for erosion and sediment transport.
- Steep base slopes and high intensity short duration rainfall represent a high risk of *Cryptosporidium* oocyst surface transport.
- Rain events mobilise significant concentrations of *Cryptosporidium* and *E. coli* particularly from fresh faecal material.
- Subsequent rainfall events can remobilise *Cryptosporidium* that have been deposited onto the surface of the soil.
- The high concentration of pathogens in faeces means that although significant levels are transported in the runoff, faecal pat materials continue to contribute pathogens for prolonged periods (weeks in summer to months in winter).

Implementation

- Plant and maintain appropriate grass vegetation cover in riparian zones and on steep sloped areas.
- Encourage animals not to defecate in riparian zones by placing shade trees, watering and feed points as far away from watercourses as possible and by fencing where acceptable.

More information

Atwill, E. R., Hou, L., Karle, B. M., Harter, T., Tate, K. W. and Dahlgren, R. A. (2002) Transport of *Cryptosporidium parvum* oocysts through vegetated buffer strips and estimated filtration efficiency. Applied & Environmental Microbiology, 68, 5517–5527.

Davies, C. M., Ferguson, C. M., Kaucner, C., Altavilla, N., Deere, D. A. and Ashbolt, N. J. (2004) Dispersion and transport of *Cryptosporidium* oocysts from faecal pats under simulated rainfall events. Applied & Environmental Microbiology, 70, 1151-1159.

FS 6 Pathogen movement in water and soil

Research Findings

- *Cryptosporidium* oocysts spiked into faeces or soil were not associated with larger particulates and did not aggregate, indicating that oocysts deposited in catchments would be mobilised and largely transported as single entities.
- Geochemical characteristics of the soil, pH, conductivity and organic matter, as well as hydraulic conditions like porosity and velocity of flow, affect the dispersion and removal of pathogens in soils.
- Physical straining as well as sorption processes influenced the overall rate of removal of pathogens in soils, particularly for *Cryptosporidium* in the first few centimetres.
- The observed sequence of removal rates was:
  Cryptosporidium oocysts > bacteria and bacterial spores > viruses
- Changes in water quality parameters, such as pH or conductivity, altered the detachment of all microorganisms (phages, bacteria and bacterial spores and oocysts). It is possible that rain events could lead to detachment and remobilisation.

Implementation

- Predictive models for *Cryptosporidium* oocyst and other pathogens' transport should assume most are transported as single entities, unlikely to aggregate and settle out of suspension.
- Catchment characteristics such as soil type and hydrology need to be accounted for in pathogen transport models.

More information

Fraser, R. H., Barten, P. K. and Pinney, D. A. K. (1998) Predicting stream pathogen loading from livestock using a geographical information system-based delivery model. Journal of Environmental Quality, 27, 935-945.

Medema, G. J. and Schijven, J. F. (2001) Modelling the sewage discharge and dispersion of *Cryptosporidium* and *Giardia* in surface water. Water Research, 35, 4307-4316.

Ashbolt, N. J. and Roser, D.J. (2003) Interpretation and management implications of event and baseflow pathogen data, CD-ROM. *In* M. J. Pfeffer, D. J. V. Abs and K. N. Brooks (ed.), Watershed Management for Water Supply Systems. American Water Resources Association, New York City, New York June 30 - July 2, 2003.

FS 7 Rainfall event hydrology and estimating pathogen loads

Research Findings

- To characterise pathogens and indicators during the hydrographs of 23 events examined, the project team:
  - developed techniques and strategies for large volume event based sampling; and
  - generated data on event timecourse behaviour between catchments, and within and between events with recurrence periods of >1 in 1 month to 1 in 4 years, to which stormwater industry approaches to describing mean event loads and concentrations were adapted for faecal microorganisms (Table 1, FS 8).
- General water quality could often be estimated from a limited number of samples (<4 per event). This is because over the hydrograph of any single event, water microbiology was generally more constant than expected, (with $\log_{10}$ standard deviations for indicators generally being < 0.3).
- The most important sources of pathogens can vary as rainfall intensity and catchment saturation vary. For example, in some catchments the pathogen pollution from septic systems became evident only during the most extensive rainfall events.
- No evidence was found for increasing contaminant dilution with increasing event size. Thus events more extreme than the largest observed in the study (one in four years) must be assumed to generate at least as poor quality for the time being.

Implementation

- Hydrology is inextricably linked with quality and thus must be routinely measured as part of source water characterisation. Such sampling will have financial implications and will need to be well resourced and focused e.g. by initial analysis of source water hydrology and better use of existing data.
- Sampling strategy refinements should include attention to hardware. For example, new devices for sample collection and storage were developed that were relatively inexpensive and helped protect personnel whilst collecting on-line data, and being capable of storing refrigerated and large volume samples, and minimising vandalism.
- Resources can be efficiently targeted by 'reconnaissance' sampling, to identify key sources from a few upstream samples collected during events (see Environmental forensics FS 10).
- Current data sets may be used for risk assessment purposes to estimate impacts especially on extraction from rivers and small reservoirs during storm events when water quality may temporarily degrade by factors of 100 to > 10,000.
- Extreme event behaviour in catchments is still not well measured nor understood and it is recommended that plans and resources be established to collect extreme event pathogen samples when and where-ever they occur to address this data gap.
- Further analysis of the data set should be undertaken to test/develop hypotheses about factors driving poor water quality during 'baseline' and 'small' events.

More information

Fisher, D. S., Steiner, J. L., Endale, D. M., Stuedemann, J. A., Schomberg, H. H., Franzluebbers, A. J. and Wilkinson, S. R. (2000) The relationship of land use practices to surface water quality in the Upper Oconee Watershed of Georgia. Forest Ecology and Management 128:39-48.

Fraser, R. H., Barten, P. K. and Pinney, A. K. (1998). Predicting stream pathogen loading from livestock using a geographical information system-based delivery model. Journal of Environmental Quality 27:935-945.

Lee, J. H. and Bang, K. W. (2000) Characterization of urban stormwater runoff. Water Research 34:1773-1780.

Roser, D., Skinner, J., LeMaitre, C., Marshall, L., Baldwin, J., Billington, K., Kotz, S., Clarkson, K. and Ashbolt, N. (2002). Automated event sampling for microbiological and related analytes in remote sites: a comprehensive system. Water Science and Technology: Water Supply 2(3):123–130.

Sadeghi, A.M. and Arnold, J. G. (2002) A SWAT/Microbial sub-model for predicting pathogen loadings in surface and groundwater at watershed and basin scales (paper 701P0102) *Total Maximum Daily Load (TMDL) Environmental Regulations: Proceedings of the March 11-13, 2002 Conference*, Fort Worth, Texas, USA. American Society of Agricultural Engineers.

FS 8 Catchment tributary microbiology: rain events versus dry baseline periods

Research Findings

- There were clear trends in microbiological impacts across the six sub-catchments studied, which ranged from fully protected surface waters, through agriculturally to septic impacted (Table 1, full dataset in MS Access database).
- Fully protected catchments had by far the highest water quality even during rain events (equivalent to over 99.9% pathogen reduction compared to unprotected), demonstrating the value of catchment protection and access exclusion policies.
- A critical finding for surface waters was that impact was directly related to rainfall-induced runoff, and therefore sampling during relatively dry periods provides minimal indication of the level of pathogen risks.
- For example, load measurements showed that as much as 300 years worth of dry weather pathogen contaminant loads could be exported during 1 day in a single 'small' event.
- Further, preceding weather conditions were as important to know as were millimetres of rainfall. For the latter, storm intensity and duration are the principal components – relating to energy required to mobilise pathogens (see FS 5 Riparian management and FS 6 Pathogen movement in water and soil).

Table 1 Geometric and flow weighted means of selected pathogen and related water quality parameters during dry and rain events respectively

System Type	*E. coli* per 100 ml		*Cryptosporidium* per 10 l		*Campylobacter* per 100 ml		24ethyl-Coprostanol ng/l*	
	Dry	Event	Dry	Event	Dry	Event	Dry	Event
Fully Protected A	26	400	<0.3	<0.3	0.03	0.07	12	88
Fully Protected B	30	1190	<1	<0.3	0.03	<2.3	20	120
Part Impacted A	31	6250	<1	4.5	-	-	5.6	220
Part Impacted B	130	6690	1.1	39	0.43	3.0	1.0	60
Urbanized	450	10400	16	290	0.36	15	18	690
Intensive Agriculture	210	17700	1.9	31	3.5	18	88	3100
Urban aquifers	<0.01		Not detected		-		0.3	

*24ethyl-Coprostanol is a biomarker of herbivore faecal contamination

Implementation

- Intensive agricultural development in less than 5% of a catchment area leads to a doubling in pathogen concentrations and risk.
- Generalised results provide primary pathogen/indicator data for event impact modelling, water quality objective development, hypothesis testing and catchment risk assessment.
- Pathogens vary through time and hydrologic conditions, making the use of a single numerical description potentially misleading. The data is, therefore, summarised in the form of load and concentration probability density distributions for different flow conditions by catchment type. Equally detailed information is provided on microbial indicators (e.g. *E. coli*), sterol biomarkers (e.g. coprostanol and 24ethyl-coporstnaol), nutrients, particulates and rainfall intensity to aid in risk assessments and management. Table 2 presents a summarised form to aid in the ADWG risk assessment approach for catchments.

Table 2 Proposed microbial qualitative risk assessment categories

Impact Level	Source Class	'Run-off' Conditions		
		Dry Weather/ Baseline Conditions	Baseline Event-Small Event	Large Event - Extreme Event
Low (protected catchment)	Large Reservoir	Very Low	Low	Moderate
	Small Reservoir	Low	Moderate	Moderate-High
	River/ Stream	Low	Moderate-High	High
Moderate (partly impacted catchment)	Large Reservoir	Low	Moderate-High	High
	Small Reservoir	Low	High	High-Very High
	River/ Stream	Moderate	High	Very High
High (heavily impacted catchment)	Large Reservoir	Low-Moderate	High	Very High
	Small Reservoir	Moderate	Very High	Extreme
	River/ Stream	High	Very High-Extreme	Extreme

- Even during baseline/small storm events, source water quality was heavily degraded in agricultural/ urbanised catchments, highlighting the need to target data collection more on high run-off periods than dry weather periods; during the latter water quality was relatively good.
- Risk management activities should be focused on wet weather event management and preventive measures should be effective during wet weather events.
- The great variation in quality between sources highlighted the need to not only identify risks in a qualitative but also in a quantitative manner.

More information

See **Rainfall event hydrology and estimating pathogen loads FS 7**

Hansen, J. S. and Ongerth, J. E. (1991) Effects of time and watershed characteristics on the concentration of *Cryptosporidium* oocysts in river water. Applied and Environmental Microbiology 57:2790-2795.

LeChevallier, M. W., Norton, W. D., Abbasadegan, M. Atherholt, T. B. (1998) Variation in *Giardia* and *Cryptosporidium* levels in the Delaware River. American Water Works Service Company, Inc.

Roser, D., Ashbolt, N., Charles, K., Deere, D., Steffensen, D. and Ferguson, C. (2003) Transforming pathogen water quality data and collection experiences into source water monitoring and control information products. Oral presentation for OzWater March, 2003 Paper oz094, Australian Water Association Annual Conference, Perth, Australia.

FS 9 Assessing the microbiological quality of vulnerable groundwaters

Research Findings

- The work comprised two phases; a general quality survey of two vulnerable aquifers and the measurement of contaminant removal along a pollution gradient.
- Concentrations of contaminants even in the vulnerable (production) bores were very low or below analytical detection limits but monitoring bore quality data had very high variance (i.e. standard deviation) highlighting the potential for missing infrequent contaminated bores during routine surveys.
- Of the indicators tested, enterococci (rather than *E. coli*) was the preferred indicator for timely warning of faecal contamination. In the future, however, value may be gained in also testing for coliphages (bacterial viruses that move in a similar manner to human viruses).
- Cholesterol was not present in surficial production bore waters but has potential to detect surface influence and hence intrusion even in the absence of standard faecal indicators. Other physicochemical parameters were of little use for predicting pathogen risks.
- In the microbial pollutant gradient study, several tens of metres of sand provided an effective natural barrier to transport of protozoan and faecal bacteria, with production bore quality being far superior to surface water quality. Protozoa and faecal bacteria were common in source material (septic supernatant) but completely absent even in contaminated leachate samples, presumably aided by unsaturated flow to the groundwater.
- The greatest uncertainty remaining was the fate and transport of viruses. Sewage coliphages (bacterial viruses) were only present in low numbers and could not be used for tracing without artificial addition. Computer modelling was scoped and appears to be of a level of development where pathogen (especially virus behaviour) can be usefully and reliably assessed.

Implementation

- For routine monitoring, enterococci tests on larger sample (1 litre) volumes can probably improve risk monitoring sensitivity by a factor of about 100.
- Subsurface pathogen movement proved difficult to predict and identify prior to sampling and analysis. Thus it is potentially valuable that a groundwater pathogen computer modelling capacity (e.g. using Hydrus 2D) especially for viruses be developed by the Australian Water Industry to ensure that surveys and quantitative risk assessment are based on sound theory as well as field data.
- To validate and maximise the reliability of virus modelling, laboratory and field studies of bacteriophage behaviour are essential and least open to bioethical concerns.

More information

Charles, K., Roser, D., Ashbolt, N., Deere, D. and McGuinness, R. (2003) Buffer distances for on-site sewage systems in Sydney's drinking water catchments. Water Science and Technology 47(7-8):183-189.

Schijven, J. F (2001) Virus removal from groundwater by soil passage. Ph.D. dissertation, University of Delft, The Netherlands, Delft.

Schijven, J. F. and Hassanizadeh, S. M. (2000) Removal of viruses by soil passage: Overview of modeling, processes, and parameters. Critical Reviews in Environmental Science and Technology 30:49-127.

Schijven, J. F., de Bruin, H. A. M., Hassanizadeh, S. M. and de Roda Husman, A. M. (2003) Bacteriophages and clostridium spores as indicator organisms for removal of pathogens by passage through saturated dune sand. Water Research 37:2186-2194.

FS 10 Environmental forensics: the complementary use of microbial indicators and faecal sterols for managing non-point source pathogens

Research Findings

- Key site monitoring (downstream in major tributaries) during dry and event conditions can provide an overall view of source water health and likely contaminant source classes. It cannot, however, identify the principal 'non-point source' (NPS) contaminant source(s) or unequivocally quantify point source impacts during periods of pathogen mobilisation.
- Reconnaissance sampling during storm events, concurrent with key site event monitoring, and analysis of land use patterns and catchment flow structure provide some indication of NPS emissions.
- During reconnaissance and key site sampling, once faecal indicators had been identified at a site, there was significantly more information gained by using both faecal sterols and microbial indicators to distinguish water from sediment contamination, as well as in discriminating between human/herbivore faecal sources. Such an approach exploited the differences in contamination from different tributaries and reaches to identify dominant NPS emissions zones and accounted for contamination seen at key sites.
- Sterol concentration and ratio data were used to estimate NPS emission loads (10 tonnes of herbivore faeces in one instance and 500 kilolitres of sewage in another) and create distinct faecal 'fingerprints' to aid in visualising contamination.

Implementation

- The combination of reconnaissance + event based sampling and geographical analysis highlighted the need to routinely complement water quality measurements with hydrography and catchment surveys to fully exploit the data collected. To aid in interpretation of a range of indicator and biomarker data a decision support system was developed (FaecalPrint) and is under evaluation.
- In two cases studies, herbivore and human contaminant emission zones were clearly identified within large rural catchments. Similar work in an urban setting showed the widespread nature of contaminant discharges. Conversely in a protected water supply, reconnaissance data indicated that small events which elevated turbidity and *E. coli*, did not imply a significant pathogen contamination risk, so reducing the need for remedial action.
- Forensic style identification of faecal sources promises to pin-point the origin of NPS pollution and allow evaluation of the effectiveness of remedial catchment works. It also assist identification of polluters to facilitate these remedial works.

More information

Leeming, R., Nichols, R. D. and Ashbolt, N. J. (1998) Distinguishing Sources of Faecal Pollution in Australian Inland and Coastal Waters using Sterol Biomarkers and Microbial Faecal Indicators. Research Report No. 204. Water Services Association of Australia.

Roser, D. J., Ashbolt, N. J., Leeming, R., Kagi, R. and Waite T. D. (2003) Source water fingerprinting using sterols and particle size analyses and the management of faecal pollution and turbidity, p. 355-362. In M. J. Boyd, J. E. Ball, M. K. Babister and J. Green (ed.), Proc. 28th International Hydrology and Water Resources Symposium, 10 - 14 November 2003, vol. 2, ISBN 0 85824 060 2. The Institution of Engineers, Australia, Barton ACT.

FS 11 Microbiological water quality data – measurement variance and quality assurance

Research Findings

- Double blinded randomised spiked water samples were provided to five NATA accreditated laboratories to assess performance. Greater than 99% of blanks were uncontaminated or contaminated at a level of minimal concern; and increases in analyte concentrations in all spiked material contained were in line with expectations. Replicate microbiological and biomarker assays showed relative standard deviations of 10-50%, variation that laboratories did not know or would not divulge.
- ColorSeed™ , a commercial fluorescently labelled highly accurate 'seed' of protozoa (*Cryptosporidium* + *Giardia*) that is added to samples and counted together with naturally occurring (oo)cysts, was tested and adopted to estimate the true 'adjusted' concentrations of protozoa in every sample. ColorSeed addressed the key recovery issue; but it also highlighted recovery variance across sample matrices (< 1 % up to 60%).
- Such high relative variances were not seen primarily as a laboratory problem, but rather reflected the extent of *Variability* in microbiological assays and added to the *Uncertainty* inherent in the use of small data sets to represent overall water quality.
- Nevertheless as a result of the initial QC trials, the services of two laboratories were discontinued, and retraining, procedure modifications and information sharing were implemented in order to ensure study data was of high quality and credible.

Implementation

- Source water monitoring and studies should include QC (e.g. blanks, repeats, spikes), initiated by water managers to provide confidence in data collected.
- When evaluating commercial tenders for water analyses, it should be recognised that documented quantitative evidence of high analytical quality is as important in competitive selection as test affordability.
- Source water monitoring programmes should incorporate estimates of *Uncertainty* and *Variability* into their reporting, objective setting, auditing and management of water quality.
- While measurement of contamination and reproducibility present problems there is a need to develop additional quantitative approaches for measuring and reporting the recovery of microorganisms from source waters.

More information

Standard Methods for Water Analysis (regarding concepts of accuracy and precision)

FS 12 Hydrodynamic distribution of pathogens in reservoirs

Research Findings

- In the past, retention times in reservoirs were considered to be considerable. For example, the retention time of Myponga Reservoir (26,000 ML) based upon extraction is about three years. However, inflow events short-circuit through the reservoir and the river inflow can reach the off-take point within 30 hours, a distance of 5km from the river input.
- Pathogen transport is driven by the river inflow. The river inflow will move through the reservoir at a depth determined by the density (temperature and salinity) relative to the density of the reservoir.
- If the inflow (river intrusion) is cooler than the reservoir water the cool dense inflow will travel along the bottom of the reservoir.
- If the inflow is warm it may travel as a mid-water column inflow or as an overflow.
- It is critical to know where the river intrusion is because this is where the pathogens are likely to be. Sampling in the reservoir should target the river intrusion to facilitate the best measure of pathogen risk.
- Increasing temperature appears to be the major factor involved in decreasing *Cryptosporidium* infectivity.
- Loss of the ability to infect correlates with depletion of energy reserves.
- Predation by microorganisms can significantly decrease numbers of *Cryptosporidium*.

Model describing pathogen fate and transport

- Two models have been built to describe pathogen fate and transport. The models are designed to be used in a decision support role to optimise sampling for pathogens, select the appropriate depth for water harvesting and determine the highest risk period following an inflow event.
- The models describe the major transport, dilution and inactivation processes (UV and temperature).
- Elcom is a three-dimensional lake model that was used to simulate the hydrodynamics, particularly the river inflow. This was linked to an ecological model (Caedym) that described particle settling and pathogen inactivation. The model can be used to predict where pathogens occur in the reservoir following a river inflow event. Details on these models can be found at www.cwr.uwa.edu.au
- Inflow is a simpler web based tool for calculating the depth of the river intrusion, the dilution of the inflow as it travels through the reservoir and the time it takes for the inflow to travel from the river input to the water harvesting point. The model also contains information about pathogen fate (inactivation and settling). The INFLOW model is available at www.cwr.uwa.edu.au/~ttfadmin/model/inflow/

More information

Brookes, J. D., Antenucci, J., Hipsey, M., Burch, M. D., Ashbolt, N. and Ferguson, C. (2004) Pathogen transport, distribution and fate in lakes and reservoirs. *Environment International* 30: 741-759.

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Pathogen movement from on-site systems

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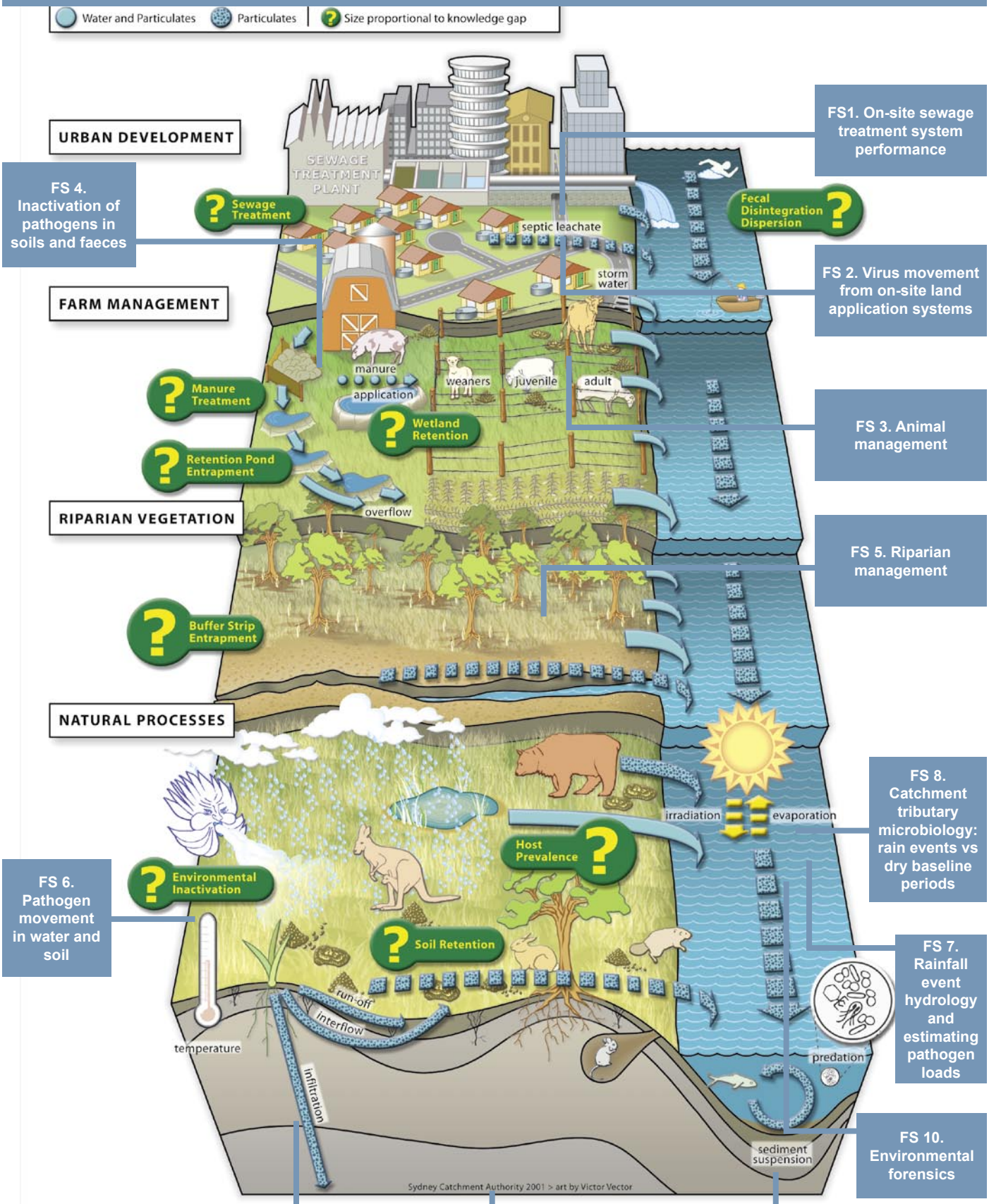

FS1. On-site sewage treatment system performance

FS 2. Virus movement from on-site land application systems

FS 3. Animal management

FS 4. Inactivation of pathogens in soils and faeces

FS 5. Riparian management

FS 6. Pathogen movement in water and soil

FS 7. Rainfall event hydrology and estimating pathogen loads

FS 8. Catchment tributary microbiology: rain events vs dry baseline periods

FS 9. Assessing the microbiological quality of vulnerable groundwaters

FS 10. Environmental forensics

FS 11. Microbiological water quality data – measurement variance and quality assurance

FS 12. Hydrodynamic distribution of pathogens in reservoirs

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