Soil and Land
Conservation
Consulting

Land capability and related issues for rural residential subdivision

Part lot 128, DP 754882, Parish of Goorooyarroo, Sutton

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Soil survey and assessment for forestry, agriculture, urban development; land degradation assessment; catchment planning; soil conservation advice and planning; farm planning; land capability mapping
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Contents

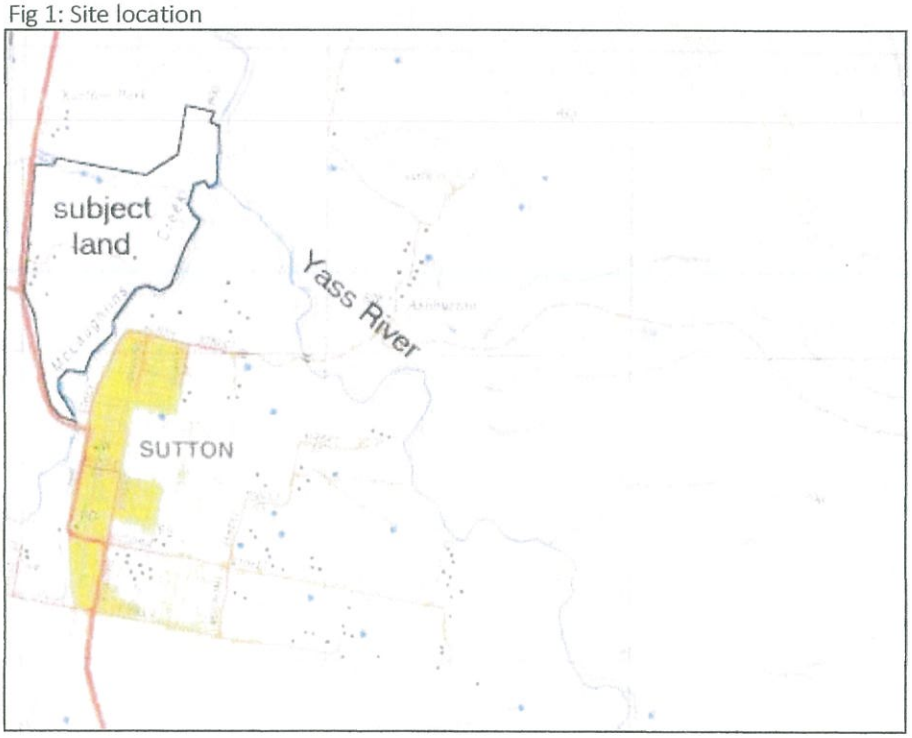
Introduction

This report addresses a range of land capability issues upon which to base future subdivision of a 30.1ha site located at Part lot 128, DP 754882, Parish of Goorooyarroo, Sutton. While council's LEP sets the parameters for lot yield, the physical makeup of the land in terms of its capacity to support building construction and effluent disposal will strongly influence ultimate lot yield and subdivision layout. Fig 1 shows the location of the site and map 1 in the appendix shows the physical makeup of the site.

The report is based on field traverse of the whole of the site, augering of representative soil profiles and review of published data on soils and water.

Subsequent to the report's preparation, Sutton Flood Study and Risk Management Plan has been completed and some land is shown to be within the 1% AEP zone. As such, the report has been amended to include measures for effluent management within this zone. Some other amendments have also been included following receipt of comments by council.

Fig 1: Site location



Physical characteristics

Terrain

The site is located on an alluvial terrace situated along the Yass River and McLaughlin's Creek. The terrain is very gently sloping across the terrace, then falls away steeply to an area of active floodplain. There is also a minor unnamed watercourse flowing from a catchment to the west of Gundaroo Road. The land on the terrace would be free draining and not prone to waterlogging or flooding, although some areas do fall within the defined 1% AEP. The alluvial flat and minor watercourse are prone to flooding or waterlogging constraints.

Soils

Soil distribution is closely related to terrain form, with the alluvial terrace supporting a well developed *red chromosol*, while the floodplain areas support *stratic rudosols*. The area is mapped as Gundaroo soil landscape in the soil landscape survey of the Canberra 1:100,000 sheet (Jenkins, 2000), and is next to the area covered in the more detailed Urban Capability Survey of the Sutton Area (Fogarty et al, 1995).

Red chromosols
These soils have developed on very old, weathered alluvium deposited by a formerly larger river system. The channel has subsequently incised, leaving the former alluvial plain elevated above the current channel. The high degree of weathering indicated by the red coloured subsoils indicate that this situation has prevailed for some considerable time.

The soil comprises a brown coloured loam textured topsoil to a depth of 20cm overlying a light to medium clay subsoil. The topsoil has weak to massive structure while the subsoil is strongly structured. Total soil depth exceeds 1m, with backhoe pits excavated on similar sites for the Sutton survey indicating soil depth exceeded 3m.

The analytical data from Jenkins (2000) for Gundaroo soil landscape, units gd 1, 2 and 3 shows low levels of salinity and a moderate phosphorous sorption capacity (~3000kg/m/ha). The cation exchange capacity is low, and dominated by magnesium and calcium, with sodium also at moderate levels.

The subsoils are free of mottling in the top metre, indicating that they are not prone to seasonally high watertables. As with all sites on the southern tablelands, short periods of saturation can be expected after extended rainfall events, but excess moisture will drain away rapidly downslope. Infiltration rate of the topsoil was estimated from tables 4.2A1 of AS1547:2000. Surface infiltration rate was in the range of 1.5 to 3m/day with a design effluent irrigation rate of 4mm/day.

Stratic rudols
These soils occur along the alluvial flats and are distinguished by a very dark coloured clay loam to clay topsoil over a yellow coloured clay subsoil. The dark topsoil is prone to cracking when it dries, indicative of both a high organic content and high clay content. There is no analytical data for these soils.

Vegetation
The site supports predominantly cropped paddocks of lucerne or annual pasture. There are willows and poplars and a range of other exotic species along the drainage channels.

Land degradation

Soil erosion
The whole site has very little land degradation apparent and is generally in a stable condition. The channels of McLaughlins Creek and the Yass River display minor bank erosion, although as a whole the channels are held together by predominantly exotic shrub and trees species.

Erosion hazard on the alluvial terrace is low due to the very gentle slope grades and the low inherent soil erodibility. Due to the proximity of the site to receiving waters however, there is potential for sediment export from the site associated with any development. The site lends itself to construction of strategically located sediment detention basins through which most of the runoff from the site can be directed, so it should be possible to minimise sediment export from the site.

Salinity
There is no salinity on the property, and it is not likely to develop on such terrain where groundwater is more likely to discharge to the river channel rather than at the landsurface.

Land capability

Building capability
Capability for residential development can be evaluated using criteria which exclude steep slopes and land with drainage constraints due to flooding or seasonal waterlogging. All of the

land forming the terrace is very gently sloping, free draining land capable of supporting residential construction, apart from land mapped as being within the 1% AEP flood level. It will be possible to ensure a subdivision layout which have building envelopes on land above the 1% AEP. The small steeply sloping fringe of the terrace and the active alluvial plain are not suited to residential construction.

Effluent management

On-site disposal of effluent will accord with the requirement's of council's LEP, which is underpinned by the state and national standards for on-site effluent planning and management:

- ANZ Standard 1547:2012 *On-site domestic wastewater management*, and
- *Environment and Health Protection Guidelines: On-site Sewage Management for Single Households* (NSW Government, 1998).

Assessment of the site in accordance with the limitation assessment procedure in the NSW guidelines (see appendix 1) shows that the alluvial terrace is free of severe limitations for effluent application by surface or sub-surface irrigation, apart from the areas mapped within the 1% AEP flood zone. More detailed, site specific effluent management reports will be prepared at the time of submitting building plans, and which will account for specific measures appropriate to land within the mapped flood zone. Regardless, no effluent management systems, including treatment units and disposal areas would be located within 100m of the Yass River and MacLaughlins Creek, 40m of the minor tributaries.

Any irrigation area would need to be sized to accept the design effluent generation rate. Typically, effluent irrigation areas for secondary treated effluent are of the order of 400 to 500sq m for a single residence. Smaller lots (<1ha) would require subsurface irrigation to disperse effluent. It would also be appropriate on lots of <1ha to require effluent treatment systems capable of nutrient reduction, as specified on the NSW Health website (https://www.health.nsw.gov.au/environment/domesticwastewater/Pages/awts.aspx). Additionally, AS1547:2012 recommends that there is sufficient land available for a spare irrigation area to use after approximately 10-15years, to avoid nutrient overloading.

A surface effluent dispersal area requires a buffer of 15m with a dwelling, 3m from boundaries on flat land, and 3m from driveways. For on-site disposal by sub-surface irrigation, the buffer with the dwelling can be reduced to 6m

It is more likely that for a small lot development, effluent would be reticulated to a package treatment plant, and disposed of by irrigation onto community land. For a large system it would also be necessary to have the capacity to provide wet weather storage to ensure effluent irrigation avoids periods when the soil does not have the capacity to absorb effluent.

Water balance and nutrient balance modelling shows that on-site effluent management can be achieved in a sustainable manner (see appendix). A typical set of management practices to achieve this outcome on any particular lot is also shown in the appendix 2.

Fig 2: showing the general appearance of the site

edge of the terrace in the northeast corner, running down to the Yass River, left of photo

part of the extensive area of terrace situated in the southern part of the site

References

Anon (1998) On-site Sewage Management for Single Households. NSW Government

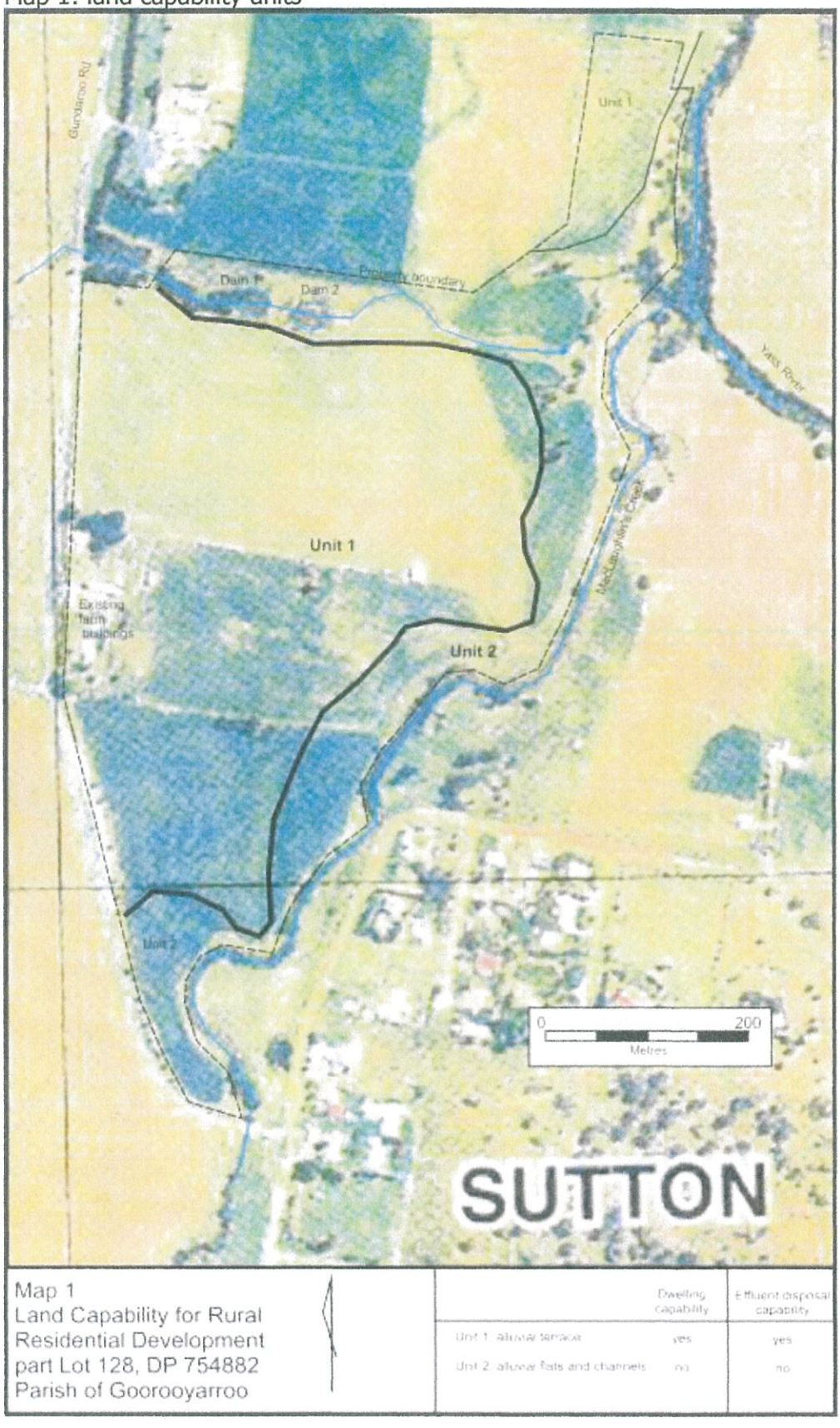
Fogarty P, Turner J and Bakker J (1995) Urban Capability of the Sutton Village Area. Dept of Conservation and Land Management

Jenkins B (2000) Soil Landscapes of the Canberra 1:100,000 Sheet DLWC.

Nicoll C and Scown J (1993) Dryland salinity in the Yass River Catchment: Processes and Management. Dept of Conservation and Land Management

Standards Australia (2012) Australian/New Zealand Standard 1547:2000 On site domestic wastewater management. Standards Australia

Map 1: land capability units



Map 1
Land Capability for Rural Residential Development
part Lot 128, DP 754882
Parish of Goorooyarroo

	Dwelling capability	Effluent disposal capability
Unit 1: alluvial terrace	yes	yes
Unit 2: alluvial flats and channels	no	no

Appendix 1: Site and Soil Limitation Assessment for effluent disposal

The following two limitation tables are a standardised guide to the site and soil characteristics which may limit the suitability of the site for effluent disposal and which would require attention through specific management practices. The tables have been reproduced from *On-site Sewage Management for Single Households* (tables 4 and 6, Anon, 1998). The italicised categories represent site and soil conditions of the land covered in this report. There are no major limitations on the upland areas designated as suitable for effluent application.

Site limitation assessment

Site feature	Relevant system	Minor limitation	Moderate limitation	Major limitation	Restrictive feature
Flood potential	All land application systems	*> 1 in 20 yrs*		Frequent, below 1 in 20 yrs	Transport in wastewater off site
	All treatment systems	*components above 1 in 100 yrs*		*Components below 1 in 100 yrs*[1]	Transport in wastewater off site, system failure
Exposure	All land application systems	*High sun and wind exposure*		Low sun and wind exposure	Poor evapo-transpiration
Slope %	Surface irrigation	*0-6*	6-12	>12	Runoff, erosion potential
	Sub-surface irrigation	0-10	10-20	>20	Runoff, erosion potential
	Absorption	*0-10*	*10-20*	*>20*	*Runoff, erosion potential*
Landform	All systems	*Hillcrests, convex sideslopes and plains*	Concave sideslopes and footslopes	Drainage plains and incised channels	Groundwater pollution hazard, resurfacing hazard
Run-on and seepage	All land application systems	*None-low*	Moderate	High, diversion not practical	Transport of wastewater off site
Erosion potential	All land application systems	*No sign of erosion potential*		Indications of erosion eg rils, mass failure	Soil degradation and off-site impact
Site drainage	All land application systems	*No visible signs of surface dampness*		Visible signs of surface dampness	Groundwater pollution hazard, resurfacing hazard
Fill	All systems	*No fill*	Fill present		Subsidence
Land area	All systems	*Area available*		Area not available	Health and pollution risk
Rock and rock outcrop	All land application systems	*<10%*	10-20%	>20%	Limits system performance
Geology	All land application systems	*None*		Major geological discontinuities, fractured or highly porous regolith	Groundwater pollution hazard

1 limited areas within 1% AEP to be managed by mounding treatment systems to ensure electrical components and tops of tanks are above designated flood level.

Soil limitation assessment

Soil feature	Relevant system	Minor limitation	Moderate limitation	Major limitation	Restrictive feature
Depth to bedrock	Surface and sub surface irrigation	*> 1.0*	.5-1.0	< 0.5	Restricts plant growth
or hardpan (m)	Absorption	> 1.5	*1.0-1.5*	*< 1.0*[1]	Groundwater pollution hazard
Depth to seasonal	Surface and sub surface irrigation	*> 1.0*	0.5-1.0	< 0.5	Groundwater pollution hazard
water table (m)	Absorption	*> 1.5*	1.0-1.5	< 1.0	Groundwater pollution hazard
Permeability[1]	Surface and sub surface irrigation	*2b, 3 and 4*	2a, 5	1 and 6	Excessive runoff and waterlogging
Class	Absorption	3, 4		1, 2, 5, 6	Percolation
Coarse fragments %	All systems	*0-20*	20-45	>40	Restricts plant growth, affects trench installation
Bulk density (g/cc) SL L, CL *C*	All land application systems	 < 1.8 *< 1.6* < 1.4		 > 1.8 > 1.6 >1.4	restricts plant growth, indicator of permeability
pH	All land application systems	> 6.0	*4.5-6.0*	-	Reduces plant growth
Electrical conductivity (dS/m)	All land application systems	*<4*	4-8	>8	Restricts plant growth
Sodicity (ESP)	Irrigation 0-40cm; absorption 0-1.2mtr	0-5	*5-10*	> 10	Potential for structural degradation
CEC mequiv/100g	Irrigation systems	> 15	*5-15*	< 5	Nutrient leaching
P sorption kg/ha	All land application systems	> 6000	*2000-6000*	< 2000	Capacity to immobilise P
Aggregate stability	All land application systems	*Classes 3-8*	class 2	class1	Erosion hazard

[1] from table 4.2A4 of A/NZS 1547:2000

Appendix 2: Sample management practices for surface irrigation of AWTS treated effluent

- The effluent must be treated by a NSW Health accredited Aerated Wastewater Treatment System (AWTS). A system with proven nutrient reduction in accordance with data provided to NSW Health should be considered where lot sizes are less than 1ha (https://www.health.nsw.gov.au/environment/domesticwastewater/Pages/awts.aspx).
- For land which is within the 1%AEP. The treatment units will be installed on a mound such that electrical components and the upper 30cm of the tank are above flood level.
- A designated effluent irrigation area sized according to the table below should be located within the land shown as suitable on the accompanying plan.

Number of occupants	Size (sq m)
4 or less	500
5	640
6 or more	760

- The irrigated area should be planted to garden shrubs. A mix of native plants and introduced species would be appropriate to maximise both nutrient and water utilisation. Appropriate native shrubs *include Callistemon pallidus, C. palludosis, Kunzea ericoides, K. parvifolia, K. phyllicoides* (burgen), *Leptospermum continentale (prickly ti tree), L. multicaule, L. flavescens, L. squarrosum, Melaleuca armillaris* (honey myrtle), *M. decussata, M. squamea, M. thymifolia, M. ericifolia, M. hypericifolia, M. linariifolia, Grevillea gaudi chaudi, Hardenbergia violacea*.
- Surface application of AWTS treated effluent may be carried out with drippers or large droplet sprays on lots in excess of 1ha while subsurface irrigation will be required from lots <1ha.
- The following buffers will be applied: 100m from the Yass River and Mc Laughlin's Creek, 40m with drainage lines and dams, 70m from any bore, 3m from the boundary, 15m from the dwelling.
- Stock and vehicular access must be excluded from the irrigation area as they compact the soil, thereby reducing the infiltration rate and water holding capacity.
- Likewise, the irrigation area should be protected from access and stockpiles during construction activities.
- Water conservation measures should be adopted to the greatest extent possible in the house, particularly in relation to the high water use activities of showering, clothes washing and toilet flushing. AAA rated plumbing appliances and fittings should be used. Measures including use of front loading washing machines, low volume shower roses and dual flush toilets can reduce water usage by 30 to 40%.

Appendix 3: Water Balance

The water balance is a useful tool for assessing whether effluent irrigation rates are appropriate, and do not lead to an excessive surplus of moisture, particularly in the cooler months. The balance is based on rainfall and evaporation data for Canberra Airport, which is the closest comparable site with both evaporation and rainfall data. The water balance procedure follows that described in the guidelines publication (Anon, 1998). The input variables are: median (ie 50 percentile) rainfall, evaporation times a crop factor of .7 to estimate evapotranspiration. A slightly higher design percolation rate of 10mm/week has been used on the basis that the ANZS 1547:2000 based estimation of permeability is relatively high, and the recommended 5mm/week is excessively conservative. The effluent application rate is based on 560l/day applied across 500sq m, that is 1.1 mm/day.

Month	Median r'fall	Evaporation	Crop factor	Evapotransp	Percolation	Effluent	Surp/def
	mm	mm		mm	mm	mm	mm
Jan	49	243	0.7	170	40	37	124
Feb	55	199	0.7	139	40	34	90
Mar	31	170	0.7	119	40	37	91
Apr	38	108	0.7	76	40	36	42
May	44	68	0.7	48	40	37	7
June	29	48	0.7	34	40	36	9
July	37	53	0.7	37	40	37	3
Aug	45	80	0.7	56	40	37	14
Sept	51	111	0.7	78	40	36	31
Oct	54	158	0.7	111	40	37	60
Nov	55	192	0.7	134	40	36	83
Dec	44	243	0.7	170	40	37	129

Comment: The surplus/deficit column indicates that the application rate does not result in a theoretical moisture surplus. Although not indicated in the water balance, in reality, there will be short periods of saturation after extended rainfall events, at any time of the year. On these occasions, water would drain downslope through the upper soil layers. Any nutrients in this water would be diluted rapidly downslope and would be utilised by vegetation within a relatively short distance.

Appendix 4: Nutrient Balance

The nutrient balance relates the surface application rate of nitrogen and phosphorous to plant uptake and soil fixation of these nutrients. The aim of the nutrient balance is to indicate that nutrient excesses which could present a hazard to water quality or groundwater, have been minimised. The balance is indicative only, as nutrient interactions with the soil and plants are very complex.

The application rates assume 4 occupants are generating effluent at 140l pp/day, and that it is applied over an irrigation area of 500sq m. The concentration of nutrients in the effluent are based on the data from Anon (1998).

Nitrogen

Application rate: 560 litres per day at 25mg/l[2] of N equals 5.1kg N p.a., spread over irrigation area of 500sq m equals 102 kg/ha/yr.

Uptake rate: Reported N uptake rates for introduced species range between 200 and 360 kg/ha/yr, and 80-100kg/ha/yr for native species. The eventual vegetation at the site will be a mix of native and introduced species.

Comment: The figures indicate that N is likely to be accounted for by plant uptake. It is possible that some leaching of nitrate will occur during periods of low growth, when the soil is saturated.

Phosphorous

Application rate: 560 litres per day at 10 mg/l of equals 2.0kg P p.a., spread over an irrigation area of 500sq m equals 41kg/ha/yr.

Uptake rate: Reported plant uptake rates are around 20kg/ha/yr for pasture and exotic species; P sorption capacity of the native soil is approximately 3000kg/ha.

Comment: Uptake of P by plants together with P sorption will account for P, for a period of 140 years. This satisfies the stated minimum requirement for 50 years minimum P sorption capacity plus utilisation by plants (Anon, 1998).

[2] N concentration for some AWTS models are considerably lower eg Ozzie Kleen and Envirocycle