STORM_CONSULTING

Water Cycle Management for Proposed Subdivision of Lot 2 DP 250984 (Grandfathers Gully)

Report Prepared for:
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Stormwater Management

1. INTRODUCTION

1.1. Background

STORM_CONSULTING have been engaged by David Brewer to undertake the preparation of an on site wastewater management report for the rural residential subdivision of Lot 2 DP 250984. The report provides a conceptual level of detail for a proposed wastewater management approach recommended for the site.

1.2. Purpose and Scope

The purpose of this report is to outline wastewater management for the proposed subdivision suitable for DA purposes and to discuss stormwater and riparian management issues on the site. This report contains information about the proposed system to facilitate assessment.

1.3. Proposed Development

The proposed development is located close to the corner of George Bass Drive and Grandfather's Gully Rd, Lilli Pilli (Figure 1.1). The land is currently zoned rural 1(c), small holdings. It is proposed to subdivide the 10.1 Ha property into 13 rural residential blocks ranging in size from 5000m^2 to 16000m^2, these blocks will be serviced by a sealed access road (Figure 1.2). It is proposed that wastewater be treated and disposed of on-site.

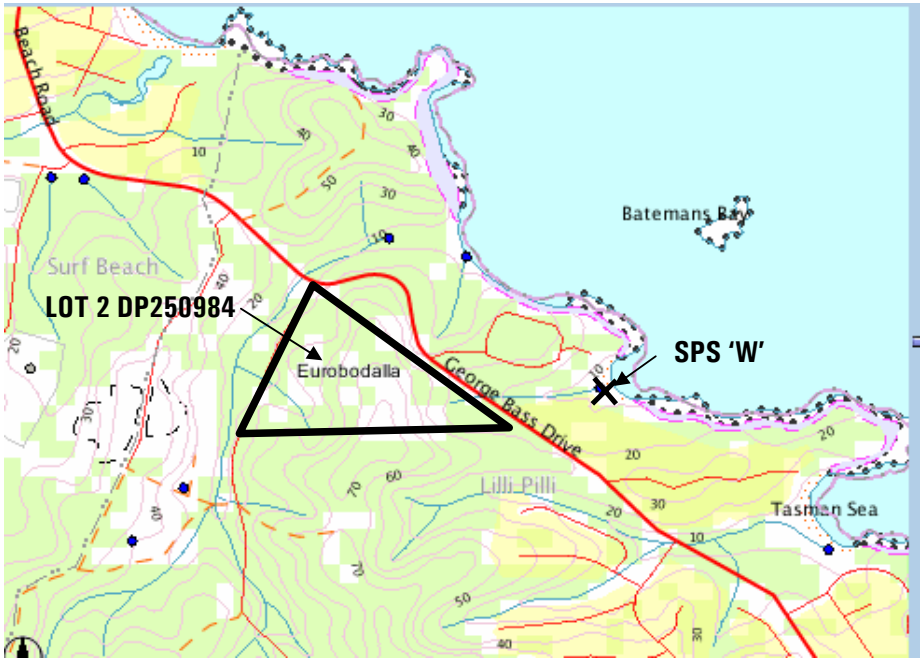


Figure 1.1 Locality

Figure 1.2 Proposed Development

1.4. Planning Context

1.4.1. ESC's on site wastewater management guidelines

Council's guidelines have been developed to guide developers or single dwelling owners in the management of wastewater disposal on site. These guidelines apply throughout the Shire to lands wherever on site wastewater disposal is allowed, including rural residential areas.

Council's objective is to:

> *'guide the Eurobodalla Shire community towards sustainable on-site management of sewage and wastewater while protecting and enhancing the quality of public health and the environment in the long term'*

The selection of treatment systems, method of disposal and siting of disposal areas is based on Council's on-site sewage management code of practice, AS1547:2000 and the *Environment and Health Protection Guidelines for on-site sewage management for single households* (i.e. the Silver Book).

1.4.2. Director General's Environmental Assessment Requirements

The following requirements are addressed in this report:

- Address potential impacts on the water quality of surface and groundwater (during construction and occupation of the site);
- Demonstrate effective riparian zone and buffering to protect the habitat values of the drainage lines and the associated vegetation;
- Address the requirements of the *NSW Floodplain Management Manual* for the site; and
- Provide a stormwater plan for the subdivision layout.

2. ON-SITE WASTEWATER MANAGEMENT

2.1. Site and Soil Assessment

STORM has undertaken a site and soil assessment to determine if on-site disposal of effluent can be applied to this site.

This assessment involved an on-site examination of topography and existing constraints and was complemented by a desktop analysis to identify the recommended buffer distances outlined in the *Environment and Health Protection Guidelines for on-site sewage management for single households* (i.e. the Silver Book).

A range of site soil samples were taken and tested to develop a further understanding of the sites capacity to adequately manage effluent disposal.

Assessment is based on the procedures outlined in the "Silver Book" and the Australian Standard 1547:2000.

2.1.1. On-Site assessment

A summary of the site assessment is contained in Table 2.1. The steepness of some areas/lots on this site is a significant constraint to effluent disposal without appropriate application techniques, particularly lots 7 and 10-13. Run-on is an issue for lots 7 and 13. Changes in grade on the lower slopes show evidence of possible waterlogging. Sites 11 and 12 show signs of possible erosion where surface vegetation has been removed during slashing.

The site is predominantly cleared and vegetation does not present a constraint for establishing disposal areas. Photos outlining the typical landscape are included in Table 2.2.

Table 2.1 Site Assessment Rating*

Lot	Average Grade	Exposure and Landform	Run-on	Site Drainage	Erosion potential
1	19	MODERATE	MODERATE	MAJOR	MODERATE
2	15	MODERATE	MODERATE	MODERATE	MODERATE
3	19	MODERATE	MODERATE	MODERATE	MODERATE
4	13	MODERATE	MODERATE	MODERATE	MODERATE
5	14	MODERATE	MODERATE	MODERATE	MODERATE
6	18	MODERATE	MODERATE	MODERATE	MODERATE
7	> 20	MINOR	MAJOR	MODERATE	MODERATE
8	19	MINOR	MODERATE	MODERATE	MODERATE
9	18	MINOR	MODERATE	MODERATE	MODERATE
10	> 20	MODERATE	MODERATE	MODERATE	MODERATE
11	> 20	MODERATE	MODERATE	MODERATE	MAJOR
12	> 20	MODERATE	MODERATE	MODERATE	MAJOR
13	17	MODERATE	MAJOR	MODERATE	MODERATE

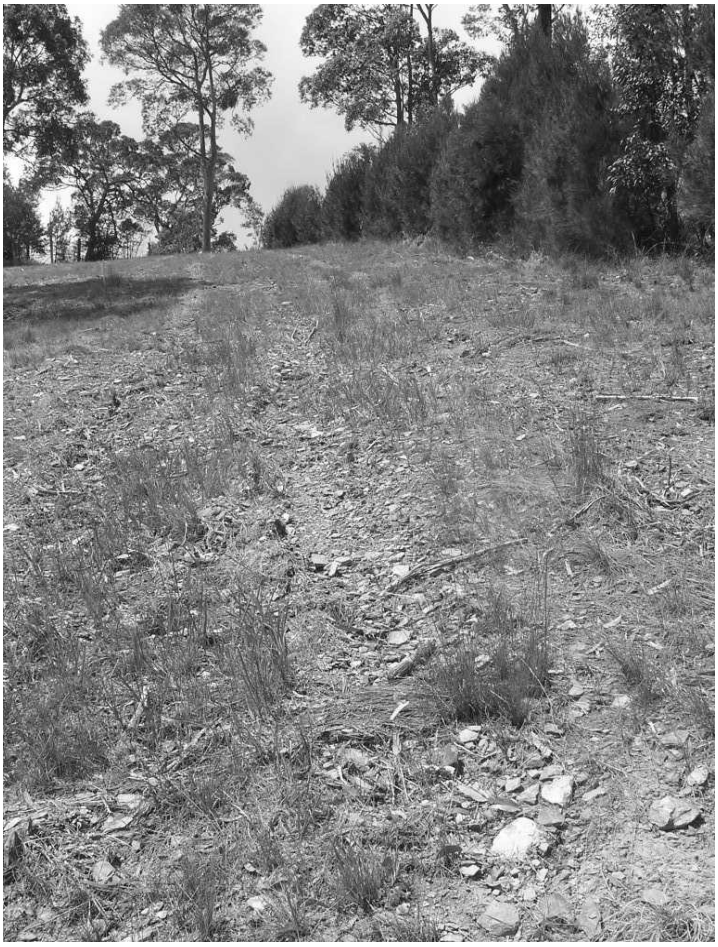
* Shaded areas denote significant constraint.

Table 2.2 Site photos and description

Photo	Description
	Looking north at large dam on proposed lot 4.

	From the base of the access road. Looking upslope at proposed lots 7 and 8. Note - predominantly cleared
	Looking north on the eastern side of the ridge at the top of the site. Looking at lots 11 and 12.

	Looking from the top of the ridge over lot 12. Note - vegetated drainage line in the midground and cleared areas on lots 5 and 6 on the other side of the drainage line.
	Example of soil on top of the ridge. Note, skeletal soils (i.e. minimal topsoil), yellow clayey soils with a high percentage of shale gravel.

	Looking north on the western side of the ridge at the top of the property over proposed lots 12 and 13.
	Looking east upslope on lot 12. Evidence of erosion starting down tracks created by slashing.

2.1.2. Buffer Areas

The recommended buffer distances from the Silver Book include:

- 40 metres to dams, intermittent waterways and drainage,
- 6 metres from boundaries, driveways and buildings

Figure 2.0 highlights the available areas for effluent disposal after these recommended buffers have been adopted.

2.1.3. Soil Assessment

A total of eight (8) soil samples were taken on this site. Sampling was performed at various points across the entirety of the site. Five (5) of these samples were sent away for analysis. The results of the samples form part of Table 2.3. Also included is a rating of results according to the *Silver Books* recommendations on the limitations of soil parameters for on-site systems. No **major** limiting factors were identified.

Table 2.3 Soil sample results and recommended limiting parameters

Lot Number	Closest Bore hole to lot	Depth of sample	Soil Texture	Limitation (assuming sub-surface irrigation)	Emerson Class Number	Limitation	pH	Limitation	P sorption (kg/Ha) (assuming bulk density of 1.5g/cm3)	Limitation (assuming sub-surface irrigation)	Cation Exchange Capacity (CEC)	Limitation (assuming sub-surface irrigation)
1	6	0.05-0.4	Weakly structured clay loam	N/A	8	Minor	5.1	Moderate	7110	Minor	-	-
2	6	0.05-0.4	Weakly structured clay loam	N/A	8	Minor	5.1	Moderate	7110	Minor	-	-
3	4	0.1-1.0	Strongly structured heavy clay	N/A	8	Minor	4.5	Moderate	9900	Minor	8.7	Moderate
4	7	0.3-0.9	Strongly structured med clay	N/A	8	Minor	4.5	Moderate	5610	Moderate	8.3	Moderate
5	7	0.3-0.9	Moderately structured medium clay	N/A	8	Minor	4.5	Moderate	5610	Minor	8.3	Moderate
6	7	0.3-0.9	Moderately structured medium clay	N/A	8	Minor	4.5	Moderate	5610	Minor	8.3	Moderate
7	5	0.15-0.65	Moderately structured medium clay	N/A	8	Minor	4.8	Moderate	7935	Minor	-	-
8	5	0.15-0.65	Moderately structured medium clay	N/A	8	Minor	4.8	Moderate	7935	Minor	-	-
9	1	0.15-1.0	Weakly structured medium clay	N/A	8	Minor	4.8	Moderate	7110	Minor	8.4	Moderate
10	1	0.15-1.0	Weakly structured medium clay	N/A	8	Minor	4.8	Moderate	7110	Minor	8.4	Moderate
11	1	0.15-1.0	Weakly structured medium clay	N/A	8	Minor	4.8	Moderate	7110	Minor	8.4	Moderate
12	1	0.15-1.0	Weakly structured medium clay	N/A	8	Minor	4.8	Moderate	7110	Minor	8.4	Moderate
13	4	0.1-1.0	Weakly structured medium clay	N/A	8	Minor	4.5	Moderate	9900	Minor	8.7	Moderate

Table 2.4 show the Design Irrigation Rates (DIR's) that can be expected for each soil type,

Table 2.4 – Design loading rates for site soils

Soil type	Irrigation DIR (mm/wk)	ETA/ETS* DIR (mm/wk)
Weakly structured clay loam	25	56
Strongly structured heavy clay	15	35
Strongly structured med clay	15	35
Moderately structured medium clay	15	35
Weakly structured medium clay	15	35

*Evapo-transpiration-assisted/absorption/seepage trenches/beds

2.2. Council Constraints Mapping

Council engaged a consultant Emmett O'Loughlin to prepare soil "wetness" maps for the Eurobodalla region as a tool to determine the appropriate use of *septic absorption trenches* as a method for disposal of wastewater on proposed development sites. The main concern is that soils that become saturated under natural conditions are not appropriate for absorption trenches as the primary treated effluent cannot escape into the soil profile and instead, will rise to the surface which may lead to potential contamination of receiving waters.

The effluent disposal area from lot 4 is located within the 1 in 5 year wetness zone of Council's constraints mapping.

2.3. On-site Management Design

2.3.1. Treatment and effluent quality

A Biolytix system or similar system that can achieve a high level of secondary treated effluent such as an Aerated Wastewater Treatment System (AWTS) is recommended. Table 2.5 contains typical expected wastewater quality after treatment.

Table 2.5 - Expected effluent quality

Parameter	AWTS*	Biolytix#
BOD	< 20mg/L	8.7mg/L
Suspended solids	< 30mg/L	5.4 mg/L
Total Nitrogen	25-50mg/L	
Total Phosphorous	10-15mg/L	
Faecal Coliforms	< 30cfu/100mL	
Dissolved oxygen	> 2mg/L	4.3 mg/L

*From table 14 "*On-site sewage management for single households*"

Test results listed on www.biolytix.com/db/pdfs/bf6_Trialreport.pdf

2.3.2. Effluent production

In accordance with Council guidelines, effluent production estimates are based on a 5 bedroom house per lot with a maximum of 7 persons using 115 L/d/p. This is based on a household with On-site roof water supply with standard water reduction fixtures (AS1547:2000). It is possible that usage estimates will be lower due to reuse (i.e. irrigation, toilet flushing) and high level water conservation fixtures such as 6/3 toilets and front load washing machines.

2.3.3. Disposal Systems

Two systems are recommended for the site:

- Subsurface irrigation system or,
- ETA/ETS system

Note due to slope constraints surface irrigation has not been considered as runoff could occur in high rainfall events before infiltration was achieved.

In assessing the above two options there are number of considerations that will ultimately come down to individual lot site and soil characteristics. Therefore STORM has provided design details for both systems along with a recommendation for each of the thirteen (13) lots.

Table 2.6 outlines the minimum disposal area and practical area required for each system (this area includes the minimum area for irrigation and an allowance for terracing and minimum distances between irrigation lines and trenches). Water balance calculation spreadsheets are contained in Appendix C.

Table 2.6 – Comparison of recommended and available disposal areas

Lot	Available Disposal Area (m^2)	Minimum Area	Practical area for subsurface irrigation (m^2)	Minimum Area	Practical area for ETA/ETS (m^2)
1	283.7	230	297	105	211
2	2177.1	230	297	105	211
3	1468.5	370	480	160	330
4	420.4	370	480	160	330
5	1779.4	370	480	160	330
6	2229.7	370	480	160	330
7	157.3	370	480	160	330
8	2590.1	370	480	160	330
9	3023.3	370	480	160	330
10	5955.2	370	480	160	330
11	5659.1	370	480	160	330
12	8110.7	370	480	160	330
13	1749.5	370	480	160	330

2.3.4. Subsurface irrigation system

Due to the steepness of the site it is recommended that the subsurface irrigation system be incorporated into a terraced landscape structure. A schematic example of this according to AS 1547 can be found in Appendix D.

It is proposed that four terraces with widths approximately 4.5 metres wide and 20 metres long be spaced evenly at 2 metres perpendicular to the gradient of the lot. This may have to be altered slightly depending on individual lots and the lot owners' location preference within outlined areas.

The areas outlined for subsurface irrigation should be lightly tilled to a depth of approximately 150mm along the alignment of subsurface irrigation lines to promote infiltration. Drip lines should be laid along contours. The irrigation system should be installed in accordance with AS 1547.

2.3.5. ETA/ETS systems

Similar to the subsurface system, an ETA/ETS system will work best if trenches are terraced across slopes. These systems rely on evapotranspiration and absorption of effluent as the method of disposal. These systems rely on vegetation uptake and transpiration of effluent to a greater extent than subsurface irrigation systems, this is why they are smaller in size. However, as plants are crucial to the success of these systems, high water use plants should be planted along the top of ETA/ETS beds. Eurobodalla Shire Council's on-site management guideline contains suggested species. For an example of an ETA/ETS bed details refer to Appendix D. ETA/ETS disposal systems are not recommended for steep slopes. It is also recommended that a surface water interceptor be constructed up-gradient from the trenches to reduce run-on.

Recommended width of trenches is 1.5m with a minimum 2m buffer between trenches.

2.3.6. On-site wastewater system maintenance

Depending on the treatment system selected, the home owner will need to nominate a supplier, with whom a maintenance contract will need to be entered into. In addition the treatment system and disposal system will be registered with Council on their on-site wastewater database and will undergo regular Council inspections to ensure systems are being operating correctly.

3. STORMWATER MANAGEMENT

3.1.1. Stormwater - Construction

An approved erosion and sediment control plan is to be provided prior to construction. This plan will be developed in accordance with "Managing Urban Stormwater – Soils and Construction" (the Blue Book). Measures will include sediment fencing around construction works, diversion structures, stockpiling, revegetation and retention of as much existing vegetation and top soil as possible.

3.1.2. Stormwater - Occupation

Stormwater management during occupation of the site focuses on erosion prevention, treatment of runoff and dispersion of overland flow to natural drainage lines. The two important sources of stormwater runoff are from the lots and the main access road.

Lot Runoff

Lot areas are a minimum of 5000m^2. This provides sufficient area to manage stormwater impacts from the lot. Roof runoff from lots will be directed to rainwater tanks as no potable water will be supplied to the site. Runoff from impervious surfaces should be directed in a dispersed manner to vegetated areas on each site.

Access Road Runoff

The proposed access road to service the subdivision is relatively steep (up to 20% slope). Therefore applying a standard kerb and gutter would quickly direct runoff to the bottom of the hill, preventing the more dispersed movement of runoff that would otherwise naturally occur. To mimic natural runoff behaviour as much as possible and treat road runoff the following stormwater management is proposed:

- The road will be crowned which will encourage runoff across rather than along the road surface;
- Rock-lined channel will be constructed on both sides of the road to intercept and convey this runoff;
- These channels will "turn out" regularly into small planted rock pool structures before allowing runoff to disperse as overland flow over grassed/vegetated areas;
- The rock-lined channels and rock pools will allow for the settling of course sediment and dispersion of flows and will allow for filtration of sediment by grassed areas, similar to grassed swales.

The channels will also prevent erosion of soils adjacent to the road. The proposed location and configuration of the rock-lined channels is shown on the attached plan P02 (Appendix E).

3.1.3. Stormwater Quality Modelling

The Model for Urban Stromwater Improvement Conceptualisation (MUSIC) has been used to demonstrate the impact of the development in relation to stormwater quality and quantity. This involves a comparison between the existing conditions and the proposed conditions on the site.

Existing Conditions

The site was recently used as a deer farm. As such, the majority of the site was cleared as grazing land for the deer. A homestead, associated farm buildings such as sheds and an access road, part paved and part unsealed exist on the site. The access road is relatively steep, and likely to be eroding during periods of rainfall, contributing to sediment runoff from the site.

Proposed conditions

The site is to be split into 13 rural residential blocks. It is assumed that each block will contain a roof area of approximately 200m^2 along with a driveway an associated paved areas. The existing access road will be decommissioned and replaced with a new, paved road. This road will have stormwater treatment as described in sections 3.1.2. Individual lots will have rainwater tanks, and runoff from paved areas should be diverted over pervious areas to provide a buffer treatment before reaching receiving waters.

Water Quality Modelling results

Water quality modelling was undertaken as a representation of the existing conditions and proposed conditions, with the suggested stormwater management measures. The event mean concentrations (EMCs) for suspended solids and nutrients assumed for the unsealed access road were at the upper limit, at 800mg/L for suspended solids and 1.5 mg/L for and phosphorous 5 mg/L for nitrogen. The EMCs used for the sealed road in both the pre and post development situation were 270, 0.5 and 2.2 mg/L for suspended solids, phosphorous and nitrogen respectively. This contributed to this significant improvement found in the proposed condition.

The results are listed in Table 3.1.

Table 3.1 MUSIC results

Annual Load	Existing conditions	Proposed conditions
Suspended solids load (kg/y)	779	426
Phosphorous load (kg/y)	1.7	1.19
Nitrogen load (kg/y)	13.3	13

By removing the existing unsealed road and replacing with a sealed road with associated treatment systems, the use of rainwater tanks on house lots, and the diversion of impervious areas to pervious areas, pollutant loads are reduced to less than their current levels.

3.1.4. Stormwater Quantity Modelling

The site is split into two catchments. The eastern corner drains down to George Bass Drive, to a watercourse that drains to Circuit Beach. The remainder of the site drains to Grandfathers Gully Creek, which passes under George Bass Drive, before discharging to the sea (Figure 3.1).

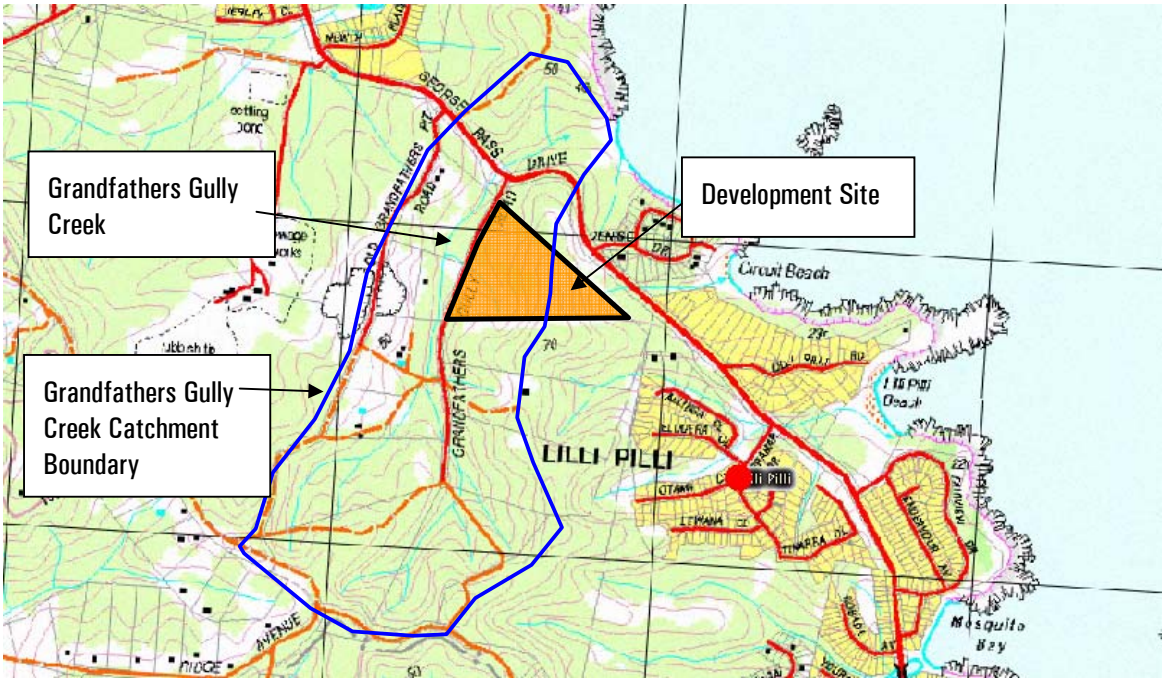


Figure 3.1 Proposed site in relation to receiving waters.

The eastern corner draining to Circuit Beach is 2.62 Ha. The impervious % of this catchment will increase from approximately 1.3% (340m^2) to 3.9% (1040m^2) impervious, a threefold increase, however this is still a very small proportion of the total catchment draining to Circuit Beach of 21Ha and unlikely to have any significant impact on peak flows.

The portion of the site draining to the Grandfathers Gully Creek is approximately 7.6Ha. The impervious proportion of this sub catchment is proposed to increase from 0.086Ha to 0.454 Ha. The site is at the lower end of the Grandfathers Gully Creek catchment (104 Ha), this, combined with the slight increase in impervious area produces a negligible impact on the total flows in the Grandfathers Gully Creek. The site in question will drain to the outlet, prior to the peak flow making its way down the creek, and as such have no real impact on flows in Grandfathers Gully Creek. A simple hydrologic model was prepared using the software XP Rafts to confirm this. Peak flows at the outlet of Grandathers Gully actually decrease slightly (Table 3.2).

Table 3.2 Comparison of Pre and Post Flows in Grandfathers Gully Creek.

	100 year ARI Peak flow at end of Grandfathers Gully Creek	5 year ARI Peak flow at end of Grandfathers Gully Creek
Existing Situation	42.959	11.056
Proposed Situation	42.886	11.052

3.1.5. Riparian Zone

Councils constraints mapping suggests that the unnamed drainage line on the site is classified as category 2 riparian zone. The DGEARs state that a riparian buffer zone be established at least 20 metres on either side of the drainage line and riparian management should be undertaken in accordance with the riparian management objectives outlined in Landcom's *Soils and Construction, Managing Urban Stormwater 4th Edition (2004)* otherwise known as the Blue Book.

The drainage line has a relatively small catchment of approximately 7 Ha. The peak runoff for the 1 in 1 year event is only 400 L/s.

From the dam upstream, no stormwater management, wastewater management or built forms are proposed within 20m of the creek centreline. The building envelope for Lot 4 is located within 20m of the edge of the dam, as is the effluent disposal area for Lot 4. However, there are significant areas on the opposite side of the dam as well as upstream to offset this encroachment and maintain the habitat and water quality objectives for the drainage line.

3.1.6. Stormwater Management Plan

Attached Plan P02 (appendix E) illustrates the stormwater management concept for this property. The concept plan focuses on the access road, highlighting the basic configuration of the rock-lined channels and how they aim to disperse water rather than channel flows off site.

4. FLOODPLAIN MANAGEMENT:

The 100yr ARI peak flow in the unnamed drainage line is 1.31 m^3/s based on the following input information:

Catchment Area = 6.87 Ha
Tc = 0.76 x $0.0687^{0.38}$ = 0.33 h
I_{100} = 172 mm/h
Runoff Coefficient = 0.4
Q_{100} = CIA = 0.278 x 0.4 x 172 x 0.0687 = 1.31 m^3/s

The building envelope on Lot 4 is the closest to the unnamed drainage line. The reduced level of the building envelope for lot 4 is approximately 24m AHD. The dam spillway is approximately RL 22.5, and dam wall approximately RL 23.2. Spillway dimensions are 1.4m base with 1V:4.5H side slopes and 0.7m deep. Assuming a conservative grade of 2% and conservative Manning's roughness value of 0.8 for the spillway, the 100 year flow through the spillway based on Manning's equation is 0.48m deep, so the 1% AEP flood level is approximately RL 23. The spillway has a capacity of approximately 3 m^3/s (based on the conservative assumptions above) before the dam wall is overtopped.

Based on these calculations the ground level of RL 24m at the building envelope for Lot 4 provides 1m of freeboard above the 1% AEP flood level of 23m in the unnamed drainage line in the vicinity of the dam. We recommend a minimum finished floor level for Lot 4 of 24m AHD to ensure that the building is well beyond flood levels in the unnamed drainage line.

5. WATER SUPPLY

Connection to Council's water supply is not possible at this site. Supply will be met through collection of rainwater from roofs to supply all indoor household uses and a proportion of outdoor uses where necessary. It is estimated, based on a roof size of 200m^2 and a 3 person household, that a 60KL tank should be sufficient to provide water supply with a high security. However, a sufficient tank size is highly variable based on roof catchment, occupancy and demand management fixtures installed in the home. It is recommended that purchasers assess their own water demand needs and level of supply security when selecting a storage size.

Each house must collect and maintain in reserve a minimum of 10KL as bushfire storage. This storage may be contained in the base of a water supply tank with the normal off take situated at the required level and a rural fire brigade compatible off take lower down for the stored 10KL. Otherwise, a separate tank may be used.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Wastewater

It is proposed that each lot have an on-site treatment system, either a Biolytix, or AWTS for wastewater treatment. The water from this treatment system will then be fed into a suitably sized subsurface irrigation or ETA/ETS trench system allowing water to be infiltrated into the ground, absorbed by vegetation and evaporated from the soil.

Lot 4 is located within the 1 in 5 year Wetness constraint area, however this is not an issue as Council's soil wetness constraint mapping was undertaken with septic absorption trenches in mind. Generally, septic absorption trench disposal systems pose a higher risk to health and the environment than secondary treatment systems. Septic tanks do not remove nutrients and the water can be highly infectious, therefore must be disposed of below the surface. Additionally, absorption trenches rely primarily on the permeability of a soil and the long term ability of the soil to accept and therefore treat the effluent through the soil profile, not on evapotranspiration.

The recommended system for Lot 4 is an AWTS providing secondary level treatment and surface, or sub-surface irrigation, so that the effect of evapotranspiration is maximised. The system has been sized such that effluent is retained to the disposal area in an average climate year. Therefore the 1 in 5 year wetness constraint is not a restriction on this lot.

Refer to Table 6.1 for suitable systems for individual lots. Appendix A illustrates potential locations of these on-site systems.

Table 6.1 – Recommended On-site system for each Lot

Lot	Recommended on-site system	Comments
1	ETA/ETS	The recommended 40m buffer to drainage lines covers much of the proposed lot. This buffer distance is a recommendation only. An ETA/ETS system of the size recommended in this report is recommended. Although this will encroach into the buffer area, this is only slight and the slope drainage path is greater than 40m.
2	Subsurface irrigation	
3	Subsurface irrigation	
4	ETA/ETS	The recommended 40m buffer to drainage lines and farm dams covers much of the proposed lot. An ETA/ETS disposal system is proposed on the lower slopes below the dam wall. The slope drainage path is approximately 40m.
5	Subsurface irrigation or ETA/ETS	
6	Subsurface irrigation	
7	Subsurface irrigation	A small dam is located on Lot 7, a 40m recommended buffer has been shown around thus dam, however, due to the size of the dam and the small size of the property it is debatable whether it would be considered a farm dam, as defined in

		the Silver Book. Subsurface irrigation is recommended in the north eastern corner of the property to avoid draining to the existing dam.
8	Subsurface irrigation or ETA/ETS	
9	Subsurface irrigation	
10	Subsurface irrigation	
11	Subsurface irrigation	
12	Subsurface irrigation	Steep Lot (>20%). The proposed location for subsurface irrigation is steep. Significant terracing will be necessary to establish even dispersal of treated effluent.
I3	Subsurface irrigation	Major run-on potential. Ensure that diversion/cut off drains are constructed up gradient of on-site system.

6.2. Water Supply

A tank size of approximately 40-50kL is recommended for each lot; however, this depends on water usage of owners and roof sizes. Separate fire storage of 10kL is required which can be included in main storage, or contained in separate tanks.

6.3. Stormwater Management

The majority of the development will retain its pervious nature. Runoff from roads will be managed by maintaining diffuse flows and allowing filtration and infiltration. The impact of runoff from lots will be restricted through the use of rainwater tanks and the large buffer distances between the runoff source and receiving waters.

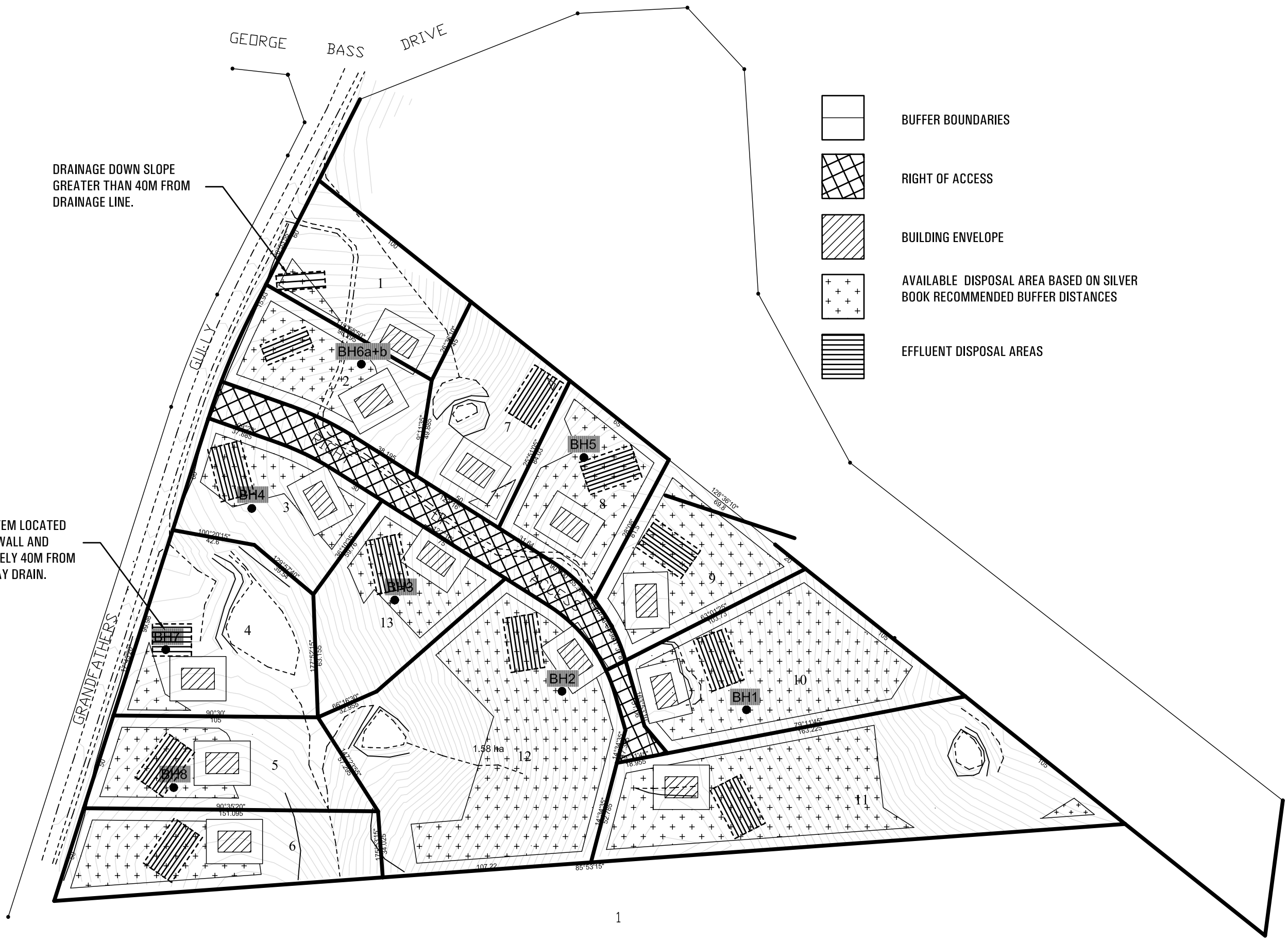
Water quality modelling demonstrates that post development impacts will be negligible. Peak flows from the sie will increase slightly, however will not increase peak flows in receiving water due to the location of the development within the catchment.

6.4. Floodplain Management

The 100 year ARI peak flow is approximately 1.3 m^3/s. The building envelope associated with Lot 4 is affected by flood levels. We recommend a minimum finished floor level for Lot 4 of 24m AHD to ensure that the building is well beyond flood levels in the unnamed drainage line.

APPENDIX A

Effluent Disposal Area and Potential Locations of On-site Systems



STORM_CONSULTING

ISSUE	REVISION	BY	CKD	DATE
A	FOR COMMENT	BA	LB	27/02/06

DOCUMENT PURPOSE: ADVANCED COPY: ☐ FOR CLIENT APPROVAL: ☐ FOR DA: ☐ FOR CC: ☐ FOR TENDER: ☐ FOR CONSTRUCTION: ☐

COORD. ORIGIN: ISG | SCALE: 1:1000
DATUM: AHD | DATE: 2006
DRAWN: BA | DESIGNED: LB | CHECKED: LB

CLIENT: DAVID BREWER, 648 THE RIDGE ROAD, MALUA BAY NSW 2536

WCM FOR GRANDFATHERS GULLY
EFFLUENT DISPOSAL
AVAILABLE AREA

DRAWING: G491/PO1
SHEET: 1 OF 1 A3

APPENDIX B
Soil Sample Results

Ecowise Environmental

Analytical Report

Storm Consulting
Unit 16 Capital Coast Centre
Church St, Maruya
NSW, 2537

Phone: **02 4474 5573**
Fax: **02 9499 4311**

Contact Name: **Lachlan Bain**
Report Number: **W06/0686**
Sample(s) Received: **27/01/2006**
Client Reference: **BH Samples**
Batch Number: **W16133**

Notes:

* See attached sheets
Particle size analysis analysed by Ecowise, Report No.56306, NATA Accreditation No.1531

The NATA accreditation of Enviro-Managers Pty Ltd does not cover analyses performed by external laboratories.
The results stated in this report relate only to the sample(s) as submitted by the client.
Samples analysed as received.

Results Approved By:

Valerie Smith
Laboratory Director

NATA Accredited Laboratory
Number. 3628 (Chemical Testing)
Number. 3629 (Biological Testing)

NATA
WORLD RECOGNISED
ACCREDITATION

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Date Reported: Wednesday March 8, 2006

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SYDNEY 02 4721 3477

Enviro-Managers Pty Ltd trading as Ecowise Environmental ABN 18 072 428 810 www.ecowise.com.au (Subsidiary of ActewAGL)

Ecowise Environmental

Analytical Report — *Report No: W06/0686*

Results:						
Client Id		BH1 0.15-1.0	BH 4 0.1-1.0	BH 5 0.15-0.65	BH 6 0.05-0.4	BH 7 0.3-0.9
Laboratory Id		W16133/001	W16133/002	W16133/003	W16133/004	W16133/005
Cation Exchange Capacity (CEC)						
Method: R&H 15G1	*Units: meq/100g*	8.4	8.7	-	-	8.3
Emerson Class No						
Method: AS 1289 C8.2 1980	*Units:*	8	8	8	8	8
Particle size analysis (sieving)						
Method: AS 1289 C6.3 1994	*Units:*	*	*	-	-	*
pH						
Method: APHA 4500 H B	*Units: pH units*	4.8	4.5	4.8	5.1	4.5
P-sorption						
Method: Dept Ag	*Units: mg/kg*	474	660	529	394	674

Date Reported: Wednesday March 8, 2006

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SYDNEY 02 4721 3477

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Ecowise Environmental

Analytical Report — ***Report No: W06/0686***

Results:						
Client Id		BH 8 0.01-0.7				
Laboratory Id		W16133/006				
Cation Exchange Capacity (CEC) *Method: R&H 15G1*	*Units: meq/100g*	-				
Emerson Class No *Method: AS 1289 C8.2 1980*	*Units:*	8				
Particle size analysis (sieving) *Method: AS 1289 C6.3 1994*	*Units:*	-				
pH *Method: APHA 4500 H B*	*Units: pH units*	4.3				
P-sorption *Method: Dept Ag*	*Units: mg/kg*	521				

Method(s):

APHA 4500 H B	pH
AS 1289 C6.3 1994	Particle size analysis (sieving)
AS 1289 C8.2 1980	Emerson Class No
Dept Ag	P-sorption
R&H 15G1	Cation Exchange Capacity (CEC)

Date Reported: Wednesday March 8, 2006

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SYDNEY 02 4721 3477

Enviro-Managers Pty Ltd trading as Ecowise Environmental ABN 18 072 428 810 www.ecowise.com.au (Subsidiary of ActewAGL)

Laboratory Sieve Test Report

Method of sieving: mechanical, wet and dry
Diameter of test sieve: 200mm
Duration of sieving: 5 min wet, 15 min dry

Material: 16133/5

LRN: 492042

Sieve Overload Mass (g)	Sieve size (mm)	Mass retained (g) Subportions			Total	Mass Passing (g)	% Total Passing
100	2.00				21.1	82	79.5
70	1.00				2.9	79.1	76.7
55	0.600				1.4	77.7	75.4
40	0.355				1	76.7	74.4
33	0.212				0.8	75.9	73.6
25	0.125				0.5	75.4	73.1
18	0.075				0.3	75.1	72.8
	Pan				0		
	Total			0	28		

Total dry mass of sample (g)	103.1
Mass retained after washing on 75um (g)	28
Total mass retained (g)	103.1
Percentage Loss (%)	0.0

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This report relates only to the items tested as specified hereon
These samples were analysed as received into the laboratory

Mauribrotta
for Manager Ecowise Environmental

Date 02/03/06

This laboratory is accredited by the National Association of Testing Authorities

eCOWISE Environmental
P.O. Box 1834
Fyshwick ACT 2609
ACN 074 205 780

Telephone 02 6270 7650
Facsimile 02 6270 7608

02-MAR-2006 THU 14:25 Ecowise Environmental FAX NO. 02 62707608 P. 03

Laboratory Sieve Test Report

Method of sieving: mechanical, wet and dry
Diameter of test sieve: 200mm
Duration of sieving: 5 min wet, 15 min dry

Material: 16133|2

LRN: 492041

Sieve Overload Mass (g)	Sieve size (mm)	Mass retained (g) Subportions			Total	Mass Passing (g)	% Total Passing
100	2.00				17.8	85.9	82.8
70	1.00				3.7	82.2	79.3
55	0.600				1.9	80.3	77.4
40	0.355				1.6	78.7	75.9
33	0.212				1.8	76.9	74.2
25	0.125				1.2	75.7	73.0
18	0.075				0.9	74.8	72.1
	Pan				0		
	Total			0	28.9		

Total dry mass of sample (g)	103.7
Mass retained after washing on 75um (g)	28.9
Total mass retained (g)	103.7
Percentage Loss (%)	0.0

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These samples were analysed as received into the laboratory

ECOWISE Environmental
P.O. Box 1834
Fyshwick ACT 2609
ACN 074 205 780

Telephone 02 6270 7650
Facsimile 02 6270 7608

for Manager Ecowise Environmental

Date 02/05/06

This laboratory is accredited by the National Association of Testing Authorities

02-MAR-2006 THU 14:25 Ecowise Environmental FAX NO. 02 62707608 P. 04

Laboratory Sieve Test Report

Method of sieving: mechanical, wet and dry
Diameter of test sieve: 200mm
Duration of sieving: 5 min wet, 15 min dry

Material: 16133/1
LRN: 492040

Sieve Overload Mass (g)	Sieve size (mm)	Mass retained (g) Subportions			Total	Mass Passing (g)	% Total Passing
100	2.00				50.2	51.7	50.7
70	1.00				2.4	49.3	48.4
55	0.600				1.2	48.1	47.2
40	0.355				0.8	47.3	46.4
33	0.212				0.6	46.7	45.8
25	0.125				0.4	46.3	45.4
18	0.075				0.4	45.9	45.0
	Pan				0		
	Total			0	56		

Total dry mass of sample (g)	101.9
Mass retained after washing on 75um (g)	56
Total mass retained (g)	101.9
Percentage Loss (%)	0.0

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This report relates only to the items tested as specified hereon
These samples were analysed as received into the laboratory

Kaen Lindsay
for Manager Ecowise Environmental
Date 02/03/06

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SOIL SAMPLE RESULTS (Enviro-Managers PTY LTD)

APPENDIX C

Disposal Area Calculations- Hydraulic Load

Subsurface Irrigation – minimum area (Lot 2)

MINIMUM AREA METHOD													
Daily water use =	805	L/d											
Design percolation rate (Based on texture classification and AS1547)=	25	mm/wk	*clay loam weakly structured*										
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Number of days		31	28	31	30	31	30	31	31	30	31	30	31
Precip		73.1	73.5	85.3	48.3	54.2	50.7	23	32.8	49.6	59.9	75.2	68.1
Evaporation		195	160.3	144.6	118.8	94.7	86.2	93.9	127.2	147.4	177	181.9	209.1
C factor		0.8	0.8	0.8	0.8	0.7	0.6	0.6	0.6	0.7	0.8	0.8	0.8
OUT													
Evapotrans with crop factor		156	128.24	115.68	95.04	66.29	51.72	56.34	76.32	103.18	141.6	145.52	167.28
Percolation		110.71	100.00	110.71	107.14	110.71	107.14	110.71	110.71	107.14	110.71	107.14	110.71
Output		266.71	228.24	226.39	202.18	177.00	158.86	167.05	187.03	210.32	252.31	252.66	277.99
IN													
Precip		73.10	73.50	85.30	48.30	54.20	50.70	23.00	32.80	49.60	59.90	75.20	68.10
Possible Effluent irrig		193.61	154.74	141.09	153.88	122.80	108.16	144.05	154.23	160.72	192.41	177.46	209.89
Actual eff irrig		110.91	100.18	110.91	107.33	110.91	107.33	110.91	110.91	107.33	110.91	107.33	110.91
Input		184.01	173.68	196.21	155.63	165.11	158.03	133.91	143.71	156.93	170.81	182.53	179.01
Storage		-82.70	-54.56	-30.18	-46.55	-11.89	-0.83	-33.14	-43.32	-53.39	-81.50	-70.13	-98.98
Cumulative		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Irrigation area (m2) =	225												
Storage (m3) =	0												

Subsurface Irrigation – minimum area (Lot 3 - 13)

MINIMUM AREA METHOD														
Daily water use =	805	L/d												
Design percolation rate (Based on texture classification and AS1547)=	15	mm/wk	Strongly structured heavy clay											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Number of days		31	28	31	30	31	30	31	31	30	31	30	31	365
Precip		73.1	73.5	85.3	48.3	54.2	50.7	23	32.8	49.6	59.9	75.2	68.1	693.7
Evaporation		195	160.3	144.6	118.8	94.7	86.2	93.9	127.2	147.4	177	181.9	209.1	1736.1
C factor		0.8	0.8	0.8	0.8	0.7	0.6	0.6	0.6	0.7	0.8	0.8	0.8	8.8
OUT														
Evapotrans with crop factor		156	128.24	115.7	95.04	66.29	51.72	56.34	76.32	103.18	141.6	145.52	167.28	1303.21
Percolation		66.43	60.00	66.43	64.29	66.43	64.29	66.43	66.43	64.29	66.43	64.29	66.43	782.14
Output		222.43	188.24	182.11	159.33	132.72	116.01	122.77	142.75	167.47	208.03	209.81	233.71	2085.35
IN														
Precip		73.10	73.50	85.30	48.30	54.20	50.70	23.00	32.80	49.60	59.90	75.20	68.10	693.70
Possible Effluent irrig		149.33	114.74	96.81	111.03	78.52	65.31	99.77	109.95	117.87	148.13	134.61	165.61	1391.65
Actual eff irrig		67.45	60.92	67.45	65.27	67.45	65.27	67.45	67.45	65.27	67.45	65.27	67.45	794.12
Input		140.55	134.42	152.75	113.57	121.65	115.97	90.45	100.25	114.87	127.35	140.47	135.55	1487.82
Storage		-81.88	-53.82	-29.36	-45.76	-11.07	-0.04	-32.32	-42.50	-52.60	-80.68	-69.34	-98.16	
Cumulative		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Irrigation area (m2) =	370													
Storage (m3) =	0													

ETA/ETS – minimum area (Lot 1)

MINIMUM AREA METHOD														
Daily water use =	805	L/d												
Design percolation rate (Based on texture classification and AS1547)=	56	mm/wk	*clay loam weakly structured*											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Number of days		31	28	31	30	31	30	31	31	30	31	30	31	365
Precip		73.1	73.5	85.3	48.3	54.2	50.7	23	32.8	49.6	59.9	75.2	68.1	693.7
Evaporation		195	160.3	144.6	118.8	94.7	86.2	93.9	127.2	147.4	177	181.9	209.1	1736.1
C factor		0.8	0.8	0.8	0.8	0.7	0.6	0.6	0.6	0.7	0.8	0.8	0.8	8.8
OUT														
Evapotrans with crop factor		156	128.24	115.68	95.04	66.29	51.72	56.34	76.32	103.18	141.6	145.52	167.28	1303.21
Percolation		248.00	224.00	248.00	240.00	248.00	240.00	248.00	248.00	240.00	248.00	240.00	248.00	2920.00
Output		404.00	352.24	363.68	335.04	314.29	291.72	304.34	324.32	343.18	389.60	385.52	415.28	4223.21
IN														
Precip		73.10	73.50	85.30	48.30	54.20	50.70	23.00	32.80	49.60	59.90	75.20	68.10	693.70
Possible Effluent irrig		330.90	278.74	278.38	286.74	260.09	241.02	281.34	291.52	293.58	329.70	310.32	347.18	3529.51
Actual eff irrig		226.86	204.91	226.86	219.55	226.86	219.55	226.86	226.86	219.55	226.86	219.55	226.86	2671.14
Input		299.96	278.41	312.16	267.85	281.06	270.25	249.86	259.66	269.15	286.76	294.75	294.96	3364.84
Storage		-104.04	-73.83	-51.52	-67.19	-33.23	-21.47	-54.48	-64.66	-74.03	-102.84	-90.77	-120.32	
Cumulative		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Irrigation area (m2) =	110													
Storage (m3) =	0													

ETA/ETS – minimum area (Lot 3-13)

MINIMUM AREA METHOD														
Daily water use =	805	L/d												
Design percolation rate (Based on texture classification and AS1547)=	35	mm/wk	*Medium to heavy clays*											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Number of days		31	28	31	30	31	30	31	31	30	31	30	31	365
Precip		73.1	73.5	85.3	48.3	54.2	50.7	23	32.8	49.6	59.9	75.2	68.1	693.7
Evaporation		195	160.3	144.6	118.8	94.7	86.2	93.9	127.2	147.4	177	181.9	209.1	1736.1
C factor		0.8	0.8	0.8	0.8	0.7	0.6	0.6	0.6	0.7	0.8	0.8	0.8	8.8
OUT														
Evapotrans with crop factor		156	128.24	115.7	95.04	66.29	51.72	56.34	76.32	103.18	141.6	145.52	167.28	1303.21
Percolation		155.00	140.00	155.00	150.00	155.00	150.00	155.00	155.00	150.00	155.00	150.00	155.00	1825.00
Output		311.00	268.24	270.68	245.04	221.29	201.72	211.34	231.32	253.18	296.60	295.52	322.28	3128.21
IN														
Precip		73.10	73.50	85.30	48.30	54.20	50.70	23.00	32.80	49.60	59.90	75.20	68.10	693.70
Possible Effluent irrig		237.90	194.74	185.38	196.74	167.09	151.02	188.34	198.52	203.58	236.70	220.32	254.18	2434.51
Actual eff irrig		155.97	140.88	155.97	150.94	155.97	150.94	155.97	155.97	150.94	155.97	150.94	155.97	1836.41
Input		229.07	214.38	241.27	199.24	210.17	201.64	178.97	188.77	200.54	215.87	226.14	224.07	2530.11
Storage		-81.93	-53.87	-29.41	-45.80	-11.12	-0.08	-32.37	-42.55	-52.64	-80.73	-69.38	-98.21	
Cumulative		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Irrigation area (m2) =	160													
Storage (m3) =	0													

APPENDIX D

Typical effluent disposal details

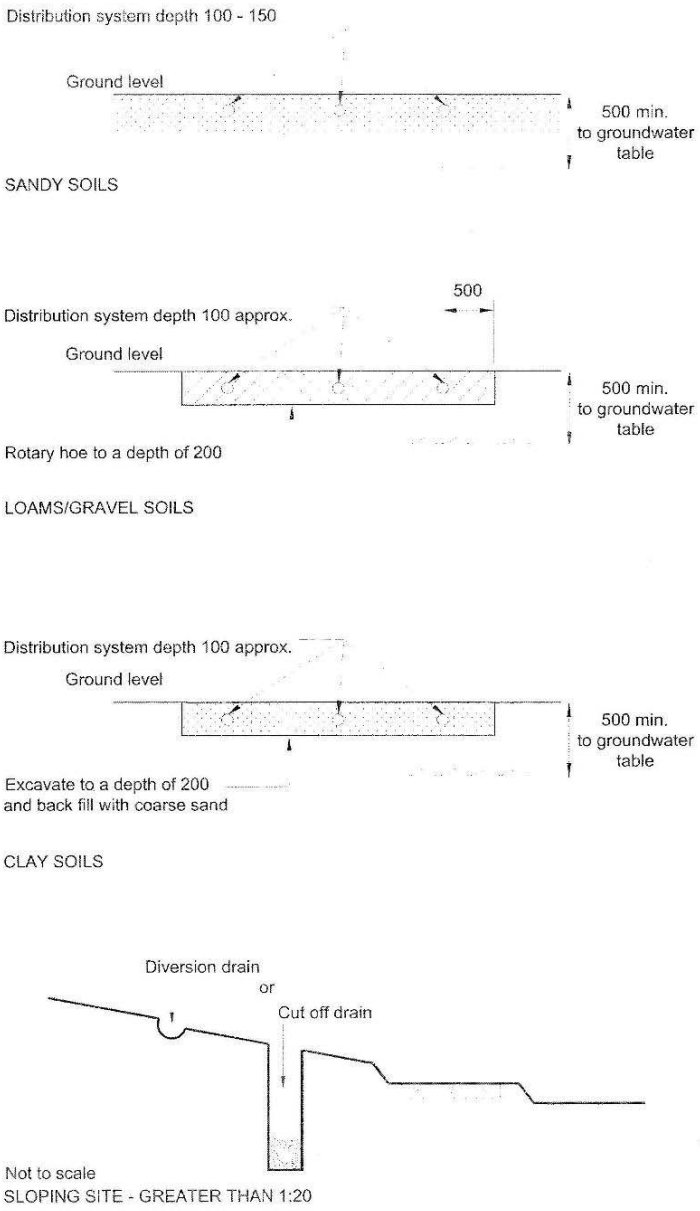


FIGURE 4.5C1 SHALLOW SUBSURFACE DRIP IRRIGATION SYSTEM

SUBSURFACE DRIPPER SYSTEM (from AS1547)

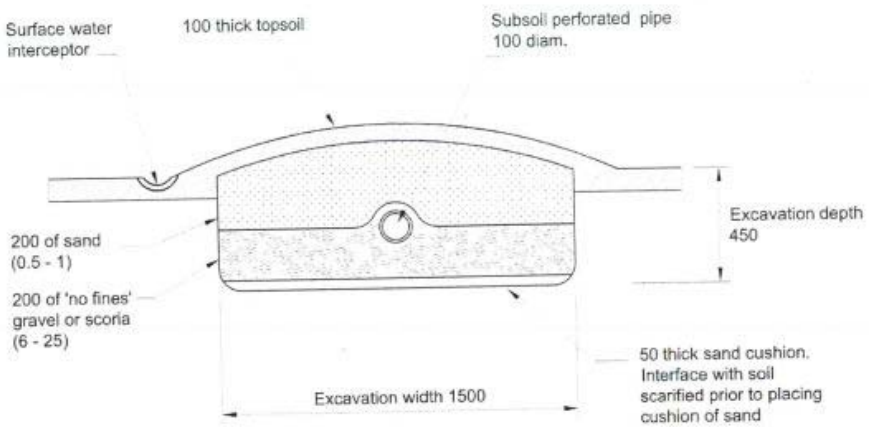


FIGURE 4.5A6 ETA/ETS BED DETAILS

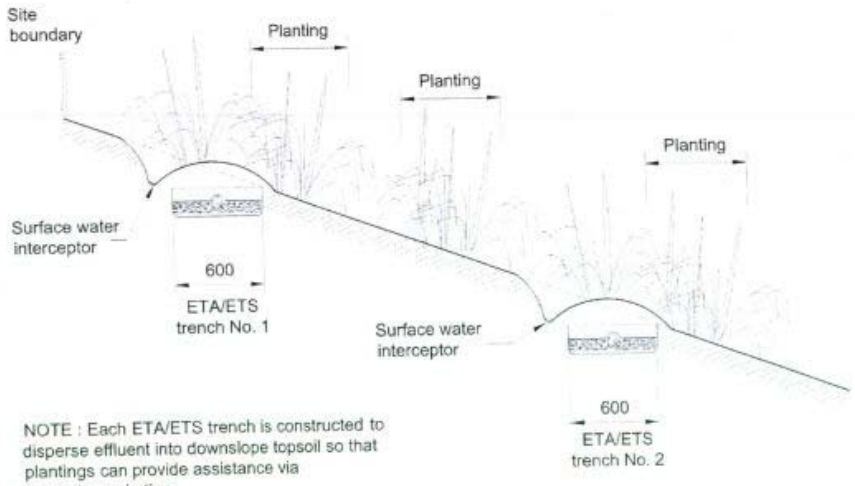
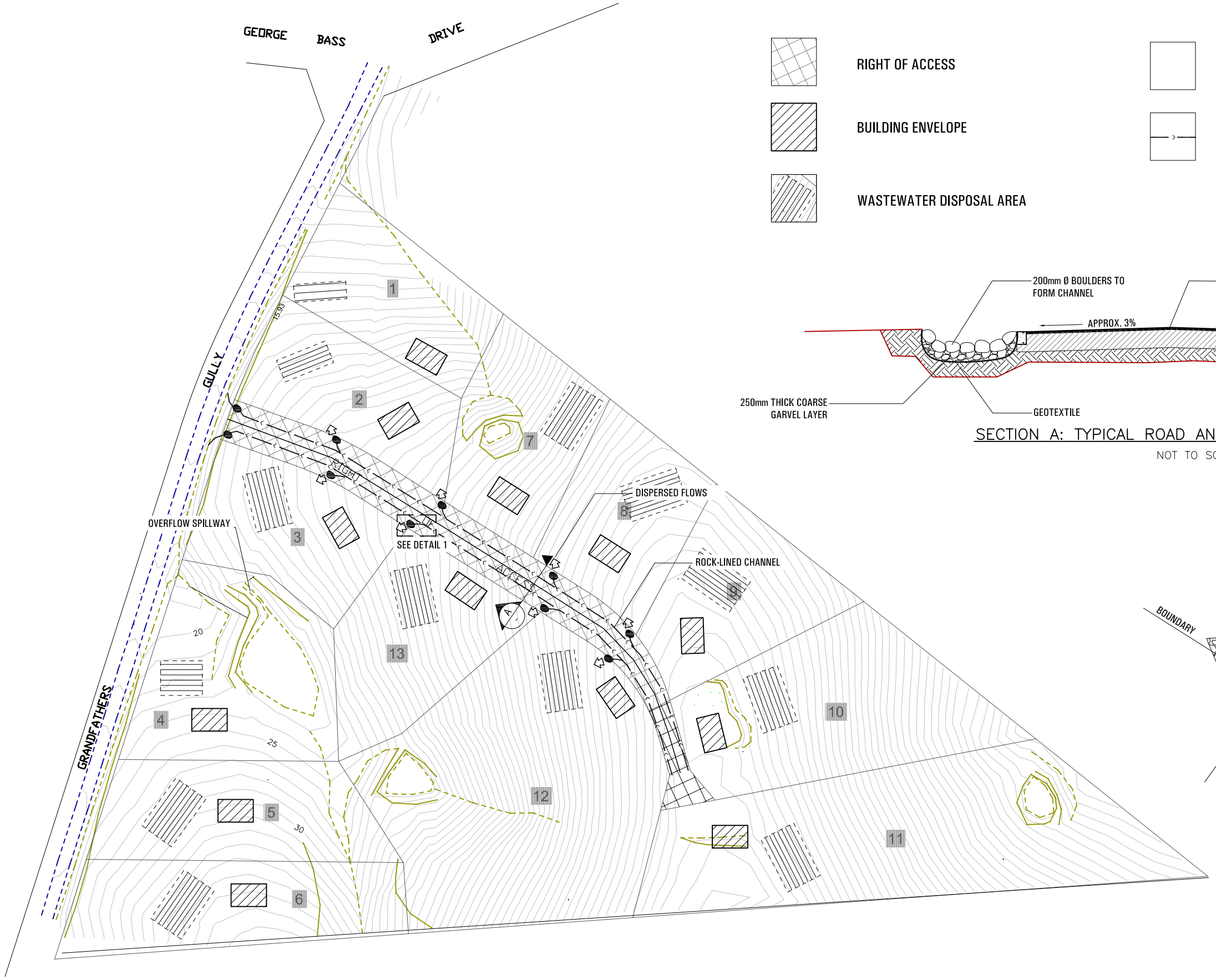


FIGURE 4.5A7 ETA/ETS TRENCHES

ETA/ETA TRENCH AND BED DETAILS (from AS1547)

APPENDIX E
Stormwater Management



RIGHT OF ACCESS

BUILDING ENVELOPE

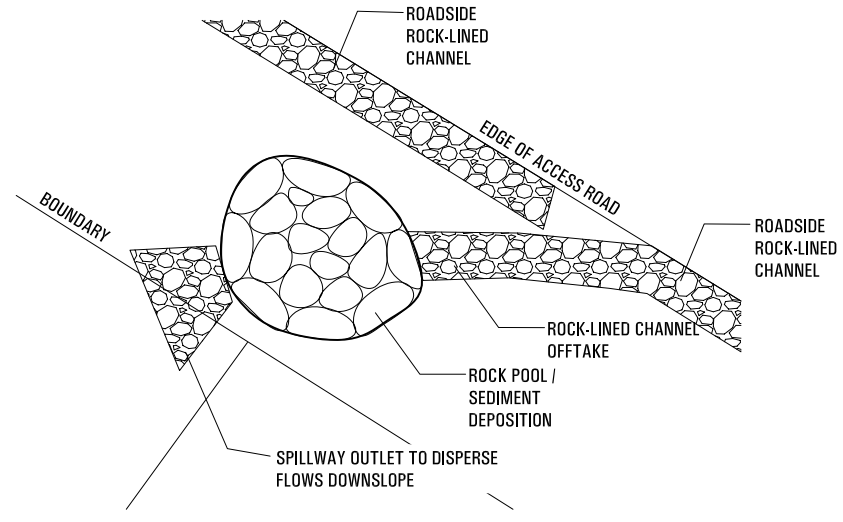
WASTEWATER DISPOSAL AREA

PROPOSED RIPARIAN BUFFER ZONE

ROADSIDE ROCK-LINED CHANNEL

SECTION A: TYPICAL ROAD AND ROCK-LINED CHANNEL

NOT TO SCALE



DETAIL 1

NOT TO SCALE

STORM_CONSULTING

ISSUE	REVISION	BY	CKD	DATE
A	FOR COMMENT	BA	LB	27/02/06
B	FOR COMMENT	BA	LB	15/02/07

DOCUMENT PURPOSE:
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FOR CC ☐
FOR TENDER ☐
FOR CONSTRUCTION ☐

COORD. ORIGIN: ISG | SCALE: 1:2000
DATUM: AHD | DATE: 2006
DRAWN: BA | DESIGNED: LB | CHECKED: LB

CLIENT: DAVID BREWER, 648 THE RIDGE ROAD, MALUA BAY NSW 2536

GRANDFATHERS GULLY
STORMWATER PLAN
CONCEPT

DRAWING: G491/PO2
SHEET: 1 OF 1
A3