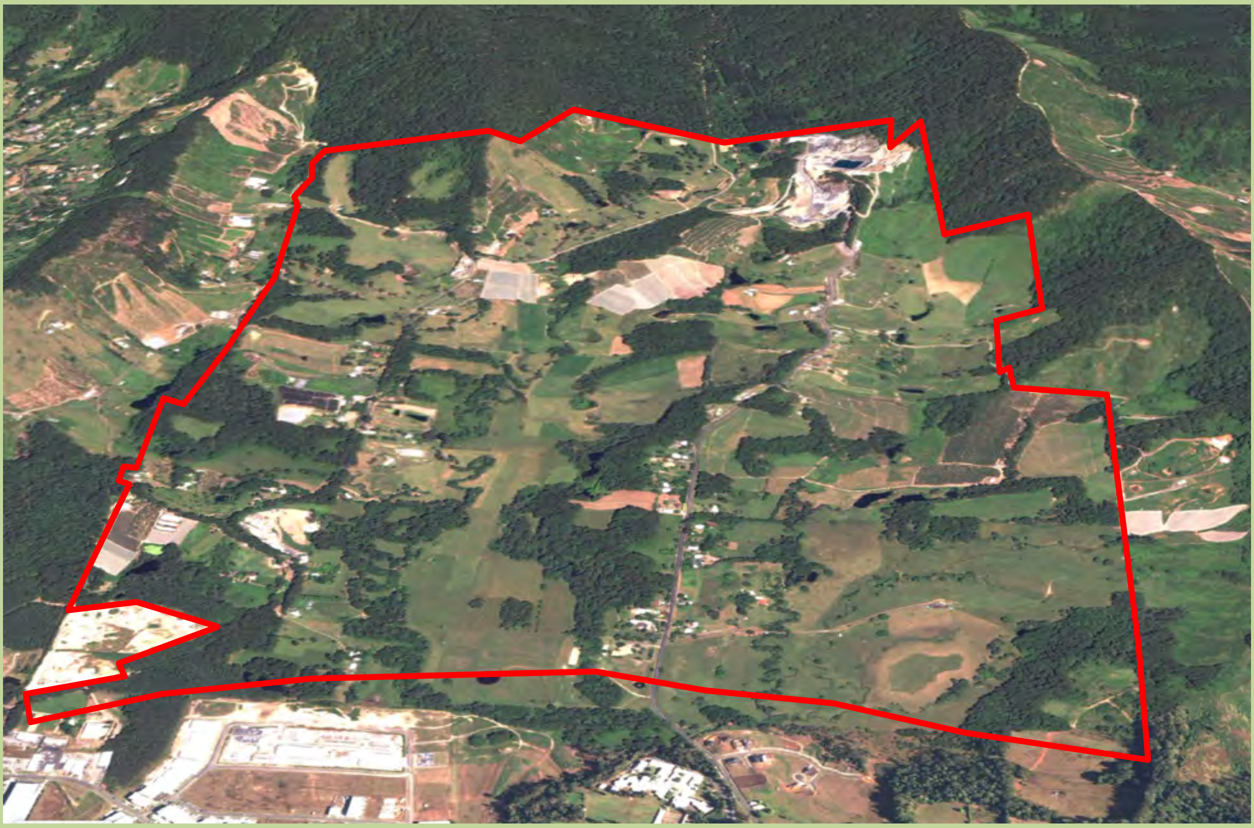
APPENDIX B – Engineering Issues

Coffs Harbour Local Environmental Plan 2013

Engineering Issues

North Boambee Valley (West)



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de Groot &

Benson Pty Ltd

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1 INTRODUCTION

This report has been prepared as part of a Local Environment Study of the North Boambee Valley, west of the proposed Pacific Highway bypass corridor and specifically to address the following major engineering issues relating to the proposed study area as defined in the original brief from Coffs Harbour City Council:

Task No	Description	Where details provided:
1.1.3	Acid Sulfate Soils (ASS)	Section 2 - ACID SULFATE SOILS
1.1.4	Geotechnical Assessment	Section 3 - GEOTECHNICAL ASSESSMENT
1.1.6	Topography	Section 4 - TOPOGRAPHY
1.1.7	Flood Liable Land	Separate Report
1.1.10	Contaminated Lands	Section 5 - CONTAMINATED LANDS
1.1.13	Water Services	Section 6 - WATER SERVICES
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1.1.15	Road Network	Section 8 - ROAD NETWORK
1.1.17	Infrastructure Costs and Staging	Section 9 - INFRASTRUCTURE COSTS AND STAGING

The Study Area is shown on Figure 1 – Study Area.

This report is based on the proposed Concept Master Plan for the Study area shown on Figure 2, Figure 3, and Figure 4.

The proposed zonings in this Planning Proposal are shown on Figure LZN_001 in the Planning Proposal. The following development zoned areas result:

Zone	Area (ha)
Zone R1	7.2 ha
Zone R2	80.4 ha
Zone R5 - potential	49.2 ha
Total Residential zones	***87.6 ha*** ***plus 49.2ha potential R5 = 130.1 ha***
Zone IN1	37.0 ha

It is noted that in the early stages of the Study, a section of Study Area around Englands Road was found to be suitable for rural residential development (R5 zoning). Council have since requested that this area is withheld from the Planning Proposal until other rural residential candidate areas identified in Council's Rural Residential Strategy 2009 are progressed.

For the residential zones, we estimate the following lot yields:

Zone	Area (ha)	No of Tenements
Zone R1 (12 tenements /ha)	7.2 ha	86
Zone R2 (10 tenements/ha)	80.4 ha	804
Total Residential zones	***87.6 ha***	***890***
Potential Zone R5 - (2.5 tenements / ha)	49.2 ha	125

2 ACID SULFATE SOILS

2.1 Scope

The envisaged scope of work for this component is summarised below:

Task 1.1.3 - Acid Sulphate Soils (ASS)
• Review the available acid sulphate mapping and Council's ground level information (ALS data) to determine the area of investigation (generally where alluvial soils may have formed below RL 5.0mAHD). Figure 8 of the Structure Plan indicates some 17 hectares of low risk ASS. Some of this area will be excluded from development as located in riparian environmental zones and floodways. • Undertake limited field investigations comprising the excavation of test pits, logging of soil profiles and collection of samples for laboratory testing. • Prepare a preliminary ASS assessment detailing the investigation and findings. This will be sufficient to identify if, and where (if applicable), ASS are likely to be a significant development constraint. Note, the level of investigation will not be sufficient to obviate the need for future developers to undertake individual ASS assessments.
Deliverables: *A preliminary Acid Sulphate Soil assessment report and land development recommendations for inclusion in the DCP if ASS is found to be a significant constraint.*

2.2 Origins of Acid Sulfate Soils

Acid sulfate soils (ASS) are soils which contain significant concentrations of pyrite that, when exposed to oxygen in the presence of sufficient moisture, oxidize and generate sulfuric acids. Unoxidised pyritic soils are referred to as potential acid sulphate soils (PASS). When PASS are exposed the oxygen and the pyrite oxidises, they become actual ASS.

Pyritic soils typically form in waterlogged, saline sediments rich in iron and sulfate. The usual environment for the formation of acid sulphate soils are tidal flats, salt marshes and mangrove swamps below about RL 5m AHD. They can also form as bottom sediments in coastal rivers and creeks, ie as alluvial soils. Pyritic soils of concern on low lying coastal NSW and coastal lands have mostly formed in the Holocene period, (ie. 10,000 year ago to the present day) predominantly in the 7,000 years since the last rise in sea level. It is feasible that such conditions existed over the lower parts of the floodplains within the study area.

Disturbance of acid sulfate soils can generate substantial sulfuric acid, which can lower soil and water pH to levels below pH 4. Fish kills in coastal rivers are highly visible examples of consequences of acid sulphate generation. In addition, high salinity soils can adversely impact vegetation growth and can produce aggressive soil conditions detrimental to concrete and steel components of structures, foundations, pipelines and other engineering works.

2.3 Review of Available Mapping

Council's acid sulphate risk mapping has been extracted from their GIS system and is attached as Figure 5 and Figure 6. This mapping was prepared by the Acid Sulfate Soils Advisory Committee, NSW Department of Land and Water Conservation, March 1998. It is predominantly based on surface elevation and landform. It is not known what, if any, actual field testing has been undertaken in the study area. The mapping provides:

Acid Sulfate Risk Maps – Refer Figure 5. The mapping shows a small section of the Study Area is considered to have a low risk of having acid sulphate soils present. This area is outside any potential residential areas, and partly covers the proposed industrial areas at the eastern end of the study area.

Acid Sulfate Planning – Refer Figure 6. The mapping shows that the eastern portion of the site has Class 4 and 5 areas. These areas are defined as:

- Class 4 – Works beyond 2m below natural ground surface; works by which the water table may be lowered beyond 2m below natural ground level;
- Class 5 – Works within 500m of the above Classes of land which are likely to lower the water level by 1m on the adjacent Class of land.

The mapping does not anticipate acid sulfate soils to be present in the class 5 land. The class 5 land is rather a buffer and is included as major works, particularly drainage works, could conceivably impact on the water table in the adjacent class 4 or higher lands.

Where significant earthworks or drainage works are proposed within the classified lands, Council requires an Acid sulphate assessment, and where present, a management plan.

The land identified as potentially suitable for industrial development overlaps with the class 4 ASS areas. This land lies across the lower floodplain of Newports Creek. To gauge if actual or potential acid sulfate soils exist, limited field work and testing was undertaken.

2.4 Limited Field Investigations

Access too much of the class 4 land was denied by the property owners. Subsequently, the location and number of sampling points was significantly constrained. Two boreholes were excavated and three samples were collected from each, ranging from 0.5 to 2.0 metres deep. The samples where then tested by Coffs Harbour Laboratory. The borehole locations are shown on Figure 7. The full test results are contained in APPENDIX A – Acid Sulfate Test Results and are summarised in table 2.1.

The samples were recovered from fine grained soils (silty clays). The action criteria for which acid sulfate management is required was taken from Table 4.4 of the Acid Sulfate Soil Manual (Ref 1).

Table 2.1 – Acid Sulfate Test Summary

Bore Hole	Action Criteria (1-1000 tonnes disturbed)	AS 1	AS 2
0.5 – 1.0m			
Equivalent Sulfur (%S)	>0.1	**0.14**	0.09
Equivalent Acidity (moles+/t)	>62	**90**	56
Lime requirement (kg/tonne)		9.5	4.2
1.0 – 1.5m			
Equivalent Sulfur (%S)	>0.1	**0.24**	**0.10**
Equivalent Acidity (moles+/t)	>62	**148**	**65**
Lime requirement (kg/tonne)		15.8	5.1
1.5 – 2.0m			
Equivalent Sulfur (%S)	>0.1	**0.19**	**0.16**
Equivalent Acidity (moles+/t)	>62	**117**	**100**
Lime requirement (kg/tonne)		12.5	7.6

2.5 Conclusions and Recommendations

Some of the land identified for potential industrial development lies across area identified as class 4 under Council's acid sulfate soil mapping. This land being the lower floodplain of Newports Creek along the eastern portion of the study area. Class 4 lands may contain acid sulfate soils and, depending on the depth and extent of any proposed earthworks and drainage works, further investigation and possible management is required.

Limited fieldwork was undertaken to gauge if acid sulfate soils are present. Due to access constraints the fieldwork was limited to just two boreholes. These however did find mild acid sulfate, sufficient to require management.

Due to flood constraints, any proposed development in these areas will generally involve filling the land. Filling the land is unlikely to expose any potential acid sulfate soils to oxidation. However, some shallow excavation of floodways and deeper excavation for service trenching will be required.

It is recommended that Council's existing policies of requiring acid sulfate assessment and, where present, management, be retained for the class 4 and 5 lands in North Boambee Valley.

As is generally found along the lower creek lines around Coffs Harbour, mild acid sulfate soils will be found in places. Management practices will be required such as treatment with lime. The investigations and management will add to the cost of development. However, as the extent of deep excavation will be limited and the likelihood of high acid sulfate soils is low, it is not expected that managing acid sulfate soils will be a significant constraint. Testing and management of acid sulfate soils will not significantly impact on the viability of development.

3 GEOTECHNICAL ASSESSMENT

3.1 Scope

The envisaged scope of work for this component is summarised below:

Task 1.1.4 - Geotechnical Assessment
The nature of geotechnical investigations, the size of the study area and the possible variability of sub-surface conditions across the study area makes it impractical and uneconomic to undertake the investigation to anything other than a preliminary 'broad brush' level. Preliminary investigation is considered to be sufficient to identify if any significant large scale geotechnical constraints exist, and if so, their likely location. The proposed methodology includes to: • Determine from the mapping and other constraints the areas most likely suitable for: o residential development and industrial development; and o any development on land greater than 20%. • Undertake limited field investigations across such areas to: o log the soil profile and depth to rock; o collect samples for laboratory testing; and o visually inspect steep areas above possible development areas for up-slope stability risks. • Undertake laboratory testing to determine indicative soil properties for residential site classification, soil stability, erodibility and road sub-grade. • Prepare a report detailing the investigation and findings. As with the acid sulphate assessment, it will not be sufficiently detailed for future assessment of individual parcels of land but will broadly classify the residential areas into likely classes in accord with AS 2870.
Deliverables *Mapping showing areas of slope stability risk and likely site classification for residential development.* *A report with recommendations regarding the suitability of land for development with respect to geotechnical constraints.*

3.2 Investigation

The geotechnical investigation was limited to the areas identified as potentially developable once environmental and quarry buffer constraints were applied. Within these areas the investigation was general or 'broad brushed' in nature. It comprised limited walk over (access to some properties was denied), and very limited sub-surface investigations. Figure 7 shows the location of bore holes.

3.3 Geotechnical Description

Across the investigation area the topography is that of moderate to steep slopes falling to gentle limited floodplains adjacent several creek lines. The general profile of soils underlying the site is:

- Under the sloping terrain – residual, having weathered from the underlying rock which, according to the 1:250,000 Geological Series Mapping (Ref 2), Sheet SH 56 – 10 & 11, is siliceous argillite, slate, rare siliceous greywacke from the Brooklana Formation of the Carboniferous period. The slopes are dominated by residual soils, that is, soils that have formed in their current location by the weathering of the underlying rock. Some slopewash may be present in isolated areas below steep slopes. Slopewash is soil that has been washed down from up-slope and deposited.

- Under the flood plains, either residual as above, or alluvial, having formed through deposition from the creeks.

The natural residual soil on the slopes is cohesive (silty clay) in nature and is generally fairly shallow. Weathered rock can be expected within several metres depth. On the steeper slopes where erosion is typically acting faster, weathered rock can be at quite shallow depths. Topsoil on the slopes is typically 100-200mm in depth. Across the floodplain the soil profile is more variable and can be significantly deeper in alluvial areas.

The hydrology of the site is that of steep sided valleys with hydraulically steep creeks. The major stream lines, including Newports Creek, flow west to east. There are many smaller ephemeral water courses feeding these streams. The overall catchment extends beyond the study area, but not substantially so. Rainfall is high and frequent with only moderate seasonal variation. Drier times are late winter & early spring.

The depth to bedrock also varies significantly. Across the higher and steeper slopes, where erosion is greater, the soil profile is quite shallow. Extremely weathered rock is typically found at 0.5 to 2.0 metres deep, firming to weathered then had rock within a few metres. Across the floodplains the range of soil depth will be greater. Deep soil depths of over 6 metres are likely, particularly near the creeks and through alluvial soils.

The residual soils are typically silty clays of medium plasticity and range in colour from browns, reds and greys. On the steeper slopes significant gravel and cobbles are often present in the soil. The borehole logs can be found in APPENDIX B – Bore Hole Logs.

The soils and geology is typical for Coffs Harbour and its valleys. They are not prone to slope instability, although the steep slope in places do pose a hazard, refer to the following section.

3.4 Suitability of Development

Notwithstanding slope hazard in limited areas, as discussed in section 4, the soils and underlying geology are generally not expected to significantly constrain development potential. The relatively shallow residual soils on the slopes are not expansive. Coupled with fairly consistent climate, they generate only low to moderate shrink/swell potential. The residual soils, and ancient alluvial soils will generally provide adequate bearing capacity for conventional low rise building construction. Younger alluvial soils may pose bearing capacity constrains although these are likely to be fairly limited in area adjacent the creek lines.

Shallow hard rock is likely to be present under some of the steeper land. In such locations excavations of over a few metres depth may be hindered by hard rock.

Acid sulphate soils may be present in very limited areas of the lower floodplains, refer to Section 2.

3.5 Site Classification for Residential Slabs and Footings.

The residual soils underlying much of the proposed residential land will generally warrant an 'M' classification in accordance with AS2870. Class 'M' is for moderately reactive sites. Such a classification calls for raft slabs stiffened with edge and internal beams and for slightly stiffer strip footings than the minimum. Based on local performance, some class 'S' sites, for slightly reactive, may be suitable. Class 'A' for negligible reactivity and class 'H' for highly reactive, will be rarely, if at all, warranted.

Class M sites are the norm for Coffs Harbour and do not pose a significant development cost over the lesser classifications, typically only a few percent of the construction cost.

A greater constraint to footing and slab design will be slope. Slab on a cut to fill earthworks pad is the most economical flooring system for residential construction. However, on slopes of over about 15% such construction generally leads to fill depth in excess of that allowed in AS2870, resulting in a 'P' classification. 'P' refers to problem sites where footings and slabs need to be designed by engineering principals. On slopes with fill, this generally results in class M slabs with additional reinforcement and supported on bored piers. The greater the slope, the deeper the fill and the greater the number and depth of piering. Regardless, slab on ground construction, possibly with steps and retaining elements, remains competitive with strip footings and suspended floors until slopes of about 20 – 25%. The cost of residential construction significantly increases on slopes of over about 25%. Figure 9 shows the distribution of slope classes across the development areas. There are significant areas where slope is greater than 15% although minimal above 28%.

Areas of poor founding soils may be present across the floodplains where soft alluvial soils have accumulated during past creek meandering. The locations of such have not been identified in this study. If and where present they may add to development costs, but overall, are not anticipated to present a significant development constraint.

With respect to bulk earthworks during subdivision, such work should be undertaken in accordance with AS3798. All fill under buildings and roadways should be placed with compact control, testing and reporting. Fill plans, reports and provisional site classifications should be a council requirement, as is current practice.

Slab and footings across the proposed industrial land will depend on loads and be a mixture of shallow footings founding in filled or natural soils and deeper piered/pilled footings to rock. The proposed industrial areas, generally across the floodplains, pose similar ground conditions to the adjacent Isle Industrial Estate. The placement of fill and subsequent development through the Isle estate has proved entirely viable.

3.6 Recommendations

The geotechnical conditions across the proposed development areas do not pose a major constraint. Slope, as discussed in Section 4, will have the greatest effect of development. The residual soils will typically yield an M classification in accordance with AS2870 although this will give way to a P classification on the steeper slopes.

This investigation is general in nature and, apart from limited field work, relies on local experience in the design and construction of residential footings throughout the Coffs Harbour region over the Brooklana Formation. This investigation does not obviate the need for site specific investigations as part of individual development.

It is recommended that Council retain existing policies that require individual site classifications and the engineering design of slabs and footings, plus compaction control of subdivision earthworks. Notwithstanding the recommendations of section 4, no additional planning and policy requirements are recommended.

4 TOPOGRAPHY

4.1 Scope:

The envisaged scope of work for this component is summarised below:

Task 1.1.6 - Topography
This component is linked to the geotechnical investigation. The fieldwork here will be combined with that undertaken for the geotechnical investigation. A considerable portion of this assessment will rely on Council's contour mapping to delineate the slopes across the study area. Samples will be collected at widely spaced discrete locations and tested for erodibility. The consultant assumes that all the ALS data and cadastral data for the study area will be available to the Study Team. This will be in the format suitable for import into our various software packages including: - Mapinfo - Autocad Civil 3D
Deliverables *Mapping based on slope and soil class indicating, in a broad sense, the location and extents of soil erosion and slope stability hazard;* *A brief report detailing where and what controls are recommended to reduce erosion potential.*

4.2 Topographical Description

The topography of the study area is that of moderately steep sided valleys and ridgelines with incised gullies draining to two main creek lines. These flow west to east within limited floodplains. The ground level within the study area varies from 5 to 170 mAHD, although not far beyond the study boundary the land continues to rise to ridgelines that in places exceed 300 m in elevation. Figure 8 provides contour mapping of the study area.

4.3 Slope Hazard

Within the study area the topographical characteristic of most importance to development potential is slope, and specifically, steep slopes. The steeper the slope the greater the erosion potential and risk of instability (land slips, slumps & soil creep). Steep slopes also increase bush fire hazard. These issues can be managed to an extent although only at increasing costs. As slopes increase beyond about 25%, the costs of constructing roads, infrastructure, building footings and retaining structures increases significantly and is generally uneconomic by about 40%. Industrial developments generally require even gentler slopes due to their larger building footprints.

The risk of slope instability is not solely a function of slope gradient, but is also influenced by the composition and depth of the soil, underlying geology and climate, specifically rainfall. The geology underlying the study area is that of the Brooklana Formation, refer to Section 3 – Geotechnical Assessment. The soil profiles across the study area vary and are somewhat related to slope:

Across the gentle floodplains the soil origin is either residual soils (soils that have formed in their current location by the weathering of the underlying rock) or alluvial (soils that have formed by deposition, in this case by action of the creeks). The depth to bedrock is likely to vary from several metres to many metres. Due to its inherent gentle slope, the floodplains are at very low risk of instability. However, due to flooding, they are at risk of erosion.

The soils of the valley sides are nearly exclusively residual in origin and are generally fairly shallow. There may be some locations, particularly below very steep areas, where slope wash will be present. Slope wash is akin to alluvial, in that it has been deposited rather than forming in place. The soil has either slipped or has been washed down from above. Slope wash is more likely to be found in and adjacent the steep incised gullies.

The physical properties and mineralogy of the Brooklana formation and its residual soils is not specifically prone to erosion or instability. The residual silty clay soils typically have an undrained internal angle of friction of between 20 & 25° (36 – 47%). The underlying rock is not known for steeply angled clay seams. Well vegetated and drained slopes of well in excess of 50% gradient prove to be stable throughout the region.

Based on local experience in similar topography and geology, and with reference to the Australian Geomechanics Society (Ref 3 & Ref 4), the study area was divided into four geotechnical hazard classes based on a qualitative risk assessment. The classes are summarised in Table 4.1 below.

Table 4.1 – Geotechnical Hazard Classes

Class	**A**
Gradient	0 – 15% (<9°)
AGS Hazard	Very low to low.
Possible Hazard	Land slip, flow.
Likelihood	Minimal
Consequence	Minor
Further investigation	Nil
Management	Conventional road and subdivision design and construction. Seepage and springs may be present at the base of steeper slopes.
Comments	Suitable for development, cost of slope and erosion management will be relatively low. Road construction can generally be on grade. Significant earthworks are unlikely to be warranted. Economic residential slab on ground construction will generally be suitable, possibly with low retaining walls.
Class	**B**
Gradient	15% – 28% (9 – 16°)
AGS Hazard	Moderate risk.
Possible Hazard	Land slip, flow.
Likelihood	Possible, increased in extreme weather.
Consequence	Medium.
Further investigation	Limited – desktop and walkover slope stability investigation.
Management	Exceeds maximum gradient limits for some road classes. May require significant earthworks and possible retaining structures for road construction. Slope assessment of significant cut and fill batters required. Footing and drainage design to consider slope hazard.
Comments	Suitable for development, but at greater cost. Road and lot layout may be partly constrained. Larger residential lots (>600 sq.m) preferred to provide greater room for batters and retaining. Not suitable for large slab on ground construction unless narrow and shaped along the contour. More expensive suspended floors likely. Access and driveway gradients need to be considered. Deeper piered footing more likely required. Drainage design important.

Table 4.1 – Geotechnical Hazard Classes

Class	C
Gradient	28% – 40% (16 – 22°)
AGS Hazard	High risk.
Possible Hazard	Land slip, flow, creep.
Likelihood	High, increased in extreme weather.
Consequence	Medium.
Further investigation	Desktop, walkover and limited sub-surface investigation recommended.
Management	All aspects of design need to consider the slope hazard. Deep fills to be avoided unless engineered to ameliorating the slope. Significant retaining structures will be required. Deep piered footings required.
Comments	Expensive to develop, may be uneconomic. Access driveways & roads will generally be in concrete and will have to cut across the slope as too steep otherwise. Earthworks to be generally limited. Larger lots preferred, Light weight building construction with suspended floors and piered footings required. Drainage design important.
Class	**D**
Gradient	>40% (>22°)
AGS Hazard	Very High risk.
Possible Hazard	Land slip, flow, creep, rock topple.
Likelihood	High, increased in extreme weather.
Consequence	Major.
Further investigation	Detailed desktop, walkover, sub-surface and slope analysis required.
Management	All aspects of design needs to address slope hazard. Substantial retaining and stabilising structures will be required.
Comments	Generally uneconomic to develop and manage risk. Specialist design and construction needed.

4.4 Hazard Mapping

Figure 9 and Figure 10 show the slope hazard classes across the proposed development areas. These figures are based on the existing ground slope average across 10 by 10 m grid cells. The slope being derived from Council's aerial laser survey data. The following is noted:

- The majority of proposed residential land, zoned R1 & R2 lies within class A, although a significant portion lies within class B. There are a few small areas of class C.

- The vast majority of proposed industrial land lies within class A, with only a small fraction within class B (excluding lot 1 DP 129036). This was the intent in assigning the proposed zoning as slope is a greater constraint to industrial developments than residential. Note, Lot 1 DP 129036 is currently used as storage and maintenance yards for Peter Ryan Earthmoving and its rezoning as industrial is a logical step to better reflect is current use.

- The proposed large lot residential, zoned R5, is approximately evenly split between class A and B plus some areas of class C.

4.5 Recommendations

There are several options available to developers and Council to manage the risk posed by the steeper land. The following is recommended:

Class A Land:

No specific planning controls are warranted. Conventional engineering design and construction practices are acceptable.

Class B Land:

No specific planning controls are recommended. The risk can be managed through good hillside engineering practice at both the subdivision and individual development stages. As part of any development or construction application, council should review and be satisfied that such practice is implemented. A summary of good hillside design is given in APPENDIX C – Slope Hazard.

Class C Land, all zones other than R5:

Much of the class C land is relatively small in size and width. At subdivision stage it could be ameliorated through bulk earthworks to reduce gradients. Alternatively, the locating of roads and individual lots can be adjusted to accommodate the steeper land. The indicative road layout in Figure 9 is an example. Residential lots containing Class C land can be expanded and adjusted to provide sufficient area of Class A or B land within the lot for dwelling construction.

No specific planning controls are recommended at subdivision stage other than to ensure good hillside engineering design and construction practice.

At the individual development stage, it is recommended that a stability assessment be undertaken for any significant building works on or immediately up/downslope (within 10m) of class C land.

Class C Land zoned R5

Within the proposed R5 lands the extent of Class 'C' land is larger and it will not be economic to address through earthworks. It is recommend that:

- At subdivision stage, a stability assessment be undertaken for any road or services infrastructure proposed across or immediately up/downslope (within 10m) of class C land.
- At subdivision stage, lots be sized to ensure sufficient area for dwelling construction (say 750 m^2) is available within class A or B land.
- At the individual development stage, a stability assessment be undertaken for any significant building works on or immediately up/downslope (within 10m) of class C land.

Class D Land, all zoning.

There is very little class D land within the proposed areas. At both subdivision and individual development stage, a detailed slope assessment will be required for any works in or within 10 metres of class D land.

5 CONTAMINATED LANDS

5.1 Scope:

The envisaged scope of work for this component is summarised below:

Task 1.1.11 - Contaminated Lands
A Preliminary Contaminated Lands Assessment will be prepared in accordance with the provisions of the *State Environmental Planning Policy (SEPP) 55 - Remediation of Land* and the *Contaminated Land Management Act 1997*. Soil contamination from past use of pesticides and herbicides, in particular arsenic across banana agriculture land, is the most likely source of contamination. Council's agriculture mapping shows that large areas within the study area are potentially affected. Those located in the potential development areas as identified in the Structure Plan are approximately: Residential - eight hectares; Neighbourhood – six hectares; and Industrial – 26 hectares. Past experience in surrounding areas suggests that it is highly likely that arsenic contamination will be found in at least some of these areas. Over such large areas it is not feasible or economic to undertake sufficient field sampling and testing to meet the EPA's Initial Site Assessment criteria for banana plantations. This would require in the order of 800 sampling points and over $100,000 in laboratory costs. As in other areas, the full site assessment burden must be passed on to the developer. For this investigation a preliminary assessment is proposed. The assessment will comprise a desktop review followed by selective indicative sampling of approximately 35 sites. Some will target suspected hot-spots such as packing sheds while the rest will be spread over the banana land. In addition to contamination from agriculture, other sources of contamination may be present such as asbestos from old structures and hydrocarbons from fuel storage. Selected sampling at suspected locations will also be undertaken.
Deliverables: *A report detailing the testing regime, locations and implications for development. The investigation is highly likely to find arsenic contamination.*

5.2 Site History

Prior to European settlement, the site would have been heavily vegetated in native forest with only rare impact from fire. Clearing and agriculture commenced in the 19th century, expanding roughly to its current extents by the mid 20th. Significant areas of land were cultivated. Most notably bananas were cultivated over the east, north and west facing slopes. The flatter floodplains were also cleared and mainly used for stock grazing. In addition to clearing and agriculture, development of roads, dwellings, storage sheds, yards and small on-stream dams have occurred over the years.

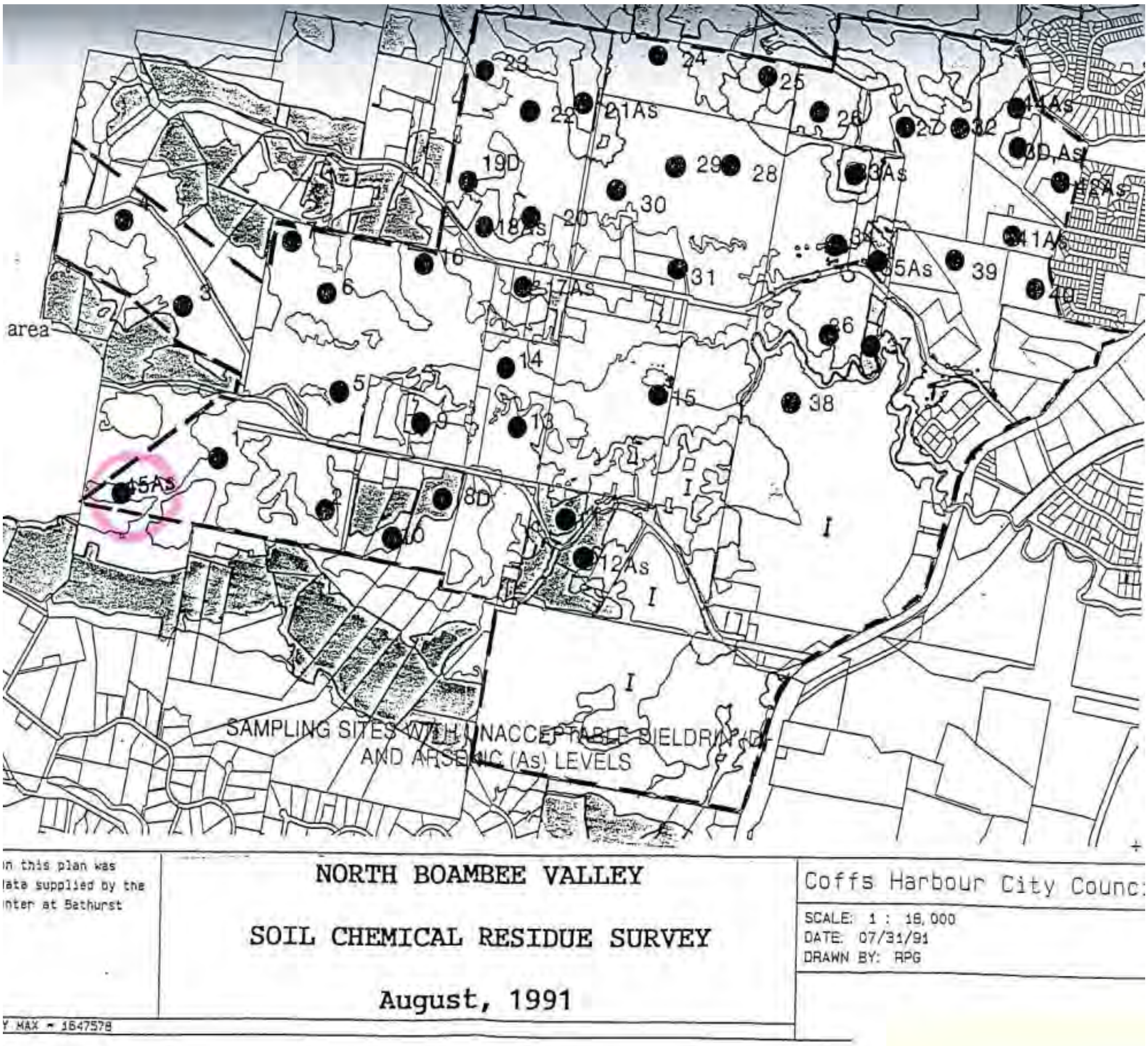
Council's mapping identifies areas that have been subject to cultivation in the past, as shown on Figure 11. Possible soil contamination exists through these areas and through areas of current cultivation due to the use of pesticides and herbicides. The use of arsenic in pesticides and herbicides during the 1940s to 1960s is considered a definite possibility, if not likely, source of soil contamination.

5.3 Previous Investigations

The most relevant previous investigation uncovered was the *Soil Pesticides Residue Survey North Boambee Valley Coffs Harbour, Study* (Ref 6). This investigation included sampling of 45 sites with a history of banana cultivation. It found arsenic and/or Dieldrin contamination at 13 sites.

It must be noted that the then concentration limits defining contamination vary from today. The limits used in the 1991 study were from the State Pollution Control Commission at 30 ppm for arsenic and 0.5 ppm for Dieldrin. The relevant limits today are the health based investigation levels in column 1 of Appendix II of "Contaminated Sites, Guidelines for the NSW Site Auditor Scheme" (Ref 7) with soil investigation limits (SIL) for arsenic at 100 ppm and Dieldrin at 10 ppm.

Extract 1 – Soil Sampling in 1991



None of the samples had Dieldrin above current soil investigation level (SIL) and only one sample, at 126 ppm showed arsenic above current SIL. The location of the sampling is shown in Extract 1 below Figure 11. Sample 45As had the elevated arsenic.

5.4 Fieldwork and Sampling

Pesticide and herbicide practices in areas of present and past banana cultivation was identified as the most likely source of any wide spread soil contamination. A soil sampling regime was prepared with reference to Ref 8 and Ref 9. It was beyond the scope of this investigation to undertake the sampling and testing in full accordance with Ref 8 which requires a 25 x 25 m grid. This would have resulted in approximately 1,000 sampling points and excessive laboratory costs.

It is noted that access to some properties was denied by the land owners as shown on Figure 7. However, most of the banana lands were available for testing.

Field work was undertaken during July 2012. Thirty three (33) sampling parcels of past and present banana cultivation land were selected, as shown on Figure 7. Between 2 and 4 sampling locations were chosen per parcel based on roughly equal spacing. Within these bounds and except for parcel C19, the exact sampling location was random, although they excluded areas where it was suspected that the land may have been disturbed within the last 50 years. All samples were taken from what appeared to be natural and the original topsoil of the area being tested.

Parcel C19 was taken around a large and old farm packing shed. Here the 3 sampling points were targeted to areas immediately adjacent and down slope of the shed. The sampling points targeted areas most likely to have contamination if there were significant chemical spills within or around the shed.

At each point samples were collected from the 0-75 mm and 0-150mm depth horizons. The individual samples were then composited to form two samples for each parcel.

5.5 Laboratory

The 66 samples collected from the field were processed and dispatched to the Coffs Harbour Analytical Laboratory on 17 July 2012. Laboratory testing was undertaken over the following weeks. The 0-150mm samples were tested for arsenic and lead while the 0-75mm samples were tested for a range of organochlorides and organophospates (OC&OPs).

5.6 Assessment and Results

The soil investigation levels (SILs) for urban development sites in NSW found in column 1 of Appendix II of "*Contaminated Sites, Guidelines for the NSW Site Auditor Scheme (2nd Edition)*" (Ref 7) were adopted for this assessment as the concentrations defining site contamination.

For all parcels, except C19, the anticipated source of contamination is that of widespread application of pesticides/herbicides to the land. In these circumstances no reduction to the SILs to account for the composite nature of the sample is appropriate, as per method 2 section 6 of "*Contaminated Sites, Sampling Design Guidelines*" (Ref 8).

For parcel C19, where hot spots may be present, the SILs were divided by the number of sampling points as per method 1 from Ref 9.

The full laboratory test results can be found in APPENDIX D – Contamination Testing and are summarised in Table 5.1 below against the relevant soil investigation levels.

Table 5.1 – Summary of Laboratory Test Results

Parcel	Arsenic (mg/kg)	Lead (mg/kg)	OCs Dieldrin (mg/kg)	OCs DDE+DDD+DDT (mg/kg)	Other (mg/kg)	OPs (mg/kg)
SIL	100	300	10	200		
C1	92	36	0.01	0.154	<0.01	<0.1
C2	59	19	<0.01	<0.01	<0.01	<0.1
C3	**110**	26	0.014	0.061	<0.01	<0.1
C4	**150**	25	<0.01	0.13	<0.01	<0.1
C5	**110**	23	<0.01	0.012	<0.01	<0.1
C6	42	26	<0.01	<0.01	<0.01	<0.1
C7	65	43	0.22	<0.01	<0.01	<0.1
C8	**160**	68	0.021	<0.01	<0.01	<0.1
C9	**110**	83	<0.01	<0.01	<0.01	<0.1
C10	100	19	<0.01	0.122	<0.01	<0.1
C11	81	22	<0.01	<0.01	<0.01	<0.1
C12	5.6	27	<0.01	0.061	<0.01	<0.1
C13	5.7	27	<0.01	<0.01	<0.01	<0.1
C14	6.5	24	<0.01	<0.01	<0.01	<0.1
C15	6.4	25	<0.01	<0.01	<0.01	<0.1
C16	6.6	25	<0.01	<0.01	<0.01	<0.1
C17	73	16	0.030	<0.01	<0.01	<0.1
C18	99	23	<0.01	<0.01	<0.01	<0.1
C20	12	51	<0.01	0.109	<0.01	<0.1
C21	34	16	<0.01	<0.01	<0.01	<0.1
C22	**120**	16	<0.01	<0.01	<0.01	<0.1
C23	27	16	<0.01	<0.01	<0.01	<0.1
C24	21	18	0.016	<0.01	<0.01	<0.1
C25	59	26	<0.01	0.117	<0.01	<0.1
C26	66	23	0.011	0.050	<0.01	<0.1
C27	55	23	0.012	<0.01	<0.01	<0.1
C28	6.5	18	<0.01	0.098	<0.01	<0.1
C29	10	32	<0.01	0.096	<0.01	<0.1
C30	28	22	<0.01	<0.01	<0.01	<0.1
C31	**150**	26	0.011	<0.01	<0.01	<0.1
C32	36	30	<0.01	<0.01	<0.01	<0.1
C33	47	26	<0.01	<0.01	<0.01	<0.1
SIL	33	100	3.33	67	<0.01	<0.1
C19	12	53	<0.01	0.108	<0.01	<0.1

Notes: <XX = not detected by the instrument with a detection limit of XX.

5.7 Conclusions and Recommendations

This preliminary investigation has concentrated on possible soil contamination from pesticide and herbicide use within past and present areas of cultivation. 32 parcels of present and ex banana land were tested as was one packing shed site. It has found:

- In many locations the arsenic concentration is well above what can be expected for the naturally occurring or background levels of arsenic, which is typically less than about 10 mg/kg. This signifies that arsenic has been applied to the land. In 7 of 32 locations arsenic was above the soil investigation levels (SIL) of 100 mg/kg that defines contamination. The highest concentration was 160 mg/kg. In an 8th parcel the concentration was right on the limit and in a 9th it was only fractionally below (99 vs 100 ppm).

- Eight parcels had low concentrations, consistent with background levels. This suggests that arsenic may not have been used over these parcels. Note, most of these were in areas under current bananas but are not shown on Council's banana lands mapping. This implies recent cultivation only, well after the use of arsenic.

- The remaining 15 parcels had elevated arsenic levels, but below the SIL.

- The 95% upper confidence level (UCL) average arsenic concentration for the 32 parcels was 75.6 mg/kg. If the 8 parcels where no arsenic use is suspected are excluded, the 95% UCL average increases to 93.4 mg/kg.

- The concentrations of lead were all comfortably below the SIL.

- Traces of Dieldrin, DDE, DDD & DDT were also found in 17 of 32 parcels although all were well below their SILs. The greatest, being Dieldrin at C7, was just 2.2% of its SIL. All other organochlorines tested for were not found within the detection limits of the laboratory equipment.

- No organphosphates tested for were found in any parcel within the detection limits of the laboratory equipment.

- The testing around the packing shed (C19) found only low concentrations of arsenic, lead, DDE & DDT. All well below their SILs.

It can be concluded that arsenic contamination is present across past banana land in the North Boambee Valley. This finding is entirely consistent with past banana land across the Coffs Harbour region.

Council's existing land contamination policies should be applied to any proposed development within the North Boambee Valley. This assessment has not been prepared in sufficient detail, in terms of sampling density, to satisfy Council's policy requirements. All proposed development within present and past cultivated areas should be subject to soil contamination assessments and where contamination is identified a remediation plan be prepared for Council's consideration.

As has been found in other areas, it is anticipated that the arsenic contamination can be readily remediated, generally through on-site vertical mixing. The cost of further investigation, and remediation if required, will fall to the developer. While an additional burden, it is not expected to significantly constrain the land's development potential.

6 WATER SERVICES

6.1 Scope

The envisaged scope of work for this component is summarised below:

Task 1.1.13 - Water Services
The assessment of potable water supply to the area is relatively uncomplicated. De Groot & Benson have undertaken the latest water supply strategic planning for the study area. The study area falls under the Roberts Hill reservoir zone. The reservoir and head works (to the north) will be assessed to determine adequacy, which from our knowledge of past investigations, is quite likely. The supply from the reservoir down through the study area is a matter of appropriate infrastructure sizing that is unlikely to be a significant economic constraint. The maximum supply level of 55mAHD used in the structure study will be reviewed, but is likely to be approximately correct. A review of the contour mapping finds that such a level is unlikely to be a significant constraint as the areas above this level are likely to be highly constrained by slope, vegetation and bushfire.
Deliverables *Water Servicing Plan detailing the assessment, findings and strategic infrastructure sizing and positioning.*

A reticulated water supply system is proposed for Zones R1, R2 and IN1. The potential Zone R5, being a large lot residential area would not be proposed for reticulation in accordance with Council's policies.

6.2 Current Strategy Study

The Coffs Harbour Water Supply Strategy Study, 1999 (Ref 10) (CHWSS) developed a water supply strategy for the City. This study is the most current city wide strategy. In preparing the strategy, this study included various growth areas across the city. In this Study, the current study area was represented by areas 15NRA1 and 15NRA2. The expected levels of development for these areas is summarised below in Table 6.1

Table 6.1 – CHWSS dwelling projections

Area	Approx equivalent area in current study	Dwellings	Population
15NRA1	The area proposed for residential development (basically the area north of North Boambee Road	920	2850
15NRA2	The area proposed for industrial and rural residential development – the remainder of the study area	1010	3050
	TOTAL	1,930	5,900

The peak day water demand estimated in the for these two areas is 4.4ML/d.

The current strategy was shown on Figure 3-15 of Ref 10 and is copied in **APPENDIX E – Extract from CHWSS**.

6.3 Estimated Water Demands

Council has set RL 55 mAHD as the maximum area that it expects to be able to reliably service in the future. The area below RL 55 is shown on Figure 13. As can be seen , the entire area proposed for residential development in the R1 and R2 zones is below RL55.

It is noted that the R5 areas are not proposed to be supplied with reticulated water and will need to rely on tank water in accord with Council's policy for servicing large residential lots.

Using the 1999 study as the basis the projected water demands for the study area are shown in Tables 6.2 and 6.3 below:

Table 6.2 – Peak Day Demands (ML/d)

Development Type	Rate	Peak Day Demands (ML/d)
Residential Developments (zones R1 and R2) - (890 tenements)	2300 L/d/tenement	2.05 ML/d
Industrial Development (37 ha)	20,000 L/d/ha	0.74 ML/d
Total		**2.79 ML/d**

Table 6.3 – Peak Instantaneous Demands (ML/d)

Development Type	Rate	Peak Day Demands (ML/d)
Residential Developments (zones R1 and R2) - (890 tenements)	0.10 L/sec/tenement	89.0 L/s
Industrial Development (37 ha)	0.35 L/sec/ha	13.0 L/s
Total		**102.0 L/s**

The peak water demands of 2.79 ML/d is less than the 4.4ML/d assumed in the CHWSS. As such the existing water supply infrastructure from Karangi Dam to the Roberts Hill Reservoir has the capacity to supply the proposed development.

Due to the changed road patterns in the area, the actual routes of water supply mains shown in the CHWSS are not achievable.

A revised concept has been prepared in this is shown on Figure 13.

7 SEWERAGE SERVICES

7.1 Scope

The envisaged scope of work for this component is summarised below:

Task 1.1.14 - Sewer Services
The assessment of sewerage infrastructure is, like water supply, a relatively uncomplicated exercise and is unlikely to reveal substantial infrastructure constraints. The assessment will consider, at a strategic level, how potential areas for development can be sewered to determine the approximate number of pump stations required and their indicative location. The infrastructure chain from the study area to the treatment works will be reviewed to determine the likely upgrade requirements, if any.
Deliverables *Sewer Servicing Plan detailing the assessment, findings and strategic infrastructure sizing and positioning.*

7.2 Current Strategy Study

The Coffs Harbour Sewerage Strategy Study, 1998 (Ref 10) (CHSSS) developed a sewerage strategy for the City. This study is the most current city wide strategy. The strategy made reference to the North Boambee Valley area.

At the time, it estimated that under ultimate development scenario, the area would have a potential sewage loading on the system of 2253 equivalent tenements (ET's) for the North Boambee Valley area.

However, the strategy was silent on how these loads would be transferred to the Coffs Harbour Water Reclamation Plant (WRP). It was suggested that the area would have its own dedicated pumping station and a new rising main running from the station to the Coffs Harbour WRP.

Whilst the strategy study did not address the transport system from the study area to the WRP, it is noted that the WRP has a staging strategy that can accommodate the additional loads resulting from the Study Area.

7.3 Estimated Sewerage Loads – Study Area

Based on the areas proposed for zoning, the total additional load on the sewerage system is likely to be:

Table 7.1.– Sewerage Loads – Study Area (ET)

Development Type	Rate	No of Equivalent Tenements (ET's)
Residential Developments (zones R1 and R2) - (890 tenements)	1 ET/tenement	890 ET
Industrial Development (37 ha) – 28.3 ha in the central area and 8.7ha in the southern area	10 ET/ha	370 ET
Total		**1,260 ET**
Potential Residential Development (zone R5) - (125 tenements) – if sewered.	1 ET/tenement	125 ET

Based on the above, we estimate that the design flow rates from the Study area would be of the order of:

- Average Dry Weather Flow (0.007 L/s/ET): 8.82L/s initially increasing to 9.69 L/s if the potential R5 areas are added.
- Peak Wet Weather Flow (assuming 0.58 L/s/Et storm allowance) 87.9 L/s initially increasing to 96.9 L/s if the potential R5 areas are added.

Preliminary discussions have been held with Coffs Harbour City Council on how the loads from the Study Area would be transferred to the Coffs Harbour WRP. Council have suggested the following strategy:

- The areas draining to North Boambee Road of 1173ET (890ET plus 283ET) – this area would be pumped to the proposed pumping station to be located at the intersection of North Boambee Road and The Lakes Way. This station is being designed for approximately 1,100 ET and has additional capacity to take part of the Study Area. Council suggest that it will have approximately 600ET spare capacity. This station will need augmentation to cater for the full study area loads.
- The areas draining from the Industrial area and the potential R5 areas off Englands Road of 212ET (125ET plus 87 ET) - these areas would be pumped to the new South Coffs pumping station (located near the intersection of Stadium Drive and the Pacific Highway. Council suggest that this station has around 400 ET of spare capacity.

It is noted that the estimated loads from the Study area exceed the spare capacity of the two pumping stations. However, the rate of development within the Study Area is likely to be of the order of 10 to 15 years and Council have indicated that they will be updating their sewerage strategy in the future. This means that the Study Area can be fully incorporated into the overall sewerage strategy for the City with appropriately staged works.

7.4 Study Area – Sewerage System

A concept for sewering the study area has been developed. This is shown on Figure 14.

The key features:

Northern Residential Areas:
The entire area north of North Boambee Road can drain by gravity to a proposed main transfer pumping station (PS1). There is a small area to the south of North Boambee Road, that cannot drain to this station and will require its own pumping station (PS2).
Central Industrial Area:
Similarly to the northern residential area, the central industrial area will be served by a gravity sewerage system draining to PS1.

Southern Industrial Area:
The eastern part of the southern industrial area is of sufficient elevation to drain by gravity to the existing Isles Industrial system. This would involve a gravity sewer main laid across the Pacific Highway bypass corridor.

The western section of this industrial area will require its own pumping station (PS3).

Potential Rural Residential Areas to the south of Englands Road
To enable the development of smaller rural residential lot sizes, the decision could be made to allow these to be sewered using Pressure Sewage Technology. This technology basically proposes that each dwelling has its own pressure sewage pumping station located near the dwelling. All power

charges for operating the station would be borne by the dwelling owner. The pressure sewerage system would pump all sewage from the potential R5 area to PS3.

In 2011, Council introduced a policy allowing the use of pressure sewerage systems where such use can be justified.

In the case of the potential R5 areas:

- The topography is such that a conventional gravity system would be uneconomic and there would be numerous small conventional stations required.
- The laying of 150mm gravity mains and manholes would be uneconomic given the average distance between allotments would be 40m to 50m.
- The pressure system would require pressure mains varying in size from 50mm to 150mm in diameter and can be laid to follow the lie of the land.
- The running costs of the stations would be borne by the property owners and so would not be a burden to Council.
- Finally, as the system is a pressure system, there is not the same issue of stormwater inflows during wet weather. Peak flows and total volumes of sewage to be treated is less than that derived from a conventional system.

Sewage Pumping Station 1:
This pumping station would be located in the RE1 zoned land on the north side of North Boambee Road. The station would have an ultimate capacity of approximately 1100ET. The rising main would run along North Boambee Road to the existing pumping station at the corner of The Lakes Way and North Boambee Road.

Sewage Pumping Station 2:
This is a small pumping station would be located in the R2 zoned land on the south side of North Boambee Road. The rising main from this station will run up to North Boambee Road and connect to the gravity system draining to PS1.

Sewage Pumping Station 3:
This station would pump to a rising main running along Englands Road to the recently constructed sewage pumping station on Stadium Drive.

8 ROAD NETWORK

8.1 Scope

The envisaged scope of work for this component is summarised below:

Task 1.1.15 - Road Network
• Liaison with the Project Team in the design of a road network generally based on the layout already shown in the Structure Plan and revised where necessary. • Liaison with RTA regarding the relationship with the highway bypass route. • Design cycleway / footpath network.
Deliverables *Master plan and DCP*

In developing a strategy for the Valley, the following objectives were adopted:

- The R1 and R2 residential areas should be separated as much as possible from the IN1 areas and the Quarry.
- As much as possible, the rural character of Englands Road should be maintained.
- A link between Englands Road and North Boambee Road should be provided.

8.2 Existing Road Hierarchy

At present, the two main roads serving the study area are Englands Road and North Boambee Road.

- Englands Road is essentially a rural class road west of the Coffs Harbour Waste Management facility.
- North Boambee Road, within the study area is essentially rural class road. Between the Study area and the Pacific Highway, the road formation varies, with sections of Kerb and guttering (eg near Bishop Druitt College) and other sections, of rural character. In the North Boambee Valley (East) Developer Contribution Plan, this section of North Boambee Road is identified as a Distributor Road, however, the Contribution Plan does not include any allowance for its upgrading to this standard, despite significant development proposed in the plan utilising this road.

These are the only two roads which access the Study area

8.3 Proposed Pacific Highway Bypass of Coffs Harbour

The RMS provided concept plans for the proposed Pacific Highway bypass of Coffs Harbour. The relationship of the bypass with the Study Area is summarised below:

- The bypass forms the eastern boundary of the Study Area. The height of the bypass above the surrounding lands varies for the length of the Study Area, however, the bypass is expected to be typically constructed on a filled embankment which could vary in height up to around 6m above the existing landform.
- An interchange with the local Coffs Harbour road network is proposed around the current intersection of Englands Road and the Pacific Highway. There will be the ability to enter and exit the highway bypass in this area.
- The highway bypass is proposed to bridge over North Boambee Road. There will be no connections from North Boambee Road to the bypass.
- No other roads are proposed to cross the bypass route other than Englands Road and North Boambee Road.

Traffic from the Study area wising to access the bypass will either access it from the Englands Road interchange or travel along North Boambee Road to the existing Pacific Highway and proceed to either the southern interchange at Englands Road, or one of the proposed northern interchanges.

8.4 Traffic Generation from the Study Area

The average daily traffic generation from the Study Area after full development is summarised below in Table 8.1

Table 8.1 – Study Area Traffic Generation

Development Type	Traffic Generating parameter	AADT (veh/day)
Residential Developments (zones R1 and R2) - (823 tenements)	890 ET @ 9 vpd / ET	8,010 veh/day
Industrial Development (37 ha) – 28.3 ha in the central area and 8.7ha in the southern area	5 veh/day per 100 m^2 GFA. GFA averages approx. 35% of site area	6,500 veh / day
Total	**1,473 ET**	**14,510 veh / day**
Potential Residential Development (zone R5) - (125 tenements)	125 ET@ 10vpd / ET	1,250 veh/day
Total	**1,598 ET**	**15,760 veh / day**

In terms of assignment to the two main roads leaving the Study Area, our expectation is as follows:

- North Boambee Road (east of the Study Area) – 8,200 veh /day
- Englands Road (from the offtake of the Industrial Area) – 7,750 veh/day

Under Clause 2.9 of Section 041 Geometric Road Layout of Council's AUS-SPEC guidelines, both road would be classed as Local Sub-Arterial Roads as their daily traffic is above 6,000 veh/day.

8.5 Study Area Road Network

In accordance with the objectives nominated in Section 8.1, the following road network system was developed:

a) The two main roads accessing the Study Area will remain as North Boambee Road and Englands Road.
b) North Boambee Road will essentially handle all the residential traffic from the proposed R1, R2 and B1 residential and business areas. North Boambee Road would need to be upgraded to a Local Sub-Arterial Class Road with a carriageway width of 13m in accordance with Clause 2.9 of Reference 11.
c) Englands Road, east of the Industrial Area offtake, will handle all the traffic from the potential R5 areas, the IN1 areas and the Quarry. It would need to be upgraded to a Local Sub-Arterial Class Road with a carriageway width of 13m in accordance with Clause 2.9 of Reference 11.
d) Englands Road west of the industrial area offtake point would be a rural residential class road with 6m sealed carriageway and 1m shoulders in accordance with Clause 3.5 of Reference 11..
e) All road in the Industrial area would have a 13m carriageway width in accordance with Clause 2.9 of Reference 11.

f) We have identified several Collector Class roads in the R1 and R2 areas. These are shown on Figure 16. These roads would have carriageway widths between 8m and 11m
g) The remaining road in the R1 and R2 areas would be Local class roads with widths varying from 5.5m to 8m in accordance with Clause 2.9 of Reference 11.
h) The remaining roads in the potential R5 areas would be rural residential class road with 6m sealed carriageway and 1m shoulders in accordance with Clause 3.5 of Reference 11.
i) A link road from the western end of the Industrial area, generally running along a ridge line up to North Boambee Road. This road would then form the main travel route for all traffic from the Quarry. It would have an 11m carriageway width in accordance with Clause 2.9 of Reference 11.
j) A further link road is proposed from the Industrial Area adjacent to the Highway Bypass corridor connecting to North Boambee Road.

8.6 External Impacts

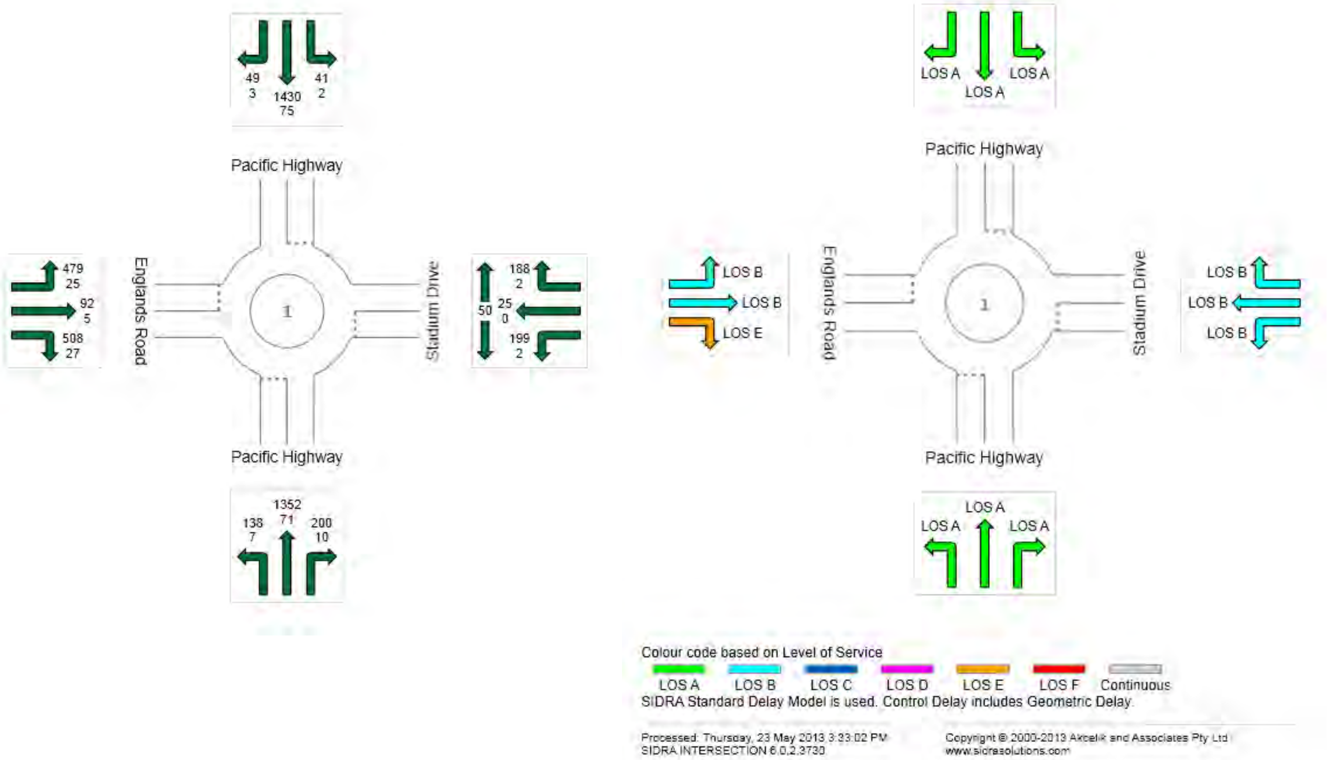
The major external impacts of the proposed development are on the intersection of North Boambee Road and the Pacific Highway and Englands Road and the Pacific Highway. The RMS were approached as to the adequacy. Their response is contained in Figure 8.6.

North Boambee Road Intersection:
RMS noted that they have allowed for 800 future residential lots from the Study area. This equates to approximately an additional 8,000 vehicles / day. This compares to the additional 8,230 vehicles per day estimated in this study. Given the likely time frame for development of the area and the eventual construction of the Coffs Harbour bypass, it is considered that this intersection should be able to handle the increased traffic from the study area.

Englands Intersection:
RMS noted that they had no information as to the capacity of this intersection. In the interim, a traffic assessment of this intersection has been undertaken as part of the development application for "Elements" estate off Stadium Drive, (one of the roads that connect to the Englands Road roundabout). The traffic assessment (Ref 12) found that the current peak hour traffic in Englands Road at the roundabout is about 800 vehicles/hour and that the intersection is at about 56% capacity. The full development of North Boambee Valley will add approximately an additional 650 vehicles/hour to the intersection (or 775 veh/hr including the potential R5 areas).

The model used in Ref 12 has been modified to include the extra traffic generated by the North Boambee Valley.

The results of the modelling are shown below:



The results indicate that the roundabout performs satisfactorily, and that through and right turn movements from Englands Road are just acceptable.

As such no specific works are proposed for this roundabout.

8.7 Proposed Footpath and Cycleway Routes

All roads in residential areas will require footpaths as part of Council's normal subdivision requirements. There is an opportunity to link these with the surrounding vegetation communities by running the paths adjacent to the bushland.

A series of cycle ways are proposed that link the various residential areas. A concept plan of pathways and cycle ways is shown on Figure 2, Figure 3 and Figure 4.

Figure 8.6.1 - RMS response

Transport
Roads & Maritime Services

File no NTH07/01182 CR2012/011216

Mr Rob de Groot
De Groot & Benson Pty Ltd.
PO Box 1908.
COFFS HARBOUR NSW 2450

Dear Sir

North Boambee Valley Planning Proposal.

I refer to your email of 12 November 2012. Roads and Maritime Services (RMS) are considering reconstruction of the traffic signals at the intersection of North Boambee Road and the Pacific Highway, Coffs Harbour. These works are dependant on a development proposal and contributions towards intersection improvements currently being considered by Coffs Harbour City Council.

Traffic modelling for the intersection improvement included an allowance for 800 future residential lots accessing the Pacific Highway along North Boambee Road. This allowance was made to include future development in the North Boambee Valley on both sides of the proposed alignment of the future bypass of Coffs Harbour. The traffic modelling has indicated that the North Boambee Road / Pacific Highway intersection will have sufficient capacity for approximately 10 years. RMS does not have available capacity information for the Englands Road intersection with the Pacific Highway.

The proposed lot yields accompanying your email appear to exceed those anticipated in traffic modelling to support the proposed intersection works at the North Boambee Road/ Pacific Highway intersection. To identify road capacity limits that will impact on developable land, it is recommended demand modelling should be undertaken. The demand model assesses traffic generation, trip distribution, mode share and traffic assignment to the road network. Alternatively a network assessment using computer modelling packages such as PARAMICS could be undertaken. This modelling will be necessary to identify the road infrastructure necessary to support the proposed land release.

The concept plan for the North Boambee Valley planning proposal includes a connection between Englands Road and Industrial Drive. The concept design for the future Coffs Harbour Bypass does not include this connection and at this time any such connection is not supported by RMS. The concept plan also includes a number of facilities in the Coffs Harbour Bypass corridor, including sporting fields and local roads in the vicinity of North Boambee Road. All facilities will need to be located outside the bypass corridor.

If you require further information please contact Mr Michael Baldwin on 6640 1362 or email Development.Northern@rms.nsw.gov.au.

Yours faithfully

17 DEC 2012

David Bell
Regional Manager, Northern Region

Roads & Maritime Services

31 Victoria Street, Grafton NSW 2460 | PO Box 576 Grafton NSW 2460
T 02 6640 1300 | **F** 02 6640 1304 | **E** development.northern@rms.nsw.gov.au **www.rms.nsw.gov.au | 13 17 82**

9 INFRASTRUCTURE COSTS AND STAGING

9.1 Scope

The envisaged scope of work for this component is summarised below:

Task 1.1.17 - Infrastructure Costs and Staging
Estimates of infrastructure costs for the provision of services (Tasks 13, 14 and 15) will be analysed in terms of staging of works and the development of a realistic and economically viable Developer Contributions Plan.

Figure 16– Section 94 Contributions – Designated Works shows the main infrastructure to be included in a Section 94 contributions plan.

The costing of these items is included in Tables 9.1 to 9.4 – Section 94 Cost Estimates.

The General classifications of costings analysed are:

1. Flood Mitigation Works – See Table 9.1
2. Traffic Management– See Table 9.2
3. Open Space and Recreation– See Table 9.3
4. Urban Planning– See Table 9.4

The potential R5 zoned land has been excluded from this analysis

9.2 Staging

To enable orderly development of the Study Area, development needs to be staged. The Study Area allows convenient staging as the three main zoning area fall into distinct geographic areas. In determining suggested staging consideration needs to be given to the provision of infrastructure. To this end, one of the main determinants of this are the upgrading requirements of North Boambee Road or Englands Road, and the construction of the main transfer sewerage pumping stations PS1 and PS3 and the provision of water reticulation mains. In addition, Staging of the Industrial areas depends on the completion of the Detention Basins.

We would envisage the following likely development staging:

Residential development off North Boambee Road Stage

- The construction of sewerage pumping station PS1 and its associated rising main as a minimum
- The construction of water supply works along North Boambee Road to bring reticulated water to the Study Area.
- Following the provision of this infrastructure, it is possible to proceed with the staged construction of the residential areas. These areas are typically developed in stages of about 20 to 50 lots at a time.
- The required upgrading works in North Boambee Road could be deferred until the completion of several of these smaller residential stages.

Industrial development off Englands Road Stage

- The construction of sewerage pumping station PS1 and its associated rising main as a minimum
- The construction of water supply works along North Boambee Road to bring reticulated water to the Study Area.
- The construction of Detention Basins. This will allow the filling of the flood plain to be undertaken.
- The upgrading of Englands Road.

- Following the provision of this infrastructure, it is possible to proceed with the staged construction of the industrial areas. These areas are typically developed in stages of 10 to 15 lots at a time.

Potential Rural Residential development off Englands Road Stage

- The construction sewerage pumping station PS3 and its associated rising main as a minimum
- Following the provision of this infrastructure, it is possible to proceed with the staged construction of the rural residential areas. These areas are typically developed in stages of 10 to 15 lots at a time.

Table 9.1 – Section 94 Contribution Cost Estimates – Flood Mitigation Works

North Boambee (West) - Planning Proposal					
Estimate of Works to be covered by Section 94 Contributions				*Costs attributable to different Zonings*	
Item No	**Description**	**Details**	**Estimate (ex GST)**	***R1 and R2 zoned areas***	***IN1 zoned areas***
		Land Area		***80.9ha***	***29ha***
		No of Et's	**1180**	*890*	*290*
Stormwater Management / Flood Mitigation Works					
F1	Detention Basins - NBV (Either Basins 2 and 3 or contribution to Basin 1)	Smaller Standalone Basin (Refer Flood Study) including Detailed Flood Planning Study and Land Acquaisitions for Easements and Dam Wall	$3,830,000		
		TOTAL	**$3,830,000**		
F2	Survey and design	15%	$574,500		
F3	Contingency	15%	$660,675		
Proportinate of Cost Attributable to North Boambee Valley (West)			**$5,065,175**		
		Interest Component	**$4,359,684.49**		
		Sub Total	**$9,424,859.49**		
	Proportion of Benefit to Industrial Area (based on land area)	26%	$2,486,997		*$2,486,996.59*
	Proportion of Benefit to Residential Area (based on land area)	74%	$6,937,863	*$6,937,862.90*	
TOTAL (For Section 94 Development Contributions)			**$9,424,859**	***$6,937,862.90***	***$2,486,996.59***

Table 9.2– Section 94 Contribution Cost Estimates – Traffic Management

North Boambee (West) - Planning Proposal					
Estimate of Works to be covered by Section 94 Contributions				*Costs attributable to different*	
Item No	**Description**	**Details**	**Estimate (ex GST)**	***R1 and R2 zoned areas***	***IN1 zoned areas***
		Land Area		***80.9ha***	***29ha***
		No of Et's	**1180**	*890*	*290*
Traffic Management					
TM1	Link Road 1	Link road from central industrial area to North Boambee Road. Road to be 8m wide - industrial standard. Length 430 m plus land acquisition costs	$1,168,690	*$881,470*	*$287,220*
TM2	Cycleways	2.5m wide cycleways - total length - 3.5km	$700,000	*$700,000*	
TM3	Bus Shelters	5 No	$100,000	*$100,000.00*	
TM4	North Boambee Road Upgrading	Upgrade of existing road - allowance 1100m of roadway (1390m x 11m wide kerb and gutter)	$3,058,000	*$3,058,000*	
TM5	Englands Road upgrading	Length 800m, width 8m, No kerb and gutter	$960,000		*$960,000*
TM6	Link Road 2 - Bridge Across Coffs Creek and associated roadworks	Length 60m, width 8m plus 2m cycleway - 600 m^2 deck area plus 240m of 8m wide road plus land acquisition costs	$1,712,550		*$1,712,550*
TM7	Link Road 3 - From Industrial area to North Boambee Road - (near Highway Bypass)	Link road from central industrial area to North Boambee Road. Road to be 11m wide - industrial standard. Length 220 m - (plus land acquisition)	$601,600		*$601,600*
		Subtotal	**$8,300,840**	***$4,739,470***	***$3,561,370***
TM8	Survey and design	15%	$1,245,126	*$710,920*	*$534,206*
TM9	Contingency	15%	$1,431,895	*$817,558*	*$614,336*
TOTAL (For Section 94 Development Contributions)			**$10,977,861**	***$6,267,948***	***$4,709,912***

Table 9.3 – Section 94 Contribution Cost Estimates – Open Space and Recreation

North Boambee (West) - Planning Proposal					
Estimate of Works to be covered by Section 94 Contributions				*Costs attributable to different*	
Item No	**Description**	**Details**	**Estimate (ex GST)**	***R1 and R2 zoned areas***	***IN1 zoned areas***
		No of Et's	**1180**	*890*	*290*
Open Space and Recreation					
O1	Neighbourhood Park	Playground Equipment, Park Seats, and Landscaping	$600,000	*$600,000.00*	
		Subtotal	**$600,000**	***$600,000***	***$0***
O2	Survey and design	15%	$90,000	*$90,000*	*$0*
O3	Contingency	15%	$103,500	*$103,500*	*$0*
TOTAL (For Section 94 Development Contributions)			**$793,500**	***$793,500***	***$0***

Table 9.4 – Section 94 Contribution Cost Estimates – Urban Planning

North Boambee (West) - Planning Proposal					
Estimate of Works to be covered by Section 94 Contributions				*Costs attributable to different*	
Item No	**Description**	**Details**	**Estimate (ex GST)**	***R1 and R2 zoned areas***	***IN1 zoned areas***
		No of Et's	**1180**	*890*	*290*
Urban Planning					
U1	Planning Proposal	Consulant team costs in prpearing the documents	$200,000	*$150,847*	*$49,153*
U2	CHCC costs	estimate	$50,000	*$37,712*	*$12,288*
TOTAL (For Section 94 Development Contributions)			**$250,000**	***$188,559***	***$61,441***

10 REFERENCES

Ref 1 – Acid Sulfate Soil Manual, (Acid Sulfate Soil Management Advisory Committee, August 1998).

Ref 2 - Dorrigo – Coffs Harbour, 1:250,000 Geological Series Sheet SH 56 – 10 & 11, (Geological Survey of NSW & University of New England, 1966)

Ref 3 - Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning, (Journal and News of the Australian Geomechanics Society Volume 42 No 1 March 2007)

Ref 4 - Landside Risk Management Concepts and Guidelines, (Australian Geomechanics Society, Sub-Committee on Landslide Risk Management, March 2000)

Ref 5 - Contaminated Sites, Guidelines for Consultants Reporting on Contaminated Sites (NSW Government, Office of Environment & Heritage, 2011, ISBN 0 7310 3892 4).

Ref 6 - Soil Pesticides Residue Survey North Boambee Valley Coffs Harbour, August 1991 (NSW Agriculture).

Ref 7 - Contaminated Sites, Guidelines for the NSW Site Auditor Scheme (2nd Edition). (Department of Environment and Conservation, April 2006, ISBN 1 74137 859 1

Ref 8 - Contaminated Sites, Sampling Design Guidelines. EPA NSW.

Ref 9 - Guidelines for Assessing Banana Plantation Sites (EPA NSW 1997)

Ref 10 - Coffs Harbour Water Supply Strategy Study - Final Report, February 1999, de Groot & Benson Pty Ltd

Ref 11 - Section 041 Geometric Road Layout of Development Specification – Design by Coffs Harbour City Council, January 2009.

Ref 12 – Traffic Assessment for “Elements” Subdivision, Stadium Drive, Coffs Harbour, for Plantations CHS Pty Ltd, May 2013; prepared by de Groot & Benson Pty Ltd

FIGURES

APPENDIX A – Acid Sulfate Test Results

DE GROOT AND BENSON ENGINEERING
GRAHAM KNIGHT
P.O. BOX 1908
COFFS HARBOUR NSW 2450

BATCH NUMBER:	12/1621
No. of SAMPLES:	3
DATE COLLECTED:	19/07/12
DATE RECEIVED:	19/07/12
TIME RECEIVED:	12:15

SAMPLE TYPE: SOILS

SAMPLE REFERENCE	SAMPLE DESCRIPTION
12/1621/1	11157 AS3 0.5-1.0M
12/1621/2	11157 AS3 1.0-1.5M
12/1621/3	11157 AS3 1.5-2.0M

ANALYSIS	METHOD NO	UNITS	12/1621/1	12/1621/2	12/1621/3
pH KCl	AS4969	pH units	5.6	4.5	4.8
TAA pH 6.5	AS4969	moles H+/ t	12	41	23
s-TAA pH 6.5	AS4969	%S	0.02	0.07	0.04
pH OX	AS4969	pH units	6.3	4.1	4.5
TPA pH 6.5	AS4969	moles H+/ t	11	206	143
s-TPA pH 6.5	AS4969	%S	0.02	0.33	0.23
TSA pH 6.5	AS4969	moles H+/ t	<5	165	121
s-TSA pH 6.5	AS4969	%S	<0.01	0.27	0.19
ANCe	AS4969	% CaCO3	<0.05	<0.05	<0.05
a-ANCe	AS4969	mol H+/t	<5	<5	<5
S KCl	AS4969	%S	0.03	0.03	0.03
S P	AS4969	%S	0.15	0.20	0.18
S POS	AS4969	%S	0.13	0.17	0.15
a-S POS	AS4969	moles H+/ t	78	108	95
Ca KCl	AS4969	%Ca	0.36	0.16	0.12
Ca P	AS4969	%Ca	0.10	0.15	0.12
Ca A	AS4969	%Ca	<0.01	<0.01	<0.01
Mg KCl	AS4969	%Mg	0.01	0.01	0.01
Mg P	AS4969	%Mg	0.01	0.01	0.01
Mg A	AS4969	%Mg	<0.01	<0.01	<0.01
S RAS	AS4969	%S	N/R	N/R	N/R
a-S RAS	AS4969	moles H+/ t	N/R	N/R	N/R
a-Net Acidity	AS4969	moles H+/ t	90	148	117
Lime Requirement 95% Ag Lime		kg / tonne	9.5	15.8	12.5
Equivalent Sulfur	AS4969	%S	0.14	0.24	0.19
Equivalent Acidity	AS4969	moles H+/ t	90	148	117

Comments

Sample(s) collected by client and analysed as received.
S - POCAS analysis performed according to Australian Standard (AS4969 - 2009)
Sulfur, Calcium and Magnesium Results determined by ICP - AES technique.
N/R = Not Required.
Note: Table 7 in Acid Sulfate Soils: Identification, Assessment and Management - April 08 provides action criteria which trigger the need to prepare an acid sulfate soil management plan. They are based on the sum of existing plus potential acidity, which is calculated as equivalent sulfur (s-TAA + s-POS) or equivalent acidity (TAA + a-SPOS)
Raw data sheets stating analysis dates are available upon request.

Approved:
B J Wadleigh
Laboratory Manager

27 July 2012

DE GROOT AND BENSON ENGINEERING
GRAHAM KNIGHT
P.O. BOX 1908
COFFS HARBOUR NSW 2450

BATCH NUMBER:	12/2094
No. of SAMPLES:	3
DATE COLLECTED:	25/09/12
DATE RECEIVED:	25/09/12
TIME RECEIVED:	14:40

SAMPLE TYPE: SOIL

SAMPLE REFERENCE	SAMPLE DESCRIPTION
12/2094/1	SOIL# 11157 - AS2 - 0.5-1.0M
12/2094/2	SOIL# 11157 - AS2 - 1.0-1.5M
12/2094/3	SOIL# 11157 - AS2 - 1.5-2.0M

ANALYSIS	METHOD NO	UNITS	12/2094/1	12/2094/2	12/2094/3
pH KCl	AS4969	pH units	4.3	4.2	3.9
TAA pH 6.5	AS4969	moles H+/ t	50	65	100
s-TAA pH 6.5	AS4969	%S	0.08	0.10	0.16
pH OX	AS4969	pH units	4.1	4.2	4.1
TPA pH 6.5	AS4969	moles H+/ t	77	82	87
s-TPA pH 6.5	AS4969	%S	0.12	0.13	0.14
TSA pH 6.5	AS4969	moles H+/ t	27	17	<5
s-TSA pH 6.5	AS4969	%S	0.04	0.03	<0.01
ANCe	AS4969	% CaCO3	<0.05	<0.05	<0.05
a-ANCe	AS4969	mol H+/t	<5	<5	<5
S KCl	AS4969	%S	0.01	0.02	0.05
S P	AS4969	%S	0.02	0.02	0.05
S POS	AS4969	%S	<0.01	<0.01	<0.01
a-S POS	AS4969	moles H+/ t	6	<5	<5
Ca KCl	AS4969	%Ca	<0.01	<0.01	<0.01
Ca P	AS4969	%Ca	<0.01	<0.01	<0.01
Ca A	AS4969	%Ca	<0.01	<0.01	<0.01
Mg KCl	AS4969	%Mg	0.04	0.02	<0.01
Mg P	AS4969	%Mg	0.03	0.02	<0.01
Mg A	AS4969	%Mg	<0.01	<0.01	<0.01
S RAS	AS4969	%S	<0.005	<0.005	<0.005
a-S RAS	AS4969	moles H+/ t	<5	<5	<5
a-Net Acidity	AS4969	moles H+/ t	56	68	100
Lime Requirement 95% Ag Lime		kg / tonne	4.2	5.1	7.6
Equivalent Sulfur	AS4969	%S	0.09	0.10	0.16
Equivalent Acidity	AS4969	moles H+/ t	56	65	100

Comments

Sample(s) collected by client and analysed as received.
S - POCAS analysis performed according to Australian Standard (AS4969 - 2009)
Sulfur, Calcium and Magnesium Results determined by ICP - AES technique.
N/R = Not Required.
Note: Table 7 in Acid Sulfate Soils: Identification, Assessment and Management - April 08 provides action criteria which trigger the need to prepare an acid sulfate soil management plan. They are based on the sum of existing plus potential acidity, which is calculated as equivalent sulfur (s-TAA + s-POS) or equivalent acidity (TAA + a-SPOS)
Raw data sheets stating analysis dates are available upon request.

Approved: ______________
B J Wadleigh
Laboratory Manager

5 October 2012

APPENDIX B – Bore Hole Logs

BOREHOLE & DCP FIELD LOG

Project North Boambee Valley
Location Lot 21 D.P 610078
Tested by AR/MS

Job No. 11157
Date 25/9/12 Time 10 am
Borehole 1 of 5

BOREHOLE LOG

0 – 0.4	Brown grey silty topsoil.
0.6	Mottled brown yellow, brown grey clayey silt. Moist & soft.
1.5	Mottled brown/yellow, brown/orange. Clayey silt. Moist & firm.
3.0	Silty clay. Moist to wet. Stiff. Mottled brown/red, grey. From 1.7m becoming brown/red, slightly drier & stiffer.
	BH end.

Site Description Flat grade. Floodplain. Overgrown with grasses/small vegetation.

Weather Conditions Slightly overcast.

Comments

DCP TESTS

Test	1					
Depth (m)	Number of blows per 100 mm penetration					
0.0 - 0.1	2	7	9			
0.1 - 0.2	2	6	11			
0.2 - 0.3	3	6	11			
0.3 - 0.4	2	7	11			
0.4 - 0.5	4	7	16			
0.5 - 0.6	3	7				
0.6 - 0.7	5	8				
0.7 - 0.8	6	8				
0.8 - 0.9	5	9				
0.9 - 1.0	6	10				

BOREHOLE & DCP FIELD LOG

Project: North Boambee Valley
Location: Lot 221 D.P 247724
Tested by: AR/MS

Job No.: 11157
Date: 25/9/12 Time: 1.30 pm
Borehole: 2 of 5

BOREHOLE LOG

Depth (m)	Description
0 – 0.2	Grey/brown silty topsoil.
0.2 – 1.0	Brown/yellow clayey silt, Moist to dry. Firm.
1.0 – 2.0	Mottled brown/red, brown/orange brown/yellow, silty clay. Moist to wet. Firm to stiff.
2.0 – 3.0	Mottled grey with brown/red/yellow. Moist & stiff.
3.0	BH end.

Site Description: Flat grade. Flood plain. BH located Northern end of Lot 221.

Weather Conditions: Slightly overcast.

Comments:

DCP TESTS

Test	1					
Depth (m)	Number of blows per 100 mm penetration					
0.0 - 0.1	2	4	9			
0.1 - 0.2	2	4	10			
0.2 - 0.3	3	6	11			
0.3 - 0.4	4	5	13			
0.4 - 0.5	3	5	14			
0.5 - 0.6	4	6				
0.6 - 0.7	3	7				
0.7 - 0.8	3	8				
0.8 - 0.9	4	9				
0.9 - 1.0	4	15				

BOREHOLE & DCP FIELD LOG

Project North Boambee Valley
Location Lot 1 DP 711234
Tested by AR/MS

Job No. 11157
Date 25/9/12 Time 11am
Borehole 3 of 5

BOREHOLE LOG

0 – 0.1	Brown/grey silty topsoil.
0.1 – 0.25	Grey clayey silt. Moist & soft.
0.25 – 0.8	Mottled grey/brown, brown/yellow clayey silt. Moist to wet. Firm.
0.8 – 1.5	Mottled grey/brown, brown/yellow. Very silty clay. Moist to wet. Firm to stiff.
1.5 – 2.5	Mottled grey & brown/yellow. Silty clay. Moist & stiff Slight increase in brown/red from 2.0m.
	BH end.

Site Description Flat grade. House paddock. BH located north of house.

Weather Conditions Mostly clear.

Comments DCP - Refusal at 1.5m.

DCP TESTS

Test	1					
Depth (m)	Number of blows per 100 mm penetration					
0.0 - 0.1	2	6				
0.1 - 0.2	2	8				
0.2 - 0.3	2	9				
0.3 - 0.4	2	13				
0.4 - 0.5	2	R				
0.5 - 0.6	2					
0.6 - 0.7	2					
0.7 - 0.8	4					
0.8 - 0.9	4					
0.9 - 1.0	5					

BOREHOLE & DCP FIELD LOG

Project: North Boambee Valley
Location: Lot 1 DP 190579
Tested by: AR/MS

Job No.: 11157
Date: 25/9/12 Time: 10:30am
Borehole: 4 of 5

BOREHOLE LOG

0 – 0.1	Grey/brown silty topsoil. High organic/root content.
0.5	Brown/yellow, Brown/grey clayey silt. Moist to dry. Firm.
0.8	Mottled brown/yellow, brown/red, brown/grey. Silty clay. Moist & firm.
2.0	Mottled brown/red & grey/red silty clay. Moist & firm to stiff.
	BH end.

Site Description: Site falls to the south @ approx 5%. BH located on eastern side of driveway approx. 400m in from main road.

Weather Conditions: Mostly clear.

Comments

DCP TESTS

Test	1					
Depth (m)	Number of blows per 100 mm penetration					
0.0 - 0.1	2	4	6			
0.1 - 0.2	3	5	5			
0.2 - 0.3	6	5	5			
0.3 - 0.4	6	5	8			
0.4 - 0.5	4	5	9			
0.5 - 0.6	4	5				
0.6 - 0.7	5	6				
0.7 - 0.8	4	6				
0.8 - 0.9	4	8				
0.9 - 1.0	5	8				

BOREHOLE & DCP FIELD LOG

Project North Boambee Valley
Location Lot 4 DP 747644
Tested by AR/MS

Job No. 11157
Date 25/9/12 Time 12 noon
Borehole 5 of 5

BOREHOLE LOG

Depth (m)	Description
0 – 0.1	Dark grey silty topsoil.
0.1 – 0.4	Grey/brown, grey clayey silt with fine gravel. Moist & firm
0.4 – 0.7	Yellow/brown clayey silt. Moist & firm.
0.7 – 1.5	Mottled brown/grey, brown/yellow. Very silty clay. Moist, firm to stiff.
1.5 – 2.5	Mottled grey, brown/yellow silty clay. Moist & stiff.
2.5	BH end.

Site Description Flat floodplain. BH located just south of the dam.

Weather Conditions Mostly clear.

Comments DCP - Refusal @ 1.6m.

DCP TESTS

Test	1						
Depth (m)	Number of blows per 100 mm penetration						
0.0 - 0.1	3	5					
0.1 - 0.2	4	7					
0.2 - 0.3	3	10					
0.3 - 0.4	3	12					
0.4 - 0.5	4	17					
0.5 - 0.6	4	R					
0.6 - 0.7	4						
0.7 - 0.8	5						
0.8 - 0.9	3						
0.9 - 1.0	4						

APPENDIX C – Slope Hazard

Extracts from "Landside Risk Management Concepts and Guidelines", (Australian Geomechanics Society, Sub-Committee on Landslide Risk Management, March 2000)

LANDSLIDE RISK ASSESSMENT – EXAMPLE OF QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

Qualitative Measures of Likelihood

Level	Descriptor	Description	Indicative Annual Probability
A	ALMOST CERTAIN	The event is expected to occur	$>\approx 10^{-1}$
B	LIKELY	The event will probably occur under adverse conditions	$\approx 10^{-2}$
C	POSSIBLE	The event could occur under adverse conditions	$\approx 10^{-3}$
D	UNLIKELY	The event might occur under very adverse circumstances	$\approx 10^{-4}$
E	RARE	The event is conceivable but only under exceptional circumstances.	$\approx 10^{-5}$
F	NOT CREDIBLE	The event is inconceivable or fanciful	$<10^{-6}$

Note: "≈" means that the indicative value may vary by say ± ½ of an order of magnitude, or more.

Qualitative Measures of Consequences to Property

Level	Descriptor	Description
1	CATASTROPHIC	Structure completely destroyed or large scale damage requiring major engineering works for stabilisation.
2	MAJOR	Extensive damage to most of structure, or extending beyond site boundaries requiring significant stabilisation works.
3	MEDIUM	Moderate damage to some of structure, or significant part of site requiring large stabilisation works.
4	MINOR	Limited damage to part of structure, or part of site requiring some reinstatement/stabilisation works.
5	INSIGNIFICANT	Little damage.

Note: The "Description" may be edited to suit a particular case.

Qualitative Risk Analysis Matrix – Level of Risk to Property

LIKELIHOOD	CONSEQUENCES to PROPERTY				
	1: CATASTROPHIC	2: MAJOR	3: MEDIUM	4: MINOR	5: INSIGNIFICANT
A – ALMOST CERTAIN	VH	VH	H	H	M
B – LIKELY	VH	H	H	M	L-M
C – POSSIBLE	H	H	M	L-M	VL-L
D – UNLIKELY	M-H	M	L-M	VL-L	VL
E – RARE	M-L	L-M	VL-L	VL	VL
F – NOT CREDIBLE	VL	VL	VL	VL	VL

Risk Level Implications

Risk Level		Example Implications(1)
VH	VERY HIGH RISK	Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to acceptable levels; may be too expensive and not practical
H	HIGH RISK	Detailed investigation, planning and implementation of treatment options required to reduce risk to acceptable levels
M	MODERATE RISK	Tolerable provided treatment plan is implemented to maintain or reduce risks. May be accepted. May require investigation and planning of treatment options.
L	LOW RISK	Usually accepted. Treatment requirements and responsibility to be defined to maintain or reduce risk.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (1) The implications for a particular situation are to be determined by all parties to the risk assessment; these are only given as a general guide.
(2) Judicious use of dual descriptors for Likelihood, Consequence and Risk to reflect the uncertainty of the estimate may be appropriate in some cases.

SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

	GOOD ENGINEERING PRACTICE	*POOR ENGINEERING PRACTICE*
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical consultant at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminant bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	

LANDSLIDE RISK MANAGEMENT — AGS SUB-COMMITTEE

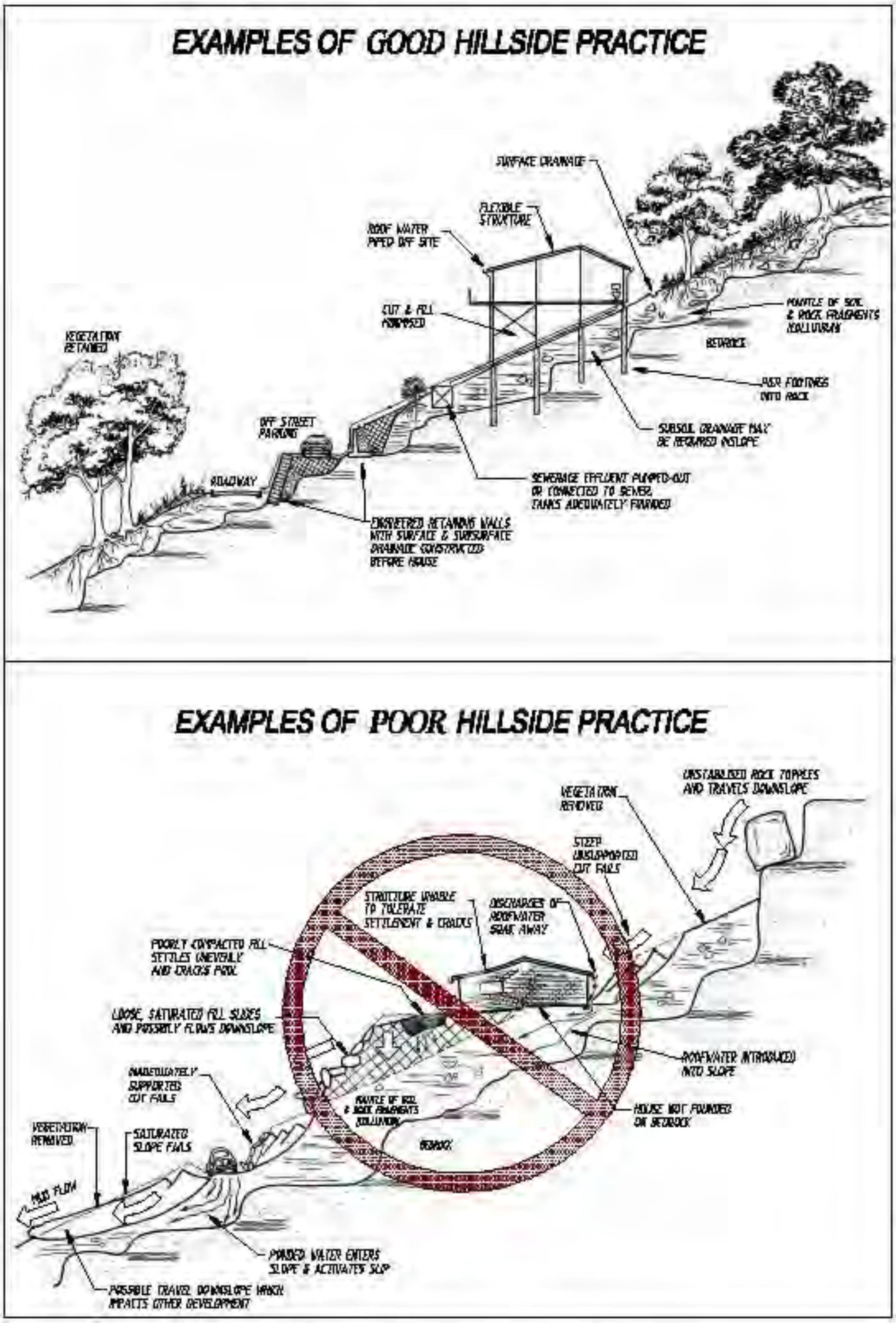


Figure J1 Illustrations of Good and Poor Hillside Practice

APPENDIX D – Contamination Testing

DE GROOT AND BENSON ENGINEERING
GRAHAM KNIGHT
P.O. BOX 1908
COFFS HARBOUR NSW 2450

BATCH NUMBER: 12/1608
No. of SAMPLES: 33
DATE COLLECTED: 10-16/07/12
DATE RECEIVED: 17/07/12
TIME RECEIVED: 15:25
DATE TESTING COMMENCED: 18/07/12

REPORT OF ANALYSIS

SAMPLE REFERENCE	SAMPLE DESCRIPTION
12/1608/1	SOIL SAMPLE 11157 - C1 - (0-150)
12/1608/2	SOIL SAMPLE 11157 - C2 - (0-150)
12/1608/3	SOIL SAMPLE 11157 - C3 - (0-150)
12/1608/4	SOIL SAMPLE 11157 - C4 - (0-150)
12/1608/5	SOIL SAMPLE 11157 - C5 - (0-150)
12/1608/6	SOIL SAMPLE 11157 - C6 - (0-150)
12/1608/7	SOIL SAMPLE 11157 - C7 - (0-150)
12/1608/8	SOIL SAMPLE 11157 - C8 - (0-150)
12/1608/9	SOIL SAMPLE 11157 - C9 - (0-150)
12/1608/10	SOIL SAMPLE 11157 - C10 - (0-150)
12/1608/11	SOIL SAMPLE 11157 - C11 - (0-150)
12/1608/12	SOIL SAMPLE 11157 - C12 - (0-150)
12/1608/13	SOIL SAMPLE 11157 - C13 - (0-150)
12/1608/14	SOIL SAMPLE 11157 - C14 - (0-150)
12/1608/15	SOIL SAMPLE 11157 - C15 - (0-150)
12/1608/16	SOIL SAMPLE 11157 - C16 - (0-150)
12/1608/17	SOIL SAMPLE 11157 - C17 - (0-150)
12/1608/18	SOIL SAMPLE 11157 - C18 - (0-150)
12/1608/19	SOIL SAMPLE 11157 - C19 - (0-150)
12/1608/20	SOIL SAMPLE 11157 - C20 - (0-150)
12/1608/21	SOIL SAMPLE 11157 - C21 - (0-150)
12/1608/22	SOIL SAMPLE 11157 - C22 - (0-150)
12/1608/23	SOIL SAMPLE 11157 - C23 - (0-150)
12/1608/24	SOIL SAMPLE 11157 - C24 - (0-150)
12/1608/25	SOIL SAMPLE 11157 - C25 - (0-150)
12/1608/26	SOIL SAMPLE 11157 - C26 - (0-150)
12/1608/27	SOIL SAMPLE 11157 - C27 - (0-150)

SAMPLE REFERENCE	SAMPLE DESCRIPTION
12/1608/28	SOIL SAMPLE 11157 - C28 - (0-150)
12/1608/29	SOIL SAMPLE 11157 - C29 - (0-150)
12/1608/30	SOIL SAMPLE 11157 - C30 - (0-150)
12/1608/31	SOIL SAMPLE 11157 - C31 - (0-150)
12/1608/32	SOIL SAMPLE 11157 - C32 - (0-150)
12/1608/33	SOIL SAMPLE 11157 - C33 - (0-150)

ANALYSIS	UNITS	12/1608/1	12/1608/2	12/1608/3	12/1608/4	METHOD NO
Arsenic*	mg/kg	92	59	110	150	NT2_49
Lead*	mg/kg	36	19	26	25	NT2_49

ANALYSIS	UNITS	12/1608/5	12/1608/6	12/1608/7	12/1608/8	METHOD NO
Arsenic*	mg/kg	110	42	65	160	NT2_49
Lead*	mg/kg	23	26	43	68	NT2_49

ANALYSIS	UNITS	12/1608/9	12/1608/10	12/1608/11	12/1608/12	METHOD NO
Arsenic*	mg/kg	110	100	81	5.6	NT2_49
Lead*	mg/kg	83	19	22	27	NT2_49

ANALYSIS	UNITS	12/1608/13	12/1608/14	12/1608/15	12/1608/16	METHOD NO
Arsenic*	mg/kg	5.7	6.5	6.4	6.6	NT2_49
Lead*	mg/kg	27	24	25	25	NT2_49

ANALYSIS	UNITS	12/1608/17	12/1608/18	12/1608/19	12/1608/20	METHOD NO
Arsenic*	mg/kg	73	99	12	12	NT2_49
Lead*	mg/kg	16	23	53	51	NT2_49

ANALYSIS	UNITS	12/1608/21	12/1608/22	12/1608/23	12/1608/24	METHOD NO
Arsenic*	mg/kg	34	120	27	21	NT2_49
Lead*	mg/kg	16	16	16	18	NT2_49

ANALYSIS	UNITS	12/1608/25	12/1608/26	12/1608/27	12/1608/28	METHOD NO
Arsenic*	mg/kg	59	66	55	6.5	NT2_49
Lead*	mg/kg	26	23	23	18	NT2_49

ANALYSIS	UNITS	12/1608/29	12/1608/30	12/1608/31	12/1608/32	METHOD NO
Arsenic*	mg/kg	10	28	150	36	NT2_49
Lead*	mg/kg	32	22	26	30	NT2_49

ANALYSIS	UNITS	12/1608/33				METHOD NO
Arsenic*	mg/kg	47				NT2_49
Lead*	mg/kg	26				NT2_49

ANALYSIS	UNITS	12/1608/1	12/1608/2	12/1608/3	12/1608/4	METHOD NO
ORGANOCHLORINE PESTICIDES *						
Hexachlorobenzene (HCB)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor Epoxide	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Aldrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
gamma BHC (Lindane)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
delta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
trans Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
cis Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Oxychlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Dieldrin	mg/kg	0.01	<0.01	0.014	<0.01	NR_19
DDE pp	mg/kg	0.110	<0.01	0.036	0.110	NR_19
DDD pp	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
DDT pp	mg/kg	0.044	<0.01	0.025	0.030	NR_19
Endrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Aldehyde	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Ketone	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endosulfan sulphate	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Methoxychlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
ORGANOPHOSPHATE PESTICIDES *						
Dichlorvos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Demeton-S-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Diazinon	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Dimethoate	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Malathion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenthion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (E)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (Z)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19

ANALYSIS	UNITS	12/1608/5	12/1608/6	12/1608/7	12/1608/8	METHOD NO
ORGANOCHLORINE PESTICIDES *						
Hexachlorobenzene (HCB)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor Epoxide	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Aldrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
gamma BHC (Lindane)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
delta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
trans Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
cis Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Oxychlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Dieldrin	mg/kg	<0.01	<0.01	0.220	0.021	NR_19
DDE pp	mg/kg	0.012	<0.01	<0.01	<0.01	NR_19
DDD pp	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
DDT pp	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Aldehyde	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Ketone	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endosulfan sulphate	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Methoxychlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
ORGANOPHOSPHATE PESTICIDES *						
Dichlorvos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Demeton-S-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Diazinon	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Dimethoate	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Malathion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenthion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (E)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (Z)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19

ANALYSIS	UNITS	12/1608/9	12/1608/10	12/1608/11	12/1608/12	METHOD NO
ORGANOCHLORINE PESTICIDES *						
Hexachlorobenzene (HCB)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor Epoxide	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Aldrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
gamma BHC (Lindane)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
delta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
trans Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
cis Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Oxychlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Dieldrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
DDE pp	mg/kg	<0.01	0.086	<0.01	0.047	NR_19
DDD pp	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
DDT pp	mg/kg	<0.01	0.036	<0.01	0.014	NR_19
Endrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Aldehyde	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Ketone	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endosulfan sulphate	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Methoxychlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
ORGANOPHOSPHATE PESTICIDES *						
Dichlorvos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Demeton-S-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Diazinon	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Dimethoate	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Malathion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenthion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (E)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (Z)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19

ANALYSIS	UNITS	12/1608/13	12/1608/14	12/1608/15	12/1608/16	METHOD NO
ORGANOCHLORINE PESTICIDES *						
Hexachlorobenzene (HCB)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor Epoxide	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Aldrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
gamma BHC (Lindane)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
delta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
trans Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
cis Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Oxychlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Dieldrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
DDE pp	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
DDD pp	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
DDT pp	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Aldehyde	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Ketone	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endosulfan sulphate	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Methoxychlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
ORGANOPHOSPHATE PESTICIDES *						
Dichlorvos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Demeton-S-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Diazinon	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Dimethoate	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Malathion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenthion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (E)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (Z)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19

ANALYSIS	UNITS	12/1608/17	12/1608/18	12/1608/19	12/1608/20	METHOD NO
ORGANOCHLORINE PESTICIDES *						
Hexachlorobenzene (HCB)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor Epoxide	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Aldrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
gamma BHC (Lindane)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
delta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
trans Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
cis Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Oxychlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Dieldrin	mg/kg	0.030	<0.01	<0.01	<0.01	NR_19
DDE pp	mg/kg	<0.01	<0.01	0.070	0.096	NR_19
DDD pp	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
DDT pp	mg/kg	<0.01	<0.01	0.038	0.023	NR_19
Endrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Aldehyde	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Ketone	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endosulfan sulphate	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Methoxychlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
ORGANOPHOSPHATE PESTICIDES *						
Dichlorvos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Demeton-S-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Diazinon	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Dimethoate	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Malathion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenthion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (E)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (Z)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19

ANALYSIS	UNITS	12/1608/21	12/1608/22	12/1608/23	12/1608/24	METHOD NO
ORGANOCHLORINE PESTICIDES *						
Hexachlorobenzene (HCB)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor Epoxide	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Aldrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
gamma BHC (Lindane)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
delta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
trans Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
cis Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Oxychlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Dieldrin	mg/kg	<0.01	<0.01	<0.01	0.016	NR_19
DDE pp	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
DDD pp	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
DDT pp	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Aldehyde	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Ketone	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endosulfan sulphate	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Methoxychlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
ORGANOPHOSPHATE PESTICIDES *						
Dichlorvos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Demeton-S-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Diazinon	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Dimethoate	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Malathion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenthion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (E)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (Z)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19

ANALYSIS	UNITS	12/1608/25	12/1608/26	12/1608/27	12/1608/28	METHOD NO
ORGANOCHLORINE PESTICIDES *						
Hexachlorobenzene (HCB)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor Epoxide	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Aldrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
gamma BHC (Lindane)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
delta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
trans Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
cis Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Oxychlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Dieldrin	mg/kg	<0.01	0.011	0.012	<0.01	NR_19
DDE pp	mg/kg	0.100	0.040	<0.01	0.076	NR_19
DDD pp	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
DDT pp	mg/kg	0.017	0.01	<0.01	0.022	NR_19
Endrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Aldehyde	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Ketone	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endosulfan sulphate	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Methoxychlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
ORGANOPHOSPHATE PESTICIDES *						
Dichlorvos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Demeton-S-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Diazinon	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Dimethoate	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Malathion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenthion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (E)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (Z)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19

ANALYSIS	UNITS	12/1608/29	12/1608/30	12/1608/31	12/1608/32	METHOD NO
ORGANOCHLORINE PESTICIDES *						
Hexachlorobenzene (HCB)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Heptachlor Epoxide	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Aldrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
gamma BHC (Lindane)	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
delta BHC	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
trans Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
cis Chlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Oxychlordane	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Dieldrin	mg/kg	<0.01	<0.01	0.011	<0.01	NR_19
DDE pp	mg/kg	0.074	<0.01	<0.01	<0.01	NR_19
DDD pp	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
DDT pp	mg/kg	0.022	<0.01	<0.01	<0.01	NR_19
Endrin	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Aldehyde	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endrin Ketone	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
alpha Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
beta Endosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Endosulfan sulphate	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
Methoxychlor	mg/kg	<0.01	<0.01	<0.01	<0.01	NR_19
ORGANOPHOSPHATE PESTICIDES *						
Dichlorvos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Demeton-S-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Diazinon	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Dimethoate	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorpyrifos-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Malathion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenthion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (E)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Chlorfenvinphos (Z)	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Parathion Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Pirimiphos Ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos Methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19
Azinphos ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	NR_19

ANALYSIS	UNITS	12/1608/33				METHOD NO
ORGANOCHLORINE PESTICIDES *						
Hexachlorobenzene (HCB)	mg/kg	<0.01				NR_19
Heptachlor	mg/kg	<0.01				NR_19
Heptachlor Epoxide	mg/kg	<0.01				NR_19
Aldrin	mg/kg	<0.01				NR_19
gamma BHC (Lindane)	mg/kg	<0.01				NR_19
alpha BHC	mg/kg	<0.01				NR_19
beta BHC	mg/kg	<0.01				NR_19
delta BHC	mg/kg	<0.01				NR_19
trans Chlordane	mg/kg	<0.01				NR_19
cis Chlordane	mg/kg	<0.01				NR_19
Oxychlordane	mg/kg	<0.01				NR_19
Dieldrin	mg/kg	<0.01				NR_19
DDE pp	mg/kg	<0.01				NR_19
DDD pp	mg/kg	<0.01				NR_19
DDT pp	mg/kg	<0.01				NR_19
Endrin	mg/kg	<0.01				NR_19
Endrin Aldehyde	mg/kg	<0.01				NR_19
Endrin Ketone	mg/kg	<0.01				NR_19
alpha Endosulfan	mg/kg	<0.01				NR_19
beta Endosulfan	mg/kg	<0.01				NR_19
Endosulfan sulphate	mg/kg	<0.01				NR_19
Methoxychlor	mg/kg	<0.01				NR_19
ORGANOPHOSPHATE PESTICIDES *						
Dichlorvos	mg/kg	<0.1				NR_19
Demeton-S-methyl	mg/kg	<0.1				NR_19
Diazinon	mg/kg	<0.1				NR_19
Dimethoate	mg/kg	<0.1				NR_19
Chlorpyrifos	mg/kg	<0.1				NR_19
Chlorpyrifos-methyl	mg/kg	<0.1				NR_19
Malathion	mg/kg	<0.1				NR_19
Fenthion	mg/kg	<0.1				NR_19
Ethion	mg/kg	<0.1				NR_19
Fenitrothion	mg/kg	<0.1				NR_19
Chlorfenvinphos (E)	mg/kg	<0.1				NR_19
Chlorfenvinphos (Z)	mg/kg	<0.1				NR_19
Parathion Ethyl	mg/kg	<0.1				NR_19
Parathion Methyl	mg/kg	<0.1				NR_19
Pirimiphos Methyl	mg/kg	<0.1				NR_19
Pirimiphos Ethyl	mg/kg	<0.1				NR_19
Azinphos Methyl	mg/kg	<0.1				NR_19
Azinphos ethyl	mg/kg	<0.1				NR_19

Comments: *Analysis conducted by a subcontracted laboratory (NATA Accreditation Number 198) O/N:E68819. Sample(s) collected by client and analysed as received in accordance with "Standard Methods for the Examination of Water & Wastewater", 21st Edition, 2005, APHA. Raw data sheets stating analysis dates are available upon request.

Approved: B J Wadleigh 31/07/12

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

Accredited for compliance with ISO/IEC 17025.
[Accreditation Numbers: 12359 (Chemical) & 14565 (Microbiological)]

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

APPENDIX E – Extract from CHWSS

Extract below from Ref 10 - Coffs Harbour Water Supply Strategy Study - Final Report, February 1999, de Groot & Benson Pty Ltd**: Text highlighted in Red relates to the Study Area:**

4.4.9 Roberts Hill

The existing reticulation system will be sufficient to meet the demand anticipated for existing serviced areas beyond the year 2021. The minimum pressure under peak instantaneous demand in Kratz Drive (node RH17) is predicted to decrease slightly, from 10 m to 9 m. This poor minimum pressure is due to the elevation of the properties serviced and there is no viable remedy.

The minimum pressure currently experienced in Victoria Street, at the top of the hill overlooking the Jetty (node RH136), is 21 m. This is predicted to decrease to 17 m by 2021. While this is low, it will not warrant any action. A similar situation exists in Anniversary Place (Node RH15). Here minimum pressure is predicted to decrease from 20 m to 16 m.

Roberts Hill Reservoir will supply the new development areas in the North Boambee Valley. The North Boambee Valley Stage 1 Release Area, Development Control Plan (CHCC, December 1996) provides details on the predicted road layout and reticulation network for 15DA3 and 15EZUL2. This information, combined with the predicted growth summarised in Section 2.6 was used to determine an indicative staging of the water supply infrastructure - as shown in **Drawing 3-15**. The predicted growth rates will see the infrastructure for Stage 1 of North Boambee Valley completed by 2007. **Stage 2, comprising of 15NRA1, is predicted to start in 2010, whilst Stage 3 is not expected until after 2021**. The predicted staging of the infrastructure includes:

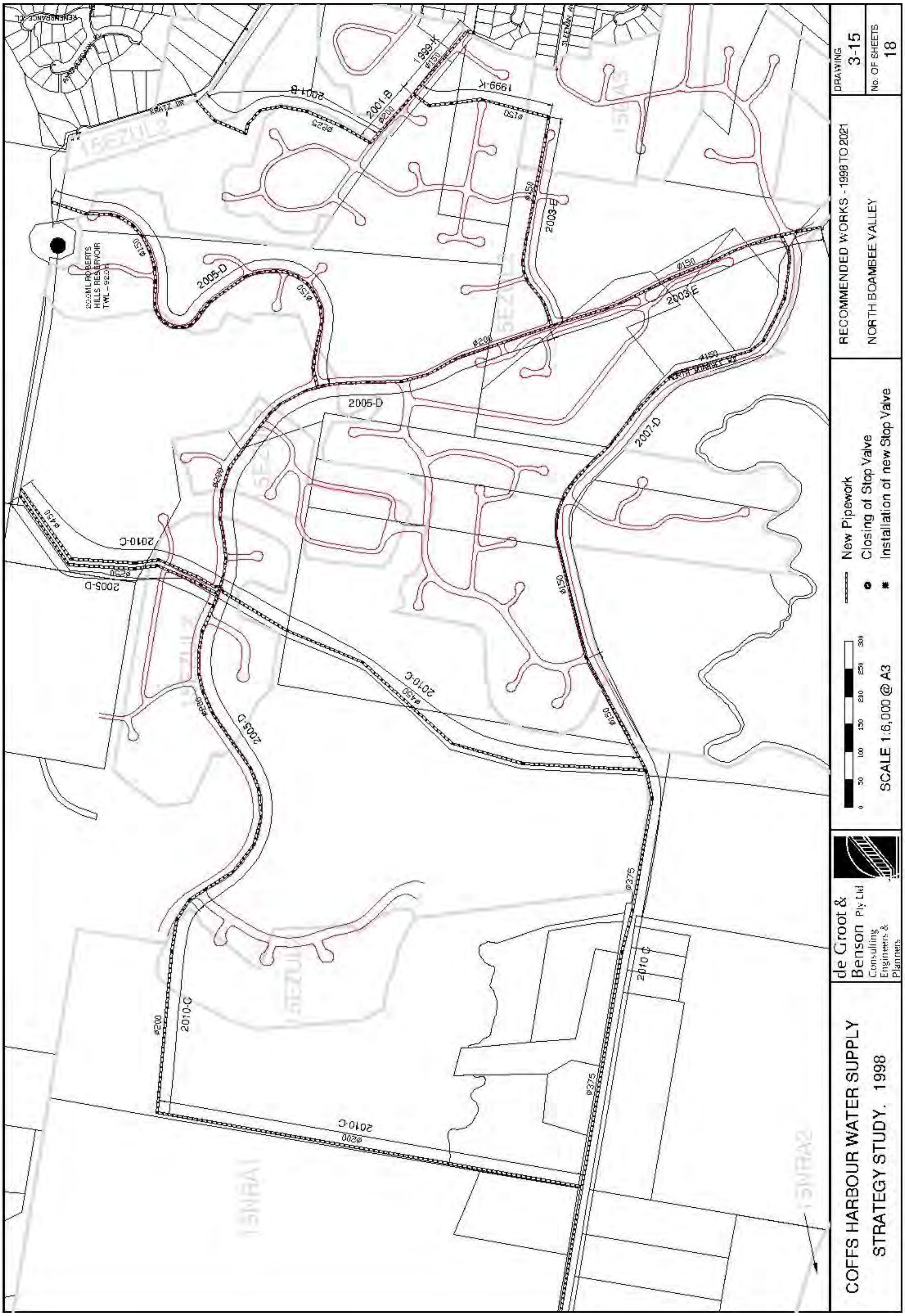
- 1999 – 250 m of 150 mm ∅ pipeline for 15DA3;
- 2001 – 415 m of 225 mm ∅ pipeline for 15EZUL2;
- 2003 – 785 m of 150 mm ∅ pipeline for 15EZUL2;
- 2005 – 455 m of 250 mm, 915 m of 200 mm ∅ and 790 m of 150 mm ∅ pipeline for 15EZUL2;
- 2007 – 960 m of 150 mm ∅ pipeline to complete 15EZUL2 (stage 1 of North Boambee Valley);

- **2010 – 1340 m of 450 mm, 770 m of 375 mm, 670 m of 250 mm, 1090 m of 200 mm ∅ and 230 m of 150 mm ∅ for 15NRA1 (stage 2 of North Boambee Valley).**

It should be noted that the 1340 m of 450 mm ∅ pipeline and a section of the 770 m of 375 mm ∅ pipelines required for 15NRA1 (Stage 2 of North Boambee Valley) have been sized to also convey the flow required for 15NRA2 (stage 3).

The pipe system indicated in the Development Control Plan (CHCC, December 1996) is sufficient for the projected demand. However, the staging of its implementation is important. The first development application for Stage 1 has already been received (15DA3). This development lies west of Sleeman and Burridge Avenues. It can be supplied off the 100 mm ∅ reticulation pipelines in these streets, or, as **Drawing 3-15** indicates off Halls Road.

The ability to supply further development off these pipelines is limited. For this reason, the staging listed above includes a link through to the trunk line in Kratz Drive. **It is important that this link be implemented relatively early (2001) in the development of North Boambee Valley**.


COFFS HARBOUR WATER SUPPLY
STRATEGY STUDY, 1998
de Groot & Benson Pty Ltd
Consulting Engineers & Planners
SCALE 1:6,000 @ A3
New Pipework
Closing of Stop Valve
Installation of new Stop Valve
RECOMMENDED WORKS - 1998 TO 2021
NORTH BOAMBEE VALLEY
DRAWING
3-15
No. OF SHEETS
18
2005-D
2010-C
2007-D
2003-E
2001-B
1999-K
ø150
ø200
ø225
ø250
ø375
ø450