SALINITY MANAGEMENT GUIDELINES

EVERGREEN WATERS ESTATE
INCORPORATING
GOLDEN GROVE – STAGES 4,5,6,7 & 8
JACKASS FLAT

PREPARED BY SIMONDS DEVELOPMENTS – AUGUST 2011

TABLE OF CONTENTS

1. INTRODUCTION

Planning Permits AM/226/2010 and AM/904/2011, issued by the City of Greater Bendigo, give conditional approval for the development of Golden Grove Estate. Both Planning Permits contain conditions relating to the testing for saline groundwater and the provision of guidelines to stipulate geotechnical standards for the construction of dwellings on land where testing shows that saline groundwater is present at a depth of between 1.6m – 2.5m.

In accordance with these conditions the Salinity Management Guidelines for the Evergreen Waters Estate (which incorporates the Golden Grove Estate) was approved by the City of Greater Bendigo. A copy of these overall guidelines is found at section 3 of these guidelines.

The Planning Permits require an agreement under Section 173 of the *Planning and Environment Act 1987* is to be registered on the Titles for each relevant lot which stipulates that:

1. *Dwellings on lots affected by saline groundwater, where the depth to the water table is 1.6m-2.5m, will be constructed in accordance with the guidelines approved under this permit.*
2. *No dwellings will be constructed on lots where the depth to the water table in 0m1.5m.*

1.1 Summary of Guidelines

In accordance with the above requirements a Groundwater Investigation Report has been prepared by Geotechnical Testing Services (GTS), a copy of which is found at section 2 of these guidelines.

Boreholes have been excavated within the area identified as **Stages 4, 5,6,7 & 8** of the Golden Grove Estate as follows:

- Stage 4 – Borehole 6 (BH6)
- Stage 5 – Borehole 7 (BH7)
- Stage 6 – Borehole 8 (BH8)
- Stage 7 – Borehole 10, 11 & 15 (BH10, BH11 & BH15)
- Stage 8 – Boreholes 12,13,14 (BH12,BH13 & BH14)

The findings of the GTS report indicates that no shallow groundwater (less than 3 metres) is present within the confines of the areas identified.

Based on these findings the specific constructions standards as detailed within the Salinity Management Guidelines, at section 3 of this report, are not necessary on any lots within stages 4-8 of the Golden Grove Estate.

2. GROUNDWATER INVERTIGATION REPORT

Golden Grove Estate
Jackass Flat

Groundwater Investigation
for
Warringal Views P/L

Report 20C 0155
March, 2020

GTS
GEOTECHNICAL TESTING SERVICES

Golden Grove Estate

Groundwater Investigation

for

Warringal Views P/L

Revision

Revision	Date	Authorised
20C 0155	16/03/20	BAB

Distribution (this revision only)

Recipient	Format	Date
GTSS	On file	16/03/2020
Warringal Views P/L c/- Spiire Attn: Brendan Ibbs	Email PDF	16/03/2020

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TABLE OF CONTENTS

APPENDIX

1 INTRODUCTION

Warringal Views P/L has commissioned Geotechnical Testing Services (GTS) to undertake a groundwater investigation at the Golden Grove Estate development.

The purpose of the investigation was to determine if there was shallow presence of groundwater along the southern and eastern sectors of the site.

2 SITE AND GEOLOGY

2.1 SITE LOCATION AND GENERAL CONDITIONS

The site is located at Golden Grove Estate, Jackass Flat.

The site is considered to have slight fall towards the Jackass Gully creek alignment bordering the sites Western sector. At the time of the investigation, the surface of the site was dry and had no grass cover. Visual evidence of surface rock was noted in the forms of exposed reefs and gravel throughout the site. There are many large trees predominately within the sites North East boundary which neighbours a flora reserve.

2.2 GEOLOGY

The Victorian Government's online "Geovic" map shows the area to be underlain by Ordovician aged sedimentary rock of the Castlemaine Group with this generally confirmed by the field data.

3 FIELDWORK

The geotechnical investigation was conducted on the 2nd March 2020 and involved the drilling of 15 borehole by Gemco drilling rig to depths of 3.0 metres or refusal.

The field investigation was conducted by a technician under the direction of a Geotechnical Engineer, who logged the subsurface profile. No groundwater was detected in the 15 boreholes, with relatively dry soil conditions experienced throughout the investigation. Borehole 8 was drilled to depth of 2.0m before refusal on medium strength extremely weathered siltstone. The engineering logs are included in the Appendix with their locations shown on the enclosed site plan.

4 IMPORTANT NOTES ABOUT THIS REPORT

The results from this investigation relate to the specified sites labelled throughout this document, and hence the information obtained may need to be extrapolated to the rest of the designated area. While care has been taken throughout this investigation, soil conditions can vary between each individual test site and at depths greater than that drilled during this investigation. Hence, if variations from this report are found during excavations/construction then Geotechnical Testing Services should be notified so it can be assessed, and appropriate advice provided.

The soil colours provided in the borehole logs attached may vary with soil moisture content and individual interpretation, therefore colour alone should not be used to identify these soils.

Strength characteristics of soils often exhibit a large variation between wet and dry conditions. Soil characteristics of a soil profile are given on the soil conditions at the time of the investigation.

5 DISCLAIMER

This investigation has been carried out in goodwill and under the instructions of Warringal Views P/L. The investigation has been undertaken with the care and skill of competent personnel as defined within Geotechnical Testing Services quality system. It is not a comprehensive investigation but a guide to the conditions throughout the designated area.

This document has been prepared for Warringal Views P/L, and hence no responsibility or liability is being accepted to any third party, where any part of the report is used in either isolation or without consideration of the whole document. This document is not appropriate where there has been a significant change in the project or either for the specific needs of the reader.

Please, don't hesitate to contact the undersigned, if you require any further information or assistance.

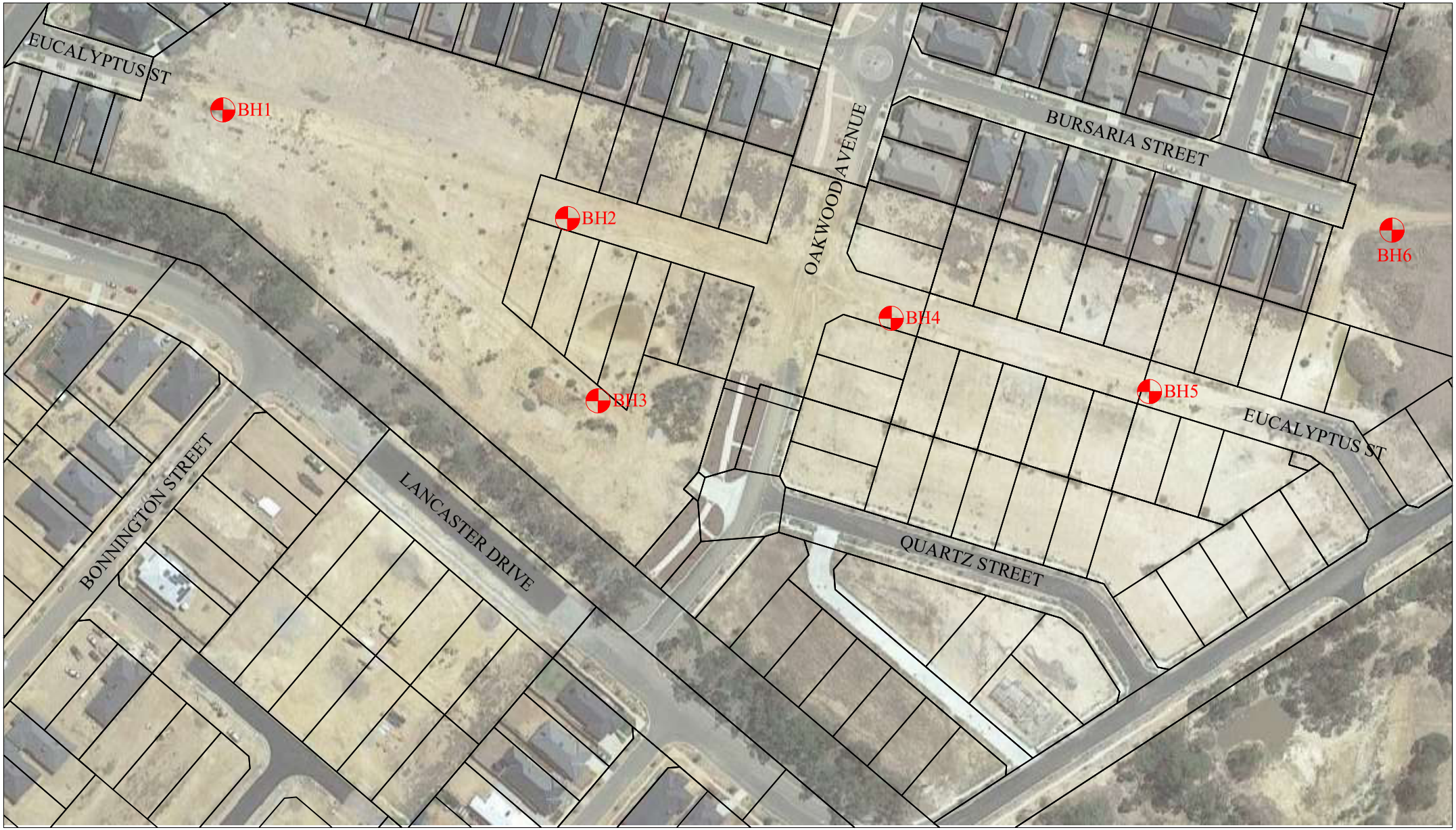
Prepared by

Jackson Blakemore BE (Hons), GradIEAust
Graduate Geotechnical Engineer

Reviewed by

Benj Beatty BA/BSc (Hons), MPA, MAusIMM
Senior Geologist

APPENDIX



GTS GEOTECHNICAL TESTING SERVICES

GEOTECHNICAL INVESTIGATION

APPROXIMATE LOCATIONS: NOT TO SCALE

CLIENT: WARRINGAL VIEWS P/L

PROJECT: GOLDEN GROVE ESTATE, JACKASS FLATS

GTS REF: 20C 0155

DATE: 2 MARCH 2020

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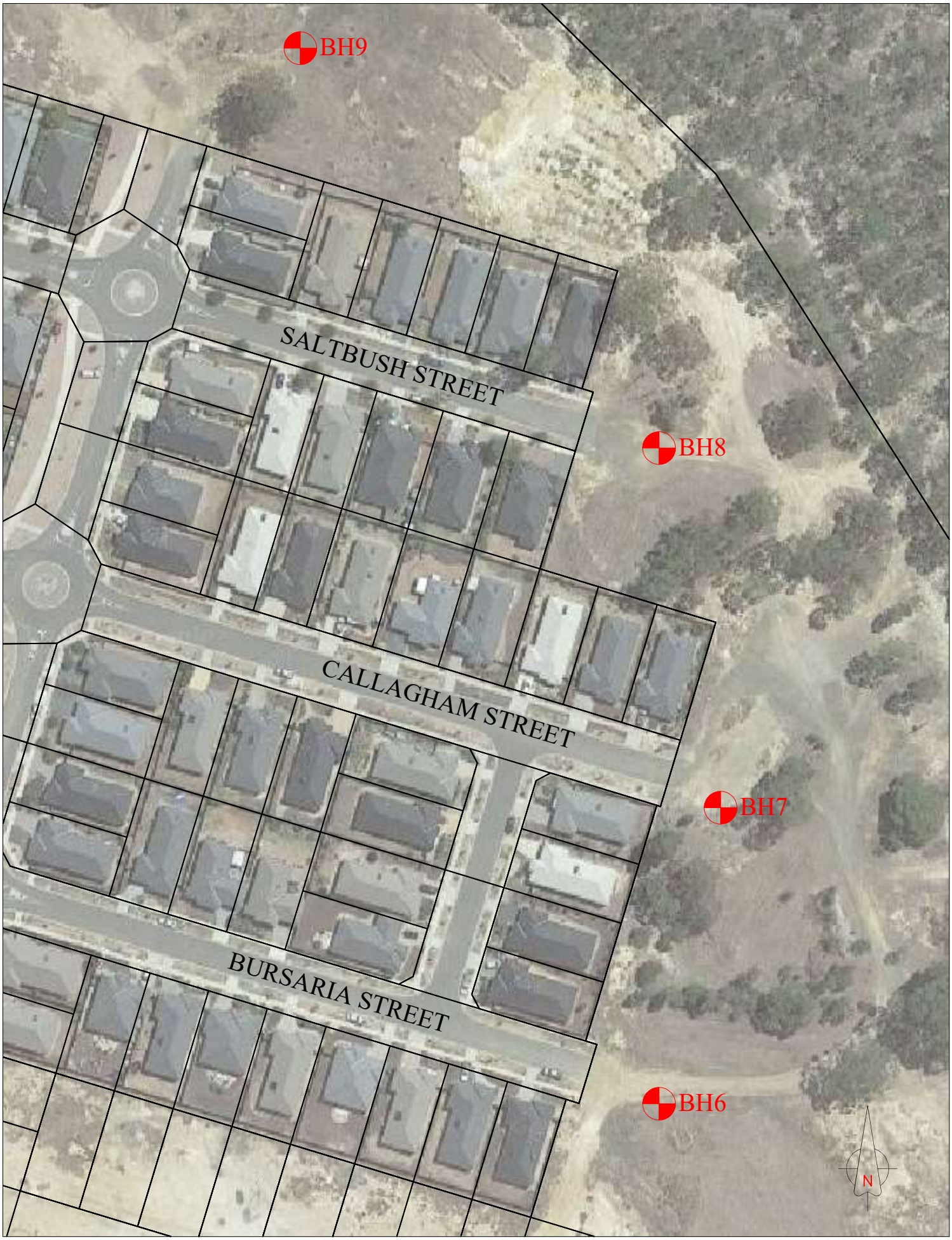


GTS
GEOTECHNICAL TESTING SERVICES

GEOTECHNICAL INVESTIGATION

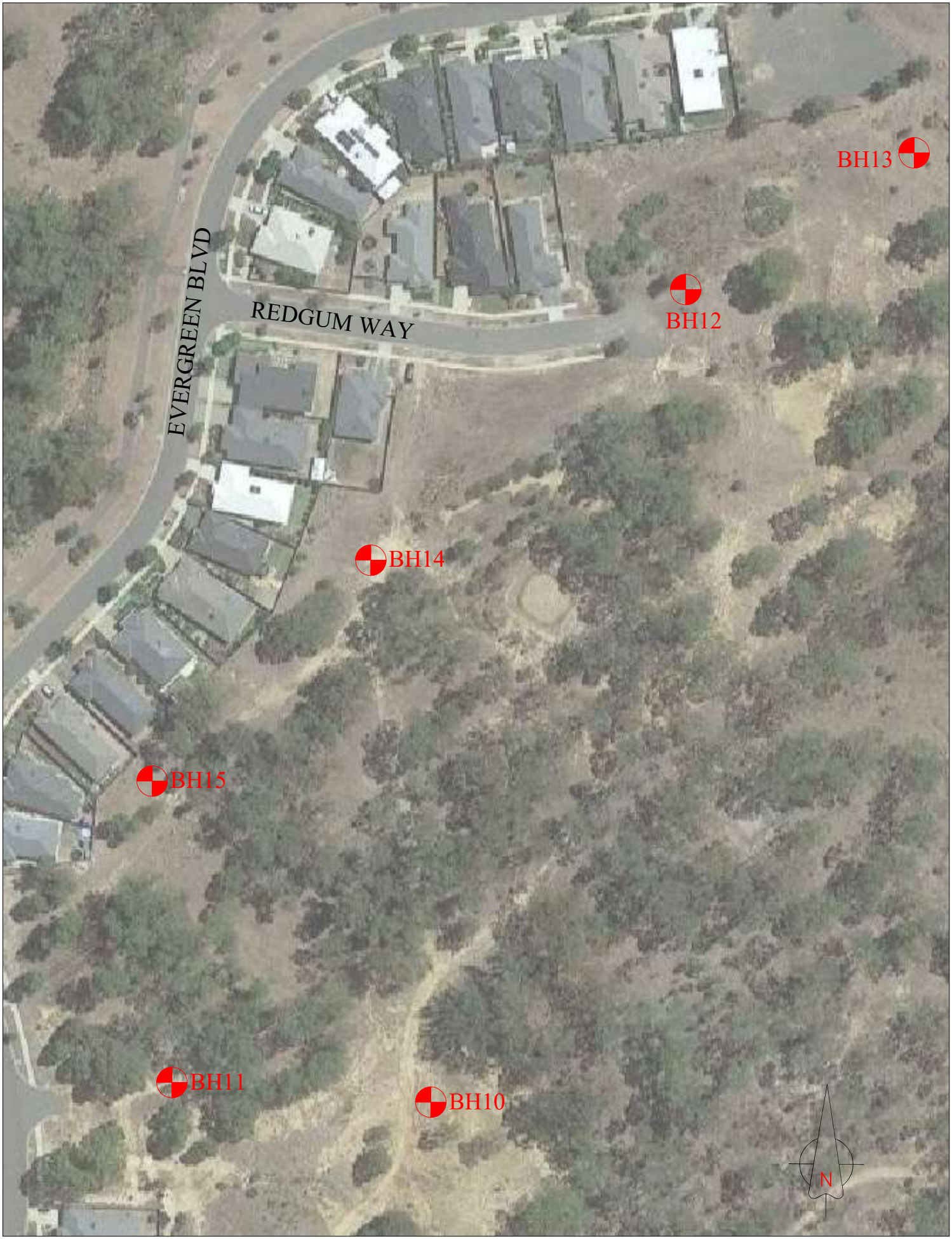
APPROXIMATE LOCATIONS NOT TO SCALE

CLIENT: WARRINGAL VIEWS P/L

PROJECT: GOLDEN GROVE ESTATE, JACKASS FLATS

GTS REF: 20C 0155

DATE: 2 MARCH 2020



GTS GEOTECHNICAL TESTING SERVICES

GEOTECHNICAL INVESTIGATION

APPROXIMATE LOCATIONS NOT TO SCALE

CLIENT: WARRINGAL VIEWS P/L

PROJECT: GOLDEN GROVE ESTATE, JACKASS FLATS

GTS REF: 20C 0155

DATE: 2 MARCH 2020

ENGINEERING BOREHOLE LOG

GTS GEOTECHNICAL TESTING SERVICES
PO Box 13, Strathdale 3550
Ph (03) 54414881 Fax (03) 5441 5089

Borehole no. 1
Sheet no. 1 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL: Gravelly Silty CLAY (CL), low plasticity, brown, grey, fine to medium gravel 900mm	0.50			D	St	FILL			
Silty CLAY (CI), medium plasticity, red brown, pale brown, some fine to medium gravel 1600mm	1.00 1.50			M	VSt				
Clayey Sandy GRAVEL (GP), fine to medium gravel, fine to coarse sand, brown, low plasticity 2000mm	2.00			D	MD				
Silty CLAY (CI), medium plasticity, pale brown mottled grey, traces of fine to medium gravel 2600mm	2.50			M	St				
SILTSTONE, extremely weathered, off white 3000mm	3.00			D	VL				
BH1 terminated at 3.0 metres	3.50 4.00					**Dry Hole**			

ENGINEERING BOREHOLE LOG

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Borehole no. 2
Sheet no. 2 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL: Clayey Sandy GRAVEL (GW), fine to coarse, pale brown, low plasticity 100mm				D	MD	FILL			
Silty CLAY (CI), medium plasticity, red brown 400mm				M	VSt				
Gravelly Silty CLAY (CL), low plasticity, pale brown, fine to medium gravel 700mm	0.50			D	St	Residual soil			
SANDSTONE/SILTSTONE, extremely weathered, pale brown 3000mm	1.00			D	L				
	1.50								
	2.00								
	2.50								
	3.00								
BH2 terminated at 3.0 metres	3.50					**Dry Hole**			
	4.00								

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Borehole no. 3
Sheet no. 3 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL: Clayey Sandy GRAVEL (GW), fine to coarse sand and gravel, pale brown 100mm				D	MD	FILL			
Gravelly Sandy Silty CLAY (CL), low plasticity, pale brown 1300mm				D	VSt				
	0.50								
	1.00								
SANDSTONE/SILTSTONE, extremely weathered, yellow brown 3000mm				D	L-VL				
sandstone layering off	1.50								
white siltstone									
	2.00								
	2.50								
	3.00								
BH3 terminated at 3.0 metres						**Dry Hole**			
	3.50								
	4.00								

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Borehole no. 4
Sheet no. 4 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL: Sandy GRAVEL (GW), fine to coarse sand and gravel, pale brown 100mm				D	MD	FILL			
Silty CLAY (CI), medium plasticity, brown, traces of fine gravel 800mm	0.50			M	St				
SILTSTONE, extremely weathered, pale brown, off white 3000mm	1.00			D	VL				
	1.50								
	2.00								
	2.50								
	3.00								
BH4 terminated at 3.0 metres	3.50					**Dry Hole**			
	4.00								

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Borehole no. 5
Sheet no. 5 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL: Gravelly Silty CLAY (CI), low to medium plasticity, brown, pale brown 1600mm	0.50			M	St-VSt	FILL			
	1.00								
	1.50								
SILTSTONE, extremely weathered, off white 3000mm	2.00			D	VL				
	2.50								
	3.00								
BH5 terminated at 3.0 metres	3.50					**Dry Hole**			
	4.00								

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Borehole no. 6
Sheet no. 6 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL: Gravelly Silty CLAY (CL), low plasticity, pale brown, brown, fine to coarse gravel 400mm				D	St				
Silty CLAY (CL), low plasticity, brown, traces of fine to medium gravel 700mm	0.50			D	St				
SILTSTONE, extremely weathered, off white, pale brown 3000mm	1.00			D	VL				
	1.50								
	2.00								
	2.50								
	3.00								
BH6 terminated at 3.0 metres	3.50					**Dry Hole**			
	4.00								

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Borehole no. 7
Sheet no. 7 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL: Gravelly Sandy SILT (ML), dark brown, fine gravel 150 mm				D	L	FILL			
SILTSTONE, extremely weathered, pale brown, off white 3000mm				D	VL				
	0.50								
	1.00								
	1.50								
	2.00								
	2.50								
	3.00								
BH7 terminated at 3.0 metres						**Dry Hole**			
	3.50								
	4.00								

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ENGINEERING BOREHOLE LOG

Borehole no. 8
Sheet no. 8 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL: Gravelly Silty CLAY (CL), low plasticity, brown, fine to coarse gravel 100mm				D	St	FILL			
Silty CLAY (CI), medium plasticity, red brown, traces of fine gravel 400mm				M	VSt				
SILTSTONE, extremely weathered, pale brown, yellow brown 2000mm	0.50			D	L-M				
	1.00								
	1.50								
	2.00								
BH8 terminated at 2.0 metres	2.50					**By Refusal** **Dry Hole**			
	3.00								
	3.50								
	4.00								

ENGINEERING BOREHOLE LOG

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Borehole no. 9
Sheet no. 9 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL:Gravelly Silty CLAY (CL), low plasticity, brown, fine to coarse gravel 100mm				D	St	FILL			
Silty CLAY (CI), medium plasticity, red brown traces of fine gravel 400mm				M	St				
Silty CLAY (CL), low plasticity, pale brown, off white 1400mm	0.50			M	St				
	1.00								
SILTSTONE, extremely weathered, pale brown, off white 3000mm	1.50			D	L				
	2.00								
	2.50								
	3.00								
BH9 terminated at 3.0 metres	3.50					**Dry Hole**			
	4.00								

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Borehole no. 10
Sheet no. 10 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL: Clayey Sandy GRAVEL (GW), fine to coarse sand and gravel, pale brown, low plasticity fines 500mm	0.50			D	D	FILL			
Silty CLAY (CI), medium plasticity, pale brown mottled pale grey 1500mm	1.00			D	VSt	Tree roots @ 1.0m			
	1.50								
Silty CLAY (CI), low to medium plasticity, brown, some fine to medium sand 2800mm	2.00			D-M	St				
	2.50								
SILTSTONE, extremely weathered, off white 3000mm	3.00			D	VL				
BH10 terminated at 3.0 metres	3.50					**Dry Hole**			
	4.00								

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Borehole no. 11
Sheet no. 11 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
Gravelly Silty CLAY (CI), low to medium plasticity, brown, dark brown 1100mm	0.50			D-M	VSt	Worked Alluvial			
	1.00								
Sandy SILT (ML), brown 1300mm				D	MD				
Silty CLAY (CI), medium plasticity, pale brown, some fine sand 2000mm	1.50			D	VSt				
	2.00								
Clayey Sandy GRAVEL (GW), low plasticity, brown, fine to coarse sand, fine to medium gravel 3000mm	2.50			D	D				
	3.00								
BH11 terminated at 3.0 metres	3.50					**Dry Hole**			
	4.00								

ENGINEERING BOREHOLE LOG

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Borehole no. 12
Sheet no. 12 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL: Silty CLAY (CI), medium plasticity, pale brown, brown, some fine to coarse sand and fine to medium gravel 600mm	0.50			D	VSt	FILL			
Sandy SILT (ML), dark grey 800mm				D	MD				
Silty CLAY (CL), low plasticity, pale brown 1200mm	1.00			D	VSt				
Silty CLAY (CI), medium plasticity, brown, some fine sand, traces of fine gravel 1900mm	1.50			D	VSt				
Sandy Silty CLAY (CL), low plasticity, brown 2300mm	2.00			D	VSt				
Clayey Sandy GRAVEL (GP), brown, fine to medium gravel, fine to coarse sand, low plasticity 3000mm	2.50			D	D				
	3.00								
BH12 terminated at 3.0 metres	3.50					**Dry Hole**			
	4.00								

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ENGINEERING BOREHOLE LOG

Borehole no. 13
Sheet no. 13 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL: Gravelly Sandy Silty CLAY (CI), medium plasticity, brown, pale brown 1200mm	0.50			D	F	FILL			
					St				
FILL: SAND (SW), fine to coarse, brown 1400mm	1.00			D	L	FILL			
Silty CLAY (CI), medium plasticity, brown, some fine sand 2000mm	1.50			D-M	VSt				
Clayey SAND (SP), fine to medium, brown, low plasticity 3000mm	2.00			D	D				
BH13 terminated at 3.0 metres	2.50					**Dry Hole**			
	3.00								
	3.50								
	4.00								

ENGINEERING BOREHOLE LOG

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Borehole no. 14
Sheet no. 14 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL: Gravelly Silty CLAY (CL), low plasticity pale brown, fine to coarse gravel 200mm				D	VSt	FILL			
Silty CLAY (CI), medium plasticity, brown, pale brown, some fine sand 1300mm				D-M	VSt				
	0.50					Tree roots @ 0.5m			
	1.00								
Sandy Gravelly Silty CLAY (CL), low plasticity, brown, fine to coarse sand, fine to medium gravel 2500mm	1.50			D	VSt				
	2.00								
	2.50								
SILTSTONE, extremely weathered, pale brown, off white 3000mm				D	L				
	3.00								
BH14 terminated at 3.0 metres						**Dry Hole**			
	3.50								
	4.00								

ENGINEERING BOREHOLE LOG

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Borehole no. 15
Sheet no. 15 of 15
Job no. 20C 0155

Client :	Warringal Views P/L			Date:	2/03/2020
Project :	Geotechnical Investigation			Logged by:	TP
Location :	Golden Grove Estate, Jackass Flats				
Drill model :	Gemco HS7	Slope	90 deg	RL surface:	*Not measured*
Hole diameter :	100mm	Bearing	- deg	Datum :	-

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
FILL: Gravelly Silty CLAY (CL), low plasticity pale brown, fine to coarse gravel 200mm				D	VSt	FILL			
Silty CLAY (CI), medium plasticity, brown, pale brown, some fine sand 1300mm				D-M	VSt				
	0.50					Tree roots @ 0.5m			
	1.00								
Sandy Gravelly Silty CLAY (CL), low plasticity, brown, fine to coarse sand, fine to medium gravel 2500mm	1.50			D	VSt				
	2.00								
	2.50								
SILTSTONE, extremely weathered, pale brown, off white 3000mm				D	L				
	3.00								
BH14 terminated at 3.0 metres						**Dry Hole**			
	3.50								
	4.00								

DESCRIPTIVE TERMS
BOREHOLE/EXCAVATION LOG

Classification Symbol & Soil Name

Classification of material and its description is based on the Unified Classification System as referenced in AS1726 – 1993 Geotechnical Site Investigations, Appendix A. A summary of the more common terms is included within.

Particle Size Descriptive Terms

Name	Subdivision	Size
Boulders		>200mm
Cobbles		63 – 200mm
Gravel	Coarse	20 – 63mm
	Medium	6 – 20mm
	Fine	2.36 – 6mm
Sand	Coarse	0.6 – 2.36mm
	Medium	200 – 600 micron
	Fine	75 – 200 micron
Silt		2 – 75 micron
Clay		< 2 micron

Consistency of Cohesive Soils

Term	Undrained shear strength, s_u (kPa)	Field Guide
Very Soft (VS)	<12	A finger can be pushed well into the soil with little effort
Soft (S)	12 – 25	A finger can be pushed into the soil to about 25mm depth
Firm (F)	25 – 50	The soil can be indented about 5mm with the thumb
Stiff (St)	50 – 100	The surface of the soil can be indented with the thumb
Very Stiff (VSt)	100 – 200	The surface of the soil can be indented by thumb nail
Hard (H)	>200	The surface of the soil can be marked only with the thumbnail
Friable (F)	-	Crumbles or powders when scraped by thumbnail

Density of Granular Soils

Term	Density Index (%)
Very Loose (VL)	< 15
Loose (L)	15 – 35
Medium Dense (MD)	35 – 65
Dense (D)	65 – 85
Very Dense (VD)	> 85

Minor Components

Term	Field Guide	Proportion of Minor Component In:
Trace of	Presence just detectable by feel or eye	Coarse grained soils: <5% Fine grained soils: <15%
Some	Presence easily detectable by feel or eye	Coarse grained soils: 5-12% Fine grained soils: 15-30%

Moisture Condition

Dry (D) — Looks & feels dry. Cohesive soils are usually hard, powdery or friable. Granular soils run freely through the hand.

Moist (M) — Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere. Free water does not form.

Wet (W) — As for moist, but with free water forming on hands when remoulded.

Method

S Auger Screwing
D Auger Drilling
R Roller/tricone
W Washboring
N Natural Exposure
E Existing Excavation
B Blade/bucket
C Coring
H Hammer Drill

Support

***** Nil
C Casing
M Mud/polymer

Water

* Not observed
Observed water level (date shown)
Observed water inflow
Observed water outflow
R Refer to report for details

Notes, Samples, Tests

U63 Undisturbed sample, 63mm diameter
D Disturbed sample
N* Standard Penetration Test, (*) Sample Figure = results

Structures, Additional Observations

PP Pocket Penetrometer test (kPa)
DCP Dynamic Cone Penetrometer test (blows/100mm)

Surface

_____ Known boundary
- - - - - - - - - - Probably boundary
-?-?-?-?-?-?- Possible boundary

3. SALINITY MANAGEMENT GUIDELINES

The following Salinity Management Guidelines, prepared by Simonds Developments is endorsed by the City of Greater Bendigo in accordance with Planning Permits AM/226/2010 and AM/904/2011 for the Evergreen Waters Estate.

The Evergreen Waters Estate is the overall development of the precinct and includes the Golden Grove Estate.

evergreen waters

SALINITY MANAGEMENT GUIDELINES

August 2011

SIMONDS DEVELOPMENTS

1. INTRODUCTION

The Evergreen Waters Estate is a new residential subdivision at Jackass Flat on the northeastern outskirts of Bendigo. The development is approximately 65Ha in size and will be staged with 30 stages anticipated to be developed for the entire site. A planning permit for the development has been issued by the City of Greater Bendigo with conditions that require a Salinity Management Plan to be prepared for development areas where the water table is between 1.6m and 2.5m below ground level.

Detailed descriptions of the site characteristics, potential salinity hazard and engineering works to drain the site and control the water table are included in the report by John Leonard Consulting Service entitled "Hydrogeological Assessment - Evergreen Waters Housing Estate, Jackass Flat" (2011).

The main focus of these Salinity Management Guidelines is to protect the integrity of buildings; however, the guidelines also contain provisions to maintain the aesthetic appeal of the subdivision.

2. BACKGROUND

Shallow water tables in the Bendigo area have been identified in a number of studies. As a result of the findings of these studies the City of Greater Bendigo & the North Central Catchment Management Authority (NCCMA) commissioned Phil Dyson to development Planning Guidelines for Urban Salinity (Dyson, 2007). This document included draft planning responses for developments based on depth to the water table and recommended that subdivisions not be allowed in areas with saline water tables within 1.5 m of the ground surface.

The Development Plan Overlay (DPO21) which applies to land zoned Residential 1 in the Jackass Flat New Development Area (NDA) has taken these considerations into account and now includes details to ensure that residential land is tested for salinity prior to any development occurring.

<u>DPO Requirements</u>
Where there is known salinity discharge or indicators of salinity, such as the presence of Spiny Rush and Sea Barley Grass, a Salinity/Water Management Plan is to be prepared by a suitably qualified hydro-geologist to the satisfaction of the Responsible Authority in consultation with the Department of Sustainability and Environment that addresses, but is not limited to, the following matters:

- A desktop assessment and field survey of the geology and geomorphology of the site to ascertain the nature of groundwater flows.
- As assessment of the likely hydro-geological performance having regard to the impact of salinity.
- An indicative assessment of the extent of the salinity issues and the post development risk it imposes.
- The depth to the watertable and salinity of the groundwater in the region of the proposed development.

- Recommendations regarding the management and future use of areas identified as being susceptible to salinity.
- An Implementation Plan outlining any works necessary to implement such recommendations.

3. SALINITY TESTING RESULTS

An extensive groundwater monitoring and testing program was carried out over the period October 2010 to April 2011 which is detailed in the report by John Leonard Consulting Service entitled "Hydrogeological Assessment - Evergreen Waters Housing Estate, Jackass Flat" (April 2011) confirms that if construction guidelines are followed, the designed site conditions will be able to:

1. Achieve a minimum clearance of 1.5 m to groundwater level from the minimum design surface level everywhere across the development, and
2. Provide an effective barrier (preferred flow zone and capillary break) to any potential rise of groundwater.

The assessment indicated that the groundwater beneath the Evergreen Waters site is mostly non-aggressive or mildly aggressive to concrete and nonaggressive to steel. The soil chemistry test results and assessed aggressiveness to concrete indicate that the soils at Evergreen Waters would not be aggressive to concrete it is recommended that plants of more salt tolerant, drought resistant species should be encourages across the Evergreen Waters site.

4. CAUSES OF URBAN SALINITY

Salinity is generally the result of changes in land use that cause increased groundwater recharged. Where the increased recharge is not matched by a commensurate increase in groundwater discharge, the water tables can rise to near the land surface, where discharge occurs by evapotranspiration. Evaporation from the shallow watertable concentrates the naturally occurring salts in the groundwater and soils, leading to salinisation. As the near surface groundwater evaporates, salts are concentrated in the groundwater and can crystallise in the soil and on or within building materials, and can cause physical stress on metal and concrete structures and vegetation.

5. EFFECTS OF SALINITY IN AN URBAN ENVIRONMENT

Excess salinity in an urban environment can result in significant problems. It can manifest itself in a number of ways. The effects of salinity can be observed in damage to building materials, infrastructure and roads and in death or poor health of vegetation. The effect of urban salinity is the result of both physical and chemical actions of the salt on concrete, bricks and metals. Salt moves into the pores of concrete and bricks and becomes concentrated when the water evaporates and can result in breakdown of materials and corrosion. Evidence of this may include crumbling, eroding or powdering of mortar or bricks, flaking of brick facing and cracking or corrosion of bricks.

High levels of salinity can result in damage to and even death of plants. Signs that vegetation is under stress from salinity include the discolouration and wilting of leaves and the death of less salt tolerant plant species. It may also be hard to establish lawns in areas that are subject to high salinity.

6. MEASURES FOR SPECIFIC ASSETS

The Building Code of Australia (BCA) contains the required technical standards for building construction in Australia. The goal of the BCA is to achieve the minimum necessary standards that are nationally consistent to ensure health, safety (including structural safety and safety from fire), amenity and sustainability objectives are met. Where building and construction regulations are the authority of the State and Territory governments in Australia, the BCA is given power to cover technical aspects of building construction through individual State and Territory enacting legislation.

As a performance based code, the BCA requires that the construction industry is able to provide practical, safe and enduring buildings that are fit for their desired purposes. Within this framework, the BCA has performance requirements ensuring that buildings are not unduly susceptible to environmental elements, such as soil moisture and salinity. It is through these performance requirements that the BCA ensures there are adequate means to maintain structural protection against soil moisture and salinity damage.

Provisions to protect buildings from the effects of saline intrusion and saline soils in the BCA are incorporated in the provisions for 'Damp and Weatherproofing' in Volume One and 'Concrete and Reinforcing' and 'Weatherproofing of Masonry' in Volume Two. These provisions ensure that buildings are protected from rising moisture in soils, as well as ensuring that concrete footings and brickwork are sufficiently resistant to degradation from environmental moisture and salinity.

The key elements from these documents and a number of other technical documents (listed in Section 7) have been summarised below based on the non-aggressive/mildly aggressive exposure rating that is deemed to apply to the site.

Construction of Dwellings

The following measures are to be used for all buildings at Evergreen Waters:

- A layer of sand followed by a membrane of thick plastic should be placed under the concrete slab to act as a moisture barrier and drainage layer to restrict capillary rise under the slab. Membranes should be extended to the outside face of the external edge beam up to the finished ground level.
- Concrete grade of at least N25 and minimum 50 mm reinforcement cover is suitable for the site as salinity test indicate the site is moderately saline at worst.
- It is essential that in all masonry buildings that a brick damp course be properly installed so that it cannot be bridged either internally or externally. This will prevent moisture moving into brick work and up the wall. It is important that the damp proof course is not breached by later additions to the building.
- As there are various exposure classifications and durability ratings for the wide range of masonry available, reference should be made to the supplier in choosing suitable bricks with the appropriate exposure quality. Water proofing agents can also be added to mortar to further restrict potential water movement.
- Cure concrete for at least seven days to ensure a hard dense surface that reduces saline water infiltration.
- Other alternatives such as suspended slab or pier & beam construction could be considered to minimise exposure.

Measures For Residents To Help Reduce Salinity

Other measures that residents can implement to decrease any potential salinity hazard include:

- Revegetate and provide surface drainage to their lot as quickly as practical.
- Reduce the amount of water applied to gardens to minimise adding to groundwater levels.
- Use a timer and drip irrigation system to limit leakage into the groundwater system.
- Retain and/or establish salt tolerant water efficient native plants.
- Maintain good drainage around the house. Use permeable paving where practical.
- Keeping lawn areas to a minimum.
- Mulch gardens to reduce the need to water.
- Provide adequate falls to the street to allow runoff of water, and to prevent water ponding, and waterlogging.
- Ensure stormwater pipes, water mains and sewers are sealed properly to prevent leaking and fix any leaking pipes immediately.
- Install a plastic membrane behind retaining walls to prevent seepage from behind.
- Line water bodies to minimise discharge of water into the groundwater system.

7. REFERENCES AND FURTHER READING

Australian Building Code Board

- ABCB. (2004). Buildings Code of Australia. Australian Building Control Board.
- ABCB. (2004). Buildings Subject to Attack from Salt and Acid Sulphate Soils – Discussion Paper. Australian Building Control Board. August 2004.
- ABCB (2007). Salinity Consultation Paper. Australian Building Control Board May 2007.
- CIE (2010). Proposal to amend the Building Code of Australia to include mitigation against the effects of Saline soils. Consultation Regulation Impact Statement (RIS 2010-02) Prepared for the Australian Building Control Board by the Centre for International Economics, Canberra. June2010.

Australian Standards

- AS 1547-2000 On Site Domestic Waste Water Management, Standards Australia.
- AS 2159-2009 Piling - Design and installation. Standards Australia.
- AS 2870-1996 Residential Slabs and Footings, Standards Australia.
- AS 3600- 2001 Concrete Structures, Standards Australia.
- AS 3700- 2001 Masonry Structures, Standards Australia.
- AS 3798-1996 Guidelines for Earthworks for Commercial and Residential Developments, Standards Australia.
- AS 4419-1998 Soils for Landscaping and Garden Use. Standards Australia.
- AS 4456.6-1997 Masonry Units and Segmental Pavers - Methods of Test Determining Potential to Effloresce. Standards Australia.
- AS 4456.10-1997 Masonry Units and Segmental Pavers - Method of Determining Resistance to Salt Attack. Standards Australia.

Buildings

- Guide to Residential Slabs and Footings in Saline Environments. Cement Concrete & Aggregates Australia. 2005.
- Building in a Saline Environment. Local Government Salinity Initiative Booklet No. 5. Department of Infrastructure Planning and Natural Resources, Sydney, 2003. ISBN: 0 7347 5375 6.
- Building in a Saline Environment Urban Salinity Prevention. Wagga Wagga City Council, October 1999.
- Development Control Plan No. 16. Building in a Saline Environment. Junee Shire. July 2004.
- EnPlan Partners. (2007). Standards for building in a saline environment. – Construction of Dwelling and Outbuildings. Prepared for the Corangamite Catchment Authority with the City of Ballarat, City of Greater Geelong, Borough of Queenscliffe and the Moorabool Shire by EnPlan Partners. November, 2007.

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- Blacktown City Council Growth Centre Precincts Development Control Plan 2010. - Appendix C Salinity Management Guidelines. NSW Government Department of Planning May 2010.

Gardens

- Waterwise Parks and Gardens. Local Government Salinity Initiative - Booklet No. 7. Department of lnfrastructure, Planning and Natural Resources, Sydney, 2004. ISBN: 0 7347 5415 9.
- NSW Department of Planning (2010). Blacktown City Council Growth Centre Precincts Development Control Plan 2010. NSW Government Planning

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- Good Housekeeping to Manage Urban Salinity. (undated) WSROC, DIPNR and the Natural Heritage Trust with the assistance of Wagga City Council and the Department of Natural Resources of South Australia.