

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
1/18 Hurley Drive Coffs Harbour NSW 2450 Australia
PO Box 704 Coffs Harbour 2450 Australia
T (+61) (2) 6651 3213 F (+61) (2) 6651 5194
www.coffey.com.au

Fax Transmission

To	Ben Fryer	From	Matt Rowbotham
Fax No		Date	12/12/07
Company	Doug Gow and Associates	Reference	Preliminary Geotechnical Assessment Workshop Letter
cc		Page	1 of
Subject	Preliminary Geotechnical Assessment - The Lakes Estate Stages 1.2 to 9.2		

Hi Ben,

Outlined below is a summary of the geotechnical issues which will need consideration for final design and development at the new release of land for The Lakes Estate (Stages 1.2 to 9.2). It is hoped that this preliminary information is helpful for your initial discussions. If you have any questions, please contact Matt Rowbotham or Iain Turner at our Coffs Harbour Office.

Slope Instability and Foundation Conditions

The investigation undertaken to date has concentrated on the assessment of slope instability, with specific reference to the proposed residential layout plan that has been provided for our use.

Work has included a stereographic review of aerial photograph pairs. The exaggerated apparent topography that this technique shows can be helpful in identifying areas of existing landslip for example. A walkover survey of the entire site for to assess geomorphology of the site and, specifically physical evidence of slope instability and groundwater seepage has been completed. Further, a programme of test pitting has been undertaken, focusing on identified key areas of potential concern.

Field Observation

Below are brief points noted during the investigations:

- None of the areas marked for residential development with slopes greater than 10° were observed to be subject to wet and boggy ground conditions or spring activity during the assessment,
- None of the natural slopes had 'hooked trees' that represent evidence of long term soil movement,
- The geomorphological mapping and stereographic viewing did not indicate the presence of past slope instability (no head scarps or toe deposits/ lobes of slides and slips were noted),

- The mapping identified no areas susceptible to potential boulder rolling from slopes above the areas to be developed.

Potential Slope Instability

Despite the above it is assessed that steep slopes across the site (in particular areas with slopes greater than 10°) will be subject to near surface soil creep movement.

The hillslopes have a distinct soil profile. Near to the crest and ridges any soil cover is relatively shallow, and locally bedrock is exposed. The slopes have a mantle of 'colluvium' that is soil derived from the weathering of the parent rock that has been subject to downslope movement. It will typically be less thick on steeper slopes, but will increase in thickness towards the axes of valleys where it will likely merge with reworked material (by river action), termed alluvium.

Pre-existing shear planes within colluvium are probable, and shear strength parameters within this previously slipped (failed) soil profile will be diminished with comparison to the strength of undisturbed residual (*in situ* weathered) materials. Although no specific evidence of slope instability has been found, in detailed assessment and design of earthworks (cuttings) and footing depths the latter must be considered.

Critical to the maintenance of any slope is the provision of drainage to reduce potential for a buildup of water pressure within the soil or rock mass. Final layouts must consider the provision of positive drainage from critical slopes, to incorporate crest and toe drains on cuttings and embankments. Additionally drainage from roadways, hardstand and rooftops for example should be directed from natural hillslopes that could be destabilised by the concentrated ingress of water flow.

Foundation Conditions

On sloping ground soil movement (including shallow creep) can have a severe impact on shallow footings and slabs potentially requiring deep foundations to be constructed. It is anticipated that buildings constructed on hillslopes will need to be piled to the underlying bedrock. Where colluvium is identified the piles should be extended to penetrate rock that might be encountered at some 2m to 4m depth. Bedrock typically comprises heavily fractured and low strength weakly metamorphosed and partly siliceous siltstone that provides carrying capacity for, largely end bearing, piles and also skin friction capacity that could be a consideration against uplift loads.

On lower level and shallower slopes (say <10°) it can be practical to construct spread (pad or strip) footings onto the underlying residual soil or relic colluvium on the advice of a geotechnical engineer. Further testing of the soil to assist in site classification would be recommended to allow design of footings to proceed (principally susceptibility to movement with variation in soil moisture content).

The top of the ridge in the far south-western end of the site has a shallow cover of soil overlying high strength meta-siltstone. In some areas the bedrock is exposed at the surface. This will provide adequate bearing capacity for the proposed houses. Further investigation to include core drilling into the bedrock will help with assessment of its capacity to withhold uplift on piles or anchors that are extended into the bedrock. There might be increased construction costs associated with difficult excavation into strong rock for footings or services. A plan is attached showing the location of shallow or exposed bedrock.

Slope Instability (Road Construction)

The design plans provided to date indicate that some of the access roads are planned along the sides of watercourses or steep slopes. Roads located in these areas will require cut and fill earthworks to effectively bench/key the roads into the sides of the hillslopes.

Depending on the slope angles and the space provided for the roads their final design may need to incorporate retaining walls on the high side or low sides of the roads. For permanent batter slopes cut and fill batters should typically be constructed no steeper than 1V:2H (26°). The provision of free drainage from slopes will be essential for their maintenance.

A plan is attached indicating critical locations.

Erosion

The potential for erosion of the sloping ground will be very significantly enhanced by site clearance. Vegetation on the hillslopes has the dual benefit of binding the soils as well as reducing the moisture content of the soil, maintaining its strength.

The hillslope soils are preliminarily assessed as not especially dispersive. Despite this any exposed soil on steep slopes during the construction period will be subject to erosion and possible deeper slope instability issues. As such only limited vegetation cover should be removed where necessary during construction.

Current plans show roadways are planned within the axes of the steeply sided valleys. In places the valley axes are deeply incised which is representative of the erosive capability for flash flows that develop in the valleys. There is some permanent flow (base flow) in the lower parts. It is advised that roads be constructed into the valley sides, and that open free drainage be maintained in the centre. The provision of drainage (culverts) to withhold flash flood volumes beneath the road might be impractical in this area. Most critical is area 6.2, but also 4.2, 5.2 and 9.2 where roads are currently shown over erosion prone water courses.

Road design may include cut and fill into the hillslopes above the watercourse areas or incorporate a ring road design whereby the road is constructed either side of the watercourse. Where the latter is adopted, between the access roads, drainage in the form of an open grassed waterway should be maintained. Consideration could be given to the provision of 'soft' erosion control systems such as proprietary geofabrics linings.

Retaining Walls

Owing to the steep nature of the slopes at certain parts of the site, (i.e. areas with slopes greater than say 10°) all retaining walls supporting structural loads should be engineer designed.

In their design shear strength parameters should be adopted that account for potential pre-existing shear surfaces (post peak/ residual strengths) as well gradients above their crest where they support or are constructed on sloping ground.

Stability must also take account of potential global (overall slope) instability.

Earthworks and Construction in Low lying Areas

Three low lying areas were identified during the investigation which may present difficulties during construction, Low Lying Area 1 (LLA1), LLA2 and LLA3 indicated on the plans provided.

LLA1 is located adjacent and nearby to the land currently under earthworks construction at The Lakes Estate. LLA1 is located in Stage 1.2.

Investigation undertaken in this area was principally aimed at acid sulphate soil assessment. Test pits indicated shallow groundwater, soft to firm clay soil and significant lenses of silt. Based on our experience with the adjacent earthworks and being typical of silt, the subsurface conditions and shallow water level together are likely to present difficulties. Compaction of wet fine grained soils and problems with traffickability have been encountered. To allow construction to proceed in this area, improved drainage will be needed. Importation and compaction of granular fill (e.g. quarried rock fill) will likely be required to allow a relatively rigid working platform to be placed that will enable placement of fill to achieve filling to a required standard for the support of structures (e.g. 'level 1' in accordance with AS3798-2007).

Further to the above it is likely that significant portions of the silt and soft to firm clay will require over excavation and removal prior to placement and compaction of the quarried fill. Care must be taken to avoid excavation below the water table in silt.

LLA2 is located between Stage 7.2 and Stage 8.2 in the axis of the valley. From the test pit investigation subsurface conditions are known to comprise moist to wet and firm to stiff 'hillwash' clay extending to some 1m depth overlying stiff to very stiff clay. Within the upper 1m groundwater seepage was observed.

Based on the plans provided, an access road and residential lots are to be located in this area. Similar to LLA1 improved drainage and the replacement of superficial clay with appropriately moisture conditioned clay fill or granular fill (rock fill) is likely to be needed.

LLA3 is located in Stage 2.2. Based on our earthworks experience in the adjacent stage it is likely that similar conditions will present to that of LLA1.

Some housing plots are shown within axes of watercourses where compressible subsoils are expected and extreme runoff (surface water) frequently occurs. A plan of such affected areas is attached.

Attached are draft plans indicating locations affected by the key geotechnical issues discussed above.

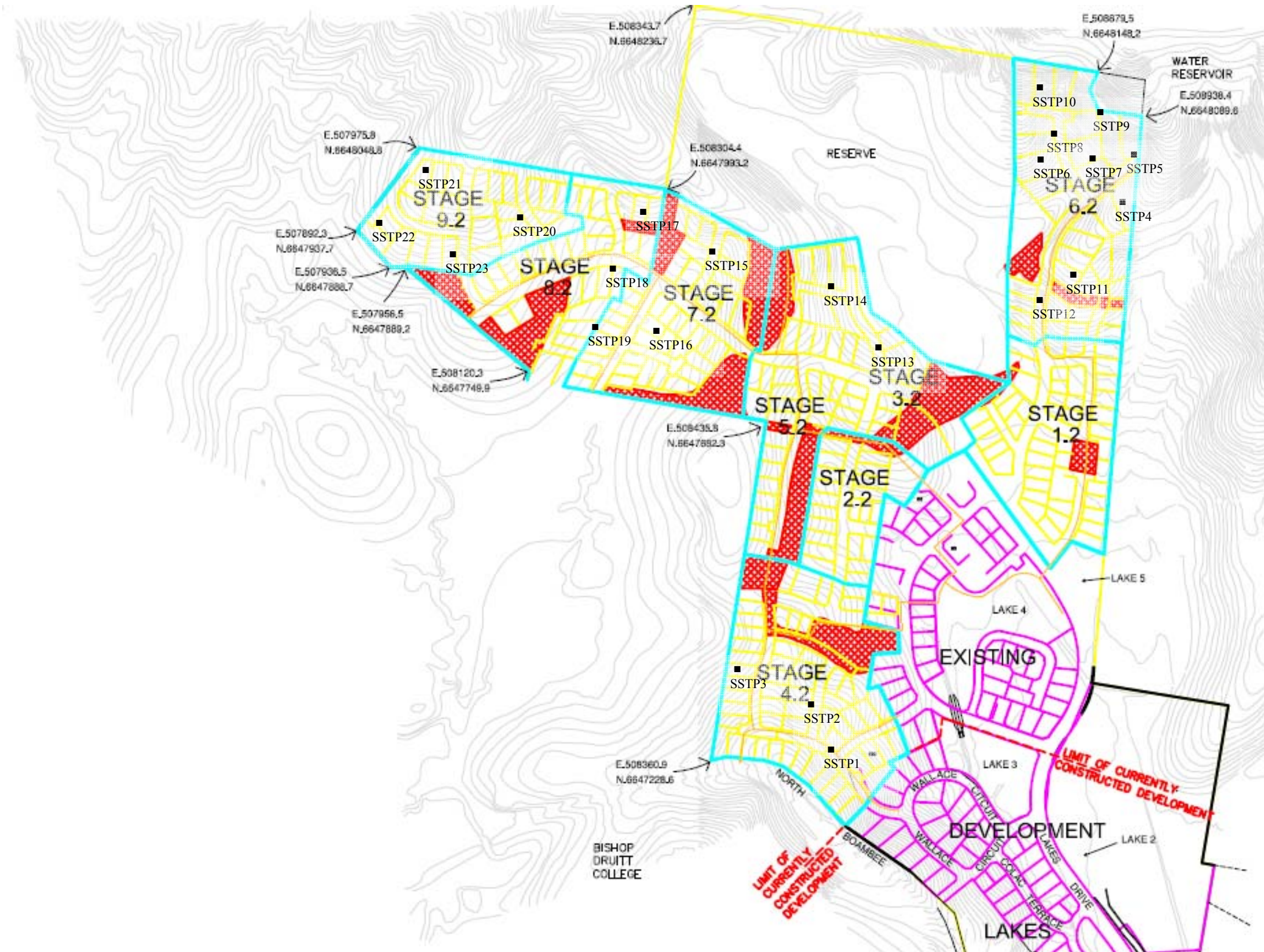
For and on behalf of Coffey Geotechnics Pty Ltd

Matthew Rowbotham

Engineering Geologist

Attachments:

Draft plan – annotated to show areas of steep ground and specific foundation conditions.



revision	description	drawn	approved	date

drawn	MR
approved	IT
date	12/12/07
scale	NTS
original size	

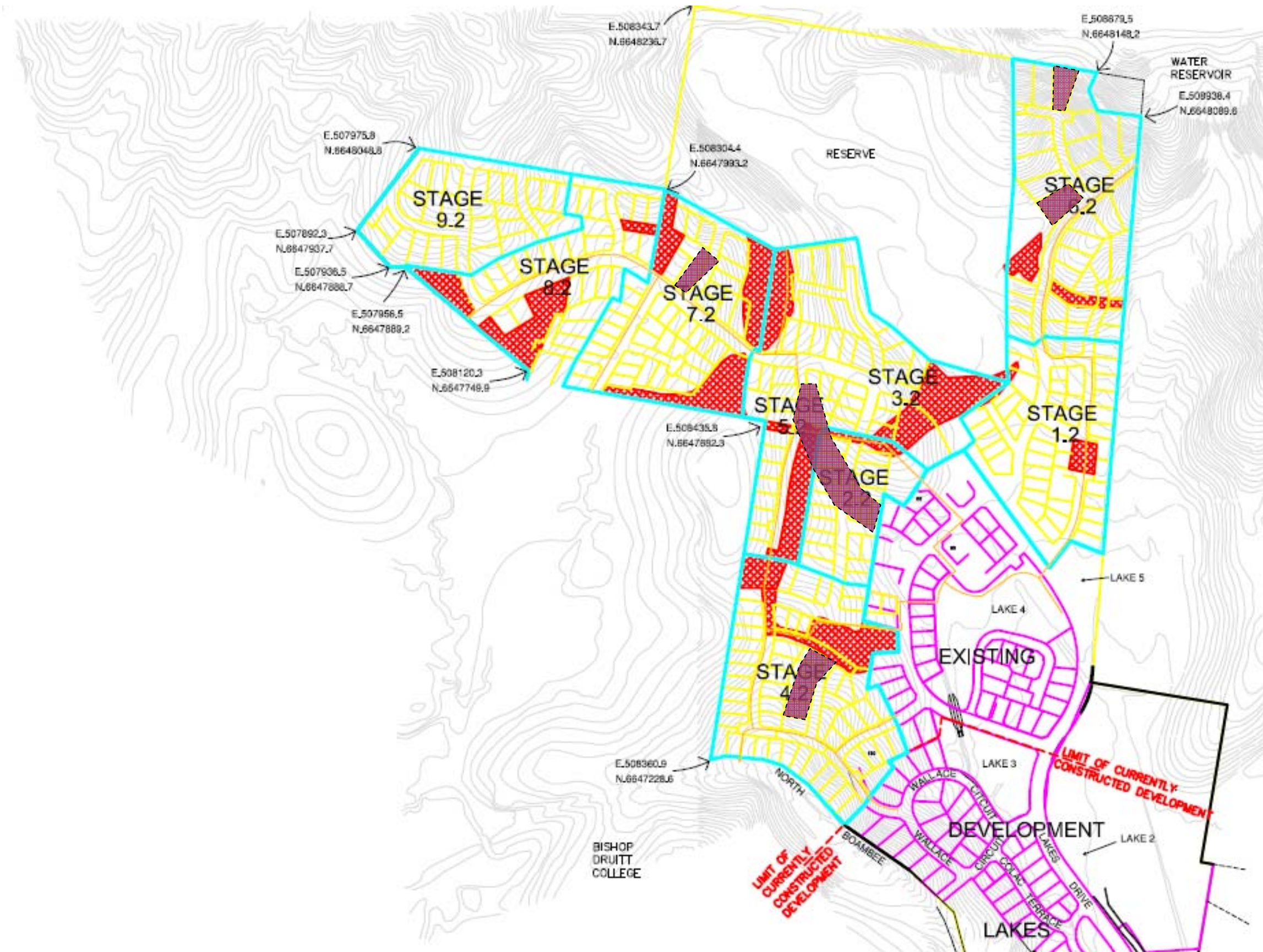


coffey

 geotechnics

SPECIALISTS MANAGING THE EARTH

client:	DOUG GOW AND ASSOCIATES PTY LTD
project:	THE LAKES ESTATE STAGES 1.2 to 9.2
title:	SITE PLAN SHOWING APPROX. TEST PIT LOCATIONS
project no:	GEOTCOFH02233AA
figure no:	FIGURE

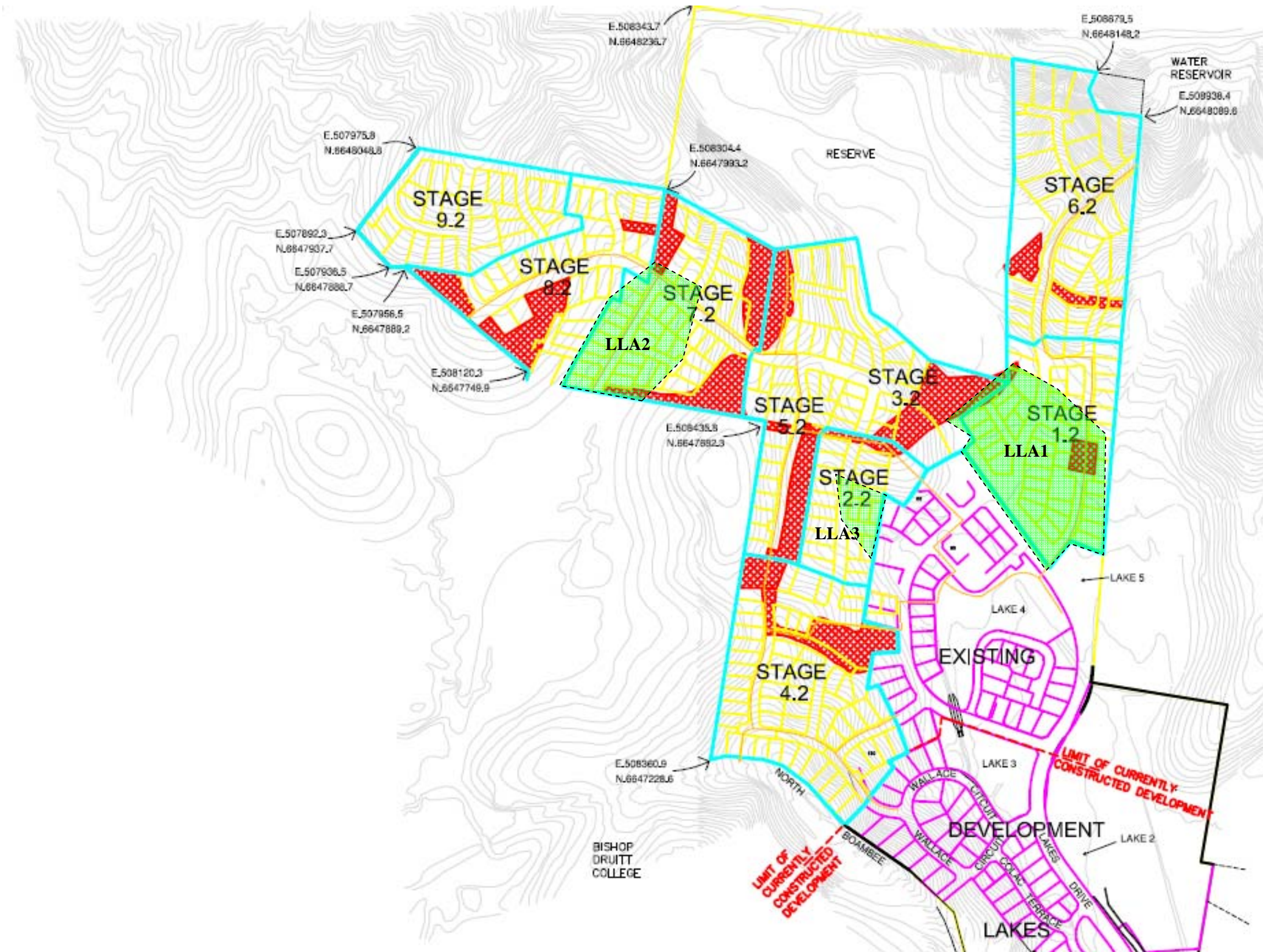



revision	description	drawn	approved	date

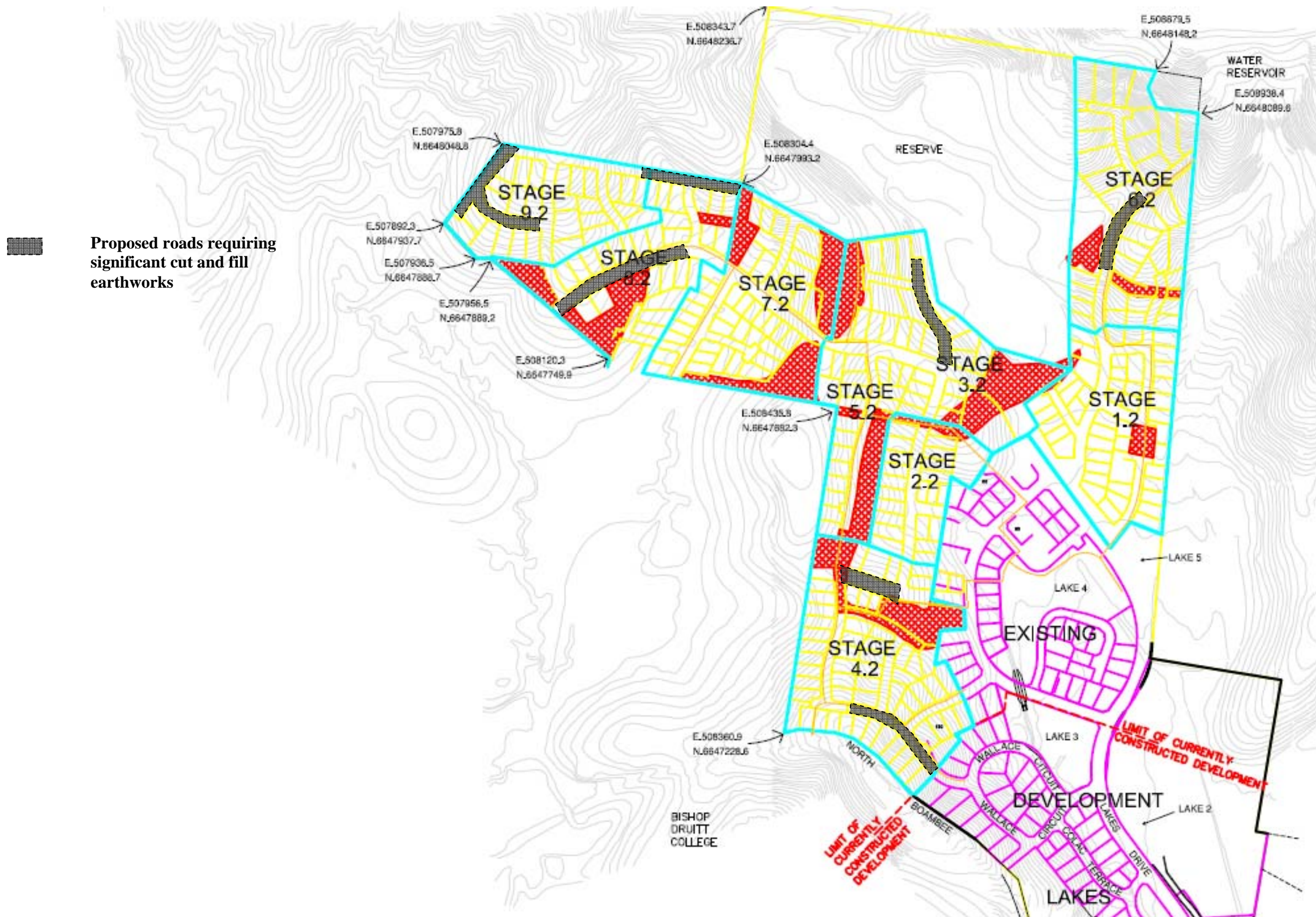
drawn	MR
approved	IT
date	12/12/07
scale	NTS
original size	

coffey 
geotechnics
 SPECIALISTS MANAGING
 THE EARTH

client:	DOUG GOW AND ASSOCIATES PTY LTD
project:	THE LAKES ESTATE STAGES 1.2 TO 9.2
title:	HOUSING NOT RECOMMENDED IN WATERCOURSES
project no:	GEOTCOFH02233AA
figure no:	FIGURE



revision	description	drawn	approved	date	drawn	MR	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	DOUG GOW AND ASSOCIATES PTY LTD		
					approved	IT		project:	THE LAKES ESTATE STAGES 1.2 to 9.2		
					date	12/12/07		title:	LOW LYING AREAS		
					scale	NTS		project no:	GEOTCOFH02233AA	figure no:	FIGURE
					original size						

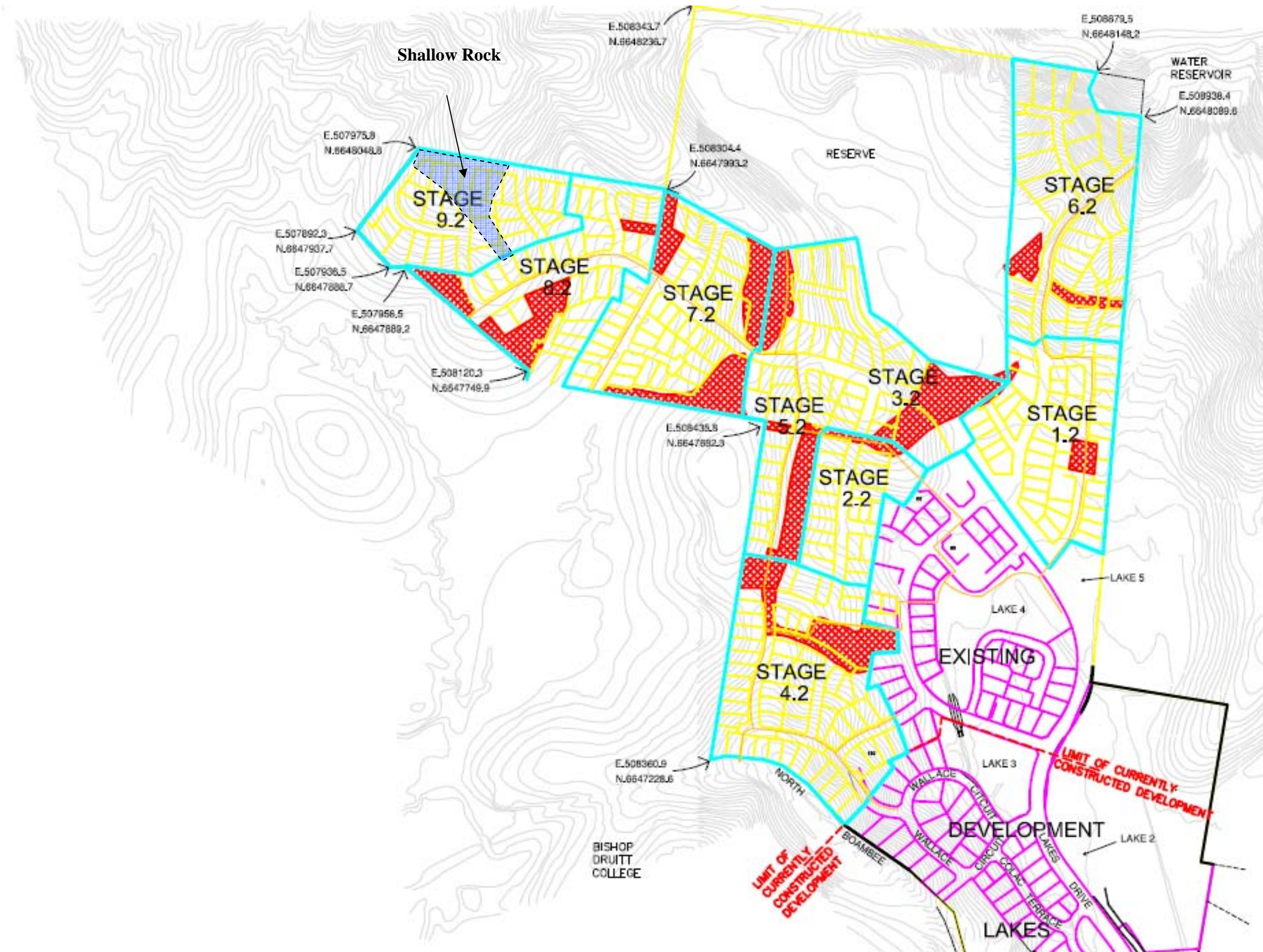


revision	description	drawn	approved	date

drawn	MR
approved	IT
date	12/12/07
scale	NTS
original size	

coffey 
geotechnics
 SPECIALISTS MANAGING
 THE EARTH

client:	DOUG GOW AND ASSOCIATES PTY LTD
project:	THE LAKES ESTATE STAGES 1.2 to 9.2
title:	ROADS LIKELY TO REQUIRE CUT AND FILL EARTHWORKS
project no:	GEOTCOFH02233AA
figure no:	FIGURE

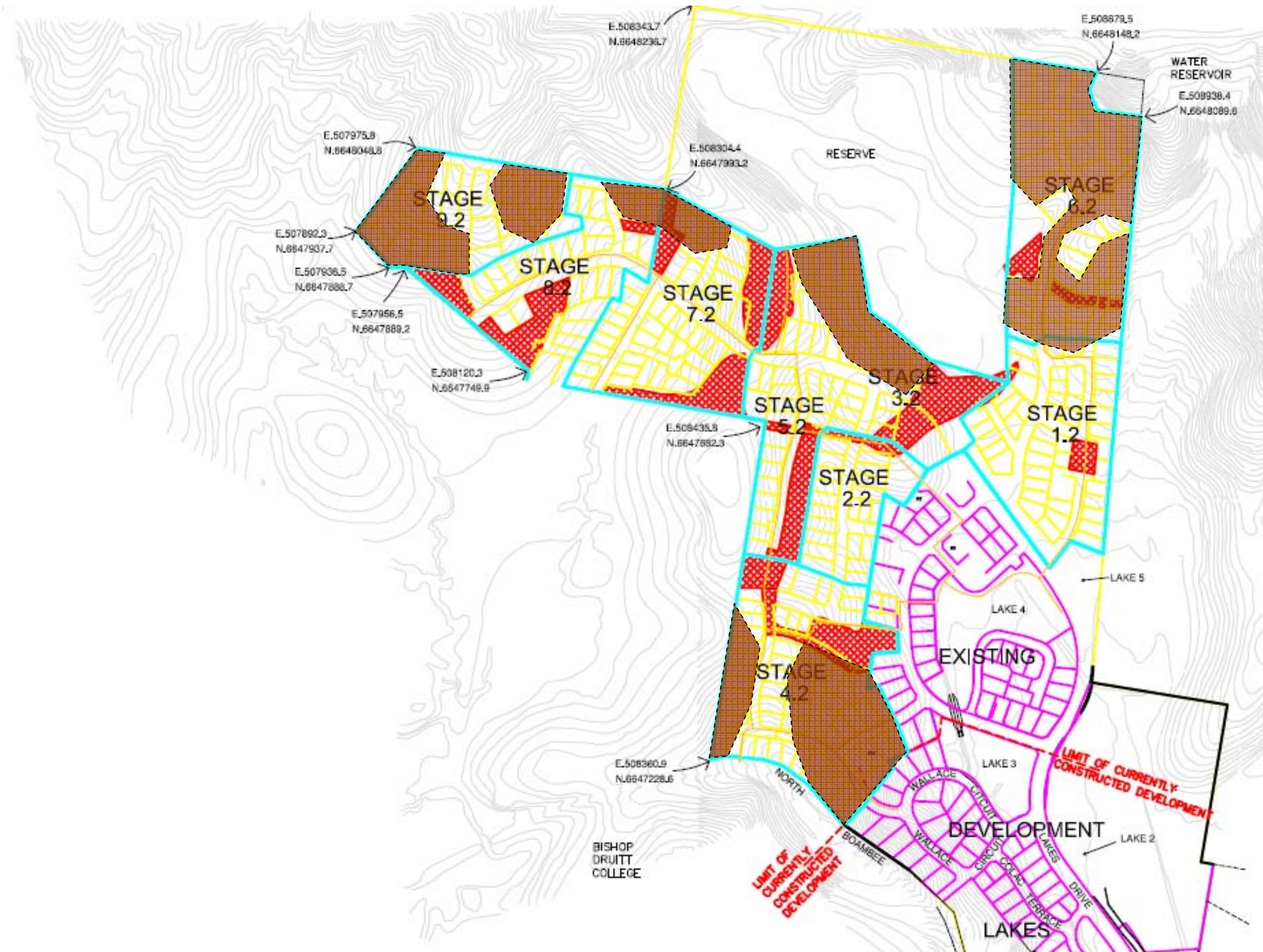


revision	description	drawn	approved	date

drawn	MR
approved	IT
date	12/12/07
scale	NTS
original size	



client:	DOUG GOW AND ASSOCIATES PTY LTD
project:	THE LAKES ESTATE STAGES 1.2 to 9.2
title:	SITE PLAN OF AREAS WITH SHALLOW BEDROCK
project no:	GEOTCOFH02233AA
figure no:	FIGURE



revision	description	drawn	approved	date

drawn	MR
approved	IT
date	12/12/07
scale	NTS
original size	



client:	DOUG GOW AND ASSOCIATES PTY LTD
project:	THE LAKES ESTATE STAGES 1.2 to 9.2
title:	STEEP SLOPES POSSIBLE REQUIRING PILES
project no:	GEOTCOFH02233AA
figure no:	FIGURE