APPENDIX 4: GROUNDWATER ASSESSMENT – KUNDIP – ROCKWATER PTY. LTD. (2011)

Rockwater
PROPRIETARY LIMITED

KUNDIP COPPER & GOLD PROJECT

IMPACT OF FINAL MINE VOIDS ON GROUNDWATER FLOW SYSTEM

FEBRUARY 2011

REPORT FOR
TECTONIC RESOURCES NL

(Report No. 253.1/11/02)

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1 INTRODUCTION

Tectonic Resources is planning to mine the Kundip copper and gold deposits, east of the Ravensthorpe-Hopetoun road, approximately 16 km south of Ravensthorpe. The Kundip project encompasses the previously mined Beryl, Harbour View and Flag underground workings. Several open-cut pits will be mined, three of which will extend below the water table.

This report presents an assessment of the impact of the final mine voids on the groundwater flow system, based on historical records and data collected during a groundwater testing and monitoring bore installation programme (Rockwater, 2004). It is an update of an earlier draft report (Rockwater, 2005) to cover revised mining plans.

2 HYDROGEOLOGICAL SETTING

2.1 CLIMATE

Ravensthorpe has a Mediterranean-type climate with cool wet winters and warm to hot, dry summers. Average rainfall is 425 mm (508 mm at Hopetoun), and average pan evaporation is about 2,000 mm. Agricultural dam evaporation rates are lower, averaging about 1,640 mm/a (Luke, Burke and O'Brien, 1988): a similar rate would apply to mine pits.

2.2 GEOLOGY

The Kundip mining area lies in a region of steeply-dipping mafic to intermediate volcanic rocks of Archaean age (Annabelle Volcanics) with some ultramafic schists (Witt, 1997). The volcanic rocks have been intruded to the west by granitic rocks, also of Archaean age. The upper reaches of the Steere River follows the contact between the granitic and the volcanic rocks.

Immediately south of the Kundip mining area, the Archaean rocks are overlain by the Proterozoic Mount Barren Group, including sediments of the Kundip Quartzite and the Kybulup Schist. The quartzite dips at about 15 degrees to the south-south-west.

2.3 HYDROGEOLOGY

The Kundip mining area is described as having "minor local aquifers" (Johnson, 1998). The Archaean volcanic rocks are generally of low permeability. Fractures and joints in the rocks, and mineralised zones, can be moderately permeable.

Drainage lines may follow zones of weakness such as fractures in the underlying rocks.

The old mine workings are reported to have intersected water-bearing fractures, and there are significant volumes of water stored in the workings. Anecdotal evidence suggests that Flag is the wettest mine, with inflows possibly in the order of 400 to 500 m^3/d; one report (Lea 1989) indicated that "the heavy inflow of water at the face of the No. 3 level east drive had caused the cessation of operations because the existing pumps were totally inadequate to cope with the volume". The Harbour View workings were also reported to be 'wet', and apparently, a large Flygt pump was run continuously during periods of mining in the 1980's to keep them dry. Inflows to Harbour View in 1903 required pumping rates of only 5,000 gallons per day (about 25 m^3/d) for a main shaft depth of 160 ft (about 50 m) (Montgomery, 1903). The Beryl workings were said to have yielded moderate amounts of water (less than 250 m^3/d), which were used as a source for tailings re-treatment. Apart from the Montgomery report, there is no written record of dewatering rates for the Kundip mining area.

These inflow rates indicate that even the mineralised zones have relatively low permeability.

Six groundwater exploration/test holes were drilled in the area and were completed as monitoring bores (Rockwater, 2004). Two (KMB1 & KMB4, Fig.1) were planned to intersect the Harbour View mineralised zone. The others were designed as regional exploration holes/monitoring bores and included two sites at the intersection of linear drainages that might follow fracture zones. An existing exploration hole was also cased for groundwater monitoring (Bore KMB7).

The bore details are summarised in Table 1.

Only trace amounts of water were intersected during drilling, with the exception of KMB6, which is situated in a drainage line along-strike of the Harbour View workings: a small flow of 60 m^3/day was measured from that hole.

The results show that in general, rocks in the area are of low permeability, even within the Harbour View mineralised zone. A very small proportion of the rainfall, probably around 0.1 percent based on the groundwater salinity, infiltrates the ground to recharge the groundwater that seeps slowly through the rocks, eventually discharging to low-lying areas in the south, possibly along Kuliba Creek.

Groundwater in the area is generally saline, with salinity ranging from about 20,000 to 40,000 mg/L TDS. The pH is near neutral at 6.8.

Table 1: Summary of Kundip Drilling Results

Bore	mE (AMG)	mN (AMG)	Elevation (m AHD)	Depth Drilled (m bgl)	Slotted Interval (m bgl)	Lithology	Static Water Level (m btc)**	Static Water Level (m AHD)	Maximum Airlift Yield (m^3/d)	Final Salinity (mg/L TDS)*
KMB1	239975	6269578	158.40	70	52 - 70	Mafic, some Ultramafic minor BIF	36.75	121.65	Trace	N/A
KMB2	240402	6270011	180.44	76	58 - 76	BIF, Interm. Volcanic Below 38m	58.04	122.40	Dry	N/A
KMB3	239985	6269062	142.18	70	46 - 70	Ultramafic	21.28	120.90	Trace	N/A
KMB4	240092	6269758	163.93	76	52 - 76	Mafic, minor porphyry	41.82	122.11	Trace	21,800
KMB5	239221	6269810	132.85	70	45 - 63	Felsic volcanic, mafic below 48m	4.08	128.77	Dry	N/A
KMB6	239580	6269319	145.71	70	46 - 70	Mafic, minor porphyry	23.56	122.15	57	37,200
KMB7^	240162	6268581	143.41	106	76 - 106	Phyllite, Conglomerate, felsic volcanic	25.85	117.56	N/A	N/A

*by electrical conductivity
**below top of surface casing, 23/1/2004
^old exploration, hole cased

Static water levels measured in December 2010 ranged from 119.1 m AHD in KMB7 to 132.6 m AHD in KMB5 and 146.8 m AHD in Bore H in the area of the planned Kaolin Pit, with a hydraulic gradient trending downwards to the south (Fig. 2). The shape of the water table is somewhat irregular, and does not closely reflect the topography, as would be expected. In particular, the water table between bores KMB1, KMB2, KMB4 and KMB6 has a very low gradient, with only a three metre fall in elevation between KMB2 and KMB6, compared with a 20 m difference in the topography. The low hydraulic gradient in this area may reflect increased permeability resulting from mine voids at the water table in the Harbour View workings.

3 PLANNED MINE PITS

Four pits are planned at Kundip, three of which (Kaolin, Harbour View, and Flag) will extend 35 to 69 m below the water table (Fig. 2). The other pit (Harbour View South) will capture, contain, and allow some rainfall-runoff to infiltrate to the groundwater, probably resulting in local groundwater level rises and lower groundwater salinities. The pit will, therefore, act as groundwater source.

The three pits extending below groundwater level will range in depth from about 50 m (Harbour View) to 80 m (Kaolin); and their characteristics with respect to groundwater levels and quality are described below.

3.1 CHARACTERISTICS OF FINAL VOIDS

The characteristics of the final voids that will extend below the water table have been assessed by simple water balances to determine whether they will act as groundwater sources, sinks or throughflow lakes.

It is estimated that about 60 percent of rain falling within the pit perimeters, i.e. 298 mm/a, will report to the bases of the pits. Evaporation from the pit lakes would be at a rate similar to that for agricultural dams (1.64 m/a). Other details used in calculating the pit water balances are included in Table 2.

Table 2: Details of Planned Pits

Pit	Pit Area (m^2) at Ground Surface	Base of Pit (m AHD)	Initial GWL (m AHD)	Est. Max. Inflow (m^3/d)	Final Pit Water Level (m AHD)
Kaolin	216,249	77	146	30	118
Harbour View	82,320	107	124	25	121
Flag	42,372	87	122	100	112

Water balance calculations are given in Table 3 below. The balance points, equivalent to the final pit water levels are given in the last column of Table 2.

Table 3: Water Balance Calculations

Kaolin:

RLWL (m AHD)	Water Area (m^2)	Inflows (m^3/d)	Rainfall (m^3/d)	Evaporation (m^3/d)	Balance (m^3/d)
147	110015	0	177	495	-318
137	83968	30	177	378	-171
127	65488	30	177	295	-87
117	43523	30	177	196	11
107	26030	30	177	117	90
97	13051	30	177	59	149
87	6022	30	177	27	180
77	1543	30	177	7	200

Harbour View:

RLWL (m AHD)	Water Area (m^2)	Inflows (m^3/d)	Rainfall (m^3/d)	Evaporation (m^3/d)	Balance (m^3/d)
147	53637	0	68	241	-174
137	41430	0	68	186	-119
127	24537	0	68	110	-43
117	12676	15	68	57	25
107	2709	25	68	12	80

Flag:

RLWL (m AHD)	Water Area (m^2)	Inflows (m^3/d)	Rainfall (m^3/d)	Evaporation (m^3/d)	Balance (m^3/d)
137	37661	0	35	169	-135
127	29879	0	35	134	-100
117	18258	20	35	82	-27
107	13323	50	35	60	25
97	5213	100	35	23	111

The results indicate that all three pits will be groundwater sinks, although the calculated final water level for Harbour View pit is only 3 m below the static groundwater level, and so in times of high rainfall the pit lake could possibly act as a groundwater source or throughflow lake. Water levels in the pits will remain below current static groundwater levels, with groundwater inflows and rainfall accumulation balancing evaporation losses.

4 IMPACT OF MINE WORKINGS ON GROUNDWATER FLOW SYSTEM

Evaporation from the Kaolin, Harbour View and Flag pits will cause the salinity of water in the pits to increase, however the water will not move into the groundwater flow system if the pits remain as groundwater sinks as indicated. The pits will, however cause localised lowering of groundwater levels.
Rainfall accumulation and infiltration to groundwater from the Harbour View South pit will introduce fresh water to the aquifer, and a localised rise in groundwater level.

Geochemical characterisation of rocks from Kundip by Graeme Campbell and Associates (2004) indicates that most were non acid forming. One sample of waste rock was potentially acid forming (PAF) and samples of transition and primary ore were also PAF. Overall, the report states that the occurrence of carbonate minerals within the fresh dacite means that the pit water should have circum-neutral pH due to buffering by submerged rocks in the pit walls.

The effect of any groundwater level changes would be undetectable at more than, say, 500 m down-gradient of the pits, because of the low permeability of rocks in the area. There are no groundwater users or groundwater-dependent ecosystems near the Kundip project that could be impacted by the changes described above.

5 CONCLUSIONS

Archaean volcanic rocks in the Kundip area are of low permeability, as shown by dewatering pumping rates during previous mining in the area, and low flows from groundwater exploration holes. Of six holes drilled at Kundip, only four intersected permeable zones; the maximum airlift yield was 60 m^3/day.

The groundwater has a salinity of about 22,000 mg/L to 38,000 mg/L TDS, and a near-neutral pH.

Four pits are planned at Kundip, three of which (Kaolin, Harbour View and Flag) will extend below the water table. The other pit (Harbour View South) will capture, contain, and allow some rainfall-runoff to infiltrate to the groundwater, resulting in a local groundwater level rise and lower groundwater salinity.

The Kaolin, Harbour View and Flag pits will be groundwater sinks, although the average water level in Harbour View pit may only be about 3 m below the static groundwater level.

Water levels in the pits will remain below current static groundwater levels, with groundwater inflows and rainfall accumulation balancing evaporation losses.

Evaporation from the Kaolin, Harbour View and Flag pits will cause increases in salinity in the pit lakes. However, the water will not move into the groundwater flow system if the pits remain as groundwater sinks as indicated. There will be localised lowering of groundwater levels around the pits.

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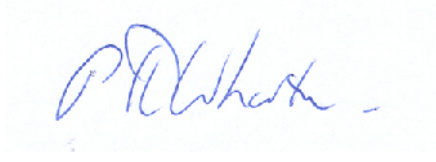
The effect of any groundwater level changes would be undetectable at more than, say, 500 m down-gradient of the pits, because of the low permeability of rocks in the area. There are no groundwater users or groundwater dependent ecosystems near the Kundip project that could be impacted by any changes to the groundwater flow system.

Dated: 8 February 2011 **Rockwater Pty Ltd**



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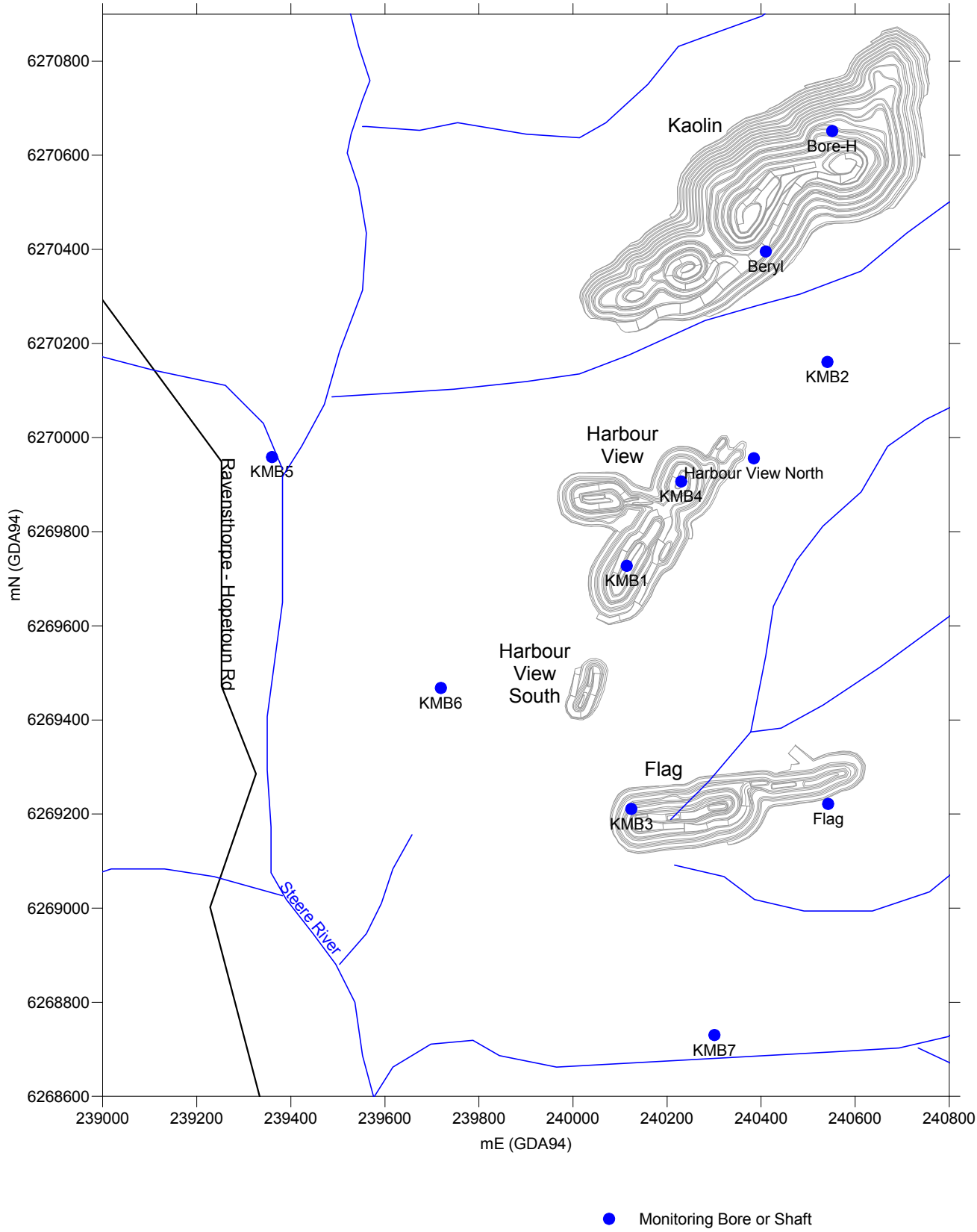
FIGURES

FIGURE 1



Location.srf

CLIENT: Tectonic Resources

PROJECT: Kundip

DATE: February 2011

Dwg No: 253.1/11/1-1

LOCATIONS OF MONITORING BORES, SHAFTS AND PLANNED PITS, KUNDIP

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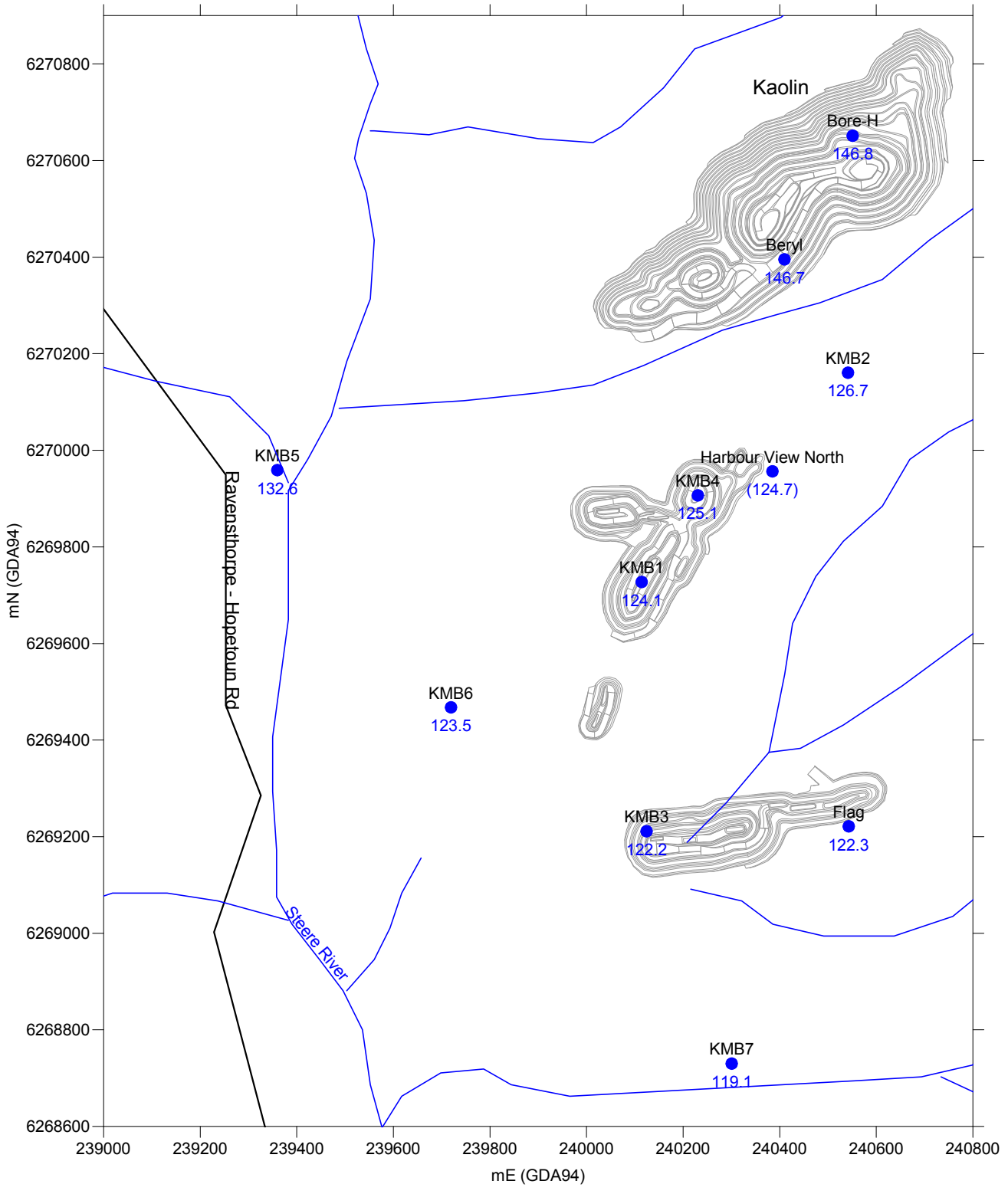
FIGURE 2



117.7 Groundwater Level Dec. 2010 (m AHD)

(124.7) Measured April 2004

dec10gwls.srf

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PROJECT: Kundip

DATE: February 2011

Dwg No: 253.1/11/1-2

GROUNDWATER LEVELS DECEMBER 2010

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