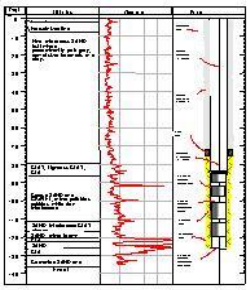
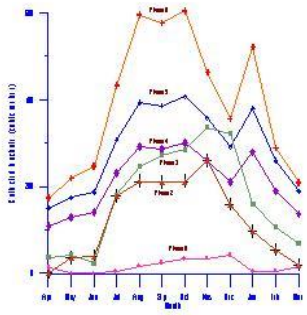
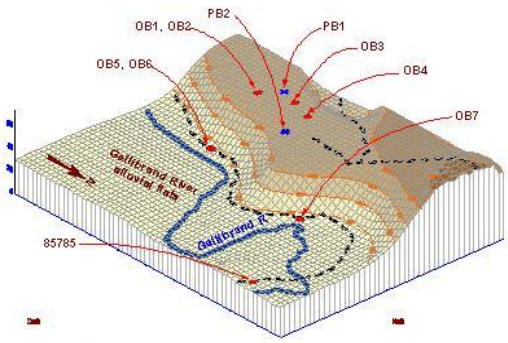
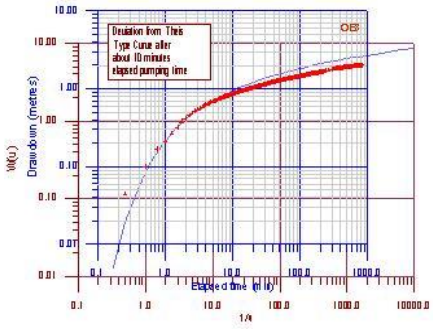
Attachment 3

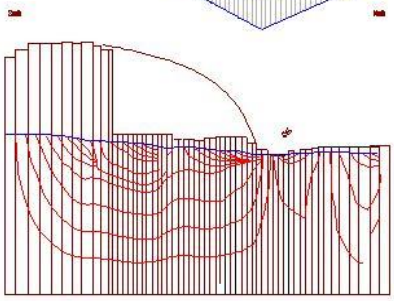
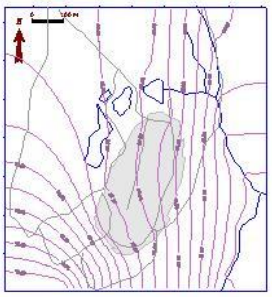
INCITEC PIVOT LTD





PRELIMINARY REPORT ON STABLE ISOTOPE ANALYSIS, PHOSPHATE HILL

August 2018

Ref. No.: GW-18/017

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APPENDIX

1.0 INTRODUCTION

A stable isotope analysis program was undertaken by ENVIRORISK MANAGEMENT PTY LTD (EnviroRisk) and JOHN LEONARD CONSULTING SERVICES PTY LTD (JLCS) on behalf of Incitec Pivot Ltd (IPL) to investigate groundwater age, source and recharge, and to ascertain whether the isotopes could be used at the Phosphate Hill Mine (PHM) to map different groundwater flow compartments.

2.0 HYDROGEOLOGICAL SETTING

A brief description of the PHM area is provided below as background for interpreting the stable isotopes analysis results. More detailed descriptions were provided in previous reports prepared by JLCS (2016) and EnviroRisk Management/JLCS (2017).

The PHM is located in the tropical savannah grasslands of northwest Queensland about 145 km south of Mt Isa. Average annual rainfall is less than 400 mm with annual totals varying greatly depending on the magnitude of the tropical influence during the hotter months (Hill et al., 2000).

The mine site is located on an alluvial plain of low relief except for a few isolated hills including Phosphate Hill. Stream channels are incised typically by 2-3 m into the alluvial plain. The streams only flow intermittently for relatively short periods following storm events that generally cause localized flooding.

The local hydrogeological setting is complex with two distinct rock sequences separated by a general north-south aligned fault, the Mehaffey Fault (location mapped in Figure 1). Older Cambrian rocks occur on the western, upthrown side of the fault with younger Ordovician rocks on the eastern down-thrown side of the fault (Table 2). Multiple lines of evidence including the observed hydraulic response to long-term groundwater extraction from bores located immediately west of the Mehaffey Fault, demonstrate that this fault is a very effective hydrogeological barrier boundary. The fault forms two hydraulically independent aquifer systems termed the Western Aquifer System (WAS) and the Eastern Aquifer System (EAS) by JLCS (2016). A number of west-east cross-cutting faults have been mapped or inferred as well as faults sub-parallel to the Mehaffey fault.

Aerial distributed recharge is low but significant recharge can occur along drainage lines (linear recharge) particularly in response to flooding events. Considerable areas of land at the PHM site notably along Dead Horse Gully, and Kolar and Railway creeks are flood prone with most flood waters infiltrating to recharge the groundwater store.

3.0 PROJECT DETAILS

Groundwater samples from selected bores and water samples from the process water pond (PWP) and the ammonia wastewater sump (AWS) were sampled and submitted for analysis of stable isotopes of oxygen (^{18}O or Oxygen-18), and hydrogen (^{2}H, Deuterium or D) and ^{3}H (Tritium). The isotope program was undertaken to address in-part Recommendation 17-6 of

Notice STAT1009 issued by Department of Environment and Heritage Protection (DEHP) to conduct or commission another environmental evaluation and submit a report concerning potential groundwater impact at the Phosphate Hill Mine (PHM) site.

3.1 SAMPLE LOCATIONS AND WATER SOURCE TYPE

The isotope analysis program focused on Easter Aquifer System (EAS) groundwater as the hydrogeology of this aquifer system has not been investigated to the same extent as the Western Aquifer System (WAS) and a number of localised areas with higher concentrations of some analytes have been identified in the EAS.

Sample locations are plotted on a site aerial image in Figure 1 and sample details tabulated in Table 1. A total of 20 water samples were collected comprised of:

- Fifteen samples from EAS bores including a shallow and a deep sample from two bores with multiple screened intervals (designated as "-S" and "-D").
- Two water samples from the WAS
- One water sample from the Ammonia Plant Wastewater Sump (AWS).
- One water sample form the Process Water Pond (PWP).
- One duplicate water sample for quality control.

3.2 SAMPLE COLLECTION AND ANALYSIS

Samples for stable isotope analysis were collected as per the sampling guidelines provided by Institute of Geological and Nuclear Sciences Limited (GNS Science), New Zealand.

The standing water levels in the bores were measured prior to collecting groundwater samples. The electrical conductivity (EC), acidity (pH) and dissolved oxygen concentration (DO) were also measured in the field prior to sampling.

The water samples were collected in HDPE screw cap bottles and sealed tightly to prevent evaporation. They were submitted to GNS Science laboratories in New Zealand. The sample shipment was accompanied by required documentation including New Zealand import permit as well as by Chain-of-Custody documents.

The water samples were analysed on an Isoprime mass spectrometer; for $\delta^{18}O$ by water equilibration at 25°C using an Aquaprep device, for $\delta^{2}H$ by reduction at 1100 °C using a Eurovector Chrome HD elemental analyser. Results were reported with respect to VSMOW2, normalized to GNS Science internal standards: SM1 with reported values of -29.12‰ for $\delta^{18}O$, -227.4‰ for $\delta^{2}H$, and INS11 with reported values of -0.36 ‰ for $\delta^{18}O$, -3.8 ‰ for δ2H. The analytical precision for this instrument is 0.2 ‰ for $\delta^{18}O$ and 2.0 ‰ for $\delta^{2}H$ (GNS Science analysis report – included in Appendix 1).

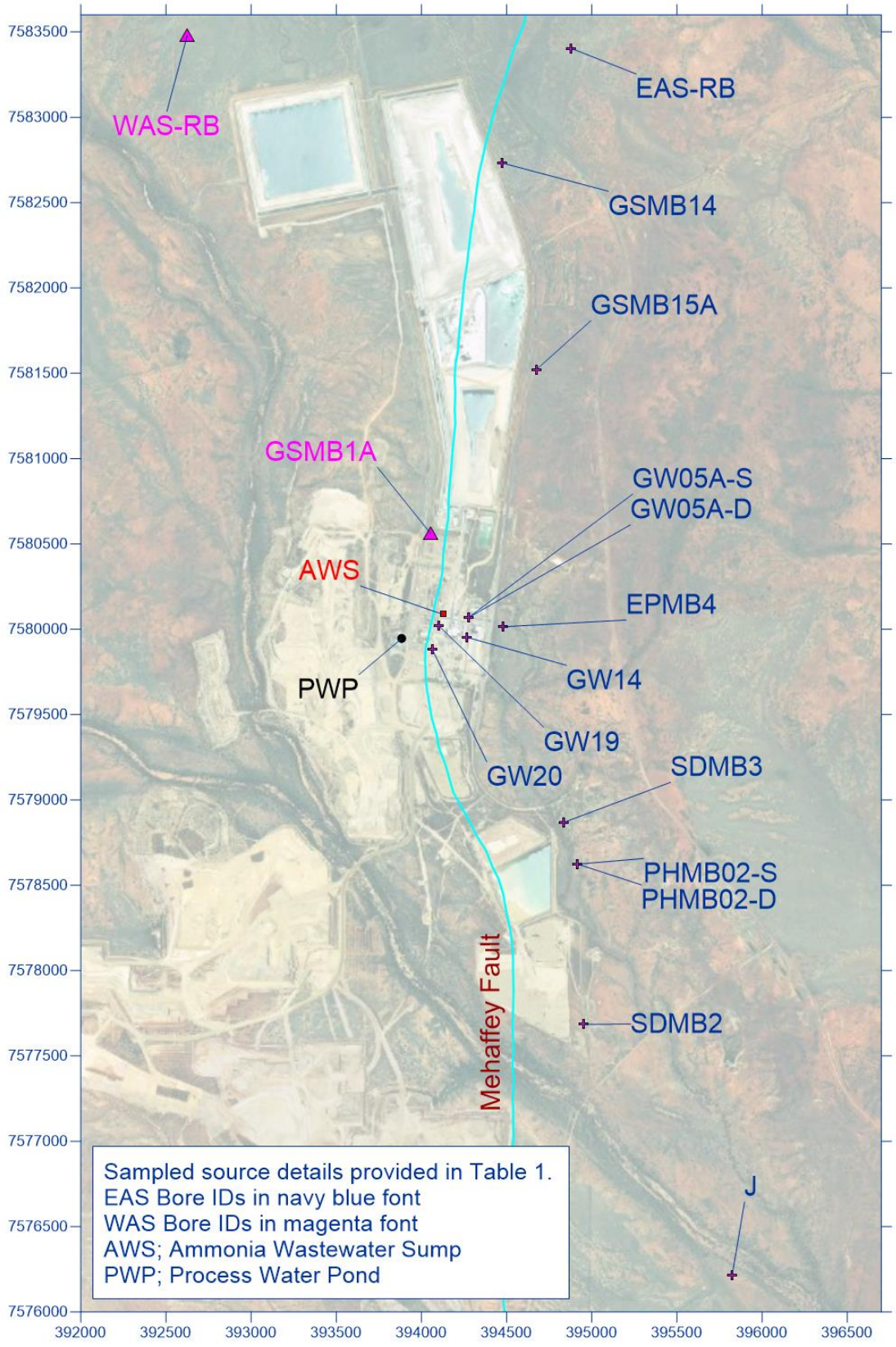


FIGURE 1 PHM Isotope Sampling Point Locations

TABLE 1 PHM Isotope Sampling Point Details

Sample ID	Sample type	Aquifer	Date sampled	Analysis			MGA Z54 coordinates		Depth (m bgl)	Screened (m bgl)
				^{18}o	^{2}h	^{3}h	Easting	Northing		
EAS-RB	GW	EAS	1/06/2018	Yes	Yes	Yes	394879.4	7583403.4	67.00	48.5 - 69.8
GSMB14	GW	EAS	30/05/2018	Yes	Yes		394471.3	7582732.6	88.00	55 - 86
GSMB15A	GW	EAS	30/05/2018	Yes	Yes	Yes	394673.9	7581520.6	102.00	72 - 90
GW05A-S	GW	EAS	4/06/2018	Yes	Yes	Yes	394275.0	7580067.7	88.00	51 - 57
GW05A-D	GW	EAS	4/06/2018	Yes	Yes		394275.0	7580067.7	88.00	81 - 87
GW14	GW	EAS	5/06/2018	Yes	Yes		394267.2	7579952.7	65.00	32 - 54
GW19	GW	EAS	5/06/2018	Yes	Yes		394100.5	7580021.4	67.00	49 - 67
GW20	GW	EAS	5/06/2018	Yes	Yes		394064.0	7579881.4	85.00	34.5 - 49.5
EPMB4	GW	EAS	30/05/2018	Yes	Yes		394479.3	7580014.7	64.00	47.2 - 59.2
SDMB3	GW	EAS	5/06/2018	Yes	Yes	Yes	394832.8	7578867.4	94.00	44.2 - 80.2
PHMB02-S	GW	EAS	29/05/2018	Yes	Yes		394917.6	7578623.7	80.00	50 - 56
PHMB02-D	GW	EAS	29/05/2018	Yes	Yes		394917.6	7578623.7	80.00	50 - 56
SDMB2	GW	EAS	29/05/2018	Yes	Yes	Yes	394953.6	7577685.1	82.00	26 - 56
J	GW	EAS?	30/05/2018	Yes	Yes		395824.5	7576216.6	88.50	58.5 - 88.5
WAS-RB	GW	WAS	1/06/2018	Yes	Yes		392625.1	7583480.2	85.00	40 - 82
GSMB1A	GW	WAS	4/06/2018	Yes	Yes	Yes	394053.0	7580561.8	89.00	68 - 74
SDMB1	GW	WAS	29/05/2018	Yes	Yes		394287.9	7578527.6	72.00	48 - 70
AWS	WW	NA	2/06/2018	Yes	Yes	Yes	394126.05	7580087.48	NA	—
PWP	PW	(WAS)	2/06/2018	Yes	Yes		393882.29	7579944.55	NA	—

Notes: 1) "-S" shallow sample from uppermost screened interval; 2) "-D", deep sample from lowermost screened interval; 3) AWS, Ammonia Wastewater Sump' and 4) PWP, Process Water Pond.

4.0 THEORETICAL CONSIDERATIONS

The theory of stable isotopes in water and relationship between ^{18}O and ^{2}H derived from a number of published reports and online resources (principally by the United States Geological Survey (USGS) are summarized as background for interpreting the available results (i.e., ^{18}O and ^{2}H. Note ^{3}H analysis not completed).

If most of the recharge is derived from direct infiltration of precipitation, groundwater will reflect the isotopic composition of that precipitation. However, if most recharge is derived from other sources, the groundwater will reflect the isotopic composition of the different source and the isotopic composition is expected to be measurably different from that of local precipitation. This difference in isotopic composition allows for differentiation of precipitation sources, and hence of recharge mechanisms. In addition to differences in isotopic composition of groundwater resulting from different recharge sources, there can be differences due to how recently recharge occurred.

Meteoric water in different regions has different compositions of stable hydrogen and oxygen isotopes, due to isotope fractionation. When meteoric water seeps into the ground to recharge groundwater, its isotopic variation is recorded in the groundwater. Hence, differences in isotope compositions can be used as a basis for the detection of groundwater sources (Yeh and Lee, 2018)

The isotopic composition of groundwater (expressed as abundance of ^{18}O and ^{2}H) is determined by the isotopic composition of recharge water. Consequently, knowledge of the factors that control the isotopic compositions of precipitation before and after recharge allows use of oxygen and hydrogen isotopes as tracers of water sources and processes. On a regional scale, the distribution of isotopic compositions is controlled by several factors:

- Altitude effect: On the windward side of a mountain, the $\delta^{18}O$ and $\delta^{2}H$ values of precipitation decrease with increasing altitude. Typical gradients are -0.15 to -0.5 ‰ per 100m for ^{18}O, and -1.5 to -4 ‰ per 100m for ^{2}H. This pattern is often not observed in interior mountains, for snow, or on the leeward side of mountains.
- Latitude effect: The $\delta^{18}O$ and $\delta^{2}H$ values decrease with increasing latitude because of the increasing degree of "rain-out".
- Continental effect: The ratios decrease inland from the coast.
- Amount effect: The greater the amount of rainfall, the lower the $\delta^{18}O$ and $\delta^{2}H$ values of the rainfall; this effect is not seen in snow.

In general, rain in the summer is isotopically heavier than rain in the winter. This change in average isotopic composition is principally caused by seasonal temperature differences but is also affected by seasonal changes in moisture sources and storm tracks. Shallow groundwater $\delta^{18}O$ and $\delta^{2}H$ values reflect the local average precipitation values but are modified to some extent by selective recharge and fractionation processes that may alter the $\delta^{18}O$ and $\delta^{2}H$ values of the precipitation before the water reaches the saturated zone (Gat and Tzur, 1967). Some of these processes include evaporation of rain during infiltration, selective recharge, interception of precipitation by vegetation, and exchange of infiltrating water with atmospheric vapor.

At a given location, the seasonal variations in $\delta^{18}O$ and $\delta^{2}H$ values of precipitation and the weighted average annual $\delta^{18}O$ and $\delta^{2}H$ values of precipitation remain fairly constant from year to year. This happens because the annual range and sequence of climatic conditions (temperatures, vapor source, direction of air mass movement, etc.) remain fairly constant from year to year.

4.1 STABLE ISOTOPES IN RAINWATER

4.1.1 Global Meteoric Water Lines

Meteoric water in different regions has different compositions of stable hydrogen and oxygen isotopes, due to isotope fractionation. When meteoric water seeps into the ground to form groundwater, its isotopic variation is recorded in the groundwater. Consequently, differences in isotope compositions can be used as a basis for the detection of groundwater sources.

During the process of seawater evaporation to inland precipitation, continuous isotope fractionation causes changes in hydrogen and oxygen isotope compositions in meteoric water. As this process is based on isotopic fractionation during evaporation and condensation, there is a specific relationship between hydrogen and oxygen isotopic distributions in atmospheric precipitation. This relationship was first proposed by Craig (1961), who analyzed H and O

isotopic compositions in rain, snow, and river water samples from around the world and used linear regression to obtain the Global Meteoric Water Line ($\delta^2H = 8\delta^{18}O + 10$). The meteoric water line shows that the ratio of the two isotopes, δ^2H and $\delta^{18}O$, is about 8:1, with intercept value around 10 ‰. The meteoric water line is an important reference line and tool in isotope hydrology research. Under room temperature conditions, stable hydrogen and oxygen isotopes in groundwater tend to preserve the same values as that in the initial meteoric water. Thus, the source and evolution process of groundwater in a specific location can be determined based on the groundwater's relationship with hydrogen and oxygen isotopes in meteoric water. As hydrogen and oxygen isotopic composition of groundwater records weather conditions (e.g., temperature and humidity) at a given time, this tool can be used to investigate the causes of isotopic variations and thus distinguish the sources and partition of groundwater, allowing past weather conditions to be examined.

Craig (1961) observed that the $\delta^{18}O$ and δ^2H (δD) values of precipitation that has not been evaporated are linearly related by:

$$\delta^2H = 8\ \delta^{18}O + 10$$

This equation, known as the "Global Meteoric Water Line" (GMWL), is based on precipitation data from locations around the globe, and has an r2 > 0.95. This high correlation coefficient reflects the fact that the oxygen and hydrogen stable isotopes in water molecules are intimately associated; consequently, the isotopic ratios and fractionations of the two elements are usually discussed together.

4.1.2 Local Meteoric Water Lines

Local Meteoric Water Lines (LMWLs) derived from precipitation collected from a single site or set of local sites reflect differences in stable isotope concentrations at different locations.

The slope and intercept of any LMWL can be significantly different from the GMWL. In general, most of the local lines have slopes of 8 +/- 0.5, but slopes in the range of 5 and 9 are not uncommon.

Several processes can cause waters to plot off the GMWL. Water that has evaporated or has mixed with evaporated water typically plots below the meteoric water line along lines that intersect the MWL at the location of the original un-evaporated composition of the water; slopes in the range of 2 to 5 are common. Geothermal exchange also increases the ^{18}O content of waters and decreases the ^{18}O content of rocks as the waters and rocks attempt to reach a new state of isotopic equilibrium at the elevated temperature. This causes a shift in the $\delta^{18}O$ values, but not the δ^2H values of geothermal waters. Low temperature diagenetic reactions involving silicate hydrolysis can sometimes cause increases in the $\delta^{18}O$ and δ^2H values of waters.

4.2 AUSTRALIAN RAINFALL ISOTOPE COMPOSITION

Isotope composition of rainfall in Australia have been reported by Liu et al. (2010), Crosbie et al. (2012), Cendon et al (2015) and Hollins et al (2018).

4.2.1 Northwest Queensland MWL

The closest stable isotope monitoring station to the PHM is at Mt Isa locate about 140 km NNE from the mine site (determined from georegistered maps). Crosbie et al (2012) include data for this station and plotted a LMWL, and determined and times series of the ^{2}H excess (d), defined as $d = \delta^{2}H - 8\delta^{18}O$. Stable isotope rainfall composition data recorded at Mt Isa are included in Table 2. The amount-weighted average δ2H and δ18O rainfall composition and associated ^{2}H-excess, and LMWL slope and intercept are included in Table 3. The regression equation for the Mt Isa LMWL is $\delta^{2}H = 7.1\ \delta^{18}O + 1.9$.

TABLE 2 Mt Isa Rainfall Stable Isotope Data

Date	^{18}O	^{2}H	Date	^{18}O	^{2}H
Sep-08	1.45	12.2	Sep-09	2.79	22.7
Oct-08	6.17	32.5	Nov-09	-0.66	6.2
Nov-08	-2.01	-6.4	Dec-09	-1.39	-3.6
Dec-08	-0.14	0.6	Jan-10	-7.07	-45.8
Jan-09	-13.11	-96.1	Feb-10	-4.54	-25.8
Feb-09	-12.26	-86.8	Mar-10	-8.40	-62.0
Apr-09	-0.27	-1.1	May-10	-10.58	-76.2

TABLE 3 Mt Isa Amount-Weighted Average δ2H and δ18O Rainfall Composition and Associated 2H-Excess, and LMWL Slope and Intercept

Station	$\delta^{18}O$ ‰	$\delta^{2}H$ ‰	^{2}H excess ‰	LMWL slope	LMWL intercept
Mt Isa	-9.05	-63.18	9.22	7.1	1.9

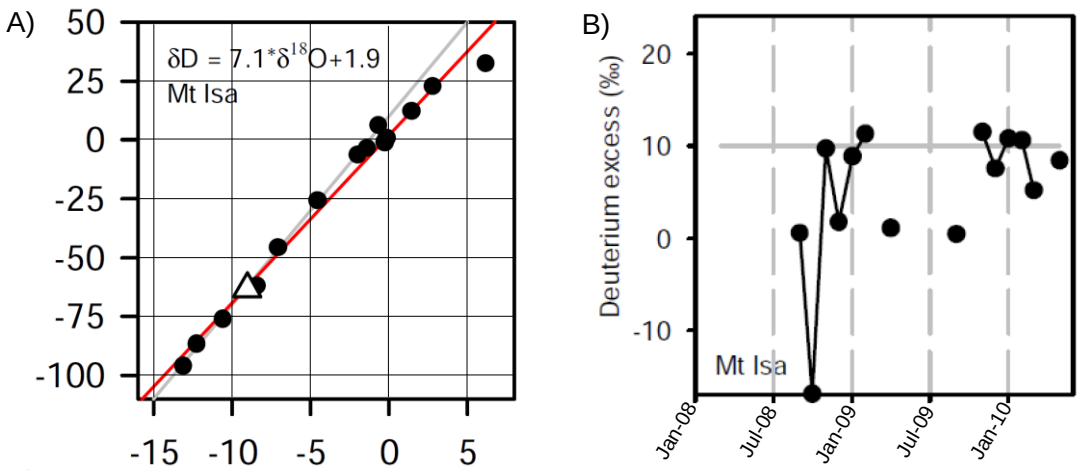


FIGURE 2 Mt Isa A) LMWL (red line) and GMWL (grey line) and amount-weighted average composition of the samples (triangle), and B) 2H-excess (grey line is global average of 10)

5.0 ANALYTICAL RESULTS

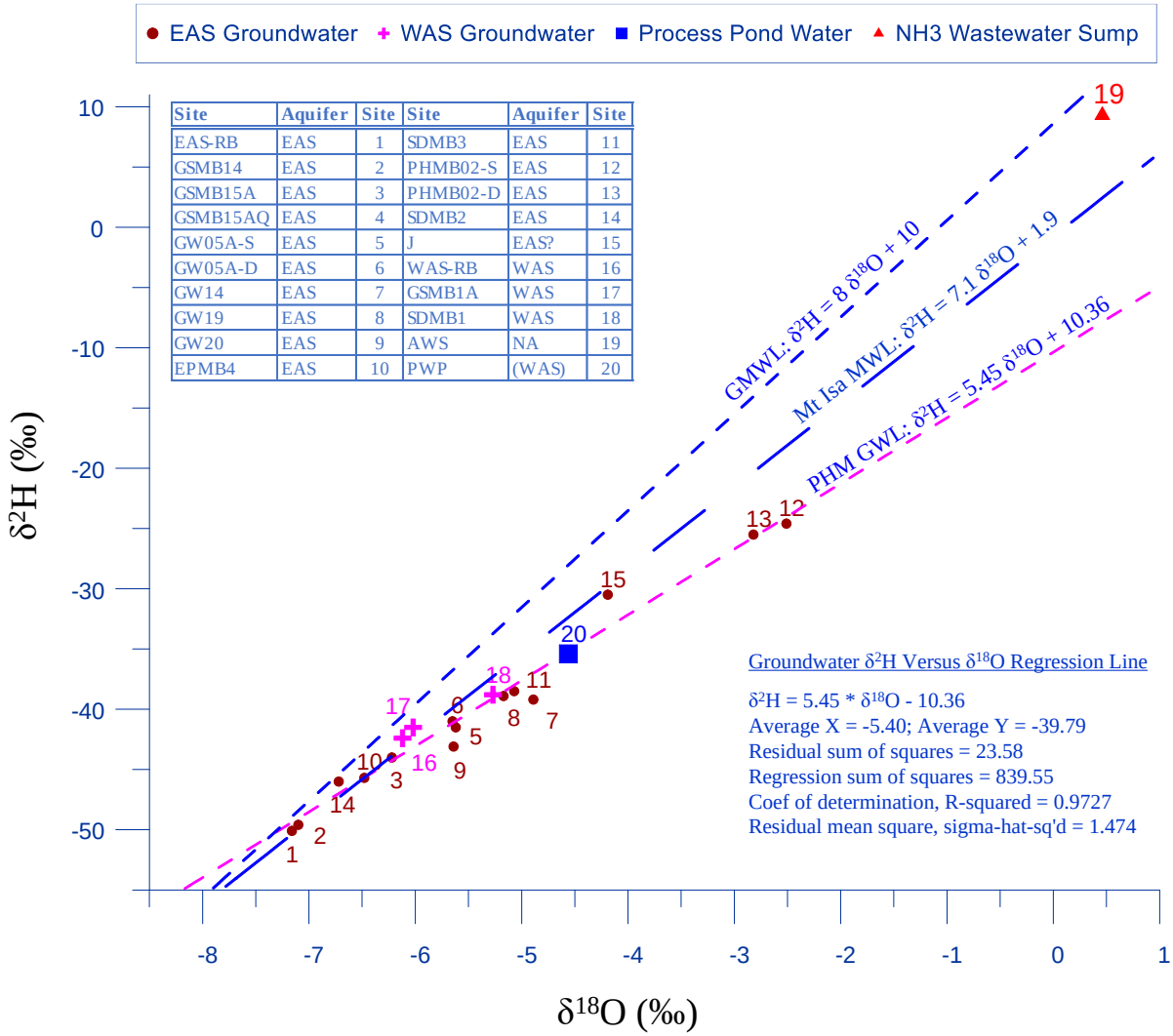
The measured field water quality parameters and the ^{2}H and ^{18}O stable isotope analytical results are presented in Table 4. The sample electronic submission Chain-of-Custody (part copy only) and the GNS Science laboratory report are both included in Appendix A.

TABLE 4 Field Parameters and 2H and 18O Analytical Results

Sample ID	Fig 3 Plot No	Sample type	Aquifer	Date sampled	Temp °C	EC µS/cm	pH units	DO mg/L	$\delta^{2}H$ ‰	$\delta^{18}O$ ‰
EAS-RB	1	GW	EAS	1/06/2018	23.74	1031	6.98	60.8	-50.1	-7.16
GSMB14	2	GW	EAS	30/05/2018	19.47	998	7.13	68.7	-49.6	-7.1
GSMB15A	3	GW	EAS	30/05/2018	27.19	2690	6.88	53.3	-44	-6.22
GW05A-S	5	GW	EAS	4/06/2018	25.44	9648	6.93	67.6	-41.5	-5.62
GW05A-D	6	GW	EAS	4/06/2018	24.17	10375	6.97	62.9	-41	-5.65
GW14	7	GW	EAS	5/06/2018	13.85	12413	6.96	68.7	-39.2	-4.89
GW19	8	GW	EAS	5/06/2018	24.44	9724	6.77	62.4	-38.9	-5.17
GW20	9	GW	EAS	5/06/2018	26.97	7942	7.01	70.7	-43.1	-5.64
EPMB4	10	GW	EAS	30/05/2018	32.11	1867	7.18	67.7	-45.7	-6.48
SDMB3	11	GW	EAS	5/06/2018	26.56	3568	6.92	58.1	-38.5	-5.07
PHMB02-S	12	GW	EAS	29/05/2018	28.2	2323	7.38	56.8	-24.6	-2.51
PHMB02-D	13	GW	EAS	29/05/2018	28.2	2323	7.38	56.8	-25.5	-2.82
SDMB2	14	GW	EAS	29/05/2018	30.39	1263	8.08	94.7	-46	-6.72
J	15	GW	EAS?	30/05/2018	26.5	904	7.23	54.8	-30.5	-4.19
WAS-RB	16	GW	WAS	1/06/2018	16.35	1355	7.51	49.2	-42.4	-6.12
GSMB1A	17	GW	WAS	4/06/2018	24.69	1414	7.32	56.2	-41.5	-6.02
SDMB1	18	GW	WAS	29/05/2018	31.19	3274	7.21	66.5	-38.8	-5.27
AWS	19	WW	NA	2/06/2018	nr	nr	nr	nr	9.3	0.46
PWP	20	PW	(WAS)	2/06/2018	nr	nr	nr	nr	-35.4	-4.56

Note: Sample Plot No 4 was a field duplicate collected from bore GSMB15A (designated as GSMB15AQ on the Chain-of-Custody documentation).

The stable Isotope data is plotted (δ2H Versus δ18)) in Figure 3. Both the GMWL and the Mt Isa MWL are also plotted in Figure 3.



Site	Aquifer	Site	Site	Aquifer	Site
EAS-RB	EAS	1	SDMB3	EAS	11
GSMB14	EAS	2	PHMB02-S	EAS	12
GSMB15A	EAS	3	PHMB02-D	EAS	13
GSMB15AQ	EAS	4	SDMB2	EAS	14
GW05A-S	EAS	5	J	EAS?	15
GW05A-D	EAS	6	WAS-RB	WAS	16
GW14	EAS	7	GSMB1A	WAS	17
GW19	EAS	8	SDMB1	WAS	18
GW20	EAS	9	AWS	NA	19
EPMB4	EAS	10	PWP	(WAS)	20

FIGURE 3 PHM Water Samples δ2H Versus δ18O, GMWL and Mt Isa LMWL Plots

Regression analysis was used to determine the PHM stable isotopes groundwater line and the degree of correlation between the data. The equation for the regression line (line of best fit through the data points was $\delta^2H = 5.45 * \delta^{18}O - 10.36$. The correlation between the data points was high; R-squared value of 0.9727.

6.0 DISCUSSION

Detailed assessment of the stable isotope data has not been undertaken. However, a number of tentative findings are discussed below. These preliminary findings should be verified by a more comprehensive assessment including reviewing the isotope data in conjunction with hydraulic and chemical data.

- The similarity between isotope composition of groundwater sampled from the WAS with that in the EAS from widely spaced sampling locations suggests similar groundwater recharge sources on both sides of the Mehaffey Fault, and that similar processes have operated on the recharge water both before and during recharge. [This finding does not mean that the two flow systems are hydraulically interconnected just that the recharge source and process are similar.]

- The stable isotopes composition in the PWP plotted on the groundwater isotopes regression line. This finding was not unexpected as the water in the pond is mainly groundwater from the WAS.

- The stable isotopes composition of the water from the AWS did not plot on the groundwater isotopes regression line. This anomalous finding indicates that the groundwater beneath the Plant Area is not impacted by the water in the AWS.

- The isotopic composition of the groundwater from the two bores where water was sampled from different screen intervals, GW05A-S and GW05A-D (Figure 3 plot point3 5 and 6, respectively), and PHMB02-S and PHMB02-D (Figure 3 plot points 12 and 13, respectively) were very similar indicating that water from deeper in the stratigraphic sequence is not likely to be contributing to groundwater closer to the water table (at least at the tested locations).

- The lack of contrast in groundwater stable isotope compositions between groundwater sampled from WAS bores and that sampled from EAS bores indicates stable isotopes most likely would not be useful in identifying different groundwater flow compartments at the PHM.

- The stable isotope composition of the Ammonia Wastewater Sump (AWS) sample has a highly modified stable isotope composition (Morgenstern, 2018).

The findings of the stable isotopic analytical program indicate that determining the isotopic composition of other process and waste water streams at the PHM is a promising method of assessing whether these potential contaminated waters have or are impacting local groundwater.

7.0 RECOMMENDATION

This report should be updated when the ^{3}H analysis results are available. All stable Isotope data should be assessed in conjunction with site groundwater chemistry and hydraulic data in the context of the Conceptual Hydrogeological Model developed by JLCS and EnviroRisk. The additional assessment should verify (or disregard) the preliminary finding presented in this report.

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9.0 LIMITATIONS OF THIS REPORT

The advice provided in this report relates only to the project described herein and must be reviewed by a competent Engineer or Scientist before being used for any other purpose. JOHN LEONARD CONSULTING SERVICES Pty Ltd accepts no responsibility for other use of the data.

Where drill hole or test pit logs, laboratory tests, geophysical tests and similar work have been performed and recorded by others the data is included and used in the form provided by others. The responsibility for the accuracy of such data remains with the issuing authority, not with JOHN LEONARD CONSULTING SERVICES Pty Ltd.

The advice tendered in this report is based on information obtained from the investigation locations, test points and sample points and is not warranted in respect to the conditions that may be encountered across the site at other than these locations. It is emphasized that the actual characteristics of the subsurface and surface materials may vary significantly between adjacent test points and sample intervals and at locations other than where observations, explorations and investigations have been made. Sub-surface conditions, including groundwater levels can change in a limited time. This should be borne in mind when assessing the data.

It should be noted that because of the inherent uncertainties in sub-surface evaluations, changed or unanticipated sub-surface conditions may occur that could affect total project cost and/or execution. JOHN LEONARD CONSULTING SERVICES Pty Ltd does not accept responsibility for the consequences of significant variances in the conditions.

An understanding of the site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure-specific and some experienced-based. This report should not be altered, amended or abbreviated, issued in part and issued incomplete in any way without prior checking and approval by JOHN LEONARD CONSULTING SERVICES Pty Ltd. JOHN LEONARD CONSULTING SERVICES Pty Ltd accepts no responsibility for any circumstances which arise from the issue of the report which has been modified in any way as outlined above.

August 2018

John Leonard
JOHN LEONARD CONSULTING SERVICES PTY LTD

APPENDIX A

GNS SCIENCE

ELECTRONIC SUBMISSION FORM (Partial Copy)

and

ANALYTICAL REPORT

Water Dating Laboratory

Sample Submission Form - New Zealand

Please contact us to discuss your needs; we can advise appropriate types of analysis including tritium,CFC and SF_6 to meet your requirements.
Please notify us before shipping samples, so that we can anticipate their arrival.
Phone: +64 4 570 1444 Fax: +64 4 570 4600 Email: WDL-Sample-Submission@gns.cri.nz

Sample Information

	Analysis required										important supplementary information											
Samle ID	Tritium	CFC	SF_6	^{18}O	^{2}H	^{14}C	Radon	^{15}N	Sampling Date	Sampling Time (24h)	Origin of Samples (e.g. river, well, spring, ect.)	Site Name	Easting (NZTM)	Northing (NZTM)	Bore depths (m below ground surface)	Screened interval Top (m below ground surface)	Screened interval Bottom (m below ground surface)	Water level (below ground)	Water Temperature (°C)	Conductivity (µS/cm)	pH	field measured Dissolved Oxygen (mg/L)
Example 1	Yes	No	No	No	No	No	No	No	3/04/2016		well	Well#34	1934969.97	5603163.1	15	14.1	14.3					
Example 2	No	No	No	No	No	No	Yes	No	6/06/2016	#########			18314/4.34	5810116.5								
EAS-RB	Yes			Yes	Yes				1/06/2018		Well	EAS-RB						58.14	23.74	1031	6.98	60.8
GSMB14				Yes	Yes				30/05/2018		Well	GSMB14						55.74	19.47	998	7.13	68.7
GSMB15A	Yes			Yes	Yes				30/05/2018		Well	GSMB15A						55.8	27.19	2690	6.88	53.3
GSMB15AQ	Yes			Yes	Yes				30/05/2018		Well	GSMB15AQ						55.8	27.19	2690	6.88	53.3
GWO5A-S	Yes			Yes	Yes				4/06/2018		Well	GWO5A-S						48.23	25.44	9648	6.93	67.6
GWO5A D				Yes	Yes				4/06/2018		Well	GWO5A D						48.23	24.17	10375	6.97	62.9
GW14				Yes	Yes				5/06/2018		Well	GW14						48.14	13.85	12413	6.96	68.7
GW19				Yes	Yes				5/06/2018		Well	GW19						34.96	24.44	9724	6.77	62.4
GW20				Yes	Yes				5/06/2018		Well	GW20						35.29	26.97	7942	7.01	70.7
EPMB4				Yes	Yes				30/05/2018		Well	EPMB4						46.17	32.11	1867	7.18	67.7
SDMB3	Yes			Yes	Yes				5/06/2018		Well	SDMB3						45.04	26.56	3568	6.92	58.1
PHMB02 S				Yes	Yes				29/05/2018		Well	PHMB02 S						46.23	28.2	2323	7.38	56.8
PHMB02 D				Yes	Yes				29/05/2018		Well	PHMB02 D						46.23	28.2	2323	7.38	56.8
SDMB2	Yes			Yes	Yes				29/05/2018		Well	SDMB2						47.13	30.39	1263	8.08	94.7
J				Yes	Yes				30/05/2018		Well	J						48.64	26.5	904	7.23	54.8
WAS RB				Yes	Yes				1/06/2018		Well	WAS RB						70.86	16.35	1355	7.51	49.2
GSMB1A	Yes			Yes	Yes				4/06/2018		Well	GSMB1A						62.4	24.69	1414	7.32	56.2
SDMB1				Yes	Yes				29/05/2018		Well	SDMB1						57.02	31.19	3274	7.21	66.5
WASTE WATER SUMP	Yes			Yes	Yes				2/06/2018		SUMP	WASTE WATER SUMP										
PRCOESS WATER				Yes	Yes				2/06/2018		DAM	PRCOESS WATER										

Note: Copy of part of the GNS Science electronic submission form (excel spreadsheet); provide here for reference only.

STABLE ISOTOPE RESULTS

National Isotope Centre
30 Gracefield Road
Lower Hutt 5010
PO Box 31 312
Lower Hutt 5040
New Zealand
T +64-4-570 1444
F +64-4-570 4657
www.gns.cri.nz

Attention: Uwe Morgenstern
Company: GNS Science
1 Fairway Drive
Avalon

SIL Order No.:	W-1801269
Client Ref.:	IC833
Date Received:	22/06/2018
Date Measured:	3/07/2018
Approved By:	A. Phillips
Date Reported:	6/07/2018

Sample Type: Water Isotopes δ^2H &$\delta^{18}O$

SIL ID	External ID	Delta 2H (‰)	Delta 18O (‰)	Analysis Type	Country Code	Other Info
W-1801269	IC833	-50.1	-7.16	D, O18	AS	EAS-RB
W-1801270	IC834	-49.6	-7.10	D, O18	AS	GSMB14
W-1801271	IC835	-44.0	-6.22	D, O18	AS	GSMB15A
W-1801272	IC836	-44.2	-6.20	D, O18	AS	GSMB15AQ
W-1801273	IC837	-41.5	-5.62	D, O18	AS	GWO5A-S
W-1801274	IC838	-41.0	-5.65	D, O18	AS	GWO5A-D
W-1801275	IC839	-39.2	-4.89	D, O18	AS	GW14
W-1801276	IC840	-38.9	-5.17	D, O18	AS	GW19
W-1801277	IC841	-43.1	-5.64	D, O18	AS	GW20
W-1801278	IC842	-45.7	-6.48	D, O18	AS	EPMB4
W-1801279	IC843	-38.5	-5.07	D, O18	AS	SDMB3
W-1801280	IC844	-24.6	-2.51	D, O18	AS	PHMB02-5
W-1801281	IC845	-25.5	-2.82	D, O18	AS	PHMB02-D
W-1801282	IC846	-46.0	-6.72	D, O18	AS	SDMB2
W-1801283	IC847	-30.5	-4.19	D, O18	AS	J
W-1801284	IC848	-42.4	-6.12	D, O18	AS	WAS-RB
W-1801285	IC849	-41.5	-6.02	D, O18	AS	GSMB1A
W-1801286	IC850	-38.8	-5.27	D, O18	AS	SDMB1
W-1801287	IC851	9.3	0.46	D, O18	AS	WASTE WATER SUMP
W-1801288	IC852	-35.4	-4.56	D, O18	AS	PROCESS WATER

Water samples are analysed on an Isoprime mass spectrometer; for $\delta^{18}O$ by water equilibration at 25°C using an Aquaprep device, for δ^2H by reduction at 1100 °C using a Eurovector Chrome HD elemental analyser.

All results are reported with respect to VSMOW2, normalized to our internal standards: SM1 with reported values of -29.12‰ for $\delta^{18}O$, -227.4‰ for δ^2H, and INS11 with reported values of -0.36‰ for $\delta^{18}O$, -3.8‰ for δ^2H. The analytical precision for this instrument is 0.2‰ for $\delta^{18}O$ and 2.0‰ for δ^2H.

Samples will be kept for 3 months from the date of the report and discarded unless otherwise notified.