Knight Piésold CONSULTING

MEMORANDUM

To:	**Savannah Resources Plc**	**Date:**	20 December 2019
Attn:	David Price	**Our Ref:**	PE19-01429
		KP File Ref.:	PE501-00080/03-A bas M19005
cc:		**From:**	Brett Stevenson

RE: MINA DO BARROSO - MINING PROPOSAL – PROCESS WATER SUPPLY

This memorandum summarises the engineering assessments undertaken to date as part of the concept level development of a water management supply system for the Mina do Barroso Project, Portugal.

1. DESIGN OBJECTIVES

The design objectives for the surface water management system are summarised as follows:

- Meet process water demand requirements under average and drier than average climatic conditions.
- Utilise groundwater resources where practical.
- Consider surface water harvesting to provide a reliable process make up supply.
- Provide for return of water, not suitable for direct release, to the process or water treatment plant.

2. DESIGN BASIS

2.1 BACKGROUND

Hydrogeological studies and pumping tests have indicated that there is:

i. A low groundwater yield potential across the project area; and
ii. Insufficient groundwater yields available to meet the projects process water demand requirements.

In order to meet the projects water demand, alternative water sources have been identified / considered and are summarised herein.

2.2 GENERAL

The following climatic conditions were adopted for the water supply assessment:

- Average climatic conditions.
- 10 yr Average Return Interval (ARI) 1 yr dry climatic conditions.
- 100 yr ARI 1 year 1 wet climatic conditions (treatment plant requirements).

2.3 OPTIONS

Three water make up supply options have been considered to supplement the planned pit sump and dewatering bores:

- Option 1: harvesting groundwater via pit dewatering bores and external borefields. No harvesting of surface water runoff.
- Option 2: Harvesting surface water runoff from the project area in addition to pit de-watering bores.
- Option 3: Harvesting surface water runoff, pit de-watering bores and water from the Rio Covas during drier months.

2.4 DESIGN PARAMETERS

The following key design parameters were adopted to determine make up water requirements.

Table 2.1: Key Design Parameters

Parameter	Value	
CATCHMENTS		
Grandao Pit	38 ha	
Reservatorio Pit	19 ha	
NOA Pit	4 ha	
Pinheiro Pit	7 ha	
Western Mine Waste Storage	76 ha	
Southern Mine Waste Storage	171 ha	
Area Upstream Grandao Pit	873 ha	
Catchment Rio Covas		
– Upstream Project	9,330 ha	
– Downstream Project	10,510 ha	
RUNOFF COEFFICIENTS		
Pit Areas	100 %	
Waste Storage Areas	80 %	
Undisturbed Catchments	30 %	
GROUNDWATER INFLOW TO PITS		
All Pit Areas	2.5 L/sec	
WATER DEMANDS		
Initial Filling of Process Systems	60,400 m^3 during first month of commissioning	
Operating hours	Primero:	7,884 hrs / yr
Mine office / mess / workshop	Primero ~ 100 staff	120 L/p/day
Laboratory	Primero:	125 L/hr
Mining Dust Suppression	Assumed:	250 m^3/day
Processing Losses	Primero: 250,000 m^3/yr:	8.8 L/sec
OTHER PARAMETERS		
Ore Moisture	Primero: 3.1%	

Note:
1. Assumed that potable water / % of process plant demand need to be sourced from clean raw water.

3. DESIGN PRECIPITAION

Design rainfall patterns, both long-term (for water balance modelling) and short-term (for design of stormwater infrastructure) were derived through statistical manipulation of available recorded rainfall data, based on records sourced from Sistema Nacional de Informação de Recursos Hídricos (SNIRH) for the weather station in Couto de Dornelas for the period 1931 to 2009.

The precipitation data is summarised in tables 3.1 to 3.5 and shown on figures 3.1 to 3.5.

Table 3.1: Annual long-term precipitation data – statistical summary

Selected Statistic	Couto de Dornelas (1931 – 2008)
Average (mm)	1,649
Median (mm)	1,565
Std. Deviation (mm)	637
Minimum (mm)	640
Maximum (mm)	3,732
25th Percentile (mm)	1,202
75th Percentile (mm)	2,141
Average # of Rain Days	122
Count (# of water years)	70
Distance to site (km)	4
Elevation at gauge (m AMSL)	670

Table 3.2: Monthly long-term precipitation data – statistical summary

Month	Average	Median	Std. Dev.	Min.	Max.	25th Pct.	75th Pct.
Jul	20.5	11.6	24.7	0.0	113.6	3.6	27.4
Aug	23.7	12.8	31.8	0.0	165.3	4.2	27.5
Sep	64.5	45.0	67.0	0.0	288.5	19.4	80.3
Oct	141.0	102.6	131.0	1.2	574.0	47.5	179.2
Nov	195.8	157.2	155.8	0.0	783.3	67.8	315.8
Dec	246.3	160.0	242.8	2.8	1306.0	73.5	353.7
Jan	254.3	205.9	227.8	0.0	1012.8	81.2	352.8
Feb	221.7	143.3	217.0	2.0	797.9	47.9	388.0
Mar	180.5	124.0	159.8	1.2	633.2	58.1	288.4
Apr	124.7	94.2	101.8	1.6	521.4	49.1	172.9
May	106.6	94.2	77.2	6.4	344.4	41.0	139.7
Jun	60.1	51.6	60.7	0.0	413.1	17.9	83.8

Table 3.3: Monthly long-term precipitation patterns

Month	Monthly Precipitation (mm)		
	100 yr ARI Wet	Average	10 yr ARI Dry
Jul	5	0	17
Aug	5	23	5
Sep	17	62	35
Oct	19	156	80
Nov	424	94	14
Dec	664	449	72
Jan	921	549	207
Feb	555	115	70
Mar	475	131	287
Apr	181	54	3
May	50	11	21
Jun	77	6	27
Total	3,393	1,650	837

Table 3.4: Design (short-term) storm events: precipitation intensity

Storm Duration	Storm Precipitation Intensity (mm/h)								
	AEP (%)	20	10	5	2	1	0.1[1]	0.01[1]	PMP
	ARI (yr)	5	10	20	50	100	1,000[1]	10,000[1]	PMP
5 min		144	156	168	180	180	264	336	564
10 min		96	108	114	126	132	186	240	402
15 min		76	84	92	104	104	148	192	324
30 min		52	58	64	72	74	106	136	228
1 h		35	40	44	50	52	74	96	161
2 h		24	28	31	35	37	52	67	113
3 h		19	22	25	28	30	42	55	92
6 h		13	15	17	20	21	30	39	65
12 h		8.7	10	12	14	15	21	27	46
18 h		6.9	8.2	9.4	11	12	17	22	37
24 h		5.9	7.0	8.0	9.4	10	15	19	32
48 h		4.2	4.9	5.8	7.1	8.3	-	-	-
72 h		3.5	4.0	4.8	5.9	7.0	-	-	-

Notes:
1. The 1,000 and 10,000 year ARI depths are based on a logarithmic interpolation between the 24 hour 100 year ARI and the 24 hour PMP, assuming the PMP is equivalent to a 10 million year ARI event.
2. AEP = annual exceedance probability, ARI = annual recurrence interval, ARI = 1 / AEP

Table 3.5: Design (short-term) storm events: precipitation depth

Storm Duration	Storm Precipitation Depth (mm)								
	AEP (%)	20	10	5	2	1	0.1[1]	0.01[1]	PMP
	ARI (yr)	5	10	20	50	100	1,000[1]	10,000[1]	PMP
5 min		12	13	14	15	15	22	28	47
10 min		16	18	19	21	22	31	40	67
15 min		19	21	23	26	26	37	48	81
30 min		26	29	32	36	37	53	68	114
1 h		35	40	44	50	52	74	96	161
2 h		47	55	61	69	74	104	134	226
3 h		57	65	74	84	90	127	164	276
6 h		77	90	102	117	126	179	231	388
12 h		104	122	140	162	178	251	325	546
18 h		124	147	169	197	217	307	396	666
24 h		141	167	193	226	250	353	457	767
48 h		202	236	276	340	400	-	-	-
72 h		249	291	342	425	502	-	-	-

Notes:
1. The 1,000 and 10,000 year ARI depths are based on a logarithmic interpolation between the 24 hour 100 year ARI and the 24 hour PMP, assuming the PMP is equivalent to a 10 million year ARI event.
2. AEP = annual exceedance probability, ARI = annual recurrence interval, ARI = 1 / AEP

4. WATER DEMAND

A site water management model was developed for the Project to identify the likely impact on surface water discharge under extreme dry and average climatic conditions.

The site water management model was developed to estimate:

- The quantity of water to be managed.
- The quality of water likely to be discharged from nominated surface water control structures.
- Water management techniques and infrastructure required to maintain a balanced system over the life of the Project.

A simplified flow diagram is included as Figure 4.1. Block diagrams of the site water management models for each of the options are presented as figures 4.2 to 4.7.

Discharge from the Project area into Rio Covas will be continuous but will vary in quality and quantity as a result of the actual climatic conditions. Minimum design water treatment plant capacities and pump station capacities from mining areas to the treatment plant (assumed to be located at the process plant) were determined as part of the water balance modelling.

The required water supply for the project was based on data provided by Primero:

- Information provided within the ‘Mina do Barroso Scoping Study, High Level Water Balance (5/11/2019)’ block model.

- ~1.5 Mt/year throughput.
- 7,884 operating hours per year.
- Process Plant demand total = 10.2 L/s process and 4.1 L/s raw water.
- Process Plant demand total = 406,020 m^3/yr (14.3 L/s).
- ~ 250,000 m^3/year water lost in concentrate (8.8 L/sec).

In addition, estimates of dust suppression demands and potable water requirements were made to derive the overall project water demand:

- Dust suppression: ~ 87,100 m^3/year (3 L/s).
- Potable water usage assumed for 100 personnel – 15,330 m^3/year (0.54 L/s).
- Total water demand: ~ 510,000 m^3/year (18 L/s).
- Approximately 46,000 m^3/year (1.6 L/s) will be introduced into the process as ore moisture.
- Remaining Project Shortfall ~ 464,000 m^3/year (16.3 L/s), consisting of:
  - Potable Water: ~ 15,600 m^3/year (0.5 L/s).
  - Process Water: ~361,300 m^3/year (12.7 L/s).
  - Dust Suppression: ~ 87,100 m^3/year (3.0 L/s).

This option study was based on supplying a minimum annual supply 465,000 m^3/year (16.3 L/s) for all considered climatic conditions. A continuous water supply of 45,000 m^3/month will be required to maintain operation year-round.

It is noted that this demand is based on the maximum amount of water being recycled within the project. Some surface water harvested from runoff may require treatment to meet process plant requirements (ie: higher water quality for reagents etc).

5. OPTIONS CONSIDERED

5.1 GENERAL

A comparison of the considered options is provided below, along with a summary of previous findings where available.

For all options considered, two months of process plant make up water supply (~ 60,000 m^3) was adopted as the stored volume required on site to establish steady state conditions in the process plant.

5.2 OPTION 1 – GROUNDWATER HARVESTING

It is noted that groundwater yields in the project area have been investigated, are low and are insufficient to meet process water demand. Pump testing on the site has confirmed groundwater yields will be insufficient to supply the process demand. No viable external borefield has been identified within an economical and manageable distance. As such, this option is considered fatally flawed. The following summary provided for information only.

Groundwater harvesting has been considered in a number of published documents. For the purposed of this assessment, two documents have been utilised, namely:

- Visa Consultants (30/07/04) Escudo Hydrogeologico da area Implantacoa da Mina de feldsapto “Mina do Barrosa”. Doc No. E.03844.003.sd.doc. Includes a partial translation: ‘Hydrogeological study of the area Implantation of the feldspar mine "Mina do Barroso"’.
- KP Memo PE19-00023: Mina do Barroso Lithium Project – Groundwater Review - Rev. 2, issued 15th January 2019;

The key conclusions stated in these documents with regard to the availability and supply of groundwater are summarised as follows:

- Groundwater chemistry data from a previous study by Visa Consultants indicate that the groundwater is fresh, slightly acidic (pH 5.5) and can contain iron and manganese.
- The published geology map shows quartz phylites (Sb and Sc) beneath the Grandao, Reservatorio, NOA and Pinheiro deposits and granitoids (ϒ g2) underlying the village of Romainho to the north.
- In the RC resource holes schist (SCH) is the predominant lithology for each deposit followed by pegmatite (FGP).
- Savannah has indicated that groundwater occurs at geological contacts but that continuous groundwater flows were not encountered during RC drilling which suggests a low yield potential.
- Based on a previous hydrogeological investigation undertaken in 2004 by Visa Consultants indicated bore yields from the schists and granitoids are expected to average 0.3 L/s and 0.5 L/s respectively.
- Pumping tests undertaken by Savannah in 2018 indicted that yields of 0.3 L/s, 0.6 L/s and 1.1 L/s were non-sustainable in the three test production bores drilled.
- The main Rio Covas and a number of its tributaries are mapped along fault lines (‘fault controlled topography’) that may form localised aquifers due to fractured rock at depth, an enhanced weathering profile and seasonal groundwater recharge. Existing wells marked on the geology map are mainly adjacent to the creek lines.
- Potential minor aquifers are the weathered zone, fractured/fault zones and geological contacts. Weathering and groundwater recharge may be enhanced along the creek lines some of which may be fault controlled.

For commissioning and the first year of operation, ~ 0.4 Mm^3 (14 L/s) would be required from an external make up supply.

Once steady state conditions have been achieved in the process plant and based on groundwater / pit dewatering bores producing ~78,900 m^3/year (~ 2.8 L/s), an additional ~ 357,000 m^3/year (13 L/s) is required to maintain steady state operations. sourced from an external borefield/s, located remote from site).

The block model indicating site flows is shown on figures 4.2 and 4.3. Make up water sources and shortfalls under a range of conditions is indicated on Figures 4.8.

Based on currently available information sustainable groundwater yields of this magnitude have not been identified in the vicinity of the project (no sustainable fresh water aquifer able to supply the required flow rates has been identified in the project vicinity.

As such, a borefield/s, comprising of up to 30 No. bores (assumed yield ~ 0.5 L/s), would need to be located / constructed remotely and an overland water supply pipeline installed (further increase to water supply costs).

5.3 OPTION 2 – DEWATERING BORES PLUS SURFACE WATER HARVESTING (FROM WITHIN MINING AREA)

In addition to pit dewatering bores (~ 78,900 m^3/year or 2.8 L/s), Option 2 sources additional make up supply utilising surface water harvested from within the mining lease areas, primarily the undisturbed catchment diverted around the Grandao Pit.

The option requires sediment control structures being constructed ahead of mining operations as planned and water harvesting from multiple structures being undertaken from process plant commissioning.

To reduce the risk of shortfalls during dry months, water collected during the wetter months will be stored on site in structures constructed as part of the sediment control system.

The block model indicating site flows is shown on figures 4.4 and 4.5.

The estimated site rainfall runoff (and possible groundwater inflows) for a range of long-term rainfall scenarios has been determined.

The results are summarised in tables 5.1 and 5.2 for the average, 1 in 100 year ARI extreme wet and 1 in 10 year ARI extreme dry conditions in the initial years (mining only in the Pinheiro and Grandao Pit Areas) and the later mining stages (mining expands to Reservatorio and NOA Areas).

Table 5.1: Estimated Rainfall Runoff within Project Area (Year 2 to 7)

Month	Runoff within Project Area (m^3)		
	1 in 100 Wet	Average	1 in 10 Dry
July	218,900	8,000	4,200
August	65,500	74,300	4,100
September	463,600	200,300	13,400
October	1,056,500	505,100	15,200
November	186,100	305,900	339,700
December	953,100	1,457,500	532,300
January	2,731,700	1,784,200	737,900
February	915,200	372,600	444,900
March	3,413,900	424,800	380,900
April	363,900	176,800	145,100
May	275,700	35,100	40,200
June	351,600	10,000	61,300
Annual	10,995,700	5,354,600	2,719,200

Forecast water supply shortfall this month – without storage provision

Table 5.2: Estimated Rainfall Runoff within Project Area (Year 8+)

Month	Runoff within Project Area (m^3)		
	1 in 100 Wet	Average	1 in 10 Dry
July	238,500	8,800	4,600
August	71,400	80,900	4,500
September	505,200	218,200	14,600
October	1,151,200	550,500	16,500
November	202,800	333,300	370,200
December	1,038,600	1,588,300	580,100
January	2,976,700	1,944,200	804,100
February	997,200	406,100	484,800
March	3,720,100	462,900	415,100
April	396,600	192,600	158,200
May	300,500	38,200	43,800
June	383,100	10,900	66,900
Annual	11,981,900	5,834,900	2,963,400

Forecast water supply shortfall this month – without storage provision

Make up water sources and shortfalls under a range of conditions is indicated on figures 4.9 to 4.10.

As the majority of the potential rainfall runoff from harvesting is sourced from the Grandao Pit diversion (upstream undisturbed catchment), the expansion in mining area over the project duration has limited impact on the water supply.

Once steady state conditions have been achieved in the process plant, in addition to the pit dewatering bores supplying ~78,900 m^3/year (2.8 L/s), ~ 300,000 m^3/year (11 L/s) will be required for the process plant and a further 87,100 m^3/year (2.8 L/s) for dust suppression. Make up will be sourced from surface water harvesting of contact water (runoff from disturbed mining areas) used as a priority when available.

It is expected that approximately 175,000 m^3/year (6.2 L/s) will be available for direct use during the development of Grandao Pit. This contact water is expected to require some polishing prior to process use and/or discharge.

During the dryer months the disturbed catchments will not generate sufficient runoff to meet demand. During these months, non contact water sourced from the Grandao Pit diversion, up to ~ 60,000 m^3/year (2 L/s) will be harvested (average conditions).

During extreme dry conditions (eg: 10 yr ARI dry), shortfalls in runoff are forecast if no additional storage capacity is available on site. Sufficient water to supply the project water demand can be harvested annually from runoff within the project area. A series of minor water storage facilities (part of the sediment control system) would be utilised to store water harvested during the wetter winter months for supply during the dryer summer months and would reduce the risk of shortfalls occurring.

Once steady state conditions have been achieved in the process plant, a total project demand of 36,000 m^3/ month (14 L/s), harvesting inflow from all available project areas will provide sufficient water for the project during 80% of the year (approximately 10 months) under average conditions. This reduces to 65% of the year under 1 in 10 year ARI extreme dry conditions.

A water storage capacity on site of approximately 100,000 m^3 would be required to provide a year-round water supply for dry conditions. This would be achieved by storing runoff during the wet months for use in the dry.

The currently planned sediment control structures across the site will provide ~ 100,000 m^3 of the storage volume requirement. An additional storage capacity of ~ 100,000 m^3 appears feasible within the current site layout constraints and would further reduce the risk of shortfalls under extreme dry conditions.

This water supply strategy is expected to reduce the annual flow in Rio Covas by < 1% under 1 in 10 ARI year Dry conditions.

5.4 OPTION 3 – DEWATERING BORES PLUS SURFACE WATER HARVESTING (FROM MINING AREAS AND RIO COVAS)

This option utilises groundwater sourced from the pit dewatering bores, surface water harvested from within the mining lease area and in case of shortfalls, water sourced from Rio Covas.

The option requires sediment control structures being constructed ahead of mining operations as planned and water harvesting from multiple structures being undertaken from process plant commissioning.

On-site water storage capacity is required but the required stored volume is reduced (compared to Option 2) due to the additional water sourced from the Covas River.

The block model indicating site flows is shown on figures 4.6 and 4.7.

Similar to Option 1 and 2, up to 78,900 m^3/year (2.8 L/s) was assumed to be generated by the pit dewatering bores.

Once steady state conditions have been achieved in the process plant, approximately 175,000 m^3 /year (6.2 L/s) will be sourced from surface water harvesting. Pit dewatering and contact water from within the mining area will be used as a priority when available. This may require some polishing prior to use.

It is noted that the majority of surface runoff occurs during the wetter winter months with limited runoff during the dry summer months. During the dryer months, the disturbed catchments will not produce sufficient runoff and non contact water from the Grandao Pit diversion, up to ~96,000 m^3/year (3.4 L/s) will be harvested. During extreme dry months, the additional required make up water will be sourced from Rio Covas at up to ~87,000 m^3/year (~ 3 L/s).

The total flow in Rio Covas is estimated at ~ 50 Mm^3 per year under average climatic conditions. During a 1 in 10 ARI dry year, the flow is forecast to reduce to ~ 23 Mm^3 (~ 50% of the average flow). With the annual project demand in the order of 0.46 Mm^3/year (16.3 L/s) of which ~ 15% may be supplied from groundwater abstraction and further 70% from harvesting contact water within the project area (assuming limited storage capacity). Under this scenario, the make up required,

~ 87,000 m^3/yr, would be harvested from the Rio Covas (only if available water on site is exhausted).

Option 3 does not require the construction of additional storage structures in order to capture water in the wetter periods.

A summary of the flow estimates upstream and downstream of the project is provided in table 5.3 and 5.4 for average and extreme dry conditions respectively.

Table 5.3: Average Climatic Conditions – Rio Covas Runoff Estimate

Month	Runoff (m^3)		
	Upstream	Downstream	Project Area
July	69,700	77,700	8,000
August	644,500	718,500	74,000
September	1,738,400	1,938,100	199,700
October	4,384,300	4,887,900	503,600
November	2,654,800	2,959,700	304,900
December	12,650,400	14,103,400	1,453,000
January	15,485,600	17,264,300	1,778,700
February	3,234,300	3,605,800	371,500
March	3,686,600	4,110,000	423,400
April	1,534,400	1,710,600	176,200
May	304,500	339,500	35,000
June	87,000	97,000	10,000
Total	46.5 M	51.9 M	5.4 M

Expected flow less than required to meet project water supply

Table 5.4: 1 in 10 year ARI Dry Climatic Conditions – Rio Covas Runoff Estimate

Month	Runoff (m^3)		
	Upstream	Downstream	Project Area
July	36,700	40,900	4,200
August	35,400	39,500	4,100
September	116,400	129,800	13,400
October	131,500	146,600	15,100
November	2,948,200	3,286,800	338,600
December	4,620,300	5,151,000	530,700
January	6,404,900	7,140,600	735,700
February	3,861,400	4,304,900	443,500
March	3,306,200	3,686,000	379,800
April	1,259,700	1,404,400	144,700
May	349,100	389,200	40,100
June	532,500	593,700	61,200
Total	23.7 M	26.4 M	2.7 M

Expected flow less than required to meet project water supply

Make up water sources and shortfalls under a range of conditions is indicated on figures 4.11 to 4.12.

During extreme dry conditions, flows in Rio Covas may not be sufficient to supply water for the project. A site wide storage capacity in the range of 2 to 3 month's supply (~100,000 to 150,000 m^3) is forecast to be sufficient to reduce the risk of shortfalls under the range of dry conditions assessed. It is expected that the proposed surface water management / sediment control structures will allow harvesting water during the wetter months for use in the dry summer months to mitigate this shortfall.

This storage capacity will reduce the reliability on continuous surface water harvesting and can provide a buffer to limit extraction from Rio Covas during times of naturally low flows.

6. WATER POLISHING / TREATMENT REQUIREMENTS

The volume of water requiring polishing prior to discharge will vary depending on the adopted supply option.

As a worse case (Option 1), assuming all runoff from disturbed mining areas requires polishing / treatment prior to discharge, a system capacity of ~ 2.9 Mm^3/yr (~100 L/s) would be required.

Under average climatic conditions, monthly peak flow rates from the mining areas of up to ~ 1.4 Mm^3/month (50 L/s) may require polishing to meet discharge criteria.

To allow for extreme design wet conditions (100 yr ARI), available water polishing capacity for up to 5.9 Mm^3/yr may be required (210 L/sec).

Approximately 30% of this discharge would need to be pumped from the north-western mining areas after Year 7 (~4.5 km) and ~ 70% from the Grandao Pit Area (~0.5 km).

The use of surface runoff from within the project area (Option 2 and 3) will slightly reduce the requirement for the annual discharge / treatment of contact water (compared to Option 1). Peak treatment rates are similar, up to 1.4 Mm^3/month (50 L/s) depending on the climatic conditions.

The pumping requirements of 280 L/sec from the north-north western mining areas after Year 7 (~4.5 km) and 630 L/sec from the Grandao Pit Area (~0.5 km) remain unchanged.

7. ASSESSMENT

An assessment of the options was undertaken using a weighted comparison approach. The detailed results are included in Table 7.1.

Table 7.1: Weighted Option Assessment

	Key Criteria for Comparison	Weighting Factors		Option 1		Option 2		Option 3	
		%	Factor	Score	Total	Score	Total	Score	Total
A	Expenditure	100%							
1	Initial Capital Cost	50%	100	1	100	4	400	5	500
2	Ongoing Capital Cost	20%	40	1	40	5	200	4	160
3	Operating Cost	30%	60	1	60	5	300	4	240
4	0	0%	0	0	0	0	0	0	0
	Total	**20%**	200		200		900		900
					3		**1**		**1**
B	Environmental	100%							
5	Flora and Fauna	10%	14	5	70	1	14	3	42
6	Surface water impacts	25%	35	5	175	3	105	3	105
7	Water Conservation	25%	35	5	175	3	105	1	35
8	Greenhouse Emissions	5%	7	3	21	4	28	2	14
9	Disturbance	10%	14	5	70	1	14	3	42
10	Hazard Rating	10%	14	4	56	2	28	3	42
11	Ease of Approval	15%	21	5	105	2	42	1	21
	Total	**14%**	140		672		336		301
					1		**2**		**3**
C	Social	100%							
12	Visual	20%	28	5	140	1	28	2	56
13	Noise	25%	35	1	35	1	35	1	35
14	Impact on downstream water users	20%	28	5	140	2	56	3	84
15	Ease of Approval	15%	21	5	105	2	42	1	21
16	Heritage	10%	50	1	50	1	50	1	50
17	Adjacent Landowners	5%	25	5	125	2	50	1	25
18	Employment	5%	25	1	25	3	75	5	125
	Total	**50%**	212		620		336		396
					1		**3**		**2**
D	Operational	100%							
19	Provides reliable project water supply	40%	60	1	60	4	240	5	300
20	Ease of Construction	20%	30	5	150	1	30	3	90
21	Ease of Operation	20%	30	5	150	2	60	3	90
22	Ease of Upgrade	5%	8	2	15	4	30	5	38
23	Maintenance requirements	15%	23	1	23	4	90	3	68
24	0	0%	0	0	0	0	0	0	0
25	0	0%	0	0	0	0	0	0	0
26	0	0%	0	0	0	0	0	0	0
27	0	0%	0	0	0	0	0	0	0
28	0	0%	0	0	0	0	0	0	0
	Total	**15%**	150		398		450		585
					3		**2**		**1**
E	Closure	100%							
29	Ease of Closure	40%	4	5	20	1	4	3	12
30	Ease of Rehabilitation	60%	6	5	30	1	6	3	18
31	0	0%	0	0	0	0	0	0	0
32	0	0%	0	0	0	0	0	0	0
	Total	**1%**	10		50		10		30
					1		**3**		**2**
	TOTAL	100%	1000		**1940**		**2032**		**2212**
	RANK				**3**		**2**		**1**

8. CONCLUSIONS

The following conclusions are made:

- For all options considered, ~ 60,000 m^3 will be required during commissioning to establish steady state conditions in the process plant.
  - Current estimates indicate that once steady stage conditions are achieved in the process plant, a peak raw water and make-up water supply of ~ 16 L/sec will be required for the project. This is equal to approximately 450,000 m^3/year (38,000 m^3/month).
  - Based on assessments completed to date groundwater flows in the project vicinity are very low with pumping tests indicating that sustainable yields are < 1 L/sec in the production bores tested.
  - Groundwater within the project area is in limited supply and will not provide a reliable project water supply option (from within the project area).
  - A water supply based on groundwater would only be possible with an offsite borefield / remote site and an overland supply pipeline. A borefield location has not been identified. The capital and operating costs associated with this approach are expected to be significant. At this stage, this option is considered fatally flawed.
  - Surface water harvesting from Rio Covas would be expected to provide a suitable back up water supply for the project over 1 to 2 months during extreme dry months.
  - Due to the distinct rainfall pattern (dry summer, wet winter), surface water runoff harvesting from within the mining areas will provide sufficient water during the wetter months but shortfalls under dryer than average climatic conditions are may occur.
  - Using the planned sediment control structures as minor water storage facilities would provide sufficient water for the project during the dry months. At this stage it is expected that a storage capacity of 100,000 m^3 would be sufficient, if water from Rio Covas is available for use.
  - If abstraction from the Rio Covas is not possible, water storage on site, as part of the water / sediment control system, with a total capacity of ~ 250,000 m^3 would reduce the risk of water shortfalls during extreme dry years.
  - Use of dewatering water from the pits, supplemented by surface water runoff (both contact and non-contact water) from within the mining area along with some abstraction from Rio Covas to provide water during extreme dry months is seen as the most reliable water supply option for the project. With the provision of a larger water storage facility on site, water harvesting from Rio Covas would not be required to maintain the required project make up water supply.
  - Based on the assessments to date, a reliable water supply for the project can be achieved utilising dewatering bores supplemented with surface water harvesting, (focusing on collecting contact water generated by mining operations).

- Water supply risk can be further reduced by harvesting non contact runoff from within the mining area and potentially supplemented by abstraction from the Rio Covas.

- Water storage facilities located on site could be used to reduce water abstraction requirements from the Rio Covas.

- To ensure water supply all year, water storage facilities are required to store runoff collected in the wet winter months for use in the dry summer months. The required size will vary from ~ 100 000 m^3 (if water can be sourced from Rio Covas) to ~ 250,000 m^3 (no abstraction from the Rio Covas).

9. OPPORTUNITIES

If revisions to the mining schedule are possible, there is an opportunity to harvest and store additional water for process use within pit voids during the later stages of operation. This would reduce the make up requirements (Option 1) or the onsite water storage requirements (Option 2 and Option 3 currently using the sediment control structures only).

10. RECOMMENDATIONS

The following recommendations are made:

- A water supply option utilising pit dewatering bores supplemented with surface water harvesting of contact water (Option 2) plus provision to abstract from the Rio Covas (Option 3) during extended dry periods would be recommended as the most reliable process water supply option.

- If abstraction from the Rio Covas is considered challenging from a permitting perspective, it is recommended Option 2 be adopted.

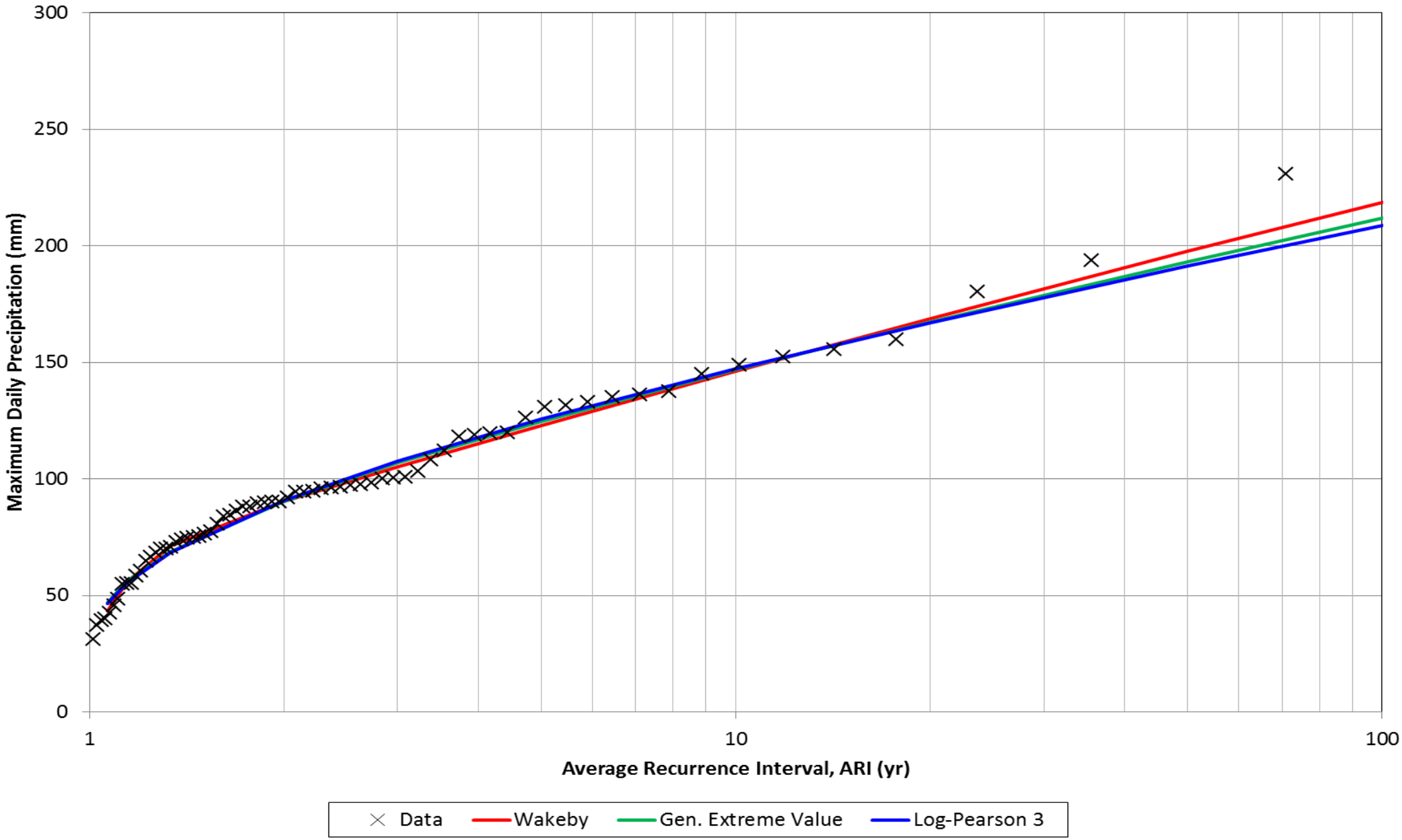
We trust this provides sufficient information at this stage, however, should you require additional information, please contact us.

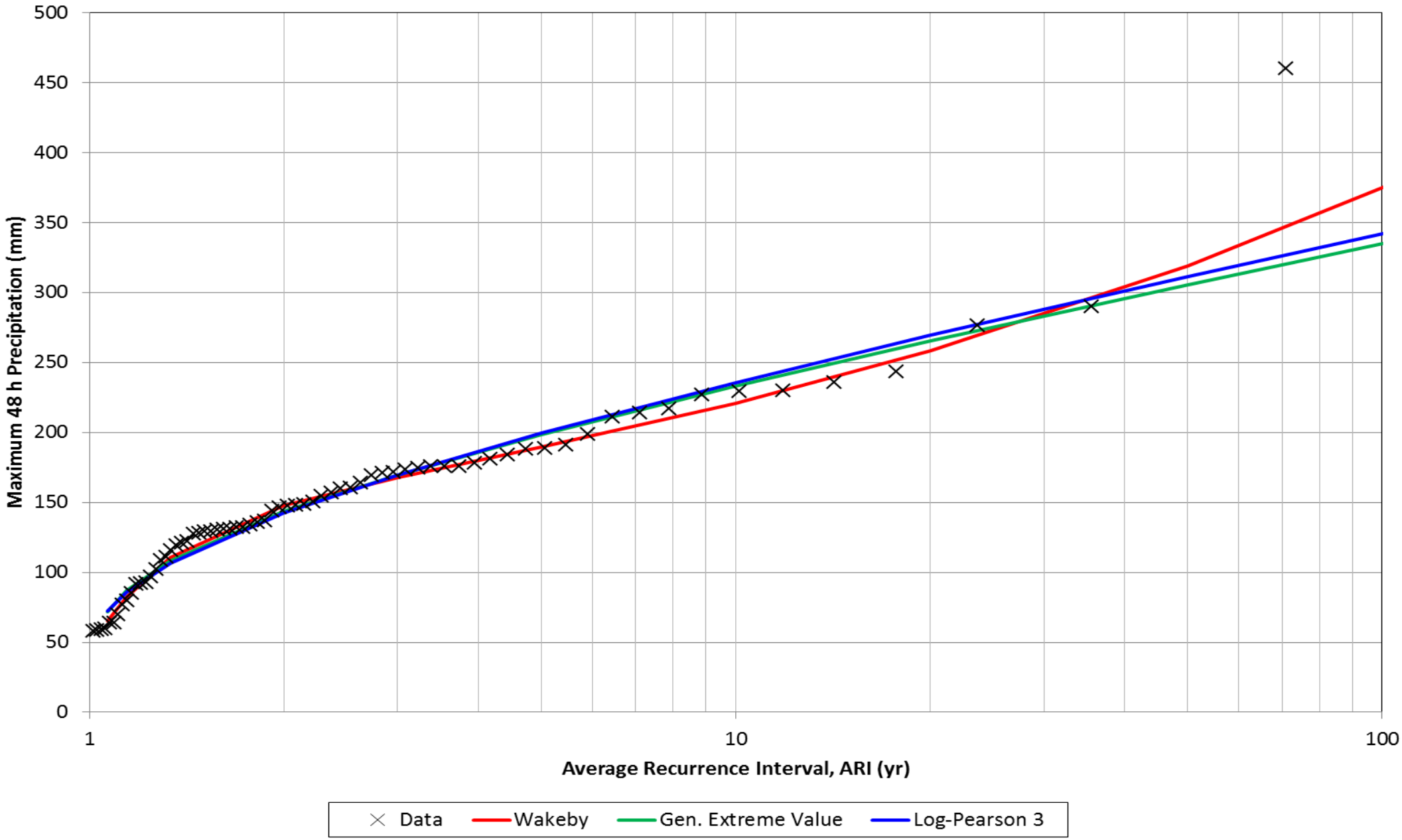
Yours faithfully
KNIGHT PIÉSOLD PTY LTD

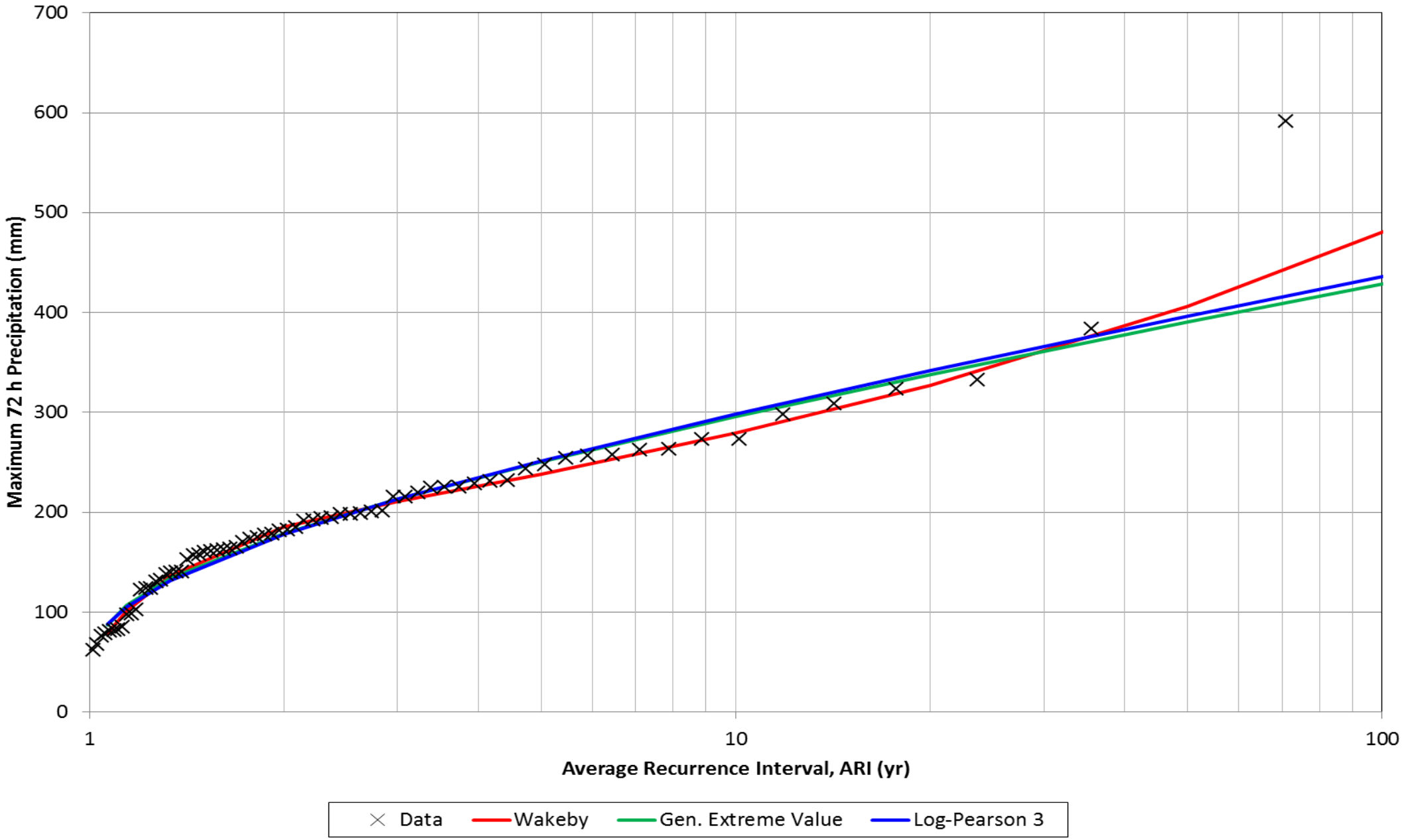
ANDREAS MITTERAGGER
Senior Engineer

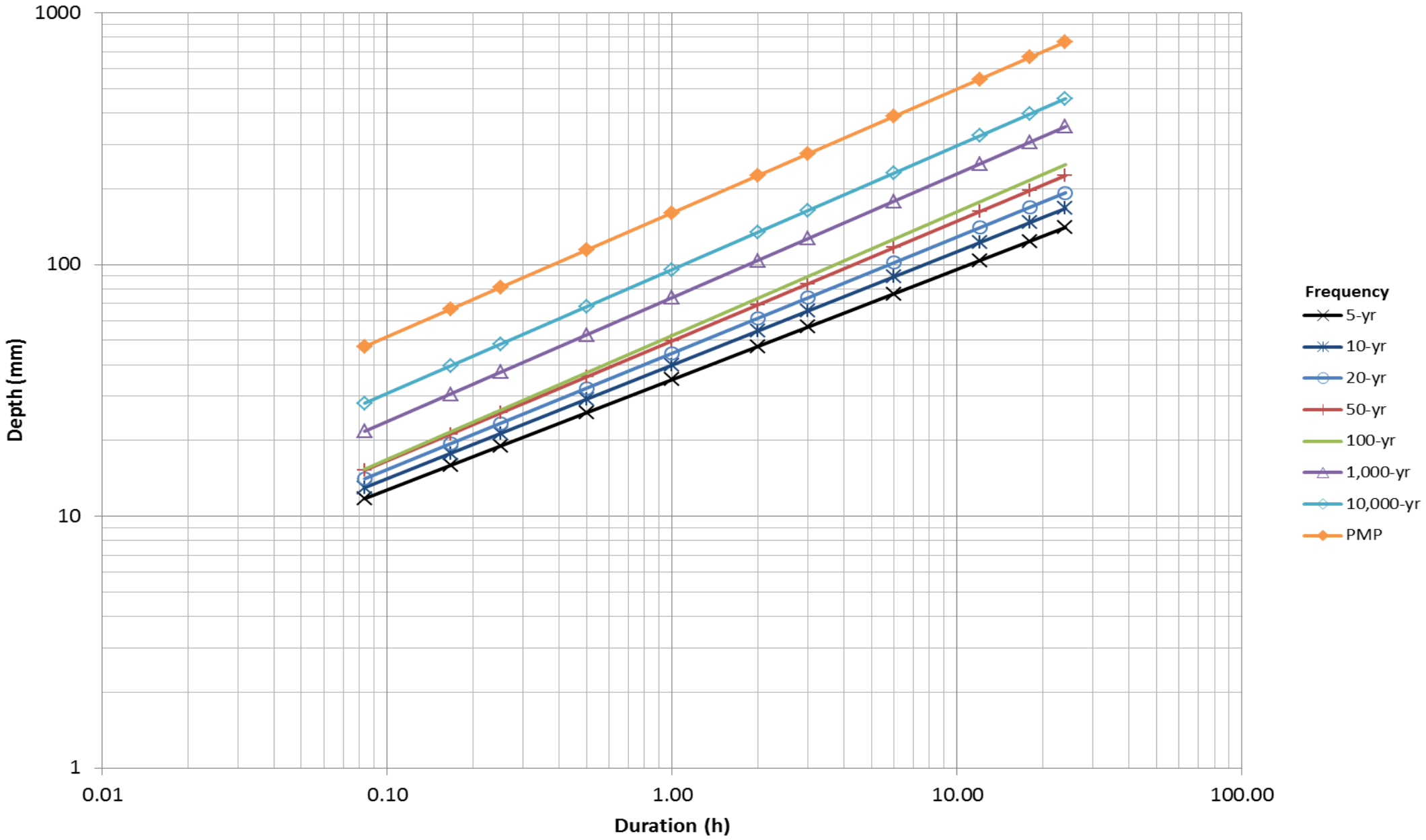
BRETT STEVENSON
Principal Engineer

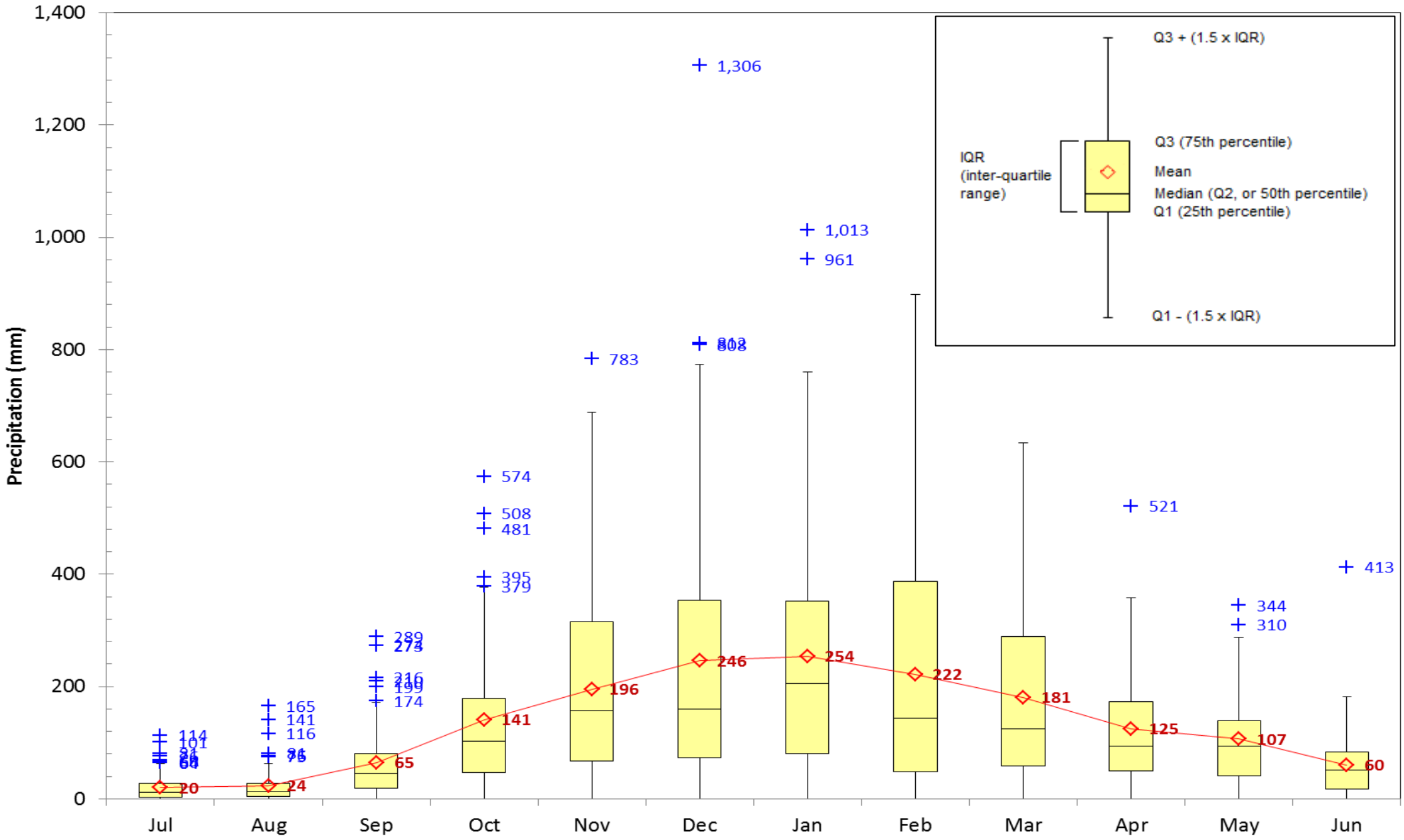
FIGURES

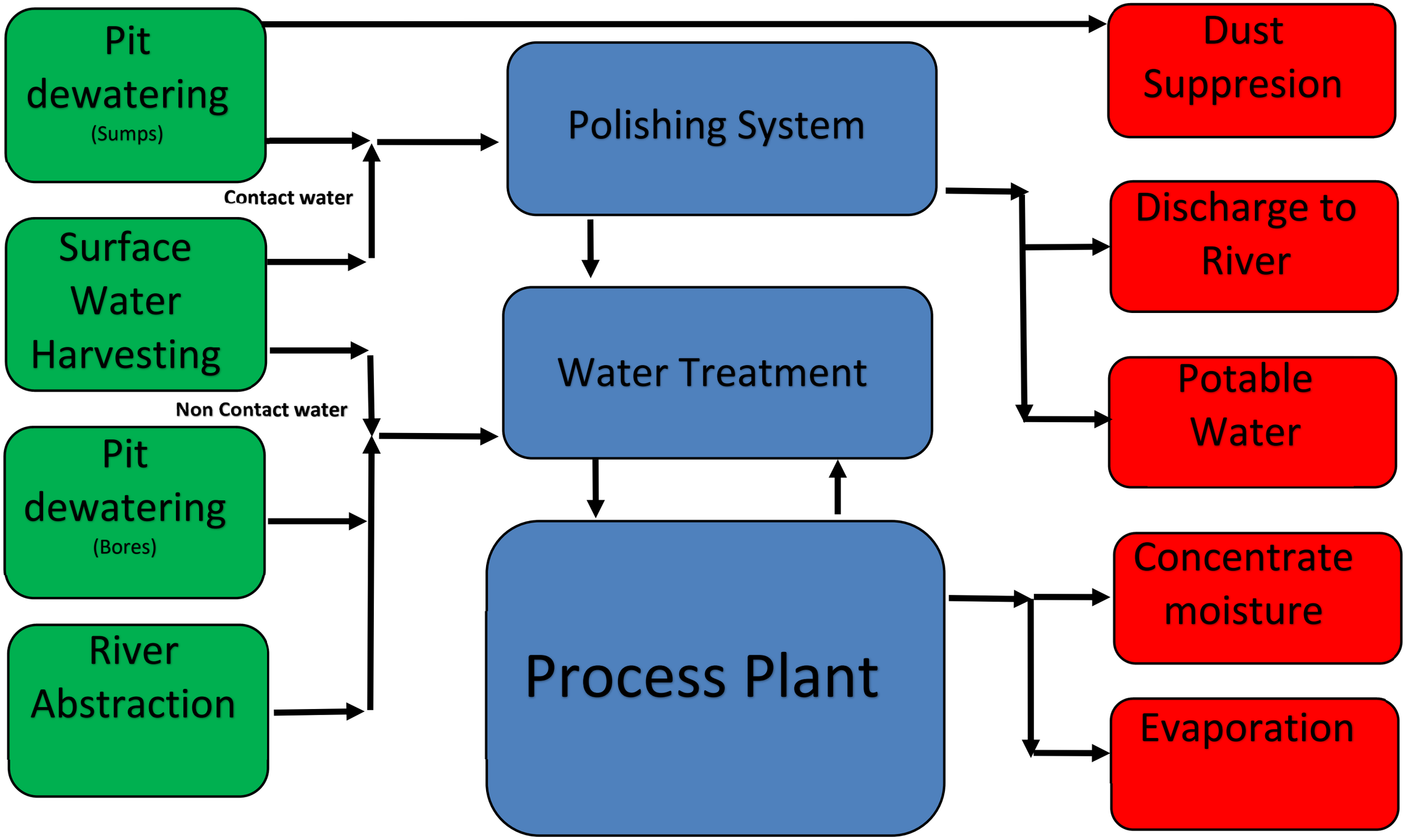

300
250
200
150
100
50
0
Maximum Daily Precipitation (mm)
1
10
100
Average Recurrence Interval, ARI (yr)
Data
Wakeby
Gen. Extreme Value
Log-Pearson 3

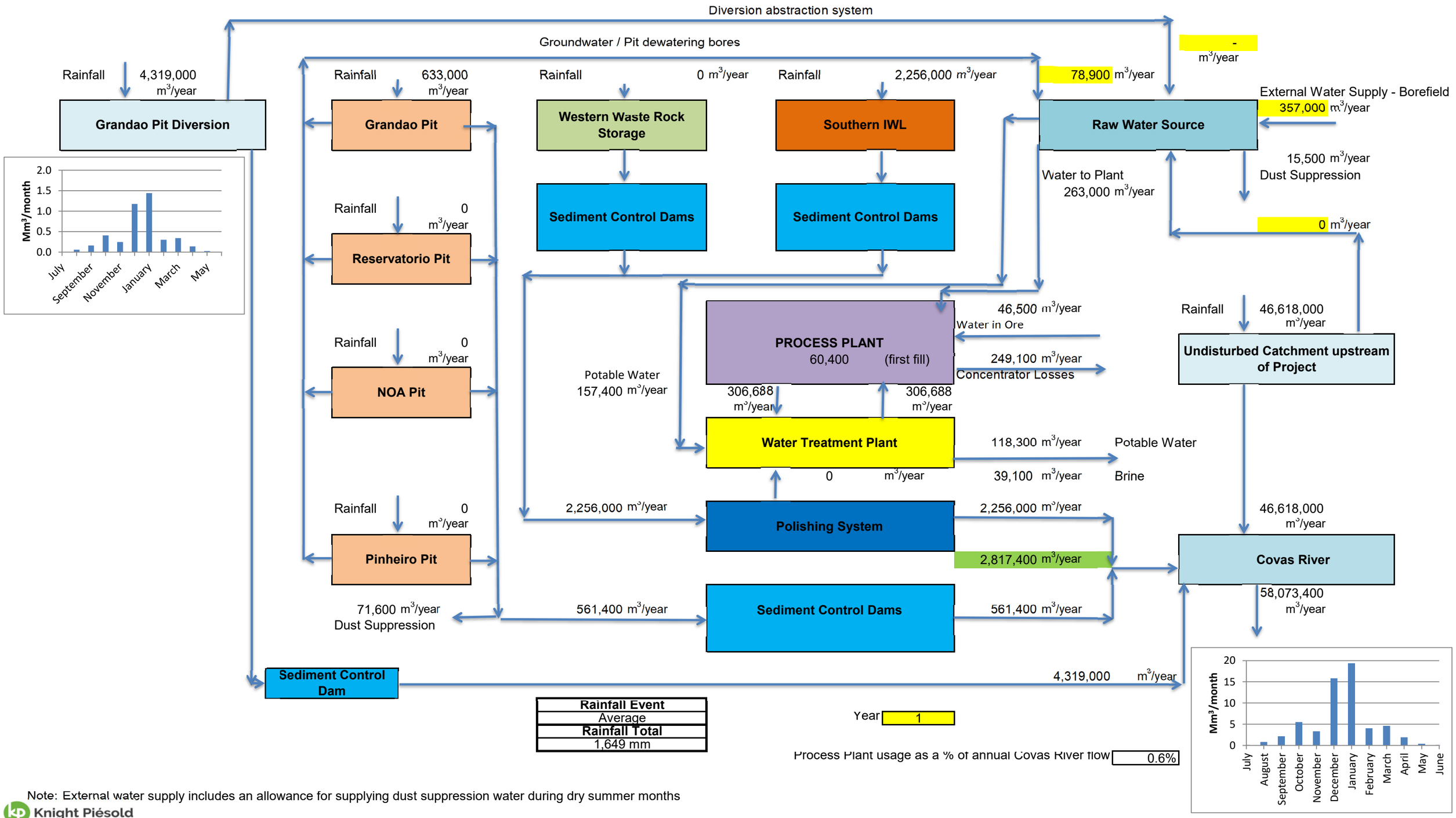

500
450
400
350
300
250
200
150
100
50
0
Maximum 48 h Precipitation (mm)
1
10
100
Average Recurrence Interval, ARI (yr)
Data
Wakeby
Gen. Extreme Value
Log-Pearson 3


700
600
500
400
300
200
100
0
Maximum 72 h Precipitation (mm)
1
10
100
Average Recurrence Interval, ARI (yr)
Data
Wakeby
Gen. Extreme Value
Log-Pearson 3


1000
100
10
1
Depth (mm)
0.01
0.10
1.00
10.00
100.00
Duration (h)
Frequency
5-yr
10-yr
20-yr
50-yr
100-yr
1,000-yr
10,000-yr
PMP


Precipitation (mm)
1,400
1,200
1,000
800
600
400
200
0
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Q3 + (1.5 x IQR)
Q3 (75th percentile)
Mean
Median (Q2, or 50th percentile)
Q1 (25th percentile)
Q1 - (1.5 x IQR)
IQR
(inter-quartile
range)
20
24
65
141
196
246
254
222
181
125
107
60
1,306
1,013
961
783
574
508
481
395
379
521
413
344
310
289
274
216
199
174
165
141
116
114
101


Pit dewatering
(Sumps)
Contact water
Surface Water Harvesting
Non Contact water
Pit dewatering
(Bores)
River Abstraction
Polishing System
Water Treatment
Process Plant
Dust Suppresion
Discharge to River
Potable Water
Concentrate moisture
Evaporation



Note: External water supply includes an allowance for supplying dust suppression water during dry summer months

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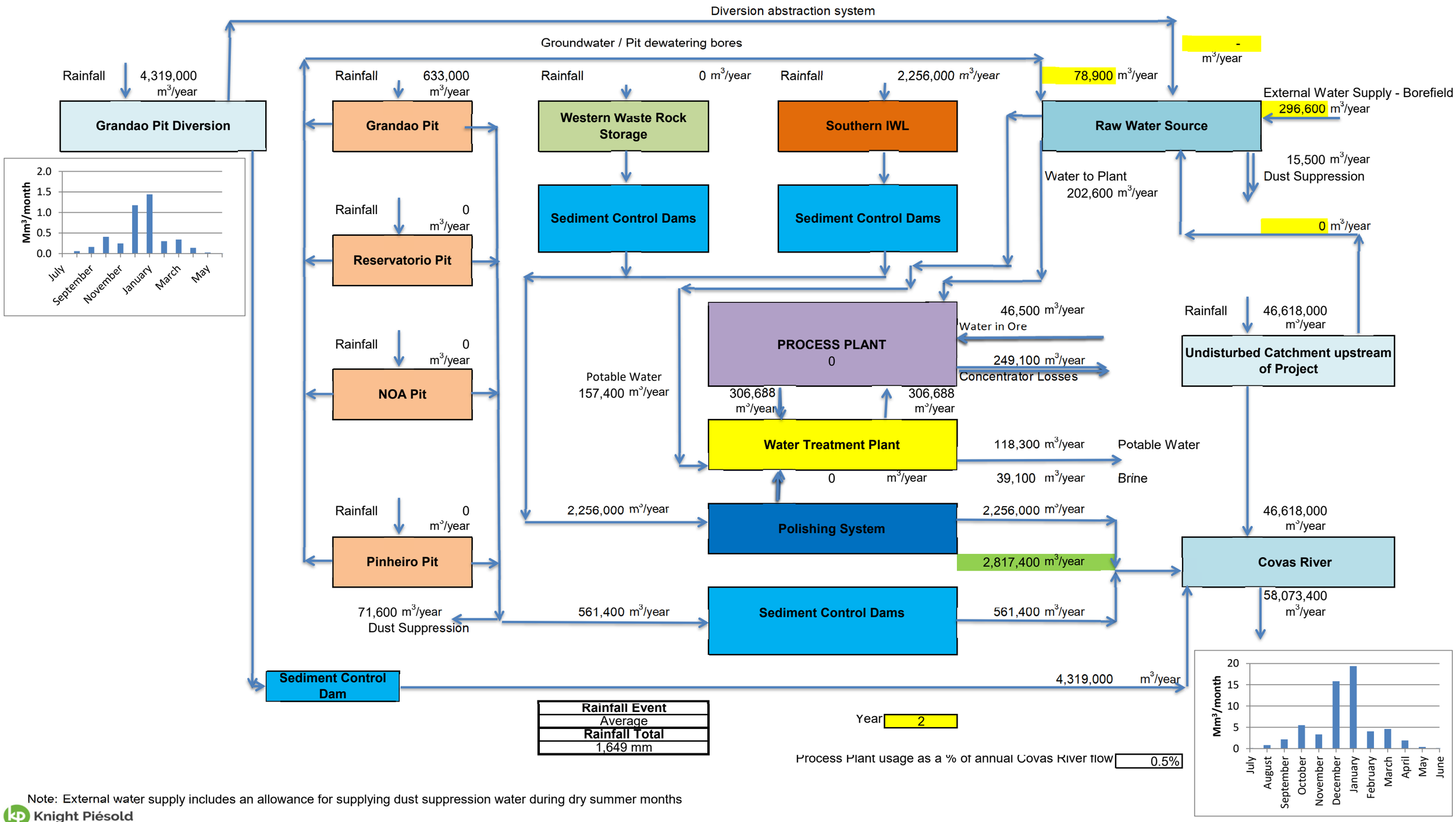
MINA DO BARROSO LITHIUM PROJECT
GLOBAL WATER BALANCE
SIMPLIFIED ANNUAL BLOCK MODEL - OPTION 1 EXTERNAL WATER SUPPLY - BOREFIELD - YEAR 1

PE501-00080 M19005
Figure 4.2

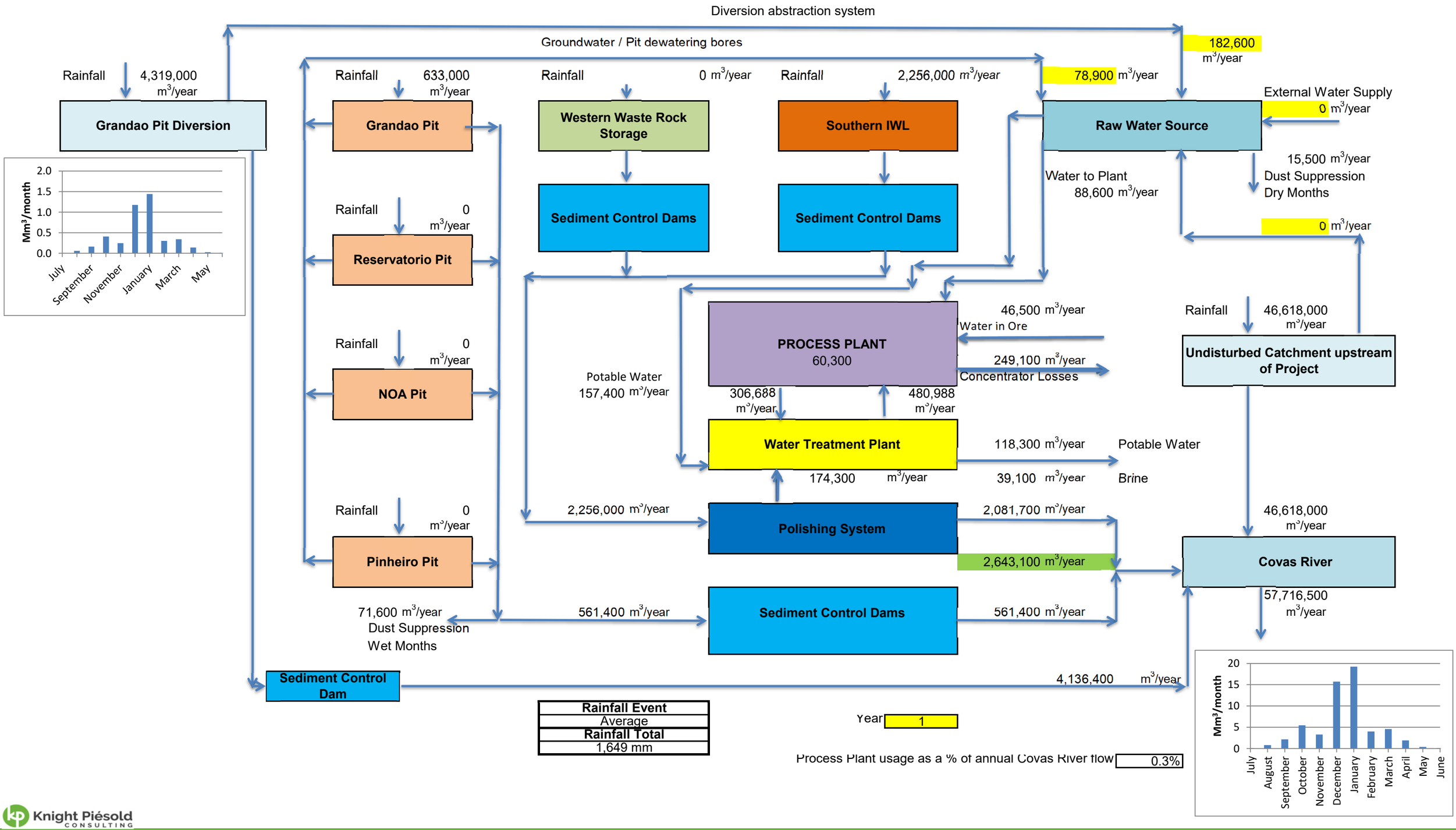


Note: External water supply includes an allowance for supplying dust suppression water during dry summer months

Knight Piésold CONSULTING

MINA DO BARROSO LITHIUM PROJECT
GLOBAL WATER BALANCE
SIMPLIFIED ANNUAL BLOCK MODEL - OPTION 1 EXTERNAL WATER SUPPLY - BOREFIELD - YEAR 2 TO 7

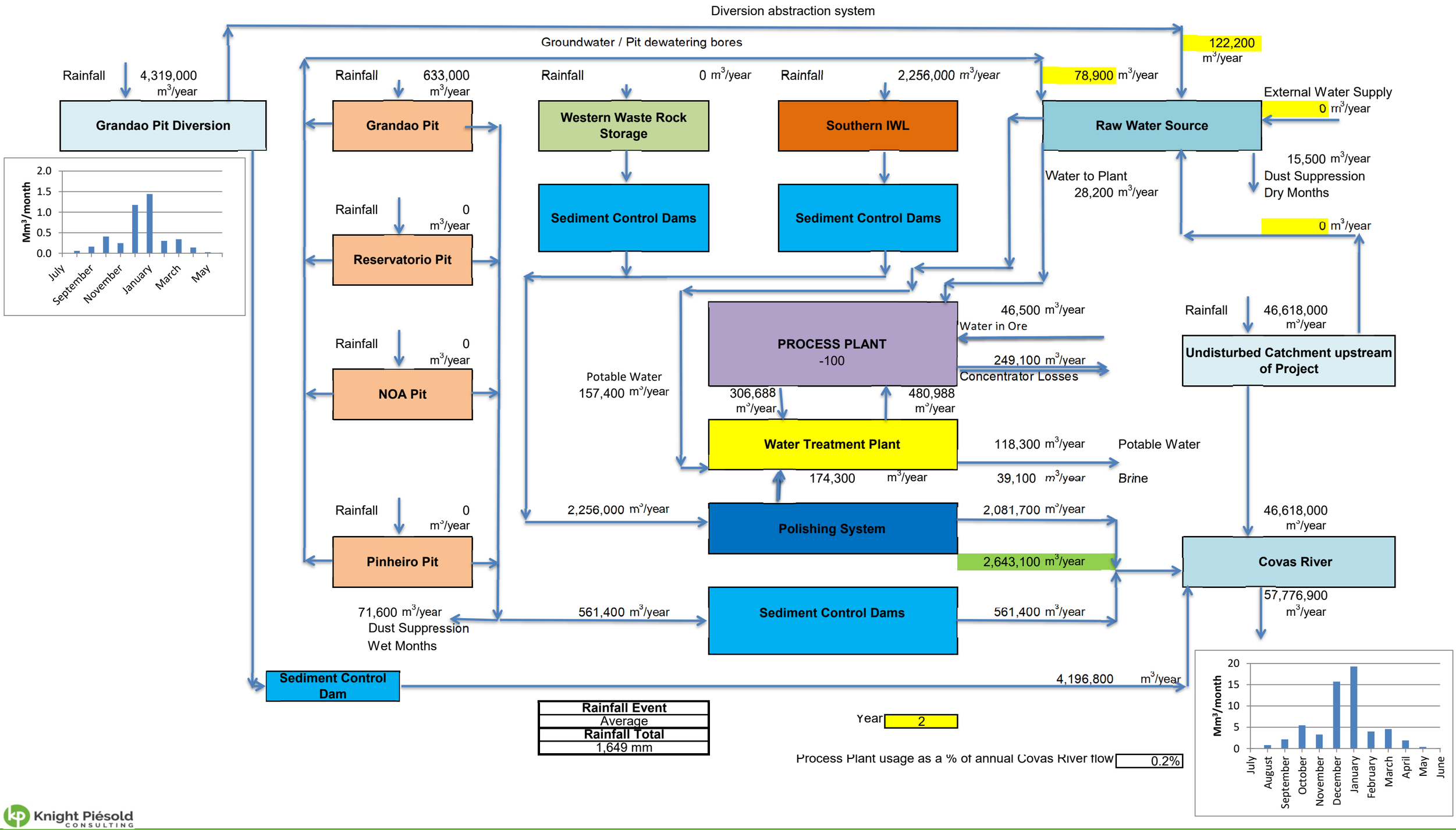
PE501-00080 M19005
Figure 4.3



Knight Piésold CONSULTING

MINA DO BARROSO LITHIUM PROJECT
GLOBAL WATER BALANCE
SIMPLIFIED ANNUAL BLOCK MODEL - OPTION 2 WATER SUPPLY & SURFACE WATER MANAGEMENT - YEAR 1

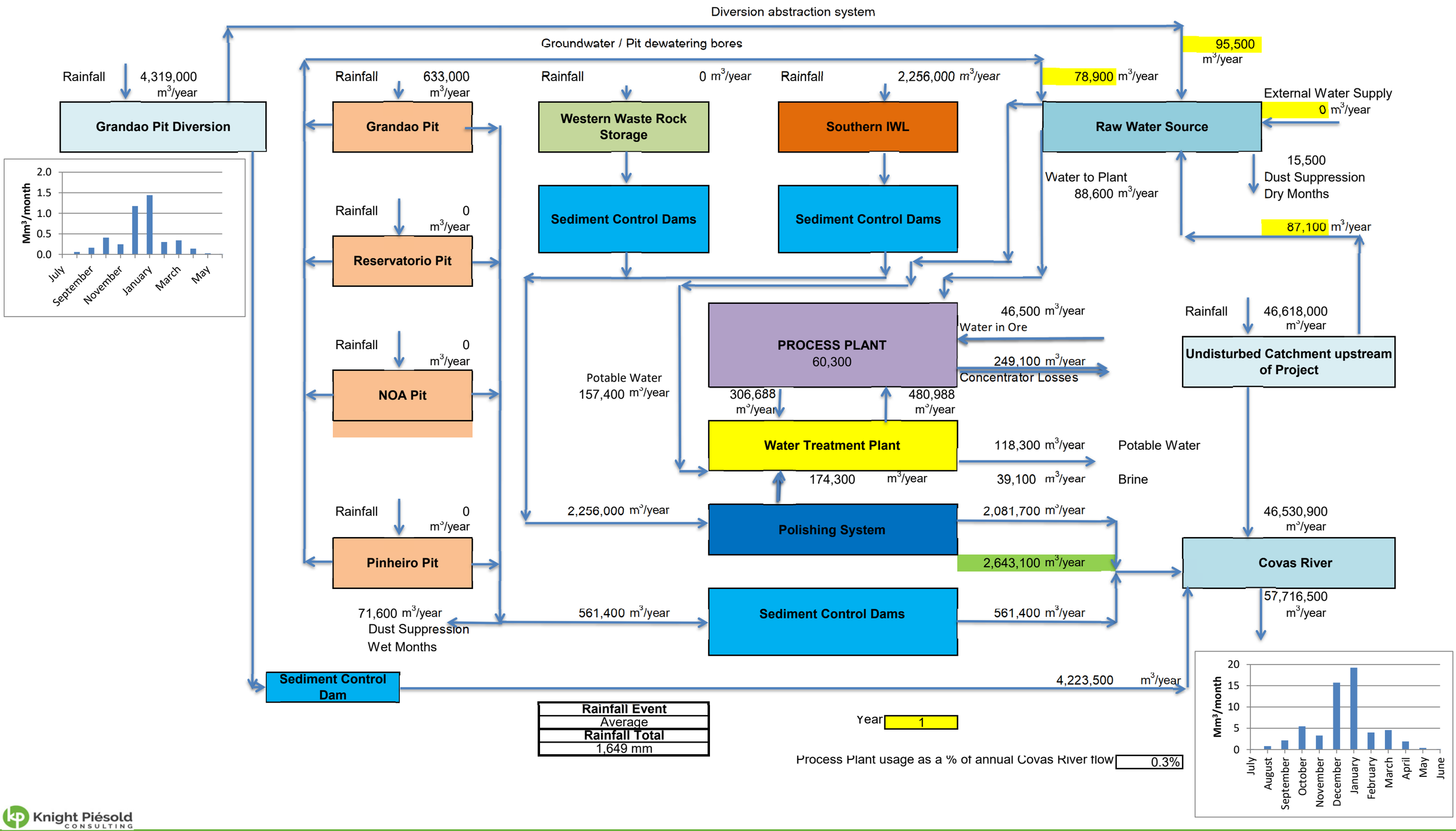
PE501-00080 M19005
Figure 4.4



Knight Piésold CONSULTING

MINA DO BARROSO LITHIUM PROJECT
GLOBAL WATER BALANCE
SIMPLIFIED ANNUAL BLOCK MODEL - OPTION 2 WATER SUPPLY & SURFACE WATER MANAGEMENT - YEAR 2 - 7

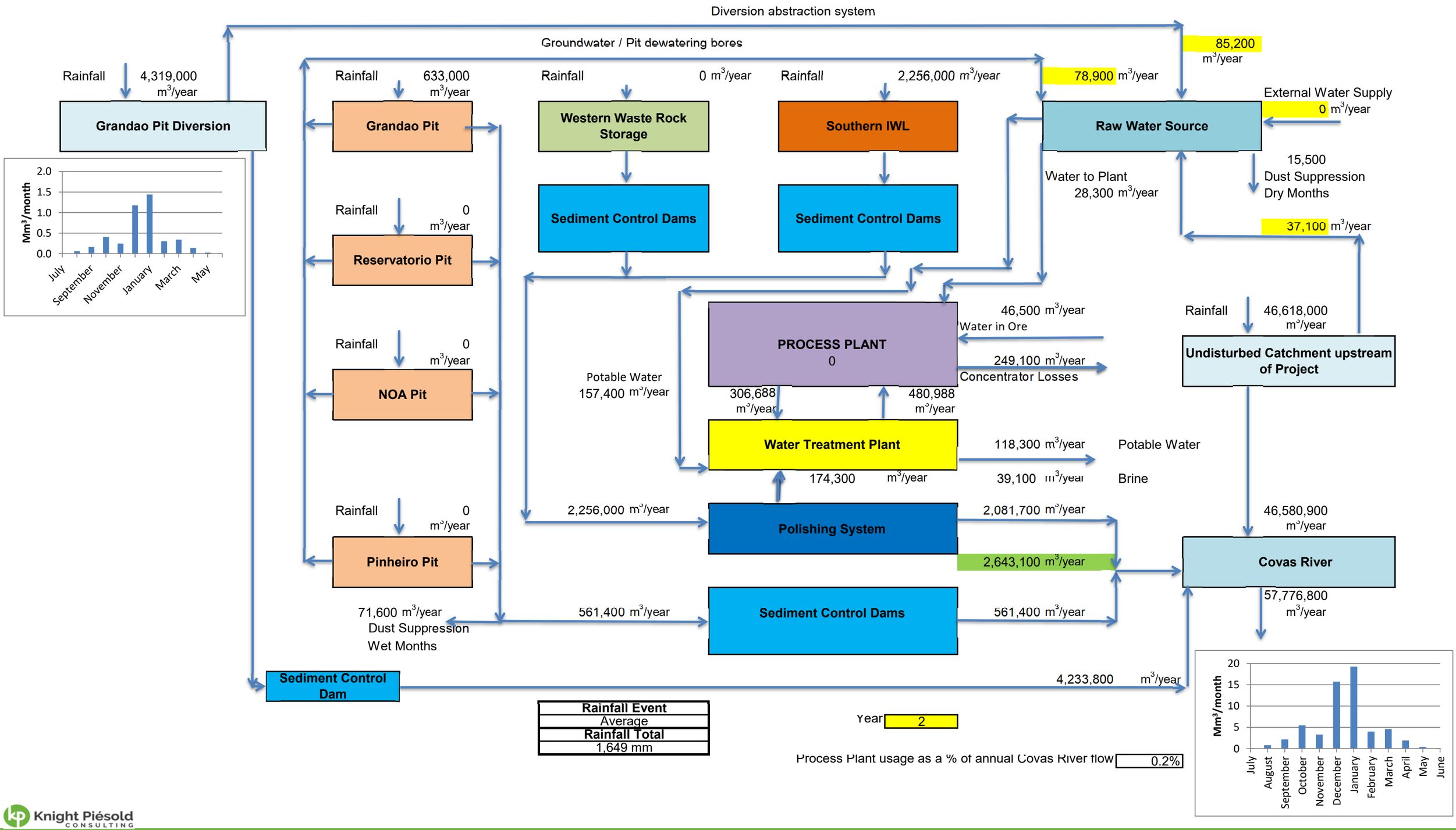
PE501-00080 M19005
Figure 4.5



Knight Piésold CONSULTING

MINA DO BARROSO LITHIUM PROJECT
GLOBAL WATER BALANCE
SIMPLIFIED ANNUAL BLOCK MODEL - OPTION 3 RIO COVAS WATER SUPPLY - YEAR 1

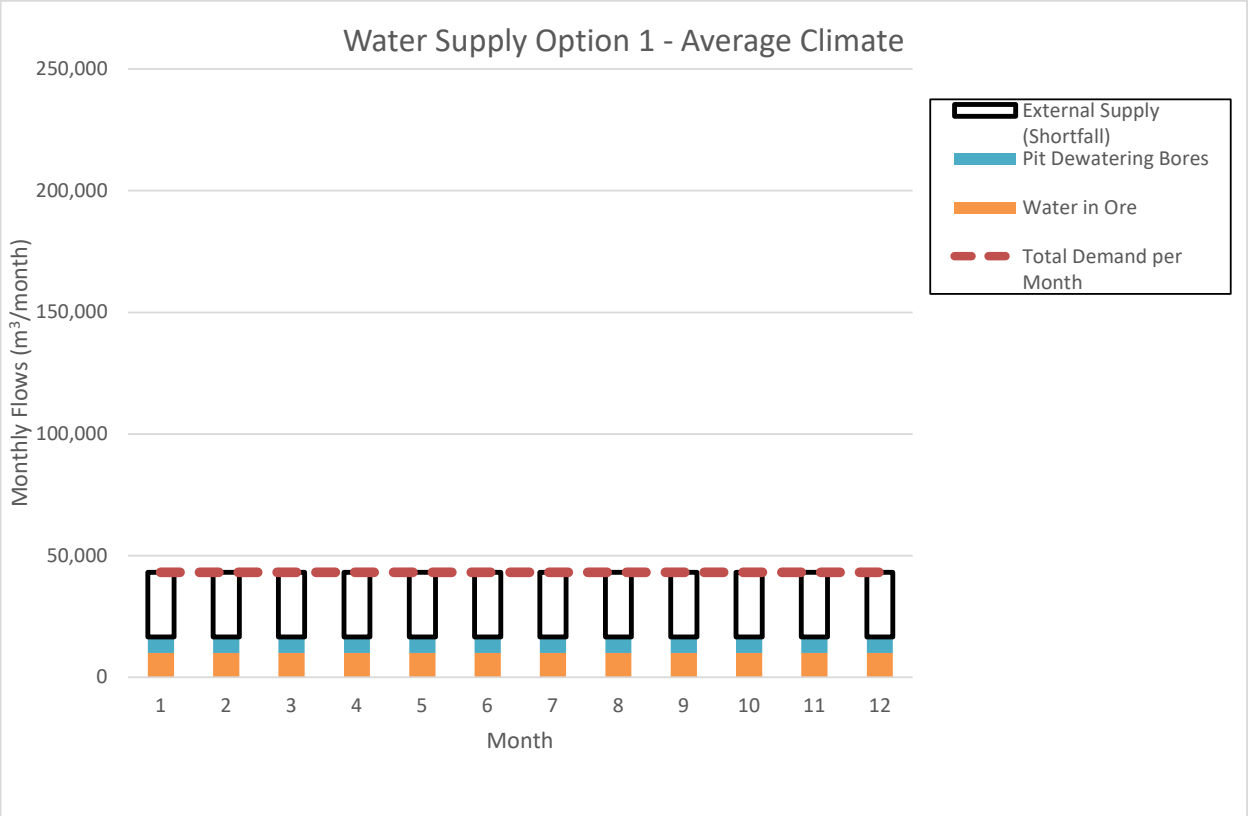
PE501-00080 M19005
Figure 4.6

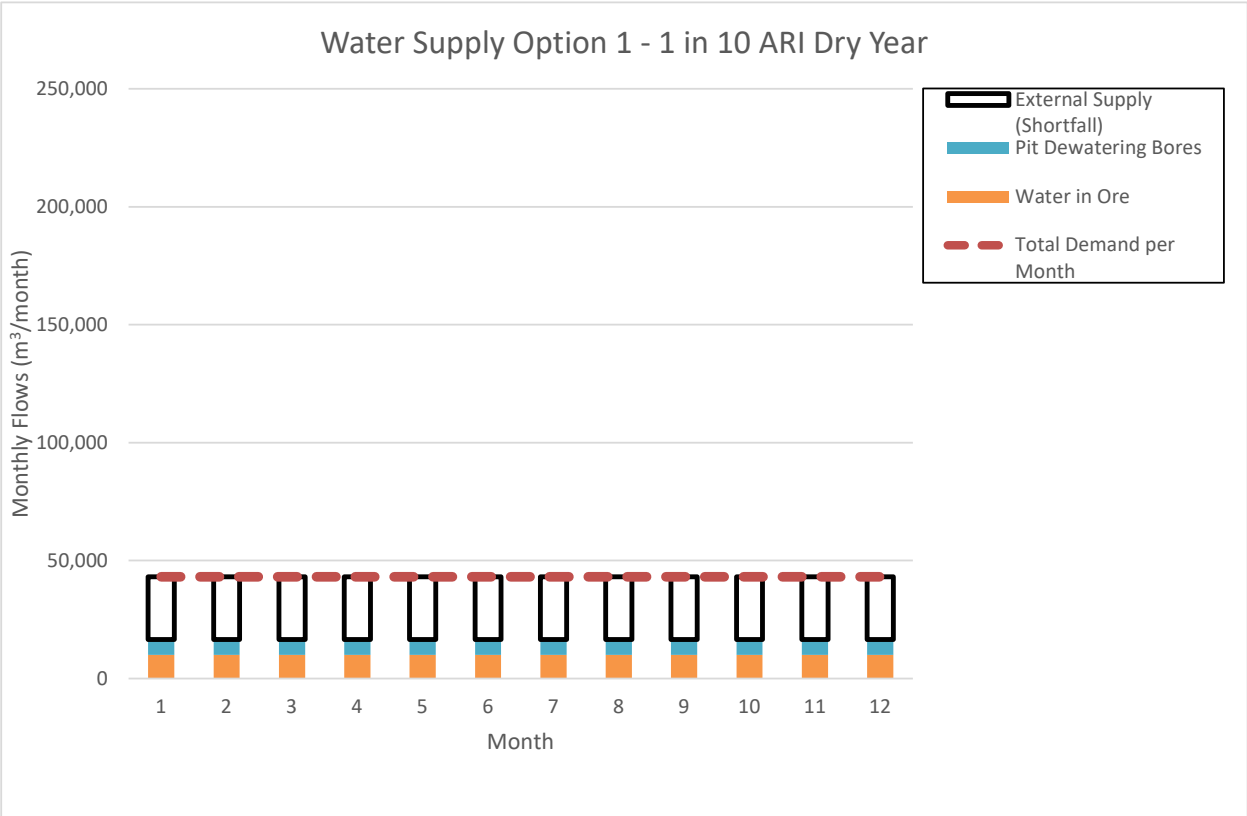


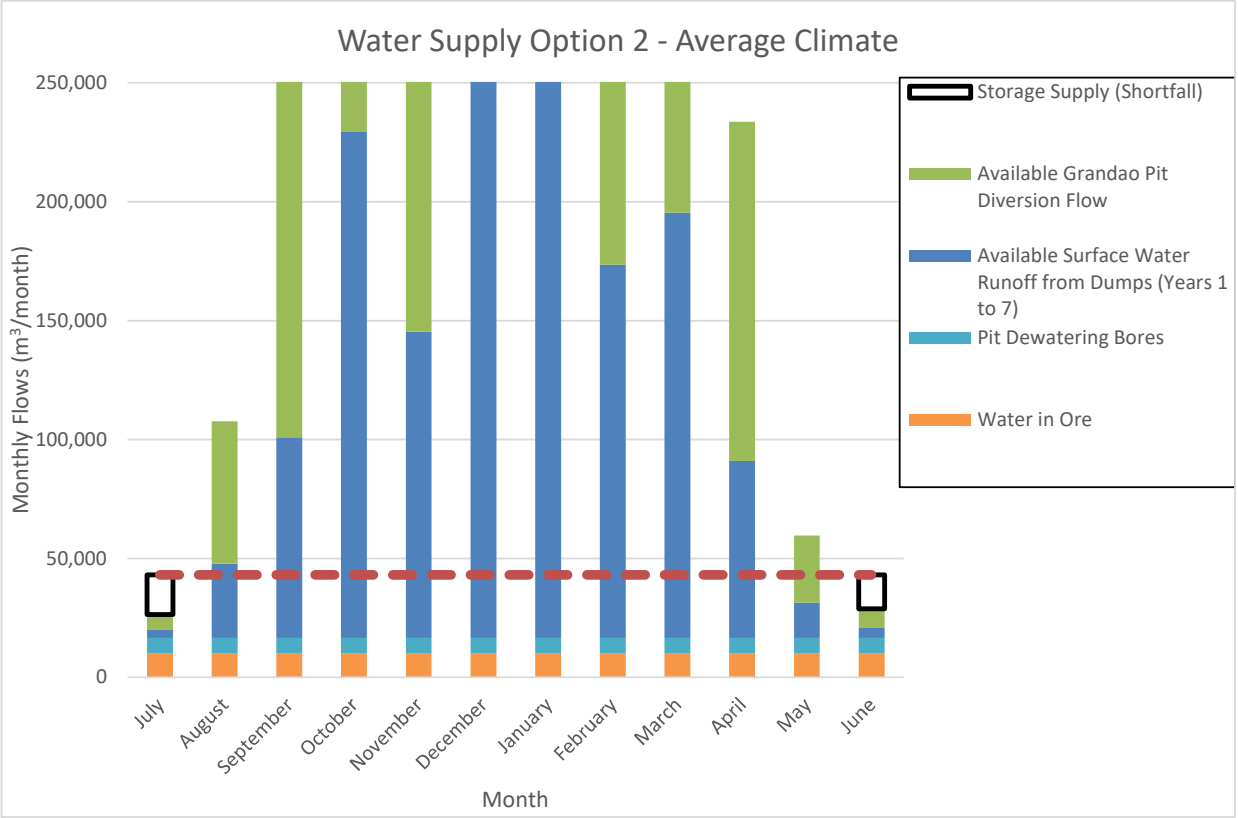
Knight Piésold CONSULTING

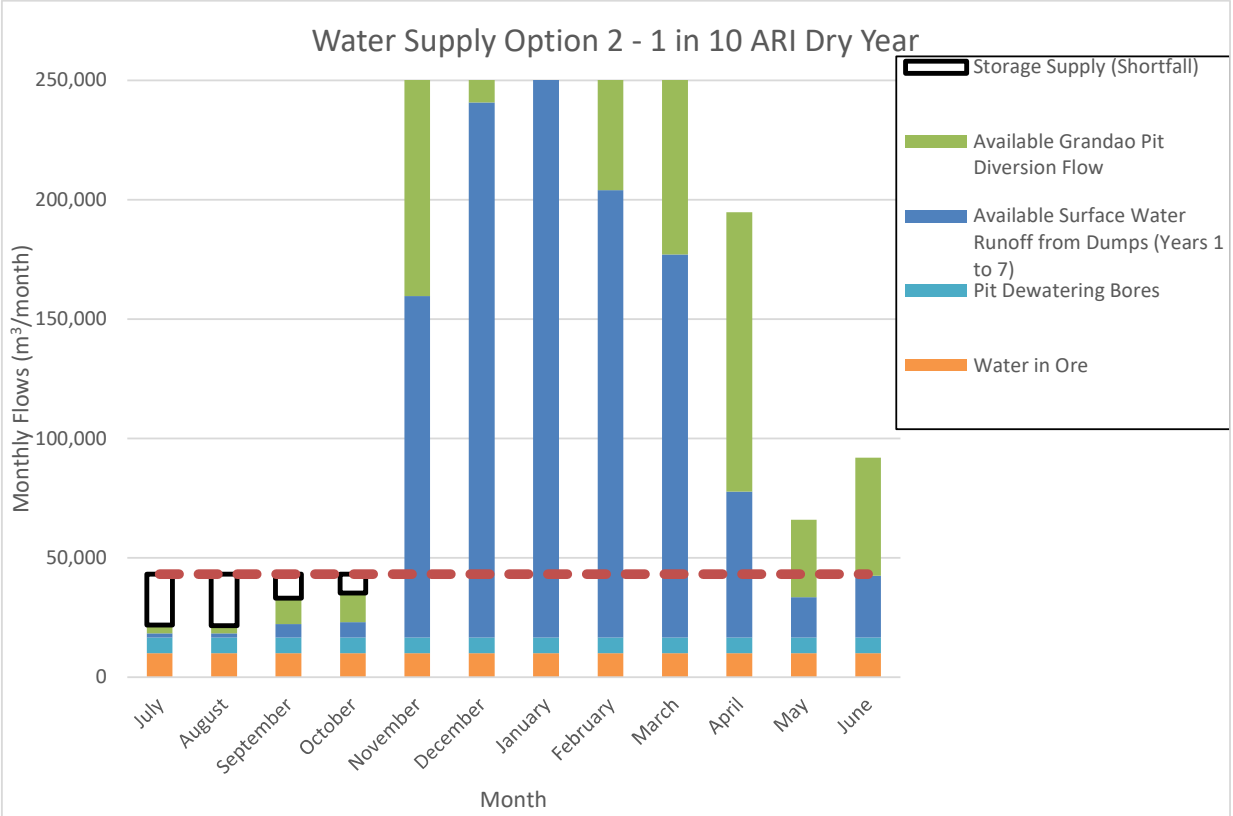
MINA DO BARROSO LITHIUM PROJECT
GLOBAL WATER BALANCE
SIMPLIFIED ANNUAL BLOCK MODEL - OPTION 3 RIO COVAS WATER SUPPLY - YEAR 2 -7

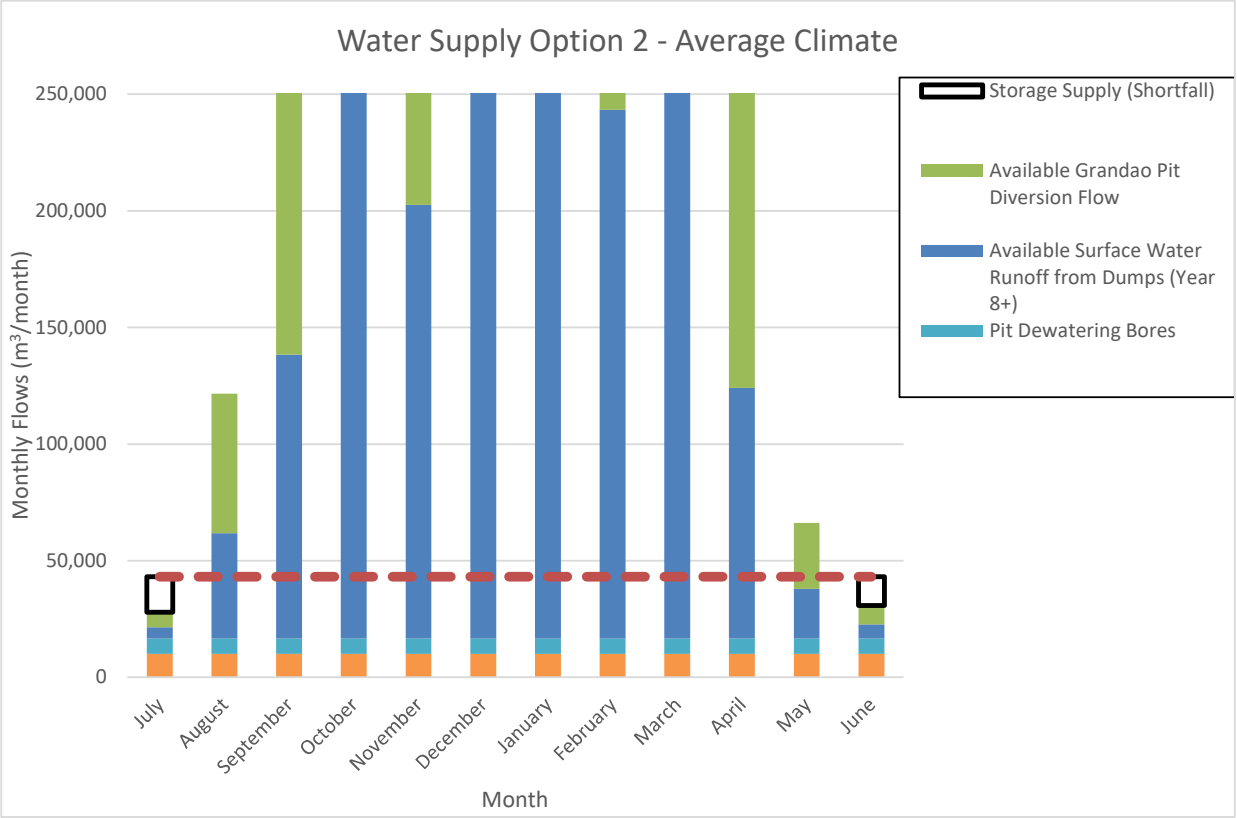
PE501-00080 M19005
Figure 4.7

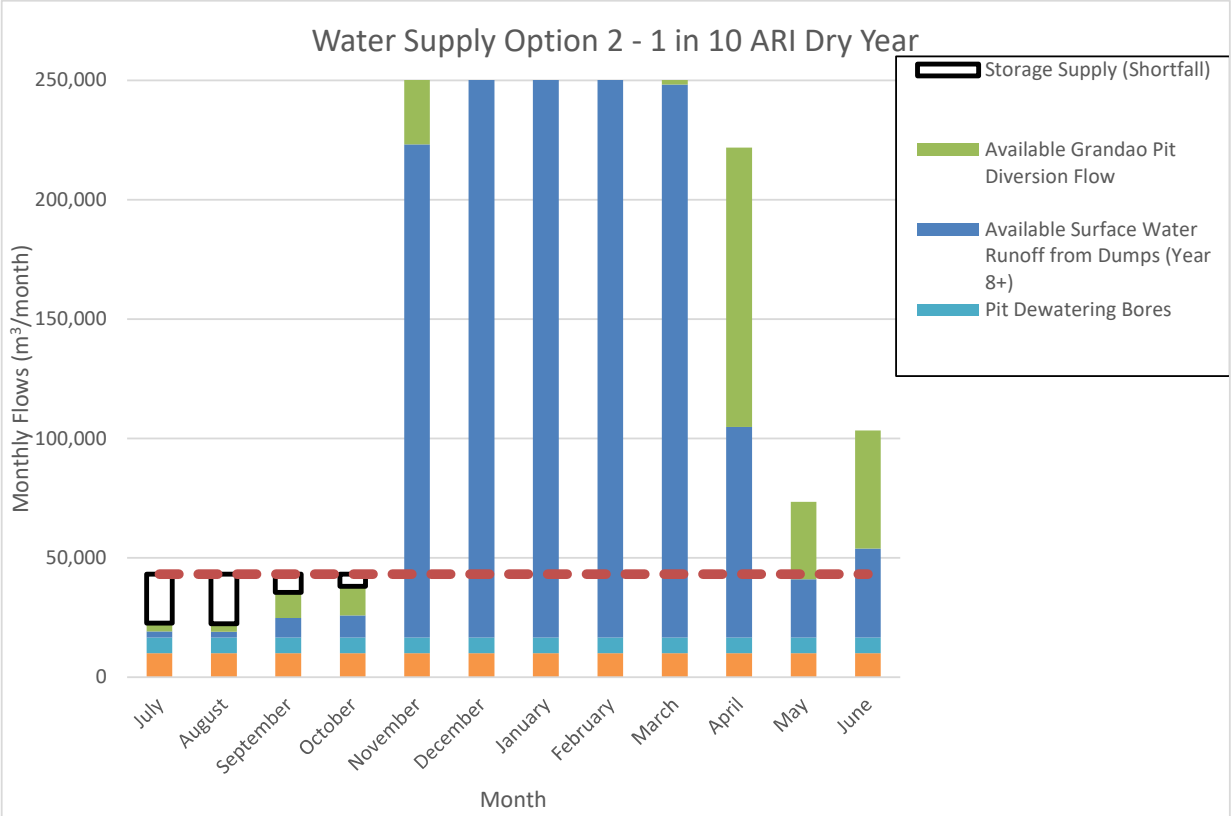

Water Supply Option 1 - Average Climate
250,000
200,000
150,000
100,000
50,000
0
Monthly Flows (m³/month)
1
2
3
4
5
6
7
8
9
10
11
12
Month
External Supply (Shortfall)
Pit Dewatering Bores
Water in Ore
Total Demand per Month

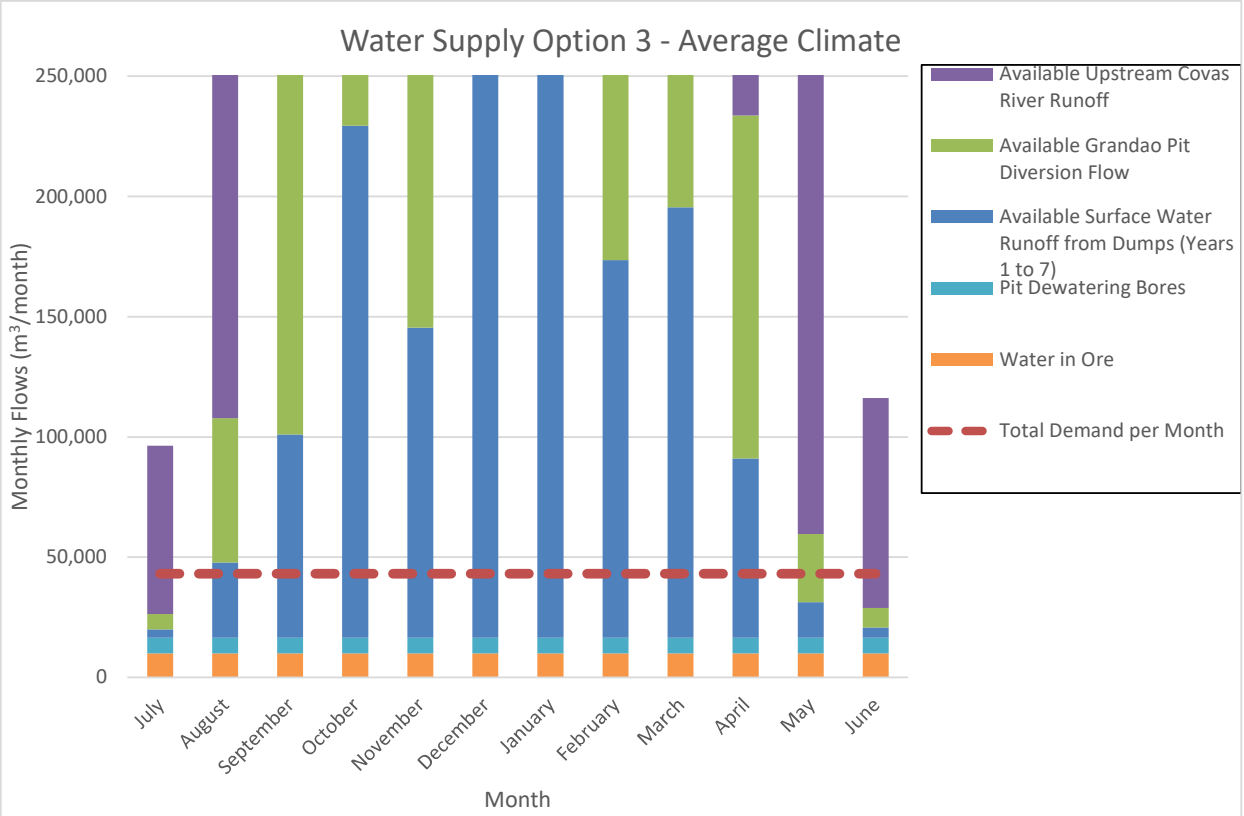

Water Supply Option 1 - 1 in 10 ARI Dry Year
250,000
200,000
150,000
100,000
50,000
0
Monthly Flows (m³/month)
1
2
3
4
5
6
7
8
9
10
11
12
Month
External Supply (Shortfall)
Pit Dewatering Bores
Water in Ore
Total Demand per Month

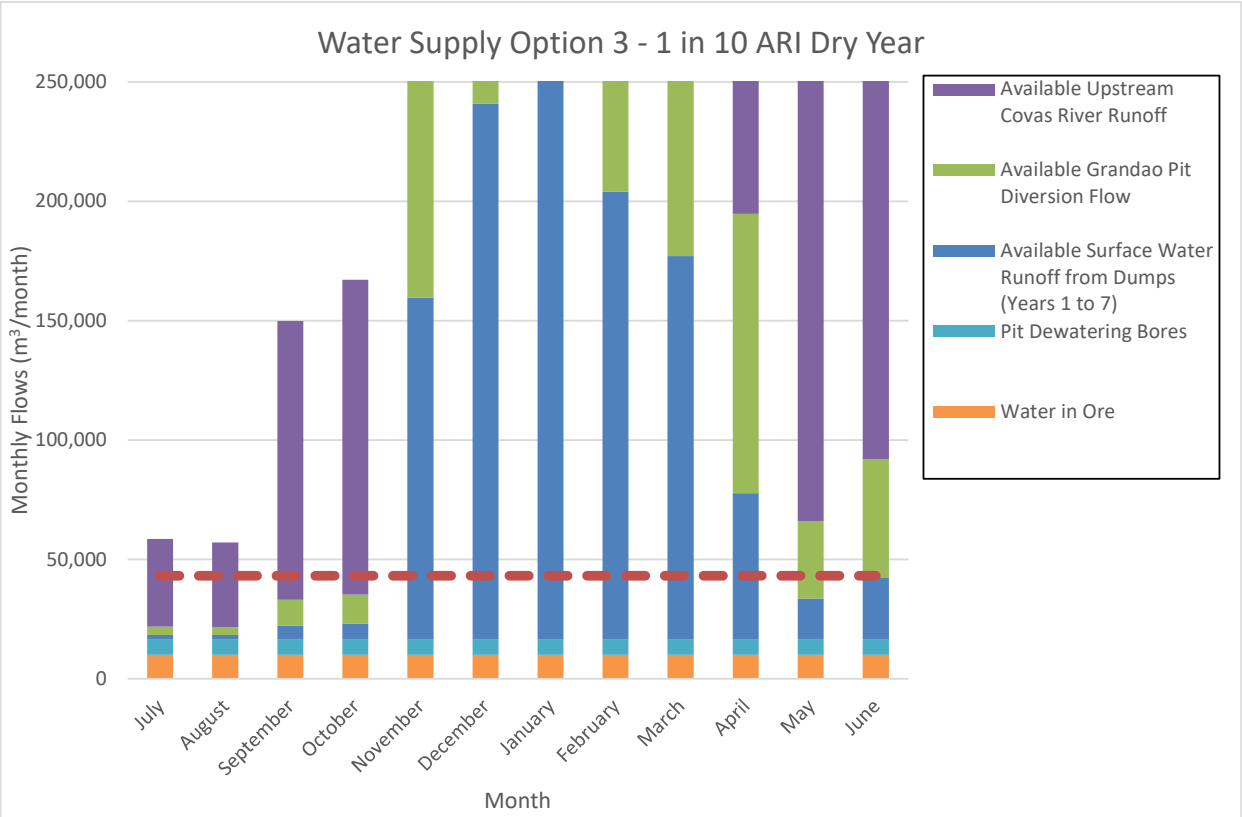

Water Supply Option 2 - Average Climate
250,000
200,000
150,000
100,000
50,000
0
Monthly Flows (m³/month)
July
August
September
October
November
December
January
February
March
April
May
June
Month
Storage Supply (Shortfall)
Available Grandao Pit Diversion Flow
Available Surface Water Runoff from Dumps (Years 1 to 7)
Pit Dewatering Bores
Water in Ore

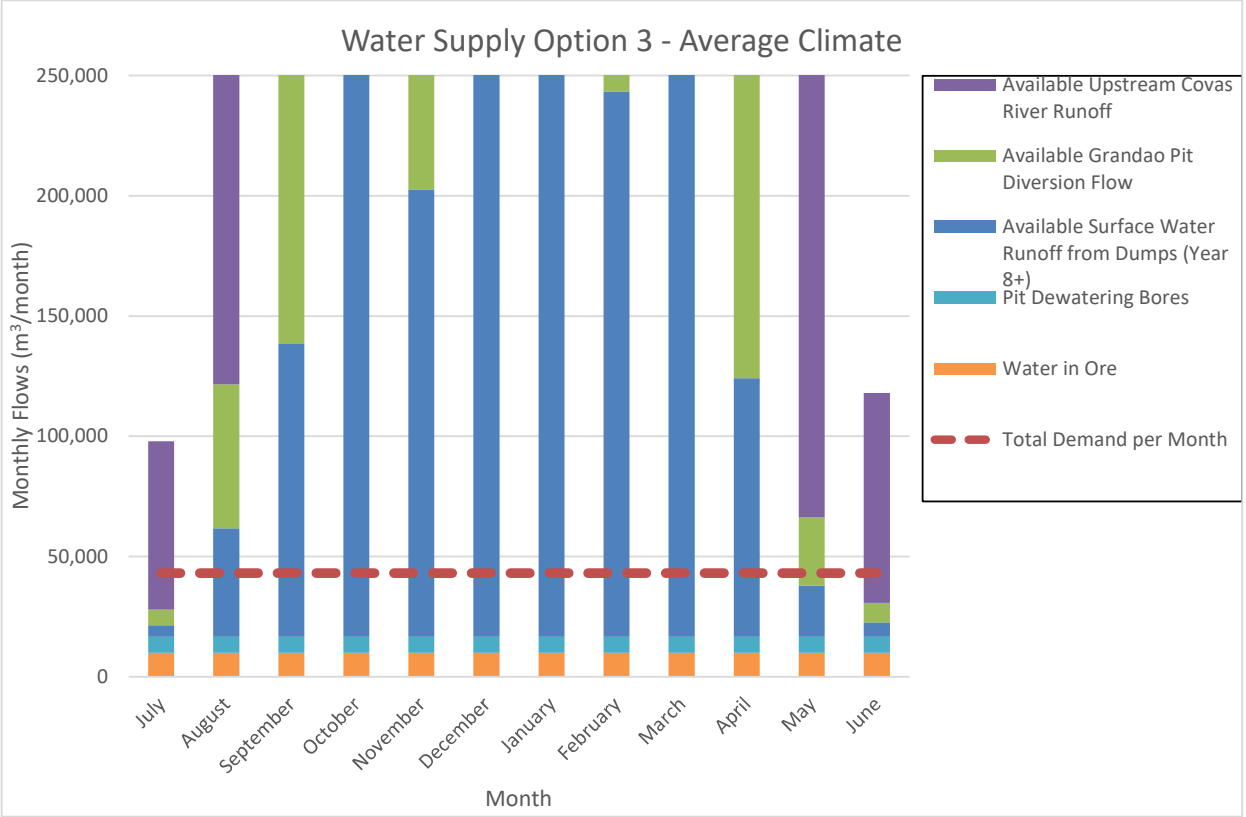

Water Supply Option 2 - 1 in 10 ARI Dry Year
250,000
200,000
150,000
100,000
50,000
0
Monthly Flows (m³/month)
July
August
September
October
November
December
January
February
March
April
May
June
Month
Storage Supply (Shortfall)
Available Grandao Pit Diversion Flow
Available Surface Water Runoff from Dumps (Years 1 to 7)
Pit Dewatering Bores
Water in Ore

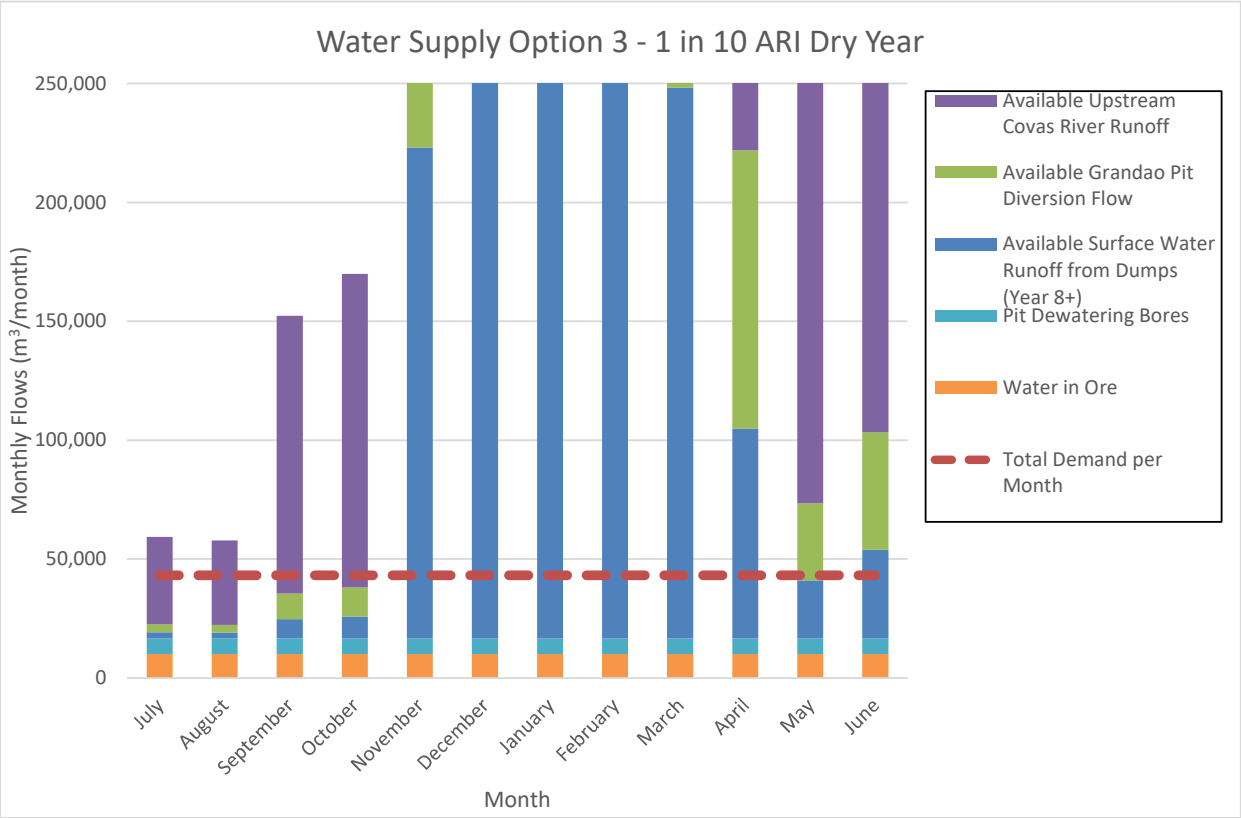

Water Supply Option 2 - Average Climate
250,000
200,000
150,000
100,000
50,000
0
Monthly Flows (m³/month)
July
August
September
October
November
December
January
February
March
April
May
June
Month
Storage Supply (Shortfall)
Available Grandao Pit Diversion Flow
Available Surface Water Runoff from Dumps (Year 8+)
Pit Dewatering Bores


Water Supply Option 2 - 1 in 10 ARI Dry Year
250,000
200,000
150,000
100,000
50,000
0
Monthly Flows (m³/month)
July
August
September
October
November
December
January
February
March
April
May
June
Month
Storage Supply (Shortfall)
Available Grandao Pit Diversion Flow
Available Surface Water Runoff from Dumps (Year 8+)
Pit Dewatering Bores


Water Supply Option 3 - Average Climate
Monthly Flows (m³/month)
250,000
200,000
150,000
100,000
50,000
0
July
August
September
October
November
December
January
February
March
April
May
June
Month
Available Upstream Covas River Runoff
Available Grandao Pit Diversion Flow
Available Surface Water Runoff from Dumps (Years 1 to 7)
Pit Dewatering Bores
Water in Ore
Total Demand per Month


Water Supply Option 3 - 1 in 10 ARI Dry Year
Monthly Flows (m³/month)
250,000
200,000
150,000
100,000
50,000
0
July
August
September
October
November
December
January
February
March
April
May
June
Month
Available Upstream Covas River Runoff
Available Grandao Pit Diversion Flow
Available Surface Water Runoff from Dumps (Years 1 to 7)
Pit Dewatering Bores
Water in Ore

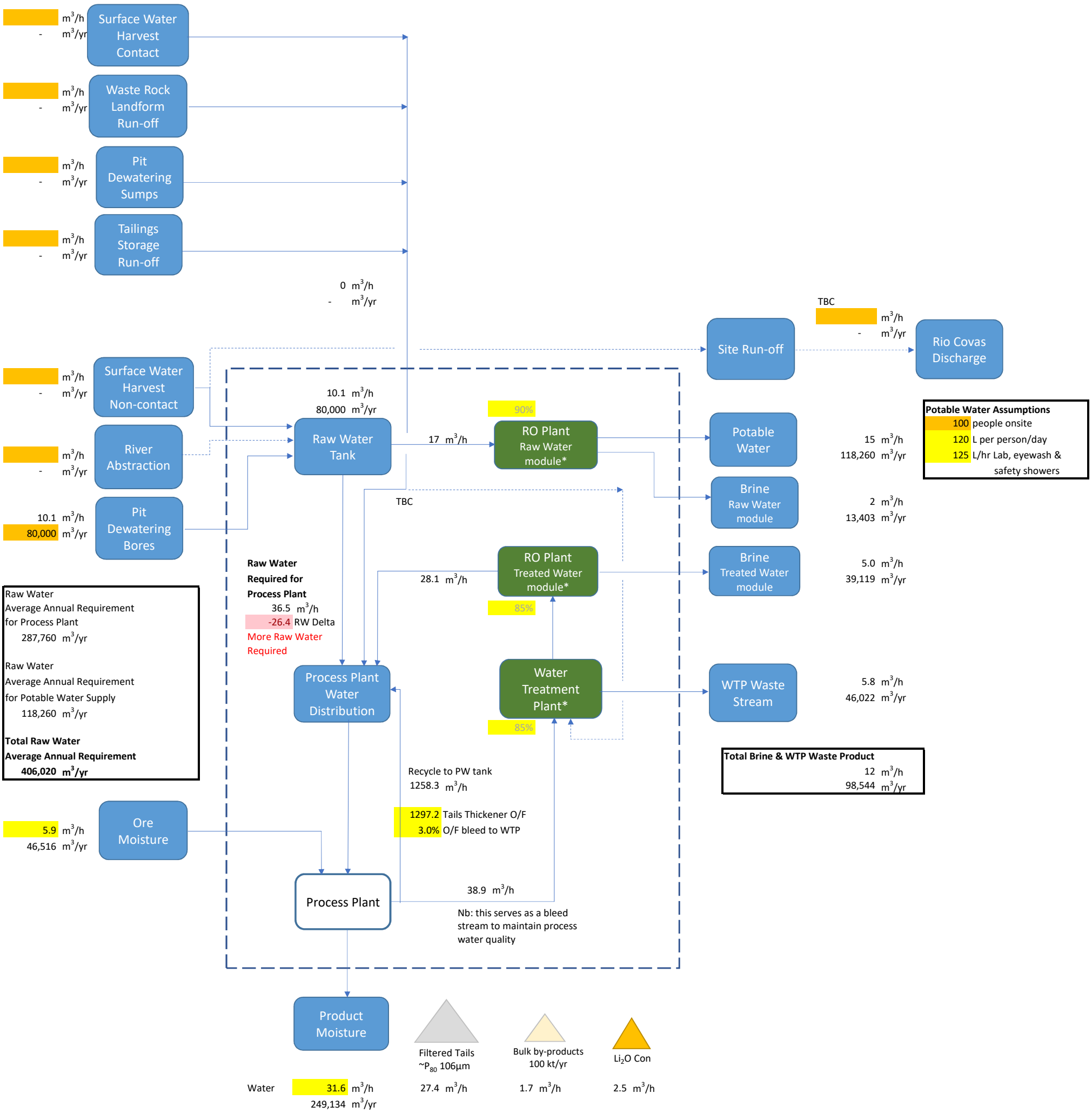

Water Supply Option 3 - Average Climate
Monthly Flows (m³/month)
250,000
200,000
150,000
100,000
50,000
0
July
August
September
October
November
December
January
February
March
April
May
June
Month
Available Upstream Covas River Runoff
Available Grandao Pit Diversion Flow
Available Surface Water Runoff from Dumps (Year 8+)
Pit Dewatering Bores
Water in Ore
Total Demand per Month


Water Supply Option 3 - 1 in 10 ARI Dry Year
Monthly Flows (m³/month)
250,000
200,000
150,000
100,000
50,000
0
July
August
September
October
November
December
January
February
March
April
May
June
Month
Available Upstream Covas River Runoff
Available Grandao Pit Diversion Flow
Available Surface Water Runoff from Dumps (Year 8+)
Pit Dewatering Bores
Water in Ore
Total Demand per Month

APPENDIX A
Process Plant Internal Water Balance Block Model

21004 - Mina do Barroso Scoping Study, High Level Water Balance 5/11/2019

PRIMERO

90% plant availability
7884 h/yr
1.50 Mtpa Plant feed

Notes: High-level water balance is based on 'whole of ore' flotation flowsheet process mass balance (Ref: 21004-CAL-PR-001_A, 30/10/19)
Raw water quality (and analyses) to be confirmed
Water treatment requirements to be confirmed
Water recovery through water treatment plants and RO plant to be confirmed
Site run-off is assumed to approximate rainfall (less any seepage)
It is assumed that non-contact site run-off requires no water treatment
It is assumed that Raw water is of high quality and suitable to use for reagent mixing and pump gland seal water
The requirement for site storage and handling of reverse osmosis plant brine and WTP waste product is to be confirmed