

PLRRRC Void Dewatering Project

OPERATIONAL LICENCED DISCHARGE REPORT – Laboratory Analytes

REPORTING PERIOD: 05/10/18 to 11/10/18

Location: Licenced Discharge Point (Engineered Spillway discharged from Dam 2 HES Basin)

Table 1: Parameters monitored as per specific requirements of EPL20814 (Conditions L2.4 and M2.2)¹

Approved Trigger Levels For Discharged Water

Parameters ^{1,2}	Units	Analytical Detection Limit (Laboratory LOR)	Required Frequency ³	No. of Sampling Events During Report Period ⁴	Sampling results 5/10/2018 (Rain Event ⁵)		Sampling results 09/10/2018 (Routine)		Criteria Period	Min Value To Date	Max Value To Date	50th Percentile (to date) (Median)	100th Percentile (to date)	90th Percentile (to date)	Compliant With EPL Criteria (Y/N)	Condition Green (Direct Discharge, Untreated)	Condition Amber (Review/ Action/ Treatment)	Condition Red (EPL Criteria) (Halt Discharge, Confirmation Checks, Adaptive Management)
					Primary Sample	QA/QC Duplicate ³	Primary Sample	QA/QC Duplicate ³										
Total Suspended Solids (TSS)	mg/L	5	Weekly during discharge	2	12	16	8	9	Dewatering completion	<5	16	6	11.4		Y	0-45	>45	100th percentile <50
Total Hardness ⁴	mg/L as CaCO ₃	1	Weekly during discharge	2	200	196	210	206	N/A	181	216	196		207.6	Y	>100	<100	Not applicable
Total Aluminium	µg/L	10	Weekly during discharge	2	240 ⁵	350 ⁵	60 ⁵	100 ⁵	Dewatering completion	30	350	100		198 ⁵	Y	See Dissolved Al	See Dissolved Al	Refer Dissolved Al
Dissolved Aluminium	µg/L	10	Weekly during discharge	2	<10 ⁵	<10 ⁵	<10 ⁵	<10 ⁵	Dewatering completion	<10	<10	<10		<10 ⁵	Y	0-55	A1: 55-80 A2: >80	90th percentile <55 ⁵
Total Zinc	µg/L	1	Weekly during discharge	2	2 ⁵	2 ⁵	2	1	Dewatering completion	1	13	2		4 ⁵	Y	See Dissolved Zn	See Dissolved Zn	Refer Dissolved Zn
Dissolved Zinc	µg/L	1	Weekly during discharge	2	<1 ⁵	<1 ⁵	<1	<1	Dewatering completion	<1	8	1		2 ⁵	Y	0-63	>63	Hardness modified 90th percentile <70 ⁶
Total Iron	µg/L	50	Weekly during discharge	2	160	250	50	80	Dewatering completion	<50	250	80		154	Y	See Dissolved Iron	See Dissolved Iron	Refer Dissolved Fe
Dissolved Iron	µg/L	50	Weekly during discharge	2	<50	<50	<50	<50	Dewatering completion	<50	<50	<50		<50	Y	0-855	>855	90th percentile <950
Total Copper	µg/L	1	Weekly during discharge	2	1	1	1	<1	Dewatering completion	0.9	2	1		1.64	Y	See Dissolved Cu	See Dissolved Cu	Refer Dissolved Cu
Dissolved Copper	µg/L	1	Weekly during discharge	2	0.9	0.9	0.9	0.9	Dewatering completion	0.6	0.9	0.9		1	Y	0-7.5	>7.5	Hardness modified 90th percentile <8.4 ⁶
Total Manganese	µg/L	1	Weekly during discharge	2	24	22	12	13	Dewatering completion	2	13	6		16.6	Y	See Dissolved Mn	See Dissolved Mn	Refer Dissolved Mn
Dissolved Manganese	µg/L	1	Weekly during discharge	2	6	6	<1	<1	Dewatering completion	<1	6	1		3.6	Y	0-2250	>2250	90th percentile <2500
Total Nickel	µg/L	1	Weekly during discharge	2	2	2	2	2	Dewatering completion	<1	2	2		2	Y	See Dissolved Ni	See Dissolved Ni	Refer Dissolved Ni
Dissolved Nickel	µg/L	1	Weekly during discharge	2	1	2	<1	1	Dewatering completion	<1	1	1		1	Y	0-54	>54	Hardness modified 90th percentile <61 ⁶
Total Barium ⁷	µg/L	1	Weekly during discharge	2	161	170	173	175	Dewatering completion	135	175	150		171.2	Y			Refer Dissolved Ba
Dissolved Barium ⁷	µg/L	1	Weekly during discharge	2	143	148	150	147	Dewatering completion	123	150	135		147.4	Y			NS ⁷
Total Lithium ⁷	µg/L	1	Weekly during discharge	2	14	16	18	18	Dewatering completion	14	18	15		17.4	Y			Refer Dissolved Li
Dissolved Lithium ⁷	µg/L	1	Weekly during discharge	2	16	17	16	17	Dewatering completion	12	17	14		17	Y			NS ⁷

- Refer to separate related report for *in situ* continuous automated water quality parameters (e.g. pH conductivity, turbidity and dissolved oxygen).
- Surface water sampling and analysis as per EPL20814 (including Condition E1.1), including 0.1µm filtered metals (herein referred to as dissolved metals).
- Relevant monitored parameter not specified in EPL20814 but included for important context (hardness-corrected trigger values)
- As per EPL20814, based on speciation modelling of bioavailable aluminium and zinc, if total and filtered metal concentrations exceed concentration limits but the bioavailable fractions are not exceeded, then the licence limits for those metals are considered compliant:
 - Speciation modelling of Aluminium (Al) shows *Bioavailable Al* is <2 µg/L where: Dissolved Al <200µg/L AND pH=6.6-8.0, hardness is >60 mg/L as CaCO₃, Alkalinity >40 mg/L as CaCO₃, and DOC >5 mg/L (Dr S.Markich 2016, as reviewed by NSW EPA)
 - Speciation modelling of Zinc (Zn) shows *Bioavailable Zn* is <1 µg/L where: pH=6.6-8.0, hardness >60 mg/L as CaCO₃, Alkalinity >40 mg/L as CaCO₃, and DOC >5.0 mg/L (Dr S.Markich 2016, as reviewed by NSW EPA)
 - All dissolved metal concentrations in the above reporting period were below hardness modified discharge criteria values and therefore compliant. No further assessment against speciation modelling parameters for bioavailable fractions was required.
- Hardness-Modified Concentration Limits** apply for zinc, copper and nickel as per EPL20814, where $HMTV = TV/(H/30)^{0.85}$, where TV = default metal guideline value (µg/L) at 30mg/L CaCO₃ ('soft' conditions) for 90% protection level for freshwater aquatic ecosystems, and H = measured minimum hardness level (i.e. 185 mg/L as CaCO₃).
- Parameter required to be monitored by EPA under Condition M5.5 of EPL20814, but no licenced discharge criteria (L2.4) specifically nominated. Accordingly, ANZECC criteria for 90% species protection applied as per the approved SDMP TARP where available.
- NS = Not Specified. Criteria for protection of freshwater species not specified by ANZECC/ARMCANZ (2000). ANZECC comments elsewhere that 'typical concentrations in unpolluted fresh water' for Lithium (Li) are 200µg/L. No typical freshwater values are noted for um, however the ANZECC recommended trigger value for Recreation Ambient Waters (Primary & Secondary Contact) is 1000 µg/L.
- Laboratory samples are routinely collected as per EPL requirements (weekly during discharge). Event-based samples are also collected in accordance with the approved SDMP, where >10mm rainfall or runoff flows observed – these may be concurrent to routine samples where timing requirements coincide.

Table 2: Other Monitored Parameters as per the approved Stormwater Dewatering Management Plan (SDMP)¹

Approved Trigger Values for Discharged Water

Parameters ²	Units	Analytical Detection Limit (Laboratory LOR)	Required Frequency	Sampling Events During Report Period	Sampling results 05/10/2018		Sampling results 09/10/2018		Criteria Period	Min Value (to date)	Max Value (to date)	50th Percentile (to date)	100th Percentile (to date)	90th Percentile (to date)	Compliant With SDMP Trigger Values ⁵	Condition Green (Direct Discharge, Untreated)	Condition Amber (Review/ Action/ Treatment)	Condition Red (SDMP/TARP) ¹ (Halt Discharge, Confirmation Checks, Adaptive Management)
					Primary Sample	QA/QC Duplicate	Primary Sample	QA/QC Duplicate										
Bicarbonate Alkalinity ³	mg/L as CaCO ₃	1	Weekly during discharge	2	174	174	179	169	Dewatering completion	143	169	158	N/A	174	N/A	>65	<65	NS
Total Alkalinity	mg/L as CaCO ₃	1	Weekly during discharge	2	174	174	179	169	Dewatering completion	143	179	158	N/A	174	N/A	See above	See above	NS
pH (Lab)	pH Units	0.01	Weekly during discharge	2	7.96	8.01	7.93	7.82	Dewatering completion	7.47	8.13	7.98	8.13	N/A	N/A	Refer Field pH (Continuous)	Refer Field pH (Continuous)	N/A ⁷ (see Continuous Monitoring Report)
Total Dissolved Solids (TDS)	mg/L	1	Weekly during discharge	2	1060	1060	1090	1080	Dewatering completion	936	1090	971.5	N/A	1070	N/A			NS
Electrical Conductivity (Lab at 25°C ⁴)	µS/cm	1	Weekly during discharge	2	1630 ⁷	1630 ⁷	1680 ⁷	1670 ⁷	Dewatering completion	1440 ⁷	1680 ⁷	1495 ⁷	N/A	1650 ⁷	N/A ⁷	Refer Field EC (Continuous)	Refer Field EC (Continuous)	N/A ⁷ (see Continuous Monitoring Report)
Dissolved Organic Carbon (DOC) ³	mg/L	1	Weekly during discharge	2	4	5	5	5	Dewatering completion	4	5	4	N/A	5	N/A	>3.0	<3.0	NS
Total Organic Carbon (TOC)	mg/L	1	Weekly during discharge	2	5	5	5	5	Dewatering completion	4	5	4	N/A	5	N/A	Refer DOC	Refer DOC	NS
Chloride	mg/L	1	Weekly during discharge	2	360	355	409	405	Dewatering completion	329	409	355	N/A	387 ^{5,6}	N ^{5,6}	<350	350	90th percentile <350 ⁶ (refer criteria period)
Sulphate	mg/L	1	Weekly during discharge	2	104	108	86	82	Dewatering completion	82	108	89	N/A	101	N/A			NS ⁴
Fluoride	mg/L	0.1	Weekly during discharge	2	0.5	0.5	0.6	0.6	Dewatering completion	0.5	0.7	0.6	N/A	0.6	N/A			NS ⁴
Calcium (total)	mg/L	1	Weekly during discharge	2	20	21	22	23	Dewatering completion	18	23	20	N/A	22	N/A			NS ⁴
Calcium (dissolved)	mg/L	1	Weekly during discharge	2	19	19	20	20	Dewatering completion	18	20	19	N/A	20	N/A			NS ⁴
Magnesium (total)	mg/L	1	Weekly during discharge	2	38	40	43	42	Dewatering completion	34	43	38	N/A	40.8	N/A			NS ⁴
Magnesium (dissolved)	mg/L	1	Weekly during discharge	2	37	36	39	39	Dewatering completion	32	39	36	N/A	37.8	N/A			NS ⁴
Potassium (total)	mg/L	1	Weekly during discharge	2	5	5	6	6	Dewatering completion	5	6	5	N/A	6	N/A			NS ⁴
Potassium (dissolved)	mg/L	1	Weekly during discharge	2	5	5	5	5	Dewatering completion	4	5	5	N/A	5	N/A			NS ⁴
Sodium (total)	mg/L	1	Weekly during discharge	2	222	234	246	245	Dewatering completion	210	246	224	N/A	239.6	N/A			NS ⁴
Sodium (dissolved)	mg/L	1	Weekly during discharge	2	219	216	228	228	Dewatering completion	198	228	210	N/A	225.6	Y	0-290	290	90th percentile <300 (refer criteria period)
SAR (Sodium Adsorption Ratio)	N/A	0.01	Weekly during discharge	2	6.74	6.72	6.78	6.84	Dewatering completion	6.4	7.53	6.64	N/A	6.93	Y	0-7.2	>7.2	90th percentile <8 (refer criteria period)
Total Nitrogen	mg/L	0.1	Weekly during discharge	2	0.3	0.3	0.2	0.2	Dewatering completion	0.2	0.5	0.3	N/A	0.4	Y	<1.0	1.2	90th percentile <1.5 (refer criteria period)
NOx (Nitrate + Nitrite)	mg/L	0.01	Weekly during discharge	2	<0.01	<0.01	<0.01	0.01	Dewatering completion	<0.01	0.08 ⁸	0.01	N/A	0.025	Y			90th percentile <0.04 (refer criteria period)
Ammonia-N	mg/L	0.01	Weekly during discharge	2	0.05	0.06	0.03	0.04	Dewatering completion	<0.01	0.06	0.03	N/A	0.055	Y			90th percentile <0.9 (@pH8, refer criteria period)
TKN (Total Kjeldahl N)	mg/L	0.1	Weekly during discharge	2	0.3	0.3	0.2	0.2	Dewatering completion	0.2	0.5	0.3	N/A	0.4	N/A			NS
Total Phosphorus	mg/L	0.01	Weekly during discharge	2	<0.01	<0.01	<0.01	<0.01	Dewatering completion	<0.01	0.02	0.01	N/A	0.01	Y	<0.05	0.1	90th percentile <0.15 (refer criteria period)
Reactive Phosphorus	mg/L	0.01	Weekly during discharge	2	<0.01	<0.01	<0.01	0.01	Dewatering completion	<0.01	0.01	0.01	N/A	0.01	Y			NS ⁴
E. Coli	CFU/100mL	1	Weekly during discharge	2	~60	~120	23	24	Dewatering completion	<1	120	3.5	N/A	42	N/A			NS ⁴

- Approved SDMP (including TARP trigger values) prepared in consultation with NSW EPA as per Condition E1.1 of EPL20814. TARP - Trigger Action Response Plan, appended to the approved SDMP.
- Refer also related report for Group 1 Field Parameters (insitu continuous automated monitoring (probe)), including pH.
- Parameters used in scenario modelling within metals speciation modelling (Dr S.Markich, 2016) noted in Table 1 above.
- NS = Not Specified by ANZECC and ARMCANZ (2000) for protection of aquatic ecosystems. However, the following are noted for protection of other waters:
 - For protection of recreation ambient waters (primary & Secondary contact) for E. coli Primary contact = 35 CFU/100mL (season median), Secondary Contact = 230 CFU/100mL (median), and for protection of Stock Drinking Water =100 CFU/100mL median or 20% >400 (4x median).
 - For fluoride, protection of recreation ambient waters (primary & Secondary contact) and for protection of Stock Drinking Water are both <2 mg/L.
 - For Sulphate, protection of recreation ambient waters (primary & Secondary contact) = 400 mg/L
 - For Calcium, for protection of Stock Drinking Water where Na and Mg dominate waters, Ca = <1000 mg/L
 - For Magnesium, for protection of Stock Drinking Water (cattle) Total Mg =<2000 mg/L
 - Reactive P is not specified for aquatic ecosystem protection, however filterable reactive P is listed as 0.02 mg/L (20 ug/L)
- Applicable period for 90th percentile criteria for lab analytes is at completion of dewatering (i.e. all discharge data). Interim results above this prior to completion conservatively trigger TARP notification and response measures/adaptive management in consultation with EPA.
- No value is specified by ANZECC for protection of aquatic ecosystems for chloride. The adopted SDMP trigger value for chloride is for agricultural irrigation (conservative low risk of cadmium uptake for sensitive crops). 90th percentile values for Chloride in upstream receiving waters in South Creek (464 mg/L) were above the trigger value during the same period. No cadmium (total and dissolved) detected in water samples at all locations to date. Electrical Conductivity (EC) during the same period was compliant for all discharges.
- EC, pH and DO can vary significantly from field to lab conditions, particularly due to temperature differences. E.g. EC -2-3% per °C, with lab results presented only for 25°C (field temps currently ~13-16 degrees). Accordingly, EPL requires these monitored insitu - refer results in Continuous Monitoring Report.
- Anomalous/isolated and suspected erroneous results for NOX as all other readings prior and since have been <0.01 and no major sources of nutrients onsite/discharges. Results have all been otherwise well below the 90th percentile trigger.