



Technical Memorandum – Phase 2 Ecotoxicology Assessment

Ashburton Salt Project

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1.0 Background

K+S Salt Australia Pty Ltd (K+S) is developing the Ashburton Salt Project (the Project), a solar salt production facility on the Pilbara Coast adjacent to Tubridgi Point. Several plants for the extraction of sea salt have been, or are currently being, established in the coastal region of this area, including the Onslow and Mardie salt operations, as indicated in **Plate 1** below.



Plate 1 Approximate Locations of K+S, Onslow and Mardie Salt Operations (adapted from Google Maps)

The Ashburton Salt Project (the Project) proposal includes the construction of solar salt evaporation and crystallisation ponds and associated infrastructure/activities. The Project will produce a hypersaline wastewater stream (bitterns), which is essentially the components of natural seawater left-over after removal of water and sodium chloride. The bitterns are proposed to be diluted with seawater in a dilution pond prior to disposal via discharge offshore (K+S, 2021).

K+S has submitted the *Ashburton Salt Project: Draft Environmental Review Document* [ERD, (K+S, 2021)] to the Western Australian (WA) Environmental Protection Authority (EPA), to report on potential ecotoxicity of bitterns. AECOM (2021) identified that once the metals within the bitterns plume are diluted such that they meet the appropriate species protection levels, the bitterns present very low risk of ecotoxicity or bioaccumulation in the marine environment. EPA advised further information was required to determine the potential toxicity of the bitterns.

Since the time of submission of the K+S (2021) ERD, a similar salt and potash operation – the Mardie Project – proposed by Mardie Minerals Pty Ltd (Mardie), which proposed to utilise seawater and evaporation to produce concentrated sulfate of potash (and other associated products), and includes a bitterns disposal pipeline and outfall, received EPA-recommendation that the proposal may be implemented (EPA, 2021). It is noted that the ecotoxicology assessment for the Mardie project was based on a whole effluent toxicity (WET) analysis surrogate prototype sample (sourced from the Onslow operation), in the absence of Project-specific bittern samples.

The purpose of this Technical Memorandum (memo) is to respond to the EPA request for further bitterns toxicity information during the current stage of the K+S Project. In the absence of WET results for Project-specific bitterns samples – and considering similar project proposals (Mardie Project) within the bioregion which have received approval – this memo will present surrogate WET analysis information from the Onslow operation in support of the Project proposal.

1.1 Environmental Scoping Document (ESD) Requirements

The requirement for a marine ecotoxicology assessment was outlined within the requirements of an Environmental Scoping Document (ESD), specifically *Task Number 5*, as follows, as presented in K+S (2021) ERD and AECOM (2021):

Task 5. “Determine the likely toxicity of the bitterns to be discharged and use in combination with bitterns plume modelling to determine the potential impacts of the discharge on benthic communities and habitats. Specifically, undertake a marine biota ecotoxicology assessment of local marine indicator species for proposed marine discharges (bitterns, dredging sediment mobilisation). This assessment will:

- a. Identify appropriate local indicator species (including benthic and pelagic species, prawn larvae and juveniles, and the most vulnerable pearl oyster life stages);
- b. Test the tolerance of indicator species to predicted bitterns discharge and turbidity (under usual operation and extreme events), with consideration given to fertilisation, embryo and larval development, growth, and chronic and acute toxicity.
- c. Establish trigger thresholds, below which discharge concentrations may be considered safe.
- d. Use the results of the biota ecotoxicology assessment to inform the marine hydrodynamic modelling and design process to determine the likely impact of the discharges modelled on marine biota sensitive receptors.”

1.2 K + S Ashburton Salt Project – Previous Ecotoxicology Assessments

The previous bitterns water quality and toxicity information considered by the EPA is summarised as follows. This information will be supplemented by the surrogate WET analysis presented in this memo.

1.2.1 Bitterns Generation and Discharge Assessment – EnviroWorks Consulting (2020)

In November 2020, in the absence of project-specific bitterns, a laboratory-generated bitterns sample was prepared using a 30 L sample of local seawater (collected by AECOM from the location of the proposed Ashburton Salt project seawater intake), which was provided to Analytical Reference Laboratory (ARL), to concentrate via evaporation, to mimic the process of formation of bitterns (EnviroWorks, 2020). Salt was precipitated (crystallised) and removed, and the evaporation process was continued until the solution remaining reached a density typical of bitterns.

The bitterns sample was then analysed to confirm it was representative of bitterns constituents at expected levels (based on known constituent levels of bitterns analysed for other salt projects). The Analytical results are summarised in **Table 2**. Based on the chemical composition, Enviroworks (2020) determined that the bitterns sample generated was representative of the expected constituents of bitterns.

EnviroWorks (2020) assessed the potential toxicity of the proposed bitterns to be discharged in accordance with the regulatory framework contained within:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018)
- Technical Guidance – Protecting the Quality of Western Australia’s Marine Environment (EPA, 2016).

Based on the composition of the bitterns sample, EnviroWorks (2020) identified two key water quality parameters which need to be assessed and regulated:

- Salinity (a physical / chemical (PC) stressor), to be assessed using on a referential approach based on baseline salinity data; and

- Metals (toxicants), to be assessed based on ANZG (2018) default guideline values for appropriate species protection levels.

Laboratory ecotoxicity testing on selected species from exposure to the whole of effluent bitterns stream was not undertaken by EnviroWorks on the basis of the following:

- WET testing for the entire bitterns effluent would introduce confounding factors because organisms would be exposed to a combination of PC stress from salinity and cumulative toxicant (metals) exposure. ANZG (2018), uses single toxicant, single-species testing as the preferred approach in order to avoid such confounding factors.
- WA EPA (2016) recommends approaches consistent with ANZG (2018).

The data generated in this report were presented in AECOM (2021) which reported an analysis of water quality parameters against ANZG (2018) criteria, and an evaluation of the level of dilution required for environmentally protective discharge of the bitterns (see **Section 1.2.3**).

1.2.2 Water Technology (2021, as cited in AECOM, 2021)

Water Technology (2021) modelled the distances from the bitterns discharge diffuser at which environmentally protective dilutions are predicted to be met. These results are reported in AECOM (2021, see **Section 1.2.3**), and the dilution levels ranged from 0 (for manganese, vanadium, cobalt, lead, nickel, cadmium, mercury and selenium) to 38 (for chromium).

1.2.3 Ecotoxicology Assessment – AECOM (2021)

In July 2021, AECOM undertook a marine ecotoxicology assessment for the Ashburton Salt Project to address the requirements of the ESD (refer to **Section 1.1**). The assessment identified the key impact bitterns can have on biota within the receiving environment is physico-chemical stress due to the high salinity which has osmotic effects on the cells of living organisms. Salinity is classified as a 'PC stressor' and is not a 'toxicant'. The only toxicants identified in the bitterns are naturally occurring metals in seawater which may be concentrated by the solar evaporation process. AECOM (2021) concluded that once the metals within the bitterns plume are diluted such that they meet the appropriate species protection level (99% or 95%), they present very low risk of ecotoxicity or bioaccumulation in the marine environment. The distances from the discharge point at which these dilutions are predicted to be met have been modelled by Water Technology (2021).

It is noted that no WET testing was undertaken as requested in the ESD Requirements, given the high salinity of the bitterns would result in mortality of ecotoxicology test species and obscure any mortality due to toxic effects from other bitterns' constituents, i.e., test organisms would suffer mortality due to PC stress well before any toxic effects of metals would occur. Furthermore, WET testing is not an approach used for the derivation of DGVs by ANZG (2018), which uses single-toxicant, single-species laboratory testing as the preferred approach in order to avoid confounding factors from multiple toxicants.

1.3 Ecotoxicology analysis Phase 2: Mardie Salt Project surrogate data

As discussed in **Section 2.1**, other facilities for the extraction of sea salt, including the Onslow and Mardie salt operations are located along the WA coast in the vicinity of the K+S facility.

Since the time of submission of the K+S ERD, the Mardie Project, which proposed to utilise seawater and evaporation to produce a concentrated salt, sulfate of potash (and other associated products) and includes bitterns disposal pipeline and outfall, has received EPA-recommendation that the proposal may be implemented (EPA, 2021).

In order to address EPA comments requesting further ecotoxicity information, the following Sections present additional EPA-approved (EPA, 2021) ecotoxicology and water quality data from comparable operations sourced from publicly-available sources.

1.3.1 Mardie WET Testing

As part of the Mardie Project investigations, WET testing was undertaken to determine potential toxicity of bitterns discharge. The basis and outcomes of the testing was reported in O2 Marine (2019). In the absence of a project-specific bitterns sample, a prototype bitterns effluent sample from the Onslow salt processing facility was used as the sample for WET testing. The composition of the prototype Onslow sample was analysed along with two seawater samples collected from the site for a control comparison with the bitterns sample for characterisation. Analytical results are summarised in **Table 2**, alongside the K+S bitterns sample for comparison, and discussed further in **Section 2.3**.

1.3.1.1 Acceptability of data from other bitterns

The Mardie approach involving the use of a prototype bitterns effluent from a different operation [the Onslow facility (O2 Marine, 2019)] was determined by the EPA (2021, Section 2.5.2 in that report) as “adequate to inform the EPA’s assessment of the proposal”, and recommended that the proposal may be implemented subject to conditions.

1.3.1.2 Species Selection and Test Method

Mardie WET analysis was undertaken by ESA on six marine organism groups (microalgae, echinoderm, crustacean, cnidarian, mollusc and fish) to represent local marine indicator species.

The test species were considered representative for local ecosystems several bases, including:

all test species are found in tropical/subtropical Australia

the test milky oyster *Saccostrea echinata* was considered representative of Pilbara milky oyster molluscs (e.g. *Saccostrea cucullata*) and pearl oysters (e.g. *Pinctada* spp.)

the test sea urchin *Heliocidaris tuberculata* is commonly found in the Pilbara

the test barramundi *Lates calcarifer* represents a common tropical fish species

the test diatom *Nitzschia Closterium* is commonly found in Pilbara waters.

This suite of test species also satisfies the ESD requirements for the K+S S Ashburton Salt proposal as described in Task 5a in **Section 1.1**.

1.3.1.3 Levels of ecological protection (LEP)

The Mardie proposal (O2 Marine, 2019) involved an assessment of the levels of ecological protection (LEPs) applicable to the receiving environment for the operation. This assessment involved the spatial designation of the area around the outfall into three LEPs, in accordance with EPA (2016) guidelines: High, Moderate and Low:

- the Low LEP extends 70 m around the outfall
- the Moderate LEP extends 250 m from the Mardie project infrastructure
- the area beyond the 250 m boundary is designated as High LEP.

The rationale and results of LEP designation for the Mardie operation is presented in **Table 1**, along with a comparison with the derivation for the K+S LEPs (AECOM, 2021; K+S, 2021).

Table 1 Levels of Ecological Protection as Designated for Mardie (O2 Marine, 2019) and K+S (AECOM, 2021) Proposals

Operation	LEP	Species Protection Level (%) ²	Designation	EPA Guideline	Dilutions Required ⁵	% Effluent (95% Confidence Interval) ⁵
Mardie	Low	80	70 m around outfall	≤70 m from diffuser	417	0.44 (0.38 – 0.65)
	Moderate	90	250 from project infrastructure	≤250 m from operation	263	0.38 (0.33 – 0.60)
	High ⁴	99	>250m from 250m project boundary	Boundary of the area allocated to the	227	0.44 (0.38 – 0.65)

Operation	LEP	Species Protection Level (%) ²	Designation	EPA Guideline	Dilutions Required ⁵	% Effluent (95% Confidence Interval) ⁵
				identified purpose		
	Maximum ⁴	No detectable biological or chemical changes (from background)	Zones within the High LEP	A high conservation zone not within 5 km of large commercial or population centres	NR	NR
K+S	Low	80	20 m around outfall	≤70 m ³	NA	NA
	Moderate	90	180 m from project infrastructure	≤250 m ³	NA	NA
	High ⁴	99	> 180 m from project boundary	Boundary of the area allocated to the identified purpose ³	NA	NA
	Maximum ⁴	No detectable biological or chemical changes (from background)	Zones within the High LEP	A high conservation zone not within 5 km of large commercial or population centres	NA	NA

NR = not reported, NA = not available

1 – See AECOM (2021) for further information

2 – EPA (2016)

3 – Represents a worst-case scenario (K+S, 2021). Best case scenario distances are 1/3 these reported values

4 – Informed by the Pilbara Coastal Water Quality Consultation Outcomes – Environmental Values and Environmental Quality Objectives, Department of Environment, Government of Western Australia, Marine Series Report No. 1 (Department of Environment, 2006)

5 – Based on WET analysis results

The LEPs adopted for both operations are consistent with the EPA (2016) guidelines, being informed by modelled water quality of discharges, and are within the maximum advised spatial extents. The High and Maximum LEPs for both operations are mapped based on the same resource (Department of the Environment, 2006) as both proposed operations occur in the Pilbara Coastal Waters.

1.3.1.4 WET Testing Outcomes

The WET testing undertaken using the prototype sample indicated salinity [which is expected to reach 325 parts per thousand (ppt)], was the primary causative agent for the toxic effects observed. It is proposed that the bitterns will be diluted with seawater prior to discharge to bring its salinity closer to that of the receiving environment (O2 Marine, 2019).

Modelling carried out for the proposal indicated that the proposed discharge of bitterns would result in the criteria for High Level of Ecological Protection Area (HEPA) no longer being achieved in an area around the discharge diffuser. Mardie proposed that the areas around the diffuser be re-designated as Low Level of Ecological Protection Area (LEPA) and Moderate Level of Ecological Protection Area (MEPA) based on modelling of bitterns disposal (EPA, 2021).

1.3.2 EPA's Assessment

The EPA's assessment – considering WET analysis data from an Onslow bitterns prototype – determined the impacts to marine water quality from bitterns disposal are likely to be consistent with the

EPA's objectives for marine environmental quality, subject to management of bitterns in accordance with the Mardie MEQMMP, and EPA considers the proposal can be implemented (EPA, 2021).

2.0 Comparative Lines of Evidence

2.1 Location and Bioregion

K+S, Onslow and Mardie are operations considered to be comparable based on geography, bioregion and comparable receiving environment.

The K+S Ashburton Salt Project is located in the north of Western Australia, about 40 km southwest of Onslow. The coastal region in this vicinity is becoming established with several plants for the extraction of sea salt, including the Onslow (operational) and Mardie (not yet operational) salt operations. The K+S, Onslow and Mardie salt operations are all located within a coastal stretch of approximately 160 km, as indicated on **Plate 1**. The K+S facility is in closer proximity to the Onslow facility, compared to the Mardie facility, which is located approximately 100 km northeast of Onslow.

Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA)¹, which is a spatial framework for classifying Australia's coasts and near-shore marine environment into bioregions, the three salt operations are located within the Pilbara bioregion. The IMCRA mesoscale bioregions are derived by jurisdictions at a finer scale than Australia's marine planning regions, and are based on biological and physical data, including the distribution of demersal fish, marine plants and invertebrates, sea floor geomorphology and sediments, and oceanographic data (ANZG, 2018).

Based on their location within the same bioregion, i.e., the Pilbara bioregion, K+S, Onslow and Mardie salt operations are expected to have similar or comparable diversity of marine ecosystems within and surrounding their operational facilities, including their respective receiving environments.

2.2 Operations

Both the K+S and the Onslow projects' operations involve salt production, whereas the Mardie project's operations involves both salt and potash production. Differences in operations and types of salts extracted are expected to generate a greater difference in the composition of bitterns. In this regard, the similarities between the K+S and Onslow operations are considered to be greater than the similarities between the Mardie and Onslow operations. EPA (2021) determined the Onslow bittern sample to be a suitable surrogate for the Mardie operations. The composition of Onslow bitterns are likely to represent K+S bitterns more closely than Mardie bitterns.

It should also be noted that, while the current report considers potential ecotoxicology of undiluted K+S bitterns, the operation itself may ultimately involve a 1:1 "pre-dilution" prior to discharge (K+S, 2021). If this is the case, then this provides an additional level of conservatism to the dilution factors proposed in **Table 4**, which do not consider this potential "pre-dilution" factor.

2.3 Bitterns Composition – Data Comparison

Analytical results characterising the K+S laboratory-generated bitterns sample as well as the Onslow prototype used by the Marie Project are summarised in Table 2.

¹ IMCRA mesoscale bioregions of Australia, as accessed via the Australian and New Zealand Guidelines for Fresh and Marine Water Quality website, on 23 September 2022, at <https://www.waterquality.gov.au/anz-guidelines/your-location/australia-marine-IMCRA>

Table 2 Comparison of Chemical Composition of Bittern Samples

Analyte	Unit	PQL / LOR	K+S Bitterns Sample ¹	*Onslow Bitterns Sample ¹	**K+S Sample ÷ Onslow Sample	99% Ecosystem Guidelines ²
pH	pH units	-	6.8	7.2		8-8.4
Electrical Conductivity	mS/cm	0.01 / 0.001	190	170	0.94	-
Total Dissolved Solids	mg/L	5	450,000	420,000	1.12	-
Specific gravity	g/mL	-	-	1.25	1.07	-
Total Alkalinity	mg CaCO ₃ /L	5	490	820		-
Bicarbonate Alkalinity	mg CaCO ₃ /L	5	490	820	0.60	-
Carbonate Alkalinity	mg CaCO ₃ /L	5	<5	<5	0.60	-
Hydroxide Alkalinity	mg CaCO ₃ /L	5	<5	<5		-
Chloride	mg/L	5 / 1	220,000	180,000		-
Sulfate	mg/L	1	44,000	56,000	1.22	-
Ionic balance	%	-	-	2.2	0.79	-
Total Hardness as CaCO ₃	mg/L	3	-	160,000		-
Filterable Reactive Phosphorus	mg/L	0.01	0.01	-		-
Ammonia-N	mg/L	0.02	0.17	-		0.5
Nitrate-N	mg/L	0.01	0.4	-		-
NO _x -N	mg/L	0.01	0.44	-		-
Nitrite-N	mg/L	0.01	0.24	-		-
Bromide	mg/L	0.1	3,600	-		-
Total Nitrogen	mg/L	0.2	0.6	-		-
Total Kjeldahl Nitrogen	mg/L	0.2	<0.2	-	-	-
Total Phosphorus	mg/L	0.01	0.16	-	-	-
Sodium - Total	mg/L	0.1	91,000	-	-	-
Sodium - Dissolved	mg/L	0.1	91,000	69,000	-	-
Calcium - Total	mg/L	0.1	210	-	1.32	-

Analyte	Unit	PQL / LOR	K+S Bitterns Sample ¹	*Onslow Bitterns Sample ¹	**K+S Sample ÷ Onslow Sample	99% Ecosystem Guidelines ²
Calcium - Dissolved	mg/L	0.1	210	230		-
Magnesium - Total	mg/L	0.1	37,000	-	0.91	-
Magnesium - Dissolved	mg/L	0.1	37,000	38,000	-	-
Potassium - Total	mg/L	0.1	8,800	-	0.97	-
Potassium - Dissolved	mg/L	0.1	8,800	12,000	-	-
Aluminium - Total	mg/L	0.01	0.06	-	0.73	-
Manganese - Total	mg/L	0.01	0.04	-	-	-
Manganese - Dissolved	mg/L	0.01	0.04	-	-	-
Tin - Total	mg/L	0.01	<0.01	-	-	-
Tin - Dissolved	mg/L	0.01	<0.01	-	-	-
Vanadium - Total	mg/L	0.01	0.01	-	-	0.05
Zinc - Total	mg/L	0.005	0.024	0.018	-	0.0033
Arsenic - Total	mg/L	0.001	0.009	0.012	1.33	0.0008 ³
Chromium - Total	mg/L	0.001	0.001	<0.005	0.75	0.001
Cobalt - Total	mg/L	0.001	<0.001	-	0.2	-
Cobalt - Dissolved	mg/L	0.001	<0.001	-	-	-
Copper - Total	mg/L	0.001	0.015	-	-	-
Copper - Dissolved	mg/L	0.001	0.015	<0.005	-	0.0003
Lead - Total	mg/L	0.001	<0.001	-	3	-
Lead - Dissolved	mg/L	0.001	<0.001	<0.005		0.0022
Nickel - Total	mg/L	0.001	0.007	-	0.2	-
Nickel - Dissolved	mg/L	0.001	0.005	<0.005	-	0.0007
Cadmium - Total	mg/L	0.0001	0.0005	<0.0005	-	0.0007
Mercury - Total	mg/L	0.0001	<0.0001	-	-	-

Analyte	Unit	PQL / LOR	K+S Bitterns Sample ¹	*Onslow Bitterns Sample ¹	**K+S Sample ÷ Onslow Sample	99% Ecosystem Guidelines ²
Mercury - Dissolved	mg/L	0.0001	<0.0001	<0.00005	-	0.0001
Selenium - Total	mg/L	0.001	<0.001	-	-	-

Notes: * – It is not specified in the O2 Marine (2021) report whether the concentrations of metals and ions reported as part of the Mardie Project composition analysis are total concentrations or dissolved concentrations. K+S analysis includes reporting of a combination of dissolved and total concentrations for certain analytes. It is noted that ecological guidelines generally apply to dissolved concentrations rather than total concentrations. It has thus been conservatively assumed herein that the Onslow concentrations reported by O2 Marine (2021) are dissolved concentrations, representative of bioavailable fractions, except in cases where dissolved concentrations have not been reported for the K+S sample.

** - where values are >0.1 and <10, the results are within an order of magnitude of each other

LOR – Limit of reporting, PQL – Practical quantitation limit¹ – **Bold and green** – exceeds 99% DGV (compared for parameters reported for both bitterns samples). For <LOR values, the LOR was adopted as the concentration (ANZG, 2018)

2 – Default guideline values (DGVs) from ANZG (2018)

3 – DGV for arsenic(V), which is the most conservative of arsenic(V) and arsenic(III) (ANZG, 2018)

4 – DGV for chromium(VI), which is the most conservative of chromium(VI) and chromium(III) (ANZG, 2018)

2.4 Receiving environment – Data Comparison

To compare the similarity of water quality for the respective receiving environments, data were compared between the Mardie and K+S (which proposes to discharge at Locker Point) receiving environments. Comparison of results (for common parameters measured between both operations) are presented in **Table 3**.

Table 3 Comparison of Mardie and K+S receiving environments

Analyte	Unit	Maximum value for K+S RE ^{2,3,4,6}	Maximum value for Mardie RE ^{1,3,4,6}	99% Ecosystem Guidelines	K+S value ÷ Mardie value ^{4,5}
Zinc	mg/L	0.016	0.003	0.0033	5.33
Arsenic	mg/L	0.002	0.002	0.0008	1.00
Chromium	mg/L	<0.001	<0.002	0.00014	0.50
Copper	mg/L	0.0008	<0.002	0.0003	0.40
Cadmium	mg/L	<0.0001	<0.0002	0.0007	0.50
Mercury	mg/L	<0.0001	<0.00002	0.0001	5.00

Notes

1 – RE = Receiving Environment. Maximum value from the two samples reported in Appendix A of O2 Marine (2021)

2 – Maximum value for 2019 – 2021 monitoring program for K+S RE (Locker Point) reported in K+S (2021)

3 – It is not known whether Mardie values are for dissolved or total metals. K+S results are for total metals. For comparisons purposes, it is assumed Mardie results are dissolved metals. This is a conservative approach, as it presents a “worst case scenario” for the Mardie receiving environment

4 – Non-detect values are substituted with LOR for this comparison (ANZG, 2018)

5 – Where values are >0.1 and <10, the results are within an order of magnitude of each other

6 – **Bold and green** – exceeds 99% DGV

Table 3 provides some indication that the receiving environments for K+S and Mardie operations are chemically similar. For the parameters commonly available for both environments, all values are within an order of magnitude of each other. The receiving environment for K+S may have a slightly higher contamination status than that for Mardie, as Locker Point shows an exceedance of the DGV for zinc that Mardie’s receiving environment does not. This suggests a less pristine condition for the K+S receiving environment relative to the Mardie receiving environment, and hence discharge dilution levels protective for Mardie would also be expected to be protective of K+S’s receiving environment.

2.5 Water quality data comparisons – Summary

The following is noted regarding the comparability of K+S and Onslow bittern samples:

- The composition of the K+S bittern sample is comparable to that of the Onslow sample (used as a surrogate in the EPA-approved Mardie Project), with concentrations of cations, anions and metals being reported within the same order of magnitude.
- A comparison of concentrations of metals in the bitterns samples compared against the 99% species protection level marine water quality ANZG (2018) guideline values (GV) determined the following, noting that where data were reported below the limits of reporting (LOR) as 'below detection limit' the numerical value of the detection limit was used for comparison (in accordance with ANZG 2018 guidance):
 - Concentrations of zinc, arsenic, chromium and copper in both K+S and Onslow samples exceeded GV.
 - Concentrations of nickel, cadmium and mercury did not exceed the GV in either of the two samples.
 - Concentration of lead exceeded the guideline in the Onslow sample, but not in the K+S sample.
- This indicates similar exceedances were noted in both K+S and Onslow samples. The exceedance of lead for the Onslow, but not K+S, sample indicates that Onslow has a higher-likelihood of metals-influenced toxicity, and WET results from this analysis might therefore actually be slightly overprotective for K+S bitterns. The water quality of the Mardie receiving environment K+S bittern sample is comparable to that for the Mardie receiving environment, with concentrations of metals being reported within the same order of magnitude.
- A comparison of concentrations of metals in the receiving environment samples compared against the 99% species protection level marine water quality ANZG (2018) guideline values (GV) determined the following, noting that where data were reported below the limits of reporting (LOR) as 'below detection limit' the numerical value of the detection limit was used for comparison (in accordance with ANZG 2018 guidance):
 - Concentrations of chromium and copper for both K+S and Mardie receiving environments exceeded GV.
 - Concentration of zinc exceeded the guideline in the K+S receiving environment, but not in the Mardie receiving environment.

This indicates similar exceedances were noted in both K+S and Mardie receiving environments. The exceedance of zinc for the K+S, but not Mardie, receiving environments indicates that K+S receiving environment has a higher metals contamination status than that for Mardie, and WET results from the Mardie analysis might therefore actually be slightly overprotective for K+S bitterns.

3.0 Conclusions and Recommendations

In the absence of a project-specific K+S bittern sample, the Onslow bittern sample is considered to be a suitable surrogate, sufficiently representative of K+S operations, on the basis of the following lines of evidence:

- Location and bioregion – K+S, Onslow and Mardie salt operations are all located within the same IMCRA bioregion, i.e., the Pilbara bioregion, and are expected to have similar or comparable diversity of marine ecosystems within and surrounding their operational facilities
- Operations – Both the K+S facility and the Onslow projects' operations involve salt production, whereas the Mardie project's operations involves both salt and potash production. In this regard, the similarities between the K+S and Onslow operations are considered to be greater than the similarities between the Mardie and Onslow operations.

- Chemical Composition – The composition of the K+S bittern sample is comparable to that of the Onslow sample used as a surrogate in the Mardie Project, with concentrations of cations, anions and metals being reported within the same order of magnitude.
- Bitterns chemical exceedances – A comparison of concentrations of metals in the bitterns samples compared against the 99% species protection level marine water quality ANZG (2018) guideline values (GV) determined the similar exceedances were noted in both K+S and Onslow samples, however one exceedance for Onslow – lead – was not observed for K+S, suggesting K+S as of lower potential toxicity.
- Receiving environments metals levels – The metals levels in the K+S receiving environment are comparable to those for the Mardie receiving environment, suggesting a comparable receiving environment for both operations.
- Receiving environments metal exceedances – A comparison of concentrations of metals in the receiving environments for K_+S and Mardie compared against the 99% species protection level marine water quality ANZG (2018) guideline values (GV) determined the similar exceedances were noted in both K+S and Mardie samples, however one exceedance for K+S – zinc – was not observed for Mardie, suggesting K+S as in less pristine condition.
- Required dilutions – Given the comparability of water quality between the K+S and Mardie samples, the proposed dilution levels for Mardie bitterns (227 – 417x, or 0.44 – 0.24% effluent, in order to protect the requisite 80 – 99% species levels) are likely to be suitable for K+S bitterns. Mardie dilution levels may in fact be conservative given the slightly higher metal (lead) toxicity expected to be associated with Mardie bitterns.

It is noted that Mardie salt project proposal has received approval to use seawater to produce salt and dispose bitterns to the marine environment (EPA, 2021). The Onslow bitterns sample, that also formed the basis of the Mardie WET testing (O2 Marine, 2021), is considered to be adequately representative of K+S operations, and is in fact expected to be more similar to the K+S operations, compared to the Mardie operations.

Based on the above lines of evidence, it is proposed that WET testing undertaken for the Mardie Salt Project are considered suitable for application to the assessment of potential impacts associated with the K+S Ashburton Salt Project.

Based on this it is recommended that the percent effluent and dilution ratios identified by the Mardie Salt Project to define levels of environmental protection associated with Bitterns discharge are applied as set out in **Table 4**.

Table 4 Recommended Guideline Values (\pm 95% CI) for the Concentration of K+S Bitterns Effluent for each Species Protection Level and LEP

Species Protection Level (%)	LEP	Estimated Dilutions	Guideline (%)	Lower 95% Confidence Limit (%)	Upper 95% Confidence Limit (%)
99	High	417	0.24	0.20	0.46
95	-	-	0.33	0.28	0.55
90	Moderate	263	0.38	0.33	0.60
80	Low	227	0.44	0.38	0.65

4.0 References

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