APPENDIX 6.3 METHODOLOGY FOR CUMULATIVE HUMAN RISK IMPACT ASSESSMENTS

Assessment Approach

1.1 The assessment approach for the cumulative risk impact was same as the one for the Human Health Risk Assessment (HHRA) for the chlorination by-products (CBPs), which has been discussed in **Appendix 6.1**.

Problem Formulation

1.2 The objective, scope, Site Conceptual Model and assessment endpoints of the cumulative risk impact assessment are same to those for HHRA, which have been presented in **Section 6** and **Appendix 6.1**.

1.3 The cumulative risk impact assessment focused on assessing the potential risks/impacts to human health due to chronic exposure to the CBPs and other pollutants present in the HATS effluent discharge.

Identification of COPC and Selection of COC

Identification of COPC

1.4 A comprehensive chemical analysis was conducted under the HATS EEFS (2004) to determine the pollutant concentrations in HATS CEPT effluent (Stage 1 and Stage 2A) and CEPT plus Biological Aerated Filters (BAF) effluent (Stage 2B). One hundred of analytes including metals, inorganic pollutants, organic pollutants, pesticides and organo-metallics were identified as COPC and analyzed.

Selection of COC

1.5 A number of selection rules were established in HATS EEFS (2004) for selection of COCs and determination of COC effluent concentrations for risk assessments. COCs selected for Project Scenarios 1 to 4 and Scenario 5 for cumulative risk impact assessment are presented in **Tables 1** and **2** respectively.

Table 1 Results of COCs Selection for Scenarios 1 to 4

COPC	Selected as COC for HHRA	Max. Conc. in CEPT Effluent (µg/L)*	Max. Total Conc. in Ambient Seawater (µg/L)*	Note
Aluminium		122	156	
Antimony	Yes	0.804	0.21	
Arsenic	Yes	1.49	1.48	
Barium	Yes	25.5	7.19	
Chromium III	Yes	18	0.43	
Copper	Yes	55.7	2.25	
Lead	Yes	1.21	0.723	
Mercury	Yes	29.4ng/L	0.06ng/L	
Nickel	Yes	28.5	1.02	
Selenium	Yes	0.4	0.05	
Silver	Yes	3.83	0.058	
Tin		0.93	0.205	A
Vanadium	Yes	29.1	2.15	
Zinc	Yes	44.1	3.54	
Ammonia		22,000	230	A
Sulphide		4,900	48	A
TCDD (I-TEQ)	Yes	0.1pg/L	0.039pg/L	
Toluene	Yes	12	<1	
Diazinon		0.048	<0.01	A
Malathion	Yes	0.031	<0.01	

Note: * Total concentration of metals for human health risk assessment
A) No available toxicity data for human health

Table 2 Results of COCs Selection for Scenario 5

COPC	Selected as COC for HHRA	Max. Conc. in secondary treated Effluent (µg/L)*	Max. Conc. in Ambient Seawater (µg/L)*	Note
Aluminium		15.4	156	
Antimony	Yes	0.631	0.21	
Arsenic		0.88	1.48	
Barium	Yes	24.5	7.19	
Chromium III	Yes	8.38	0.43	
Copper	Yes	9.98	2.25	
Lead		0.135	0.723	
Mercury		3.48ng/L	0.06ng/L	A
Nickel	Yes	22.3	1.02	
Selenium	Yes	0.14	0.05	
Silver	Yes	0.387	0.058	
Tin		0.612	0.205	B
Vanadium	Yes	30.5	2.15	
Zinc	Yes	11.8	3.54	
Ammonia		4,200	230	B
Sulphide		53	48	B
TCDD (I-TEQ)	Yes	0.062pg/L	0.039pg/L	
Toluene		<1	<1	
Diazinon		0.058	<0.01	B
Malathion	Yes	0.015	<0.01	

Note: * Total concentration of metals for human health risk assessment
A) Rinsate blank of dissolved mercury is greater than 20% of sample value
B) No available toxicity data for human health

Identification of Potential Human Receptors

1.6 The potential human receptors for cumulative risk impact assessment are:

- People who swim or engage in other water related activities in the sea area which is contaminated by the selected COCs discharged from the outfall of SCISTW
- People who consume seafood which is contaminated by the selected COCs discharged from the outfall of SCISTW

Exposure Assessment

1.7 The exposure assessment is same to the one for HHRA for CBPs

1.8 The water-to-fish bioconcentration factor and food chain multiplier (for trophic level 4) were presented in **Table 3** whereas the parameters related to dermal exposure were presented on **Table 4**.

Table 3 Bioconcentration Factor and Food Chain Multiplier of COC

COC	Water-to-fish Bioconcentration Factor	FCM[a]
Aluminum	2.7[c]	1.0
Antimony	40[b]	1.0
Arsenic	114[b]	1.0
Barium	633[b]	1.0
Chromium (III)	19[b]	1.0
Copper	710[c]	1.0
Lead	0.09[b]	1.0
Mercury	3,190[d]	1.0
Nickel	78[b]	1.0
Selenium	129[b]	1.0
Silver	87.7[b]	1.0
Tin	138[d]	1.0
Vanadium	N/A	-
Zinc	2,060[b]	1.0
Ammonia	N/A	-
Sulphide	N/A	-
Dioxins and furans (TEQ)	34,400[b]	27
Toluene	171[b]	1.0
Diazinon	171[b]	1.0
Malathion	13.1[b]	1.0

N/A: Not Available

Note: [a] FCMs were developed using K_{ow} values reported in USEPA (1995), as in USEPA (1999b).

[b] BCF values documented in USEPA (2005).

[c] No recommended BCF value identified. Regression equation was used to calculate the BCF values (Bintein *et al.* (1993), as in USEPA (1999b)).

[d] MW (1998).

Table 4 Parameters related to Dermal Exposure

COC	Kp (cm/hr)	T (hr)	t* (hr)	B
Antimony[a]	1E-3	-	-	-
Arsenic[a]	1E-3	-	-	-
Barium[a]	1E-3	-	-	-
Chromium (III) [a]	1E-3	-	-	-
Copper[a]	1E-3	-	-	-
Lead[a]	1E-3	-	-	-
Mercury[a]	1E-3	-	-	-
Nickel[a]	1E-3	-	-	-
Selenium[a]	1E-3	-	-	-
Silver[a]	1E-3	-	-	-
Tin[a]	1E-3	-	-	-
Vanadium[a]	1E-3	-	-	-
Zinc[a]	1E-3	-	-	-
Ammonia	N/A	N/A	N/A	N/A
Sulphide	N/A	N/A	N/A	N/A
Dioxins and furans (TEQ)[a]	1.4	8.1	38	6.3E+2
Toluene[a]	4.5E-2	3.2E-1	7.7E-2	5.4E-2
Diazinon[b]	1.34E-3	6.29	45.5	0.64
Malathion[b]	8.76E-4	9.01	21.6	0.023

Note: [a] parameter values were adopted from USEPA (1992).

[b] No recommended values documented, values were calculated using equations documented in USEPA (1992).

Dose-response Assessment

1.9 The Cancer Slope Factor (CSF) and reference dose of the COCs adopted in World Health Organization (WHO) and USEPA[1] were presented in **Table 5**. More stringent value was typed in bold adopted. For the identified COCs, adjustment of oral toxicity data (cancer slope factor and/or reference dose) for calculation of the risk/hazard due to absorbed doses was not needed according to USEPA (2001b). Therefore, the oral cancer slope factor and reference dose selected for oral exposure were used for the risk calculation in dermal exposure pathway.

Table 5 Cancer Slope Factor and Reference Dose of COCs

COC	Cancer Slope Factor (oral, $(mg/kg/d)^{-1}$)		Reference Dose (µg/kg/d)	
	WHO	USEPA	WHO	USEPA
Antimony	N/A	N/A	6[b]	**0.4**[a]
Arsenic	N/A	**1.5**[a]	N/A	**0.3**[a]
Barium	N/A	N/A	N/A	**0.3**[a]
Chromium (III)	N/A	N/A	N/A	**1,500**[a]
Copper	N/A	N/A	N/A	N/A
Lead	N/A	N/A	**3.5**[b]	N/A
Mercury	N/A	N/A	**0.71**[b]	N/A
Nickel	N/A	N/A	**5**[b]	20
Selenium	N/A	N/A	**4**[b]	5[a]
Silver	N/A	N/A	N/A	**5**[a]
Tin	N/A	N/A	N/A	N/A
Vanadium	N/A	N/A	N/A	**9**[a,c]
Zinc	N/A	N/A	N/A	**300**[a]
Ammonia	N/A	N/A	N/A	N/A
Sulphide	N/A	N/A	N/A	N/A
Dioxins and furans (TEQ)	N/A	**1.5E+5**[d]	N/A	**1E-6**[d]
Toluene	N/A	N/A	223[c]	**80**[a]
Diazinon	N/A	N/A	N/A	N/A
Malathion	N/A	N/A	N/A	**20**[a]

Note: N/A: Not Available
[a] Source: USEPA IRIS Database
[b] Source: WHO (2004b)
[c] Based on vanadium peroxide
[d] USEPA Office of Air Quality Planning and Standards

Risk/Hazard Characterization

1.10 The risk/hazard characterization for the cumulative risk impact was same as the risk assessments for the CBPs.

[1] In SSDS/EIAS DRA (1998), values adopted from National Health and Medical Research Council and Agricultural and Resource Management Council of Australia and New Zealand (NHMRC) were also compared. However, cancer slope factor and reference dose for the COCs were not identified in NHMRC (2004).

References

1. NHMRC (2004). Australian Drinking Water Guidelines 2004.
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5. USEPA (1998). Methodology for Assessing Health Risks associated with Multiple Pathways of Exposure to Combustor Emissions.
6. USEPA (2001b). Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment.
7. USEPA (2005). Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities – Final.
8. WHO (2004b). Guidelines for Drinking-water Quality (Third Ed.) – Volume 1.