

Appendix 5.3
Groundwater Risk Assessment

Risk-Based Assessment for Groundwater Remediation for South Apron Area of Former Kai Tak Airport

Table 1 - Source Concentrations & Oral Slope Factor/Oral Reference Dose for Risk Assessment

Parameter	Source Concentration	Sample I.D.	Noncarcinogenic Oral Reference Dose ^a (RfDo)	Minimum Noncarcinogenic Oral Reference Dose ^a (RfDo)	Carcinogenic Oral Slope Factor ^b (CSFo)
	[mg/L]		[mg/kg-day]	[mg/kg-day]	1/[mg/kg-day]
TPHs	2.87E+00	RSB-01	0.03to 5.00	3.00E-02	Not applicable
Barium	6.80E-01	GFSD-02	7.00E-02	Not applicable	Not applicable
Cadmium	2.70E-02	GFSD-03	5.00E-04	Not applicable	Not applicable
Chromium*	6.40E-02	GFSA-21	3.00E-03	Not applicable	Not applicable
Cobalt	2.00E-01	GFSD-03	2.00E-02	Not applicable	Not applicable
Copper	9.20E-02	RSB-01A	4.00E-02	Not applicable	Not applicable
Lead	2.10E+00	GFSD-02	3.60E-03	Not applicable	Not applicable
Phenanthrene	2.30E-03	RSB-08	4.00E-02	Not applicable	Not applicable
Mercury	1.20E-03	GFSA-17	3.00E-04	Not applicable	Not applicable
Molybdenum	3.90E-02	GFSA-19	5.00E-03	Not applicable	Not applicable
Xylenes	3.00E-02	All**	2.00E-01	Not applicable	Not applicable
Zinc	1.00E+00	GFSD-02	3.00E-01	Not applicable	Not applicable

^a Source for TPHs : TPH Criteria Working Group, 1999. *Total Petroleum Hydrocarbons Criteria Working Group Series Volume 5*

– *Human Health Risk-Based Evaluation of Petroleum Release Sites: Implementing the Working Group Approach*. Massachusetts, U.S.A., Amherst Scientific Publishers.

Source for Ba, Cd, Cr, Co, Cu, Hg, Mo, Zn, Phenanthrene & Xylenes : USEPA Region IX Risk-based Concentration Table (revised on Oct 04), USEPA Region IX.

Source for Pb: The value is referenced to the tolerable daily intake (TDI) from the National Institute of Public Health and the Environment (RIVM), The Netherlands, 2001.

^b Source for TPHs, Ba, Cd, Cr, Co, Cu, Hg, Mo, Pb, Zn, Phenanthrene, Xylenes: USEPA Region IX Risk-based Concentration Table (revised on Oct 04), USEPA Region IX.

** All sampling locations showed the same concentrations for Xylenes (i.e. 30ug/L as the Ductch B level).

* Chromium is assumed to be Cr(VI) as conservative assessment.

Assumptions:

Exposure Pathway:

The applicable and dominant complete pathway is considered to be direct groundwater ingestion.

Receptor:

The most sensitive receptors are considered to be the construction workers.

Input Parameters for Calculations (for Direct Groundwater Ingestion):

IR = water ingestion rate [L/day] = 0.02 (The assumed water ingestion rate of 0.02 L/d is two orders of magnitude lower than the USEPA default drinking water rate of 2 L/day for adults. In addition, the 0.02 L/d water ingestion rate was adopted for many groundwater risk assessment in previous land contamination studies, such as South East Kowloon Development Infrastructure at North Apron Area of Kai Tak Airport; Reclamation Works for DOS&GIC Facilities in North Tsing Yi and Decommissioning of Cheoy Lee Shipyard at Penny's Bay EIA Study. As a result, the assumed water ingestion rate of 0.02L/d is adequate for groundwater risk assessment.)

EF = exposure frequency [day/yr] = 180 (assume construction workers expose for 6 months of site formation works)

ED = exposure duration [yr] = 1

BW = body weight [kg] = 70

AT = Averaging time [day] = 365 (for non-carcinogens: ED x 365 days)
25550 (for carcinogens: 70 yrs x 365 days)

Table 2 - Calculations for Direct Groundwater Ingestion

Calculations	TPHs	Barium	Cadmium	Chromium*	Cobalt	Copper	Lead	Phenanthrene	Mercury	Molybdenum	Xylenes	Zinc
1. Groundwater conc. [mg/L] =	2.87E+00	6.80E-01	2.70E-02	6.40E-02	2.00E-01	9.20E-02	2.10E+00	2.30E-03	1.20E-03	3.90E-02	3.00E-02	1.00E+00
2. Natural attenuation factor =	1	1	1	1	1	1	1	1	1	1	1	1
3. Exposure medium [mg/L] = (1) / (2) =	2.87E+00	6.80E-01	2.70E-02	6.40E-02	2.00E-01	9.20E-02	2.10E+00	2.30E-03	1.20E-03	3.90E-02	3.00E-02	1.00E+00
4. Exposure multiplier [L/kg/day] = (IR x EF x ED) / (BW x AT) =	1.41E-04	1.41E-04	1.41E-04	1.41E-04	1.41E-04	1.41E-04	1.41E-04	1.41E-04	1.41E-04	1.41E-04	1.41E-04	1.41E-04
5. Average Daily Intake Rate [mg/kg/day] = (3) x (4) =	4.05E-04	9.58E-05	3.80E-06	9.02E-06	2.82E-05	1.30E-05	2.96E-04	3.24E-07	1.69E-07	5.50E-06	4.23E-06	1.41E-04
6. Maximum Pathway Intake [mg/kg/day] = (groundwater ingestion as dominant pathway)	4.05E-04	9.58E-05	3.80E-06	9.02E-06	2.82E-05	1.30E-05	2.96E-04	3.24E-07	1.69E-07	5.50E-06	4.23E-06	1.41E-04
7. Maximum Toxicant Intake Rate [mg/kg/day] =	4.05E-04	9.58E-05	3.80E-06	9.02E-06	2.82E-05	1.30E-05	2.96E-04	3.24E-07	1.69E-07	5.50E-06	4.23E-06	1.41E-04
8. Noncarcinogenic Oral Reference Dose [mg/kg-day] =	3.00E-02	7.00E-02	5.00E-04	3.00E-03	2.00E-02	4.00E-02	3.60E-03	4.00E-02	3.00E-04	5.00E-03	2.00E-01	3.00E-01
9. Individual Chemical of Concern Hazard Index = (7) / (8) =	1.35E-02	1.37E-03	7.61E-03	3.01E-03	1.41E-03	3.24E-04	8.22E-02	8.10E-06	5.64E-04	1.10E-03	2.11E-05	4.70E-04
10. Maximum Carcinogenic Intake Rate [mg/kg/day] =												
11. Carcinogenic Oral Slope Factor (1/[mg/kg-day]) =												
12. Individual Chemical of Concern (COC) Risk = (10) x (11) =												
Total pathway hazard index =	1.12E-01	< 1 (USEPA recommended hazard index)										
(after adding contributions from all chemical of concern)												
Total pathway carcinogenic risk =	Nil	< 1.00E-06 (USEPA lifetime cancer risk level)										
(contributed by Bezo(a)Pyrene and Benzene)												
RBSL [mg/L] =												
Min. of (Groundwater Conc./ Hazard Quotient) or (Groundwater Conc. x Cancer Risk / Risk of Contaminant)	2.13E+02	4.97E+02	3.55E+00	2.13E+01	1.42E+02	2.84E+02	2.56E+01	2.84E+02	2.13E+00	3.55E+01	1.42E+03	2.13E+03
= Minimum of	>>	>>	>>	>>	>>	>>	>>	>>	>>	>>	>>	>>
Groundwater conc. [mg/L] =	2.87E+00 (in mg/L)	6.80E-01 (in mg/L)	2.70E-02 (in mg/L)	6.40E-02 (in mg/L)	2.00E-01 (in mg/L)	9.20E-02 (in mg/L)	2.10E+00 (in mg/L)	2.30E-03 (in mg/L)	1.20E-03 (in mg/L)	3.90E-02 (in mg/L)	3.00E-02 (in mg/L)	1.00E+00 (in mg/L)
Risk	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Keys : NA = Noncancer, CA = Carcinogen