Abbreviated Assessment of Human Health Impact from Whakatane Old Sawmill Site

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Environment Bay of Plenty Preface

The results of the ESR assessment represent a reasonable ‘worst case’ risk assessment. The exposure data used for the assessment provide acceptable ‘worst-case’ values for all of the exposure scenarios and the various parameters used for the exposure assessments are generally consistent with those recommended or used by other agencies. However, the way that this information applies to the context of the current site needs to be given.

Kopeopeo Canal

The hazard quotients and cancer risks from sediment exposure were all very high, although it should be noted that the exposure assumptions are fairly extreme. Nonetheless, the results indicate the need for public health warnings against the use of this part of the canal, and extensive site remediation. Environment BOP has already initiated action on both of these matters.

The hazard quotients and cancer risks from consumption of eels backs up the actions already taken by the Medical Officer of Health to issue a public health warning for the taking of eels from this section of the canal.

The Sawmill Site

The ESR report clearly concludes that the sawmill site is not suitable for residential use. Although part of the site has previously been in residential use, Environment Bay of Plenty is not aware of any intented future residential use for any part of the site.

Part of the ex-sawmill site is currently subject to redevelopment. The area currently subject to redevelopment is referred to by the developer as Stage 2, and area of approximately 3.5 hectares at the eastern end of the site. The Stage 2 redevelopment covers area 4 and part of area 3 referred to in the ESR Report.

The risk identified in the ESR report demonstrates the need to manage the site carefully during redevelopment and to ensure, if further remediation isn’t undertaken, that an adequate barrier is put in place between the existing ground and any post development users of the site. The adequate barrier would need to involve both physical and management components.

At the completion of Stage 2 the entire Stage 2 area is expected to be covered in either concrete floor building or hotmix seal above a layer of clean imported hardfill basecourse. The minimum thickness of cover above the original ground will be 200mm, with over 1 metre in some parts of Stage 2. This thickness of material along with a management plan to ensure the barrier remains in place is considered adequate to negate any exposure pathway from the contaminated ground to users of the site, apart from those carrying out below ground maintenance work.

However, the results of the risk assessment clearly demonstrate the need for an effective site management plan during the development of this site, including specific measures for employee protection. They also demonstrate the need for the same precautions in any future site maintenance activities involving excavation on the site, as required by the conditions of the land use consent for stage 2.

The results also demonstrate the need for good sediment and dust control during any earthworks on site to ensure there is no uncontrolled spreading of contamination from the site.

The remaining area of the sawmill site, which we shall refer to as Stage 3, is not currently being developed. Future use and redevelopment of the stage 3 area requires control measures that take in account the risks highlighted in the ESR report.

<u>Summary</u>

The ESR report clearly supports the conclusion that the sawmill site is not suitable for residential use. However, future use of the site as a managed sealed site is appropriate. Special caution in getting the site to a sealed site is necessary.

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ACKNOWLEDGEMENTS

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GLOSSARY OF TERMS

ATSDR	Agency for Toxic Substances and Disease Registry of the Centers for Disease Control of the United States
CalEPA	California State Environmental Protection Agency
Dioxin TEQ	Toxic equivalents expressed in units of 2,3,7,8-TCDD
HEAST	Health Effects Assessment Summary Tables
1,2,3,4,6,7,8 HpCDD	Heptachlorodibenzo-*p*-dioxin
I-TEQ	International calculation scheme for TEQ
ITER	International Toxicity Estimates of Risk
NOAEL	No observable adverse effects level
OCDD	Octachlorodibenzo-p-dioxin
OTAG	Organochlorines Technical Advisory Group/Committee
RfD	Reference Dose
RIVM	Rijksinstituut voor Volksgezondheid en Milieu (RIVM; National Institute of Public Health and the Environment, the Netherlands)
PCP	Pentachlorophenol
SWAP	Sawmill Workers Against Poison
2,3,7,8-TCDD	2,3,7,8 Tetrachlorodibenzo-*p*-dioxin
TEQ	Toxic equivalent concentration (of 2,3,7,8-TCDD)
TDI	Tolerable Daily Intake
USEPA	United States Environmental Protection Agency
WHO-TEQ	World Health Organisation calculation scheme for TEQ

SUMMARY

This is a preliminary risk assessment using exposure point concentrations previously derived by the consulting firm Tonkin and Taylor (onsite soils) and the Environment Bay of Plenty (sediment and eels in Kopeopeo Canal). Limited exposure scenarios are conducted after evaluation during a site visit to the Whakatane Old Sawmill on Marshall Road, Whakatane and consultation with Environment Bay of Plenty and Sawmill Workers Against Poison (SWAP), a local environmental advocacy group. Exposure scenarios are limited to evaluation of areas and constituents for which data was available. Of note, this report does not cover: adjacent agricultural properties, ecotoxicity onsite or offsite, seasonal fluctuation of exposure point concentrations, ongoing seepage release of PCP and other contaminants from the site, but most importantly development of the site began during the writing of this report – it is likely that the site will have been altered significantly by the time this report is released. Dioxin sampling is not complete and this is addressed in this report.

This risk assessment is conducted using USEPA standard default guidance for all exposure scenarios and quantitative risk estimates, except for the local eel consumers for whom body weights are increased to reflect adolescent exposures rather than small children.

All exposure scenarios evaluated resulted in risk estimates greater than one (above recommended exposure levels), due primarily to dioxin total equivalents (TEQ) but also from arsenic and lead. Cancer risks were greater than 2 per 100,000 in all scenarios including workers. The constituents contributing to cancer risk were pentachlorophenol, arsenic and dioxin.

The greatest health risk is to local eel consumers, who are exposed through contaminated eel flesh and sediment. Exposures near the sawmill outfall to Kopeopeo Canal are estimated at between ten and 380 times greater than the safe limit of exposure over a lifetime, and excess lifetime cancer risk of between 0.4 and 25 cancers per one thousand people exposed.

From the assessment done in this report, it would not be safe to live anywhere on this site.
Even the worker exposure without effective protection for limited periods of time on an unsealed site shows that dioxin contamination in soils is unsafe, at between one (average scenario in Area 2) and seventy times the hazard quotient or safety limit (Area 3, trench worker for one year). The hazard quotient for the trench worker would remain unchanged with the site in a sealed condition.

Overall, it is clear that the former Whakatane sawmill site remains a source of significant human health risk, the majority of which is the result of dioxin TEQs left in soils and sediment from environmental release of PCP. Although surface sealing may reduce some onsite risk in those areas that are sealed, it will not reduce the onsite risk for ground maintenance workers (trenchworker), unsealed areas or the offsite risk in the Kopeopeo Canal.

1. BACKGROUND

The Whakatane Former Sawmill Site on State Highway 2 West of Whakatane operated between 1949 and 1989. Wood treatment processes used a variety of chemicals including pentachlorophenol (PCP), sodium pentachlorophenate, boron, arsenic, copper and chromium as preservatives. Remediation events to remove contaminated onsite soils were conducted in 1995 and 2004.

Environmental sampling onsite and on adjacent properties has been ongoing since 1993. Media sampled include surface and subsurface soils, groundwater, canal sediments, biota and wood waste.

A full risk assessment to determine the possibility and potential magnitude of hazards to human health from exposures onsite and offsite from the former sawmill has not previously been conducted. Therefore, a preliminary risk assessment using available data and relevant exposure pathways was commissioned by the Regional Council Environment Bay of Plenty. This risk assessment is not intended to be a stand-alone document, but follows on from work previously conducted:

> Tonkin and Taylor Ltd Report for Carter Holt Harvey: Whakatane Former Sawmill Remediation Validation and Ground Contamination Summary. June 2004. 18 pp.
>
> Environment Bay of Plenty 2005a. Whakatane Wood Waste Sites: Investigation of Contaminants in the Receiving Environment. Prepared by Stephen Park, Senior Environmental Scientist and Paul Futter, Senior Project Implementation Officer, Environment Bay of Plenty, Environmental Publication 2005/06, Whakatane, New Zealand. ISSN 1175-9372. 15 pp.
>
> Environment Bay of Plenty 2005b. Investigation of Organic Contaminants in the Kopeopeo Canal. Prepared by Stephen Park, Senior Environmental Scientist, Environment Bay of Plenty, Environmental Publication 2005/23, Whakatane, New Zealand. ISSN 1175-9372. 17 pp.

2. EXPOSURE ASSUMPTIONS USED IN THIS RISK ASSESSMENT

Exposure scenarios were derived using the following information sources:

- Tonkin and Taylor report of June 2004
- Site visit to the former mill site in July 2005
- Consultation with local council Environmental Bay of Plenty
- Consultation with representatives of the local advocacy group SWAP (Sawmill Workers Against Poison)

The 10.4 hectare site itself is currently vacant. It has been previously described for potential subdivision (Tonkin and Taylor 2004) as four main areas: Areas 1 and 2 (the western end of the site, previously residential), Area 3 (central and largest part of the site where previous remediation has taken place) and Area 4 (eastern end of the site, previously housed offices). The proposed land use for some of the site (Area 4 and part of Area 3) is to be paved, with commercial retail buildings put in. Residential land use of other parts of the site is not to be ruled out. Offsite discharges to the local canal dictate the necessity of assessing exposure to local residents who use this waterway.

In this risk assessment the potential risk associated with the proposed development of specific areas of the site have not been addressed. Rather, the potential risks of the unsealed site are described, with some comment made on how sealing might affect the risk. It is up to the reader to judge those risks that will apply most succinctly to the site after development takes place since it is not possible to predict how these changes will affect soil exposures.

Exposure scenarios selected for evaluation in this risk assessment include:

Current and future industrial scenarios: Workers onsite engaged in construction and/or remediation activities. The typical scenario is for a worker onsite during the workday. This site will be used for further development as stated by the current owners.

The worker *trenching scenario* represents a more intense soil exposure from inadvertent soil ingestion over a shorter period of time digging foundations, laying pipe, etc. for the whole site and by individual area.

Future residential, to include all areas of the site (in spite of the fact that some are deemed to be industrial in their future land use).

Current and future recreational scenario: the Kopeopeo Canal, adjacent to the sawmill site on the north, is a waterway that supports eels and has the potential to attract local children in recreational activities. The eels caught from this canal are consumed by local families. Therefore, a local swimming in the canal and an eel consumer exposure scenario is considered for consumption of eels and dermal exposure to contaminants in the canal while fishing, swimming and playing.

Agricultural scenarios should be evaluated as there is pasture-land adjacent to the site, across Marshall Road on the south side of the site. During heavy rain or flood events water can flow offsite to a drainage area in the paddock across the road. This could pose a problem for ecological health, but no visual evidence of boron toxicity to plants surrounding the drainage area was visible at the time of the site visit. However, a lack of environmental data available for adjoining properties where agricultural uses are apparent prevented us from using this exposure scenario.

Table 1. Exposure Assumptions Used in Risk Estimation

	Onsite Worker		Residential (Adult)		Residential (Child)	
	Average	Reasonable Maximum (Trenchworker)	Average	Reasonable Maximum	Average	Reasonable Maximum
Inadvertant soil ingestion by area						
Body weight (kg)	70	70	70	70	15	15
Ingestion rate (mg/day)	50	100 (480 trench worker)	100	100	200	200
Frequency (days/year)	250	250	350	350	350	350
Duration (years)	6.6	25 (1 trench worker)	9	30	6	6
Soil (dust) inhalation						
Inhalation rate (m^3/day)	20	20	5	20	5	10
Dermal soil exposure: Hands, lower legs, forearms and head						
Surface area exposed (cm^2)	5000	5800	5000	5800	2328	2725
Soil Loading (mg/cm^2)	0.2	1.0	0.2	1.0	0.2	1.0
Frequency (days/year)	40	250	40	350	40	350
Recreational swimming dermal exposure in Kopeopeo Canal: whole body						
Body weight (kg)			70	70	29	60
Years exposed			9	30	6	6
Exposed skin surface area (cm^2)			20,000	23,000	11600	21100
Events per year			5	150	5	150
Duration of swimming event (hours)			0.5	1	0.5	1
			Local Eel Consumer (Adult)		**Local Eel Consumer (Child)**	
Consumption of Eels from Kopeopeo Canal						
Body weight (kg)			70	70	29	60
Amount consumed/day (g)			54	100	54	100
Exposure duration (years)			9	30	2	10
Days/year			350	350	350	350
Dermal absorption of sediment for local eel consumers						
Events per year			40	350	40	350
Body parts exposed			Hands, lower legs, forearms and head			
Exposed skin surface area (cm^2)			5000	5800	2328	2725
Soil to skin adherence rate (mg/cm^2-event)			0.2	1	0.2	1

3. TOXICITY VALUES USED IN THIS RISK ASSESSMENT

Toxicity values were selected on the basis of their availability, the reliability of the source and the year of derivation and/or publication. Databases researched include those listed with ITER (International Toxicity Estimates for Risk), a web-based toxicology data source provided by the US Library of Medicine.

Table 2. Toxicity Values Used in this Risk Assessment

Constituent	Oral		Inhalation	
	Reference Dose (mg/kg-day) and target organ	Cancer Risk Slope Factor (kg-day/mg)	Reference Dose (mg/kg-day) and target organ	Cancer Risk Slope Factor $(\mu g/m^3)^{-1}$
Arsenic	0.0003 [B] skin problems	1.5 [B] skin	0.001 [A] lung	0.0043 [B] lung
Boron	0.2 [A] decreased fetal weight			
Chromium	1.5 [B] decreased organ weights			
Copper	0.14 [A] essential element with gastrointestinal effects		0.001 [A] lung, immune system	
Dioxin TEQ	1×10^{-9} [C] developmental toxicity	150,000 [D]		
Lead	0.0036 [A] brain, central nervous system			
Nickel	0.02[B] decreased organ weights			
PCP	0.03 [A] thyroid	0.12 [B]		
Zinc	0.3 [B] blood			

A. RIVM
B. USEPA *(IRIS)*
C. ATSDR
D. Derived from HEAST

4. EXPOSURE POINT CONCENTRATIONS

Independent analysis of chemical concentrations onsite and for Kopeopeo Canal was not within the scope of this report. Exposure data was gleaned from available sources:

- Soil concentrations - Tonkin and Taylor 2004
- Sediment and biota – Environment Bay of Plenty 2005a and 2005b.
- Surface and groundwater concentrations – Tonkin and Taylor 2004, Environment Bay of Plenty 2005a.

Soil

Surface and subsurface soil concentrations were not derived separately in the Tonkin and Taylor report. Both average values and the 95% upper confidence limit of each chemical's concentration in soil overall were made available by Tonkin and Taylor in their June 2004 report on behalf of Carter Holt Harvey. These were listed for the whole site combined (Table 1), Areas 2 and 3 (Tables 2 and 3), and the former Sorting Table Area (page 16 of the Tonkin and Taylor report). See Appendix A of this report. The 95% Upper confidence limit was used as the exposure concentration in both the average and maximum reasonable scenarios, according to EPA guidance (USEPA 1992).

Dioxin TEQ in soil

Values of dioxin TEQ were derived from laboratory reports supplied by Agriquality New Zealand Limited, and converted to units of µg/kg dry weight as reported in the Tonkin and Taylor Report of June 2004.

Full congener analysis using USEPA Method 1613B was available for four samples from this site (two from soil and two from sediment), as found in the Tonkin and Taylor 2004 report and the Environment Bay of Plenty Report (2005b). The relative contribution of 2,3,7,8-TCDD to total dioxin equivalents (TEQ) using the International TEQ[1] for these four samples was small (less than three percent), but the contribution of OCDD and 1,2,3,4,6,7,8-HpCDD combined was roughly half the I-TEQ (between 47 and 65%), for all samples.

In the absence of full congener analysis of dioxin to measure total equivalents **(TEQ), dioxin TEQ were assumed to be equal to twice the OCDD I-TEQ values reported, which were a combined measurement of OCDD and 1,2,3,4,6,7,8-HpCDD using recommended International Toxic Equivalency Factors as quantified below:**

((1234678 HpCDD (ng/g) * 0.01) + (OCDD (ng/g) * 0.001))

Based on the limited amount of information available (four samples), it appears as though dioxin TEQ would not be present in quantities greater than the estimate arrived at from the abbreviated analyses of OCDD and 1,2,3,4,6,7,8-HpCDD that have been used to estimate dioxin TEQ at this site. However, it must be noted with some caution that this assumption has NOT BEEN VALIDATED OR PUBLISHED.

[1].Kutz FW, Barnes DG, Bottimore DP, Greim H and Bretthauser EW. 1990. The international toxicity equivalency factor (I-TEF) method of risk assessment for complex mixtures of dioxins and related compounds. Chemosphere 20:751-757.

Surface Water
Pentachlorophenol in surface water near the site (Kopeopeo Canal) was measured at 0.95 ng/L (9.5 ten millionths of one mg/L) (Environment Bay of Plenty Report 2005a).

Ground Water
Summarised values of the chemicals of potential concern in groundwater by area are not available for this report. Groundwater found onsite is not likely to be used for potable sources as the site falls within city limits and the city of Whakatane is on reticulated water supply. The possibility of future residential land use of ground water is not evaluated in this report.
Dermal exposures to seasonal surface water and groundwater from industrial and future residential exposures were not evaluated in this report.

Sediment
A single value of 22 ng/g (0.022 mg/kg) of PCP was reported in sediment at Site 2a of the Kopeopeo Canal, approximately 1.5 km downstream of the sawmill site outfall.

Sediment concentrations of dioxin TEQ in Kopeopeo Canal near the outfall from the sawmill site were measured in 2004 and 2005 and made available by the Environment Bay of Plenty. Samples were analysed by Agriquality New Zealand Limited using DR-Calux bio-assay and USEPA Method 1613B. The range of values reported was between 12 and 2,300 WHO-TEQ pg/g dry weight. A medium value of 294 pg/g WHO TEQ was selected as the exposure point concentration as it was derived using USEPA Method 1613B (the same method as was used for previous site samples). (The I-TEQ value for the same sediment sample was 432 pg/g.)

Biota
Local eels from the Kopeopeo Canal were sampled during December 2004 and August 2005 in lots of ten to twelve eels per section, over six different sections of the canal. Eel flesh alone was analysed (rather than whole eels) by wet weight using the analytical methods described above for sediment. According to the Bay of Plenty report, TEQ values found in eel flesh are elevated when the sediments are elevated. The TEQ values for the sediment are highest at the sawmill outfall, and “declines with distance from Site 5 [the outfall]”.

The I-TEQ value of 2.92 pg/g was selected as the exposure point concentration as it was derived using USEPA Method 1613B (the same method as was used for previous site samples).

5. RESULTS

Inhalation of dust from onsite soils and dermal exposure to PCP in surface water are not significant exposure pathways (all hazard quotients less than 0.5 and cancer risks less than one per 10 million).

Soil ingestion and dermal absorption are significant pathways for dioxin TEQ (see tables 3 and 4 below), arsenic and lead. Hazard quotients greater than 0.5 from future residential soil ingestion and dermal exposure under the reasonable maximum exposure scenario include the following:

Lifetime Arsenic Hazard Index = 1.8 (whole site), 3.3 (Area 2) and 1.5 (Area 3)
Lifetime Lead Hazard Index = 1.3 (Area 2)

Among workers, lifetime hazard indexes for lead and arsenic by ingestion and dermal exposure are each 0.3 (nonsignificant) in Area 2.

Significant risks from dioxin TEQ exposures under the following scenarios are reported in Tables 3 and 4 below.

The highest single risk exposure in this analysis is regularly fishing in Kopeopeo Canal with hands, lower legs, forearms and head exposed to contaminated sediment. The lifetime hazard index for an exposed person would be between 25 and 559 times over a safe dioxin dose from a combination of catching and eating eel. The combined excess lifetime cancer risk (child plus adult reasonable maximum) is 2.9 cancers per one hundred people exposed. It is notable that these exposures are evaluated using exposure point concentrations estimated using full congener analysis of dioxin TEQ as per the Environment Bay of Plenty report, 2005. Note – It should be noted that off site remedial action is required to address the risk associated with the Kopeopeo Canal. Onsite remediation cannot eliminate this risk.

Cancer risks onsite and offsite (Table 4) are several orders of magnitude greater than the recommended environmental exposure limit of one per million. The greatest contributor to the overall cancer risk is dioxin TEQ (between 91 and 99 percent of total cancer risk), followed by arsenic (between less than one and six percent) and pentachlorophenol (less than one to two percent). Inhalation of dust from onsite soils is not a significant contribution to the overall cancer risk.

For future residents it is of note that even in Area 2 (previously described as "clean"), there is significant health risk from inadvertent soil ingestion and dermal exposures to not only dioxin but also to lead, arsenic and pentachlorophenol (PCP). Lifetime noncancer risks are between 27 and 35 times greater (rounded values) than a safe exposure limit from dioxin alone. Lifetime excess cancer risks are 2.6 per one hundred thousand (1×10^{-5}) for PCP, and 9.4 per one hundred thousand for arsenic under the reasonable maximum residential scenario.

Industrial scenario results indicate that even under short-term exposure scenarios as those suggested by the developers (one year for the trenchworker, for example), workers are likely to be exposed to levels of dioxin equivalents that are as high as 70 times the safe exposure limit. While sealing the site may eliminate soil exposure pathways for most regular users of the site, the exposure risk for the trenchworker will not be affected by this action alone.

Therefore, none of the evaluated uses of this site in an unsealed state are safe for human health concerns given the level of contamination found so far.

Table 3. Noncancer Dioxin TEQ Hazard Quotients from Dioxin TEQ in Soils, Sediment and Biota

	Current Industrial		Future Residential Adult		Future Residential Child	
	Average	Reasonable Maximum (trenchworker)	Average	Reasonable Maximum	Average	RME
Inadvertant Soil Ingestion by area						
Whole site	4.3	8.6 (41.3)	12.1	12.1	112.5	112.5
Area 2	0.9	1.8 (8.9)	2.6	2.6	24.2	24.2
Area 3	6.1	12.3 (58.9)	17.2	17.2	160.3	160.3
Sorting Table Area	4.5	9.0 (43.2)	12.6	12.6	117.6	117.6
Dermal Soil Exposure by area						
Whole site	0.2	8.0	0.2	11.2	0.5	24.5
Area 2	0.05	1.7	0.0	2.4	0.1	5.3
Area 3	0.3	11.4	0.3	15.9	0.7	35.0
Sorting Table Area	0.2	8.4	0.2	11.7	0.5	25.6
Hazard Index for combined exposure routes by scenario and area						
Whole site	4.5	16.6 (49.3)	12.3	23.3	113.0	137.0
Area 2	0.95	3.5 (10.6)	2.6	5.0	24.3	29.5
Area 3	6.4	23.7 (70.3)	17.5	33.1	161.0	190.2
Sorting Table Area	4.7	17.4 (51.6)	12.8	14.3	118.1	143.2
			Local Consumer (Adult)		**Local Consumer (Child)**	
Consumption of Eels from Kopeopeo Canal						
			2.2	4.0	5.2	4.7
Dermal absorption of sediment in Kopeopeo Canal						
			7.4	375.0	9.7	175.6
Hazard Index for combined exposure routes by scenario						
			9.6	379.0	14.9	180.3

Table 4. Lifetime Excess Cancer Risks (per head of population) from Exposure to Dioxin TEQ, PCP and Arsenic in Soils, Sediment and Biota

	Current Industrial		Future Residential Adult		Future Residential Child	
	Average	Reasonable Maximum (trenchworker)	Average	Reasonable Maximum	Average	RME
Inadvertent Soil Ingestion by area						
Whole site	6.2×10^{-5}	4.7×10^{-4} (9.1×10^{-5})	2.4×10^{-4}	8.0×10^{-4}	1.5×10^{-3}	1.5×10^{-3}
Area 2	1.5×10^{-5}	1.1×10^{-4} ($2.2 X 10^{-5}$)	5.7×10^{-5}	1.9×10^{-4}	3.6×10^{-4}	3.6×10^{-4}
Area 3	8.8×10^{-5}	$6.7 X 10^{-4}$ (1.3×10^{-4})	3.4×10^{-4}	1.1×10^{-3}	2.1 x 10-3	2.1×10^{-3}
Sorting Table Area	6.4×10^{-5}	4.8×10^{-4} (9.3×10^{-5})	2.4×10^{-4}	8.1×10^{-4}	1.5×10^{-3}	1.5×10^{-3}
Dermal Soil Exposure by area						
Whole site	3.4×10^{-6}	4.7×10^{-4}	4.6×10^{-6}	7.8×10^{-4}	6.7×10^{-6}	3.4×10^{-4}
Area 2	9.4×10^{-7}	1.3×10^{-4}	1.3×10^{-6}	2.2×10^{-4}	1.9×10^{-6}	9.5×10^{-5}
Area 3	4.7×10^{-6}	6.5×10^{-4}	6.4×10^{-6}	1.1×10^{-3}	9.3×10^{-6}	4.8×10^{-4}
Sorting Table Area	3.7×10^{-6}	5.0×10^{-4}	5.0×10^{-6}	8.5×10^{-4}	7.3×10^{-6}	3.7×10^{-4}
Cancer Risk for combined exposure routes by scenario and area						
Whole site	6.5×10^{-5}	9.4×10^{-4} (2.8×10^{-3})	2.4×10^{-4}	1.6×10^{-3}	1.5×10^{-3}	1.7×10^{-3}
Area 2	1.6×10^{-5}	2.4×10^{-4} (1.2×10^{-3})	5.8×10^{-5}	4.1×10^{-4}	3.6×10^{-4}	4.6×10^{-4}
Area 3	9.3×10^{-5}	1.3×10^{-3} (3.9×10^{-3})	3.4×10^{-4}	2.2×10^{-3}	2.2×10^{-3}	2.6×10^{-3}
Sorting Table Area	6.7×10^{-5}	9.8×10^{-4} (2.8×10^{-3})	2.4×10^{-4}	1.7×10^{-3}	1.6×10^{-3}	1.9×10^{-3}
			Local Consumer (Adult)		**Local Consumer (Child)**	
Consumption of Eels from Kopeopeo Canal						
			4.2×10^{-5}	2.6×10^{-4}	2.2×10^{-5}	1.0×10^{-4}
Dermal absorption of sediment in Kopeopeo Canal						
			1.4×10^{-4}	2.4×10^{-2}	4.2×10^{-5}	3.8×10^{-3}
Cancer Risk for combined exposure routes by scenario						
			1.8×10^{-4}	2.4×10^{-2}	6.4×10^{-5}	3.9×10^{-3}

6. SOURCES OF UNCERTAINTY IN THE RISK ASSESSMENT

6.1. Dioxin Contamination

Concentrations of 2,3,7,8-TCDD were not measured throughout the site.

It has been assumed thus far that dioxin contamination at this site is adequately measured by the analysis of two dioxin congeners, OCDD and 1,2,3,4,6,7,8-HpCDD.

The full extent of dioxin contamination at this site remains a source of uncertainty in this risk assessment, and will require further testing to provide more accurate risk assessment results.

Background Dioxin Concentration – It is important to consider the existing risk to human health from background or ambient concentrations of dioxin, especially if these are greater than onsite risks. A background value for dioxin TEQ in flat land pasture of 0.52 ng/kg dry weight was obtained from the MfE Soil Survey (Buckland et al 1998). This did not contribute significantly to the results derived in this report, as background TEQ is four orders of magnitude less than site concentrations.

6.2. Exposure Factors

Standard USEPA guidance was used for default exposure factors in calculating the amount of each site constituent the exposed subjects were exposed to in each scenario.

These are available in the absence of site-specific data.

However, there are some limitations to using standard assumptions for this site. One of these limitations is that local data concerning the indigenous Maori and other populations may differ significantly from default values.

Eel Consumption: Using standard default exposure parameters (USEPA 1991a), it is assumed that a local resident will eat 54 to 100g/day of local fish (eels). This is the same as 1.6 - 3.1 kg/person-month. Previous New Zealand estimates have been quoted in the range of 2.5 - 7.3 kg/person-month, but it is unlikely that all eels consumed by a single family would come from the area of the sawmill outfall in Kopeopeo Canal on a regular basis.

Canal exposure: Using the average default dermal exposure factors found in Table 8-6 of the Dermal Exposure Assessment: Principles and Applications document (USEPA 1992) and discussed in further guidance (CalEPA 2000), the average child who swims in the Kopeopeo Canal has been assumed to swim for 30 minutes to an hour on 5 to 150 days per year, and is exposed to sediments on 40 to 350 occasions per year.

These may be overestimates or underestimates of actual exposures at the site. However, without valid alternatives of local data to rely on, default exposure factors remain best practice. A detailed survey of exposure factors for local residents was not within the scope of this report, but could be undertaken at some stage in the future for this and other sites in the area.

In the dermal exposure route we used the lower exposure assumptions for the soil to skin adherence factor of 0.2 to 1 mg/cm2 (a factor of 10 would be more realistic, given the muddy quality of the canal banks (CalEPA 2000)). This has lowered the risk estimate that would have otherwise been obtained.

Default values for adolescent body weights and years spent playing in the canal and/or fishing were not available from standard guidance – therefore, a maximum of 10 years and a minimum of two years' exposure, with body weights of 29 and 60 kg, respectively, were assumed for the recreational child exposure scenarios.

6.3. Inhalation of Dust, Volatiles and Vapours

Assessment of human health risk from inhalation exposures relies on the availability of suitable toxicity data. For the chemicals of potential concern at this site, there were only two inhalation reference doses available – those of arsenic and copper.

Therefore, the inhalation risks of other onsite constituents were not evaluated.

Onsite groundwater as an inhalation exposure pathway for volatile organics in the industrial trenching scenario was not analysed, since inhalation toxicity values for volatile compounds of interest (PCP) were not available.

6.3.1. Exposure Concentrations

Uncertainty with regard to actual exposure concentrations and those derived from site sampling is an inherent inaccuracy when predicting human health risk. As previously stated, the author of this report made no attempt to collect new data or to derive exposure point concentrations from available data. Had I conducted this exercise, I may have reached different exposure point concentrations than those previously reported. Whether the risk values derived here are an overestimate or underestimate of a more precise calculation is not possible to determine.

Onsite soils: Under the exposure scenarios used, there would ideally be separate measurements of surface and subsurface soils available for risk assessment. This is because surface soils are more exposed and prone to erosion, more likely to be inadvertently ingested, etc. while subsurface soils are more important in the short-term industrial scenarios where builders will be involved in digging soils, etc.

Without separate values for surface and subsurface soils we were obliged to assume homogeneity of site soils, which may increase or decrease derived risk profiles. The overall effect is a likely "washout" effect whereby the risk from the whole site is distributed evenly on paper but not by individual area at the physical site. In conclusion, localised "hot spots" may exist that are not apparent from this risk assessment. In particular, two soil samples in Area 2 had high lead concentrations (782 and 786 mg/kg): this has not been addressed with historical information to establish the lead source, nor is the extent of the lead contamination known.

6.3.2. Uncertainty in the Toxicity Value for DIOXIN TEQ

The endpoint used to derive the toxicity threshold for dioxin by ATSDR in 1998 was reproductive toxicity in rhesus monkeys who were chronically exposed to dioxin. No "safe" level of exposure was reached in this study. The lowest observable effect level (LOAEL) was determined by the lowest dose administered, and after applying an uncertainty factor of 90 to this, the reference dose was derived. It is possible that humans may be more or less sensitive to the reproductive effects of dioxin than the rhesus monkey.

The reference dose of 1×10^{-9} mg/kg-day as derived from the above study matches exactly the Interim Maximum Monthly Intake (IMMI) recommended by the Organochlorines Technical Advisory Committee (OTAG) to the Deputy Director-General of Public Health in 2002 (Ministry of Health, 2002). This value, set at 30 pg TEQ/kg-month, is the monthly summary value of the WHO recommendation of a Tolerable Daily Intake (TDI) set at 1 to 4 pg/kg-day by the WHO (Van Leeuwen and Younes, 2000).

As the ATSDR derived a reference dose using standard quantitative methods for dose-response evaluation that was equal to the WHO's TDI and OTAG's IMMI, the value of 1×10^{-9} mg/kg-day was the toxicity reference value of choice for this risk assessment. Since there is no "safe" level of exposure to dioxin previously identified, it is unlikely that this reference dose represents an overestimate of the risk at this site.

7. CONCLUSIONS

The interpretation of a hazard quotients or a hazard index is that any value greater than 1.0 represents a hazard to human health above that which is known to be safe. Likewise, cancer risks greater than one per million are interpreted as higher than desirable. In the case of the dioxin hazard at this site, the current risk assessment presents information that the hazards from living on or working at the old sawmill site, in its unsealed state, are literally hundreds of times higher than safe limits would permit. Playing in the nearby Kopeopeo Canal is also literally hundreds of times higher than safe limits would permit.

Significant uncertainties with regard to the concentration of dioxin onsite remain. The methodology used in this assessment (doubling of the TEQ from OCDD and 1,2,3,4,6,7,8-HpCDD) has not been validated or published. It was recommended by several relevant stakeholders as a substitute for full congener analysis measurements, and was used in proxy for having such data. However, in light of the fact that dioxin is driving the risk assessment, and none of the areas tested can be assumed to be safe from the exposure scenarios evaluated so far, it is prudent to have sufficient dioxin testing using full congener analysis conducted.

There is no uncertainty with regard to concentrations of dioxin from eels and sediment in Kopeopeo Canal, as these exposure point concentrations were derived using full congener analysis and easily verifiable sampling methods from the information provided. The risk estimates to local eel consumers and users of the canal are accurate to the best of our quantitative predictive ability.

Overall, it is clear that in an unsealed condition the former Whakatane sawmill site remains a source of significant human health risk, the majority of which is the result of dioxin TEQs left in soils and sediment from environmental release of PCP.

Although surface sealing may reduce some onsite risk in those areas that are sealed, it will not reduce the onsite risk for ground maintenance workers (trenchworker), unsealed areas or the offsite risk in the Kopeopeo Canal.

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APPENDIX A

Soil Concentrations from Tonkin and Taylor 2004 report

	Whole Site		Area 2		Area 3	
Analyte	Average (mg/kg)	UCL	Average (mg/kg)	UCL	Average (mg/kg)	UCL
PCP	6.4	17.5	0.81	5.2	8.4	22.01
Boron	429	1181.5	93	276	525.8	1111.5
Arsenic	11.7	23.02	11.4	27.8	5.5	12.5
Copper	46.7	111.8	71.2	199.7	19	22.4
Chromium	13.5	14.42	13.2	14.6	16.2	18.3
Nickel	13.26	17.76	13.7	20.4	12.5	14.3
Lead	50.14	125.5	76.7	276.4	33.3	55.7
Zinc	84	108	92.4	109.4	70.4	80.2
OCDD I-TEQ	0.83 µg/kg	4.4 µg/kg	0.263 µg/kg	0.945 µg/kg	0.78 µg/kg	4.4 µg/kg

Sorting Table

Analyte	Average (mg/kg)	UCL
PCP	17.2	94.1
Boron	76.1	152
Arsenic	not reported	not reported
Copper	not reported	not reported
Chromium	not reported	not reported
Nickel	not reported	not reported
Lead	not reported	not reported
Zinc	not reported	not reported
OCDD I-TEQ	0.57 µg/kg	4.6 µg/kg

Appendix B

Absorption Fraction used in dermal exposure scenarios

Constituent	Absorption fraction	Reference
Dioxin	0.016	USEPA 1992
PCP	0.25	CalEPA 2004
Boron	0.01	CalEPA 2004
Arsenic	0.04	CalEPA 2004
Copper	0.01	CalEPA 2004
Lead	0.01	CalEPA 2004
Zinc	0.01	CalEPA 2004
Chromium	0.01	CalEPA 2004
Nickel	0.0002	CalEPA 2004

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Peer Review of the ESR Report on Human Health Impact Assessment – Whakatane Old Sawmill Site

Report to Environment BOP

Prepared by Dr Bruce Graham

March 2006

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Contents

Peer Review of the ESR Report on Human Health Impact Assessment – Whakatane Old Sawmill Site

1. Introduction

This report provides an independent peer review of an ESR[1] report entitled *Abbreviated Assessment of Human Health Impact from Whakatane Old Sawmill Site* (ESR client report FW05121, December 2005).

The ESR report gives a health risk assessment of possible human exposures to contaminated materials on or near the Old Sawmill site in Whakatane. This site was used as a sawmill and timber treatment plant from 1949 to 1989. Extensive remediation works have since been carried out at the site to address the contamination caused by the previous activities, and it is now being redeveloped for commercial use.

The assessment by ESR was based on existing data for soil contamination levels at the site. The risks from contaminated sediment and eels taken from the nearby Kopeopeo Canal were also assessed. This canal was the main discharge point for stormwater run-off from the site.

A number of different aspects of the ESR report have been evaluated for the peer review, and are discussed in the following sections, as indicated below:

- Assessment methodology, including exposure data, exposure scenarios, risk factors and other assumptions (covered in section 2 of this review)
- Risk calculations, including accuracy and significance of the results (section 3)
- Report conclusions and qualifying remarks (section 4)
- Presentation aspects (section 5).

The review concludes with an overall summary and conclusions (section 6).

2 Review of the Assessment Methodology

The method used for the ESR assessment was to take so-called 'exposure point concentrations' (ie. contaminant levels in soil, sediment, water and eels), convert these into possible exposures for a number of different scenarios (eg. on-site residence, trench digging, eel consumption), and assess the potential risks by relating the exposure levels to published risk factors. Each of these steps is discussed below.

2.1 Exposure Data

The exposure concentrations used by ESR were presented and discussed in section 4 and Appendix A of their report.

The main source of the soil concentration data was a report by Tonkin and Taylor (2004). This report gives a summary and analysis of the results for about 450 samples taken from the site, of which 264 were analysed for boron, 71 for arsenic, chromium and copper, 61 for lead, nickel and zinc, 431 for pentachlorophenol, and 32 for dioxins (as OCDD[2]). These numbers of samples give a high degree of confidence that the results are representative of actual concentrations throughout the site. The statistically-determined

1 ESR = Institute of Environmental Science & Research, Porirua, Wellington, New Zealand.
2 OCDD = octachlorodibenzo-*p*-dioxin

95% upper confidence level was used in the risk calculations, which provides for a reasonable 'worst-case' approach.

Contaminant levels for water, sediment and eels from the Kopeopeo canal were taken from two recent reports by Environment BOP (EBOP, 2005a and b). The results for water and sediment appear to be based on single samples, while those for eels are based on a single composite of twelve samples (eels). While these numbers are very limited, it should be noted that the samples were part of a much wider survey of sites in the area and, as such, can be taken as representing a 'worst-case' situation for canal contamination.

All of the above samples appear to have been collected by suitably trained personnel, using standard sampling procedures. Analyses were done by accredited laboratories using standard analytical methods.

2.2 Exposure Scenarios

A number of different exposure scenarios were considered in the report, using a variety of exposure factors, which are discussed below. These exposure factors can be compared with those used previously in New Zealand by the Ministry for the Environment (MfE, 1997a and b) and a more widely recognised set of recommendations from the US (USEPA, 1997).

Adult/Child Parameters: body weights of 70 and 15 kg were used, respectively, which is consistent with the values used by MfE, although the US EPA has recommended the slightly higher figure for adults of 71.8 kg.

ESR also used a body weight range of 29 to 60 kg for assessing the consumption of eels by adolescents. This is consistent with the range given by the EPA for children between 9 and 16 years of age.

Activity Duration: ESR considered a range of time periods depending on the exposure scenario (trench worker, worker, resident, time spent swimming, etc). The choice of time periods is relatively subjective, but I understand these were agreed in advance with Environment BOP and other participants in this study. They are also generally consistent with periods recommended by the US EPA (eg. population mobility: 9 to 30 years, occupational tenure: 6.6 years).

Soil Ingestion Rate: the ingestion rates of 50, 100, 200 and 480 mg/day are higher than those used by MfE (25, adult, 100, child and 'maintenance' worker) but more consistent with the EPA recommendations. They are also appropriate for a worst-case approach.

Inhalation Exposure: the breathing rates of 5, 10 and 20 m^3/day are generally consistent with the rates used by MfE and the US EPA. The inhalation calculations also require an estimate of the concentration of dust in air, and I am advised by ESR that this was derived using a particulate emission factor (PEF) of 4.63×10^9 m^3/kg. This factor implies significantly lower dust concentrations than those used by MfE (1997a) in their development of the timber treatment site guidelines (PEFs of 1.9×10^8 and 2.9×10^7 m^3/kg, for residential and industrial settings, respectively). The MfE factors are based on realistic estimates of dust concentrations in New Zealand. I therefore suspect that the risk estimates for dust exposure have been significantly underestimated, but am unable to check this as there are no results given in the ESR report.

Skin exposure and absorption: The skin surface areas of 5000/5800 and 2328/2725 cm^2, for adults and children respectively, are similar to the figures used by MfE. The calculations for skin absorption also require the use of a soil-to-skin adherence factor, and an absorption factor for each contaminant. The factors used by ESR were taken from recognised sources and are listed in Appendix B of their report.

Eel Consumption: the ESR assessment was based on US recommendations although, as indicated on page 12 of the report, the consumption rate is quite consistent with fish consumption rates used previously in New Zealand. A more important issue here, as acknowledged in the report, is whether or not the rates of consumption could actually be sustained by eels taken solely from this short section of the Kopeopeo Canal.

2.3 Risk Factors

Two types of risk factors, or toxicity values, were used in the ESR assessment, as indicated in section 3 of their report. These are as follows:

Reference Dose (RfD): this is used for non-cancer effects and has been defined as "*an estimate of daily exposure to the human population that is likely to be without appreciable risk of deleterious effects during a lifetime of exposure*" (MfE, 2001).

The values of RfD used by ESR are listed in Table 2 of their report, for each of the contaminants. These factors were taken from various recognised sources, as indicated in the table, and I can see no problems with the factors chosen.

Cancer Risk Factors: these give an indication of the potential risk of increased cancers from a lifetime exposure to a unit dose of each contaminant, and are sometimes also referred to as Cancer Potency Factors. As an example, the factor of 1.5 for arsenic (see ESR Table 2) indicates an additional risk of 1.5 cancers from a lifetime exposure to arsenic at a rate of 1 mg per kg of body weight, per day. Once again, the factors used by ESR were taken from recognised sources.

The only factor which needs further discussion is that for dioxin. The figure of 150,000 $(mg/kg\text{-}day)^{-1}$ is stated to have been derived from a US EPA document (*Health Effects Assessment Summary Tables*), although there is no indication of how the figure was actually derived. Other references give a range of risk factors for dioxins (eg. MfE, 2001 and USEPA, 2004) and prior to 2004, the factor more commonly recommended by the EPA was 1.6×10^{-4} $(pg/kg\ bw/day)^{-1}$. This is equivalent to 160,000 $(mg/kg\text{-}day)^{-1}$ and therefore reasonably comparable to the factor quoted by ESR[3].

In 2004 the EPA proposed a revised factor for dioxins of 1×10^{-3} $(pg/kg\ bw/day)^{-1}$. This factor has not yet been widely adopted for use in risk assessments and it is therefore appropriate that the ESR report should be based on the older, more widely recognised, factor. However, it should be noted that if the new factor had been used the estimated cancer risks would have been about 6 times higher than those given in the report.

2.4 Other Assumptions

Two other assumptions should be noted, as follows:

TEQ Estimates: some of the dioxin figures reported by Tonkin and Taylor were based on a limited analysis for only the hepta- and octa- congeners, and the toxic equivalent values for these results were doubled to give an approximation of the full congener analysis (tetra- to octa-). The ESR report expresses some reservations about this

[3] 1 picogram (pg) = 10^{-9} milligrams or, conversely, there are 10^9 picograms in a milligram

approach. However, it is well supported by the more detailed analyses reported by both Tonkin and Taylor and Environment BOP. It is also quite consistent with the known dioxin congener distributions in the pentachlorophenol timber treatment products (eg. MfE, 1997a and WHO, 1987).

Soil Variations with Depth: this was also noted as a possible limitation in the ESR report, in that the values for soil concentrations (ESR Appendix A) were assumed to be evenly distributed across all soil depths. The Tonkin and Taylor report (2004) does, in fact, include information on variations with depth, although most samples were taken from the top 0.5 metres. Some of the samples collected at lower depths show higher concentrations of pentachlorophenol, which would be consistent with its moderate soil mobility. As such, the risk estimates for trench worker exposures to pentachlorophenol have most likely been under-estimated.

3. Review of the Risk Calculations

There was no information given in the ESR report on the methodology used for the risk calculations, although they appear to have been based on standard methodologies (eg. MfE, 1997a and b).

3.1 Non-Cancer Hazard Quotients

Hazard quotients are calculated from the daily intake divided by the reference dose. In other words, the quotient indicates whether the calculated dose is higher or lower than the recommended 'safe' level (see 2.3 above) and by how much. As such, it is simply a crude indicator of relative risk, rather than providing any measure of likely effects.

The results for non-cancer hazard quotients were given in Table 3 of the ESR report. Some of the values given in the table were checked by repeat calculations, and found to be correct. In addition, all of the values in the table were checked for internal consistency within each exposure scenario.

My only reservation with these calculations is the reporting of single (combined) hazard quotients for all contaminants. This has apparently been done for the sake of simplicity but is debatable, given that the different contaminants have different effects (eg. skin problems for arsenic, thyroid for pentachlorophenol). However, I would concede that the issue is not really relevant when the combined quotients have values in the order of tens or hundreds. It is only significant when the combined total is close to a value of one.

3.2 Excess Cancer Risks

The calculations for excess cancer risk are more complicated than for the hazard quotients, but can be expressed quite simply by the equation:

Risk = Chronic Daily Intake x Cancer Slope Factor

The figures for daily intake are adjusted to give time-weighted exposures over a full lifetime, and the results then multiplied by the risk factors discussed in section 2.3 to give a lifetime risk estimate.

Checks on the risk calculations for the results given in Table 4 indicated that some of the values were incorrect. This was confirmed by ESR, and a revised version of the Table was received for review on 3 March. I am satisfied that the figures given in this version of Table 4 are correct.

As noted previously, the calculated risks for dioxin exposures would be about six times higher than those shown in the table, if the more recent US EPA risk factor had been used.

4. Review of the Results and Conclusions

The results of the ESR assessment were presented in section 5 of their report, followed by some fairly broad conclusions in section 7. The key points from these are summarised below, along with my comments, as appropriate.

Dust inhalation: stated to be not significant, although no results were presented to demonstrate that this was the case. In addition, the particulate emission factor used for these calculations may have been unrealistically low.

Residential Child Exposures: hazard quotients for soil ingestion are very high and so are the cancer risks, even for the average exposure scenarios. This clearly supports the conclusion that the sawmill site is not suitable for residential use.

Residential Adult Exposures: comments as for child exposures above.

Worker Exposures: the hazard quotients and cancer risks are slightly lower than for residential exposures, as would be expected for the shorter exposure periods, but the risks are still unacceptably high. However, it should be recognised that this assessment was based on the assumption that the site was unsealed. Covering the site with concrete or asphalt is an effective method of sealing in the contaminants, and effectively reducing the worker risk to zero. The only exception to this is activities that might involve breaking through these surfaces, such as trench digging (see below).

Trench Worker Exposures: the hazard quotients and cancer risks for this scenario are also high, despite the much shorter exposure periods. These results clearly demonstrate the need for an effective site management plan during the development of this site, including specific measures for employee protection (such as the use of protective clothing by those workers involved in extensive earthworks). They also demonstrate the need for the same precautions in any future site maintenance activities involving such excavations.

Swimming or Fishing in the Canal: the results for skin exposures to pentachlorophenol while swimming in the canal were not reported, but were simply stated to be not significant. The hazard quotients and cancer risks from sediment exposure were all very high, although it should be noted that the exposure assumptions are fairly extreme (mud exposures over the entire area of both arms, lower legs and head, and swimming for up to 150 days a year). Nonetheless, the results indicate the need for public health warnings against the use of this part of the canal, and extensive site remediation. I understand that Environment BOP has already initiated action on both of these matters.

Eel consumption: once again, the results indicate a significant exposure risk, although all of the scenarios required the sustained consumption of 54 or 100g of eels for 350 days of the year. This equates to a weekly consumption of between about 2 and 4 eels, per person (based on the median eel weights reported in EBOP, 2005b), which may not be sustainable from the relatively short section of the canal. I understand that a public health warning has already been issued for the taking of eels from this section of the canal.

5. Presentation Aspects

The ESR report appears to have been written with a reasonably specialised audience in mind and, as such, I suspect many people will find it difficult to follow. In particular the report would benefit from more attention to the following:

- Explanations of the various factors and other parameters used in the assessment
- A description of the calculations used for hazard quotients and cancer risks
- Brief definitions or explanations of all technical terms, acronyms, abbreviations and units
- A more systematic layout and presentation within each section, especially 5
- Some key direction pointers for the reader (eg. one might expect section 5 to start with a statement that 'results are presented in Tables 3 and 4 and discussed below')
- A clearer listing (eg as bullet points) of the key conclusions from the work.

Two other specific matters were noted as follows:

Toxic Equivalents: a number of schemes have been developed for calculating dioxin toxic equivalents, and two such schemes were relevant to the report—those commonly referred to as the WHO scheme (TEQ-WHO) and the International scheme (I-TEQ). There are differences between some of the factors used in each of these schemes and this is reflected in the reporting of analytical results. The report is quite lax in the way these differences are handled, in that some values are quoted on the basis of one or the other scheme, some are given in both, and in other cases the basis is not quoted at all. It would have been more appropriate to have worked exclusively in one scheme, and made a clear statement near the start of the report as to which was being used.

On-site Versus Off-site: the use of these terms in the report is occasionally confusing—for example, I am not sure what to make of the statement on page 8 that 'off site remedial action is required to address the risk associated with the Kopeopeo canal'?

6. Summary and Conclusions

The key points from this peer review can be summarised as follows:

1. The exposure data used for the assessment provide acceptable 'worst-case' values for all of the exposure scenarios.
2. The various parameters used for the exposure assessments are generally consistent with those recommended or used by other agencies, with the exception of the particulate emission factor used for inhalation exposures, which appears to be based on relatively low dust levels.
3. The risk factors used in the assessment were taken from appropriately recognised sources, although the factor used for dioxins is lower than the figure recommended most recently (2004) by the US EPA.
4. Other assumptions made in the report were generally acceptable, although the trench worker exposures may have been underestimated by assuming uniform soil distributions of pentachlorophenol.
5. An initial cross-check on the calculations indicated possible errors in some of the figures given in Table 4. A revised version of the table was received on 3 March, and I am satisfied that all of the figures given in Tables 3 and 4 are now correct.

6. The readability of the report could have been improved by greater attention to the various presentation matters noted in section 5 above.

In conclusion, I have a few reservations about the report, as noted above, but nonetheless consider that the overall conclusions are sound.

B W Graham

4 March 2006

Appendix 1: List of Documents Consulted for this Review

EBOP, 2005a. Whakatane Wood Waste Sites: Investigation of Contaminants in the Receiving Environment. Environment Bay of Plenty, Environmental Publication 2005/23.

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