Kopeopeo Canal Remediation Project

Discharge Water Quality from the Kopeopeo Canal Containment Sites

Bay of Plenty Regional Council

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Prepared By

James Gladwin
Environmental Scientist

Reviewed By

Peter Askey
Principal Environmental Engineer

Approved for Release By

Brendon Love
Project Manager Kopeopeo Canal Remediation

Opus International Consultants Ltd
Whakatane Office
Level 1, Opus House, 13 Louvain Street
PO Box 800, Whakatane 3158
New Zealand

Telephone: +64 7 308 0139
Facsimile: +64 7 308 4757

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Glossary

BOPRC	Bay of Plenty Regional Council
Dewatering	The removal of water from canal sediments.
Dioxin	A group of chemically-related compounds that are persistent organic pollutants (POPs). They are found throughout the world in the environment and they accumulate in the food chain, mainly in the fatty tissue of animals and are highly toxic. They are associated with sawmill contamination due to their presence as a by-product in the historically used timber preservative pentachlorophenol.
Dredging	Removal of sediment from the bottom of the canal.
Filtrate	Water discharged as a result of the dewatering process.
HDPE	High-density polyethylene
I-TEQ Upper	International Toxic Equivalency Upper: Maximum theoretical level for dioxin in any given sample. Records dioxins and furans only.
Lowest observed adverse effects level (LOAEL)	The lowest dose or concentration of a toxicant that causes a significant increase in the frequency or severity of an adverse effect when compared to the frequency or severity of the same effect in an unexposed control population.
No observed adverse effects level (NOAEL)	The highest dose or concentration level of a toxicant at which the incidence of a toxic effect was not significantly different from the untreated group (from a statistical and biological assessment). The NOAEL will depend on the sensitivity of the methods used, the sizes of the exposed groups and the differences between estimated exposures or doses. The NOAEL is an observed value that does not take into account the nature or steepness of the dose.
NTU	Nephelometric Turbidity Units
pg/L	Picogram (10^{-12}) per litre
Turbidity	The measure of water clarity i.e. how much the material suspended in water decreases the passage of light through the water.
WHO-TEQ Upper	World Health Organisation Toxic Equivalency Upper: Maximum theoretical level for dioxin in any given sample. Records dioxins, furans and PCBs.

Contents

1 Introduction

The remediation of the Kopeopeo Canal involves the removal and treatment of dioxin contaminated sediment from a 5km stretch the Kopeopeo Canal near Whakatane. SKM, ESR and ToxConsult completed a series of risk assessment reports that were submitted in support of the Assessment of Effects (AEEs) as part of the original consent application. These assessments concluded that 60pg/g was a suitable target post remediation for sediments in the canal for the purpose of protecting of human health. This level was set as a condition in consent 67173. The consented level now forms the baseline against which the proposed methodology is assessed. A further assessment completed by Wildlands assessed the remediation methodology and made comment on its effects on ecology.

The currently consented methodology involves the dewatering of sections of the Kopeopeo Canal and excavating the dioxin contaminated sediment. This is followed by the use of geotextile containment cells at three locations where the sediment is further dewatered and bioremediated to break down dioxins into their non-toxic components. The current consent allows for filtrate from these containment sites along with rainwater to seep through the containment site into groundwater. A new methodology has been proposed that would utilise dredging sediment from the canal, pumping the slurry along a pipeline to the containment sites where it is treated and contained within geotextile bags (geobags) within an impermeable HDPE lined containment cell. The treated water and rainfall that collects within the containment area is then is then returned into the Kopeopeo Canal.

Two distinct phases of discharge is proposed under the new methodology. Phase 1, the treatment phase will occur during active dredging when a high volume of dredged and treated canal water is returned to the canal. During this phase control measures will be in place within the canal that will limit the migration of any particulate within the canal. Phase 2 occurs following the dredging phase when residual water and rainfall is discharge back into the canal. During this phase the discharge is lower in volume but will continue for a number of years.

2 Scope of Work

Bay of Plenty Regional Council (BOPRC) have requested that Opus International Consultants review the consented and proposed methodologies with specific regard to discharging filtrate back into the Kopeopeo Canal and not to groundwater.

3 Current Methodology

The current consented methodology involves the dewatering and excavation of the dioxin contaminated sediment from the canal. This is followed by the use of geotextile containment cells at three locations where the sediment is further dewatered and bioremediated to break down dioxins into their non-toxic components. The current consent allows for filtrate from these containment sites along with rainwater to seep through the containment site into groundwater.

Jacobs (2016) note that "*three containment sites are proposed, these are referred to as CS1, CS2 and CS3. The current containment cell design at the containment sites consists of a large bunded cell, which is divided into sub-cells by the use of internal bunds. Each sub-cell is lined with a permeable geotextile fabric which is designed to act as a filter and prevent all but the finest colloidal material from leaving the cell. Excavated sludge is placed directly in the cells, and is allowed to drain naturally through the base of the cells.*

Once dewatered, the sediment is inoculated with fungi, trees are planted and the bioremediation process commences" (Baker, 2016).

4 Proposed Methodology

The proposed methodology will use dredging technology to suck contaminated sediment from the canal bed under water, material is then pumped through a treatment plant where it is dosed with flocculant and coagulant before it is piped into geotubes. This process causes the fine sediments to bind together and be trapped within the geofabric of the geotubes which have pores that are 180 microns. Water is able to pass through the geofabric for return to the canal and not soaked back into groundwater.

Jacobs (2016) note that *"the revised construction methodology* [for the containment sites] *is fundamentally different from the original design. The key difference is that the containment cells are lined with an impermeable High Density Polyethylene (HDPE) liner (of approximately 1.5 mm thickness). The sediment removed from the canal will be dewatered in geotubes within the lined containment cells, and the treated water discharged back into the canal"* (Baker, 2016).

"Once dewatered, the sediment is inoculated with fungi, trees are planted and the bioremediation process commences.

HDPE ponds are constructed by rolling out sheets of HDPE into place. The sheets are then hot edge welded together to form a water tight seal. This form of construction is typically referred to as wedge or fusion welding. The process creates a double-track weld along the length of overlapping sheets of HDPE. The cavity between the sheets is then sealed at each end and pumped with air until it reaches the test pressure. If the air pressure holds without dropping more than the allowable percentage over a set period of time, the seam is considered compliant" (Baker, 2016).

A conceptual design of the containment bunds has been provided in Appendix 1.

5 Discussion

5.1 Mixing Zones

ANZECC (2000) provides guidance on mixing zones and in Volume 2 Appendix 1 notes:

"Mixing zones are generally designated to manage the controlled discharge of soluble, non bioaccumulatory toxicants whose impacts on local biota are primarily related to their concentration. The use of mixing zones is not appropriate for managing the discharge of nutrients, bio-accumulatory or particulate substances." (ANZECC, 2000)

As dioxins bioaccumulate and are bound to particulates the use of a mixing zone is not considered suitable and the concentrations of dioxins being returned to the canal should therefore be minimised at source.

5.2 Sediment Stability

SKM (2008) note that "*sediment in the canal consists of mainly unconsolidated silts of median diameter of 10 µm which can easily be put in suspension by current velocity of more than 0.01 m/s. Dioxin molecules tend to have a higher affinity to smaller sediment particles of 75um or less. The flood tide velocity is an order of magnitude in excess of the estimated critical erosion velocity of the fine silt particles that hold the highest concentration of dioxin. Significant sediment (hence dioxin) transport in suspension during tidal movements was observed and is expected on every tidal cycle. Sediment movement will be enhanced by stormwater floods.*

"MIKE 11 simulations show that a net migration of bed surface dioxin concentration seaward occurs over time. This may cause relatively rapid dioxin dilution of dioxin concentrations within the sediment of the canal bed. MIKE11 simulations indicate that any recontamination is likely to be temporal during tidal movements as the fine particles are unlikely to settle for long" (Robotham, Jayaratne, & Chin, 2008).

This indicates that particulates within the filtrate discharge are also likely to be highly mobile within the receiving environment. Any particulates that are returned into the canal from the filtrate are likely to move with tides, be push seaward with time and dispersed within the aquatic environment. Control measures such as silt curtains and sheet pile will help minimise this.

5.3 Methodology Comparison

Table 1 discusses the differences between the proposed methodology and the current consented method.

Table 1: Comparison of potential effects associated with the two methods

Discharge Phase	Current Consent Methodology	Proposed Methodology	Conclusion
Phase 1 - Discharge of Filtrate from containment site during dredging	Eel and fish killed and removed prior to dewatering. Entire canal dewatered in sections. 100% aquatic life mortality as partially dewatered sediment is removed.	Eel and fish killed and removed prior to dredging. High water level maintained which avoids 100% mortality of aquatic life. Discharge of treated water from containment site back to canal with containment systems in place in canal that minimise migration of residual contaminated particulate in discharge.	The proposed methodology will result in a reduction of effects on aquatic life during the dredging and initial dewatering operation when filtrate is discharged back to the canal.
Phase 2 - Discharge of Filtrate from containment site post dredging	Partially controlled discharge to groundwater. Filtrate would percolate through the geotextile cloth and into the groundwater with no facility to check water quality before it entered the saturated zone. The compliance limit for groundwater surrounding the site is currently set at 30 pg/L.	Controlled discharge to surface water. The conceptual design of the containment sites (Appendix 1) shows that there is a holding sump before discharge to the canal occurs. There is also an option to recycle the water back through the treatment system. As dioxin is hydrophobic and binds tightly to fine sediment particles continuous monitoring of turbidity would provide an indicator of the dioxin content of the filtrate. A system could be installed to pump to the canal when water in the sump is below a turbidity threshold and to hold or recirculate the water when it is above the threshold. This turbidity threshold would need to be determined.	The proposed methodology is a controlled discharge. It provides a level of monitoring and control that is not feasible in the current consented method.

5.4 Potential Contaminant Standards

This section outlines the ecotoxic contaminant standards that have been identified. Research indicates that there are few contaminants standards for dioxins that consider the effect on the aquatic environment as most are predominately human health related. ANZECC Guidelines have no dioxin trigger levels for sediment (Volume 1, Chapter 3, Table 3.5.1) and have determined that there is "insufficient data to derive a reliable trigger value" in water (Volume 1, Chapter 3, Table 3.4.1) (ANZECC, 2000).

The Canadian Sediment Quality Guidelines have been developed by the CCME (Canadian Council of Ministers of the Environment) (2001). The Canadian Sediment Quality Guidelines were developed for the Protection of Aquatic Life from a variety of contaminants including Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans (PCDD/Fs). Chemical and biological data was evaluated from numerous studies to establish a link between concentrations measured in the sediment. Two assessment values are calculated, the lower threshold effect level (TEL) and the higher probable effect level (PEL). TEL represents the concentration below which adverse biological effects (mortality, reproductive success and growth issues) are expected to occur rarely (<25% of the adverse effects occur below the TEL). PEL defines the level above which adverse effects are expected to occur frequently (50% of the adverse effects occur above the PEL). The range between the TEL and PEL is known as the possible effect range with 25% to 50% of adverse effects occurring. The TEL and PEL for dioxin is 0.85 pg/g and 21.5 pg/g respectively (Canadian Council of Ministers of the Environment, 2001).

It should be noted that these levels have been calculated using alternative Toxicity Equivalency Factors (TEFs) that are specific to the toxicity of the various PCDDs and PCDFs to fish and have a safety factor of ten incorporated into the calculations. Table 2 shows a comparison of WHO TEFs and TEF_{fish} from the Canadian Sediment Quality Guidelines.

Table 2 - Comparison of WHO-TEFs and TEF_{fish} from the CSQGs

Structure	WHO 2005 TEF	TEFs for Fish (TEF_{fish})
PCDDs		
2,3,7,8-TCDD	1	1
1,2,3,7,8-PeCDD	1	1
1,2,3,4,7,8-HxCDD	0.1	0.5
1,2,3,6,7,8-HxCDD	0.1	0.01
1,2,3,7,8,9-HxCDD	0.1	0.01
1,2,3,4,6,7,8-HpCDD	0.01	0.001
OCDD	0.0003	0.0001
PCDFs		
2,3,7,8-TCDF	0.1	0.05
1,2,3,7,8-PeCDF	0.03	0.05
2,3,4,7,8-PeCDF	0.3	0.5
1,2,3,4,7,8-HxCDF	0.1	0.1
1,2,3,6,7,8-HxCDF	0.1	0.1
1,2,3,7,8,9-HxCDF	0.1	0.1
2,3,4,6,7,8-HxCDF	0.1	0.1
1,2,3,4,6,7,8-HpCDF	0.01	0.01
1,2,3,4,7,8,9-HpCDF	0.01	0.01
OCDF	0.0003	0.0001

This indicates that toxic effects of dioxins on fish are mostly more acute than in humans and mammals for which WHO TEFs are based on. The TEF_{fish} needs to be applied to existing data from the Kopeopeo Remediation Project so that a direct comparison can be completed. This has been completed in section 5.5.

A recommendation was made to the UK National Rivers Authority (precursor of the Environment Agency) by Grimwood and Dobbs (1995) on the protection of ecosystem receptors from dioxins (threshold for pollution control and remediation activities). A guideline value of 11 to 38pg/L was made and appears to have been based on an aquatic toxicity study of 2,3,7,8-tetrachlorodibenzo-p-dioxin (or for mixtures of congeners expressed as 2,3,7,8-TCDD equivalents). The levels corresponds to the no observed effect concentration/lowest-observed effect concentration determined for mortality, growth, and behavioural effects seen in rainbow trout early life stages. The trout were exposed to 2,3,7,8-TCDD in a flow-through system over a 28-day period, followed by 28 days of no exposure (Grimwood & Dobbs, 1995; Buckley-Golder, 1999).

Table 2.1 from 'Technical Report 11 - Ecological risk assessment of dioxins in Australia' indicates a study that shows 1.1pg/L is NOAEL and 38pg/L is LOAEL (45% Mortality) for Rainbow Trout swim up fry with a 28 day exposure and 28 day observation period (Gatehouse, 2004). This information was sourced from the USEPA (1993) 'Interim report on data and methods for assessment of 2,3,7,8-tetrachlorodibenzo-p-dioxin risk to aquatic life and associated wildlife' which accredits the study to Mehrle et al (1988) 'Toxicity and bioconcentration of 2,3,7,8-tetrachlorodibenzo-p-dioxin and 2,3,7,8-tetrachlorodibenzofuran in rainbow trout' (US EPA, 1993).

5.5 Trial Data

A summary of the aqueous and particulate sampling completed on the filtrate samples during the dredge trial are shown in Table 3. Aqueous results are completed using the USEPA Method 1613B (GC-HRMS) and is accredited by IANZ. The toxic equivalence (TEQ) is calculated for each sample using both the WHO toxic equivalency factors (WHO-TEFs) and international toxic equivalency factors (I-TEFs). The particulate results are calculated using an AsureQuality Method (gravimetric) which is not accredited. For each result the upper bound measurement has been used. This is the most conservative as it uses the reporting limit for the contribution for each non-quantified analyte and does not necessarily measure the actual dioxin levels within the sediment, but the theoretical maximum. Also of note is the TEQ_{fish} calculated using the TEF_{fish} to allow for direct comparison to the Canadian Sediment Quality Guidelines as discussed in section 5.4. A spreadsheet showing the calculations of TEQ_{fish} using TEF_{fish} has been included in Appendix 2.

Table 3 - Summary of filtrate results during the Kopeopeo Dredge Trial[1]

	Minimum	Maximum	Mean	95% UCL
I-TEQ Aqueous (pg/L)	3.74	7.54	4.75	5.27
WHO-TEQ Aqueous (pg/L)	4.5	8.24	5.45	6
I-TEQ Particulate (pg/g)	3.15	15.1	6.01	7.47
WHO-TEQ Particulate (pg/g)	3.75	13	6.2	7.29
TEQfish Particulate (pg/g)	4.09	10.85	6.43	7.24

[1] *For all results received by Opus International Consultants as of 24 March 2016.*

The trial data in Table 3 shows that the maximum, mean and UCL for the particulate calculations are all well below the upper limits of the Canadian Sediment Quality Guidelines (PEL of 21.5pg/g). There is little difference between the I-TEQ, WHO-TEQ and TEQ_{fish}. The aqueous results are below both the Grimwood and Dobbs (1995) guideline values of 11 and 38pg/L and the upper guideline from Mehrle et all (1988) (38pg/L).

The mean I-TEQ particulate readings are a factor of 1.27 greater than the mean I-TEQ aqueous readings and the mean WHO-TEQ particulate readings are a factor of 1.13 greater than the mean WHO-TEQ aqueous readings. If these multiplication factors hold true then this indicates that if the 38pg/L were applied from either the Grimwood and Dobbs (1995) or Mehrle et al (1988) the mean particulate concentration would be 48.26 pg I-TEQ/g or 42.94 pg WHO-TEQ/g. This is lower than the consented limit of the canal sediment.

SKM (2008) note that New Zealand background levels are 0.081 to 2.71pg I-TEQ/g, which although not using TEF_{fish} calculations would likely put background levels within the possible effect range as defined in the Canadian Sediment Quality Guidelines. The lower guideline TEL value of 0.85 pg/g is therefore not feasible.

The dredge trial shows that there are significant reductions in dioxin contaminants in the filtrate water compared to the material that was dredged from the canal. Filtrate contained between 3.15 and 15.1 pg ITEQ/g in the particulate phase compared to 110 and 650 pg ITEQ/g in the sediment. The dioxin levels within the filtrate particulate from the trial are significantly below the consented remediation target of 60 pg/g.

6 Summary

ANZECC considers the used of mixing zones for managing the discharge of bio-accumulatory or particulate substances as *"not appropriate"*. Any concentrations of dioxins that are returned to the Kopeopeo canal should therefore be controlled at source.

The current consented methodology has a relatively uncontrolled discharge to groundwater, meaning that if there was an increase in dioxins coming from the containment sites it would be difficult to control. The new proposed methodology has a controlled discharge from the containment sites, the conceptual design of the containment sites (Appendix 1) shows that there is a holding sump before discharge to the canal. The design also indicates an option to recycle the water back through the treatment system. As dioxin is hydrophobic and binds tightly to fine sediment particles continuous monitoring of turbidity could be used as an indicator of the dioxin content of the filtrate. A system with a turbidity controlled pump could be used to send filtrate to the canal when water in the sump is below a turbidity threshold and to hold or recirculate the water when it is above a threshold. The turbidity threshold would need to be determined using field and laboratory data. Additional sampling (monthly during normal operation) from the outfall would also need to be completed to check that dioxin levels remain consistent with turbidity levels over the course of the discharge. It is therefore considered that the proposed methodology provides for a level of monitoring and control that is not feasible in the current consented method.

The proposed methodology will also result in a reduction of effects on aquatic life during the dredging and initial dewatering operation when filtrate is discharged back to the canal. This is because a high water level is maintained which avoids 100% mortality of aquatic life. Discharge of treated filtrate from containment site back to canal combined with containment systems will minimise the migration of residual contaminated particulate in discharge.

A level of 60pg/g for the sediment within the Kopeopeo Canal was set as a condition in consent 67173. This consented level forms the baseline against which the proposed methodology is assessed. Based on the discussions in section 5.5, which compared particulate and aqueous concentrations, a mean multiplication factor of 1.27 was identified for I-TEQ. This means the Grimwood and Dobbs (1995) threshold for pollution control and remediation activities of 38pg/L is likely to have a particulate value in the region of 48pg/g. Any new sediment deposited on the canal bed from the filtrate using this guideline is therefore likely to be below the consented level of 60pg/g. Based on the mean multiplication factor of 1.27, concentrations in the filtrate would likely need to be 47.3pg/L or above to exceed the 60pg/g sediment remediation validation limit. Based on the research undertaken and considering potential effects associated with the existing consent, cumulative effects of any filtrate discharged from the containment sites at a concentration at or below 38 pg/L I-TEQ/g is not expected to lead to dioxin concentrations increasing over time to a point that exceeds the current sediment remediation target.

The aqueous results from the filtrate of the Kopeopeo Dredge Trial were all well below the Grimwood and Dobbs (1995) threshold for pollution control and remediation activities (38pg/L). Similar levels of dioxins within the filtrate of the full scale dredge operation should be achievable provided the treatment process (pump rate, flocculant mix and reaction times etc.) remain consistent with the trial as described in the EnviroWaste (2015) Dredging Trial Report. This means that the actual concentration of dioxins in filtrate is likely to be considerably less than the guidelines discussed.

Ongoing monitoring is important in maintaining confidence in the treatment process and testing of the filtrate at the discharge point should be completed on a monthly basis during normal operation. The TSS/turbidity/dioxin proxy to be developed in accordance with the current consented method will enable real time monitoring of filtrate discharge quality. BOPRC have already committed to long term monitoring of dioxins within eel flesh as part of the current consent conditions, which is probably the most important indicator of the effectiveness of the remediation project.

7 References

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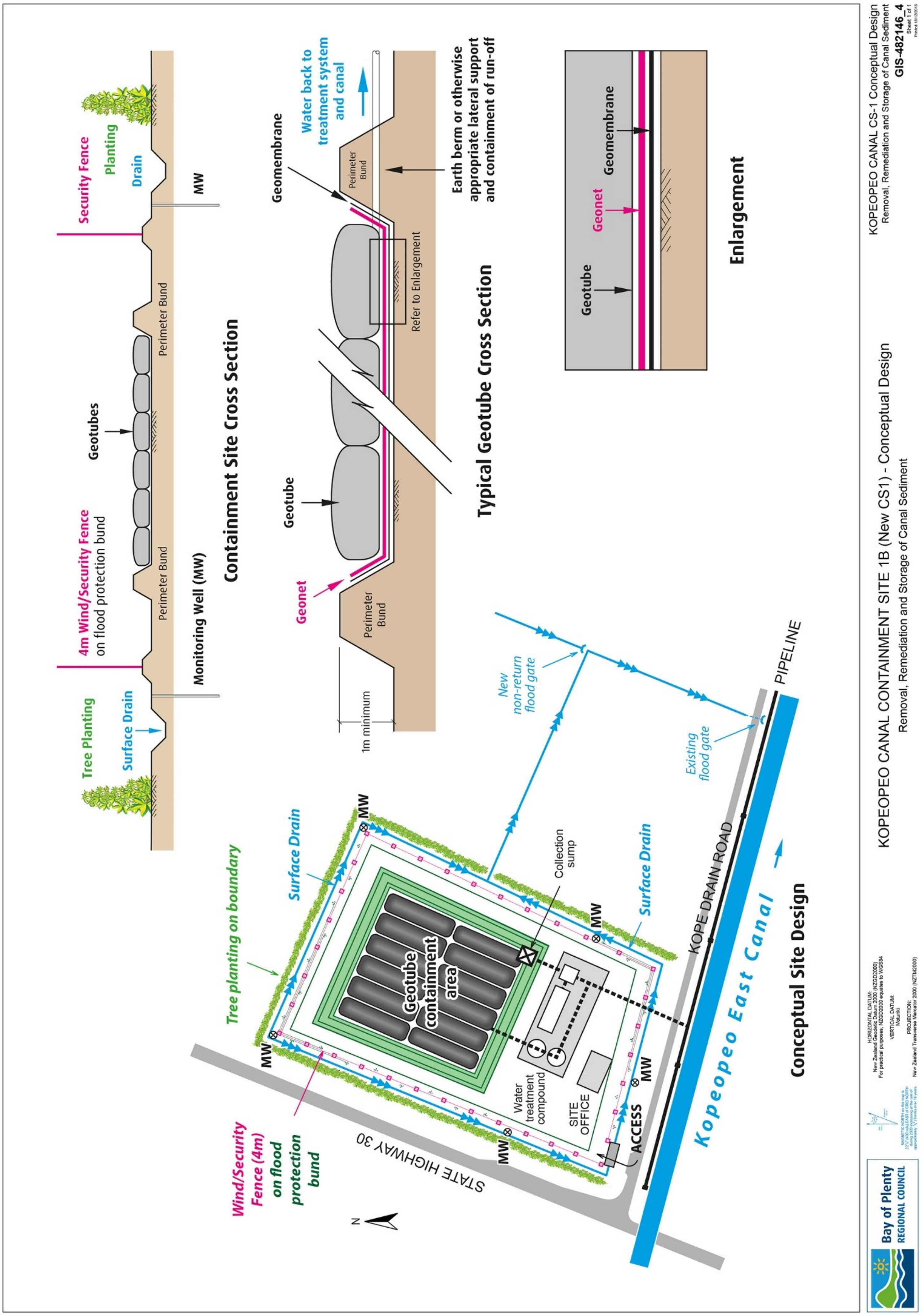
8 Appendix 1 - Conceptual design of the containment sites


Tree Planting
Surface Drain
4m Wind/Security Fence
on flood protection bund
Geotubes
Security Fence
Planting
Drain
Perimeter Bund
Monitoring Well (MW)
MW
Containment Site Cross Section
Geonet
Geotube
Geomembrane
Perimeter Bund
1m minimum
Refer to Enlargement
Water back to treatment system and canal
Earth berm or otherwise appropriate lateral support and containment of run-off
Typical Geotube Cross Section
Geotube
Geonet
Geomembrane
Enlargement
Tree planting on boundary
Surface Drain
Geotube containment area
Collection sump
Water treatment compound
SITE OFFICE
ACCESS
Wind/Security Fence (4m) on flood protection bund
STATE HIGHWAY 30
KOPE DRAIN ROAD
Kopeopeo East Canal
New non-return flood gate
Existing flood gate
PIPELINE
Conceptual Site Design
KOPEOPEO CANAL CONTAINMENT SITE 1B (New CS1) - Conceptual Design
Removal, Remediation and Storage of Canal Sediment
KOPEOPEO CANAL CS-1 Conceptual Design
Removal, Remediation and Storage of Canal Sediment
GIS-482146_4
Bay of Plenty REGIONAL COUNCIL

9 Appendix 1 – Calculations for TEQfish

Structure	WHO 2005 TEF	TEFs for Fish (TEFfish)		15/0407-19	15/0411-7	15/0411-15	15/0411-25	15/0417-10	15/0419-8	15/0433-13	15/0495	15/0497-10	15/0547-1	15/0583-1	15/0812-1	15/0936-1
PCDDs																
2,3,7,8-TCDD	1	1		1.75	1.56	1.63	1.56	1.63	1.68	1.92	1.75	0.958	1.13	1.35	1.24	1.18
1,2,3,7,8-PeCDD	1	1		1.06	1.77	1.65	1.13	1.3	1.1	1	1.17	1.54	2	1.8	2.13	2.28
1,2,3,4,7,8-HxCDD	0.1	0.5		3.41	4.46	2.42	2.52	3.24	3.19	2.55	6	1.4	1.58	2.82	1.91	4.03
1,2,3,6,7,8-HxCDD	0.1	0.01		3.82	4.69	2.57	2.71	3.35	3.56	2.77	10.9	1.53	1.63	2.91	1.9	4
1,2,3,7,8,9-HxCDD	0.1	0.01		3.55	4.65	2.52	2.63	3.38	3.32	2.66	6.26	1.42	1.6	2.85	1.94	4.1
1,2,3,4,6,7,8-HpCDD	0.01	0.001		54.4	51.4	18.1	33.3	28.7	52.7	39.6	281	4.28	4.97	10.9	6.27	5.36
OCDD	0.0003	0.0001		538	491	176	299	421	551	477	2970	40.6	36.6	16.9	55.2	6.67
PCDFs																
2,3,7,8-TCDF	0.1	0.05		1.11	1.27	1.31	1.18	1.1	1.19	0.969	1.44	0.814	0.597	2.17	1.29	1.49
1,2,3,7,8-PeCDF	0.03	0.05		0.791	0.858	0.699	0.789	0.883	0.67	1.48	1.23	0.72	1.02	1.12	0.713	0.889
2,3,4,7,8-PeCDF	0.3	0.5		0.822	0.874	0.696	0.793	0.923	0.679	1.4	1.28	0.614	0.66	1.07	0.69	0.778
1,2,3,4,7,8-HxCDF	0.1	0.1		1.82	1.94	1.96	1.72	2.72	2.77	3.21	5.87	1.02	0.947	2.22	1.48	3.04
1,2,3,6,7,8-HxCDF	0.1	0.1		1.77	1.89	2.01	1.69	2.64	2.77	3.04	5.73	0.94	0.915	2.23	1.4	2.95
1,2,3,7,8,9-HxCDF	0.1	0.1		2.33	2.57	2.6	2.32	3.61	3.68	4.25	7.79	1.28	1.16	2.85	1.92	4.31
2,3,4,6,7,8-HxCDF	0.1	0.1		1.93	2.11	2.12	1.82	2.88	2.98	3.4	6.31	1.05	0.968	2.24	1.55	2.91
1,2,3,4,6,7,8-HpCDF	0.01	0.01		9.44	11.3	4.49	7.29	6.16	14.5	12.8	70	1.62	1.19	4.39	2.71	2.53
1,2,3,4,7,8,9-HpCDF	0.01	0.01		3.3	4.16	4.46	3.3	4.05	6.95	6.23	8.97	1.99	1.46	5.74	3.35	3.38
OCDF	0.0003	0.0001		59.9	70.4	25.4	46.1	42.1	133	77.2	428	9.97	9.3	28.5	8.21	6.77
		WHO TEQ		**5.91**	**6.81**	**5.59**	**5.15**	**6.05**	**6.30**	**6.42**	**12.99**	**3.74**	**4.39**	**5.76**	**5.08**	**6.52**
		TEQ_{Fish}		**6.12**	**7.31**	**5.99**	**5.43**	**6.54**	**6.43**	**6.75**	**10.85**	**4.09**	**4.80**	**6.39**	**5.52**	**7.45**

Opus International Consultants Ltd
Level 1, Opus House, 13 Louvain Street
PO Box 800, Whakatane 3158
New Zealand

t: +64 7 308 0139
f: +64 7 308 4757
w: www.opus.co.nz