APPENDIX C – DEVELOPMENT OF WATER QUALITY-BASED EFFLUENT LIMITS

The calculations for water quality-based effluent limits are done according to procedures in Chapter 5 of EPA's *Technical Support Document for Water Quality-Based Toxics Control (TSD).*

The spreadsheets following this document contain the calculations for water quality-based limits for the Red Dog Port Site Outfalls 001 and 005.

Step 1 – Determine the Wasteload Allocations (WLAs) for each parameter

WLAs define the allowable concentration of pollutant in the effluent. The water quality criteria are converted to WLAs for the receiving water based on the following mass balance equation:

$WLA = (C_r - C_b) * \text{dilution}$ where,

C_r	=	Criteria that cannot be exceeded at the edge of the mixing zone
C_b	=	Background concentration of pollutant
Dilution	=	Designated mixing zone

Step 2 – Determine Long Term Averages

The acute and chronic WLAs are converted to Long Term Averages (LTA_{acute} and $LTA_{chronic}$) using the following equations:

$LTA_{acute} = WLA_{acute} * e[0.5\sigma^2 - z\sigma]$ where,

σ^2	=	$\ln(CV^2 + 1)$
CV	=	Coefficient of variation of the effluent data
z	=	2.326 for the 99th percentile probability basis

$LTA_{chronic} = WLA_{chronic} * e[0.5\sigma^2 - z\sigma]$ where,

σ^2	=	$\ln(CV^2/4 + 1)$
CV	=	Coefficient of variation of the effluent data
z	=	2.326 for the 99th percentile probability basis

Step 3 – Determine Average Monthly and Maximum Daily Limits

To protect a waterbody from both acute and chronic effects, the more limiting of the calculated LTA_{acute} and $LTA_{chronic}$ is used to derive the effluent limitations. The TSD recommends using the 95th percentile for the Average Monthly Limit (AML) and the 99th percentile for the Maximum Daily Limit (MDL).

To derive the MDL and the AML, the following calculations are used:

MDL = LTA * $e[z\sigma-0.5\sigma^2]$ where,

σ^2	=	$\ln(CV^2 + 1)$
CV	=	Coefficient of variation of the effluent data
z	=	2.326 for the 99th percentile probability basis

AML = LTA * $e[z\sigma-0.5\sigma^2]$ where,

σ^2	=	$\ln(CV^2/n + 1)$
CV	=	Coefficient of variation of the effluent data
n	=	Number of sampling events required in permit per month
z	=	1.645 for the 95th percentile probability basis

Step 4 – Compare Aquatic Life and Technology-based Effluent Limits

Compare water quality-based (aquatic life) and technology-based effluent limits and put the more stringent limits in the permit.

APPENDIX C - OUTFALL 001
WATER QUALITY BASED
PERMIT LIMIT CALCULATIONS

Dilution (Dil'n) factor is the inverse of the percent effluent concentration at the edge of the acute or chronic mixing zone.

Permit Limit Calculation Summary

Waste Load Allocation (WLA) and Long Term Average (LTA) Calculations

Statistical variables for permit limit calculation

PARAMETER	Acute Dil'n Factor	Chronic Dil'n Factor	Metal Criteria Translator Acute	Metal Criteria Translator Chronic	Ambient Concentration *ug/L*	Water Quality Standard Acute *ug/L*	Water Quality Standard Chronic *ug/L*	Average Monthly Limit (AML) ug/L	Maximum Daily Limit (MDL) ug/L	Limits used in permit	WLA Acute *ug/L*	WLA Chronic *ug/L*	LTA Acute *ug/L*	LTA Chronic *ug/L*	LTA Coeff. Var. (CV) *decimal*	LTA Prob'y Basis *decimal*	Limiting LTA *ug/L*	Coeff. Var. (CV) *decimal*	AML Prob'y Basis *decimal*	MDL Prob'y Basis *decimal*	# of Samples per Month *n*	
Total Residual Chlorine	92	140				13.00	7.50	**502.1**	**1196.0**	TB	1196	1050.00	384.0	553.8	0.60	0.99	384.0	0.60	0.95	0.99	12.00	1.00

TB = Technology Based

APPENDIX C - OUTFALL 005
WATER QUALITY BASED
PERMIT LIMIT CALCULATIONS

Dilution (Dil'n) factor is the inverse of the percent effluent concentration at the edge of the acute or chronic mixing zone.

Permit Limit Calculation Summary

Waste Load Allocation (WLA) and Long Term Average (LTA) Calculations

Statistical variables for permit limit calculation

PARAMETER	Acute Dil'n Factor	Chronic Dil'n Factor	Metal Criteria Translator Acute	Metal Criteria Translator Chronic	Ambient Concentration *ug/L*	Water Quality Standard Acute *ug/L*	Water Quality Standard Chronic *ug/L*	Average Monthly Limit (AML) ug/L	Maximum Daily Limit (MDL) ug/L	Limits used in permit	WLA Acute *ug/L*	WLA Chronic *ug/L*	LTA Acute *ug/L*	LTA Chronic *ug/L*	LTA Coeff. Var. (CV) *decimal*	LTA Prob'y Basis *decimal*	Limiting LTA *ug/L*	Coeff. Var. (CV) *decimal*	AML Prob'y Basis *decimal*	MDL Prob'y Basis *decimal*	# of Samples per Month *n*	
Cadmium	92	140	0.994	0.994	1.09	40.00	8.80	**811.8**	**1957.1**	Technology Based	3581	1080.49	804.4	437.0	0.90	0.99	437.0	0.90	0.95	0.99	4.00	0.994
Mercury	92	140	0.850	0.850	0.15	1.80	0.94	**56.5**	**178.8**	Technology Based	152	110.75	15.9	19.2	2.40	0.99	15.9	2.40	0.95	0.99	4.00	0.850
Lead	92	140	0.951	0.951	3.90	210.00	8.10	**360.9**	**1098.4**	Technology Based	18965	591.90	2300.5	126.7	1.89	0.99	126.7	1.89	0.95	0.99	4.00	0.951
Zinc	92	140	0.946	0.946	56.75	90.00	81.00	**1471.9**	**3293.6**	Technology Based	3116	3451.75	814.4	1572.6	0.76	0.99	814.4	0.76	0.95	0.99	4.00	0.946

This spreadsheet calculates water quality based permit limits based on the two value steady state model. The procedure and calculations are done per the Technical Support Document for Water Quality-based Toxics Control, U.S. EPA, March, 1991 (EPA/505/2-90-001),