May 12, 2017

West Point Treatment Plant Restoration Near-Field Effluent Mixing Water Quality Analysis

The following analysis addresses the effects of the West Point wastewater treatment effluent discharge of contaminants to concentrations in the near-field zone of initial mixing at the West Point outfall located in Puget Sound approximately 3,600 feet offshore at a depth of 240 feet below mean lower low water. The outfall pipe terminates in a diffuser section 600 feet long that releases effluent from 200 individual ports. Initial mixing of effluent with seawater occurs as a result of the pressurized discharge from the diffuser ports with substantial velocity and turbulence, transport away from the diffuser with tidal flow, and buoyant rising of effluent upward through the water column due to the generally lower density and higher temperature of effluent compared to surrounding seawater. Modeling of the effluent discharge was conducted by King County in 2013 using Ecology-specified procedures for renewal of the West Point NPDES permit to determine the size of the initial zone of mixing. For protection of aquatic life from harm due to chronic exposures (i.e., long-term) to contaminants, the modeling is based on typical tidal flow and effluent discharge rates resulting in effluent dispersion throughout a volume of water with approximate dimensions of 1,460 feet along the axis of the diffuser pipeline, 860 feet in a north-south direction of tidal flow, and the full 240 feet depth of water. Mixing under the chronic flow conditions results in a 188:1 dilution ratio of seawater to effluent. For protection of aquatic life from harm due to acute exposure (short-term), the modeling of peak daily effluent discharge into minimal tidal flow conditions results in a smaller mixing volume that is 686 feet long, 86 feet wide, and the full 240 feet deep. Mixing under the acute flow conditions results in a 28:1 dilution ratio of seawater to effluent.

Conservative estimates of the maximum concentrations for each contaminant at the edge of the zone of initial mixing are calculated with the dilution ratios above for acute and chronic exposure scenarios using the estimated 95^{th} percentile discharge concentration and 90^{th} percentile receiving water concentration. This analysis is conducted for those constituents detected in West Point effluent for which Washington has adopted marine water quality criteria for protection of aquatic life, consisting of the majority of the trace metals, cyanide, ammonia, and chlorine. The damage to West Point facilities (and effluent quality) was a temporary and short-term incident, and the duration of wastewater discharge with reduced quality was approximately three months. Therefore, this analysis does not consider the effects of the reduced level of treatment at West Point on changes in water quality concentrations for constituents that are regulated for human health protection because human health criteria are established for lifetime (70 year) exposure assumptions.

The following near-field mixing water quality analysis was conducted for West Point data collected from February 28th through April 24th. As a result of the reduced level of treatment (and specifically the reduced level of suspended solids removal), the maximum concentration of either current effluent sample values, or influent samples from the past five years were used for the analysis. The use of influent sample concentrations (if higher than historical 95% effluent concentrations) provides an additional conservative assumption of the maximum concentrations that may be present in the effluent given the low level of solids removal occurring at times while West Point repairs were underway through April. The analysis method, and all other variables used in the spreadsheet calculations, are consistent with Ecology protocols used for development of West Point's current NPDES permit. **Table 1** below shows the calculated receiving water concentrations in comparison to the equivalent concentrations developed for the NPDES permit renewal (see **Table 2**), and percent change under the current reduced level of treatment relative to the Table 2 values for historical comparison.

The near-field mixing water quality analysis for data collected at West Point during the period of reduced treatment indicates:

- The undiluted (i.e., "end of pipe") maximum concentrations for arsenic, cadmium, chromium, nickel, and selenium that may be present in the West Point effluent are lower than their respective water quality criteria.
- Concentrations in the initial zone of mixing for most of the contaminants may be higher as a result of the reduced level of treatment compared to conditions that typically exist with normal West Point operations. Concentrations may have ranged from 10-100% higher than conditions based on historical effluent data.
- The analysis indicates that the concentrations of all constituents that may exceed water quality criteria in the undiluted effluent are anticipated to all be lower than the applicable acute and chronic water quality criteria in the initial zone of mixing.

Table 1. Analysis of Contaminant Concentrations in Initial Zone of Mixing and Comparison to Historical Conditions.

Constituent	Aquatic Life Criteria		Analysis of Constituent Concentrations in Initial Zone of Mixing									
			Current Conditions (worst-case historical or measured)				Historical (NPDES Permit)		% Difference (current compared to historical)		Criteria Exceeded at Edge of Mixing Zone	
	Acute Criteria (ug/L)	Chronic Criteria (ug/L)	95% Effluent Conc. (ug/L)	Ambient Puget Sound Conc. (ug/L)	Acute Conc. (ug/L)	Chronic Conc. (ug/L)	Acute Conc. (ug/L)	Chronic Conc. (ug/L)	Acute (%)	Chronic (%)	Acute	Chronic
Ammonia	8923	1340	15200	85	1025	225	1189	249	-16%	2%	N	N
Arsenic	69	36	2.75	1.4	1.4	1.4	1.5	1.4	-7%	0%	N	N
Cadmium	42	9.3	1.12	0.072	0.109	0.078	0.076	0.073	30%	6%	N	N
Chromium	1100	50	10	0.14	0.49	0.19	0.20	0.15	60%	23%	N	N
Copper	4.8	3.1	86.5	0.5	3.0	0.9	1.2	0.6	62%	32%	N	N
Lead	210	8.1	15.3	0.01	0.52	0.08	0.13	0.02	75%	71%	N	N
Mercury	1.8	0.025	0.218	0.0002	0.0068	0.0014	0.0007	0.0003	90%	79%	N	N
Nickel	74	8.2	8	0.43	0.70	0.47	0.63	0.46	10%	2%	N	N
Selenium	290	71	1.58	0	0.04	0.01	0.03	0.01	23%	17%	N	N
Silver	1.9	n/a	1.22	0.03	0.06	0.03	0.03	0.03	47%	15%	N	n/a
Zinc	90	81	274	1.0	10.2	2.4	2.7	1.2	74%	50%	N	N
Cyanide	9.1	2.8	16.3	0	0.58	0.09	0.02	0.00	97%	97%	N	N
Chlorine	13	7.5	308	0	11.0	1.6	10.6	1.6	4%	0%	N	N

Table 2. Historical Conditions - Initial Zone of Mixing Water Quality Analysis from West Point NPDES Permit (December 9, 2014).

Reasonable Potential Calculation

Facility	West Point WWTP
Water Body Type	Marine

Dilution Factors:	Acute	Chronic
Aquatic Life	28.0	188.0
Human Health Carcinogenic		324.0
Human Health Non-Carcinogenic		324.0

Pollutant, CAS No. & NPDES Application Ref. No.		AMMONIA, Criteria as Total NH3	ARSENIC (dissolved) 7440382 2M	CADMIUM - 7440439 4M Hardness dependent	CHROMIUM(HEX) 18540299	COPPER - 744058 6M Hardness dependent	LEAD - 7439921 7M Dependent on hardness	MERCURY 7439976 8M	NICKEL - 7440020 9M - Dependent on hardness	SELENIUM 7782492 10M	SILVER - 7740224 11M dependent on hardness.	ZINC- 7440666 13M hardness dependent	CYANIDE 57125 14M	CHLORINE (Total Residual) 7782505
Effluent Data	# of Samples (n)	53	15	15	15	15	15	21	23	15	15	23	15	1825
	Coeff of Variation (Cv)	0.6	0.6	0.6	0.6	0.6	0.6	0.63	0.48	0.373	0.6	0.226	0.0001	0.32
	Effluent Concentration, ug/L (Max. or 95th Percentile)	31,000	2.196	0.1233	1.235	16.3	2.475	0.0155	5.999	0.74	0.143	50.78	0.57	296
	Calculated 50th percentile Effluent Conc. (when n>10)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Receiving Water Data	90th Percentile Conc., ug/L	85	1.388	0.072	0.139	0.487	0.005	0.0002	0.432	0	0.028	0.995	0	0
	Geo Mean, ug/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Water Quality Criteria	Aquatic Life Criteria, ug/L Acute	8,923	69	42	1100	4.8	210	1.8	74	290	1.9	90	9.1	13
	Aquatic Life Criteria, ug/L Chronic	1,340	36	9.3	50	3.1	8.1	0.025	8.2	71	-	81	2.8	7.5
	WQ Criteria for Protection of Human Health, ug/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Metal Criteria Translator, decimal Acute	-	1	0.994	0.993	0.83	0.951	0.85	0.99	-	0.85	0.946	-	-
	Metal Criteria Translator, decimal Chronic	-	-	0.994	0.993	0.83	0.951	-	0.99	-	-	0.946	-	-
	Carcinogen?	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Aquatic Life Reasonable Potential

Effluent percentile value		0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950
s	$s^2=\ln(CV^2+1)$	0.555	0.555	0.555	0.555	0.555	0.555	0.578	0.455	0.361	0.555	0.223	0.000	0.312
Pn	$Pn=(1-\text{confidence level})^{1/n}$	0.945	0.819	0.819	0.819	0.819	0.819	0.867	0.878	0.819	0.819	0.878	0.819	0.998
Multiplier		1.00	1.50	1.50	1.50	1.50	1.50	1.00	1.00	1.30	1.50	1.00	1.00	1.00
Max concentration (ug/L) at edge of...	Acute	1,189	1.456	0.076	0.198	1.160	0.131	0.001	0.631	0.034	0.034	2.7	0.020	10.6
	Chronic	249	1.398	0.073	0.148	0.587	0.024	0.000	0.462	0.005	0.029	1.2	0.003	1.6
Reasonable Potential? Limit Required?		**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**