

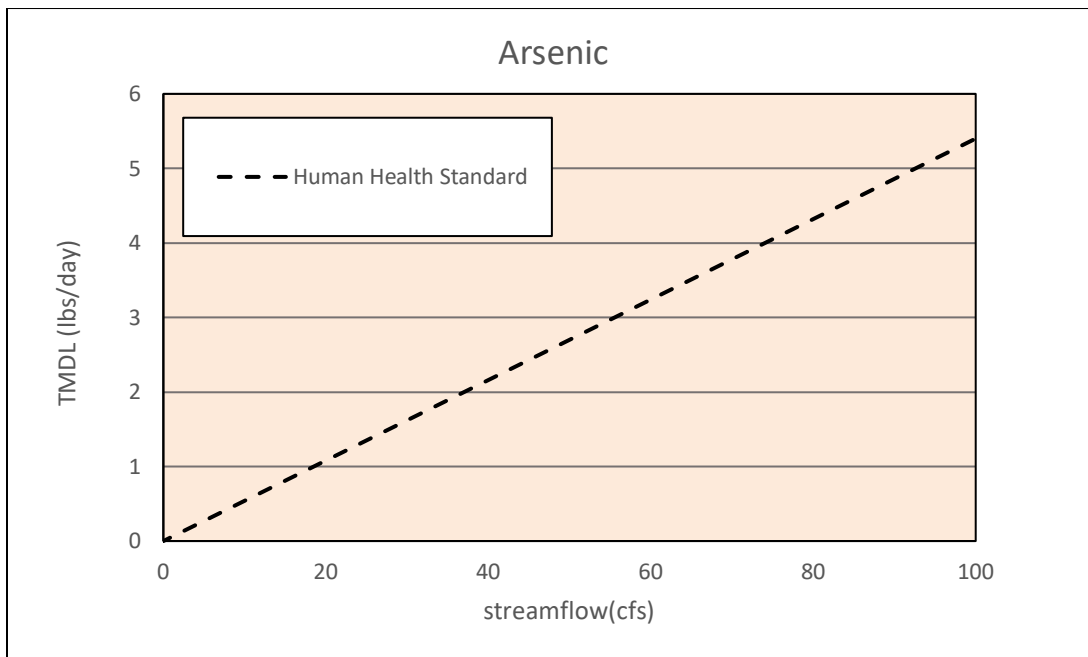
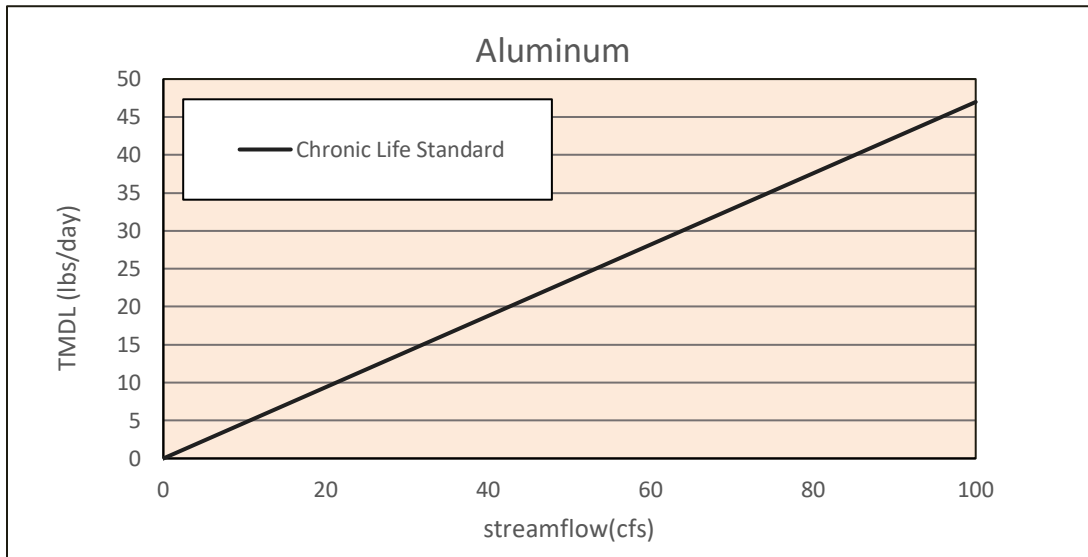
APPENDIX C – METAL TMDL EXAMPLES AND CALCULATIONS

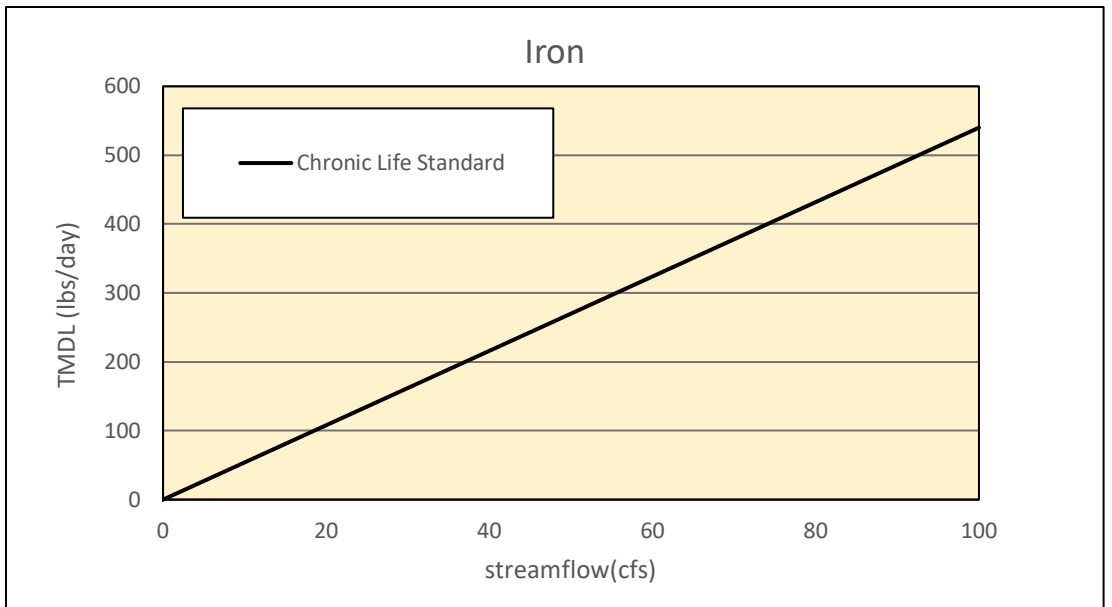
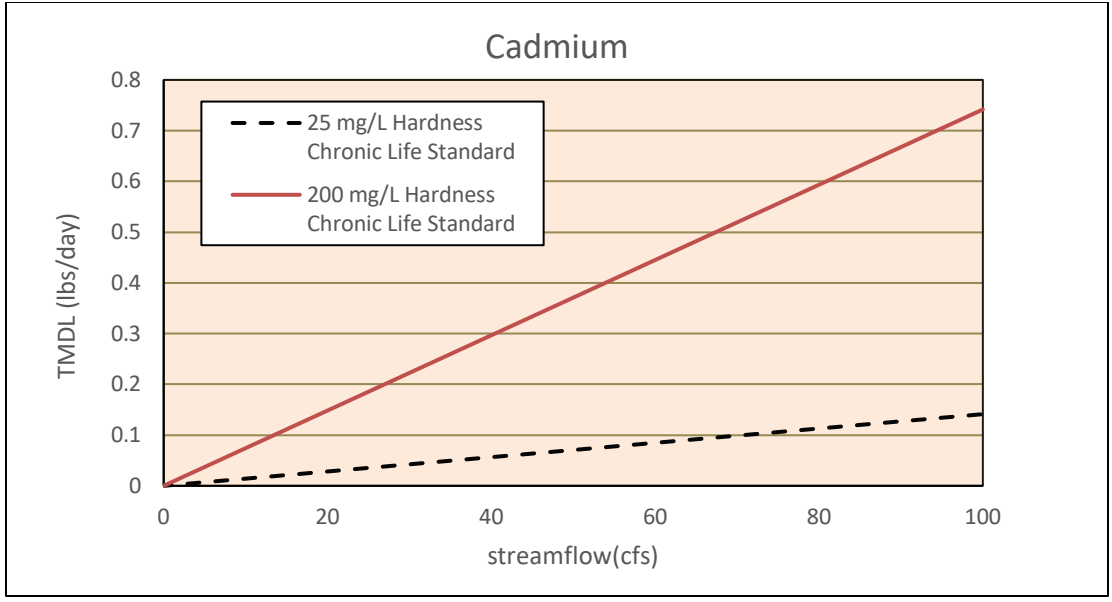
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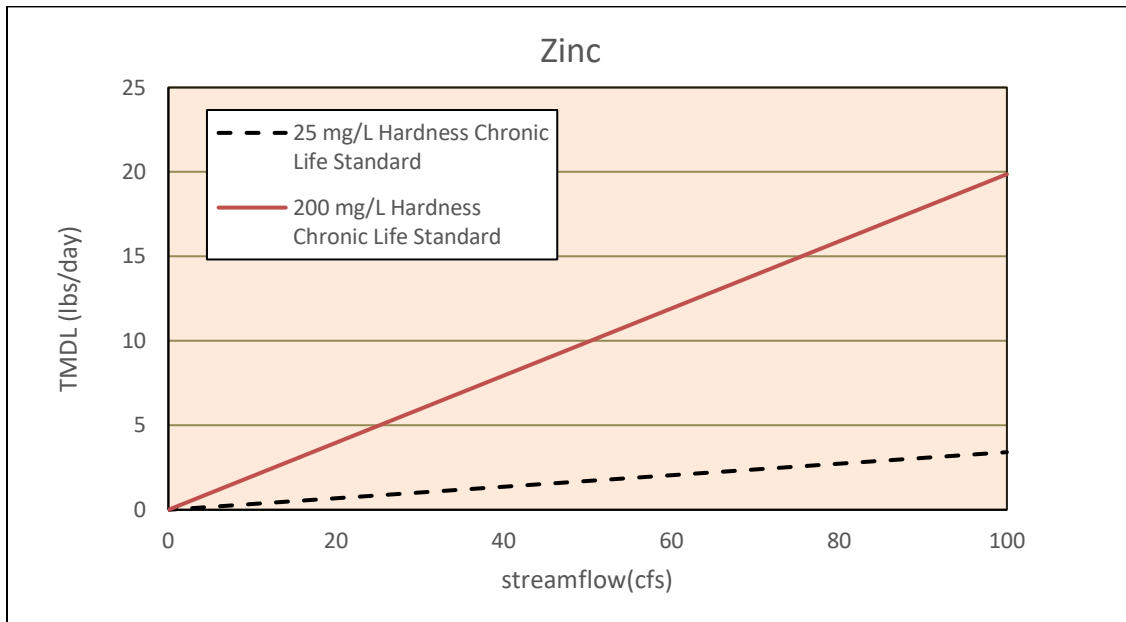
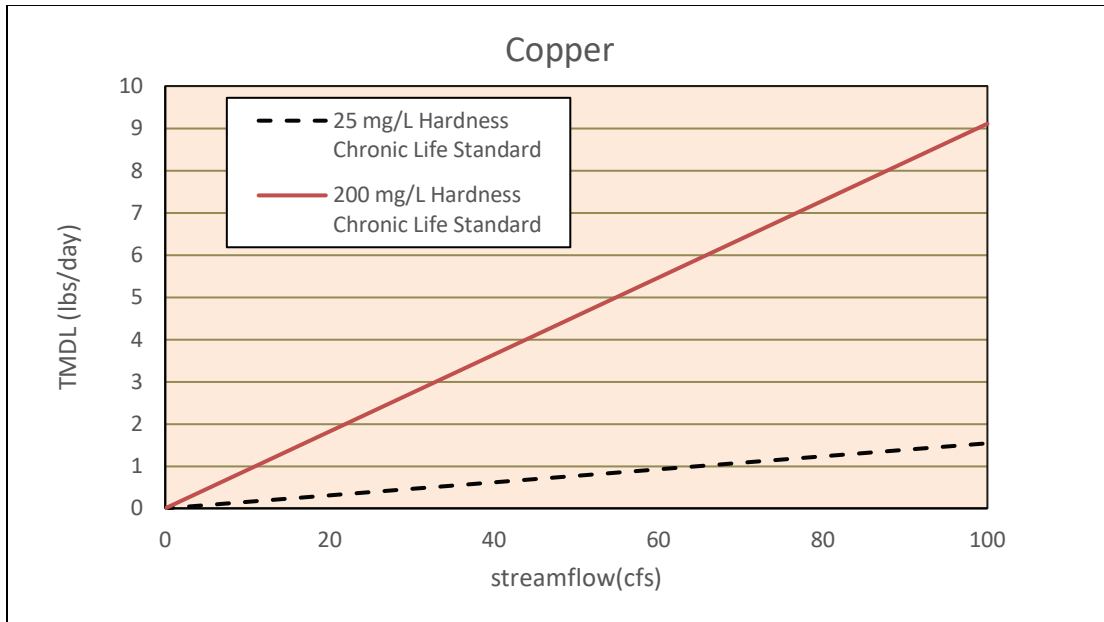
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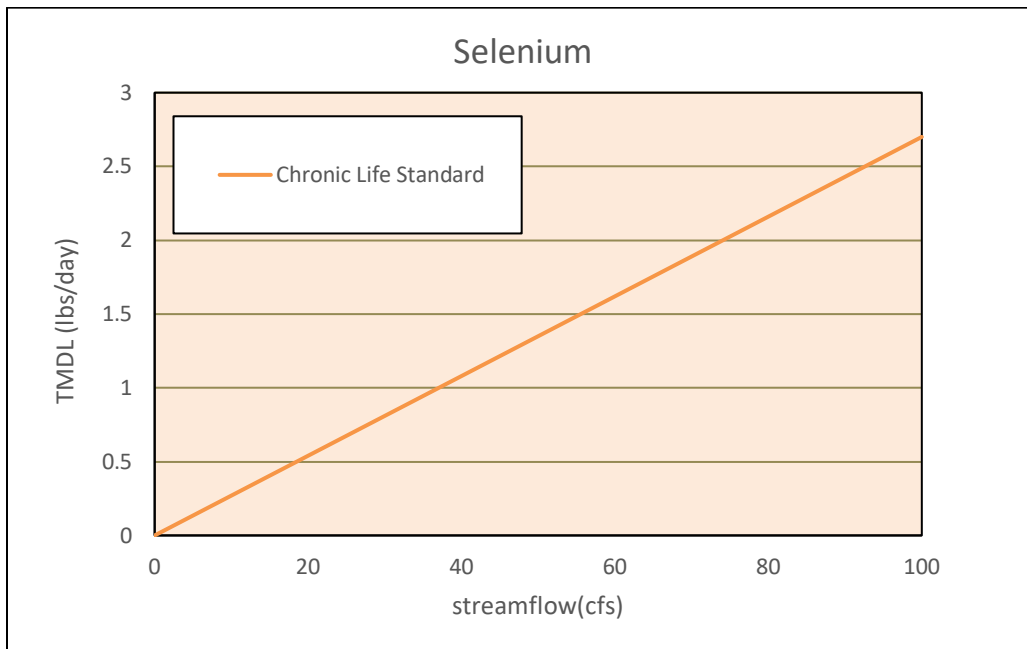
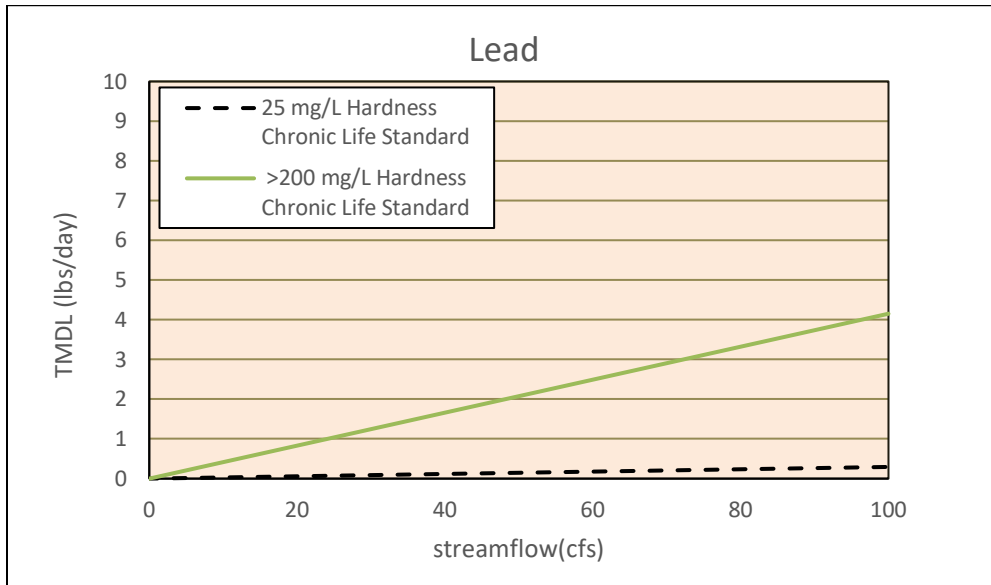
C.0 METALS TMDL EXAMPLES AND CALCULATIONS

C.1. GRAPHS ILLUSTRATING TMDLs FOR EACH POLLUTANT AT DIFFERENT EXAMPLE FLOWS









C.2. CALCULATIONS USED IN DEVELOPMENT OF METALS TMDLS

Table C-1 Calculations Used in Development of Example Lead TMDLs

	Bloody Dick Creek	
	Low Flow	High Flow
Flow (cfs)	189.60	458.81
Hardness	25.00	25.00
Target Concentration (ug/L) ($EXP(1.273*(LN(hardness)))-4.705$)	0.54	0.54
Measured Concentration (µg/L)	0.70	0.70
Reference Concentration (µg/L)	0.48	0.48
Existing Load (µg/L) ($Measured\ \mu\text{g/L} * Flow * 0.0054$)	0.72	1.73
TMDL Load (lbs/day) ($Target\ \mu\text{g/L} * Flow * 0.0054$)	0.56	1.35
Natural Load (lbs day) ($Reference\ \mu\text{g/L} * Flow * 0.0054$)	0.49	1.19
WLA_{ACTIVE} (lbs/day) ($Outfall\ Flow\ cfs * Concentration\ \mu\text{g/L} * 0.0054$)	0.07	0.16
LA_{up} (lbs/day) ($Upstream\ Flow\ cfs * Target\ Concentration\ \mu\text{g/L} * 0.0054 - Upstream\ Natural\ Load$)	0.00	0.00
WLA_{Comp} (lbs/day) (TMDL Load-Natural Load- LA_{up} - WLA_{ACTIVE})	0.07	0.16
% Reduction ($(Existing\ Load - TMDL\ Load / Existing\ Load) * 100$)	22.29	22.29

Table C-2 Calculations Used in Development of Example Iron TMDLs

	Little Sheep Creek		Medicine Lodge Creek		Muddy Creek	
	Low Flow	High Flow	Low Flow	High Flow	Low Flow	High Flow
Flow (cfs)	10.79	22.29	0.42	5.10	0.86	2.33
Hardness	245.00	216.00	245.00	263.00	167.00	199.00
Target Concentration (ug/L) (1000 µg/L)	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
Measured Concentration (µg/L)	3340.00	1240.00	1470.00	1750.00	810.00	5940.00
Reference Concentration (µg/L)	221.00	221.00	221.00	221.00	221.00	221.00
Existing Load (µg/L) ($Measured\ \mu\text{g/L} * Flow * 0.0054$)	194.61	149.25	3.33	48.20	3.76	74.74
TMDL Load (lbs/day) ($Target\ \mu\text{g/L} * Flow * 0.0054$)	58.27	120.37	2.27	27.54	4.64	12.58
Natural Load (lbs day) ($Reference\ \mu\text{g/L} * Flow * 0.0054$)	12.88	26.60	0.50	6.09	1.03	2.78
WLA_{ACTIVE} (lbs/day) ($Outfall\ Flow\ cfs * Concentration\ \mu\text{g/L} * 0.0054$)	0.00	0.00	0.00	0.00	0.00	0.00
LA_{up} (lbs/day) ($Upstream\ Flow\ cfs * Concentration\ \mu\text{g/L} * 0.0054$)	0.00	0.00	0.00	0.00	0.00	0.00
WLA_{Comp} (lbs/day) (TMDL Load-Natural Load- LA_{up} - WLA_{ACTIVE})	45.39	93.77	1.77	21.45	2.78	9.80

Table C-2 Calculations Used in Development of Example Iron TMDLs

	Little Sheep Creek		Medicine Lodge Creek		Muddy Creek	
	Low Flow	High Flow	Low Flow	High Flow	Low Flow	High Flow
% Reduction ((Existing Load-TMDL Load/Existing Load)*100	70.06	19.35	31.97	42.86	0.00	83.16

Table C-3. Calculations Used in Development of Example Copper TMDLs

	Peet Creek	
	Low Flow	High Flow
Flow (cfs)	1.64	6.83
Hardness	113.00	113.00
Target Concentration (ug/L) $EXP(0.8545*(LN(hardness)))-1.702$	10.35	10.35
Measured Concentration (µg/L)	16.00	2.00
Reference Concentration (µg/L)	0.90	0.90
Existing Load (µg/L) (Measured µg/L * Flow * 0.0054)	0.14	0.07
TMDL Load (lbs/day) (Target µg/L * Flow * 0.0054)	0.09	0.38
Natural Load (lbs day) (Reference µg/L * Flow * 0.0054)	0.01	0.03
WLA _{ACTIVE} (lbs/day) (Outfall Flow cfs * Concentration µg/L * 0.0054)	0.00	0.00
LA _{Up} (lbs/day) (Upstream Flow cfs * Target Concentration µg/L * 0.0054 – Upstream Natural Load)	0.00	0.00
WLA _{Comp} (lbs/day) (TMDL Load-Natural Load-LA _{Up} -WLA _{ACTIVE})	0.08	0.35
% Reduction ((Existing Load-TMDL Load/Existing Load)*100	35.31	0.00

Table C-4. Calculations Used in Development of Example Cadmium TMDLs.

	Peet Creek	
	Low Flow	High Flow
Flow (cfs)	1.64	6.83
Hardness	113.00	113.00
Target Concentration (ug/L) $EXP(0.7977*(LN(hardness)))-3.909$	0.87	0.87
Measured Concentration (µg/L)	4.31	0.21
Reference Concentration (µg/L)	0.06	0.06
Existing Load (µg/L) (Measured µg/L * Flow * 0.0054)	0.04	0.01
TMDL Load (lbs/day) (Target µg/L * Flow * 0.0054)	0.008	0.03
Natural Load (lbs day) (Reference µg/L * Flow * 0.0054)	0.001	0.002
WLA _{ACTIVE} (lbs/day) (Outfall Flow cfs * Concentration µg/L * 0.0054)	0.00	0.00
LA _{Up} (lbs/day) (Upstream Flow cfs * Concentration µg/L * 0.0054)	0.00	0.00
WLA _{Comp} (lbs/day) (TMDL Load-Natural Load-LA _{Up} -WLA _{ACTIVE})	0.007	0.03
% Reduction ((Existing Load-TMDL Load/Existing Load)*100	79.81	0.00

Table C-5. Calculations Used in Development of Example Aluminum TMDLs

	Bloody Dick Creek		Fish Creek		Trail Creek	
	Low Flow	High Flow	Low Flow	High Flow	Low Flow	High Flow
Flow (cfs)	189.60	458.81	2.25	4.63	55.96	118.56
Hardness	25.00	25.00	130.00	153.00	26.00	30.00
Target Concentration (ug/L)	87.00	87.00	87.00	87.00	87.00	87.00
Measured Concentration (ug/L)	257.00	146.00	183.00	16.00	141.00	112.00
Reference Concentration (ug/L)	24.00	24.00	62.00	62.00	24.00	24.00
Existing Load (µg/L) (<i>Measured µg/L * Flow * 0.0054</i>)	263.13	361.73	2.22	0.40	42.61	71.71
TMDL Load (lbs/day) (<i>Target µg/L * Flow * 0.0054</i>)	89.07	215.55	1.06	2.18	26.29	55.70
Natural Load (lbs day) (<i>Reference µg/L * Flow * 0.0054</i>)	24.57	59.46	0.75	1.55	7.25	15.37
WLA _{ACTIVE} (lbs/day) (<i>Outfall Flow cfs * Concentration µg/L * 0.0054</i>)	0.00	0.00	0.00	0.00	0.00	0.00
LA _{up} (lbs/day) (<i>Upstream Flow cfs * Concentration µg/L * 0.0054</i>)	0.00	0.00	0.00	0.00	0.00	0.00
WLAComp (lbs/day) (TMDL Load-Natural Load-LA _{up} -WLA _{ACTIVE})	64.50	156.09	0.30	0.63	19.04	40.33
% Reduction (<i>(Existing Load-TMDL Load/Existing Load)*100</i>)	66.15	40.41	52.46	0.00	38.30	22.32

Table C-6. Calculations Used in Example Selenium TMDL

	Peet Creek	
	Low Flow	High Flow
Flow (cfs)	1.64	6.83
Hardness	113.00	113.00
Target Concentration (5 ug/L)	5.00	5.00
Measured Concentration (ug/L)	8.00	0.22
Reference Concentration (ug/L)	1.10	1.10
Existing Load (µg/L) (<i>Measured µg/L * Flow * 0.0054</i>)	0.07	0.01
TMDL Load (lbs/day) (<i>Target µg/L * Flow * 0.0054</i>)	0.04	0.18
Natural Load (lbs day) (<i>Reference µg/L * Flow * 0.0054</i>)	0.01	0.04
WLA _{ACTIVE} (lbs/day) (<i>Outfall Flow cfs * Concentration µg/L * 0.0054</i>)	0.00	0.00
LA _{up} (lbs/day) (<i>Upstream Flow cfs * Concentration µg/L * 0.0054</i>)	0.00	0.00
WLAComp (lbs/day) (TMDL Load-Natural Load-LA _{up} -WLA _{ACTIVE})	0.03	0.14
% Reduction (<i>(Existing Load-TMDL Load/Existing Load)*100</i>)	37.50	0.00

Table C-7. Calculations Used in Example Arsenic TMDL

	Metzel Creek		Muddy Creek		Peet Creek		Price Creek	
	Low Flow	High Flow	Low Flow	High Flow	Low Flow	High Flow	Low Flow	High Flow
Flow (cfs)	2.70	4.61	0.86	2.33	1.64	6.83	0.04	2.23
Hardness	219.00	172.00	167.00	199.00	113.00	113.00	257.00	257.00
Target Concentration (10 ug/L)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Measured Concentration (ug/L)	13.00	13.00	8.00	12.00	15.00	6.00	14.00	4.00
Reference Concentration (ug/L)	3.00	3.00	3.00	3.00	6.00	6.00	6.00	6.00
Existing Load (µg/L) (Measured µg/L* Flow * 0.0054)	0.19	0.32	0.04	0.15	0.13	0.22	0.003	0.05
TMDL Load (lbs/day) (Target µg/L* Flow * 0.0054)	0.145	0.248	0.05	0.13	0.09	0.37	0.002	0.12
Natural Load (lbs day) (Reference µg/L* Flow*0.0054)	0.04	0.07	0.01	0.04	0.05	0.22	0.001	0.07
WLA _{ACTIVE} (lbs/day) (Outfall Flow cfs *Concentration µg/L * 0.0054)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LA _{Up} (lbs/day) (Upstream Flow cfs*Concentration µg/L * 0.0054)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WLAComp (lbs/day) (TMDL Load-Natural Load-LA _{Up} -WLA _{ACTIVE})	0.10	0.17	0.03	0.09	0.04	0.15	0.001	0.048
% Reduction ((Existing Load-TMDL Load/Existing Load)*100	23.08	23.08	0.00	16.67	33.33	0.00	28.57	0.00