

Table B6 - 2 Background-related DQO Statistics for Remaining On-site Area Soils (0 - 5 feet)

Metal	Background Data Set			Site Characterization Statistics				Pooled Statistics /1		Estimation Uncertainty Based on Two-sample t-test Ho: Study Area Within Background				Toxicity-Related Decision Uncertainty /3					DQO assessment considering both Estimation Uncertainty and Decision Uncertainty /6			
	N used for test	Background Mean	Background Stdev	N	Study Area Mean	Study Area Stdev	Point Difference (study area mean - background mean)	N _{pooled}	S ² _{pooled}	beta	alpha	MDD /2	Study Area Within Background?	Estimation Uncertainty (likelihood of beta-type error > 0.1)	20% Background Mean	SL /4 Lowest Toxicological Screening Level	Stated MDDgoal	MDD/MDDgoal	Stated Decision Uncertainty (low if MDD/MDDgoal < 1)	Actual Decision Uncertainty /5	Background-Related DQO Met?	Comment
Barium	41	70.40	33.51	39	99.8	114.5	29.40487805	40.0	73.68	0.1	0.2	4.14	reject at alpha < 0.2	adequate (low)	14.08	330	330.00	0.013	adequate (low)	adequate (low)	Yes	DQO well met.
Beryllium	17	0.56	0.13	39	0.487	0.468	-0.068294118	23.7	0.17	0.1	0.2	0.26	accept	high	0.11	10	10.00	0.026	adequate (low)	adequate (low)	Yes	Overall DQO adequately met. Conclusion of within background is uncertain, however study area mean is well below SL.
Cadmium	42	1.18	0.60	39	1.05	1.128	-0.13047619	40.4	0.72	0.1	0.2	0.41	accept	high	0.24	0.36	0.36	1.126	high *	moderate	OK	Stated DQO is not met however it is unlikely to be met by adding any feasible number of samples. Decision uncertainty exists due to proximity of study area mean and background mean.
Chromium	42	36.89	12.79	39	28.6	27.1	-8.288095238	40.4	478.36	0.1	0.2	10.48	accept	high	7.38	0.4	7.38	1.420	high *	moderate	OK	Stated DQO is not met however it is unlikely to be met by adding any feasible number of samples. Decision uncertainty exists due to proximity of study area mean and background mean.
Cobalt	42	6.92	5.89	39	5.13	5.077	-1.788809524	40.4	30.67	0.1	0.2	2.65	accept	high	1.38	13	13.00	0.204	adequate (low)	moderate	OK	Stated DQO is not met however it is unlikely to be met by adding any feasible number of samples. Decision uncertainty exists due to proximity of study area mean and background mean.
Copper	35	9.47	3.85	39	16.7	15.82	7.232857143	36.9	154.18	0.1	0.2	6.24	reject at alpha < 0.2	adequate (low)	1.89	28	28.00	0.223	adequate (low)	adequate (low)	Yes	Overall DQO well met.
Lead	35	6.14	1.65	39	9.99	14.17	3.852	36.9	53.96	0.1	0.2	3.69	reject at alpha < 0.2	adequate (low)	1.23	11	11.00	0.336	adequate (low)	adequate (low)	Yes	Overall DQO well met.
Mercury	17	0.02	0.01	38	0.0306	0.0277	0.015205882	23.5	0.0007	0.1	0.2	0.0167	accept	high	0.0031	0.1	0.10	0.167	adequate (low)	adequate (low)	Yes	Overall DQO adequately met. Conclusion of within background is uncertain, however study area mean is well below SL.
Molybdenum	41	4.43	1.63	39	3.547	3.461	-0.879585366	40.0	7.50	0.1	0.2	1.32	accept	high	0.89	2	2.00	0.660	adequate (low)	moderate	OK	Stated DQO is not met however it is unlikely to be met by adding any feasible number of samples. Decision uncertainty exists due to proximity of study area mean and background mean.
Nickel	42	28.10	8.14	39	30.5	30.19	2.4	40.4	481.81	0.1	0.2	10.52	accept	high	5.62	30	30.00	0.351	adequate (low)	moderate	OK	Stated DQO is not met however it is unlikely to be met by adding any feasible number of samples. Decision uncertainty exists due to proximity of study area mean and background mean.
Selenium	42	1.11	0.68	39	1.77	1.77	0.660495238	40.4	1.75	0.1	0.2	0.63	reject at alpha < 0.2	adequate (low)	0.22	1	1.00	0.634	adequate (low)	adequate (low)	Yes	Overall DQO is met however some decision uncertainty exists. Conclusion of within background has lower power than desired and conclusion drives COPC selection.
Thallium	17	0.32	0.12	39	0.398	0.499	0.07385	23.7	0.12	0.1	0.2	0.22	accept	high	0.06	1	1.00	0.216	adequate (low)	adequate (low)	Yes	Overall DQO adequately met. Conclusion of within background is uncertain, however study area mean is well below SL.
Tin	10	37.30	3.02	39	47.9	47.56	10.6	15.9	1856.80	0.1	0.2	33.80	accept	high	7.46	50	50.00	0.676	adequate (low)	moderate-high	No	DQO not met. Conclusion of "within background" has estimation uncertainty higher than beta=0.1 and conclusion potentially drives COPC selection.
Vanadium	42	37.13	15.05	39	26.5	26.46	-10.63333333	40.4	455.29	0.1	0.2	10.22	accept	adequate (low)	7.43	2	7.43	1.377	high *	adequate (low)	Yes	Overall DQO well met.
Zinc	42	50.63	23.06	39	46.8	46.58	-3.830952381	40.4	1329.53	0.1	0.2	17.47	accept	high	10.13	50	50.00	0.349	adequate (low)	moderate	OK	Stated DQO is not met however it is unlikely to be met by adding any feasible number of samples. Decision uncertainty exists due to proximity of study area mean, background mean, and SL.

/1 Pooled Statistics

Sample Size: $N_{pooled} = (2 \cdot N1 \cdot N2) / (N1 + N2)$

Degrees of Freedom: $D1 = N1 - 1$; $D2 = N2 - 1$; $D_{pooled} = N_{pooled} - 1$

Pooled standard deviation: $S^2_{pooled} = (S1^2 \cdot D1 + S2^2 \cdot D2) / (D_{pooled})$

/2 t-test statistics

H0: study area is within background

HA: study area exceeds background

point difference = study area mean - background mean

Reject H0 if $MDD < \text{point difference}$

Sources of uncertainty are bolded

/3 Stated DQO goal is **not** met if $MDD/MDDgoal > 1$

* Stated MDLgoal from work plan included estimation uncertainty and an approximate measure of decision uncertainty. However, occasionally actual decision uncertainty was not accurately represented in the Stated MDDgoal.

/4 SL = the lowest toxicological screening level is used without consideration of the background UTL to avoid circularity in assessing the background-related DQO.

/5 Actual Decision Uncertainty is high when study area mean is close to the SL.

/6 Background-related DQO is not met if both estimation uncertainty and actual decision uncertainty are high:

↑
Estimation uncertainty high

↑
Decision Uncertainty high

Minimum detectable difference (MDD) at stated alpha and beta: $MDD = \text{SQRT}(2S^2_{pooled}/N_{pooled}) \cdot (t_{alpha, D_{pooled}} + t_{beta, D_{pooled}})$

(Zar (1984), minimum detectable difference for t-test with unequal sample sizes)

If $MDD < \text{absolute value of (point difference)}$, then power was inadequate to detect a difference from background.