

PT15-05 - CALA PT Program - Regression Equations
Revision 1.4 - October 26, 2016



CALA
Proficiency Testing

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REGRESSION EQUATIONS

1.0 INTRODUCTION

The CALA evaluation procedure involves the use of historic data to establish regression equations of sample concentration against inter-laboratory standard deviation. As well, one of the checks performed with every study is to compare the inter-laboratory standard deviation in a study against warning limits established from the past data. This document provides details on how these regression equations are developed.

2.0 REGRESSION EQUATIONS

A regression equation is established between sample concentration and inter-laboratory standard deviation for each analyte in the PT program with the exception of C20 (asbestos), C05B (microbiology) and C15 (pH). The steps involved in determining the regression equation for an analyte are as follows:

- i) compile the consensus means and inter-lab standard deviations used from all historic studies;
- ii) remove data that is below the currently published concentration range;
- iii) plot consensus mean against inter-lab standard deviation and remove any data pairs that are inconsistent with the data set as a whole;
- iv) calculate the slope and intercept of consensus mean against inter-lab standard deviation;
- v) If the intercept is negative, force the line through zero to prevent unreasonably low standard deviations at lower concentrations.

The following table contains the slope and intercept currently being used for all applicable analytes, using data from studies between 1991 and January 2012, inclusive.

Values for C02A, C02B and C02C are fixed limits that were determined after consultation with laboratory experts, government regulators and Canadian accreditation bodies.

Analyte	Slope	Intercept
C01A Major Anions in Water		
Alkalinity	0.0385	2.00
Calcium	0.0427	0.1402
Chloride	0.0428	0.174
Conductivity	0.0233	1.838
Fluoride	0.0473	0.0278
Hardness	0.0302	0.705
Inorganic Carbon	0.0637	0.5215
Magnesium	0.0448	0.0273
Nitrate	0.0395	0.0335
Nitrate+Nitrite	0.0413	0.0315
Potassium	0.0543	0.0319
Silica	0.0508	0.0468
Sodium	0.0476	0.0548
Sulphate	0.045	0.245
C01B Nutrients in Water		
Ammonia	0.0592	0.0177
Bromide	0.0465	0.0237
Organic Carbon	0.0385	0.226
Nitrite	0.0485	0.0072
Phosphate	0.0522	0.0038
C02A Metals (full range) in Water		
Aluminum	+ 15 %	
Antimony	+ 20 %	
Arsenic	+ 20 %	
Barium	+ 15 %	
Beryllium	+ 15 %	
Boron	+ 15 %	
Cadmium	+ 15 %	
Chromium	+ 15 %	
Cobalt	+ 15 %	
Copper	+ 15 %	
Iron	+ 15 %	
Lead	+ 15 %	
Manganese	+ 15 %	
Molybdenum	+ 15 %	
Nickel	+ 15 %	
Selenium	+ 20 %	
Silver	+ 15 %	
Strontium	+ 15 %	
Thallium	+ 20 %	
Tin	+ 20 %	
Titanium	+ 15 %	
Uranium	+ 15 %	
Vanadium	+ 15 %	
Zinc	+ 15 %	
C02B Metals (high range) in Water		
Aluminum	+ 15 %	
Barium	+ 15 %	
Boron	+ 15 %	
Chromium	+ 15 %	
Cobalt	+ 15 %	
Copper	+ 15 %	
Iron	+ 15 %	
Lead	+ 15 %	
Manganese	+ 15 %	
Molybdenum	+ 15 %	
Nickel	+ 15 %	
Strontium	+ 15 %	
Thallium	+ 20 %	
Titanium	+ 15 %	
Vanadium	+ 15 %	
Zinc	+ 15 %	
C02C Metals (total) in Water		
Aluminum	+ 15 %	
Boron	+ 15 %	
Barium	+ 15 %	
Chromium	+ 15 %	
Cobalt	+ 15 %	
Copper	+ 15 %	
Iron	+ 15 %	
Lead	+ 15 %	
Manganese	+ 15 %	
Molybdenum	+ 15 %	
Nickel	+ 15 %	
Strontium	+ 15 %	
Thallium	+ 20 %	
Titanium	+ 15 %	

Analyte	Slope	Intercept
C02C (cont)		
Vanadium	+ 15 %	
Zinc	+ 15 %	
C03 Total Nutrients in Water		
Kjeldahl Nitrogen	0.129	0.0429
Phosphorus	0.0505	0.0089
C04A Solids in Water		
Dissolved Solids	0.018	12.8
Suspended Solids	0.069	0.859
Volatile Suspended	0.102	0.523
C04B BOD in Water		
BOD	0.157	0.806
CBOD	0.157	0.806
C04C Turbidity in Water		
Turbidity	0.0887	0
C04D COD in Water		
COD	0.0308	3.15
C05A Microbiology in Water		
E. coli	0.16	1.45
Fecal coliforms	0.252	0.219
Heterotrophic Plate Count	0.140	7.62
Total coliforms	0.144	2.24
C06A/C06B OC Pesticides and PCBs in Water		
Alpha- BHC	0.246	0.0056
Alpha-Chlordane	0.1899	0.0
Aldrin	0.2222	0.0286
Dieldrin	0.203	0.0151
Endosulphan I	0.2416	0.0155
Endosulphan II	0.2028	0.0457
Endrin	0.216	0.0354
Gamma-Chlordane	0.1713	0.0022
Heptachlor	0.329	0.0
Heptachlor epoxide	0.164	0.0471
Lindane	0.234	0.0
Mirex	0.2447	0.0294
o,p-DDT	0.2043	0.031
p,p-DDT	0.243	0.0216
p,p-Methoxychlor	0.2084	0.0499
PCBs	0.2863	0.0336
C07 Polycyclic Aromatic Hydrocarbons in Water		
Acenaphthene	0.1445	0.0613
Acenaphthylene	0.167	0.0323
Anthracene	0.179	0.0714
Benzo(a)anthracene	0.218	0.0402
Benz(a)pyrene	0.2336	0.069
Benzo(b)fluoranthene	0.237	0.0382
Benzo(g,h,i)perylene	0.247	0.065
Benzo(k)fluoranthene	0.239	0.0204
Chrysene	0.1974	0.0417
Dibenzo(a,h)anthracene	0.238	0.1203
Fluoranthene	0.164	0.051
Fluorene	0.158	0.0472
Indeno(1,2,3-cd)pyrene	0.257	0.0523
Naphthalene	0.177	0.0326
Phenanthrene	0.1757	0.0368
Pyrene	0.159	0.0655
C08 PCBs in Oil		
PCBs	0.177	0.653
C09 Metals on Quartz Filters		
Cadmium	0.0777	0.425
Copper	0.101	0.210
Lead	0.108	0.137
Zinc	0.153	0.138
C11/C12/C13 Toxicology		
Trout	0.117	0.040
Daphnia	0.141	0
Microtox	0.200	0
C14 Cyanide in Water		
Cyanide (SAD)	0.126	0.0175
C15 pH in Water		
pH	0	0.1

Analyte	Slope	Intercept
C16 Volatile Organic Compounds in Water		
1,1-Dichloroethane	0.108	0.237
1,1-Dichloroethylene	0.151	0.357
1,1,1-Trichloroethane	0.119	0.174
1,1,2-Trichloroethane	0.0978	0.105
1,1,2,2-Tetrachloroethane	0.138	0
1,2-Dichlorobenzene	0.105	0.275
1,2-Dichloroethane	0.105	0.186
1,2-Dichloropropane	0.0975	0.0326
1,3-Dichlorobenzene	0.118	0.0175
1,4-Dichlorobenzene	0.109	0.461
Acetone	0.233	2.05
Benzene	0.123	0.219
Bromodichloromethane	0.133	0
Bromoform	0.169	0
Carbon Tetrachloride	0.134	0.356
Chlorobenzene	0.0992	0.0693
Chlorodibromomethane	0.136	0
Chloroform	0.140	0
cis(1,2)Dichloroethylene	0.111	0.403
cis(1,3)Dichloropropene	0.142	0.0342
Dichloromethane	0.139	0.290
Ethylbenzene	0.136	0.156
Ethylene Dibromide	0.0989	0
m,p-xylene	0.134	0
Methyl ethyl ketone	0.198	1.59
Methyl isobutyl ketone	0.153	1.24
Methyl-t-butyl ether	0.138	0.142
o-xylene	0.125	0.413
Styrene	0.109	0.827
Tetrachloroethylene	0.132	0.341
Toluene	0.122	0.352
trans(1,2)Dichloroethylene	0.137	0.106
trans(1,3)Dichloropropene	0.145	0.168
Trichloroethylene	0.124	0.162
Trichlorofluoromethane	0.142	0.178
Vinyl Chloride	0.1795	0.276
C17 Metals in Soil		
Aluminum	0.131	400
Antimony	0.573	0
Arsenic	0.111	0.62
Barium	0.0692	2.09
Beryllium	0.132	0.045
Boron	0.438	0
Cadmium	0.0866	0.153
Chromium	0.0761	1.53
Cobalt	0.0978	0
Copper	0.0836	0
Iron	0.0913	0
Lead	0.0746	1.68
Manganese	0.0733	0
Mercury	0.255	0
Nickel	0.103	0
Strontium	0.0871	0.459
Tin	0.240	0.613
Titanium	0.253	14.2
Uranium	0.0872	0.0649
Vanadium	0.141	0.155
Zinc	0.08	0.283
C18 Polycyclic Aromatic Hydrocarbons in Soil		
Acenaphthene	0.209	0.0161
Acenaphthylene	0.445	0
Anthracene	0.321	0
Benzo(a)anthracene	0.241	0
Benzo(a)pyrene	0.232	0.0058
Benzo(b)fluoranthene	0.280	0.0836
Benzo(g,h,i)perylene	0.243	0.039
Benzo(k)fluoranthene	0.372	0
Chrysene	0.221	0.056
Dibenzo(a,h)anthracene	0.303	0.0102
Fluoranthene	0.206	0.0165
Fluorene	0.25	0.112
Indene(1,2,3-cd)pyrene	0.223	0.107
Naphthalene	0.373	0
Phenanthrene	0.209	0
Pyrene	0.200	0.0423

Analyte	Slope	Intercept
C19 Mercury in Water		
Mercury	0.0917	0.0436
C21 Metals on Cellulose Ester Filters		
Cadmium	0.0474	0
Chromium	0.0509	0
Lead	0.0519	0
Zinc	0.0511	0.638
C22 Organophosphorus Pesticides in Water		
Atrazine	0.204	0
Azinphos-methyl	0.250	0.356
Bendiocarb	0.223	0.598
Carbaryl	0.301	0.073
Carbofuran	0.309	0
Chlorpyrifos	0.188	0.147
Cyanazine	0.275	0.164
Diiazinon	0.254	0
Dimethoate	0.302	0.227
Diuron	0.238	0.583
Malathion	0.197	0.260
Metolachlor	0.179	0.191
Metribuzin	0.216	0.263
Parathion	0.237	0.0776
Phorate	0.274	0
Simazine	0.25	0.0079
Terbufos	0.279	0.0389
Trifluralin	0.260	0.0121
C24 Aryloxy Acid Pesticides in Water		
2,4-D	0.264	0.0979
2,4,5-T	0.244	0.0761
Bromoxynil	0.230	0.0704
Dicamba	0.290	0.0108
Dichlorofop-methyl	0.363	0
Dinoseb	0.339	0.0979
Picloram	0.482	0.0957
C25 Chlorophenols in Water		
2,3,4,6-Tetrachlorophenol	0.207	0.387
2,4-Dichlorophenol	0.237	0.278
2,4,6-Trichlorophenol	0.240	0
Pentachlorophenol	0.206	0.406
C27 Glyphosate in Water		
Glyphosate	0.138	1.85
C29 Aldicarb in Water		
Aldicarb	0.174	0.326
C31A/C31B BTEX and Petroleum Hydrocarbons in Soil		
Benzene	0.375	1.85
Ethylbenzene	0.243	2.23
F1	0.213	38.9
m/p-xylene	0.232	0
o-xylene	0.251	0
Toluene	0.263	1.45
F2	0.220	40.3
F3	0.227	26
F4	0.300	35
F4 Gravimetric	0.187	570
VH	0.213	38.9
C32 Chlorine in Water		
Total Chlorine	0.0576	0.0193
Free Chlorine	0.0661	0.00248
C33 Phenolics in Water		
Phenolics	0.0678	0.0035
C34 Oil and Grease in Water		
Oil and Grease	0.185	7.15
C35 PCBs in Soil		
PCBs	0.339	0
C36 Volatile Organic Compounds in Soil*		
1,1-Dichloroethane	0.437	0.025
1,1-Dichloroethylene	0.643	0
1,1,1-Trichloroethane	0.395	0.245
1,1,2-Trichloroethane	0.226	0.426
1,1,2,2-Tetrachloroethane	0.205	0
1,2-Dichlorobenzene	0.223	0.291
1,2-Dichloroethane	0.324	0
1,2-Dichloropropane	0.291	0
1,3-Dichlorobenzene	0.222	0.842
1,4-Dichlorobenzene	0.192	1.65
Acetone	0.392	0
Benzene	0.314	0.351
Bromodichloromethane	0.267	0

Analyte	Slope	Intercept
C36 (cont)		
Bromoform	0.204	0.895
Carbon Tetrachloride	0.378	0.129
Chlorobenzene	0.206	0.193
Chlorodibromomethane	0.223	0.136
Chloroform	0.401	0.225
cis(1,2)Dichloroethylene	0.344	0.296
cis(1,3)Dichloropropene	0.277	0
Dichloromethane	0.606	0.0118
Ethylbenzene	0.160	2.25
Ethylene Dibromide	0.248	0
m,p-xylene	0.162	5.94
Methyl ethyl ketone	0.361	0
Methyl isobutyl ketone	0.313	0
Methyl-t-butyl ether	0.283	0.901
o-xylene	0.155	2.19
Styrene	0.214	0.297

Analyte	Slope	Intercept
Tetrachloroethylene	0.272	0
Toluene	0.182	2.03
trans(1,2)Dichloroethylene	0.389	0.727
trans(1,3)Dichloropropene	0.278	0
Trichloroethylene	0.309	0
Trichlorofluoromethane	0.8366	0.2568
C37 Colour in Water		
True Colour	0	0
P50 Chlorine for Test Kits		
Free Chlorine	0.0576	0.0193
Total Chlorine	0.0661	0.00248
P51 Turbidity for Test Kits		
Turbidity	0.0887	0
P52 pH for Test Kits		
pH	0	0.1

Note: A slope and intercept of zero means that equations have not yet been developed.

* Fewer than five studies have been completed. Equations will be updated when five studies have been completed.