

PT15-05 - CALA PT Program - Regression Equations  
**Revision 1.6** – April 20, 2018



**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.

## 3.0 FIXED LIMITS

Fixed limits are indicated as  $\pm \#\%$  and were derived after consultation with technical experts, regulators, accreditation bodies and other PT schemes.

Analyte	Slope	Intercept
<b>C01A Major Anions in Water</b>		
Alkalinity		+ 15 %
Calcium		+ 15 %
Chloride		+ 15 %
Conductivity		+ 10 %
Fluoride		+ 15 %
Hardness		+ 15 %
Inorganic Carbon		+ 20 %
Magnesium		+ 15 %
Nitrate		+ 15 %
Nitrate+Nitrite		+ 15 %
Potassium		+ 15 %
Silica		+ 20 %
Sodium		+ 15 %
Sulphate		+ 15 %
<b>C01B Nutrients in Water</b>		
Ammonia		+ 20 %
Bromide		+ 15 %
Organic Carbon	0.0385	0.226
Nitrite		+ 15 %
Phosphate		+ 15 %
<b>C02A Metals (full range) in Water</b>		
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 %
<b>C02B Metals (high range) in Water</b>		
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 %
<b>C02C Metals (total) in Water</b>		
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
<b>C02C (cont)</b>		
Vanadium		+ 15 %
Zinc		+ 15 %
<b>C03 Total Nutrients in Water</b>		
Kjeldahl Nitrogen		+ 25 %
Phosphorus		+ 20 %
<b>C04A Solids in Water</b>		
Dissolved Solids	0	22.5
Suspended Solids		+ 20 %
Volatile Suspended		+ 25 %
<b>C04B BOD in Water</b>		
BOD		+ 35 %
CBOD		+ 35 %
<b>C04C Turbidity in Water</b>		
Turbidity	0.0887	0
<b>C04D COD in Water</b>		
COD	0.0308	3.15
<b>C05A Microbiology in Water</b>		
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
<b>C06A/C06B OC Pesticides and PCBs in Water</b>		
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
<b>C07 Polycyclic Aromatic Hydrocarbons in Water</b>		
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
<b>C08 PCBs in Oil</b>		
PCBs	0.177	0.653
<b>C09 Metals on Quartz Filters</b>		
Cadmium	0.0777	0.425
Copper	0.101	0.210
Lead	0.108	0.137
Zinc	0.153	0.138
<b>C11/C12/C13 Toxicology</b>		
Trout	0.117	0.040
Daphnia	0.141	0
Microtox	0.200	0
<b>C14 Cyanide in Water</b>		
Cyanide (SAD)		+ 30 %
<b>C15 pH in Water</b>		
pH	0	0.1

Analyte	Slope	Intercept
<b>C16 Volatile Organic Compounds in Water</b>		
1,1-Dichloroethane		+30%
1,1-Dichloroethylene		+40%
1,1,1-Trichloroethane		+30%
1,1,2-Trichloroethane		+30%
1,1,2,2-Tetrachloroethane		+35%
1,2-Dichlorobenzene		+30%
1,2-Dichloroethane		+30%
1,2-Dichloropropane		+30%
1,3-Dichlorobenzene		+30%
1,4-Dichlorobenzene		+30%
Acetone	0.233	2.05
Benzene		+30%
Bromodichloromethane		+30%
Bromoform		+30%
Carbon Tetrachloride		+30%
Chlorobenzene		+30%
Chlorodibromomethane		+30%
Chloroform		+30%
cis(1,2)Dichloroethylene		+30%
cis(1,3)Dichloropropene		+30%
Dichloromethane		+35%
Ethylbenzene		+30%
Ethylene Dibromide		+30%
m,p-xylene		+30%
Methyl ethyl ketone		+45%
Methyl isobutyl ketone		+40%
Methyl-t-butyl ether		+30%
o-xylene		+30%
Styrene		+30%
Tetrachloroethylene		+30%
Toluene		+30%
trans(1,2)Dichloroethylene		+30%
trans(1,3)Dichloropropene		+30%
Trichloroethylene		+35%
Trichlorofluoromethane		+40%
Vinyl Chloride		+45%
<b>C17 Metals in Soil</b>		
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
<b>C18 Polycyclic Aromatic Hydrocarbons in Soil</b>		
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
<b>C19 Mercury in Water</b>		
Mercury		+ 30 %
<b>C21 Metals on Cellulose Ester Filters</b>		
Cadmium	0.0474	0
Chromium	0.0509	0
Lead	0.0519	0
Zinc	0.0511	0.638
<b>C22 Organophosphorus Pesticides in Water</b>		
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
Diazinon	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
<b>C24 Aryloxy Acid Pesticides in Water</b>		
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
Dichlorop-methyl	0.363	0
Dinoseb	0.339	0.0979
Picloram	0.482	0.0957
<b>C25 Chlorophenols in Water</b>		
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
<b>C27 Glyphosate in Water</b>		
Glyphosate	0.138	1.85
<b>C29 Aldicarb in Water</b>		
Aldicarb	0.174	0.326
<b>C31A/C31B BTEX and Petroleum Hydrocarbons in Soil</b>		
Benzene		+35%
Ethylbenzene		+35%
F1	0.213	38.9
m/p-xylene		+40%
o-xylene		+35%
Toluene		+35%
F2	0.220	40.3
F3	0.227	26
F4	0.300	35
F4 Gravimetric	0.187	570
VH	0.213	38.9
<b>C32 Chlorine in Water</b>		
Total Chlorine	0.0576	0.0193
Free Chlorine	0.0661	0.00248
<b>C33 Phenolics in Water</b>		
Phenolics	0.0678	0.0035
<b>C34 Oil and Grease in Water</b>		
Oil and Grease	0.185	7.15
<b>C35 PCBs in Soil</b>		
PCBs	0.339	0
<b>C36 Volatile Organic Compounds in Soil</b>		
1,1-Dichloroethane		+ 40%
1,1-Dichloroethylene		+ 40%
1,1,1-Trichloroethane		+ 45%
1,1,2-Trichloroethane		+35%
1,1,2,2-Tetrachloroethane		+35%
1,2-Dichlorobenzene		+35%
1,2-Dichloroethane		+35%
1,2-Dichloropropane		+35%
1,3-Dichlorobenzene		+35%
1,4-Dichlorobenzene		+35%
Acetone	0.204	1.21
Benzene		+35%
Bromodichloromethane		+35%

Analyte	Slope	Intercept
<b>C36 (cont)</b>		
Bromoform	+35%	
Carbon Tetrachloride	+35%	
Chlorobenzene	+35%	
Chlorodibromomethane	+35%	
Chloroform	+35%	
cis(1,2)Dichloroethylene	+35%	
cis(1,3)Dichloropropene	+35%	
Dichloromethane	+40%	
Ethylbenzene	+35%	
Ethylene Dibromide	+35%	
m,p-xylene	+40%	
Methyl ethyl ketone	+55%	
Methyl isobutyl ketone	+45%	
Methyl-t-butyl ether	+40%	
o-xylene	+35%	
Styrene	+35%	
Tetrachloroethylene	+45%	
Toluene	+35%	
trans(1,2)Dichloroethylene	+35%	
trans(1,3)Dichloropropene	+35%	
Trichloroethylene	+40%	
Trichlorofluoromethane	+50%	
<b>C37 Colour in Water</b>		
True Colour	0.081	0.933
<b>C38 VOCs by TCLP</b>		
1,2-Dichlorobenzene	0	0
1,2-Dichloroethane	0	0
1,4-Dichlorobenzene	0	0
Benzene	0	0
Carbon tetrachloride	0	0
Chlorobenzene	0	0
Chloroform	0	0
Dichloromethane	0	0
Methyl Ethyl Ketone	0	0
Tetrachloroethylene	0	0
Trichloroethylene	0	0

Analyte	Slope	Intercept
<b>C39 Inorganics by TCLP</b>		
Silver	0	0
Arsenic	0	0
Boron	0	0
Barium	0	0
Cadmium	0	0
Chromium	0	0
Lead	0	0
Selenium	0	0
Uranium	0	0
Mercury	0	0
Fluoride	0	0
Nitrate-N	0	0
Nitrate and Nitrite as N	0	0
Cyanide (WAD)	0	0
<b>C40A Volatile PHCs in Water</b>		
Benzene	+ 30%	
Ethylbenzene	+ 30%	
F1: C6-C10	0.162	119
m/p-Xylene	+ 30%	
o-Xylene	+ 30%	
Toluene	+ 30%	
<b>C40B PHCs in Water</b>		
F2: C10-C16	0.172	492
F3: C16-C34	0	0
F4: C34-C50	0.215	452
<b>C41 Hexavalent Chromium in Water</b>		
Hexavalent Chromium	+ 20%	
<b>C42 Sulphide in Water</b>		
Sulphide	0.121	0.282
<b>P50 Chlorine for Test Kits</b>		
Free Chlorine	0.0576	0.0193
Total Chlorine	0.0661	0.00248
<b>P51 Turbidity for Test Kits</b>		
Turbidity	0.0887	0
<b>P52 pH for Test Kits</b>		
pH	0	0.1

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