RUNNING THE BLM SOFTWARE

April 6, 2017

ACWA Workshop on Oregon's Copper Standard

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Clean Water Services

Goals of this Portion of the Workshop

- Show how we have been using the model to generate WQ Criteria for specific sampling events
- Provide tips for getting large datasets ready to input into the model software, including estimating missing parameters needed to run the model
- Step-by-step instructions for running the model
- Show an example dataset used to run the model
- Display results, showing the WQ Criteria generated for the example dataset

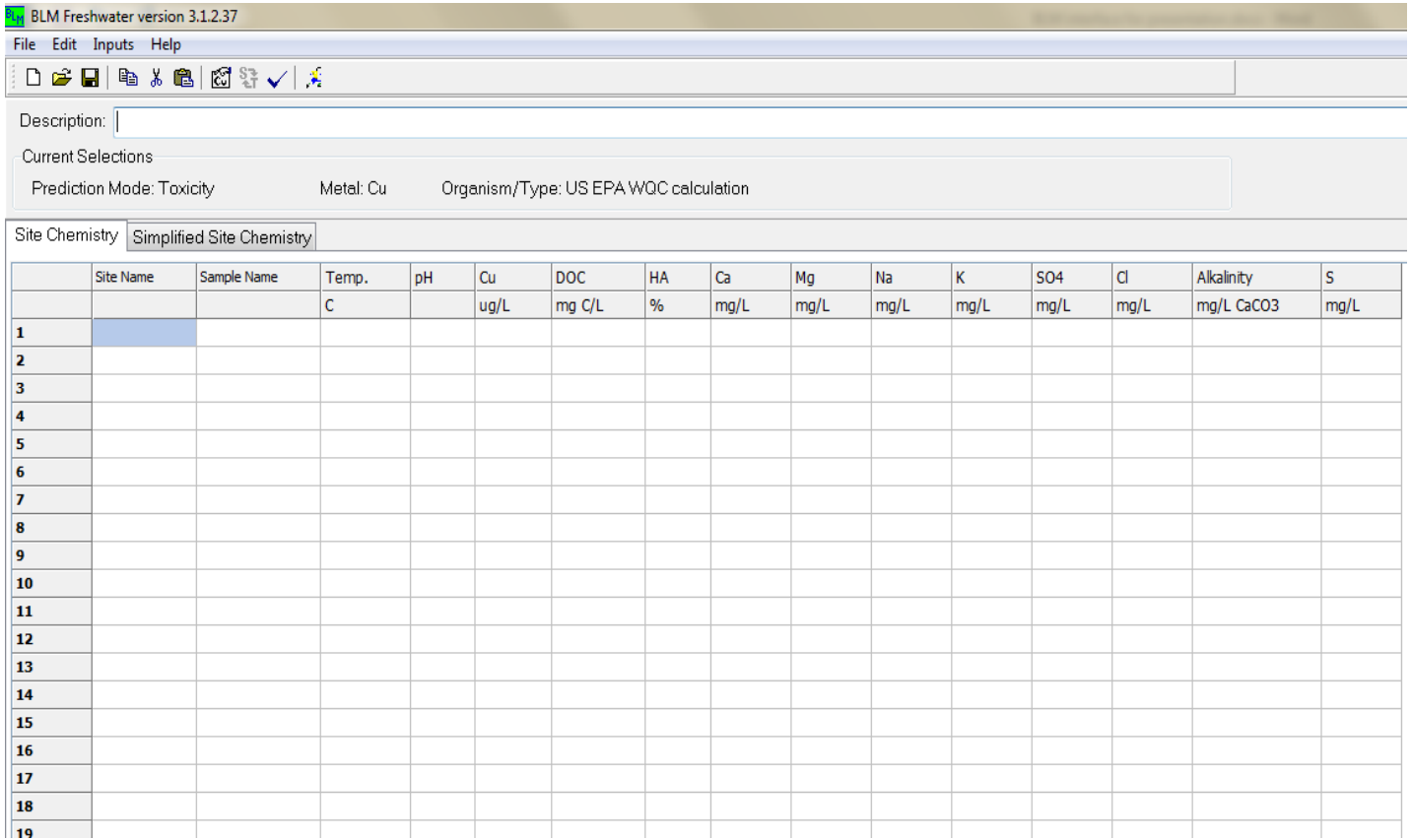
User's Guide by Windward Environmental

- **BIOTIC LIGAND MODEL WINDOWS® INTERFACE, RESEARCH VERSION 3.1.2.37: USER'S GUIDE AND REFERENCE MANUAL**

- **October 2015**

Windward environmental LLC

BLM Interface



	Site Name	Sample Name	Temp.	pH	Cu	DOC	HA	Ca	Mg	Na	K	SO4	Cl	Alkalinity	S
			C		ug/L	mg C/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L CaCO3	mg/L
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Example Dataset – Parameters Missing

Sample Point Name	Calendar Date	00010 - Temperature ºC	00400 - pH S.U.	01040 - Cu-Sol µg/L	88998 - NPOC mg/L	HA %	00916 - Ca mg/L	00927 - Mg mg/L	00929 - Na mg/L	00937 - K mg/L	00946 - SO4 mg/L	00941 - Cl mg/L	00410 - Alkalinity mg/L	S mg/L
TR@FERN HILL	1/19/2016	7.9	7.3									3.29	22.6	
TR@FERN HILL	2/9/2016	7.7	7.15	0.619	1.17		6.81	2.35	4.07	0.538	2.95	3.39	28.5	
TR@FERN HILL	2/23/2016	6.6	7.41									3.35	29.2	
TR@FERN HILL	3/1/2016	8	7.01	0.792	1.21		7.07	2.54	4.28	0.572	2.93	3.32	29	
TR@FERN HILL	3/8/2016	7.9	7.2									2.88	27	
TR@FERN HILL	3/22/2016	9	7.15									3.19	29.2	
TR@FERN HILL	4/5/2016	10.5	7.19									3.55	35	
TR@FERN HILL	4/13/2016	10.9	7.12		1.43							3.85		
TR@FERN HILL	4/19/2016	15.2	7.21									4.18	36.8	
TR@FERN HILL	4/26/2016	11.3	7.25		1.43							4.42		
TR@FERN HILL	5/2/2016	14.3	7.23									4.39	41.2	
TR@FERN HILL	5/16/2016	12	7.42	0.715	1.21		8.3	2.72				3.96	36.1	
TR@FERN HILL	6/13/2016	13.2	7.49	0.694	1.2		7.41	2.38	4.33	0.447	2.12	3.65	33	
TR@FERN HILL	6/27/2016	14.2	7.42									3.52	29.7	
TR@FERN HILL	7/11/2016	12.3	7.57	0.661	1.19		6.16	2.15	3.66	0.37	2.12	3.57	29.2	
TR@FERN HILL	7/25/2016	11.8	7.27									3.09	27.8	
TR@FERN HILL	8/15/2016	12.4	7.46		1.09						2.09	2.92	26.9	

DEQ's Specific Conductance Regression Equations

Uses Specific Conductance (X) to estimate the Missing Parameter (Y)

Parameter	Regression Equation	Adjusted R^2	p-value
DOC	ln(y) = 0.69·ln(x)–2.43	0.31	< 0.001
Hardness	ln(y) = 1.02·ln(x)–1.16	0.92	< 0.001
Alkalinity	ln(y) = 0.88·ln(x)– 0.41	0.77	< 0.001
Calcium	ln(y) = 0.96·ln(x)–2.29	0.89	< 0.001
Sodium	ln(y) = 0.86·ln(x)–2.22	0.82	< 0.001
Magnesium	ln(y) = 0.91·ln(x)–3.09	0.85	< 0.001
Potassium	ln(y) = 0.84·ln(x)–3.74	0.70	< 0.001
Chloride	ln(y) = 01.15·ln(x)–3.82	0.77	< 0.001
Sulfate	ln(y)= 1.45·ln(x)–5.59	0.76	< 0.001

DEQ's Specific Conductance Regression Equations

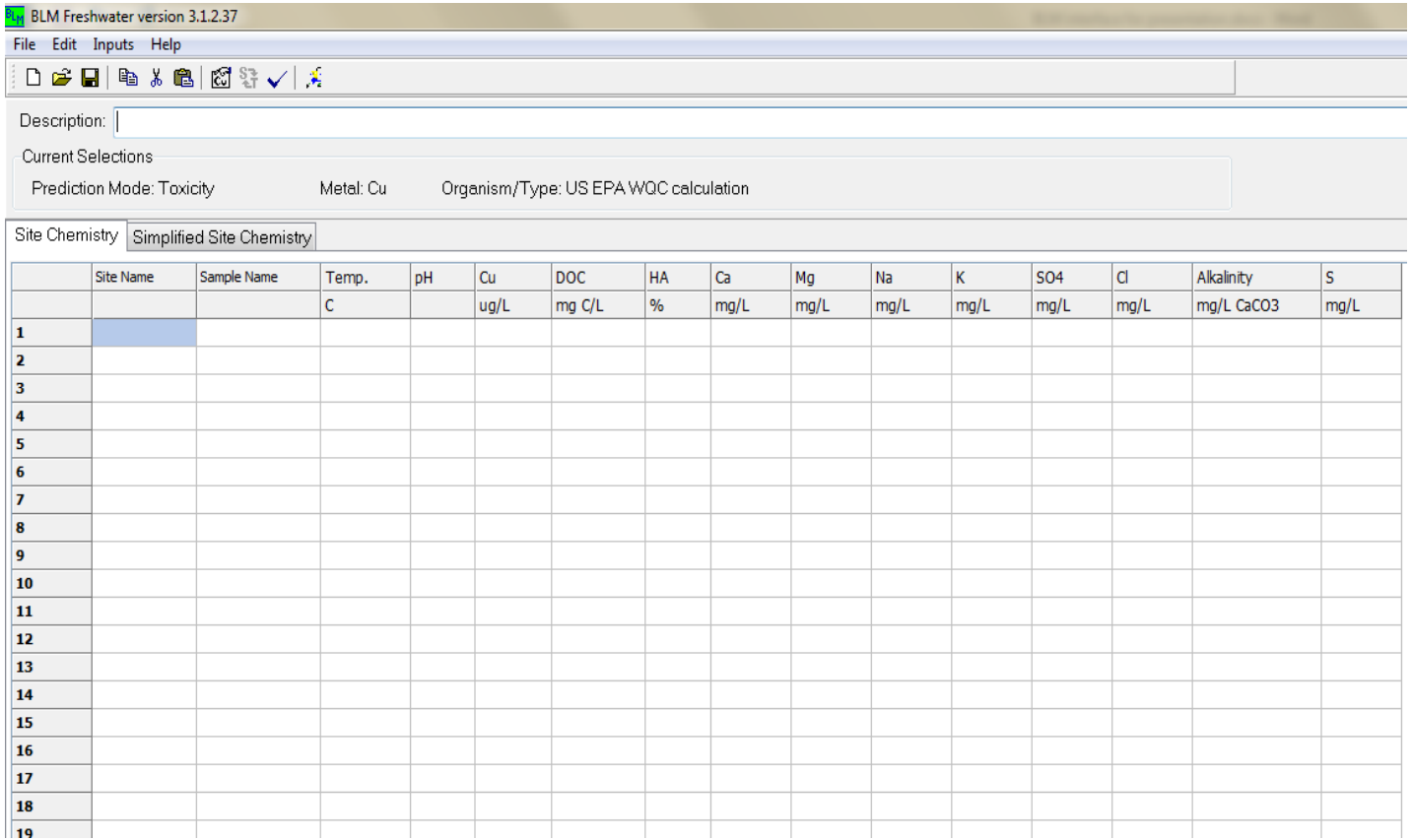
Parameter	Equation
Alkalinity	$Alk. = \exp^{(0.88 \cdot [\ln(SpC)] - 0.41)}$
Calcium	$Ca = \exp^{(0.96 \cdot [\ln(SpC)] - 2.29)}$
Chloride	$Cl = \exp^{(1.15 \cdot [\ln(SpC)] - 3.82)}$
Magnesium	$Mg = \exp^{(0.91 \cdot [\ln(SpC)] - 3.09)}$
Potassium	$K = \exp^{(0.84 \cdot [\ln(SpC)] - 3.74)}$
Sodium	$Na = \exp^{(0.86 \cdot [\ln(SpC)] - 2.22)}$
Sulfate	$SO_4 = \exp^{(1.45 \cdot [\ln(SpC)] - 5.59}$

Example Dataset – Missing Parameters Estimated

(Except Humic Acid and Sulfide)

Sample Point Name	Calendar Date	00010 - Temperature ºC	00400 - pH S.U.	01040 - Cu-Sol µg/L	88998 - NPOC mg/L	HA %	00916 - Ca mg/L	00927 - Mg mg/L	00929 - Na mg/L	00937 - K mg/L	00946 - SO4 mg/L	00941 - Cl mg/L	00410 - Alkalinity mg/L	S mg/L
TR@FERN HILL	1/19/2016	7.9	7.3		1.65		6.42	2.23	3.73	0.518	2.45	3.29	22.6	
TR@FERN HILL	2/9/2016	7.7	7.15	0.619	1.17		6.81	2.35	4.07	0.538	2.95	3.39	28.5	
TR@FERN HILL	2/23/2016	6.6	7.41		1.31		7.10	2.42	4.12	0.676	2.87	3.35	29.2	
TR@FERN HILL	3/1/2016	8	7.01	0.792	1.21		7.07	2.54	4.28	0.572	2.93	3.32	29	
TR@FERN HILL	3/8/2016	7.9	7.2		1.33		6.52	2.26	3.79	0.541	2.51	2.88	27	
TR@FERN HILL	3/22/2016	9	7.15		1.44		7.30	2.47	4.23	0.723	2.99	3.19	29.2	
TR@FERN HILL	4/5/2016	10.5	7.19		1.77		8.00	2.66	4.63	0.884	3.42	3.55	35	
TR@FERN HILL	4/13/2016	10.9	7.12		1.43		8.32	2.75	4.81	0.958	3.61	3.85	34.1	
TR@FERN HILL	4/19/2016	15.2	7.21		2.74		8.53	2.81	4.93	1.007	3.74	4.18	36.8	
TR@FERN HILL	4/26/2016	11.3	7.25		1.43		8.83	2.89	5.11	1.077	3.92	4.42	36.1	
TR@FERN HILL	5/2/2016	14.3	7.23		2.62		9.35	3.03	5.40	1.196	4.24	4.39	41.2	
TR@FERN HILL	5/16/2016	12	7.42	0.715	1.21		8.3	2.72	4.74	0.927	3.53	3.96	36.1	
TR@FERN HILL	6/13/2016	13.2	7.49	0.694	1.2		7.41	2.38	4.33	0.447	2.12	3.65	33	
TR@FERN HILL	6/27/2016	14.2	7.42		1.19		6.98	2.38	4.05	0.647	2.79	3.52	29.7	
TR@FERN HILL	7/11/2016	12.3	7.57	0.661	1.19		6.16	2.15	3.66	0.37	2.12	3.57	29.2	
TR@FERN HILL	7/25/2016	11.8	7.27		1.11		6.52	2.26	3.79	0.541	2.51	3.09	27.8	
TR@FERN HILL	8/15/2016	12.4	7.46		1.09		6.43	2.23	3.74	0.520	2.09	2.92	26.9	

BLM Interface



	Site Name	Sample Name	Temp.	pH	Cu	DOC	HA	Ca	Mg	Na	K	SO4	Cl	Alkalinity	S
			C		ug/L	mg C/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L CaCO3	mg/L
1															
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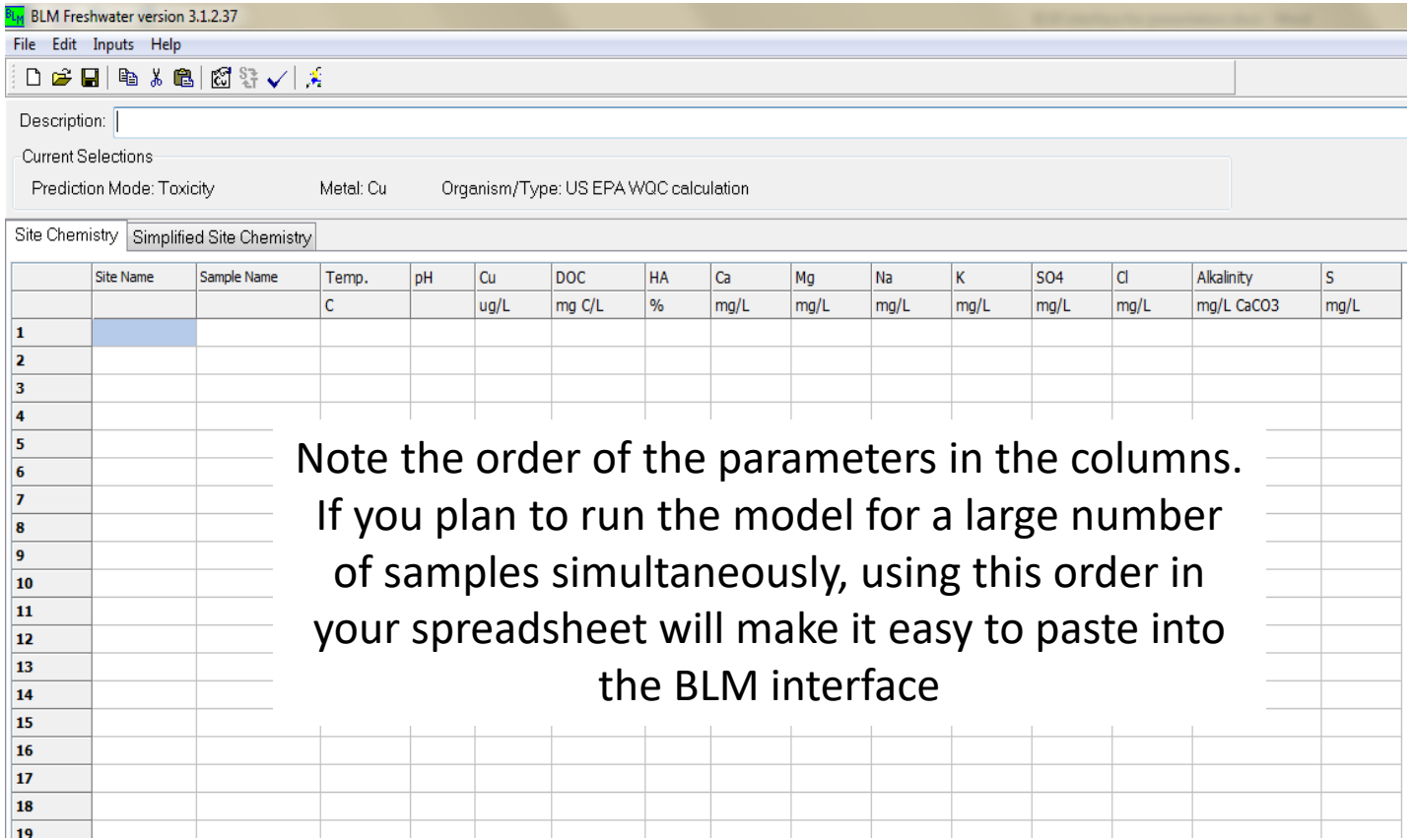
BLM Interface

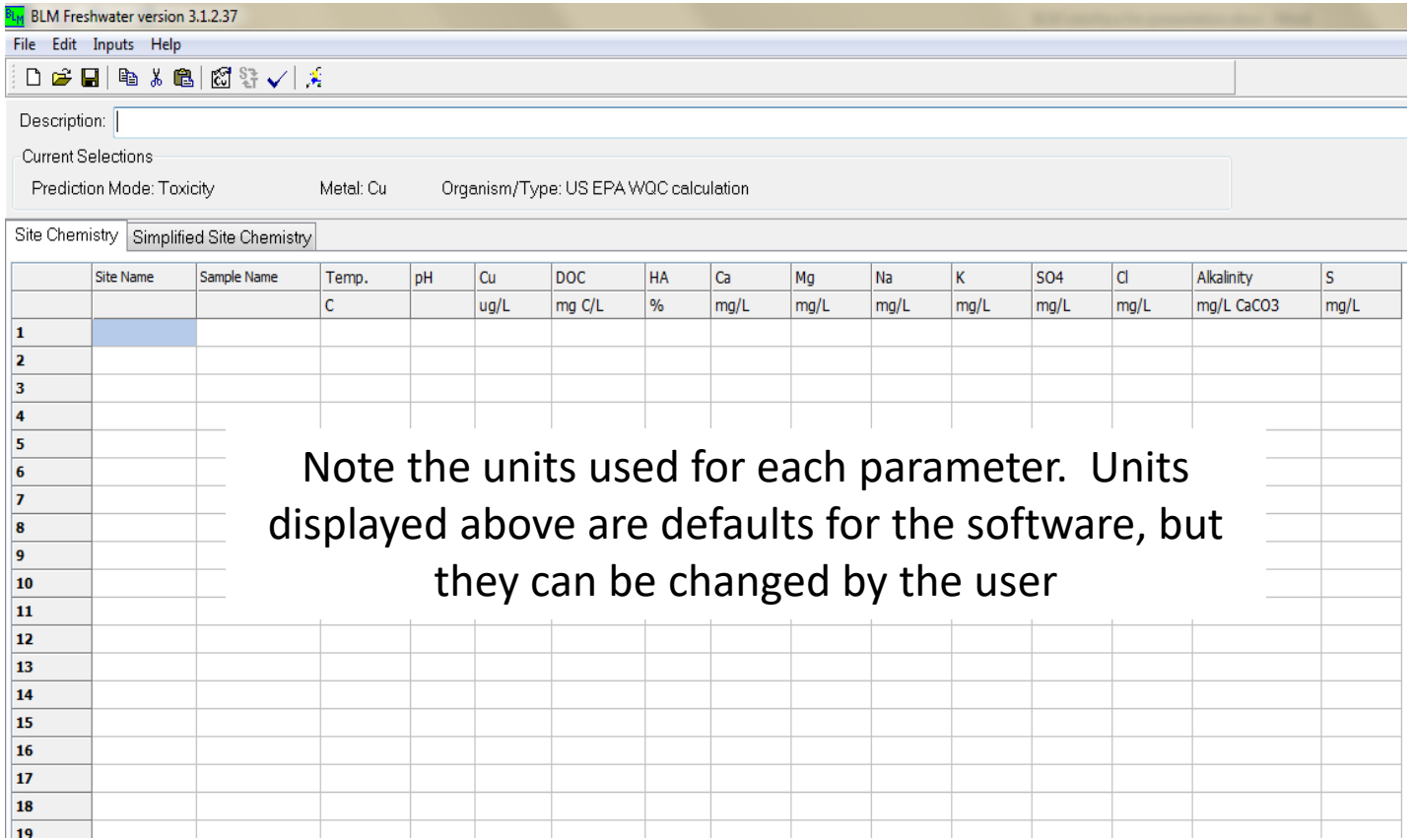


Note the order of the parameters in the columns. If you plan to run the model for a large number of samples simultaneously, using this order in your spreadsheet will make it easy to paste into the BLM interface

Column Order of the Parameters

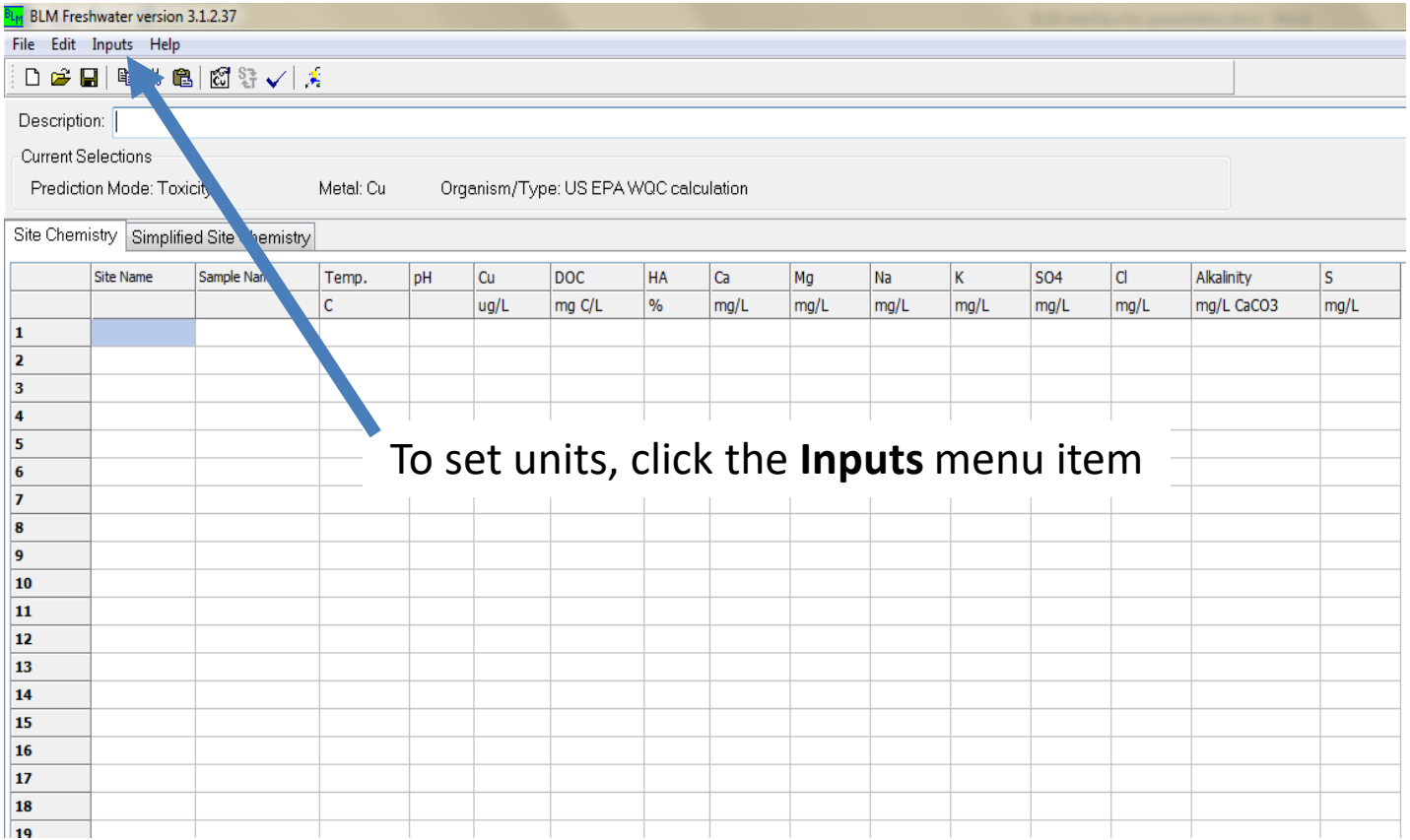
Order	Parameter
1	Site Name
2	Sample Name
3	Temperature
4	pH
5	Copper (not necessary to run the model
6	Dissolved Organic Carbon
7	Humic Acid
8	Calcium
9	Magnesium
10	Sodium
11	Potassium
12	Sulfate
13	Chloride
14	Alkalinity
15	Sulfide

BLM Interface

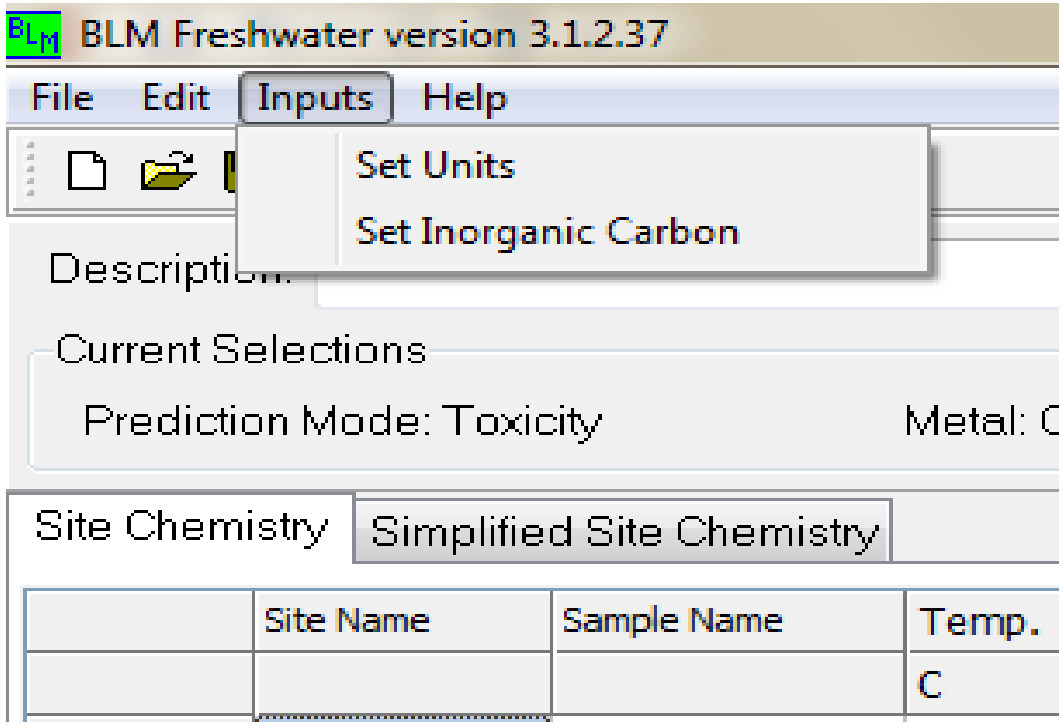


Note the units used for each parameter. Units displayed above are defaults for the software, but they can be changed by the user

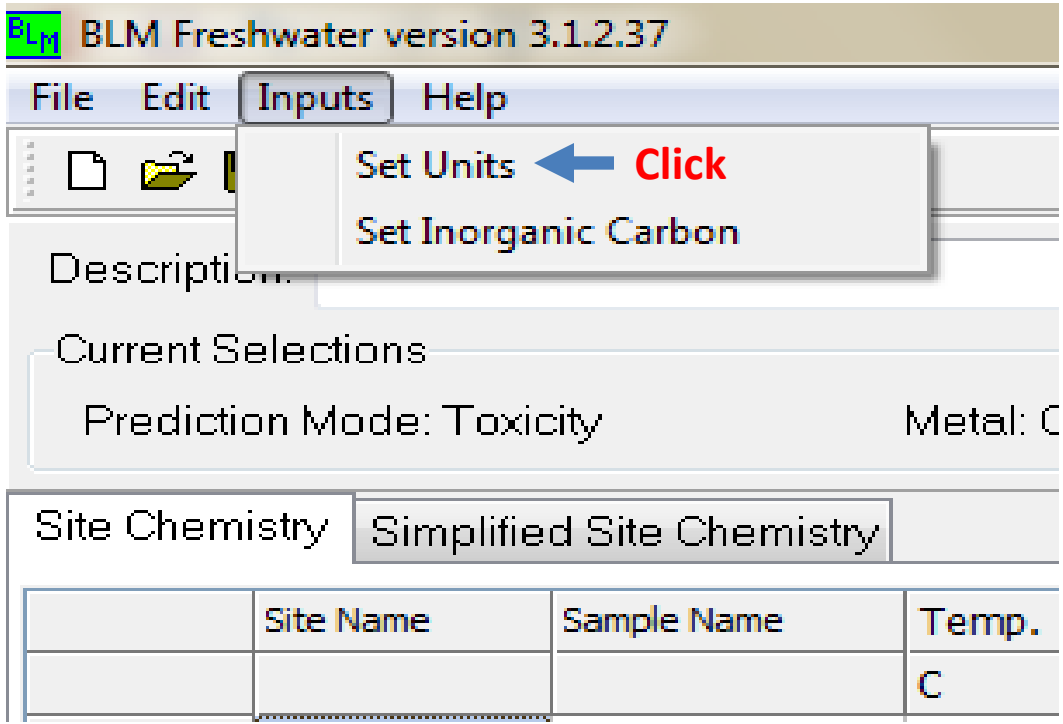
BLM Interface



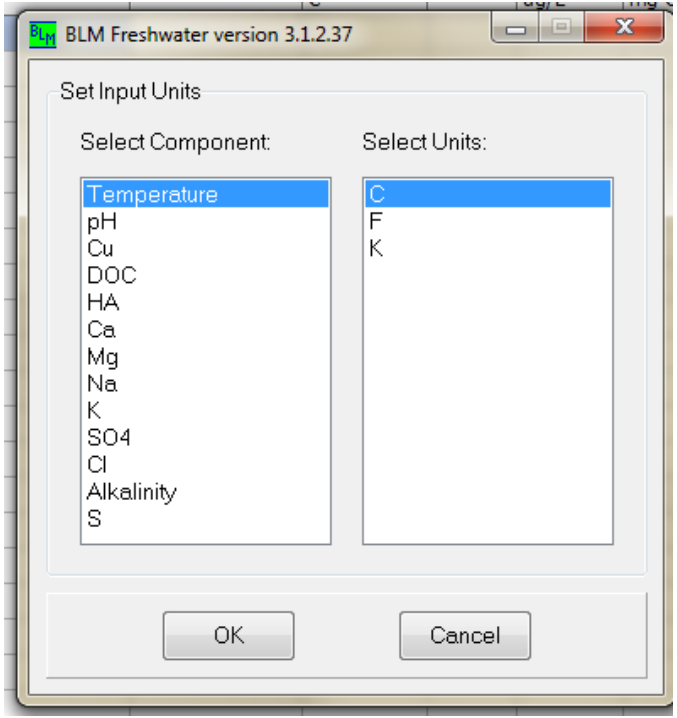
Setting the Units



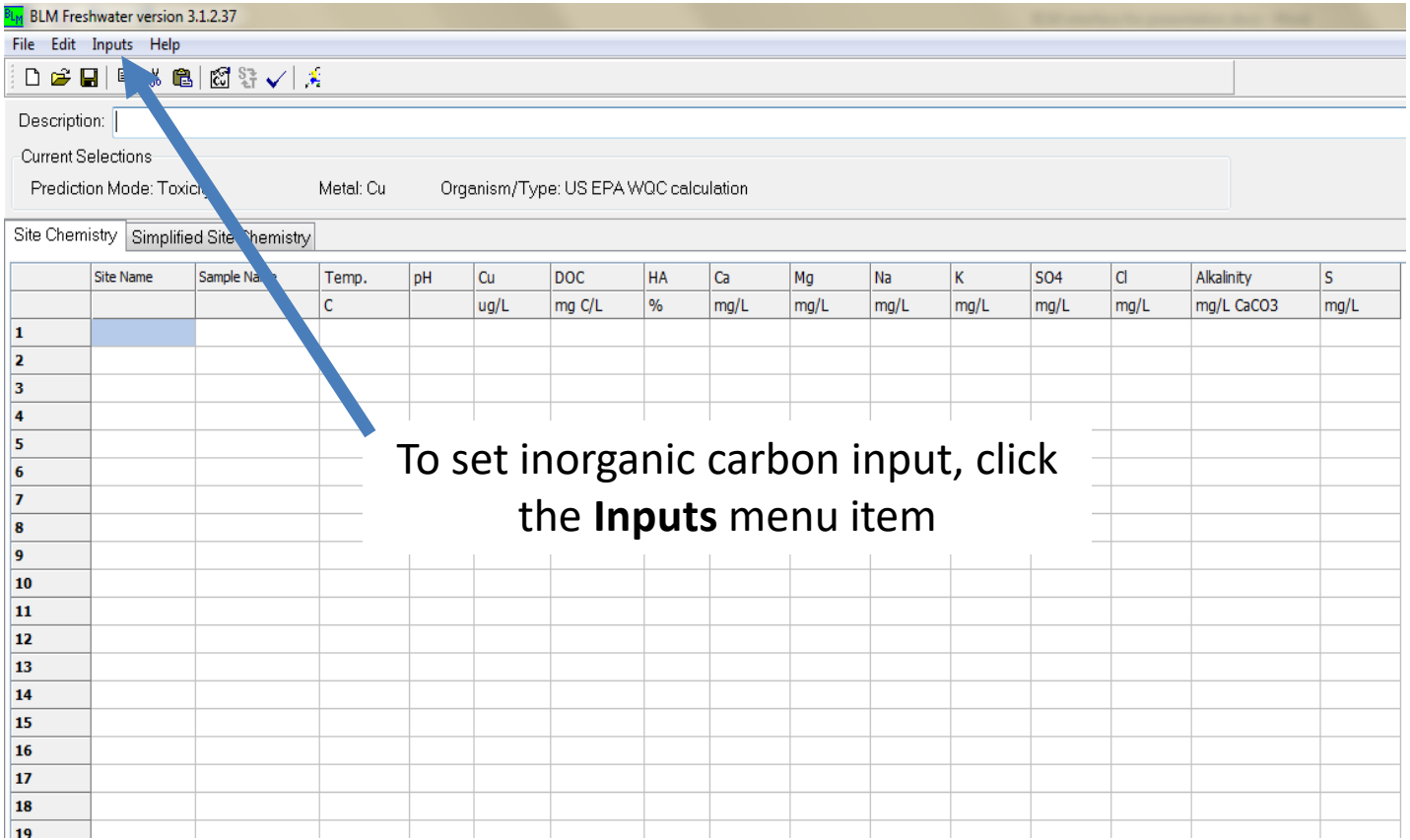
Setting the Units



Dialogue Box for Setting Parameter Units

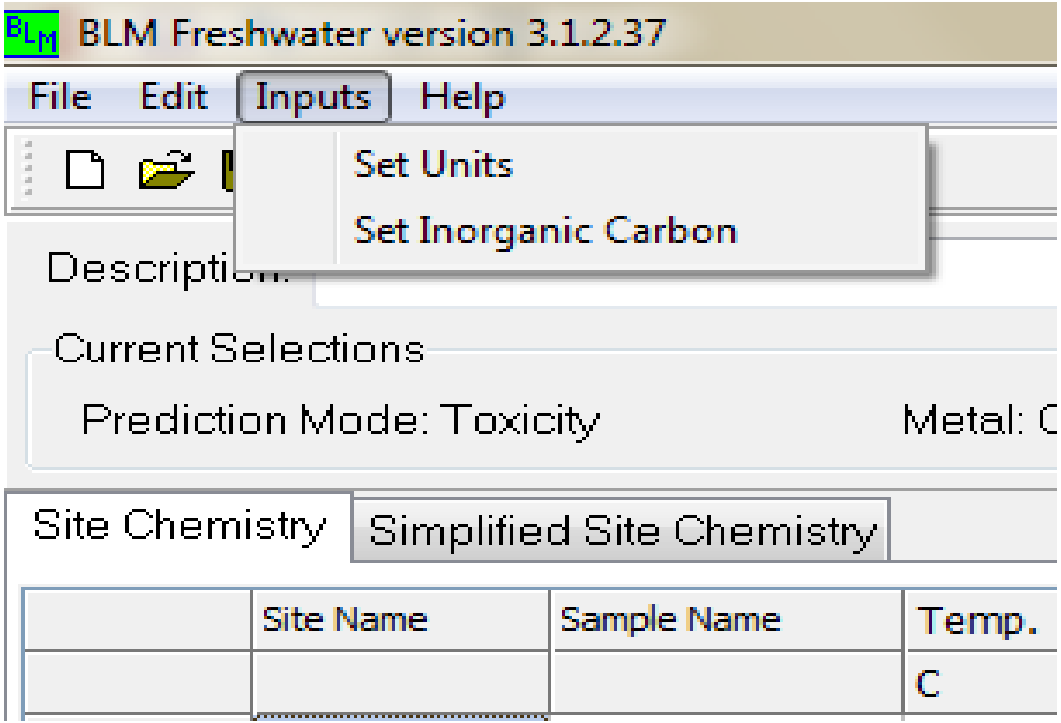


BLM Interface

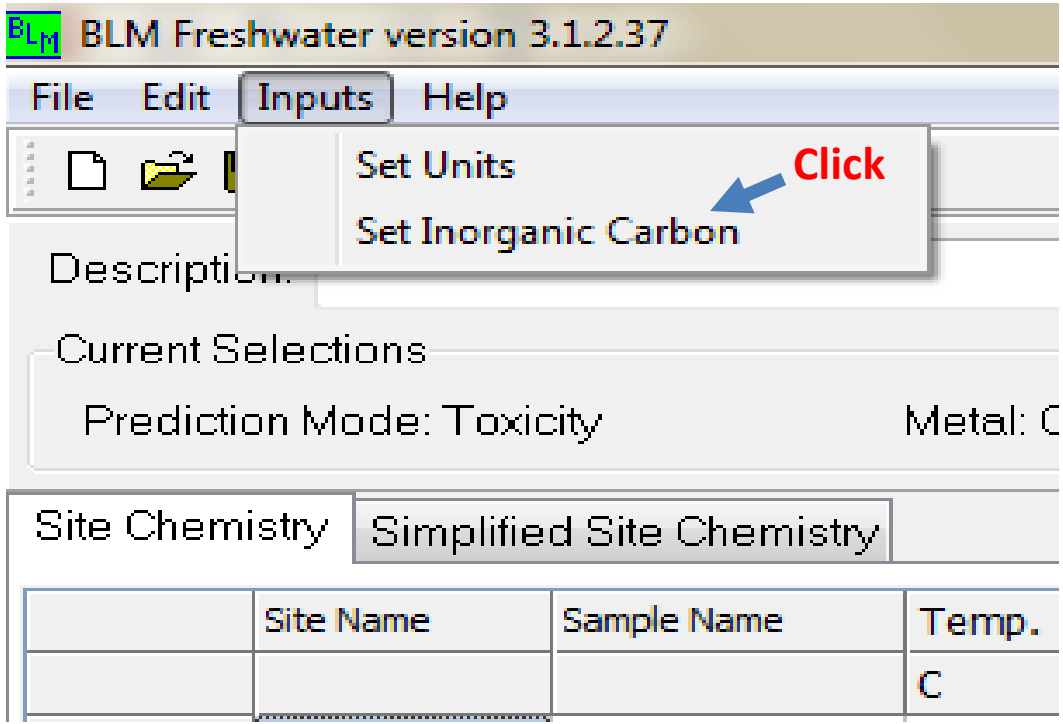


To set inorganic carbon input, click the **Inputs** menu item

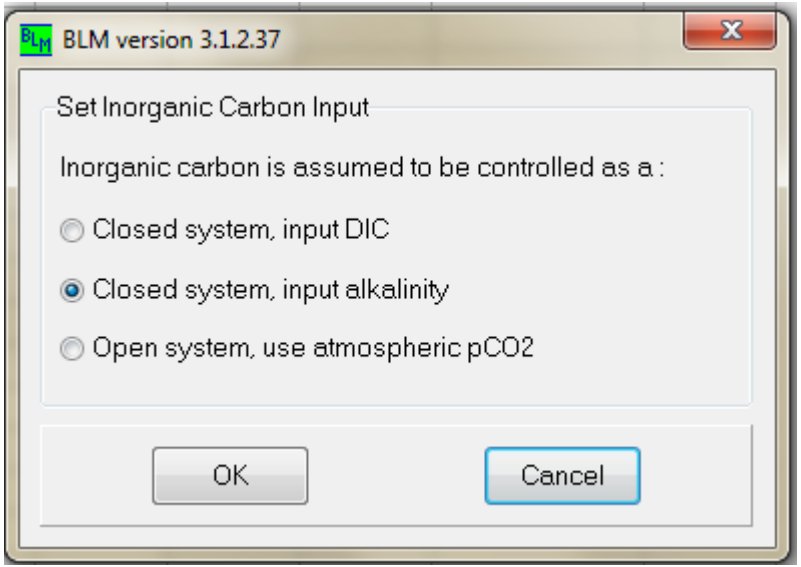
Setting Inorganic Carbon Input



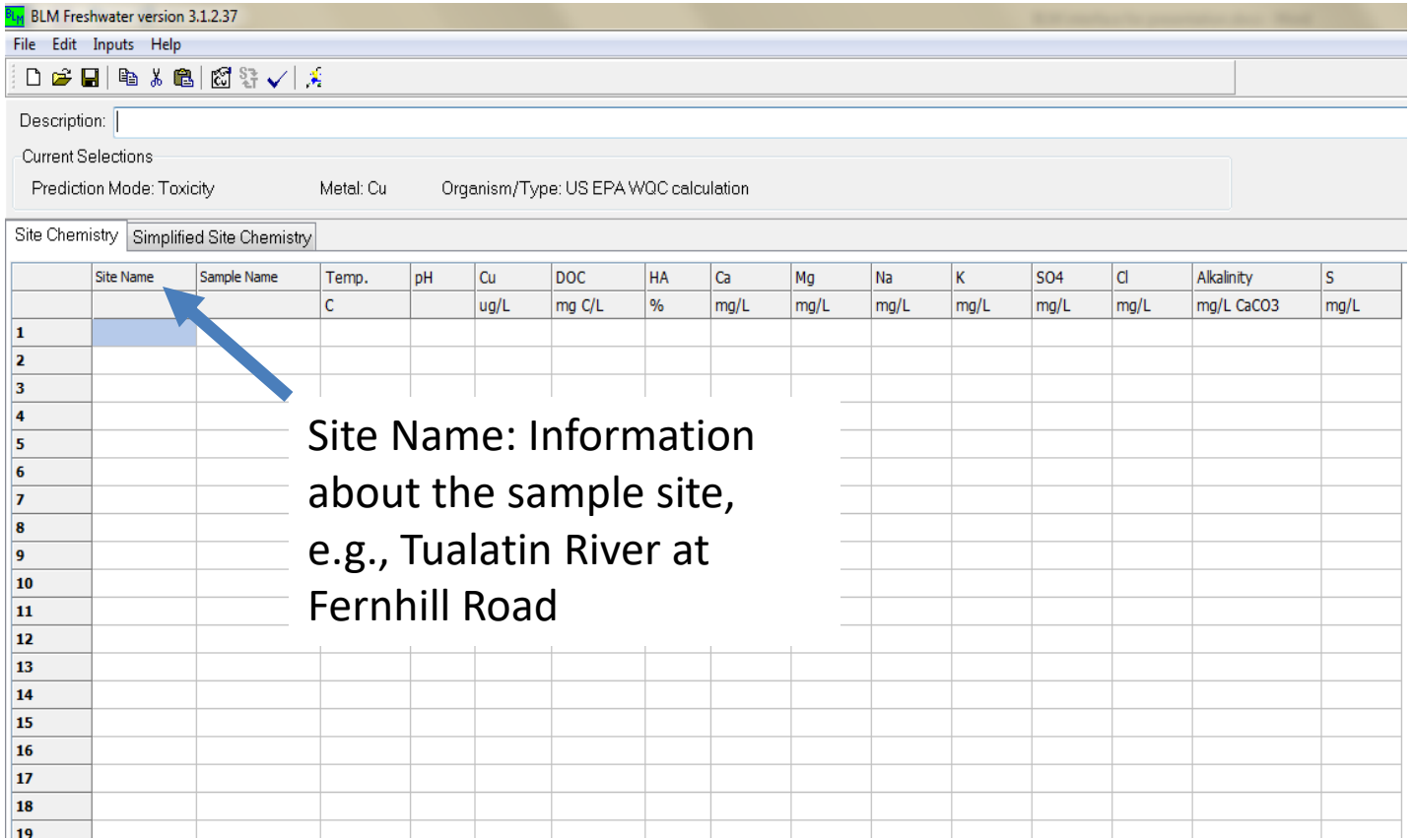
Setting Inorganic Carbon Input



Dialogue Box for Setting Organic Carbon Input

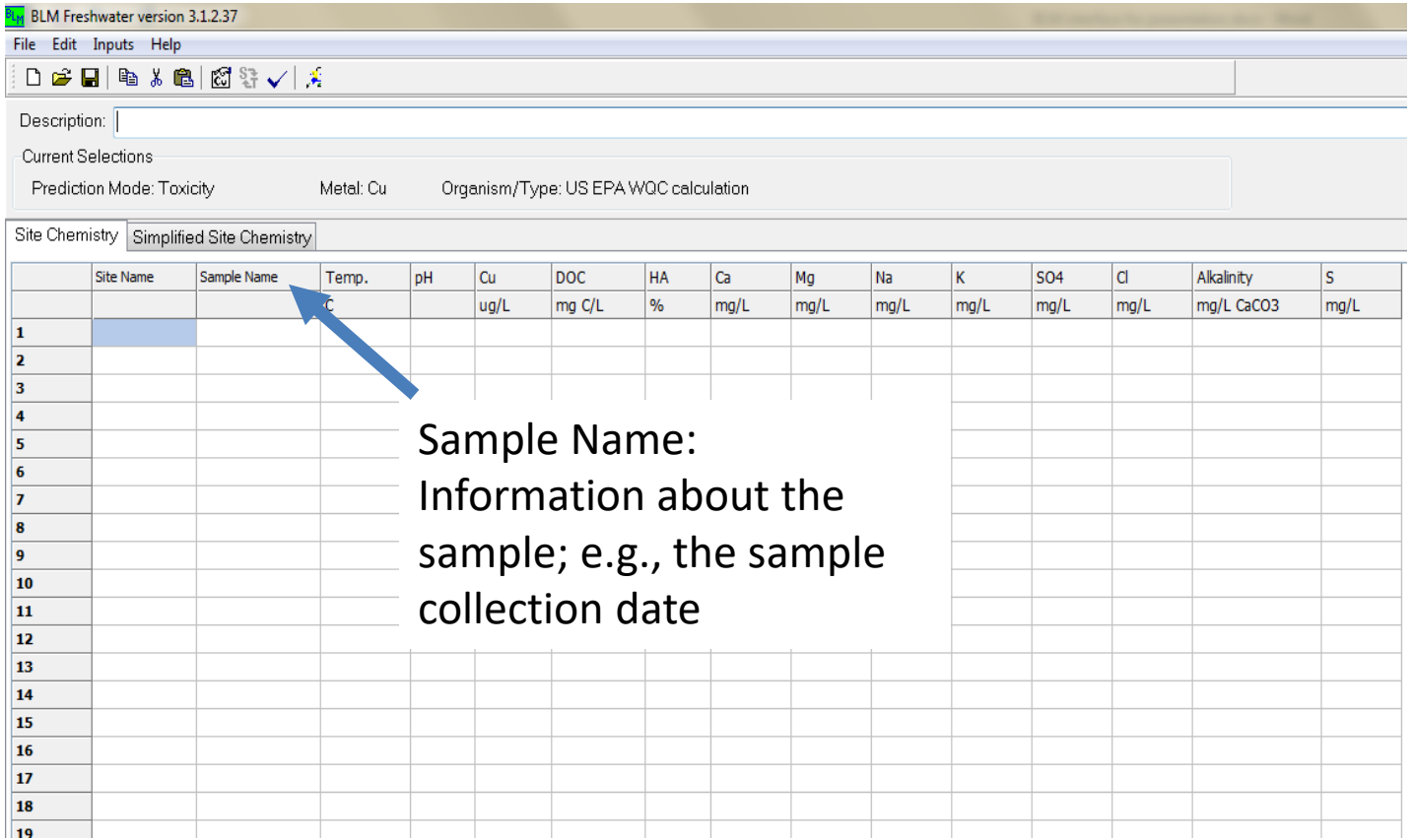


BLM Interface



Site Name: Information about the sample site, e.g., Tualatin River at Fernhill Road

BLM Interface



Sample Name: Information about the sample; e.g., the sample collection date

Default Value of 10% for Humic Acid

BLM Freshwater version 3.1.2.37 - H:\My Documents\BLM\BLM software\Forest Grove upstream.blm

File Edit Inputs Help

Description: Forest Grove upstream

Current Selections

Prediction Mode: Toxicity Metal: Cu Organism/Type: US EPA WQC calculation

Site Chemistry | Simplified Site Chemistry

	Site Name	Sample Name	Temp.	pH	Cu	DOC	HA	Ca	Mg	Na	K	SO4	Cl	Alkalinity	S
			C		ug/L	mg C/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L CaCO3	mg/L
149	TR@FERN HILL	1/19/2016	7.90	7.30	-6.35E+	1.51	10.00	6.42	2.22	3.32	0.52	3.55	3.29	22.60	1.00E-001
150	TR@FERN HILL	2/9/2016	7.70	7.15	0.62	1.17	10.00	6.81	2.35	4.07	0.54	2.95	3.39	28.50	1.00E-001
151	TR@FERN HILL	2/23/2016	6.60	7.41	-6.35E+	1.22	10.00	7.10	2.41	3.73	0.68	3.99	3.35	29.20	1.00E-001
152	TR@FERN HILL	3/1/2016	8.00	7.01	0.79	1.21	10.00	7.07	2.54	4.28	0.57	2.93	3.32	29.00	1.00E-001
153	TR@FERN HILL	3/8/2016	7.90	7.20	-6.35E+	1.24	10.00	6.52	2.25	3.38	0.54	3.62	2.88	27.00	1.00E-001
154	TR@FERN HILL	3/22/2016	9.00	7.15	-6.35E+	1.33	10.00	7.30	2.47	3.85	0.72	4.11	3.19	29.20	1.00E-001
155	TR@FERN HILL	4/5/2016	10.50	7.19	-6.35E+	1.62	10.00	8.00	2.66	4.26	0.88	4.56	3.55	35.00	1.00E-001
156	TR@FERN HILL	4/13/2016	10.90	7.12	-6.35E+	1.40	10.00	8.32	2.75	4.45	0.96	4.76	3.85	34.20	1.00E-001
157	TR@FERN HILL	4/19/2016	15.20	7.21	-6.35E+	2.45	10.00	8.53	2.81	4.58	1.01	4.90	4.18	36.80	1.00E-001
158	TR@FERN HILL	4/26/2016	11.30	7.25	-6.35E+	1.40	10.00	8.84	2.89	4.76	1.08	5.09	4.42	36.10	1.00E-001
159	TR@FERN HILL	5/2/2016	14.30	7.23	-6.35E+	2.34	10.00	9.35	3.04	5.07	1.20	5.42	4.39	41.20	1.00E-001
160	TR@FERN HILL	5/16/2016	12.00	7.42	0.71	1.21	10.00	8.30	2.72	4.37	0.93	4.68	3.96	36.10	1.00E-001
161	TR@FERN HILL	6/13/2016	13.20	7.49	0.69	1.20	10.00	7.41	2.38	4.33	0.45	2.12	3.65	33.00	1.00E-001
162	TR@FERN HILL	6/27/2016	14.20	7.42	-6.35E+	1.12	10.00	6.98	2.38	3.65	0.65	3.90	3.52	29.70	1.00E-001
163	TR@FERN HILL	7/11/2016	12.30	7.57	0.66	1.19	10.00	6.16	2.15	3.66	0.37	2.12	3.57	29.20	1.00E-001
164	TR@FERN HILL	7/25/2016	11.80	7.27	-6.35E+	1.05	10.00	6.52	2.25	3.38	0.54	3.62	3.09	27.80	1.00E-001
165	TR@FERN HILL	8/15/2016	12.40	7.46	0.79	1.09	10.00	6.45	2.08	3.54	0.43	2.09	2.92	26.90	1.00E-001
166	TR@FERN HILL	8/29/2016	14.40	7.50	-6.35E+	1.12	10.00	6.48	2.24	3.36	0.53	3.59	3.00	27.10	1.00E-001
167	TR@FERN HILL	9/12/2016	15.70	7.50	-6.35E+	1.16	10.00	6.76	2.32	3.52	0.60	1.89	3.33	28.60	1.00E-001
168															

Arbitrary Value for Sulfide Needed to Run the Model

BLM Freshwater version 3.1.2.37 - H:\My Documents\BLM\BLM software\Forest Grove upstream.blm

File Edit Inputs Help

Description: Forest Grove upstream

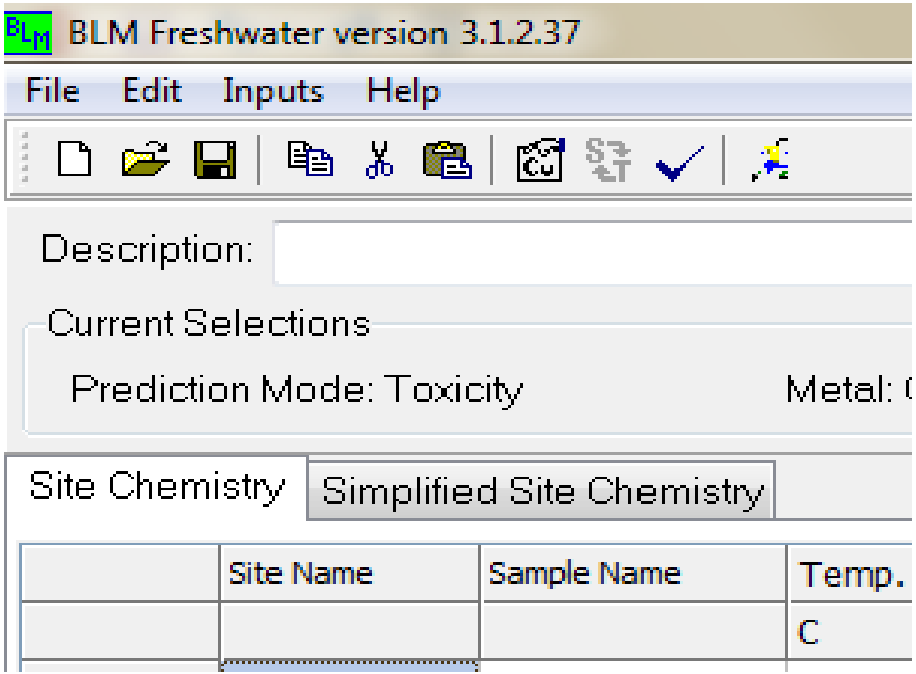
Current Selections

Prediction Mode: Toxicity Metal: Cu Organism/Type: US EPA WQC calculation

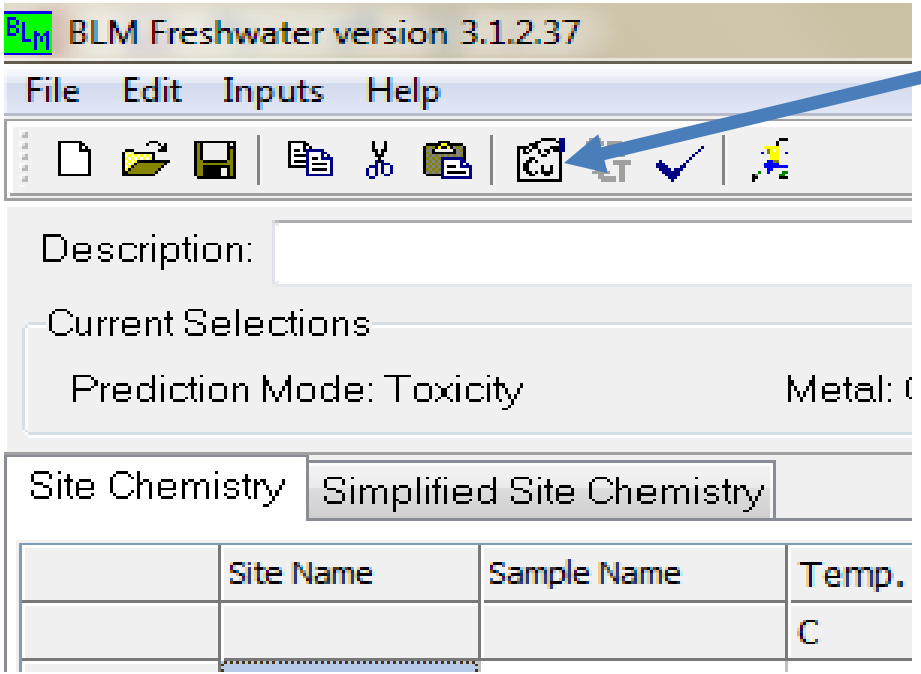
Site Chemistry | Simplified Site Chemistry

	Site Name	Sample Name	Temp.	pH	Cu	DOC	HA	Ca	Mg	Na	K	SO4	Cl	Alkalinity	S
			C		ug/L	mg C/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L CaCO3	mg/L
149	TR@FERN HILL	1/19/2016	7.90	7.30	-6.35E+	1.51	10.00	6.42	2.22	3.32	0.52	3.55	3.29	22.60	1.00E-001
150	TR@FERN HILL	2/9/2016	7.70	7.15	0.62	1.17	10.00	6.81	2.35	4.07	0.54	2.95	3.39	28.50	1.00E-001
151	TR@FERN HILL	2/23/2016	6.60	7.41	-6.35E+	1.22	10.00	7.10	2.41	3.73	0.68	3.99	3.35	29.20	1.00E-001
152	TR@FERN HILL	3/1/2016	8.00	7.01	0.79	1.21	10.00	7.07	2.54	4.28	0.57	2.93	3.32	29.00	1.00E-001
153	TR@FERN HILL	3/8/2016	7.90	7.20	-6.35E+	1.24	10.00	6.52	2.25	3.38	0.54	3.62	2.88	27.00	1.00E-001
154	TR@FERN HILL	3/22/2016	9.00	7.15	-6.35E+	1.33	10.00	7.30	2.47	3.85	0.72	4.11	3.19	29.20	1.00E-001
155	TR@FERN HILL	4/5/2016	10.50	7.19	-6.35E+	1.62	10.00	8.00	2.66	4.26	0.88	4.56	3.55	35.00	1.00E-001
156	TR@FERN HILL	4/13/2016	10.90	7.12	-6.35E+	1.40	10.00	8.32	2.75	4.45	0.96	4.76	3.85	34.20	1.00E-001
157	TR@FERN HILL	4/19/2016	15.20	7.21	-6.35E+	2.45	10.00	8.53	2.81	4.58	1.01	4.90	4.18	36.80	1.00E-001
158	TR@FERN HILL	4/26/2016	11.30	7.25	-6.35E+	1.40	10.00	8.84	2.89	4.76	1.08	5.09	4.42	36.10	1.00E-001
159	TR@FERN HILL	5/2/2016	14.30	7.23	-6.35E+	2.34	10.00	9.35	3.04	5.07	1.20	5.42	4.39	41.20	1.00E-001
160	TR@FERN HILL	5/16/2016	12.00	7.42	0.71	1.21	10.00	8.30	2.72	4.37	0.93	4.68	3.96	36.10	1.00E-001
161	TR@FERN HILL	6/13/2016	13.20	7.49	0.69	1.20	10.00	7.41	2.38	4.33	0.45	2.12	3.65	33.00	1.00E-001
162	TR@FERN HILL	6/27/2016	14.20	7.42	-6.35E+	1.12	10.00	6.98	2.38	3.65	0.65	3.90	3.52	29.70	1.00E-001
163	TR@FERN HILL	7/11/2016	12.30	7.57	0.66	1.19	10.00	6.16	2.15	3.66	0.37	2.12	3.57	29.20	1.00E-001
164	TR@FERN HILL	7/25/2016	11.80	7.27	-6.35E+	1.05	10.00	6.52	2.25	3.38	0.54	3.62	3.09	27.80	1.00E-001
165	TR@FERN HILL	8/15/2016	12.40	7.46	0.79	1.09	10.00	6.45	2.08	3.54	0.43	2.09	2.92	26.90	1.00E-001
166	TR@FERN HILL	8/29/2016	14.40	7.50	-6.35E+	1.12	10.00	6.48	2.24	3.36	0.53	3.59	3.00	27.10	1.00E-001
167	TR@FERN HILL	9/12/2016	15.70	7.50	-6.35E+	1.16	10.00	6.76	2.32	3.52	0.60	1.89	3.33	28.60	1.00E-001
168															

Running the Model – Selecting Metal/Organism

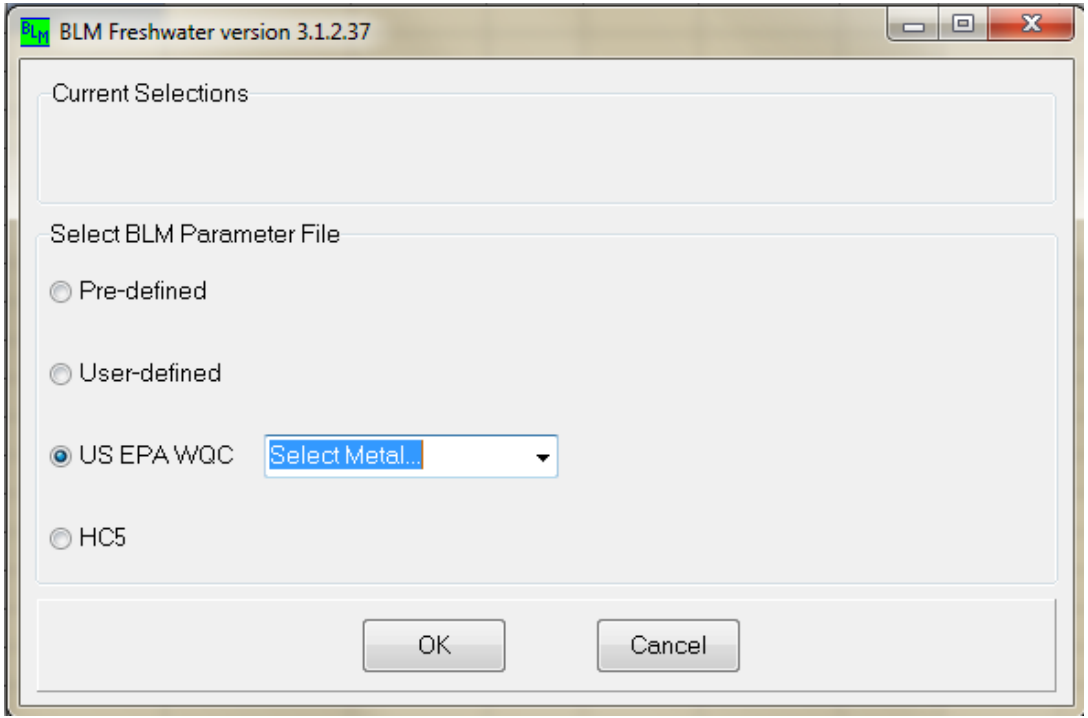


Running the Model – Selecting Metal/Organism

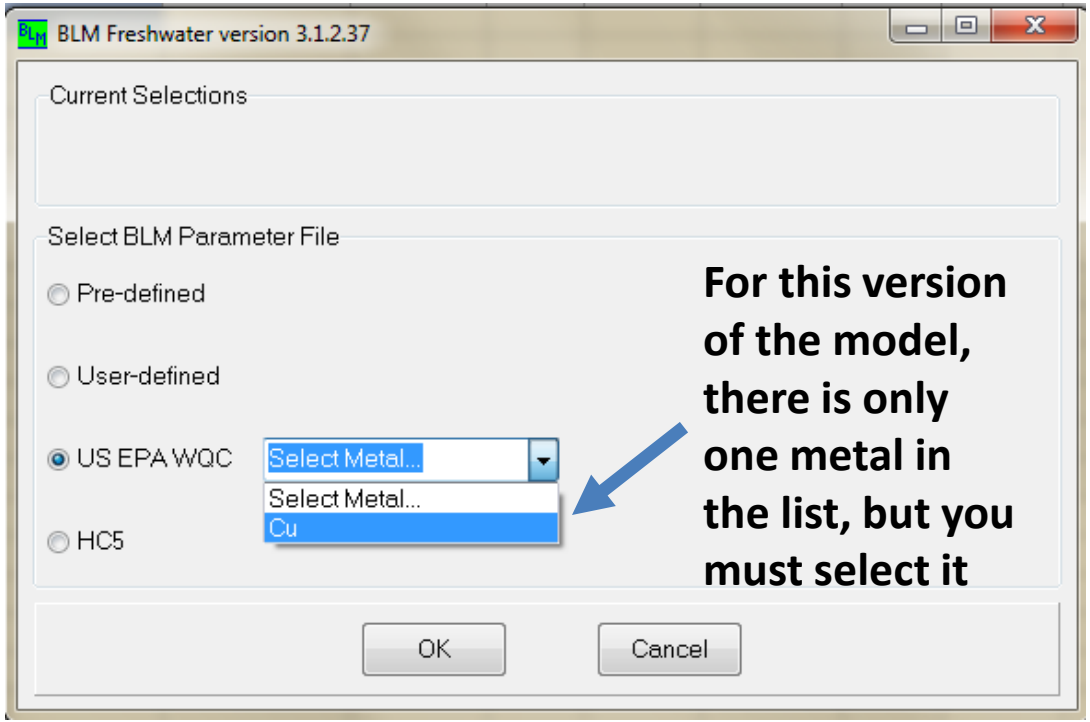


Click to select metal/organism

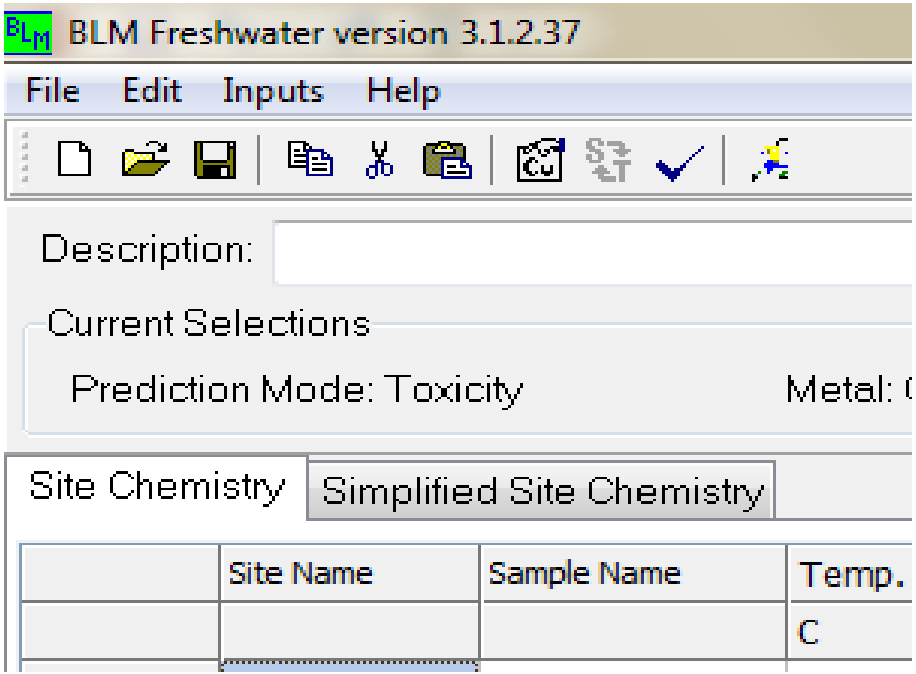
Selecting the Metal/Organism



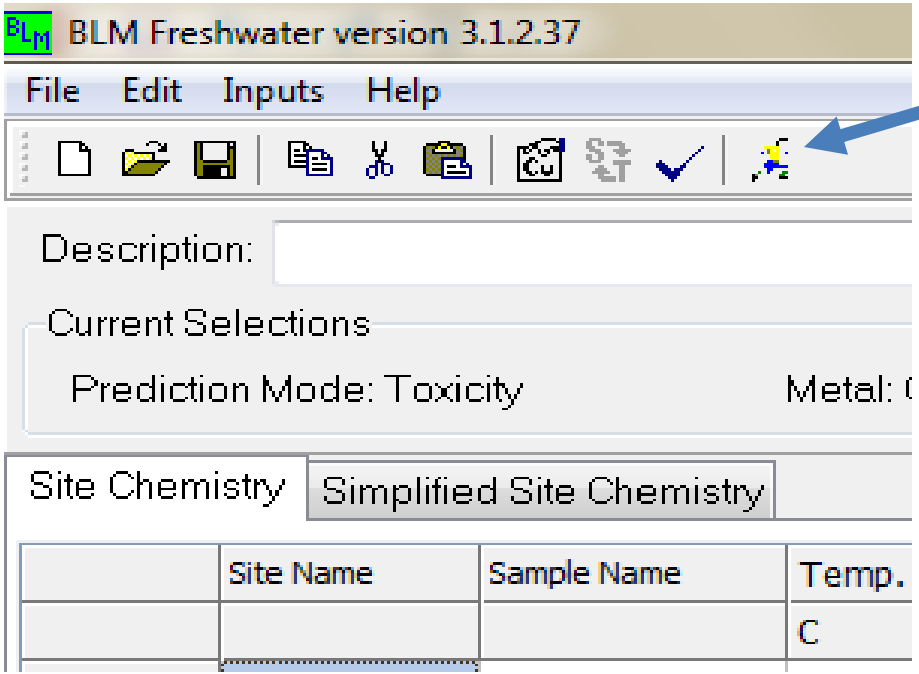
Selecting the Metal/Organism



Running the Model



Running the Model



Click here to run the model

BLM Output – Water Quality Criteria

Site Label	Sample Label	Final Acute Value	CMC	CCC	Cu	Acute Toxic Units	Chronic Toxic Units	Censored Flag
		(FAV), ug/L	(CMC=FAV/2), ug/L	(CCC=FAV/ACR), ug/L	ug/L	(Acute TU=Cu/CMC)	(Chronic TU=Cu/CCC)	(0 = quantified, 1 = BDL)
"TR@FERN HILL	"1/19/2016	7.20	3.60	2.24	0.64	0.18	0.28	0.00
"TR@FERN HILL	"2/9/2016	5.24	2.62	1.63	0.62	0.24	0.38	0.00
"TR@FERN HILL	"2/23/2016	5.24	2.62	1.63	0.64	0.24	0.39	0.00
"TR@FERN HILL	"3/1/2016	4.42	2.21	1.37	0.79	0.36	0.58	0.00
"TR@FERN HILL	"3/8/2016	4.42	2.21	1.37	0.64	0.29	0.46	0.00
"TR@FERN HILL	"3/22/2016	4.42	2.21	1.37	0.64	0.29	0.46	0.00
"TR@FERN HILL	"4/5/2016	4.42	2.21	1.37	0.64	0.29	0.46	0.00
"TR@FERN HILL	"4/13/2016	4.42	2.21	1.37	0.64	0.29	0.46	0.00
"TR@FERN HILL	"4/19/2016	4.42	2.21	1.37	0.64	0.29	0.46	0.00
"TR@FERN HILL	"4/26/2016	4.42	2.21	1.37	0.64	0.29	0.46	0.00
"TR@FERN HILL	"5/2/2016	4.42	2.21	1.37	0.64	0.29	0.46	0.00
"TR@FERN HILL	"5/16/2016	7.80	3.90	2.42	0.71	0.18	0.30	0.00
"TR@FERN HILL	"6/13/2016	8.55	4.27	2.65	0.69	0.16	0.26	0.00
"TR@FERN HILL	"6/27/2016	8.55	4.27	2.65	0.64	0.15	0.24	0.00
"TR@FERN HILL	"7/11/2016	9.33	4.66	2.90	0.66	0.14	0.23	0.00
"TR@FERN HILL	"7/25/2016	9.33	4.66	2.90	0.64	0.14	0.22	0.00
"TR@FERN HILL	"8/15/2016	7.44	3.72	2.31	0.79	0.21	0.34	0.00
"TR@FERN HILL	"8/29/2016	7.44	3.72	2.31	0.64	0.17	0.27	0.00
"TR@FERN HILL	"9/12/2016	7.44	3.72	2.31	0.64	0.17	0.27	0.00

Questions...