WATERHOUND

WATERHOUND FUTURES LTD

ONLINE PREDICTIVE SIMULATION

Introduction

Waterhound Futures is a digital predictive modelling and analytics solution, which simulate water and wastewater treatment plants to provide actionable insight to operators, engineers and management.

The cloud-based software is being converted from an offline Model containing proven algorithms based on first principles (physics, chemistry, engineering) and 25 years of design and manufacturing of wastewater treatment systems.

Waterhound's predictive simulation modelling is technology and industry-agnostic and can be used to simulate and monitor an existing plant or model and verify modifications to the design.

Hydraulic fracturing and produced water simulation

The printout below is taken from an online zoom demonstration inAugust 2019 using v1 of Waterhound's software. The contaminants and treatment process data (Figure 1 & 2) is taken from a produced and hydraulic fracture flow back case study.

The first case (Case 1) was to determine how much sodium and chloride remained in the discharge water. Figure 2 displays the selected treatment processess. Figure 3 displays that the sodium, chloride, carbonates and sulphates discharge limits were exceeded (numbers in **red**).

The second case (Case 2) added the Low Pressure Reverse Osmosis treatment. (Figure 4). Figure 5 shows all the red contaminants are well below discharge limits. This flowback and produced water is now optimised for reuse for next hydraulic fracturing treatment by reducing the sodium, chlorides (fresher water reduces chemical use (friction reducers) for hydraulic fracturing) , sulphates (barium sulphate) and carbonates (less scaling tendency)

Figure 1 Contaminants

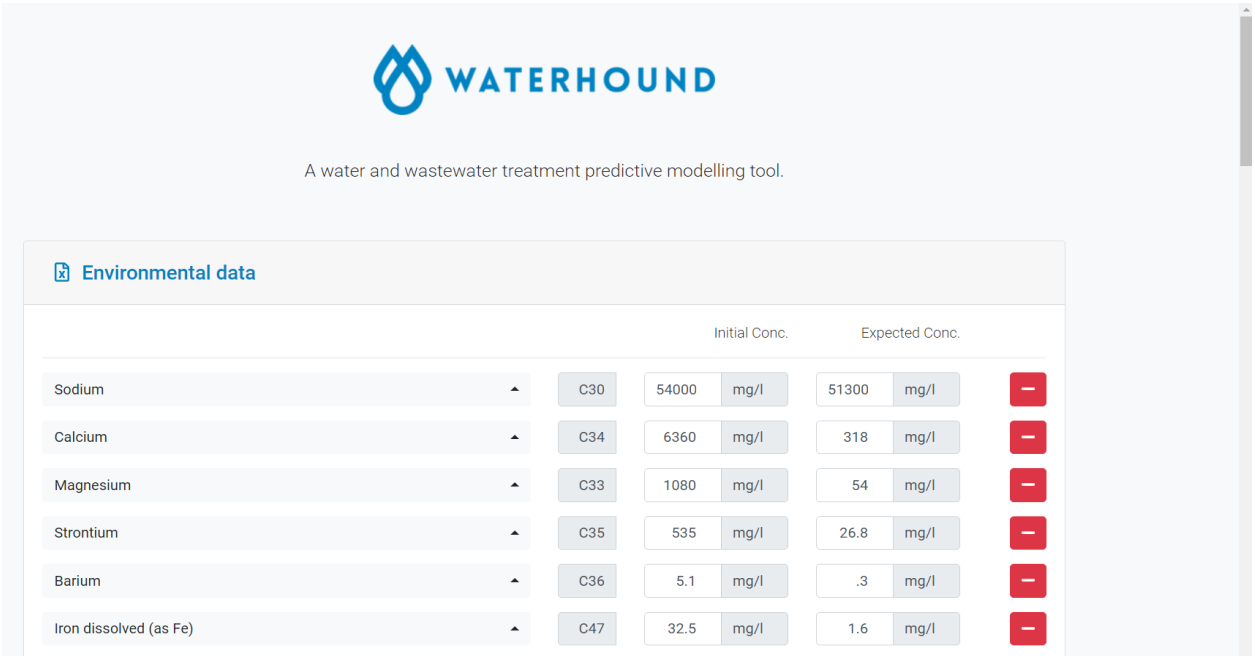


Figure 1 (continued)

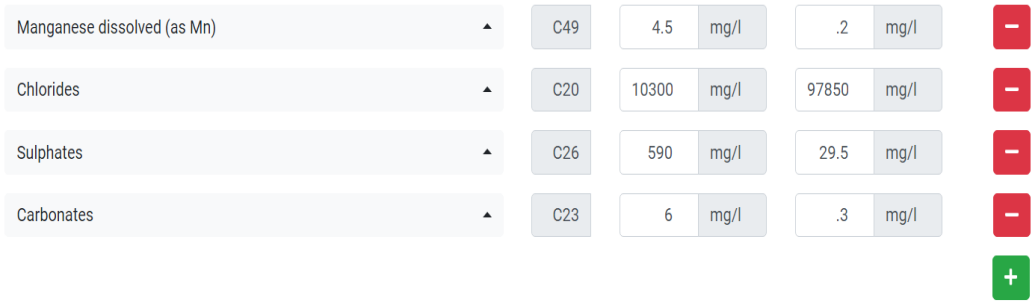


Figure 2 Case 1 Selected Treatment Processes

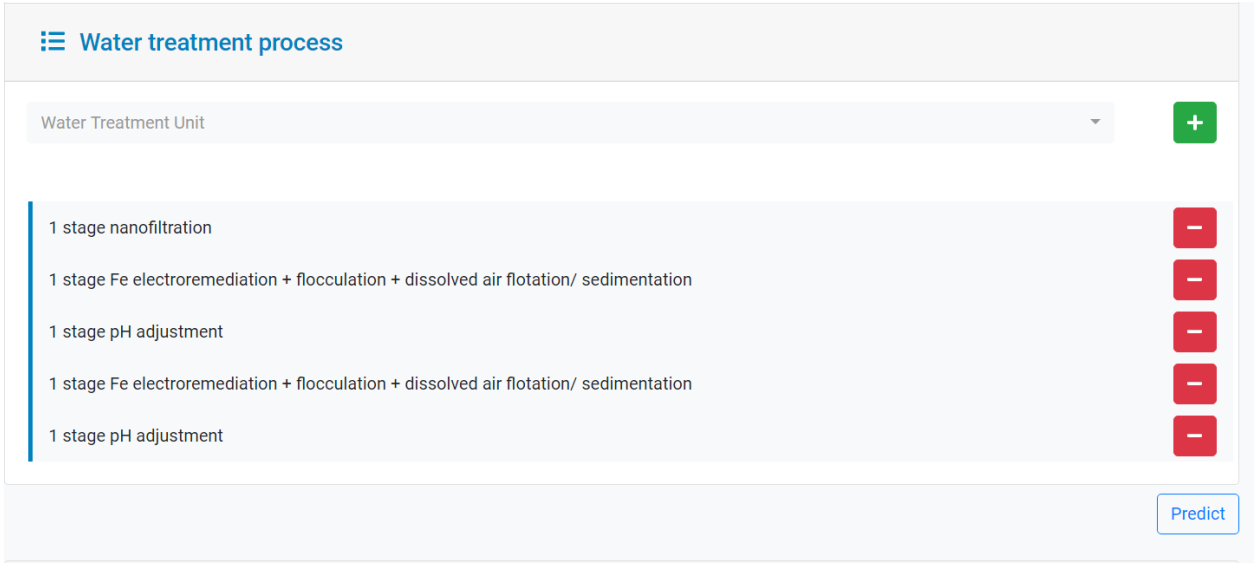
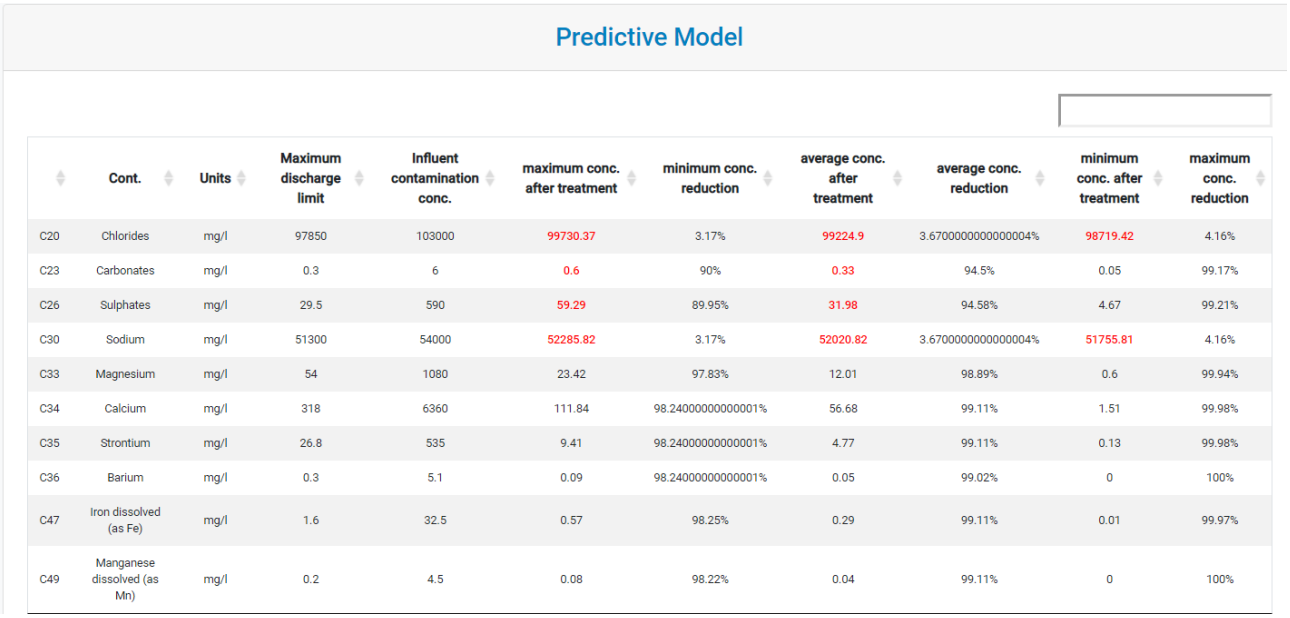


Figure 3 Case 1 Predictive Model



Predictive Model

	Cont.	Units	Maximum discharge limit	Influent contamination conc.	maximum conc. after treatment	minimum conc. reduction	average conc. after treatment	average conc. reduction	minimum conc. after treatment	maximum conc. reduction
C20	Chlorides	mg/l	97850	103000	99730.37	3.17%	99224.9	3.67000000000000004%	98719.42	4.16%
C23	Carbonates	mg/l	0.3	6	0.6	90%	0.33	94.5%	0.05	99.17%
C26	Sulphates	mg/l	29.5	590	59.29	89.95%	31.98	94.58%	4.67	99.21%
C30	Sodium	mg/l	51300	54000	52285.82	3.17%	52020.82	3.67000000000000004%	51755.81	4.16%
C33	Magnesium	mg/l	54	1080	23.42	97.83%	12.01	98.89%	0.6	99.94%
C34	Calcium	mg/l	318	6360	111.84	98.24000000000001%	56.68	99.11%	1.51	99.98%
C35	Strontium	mg/l	26.8	535	9.41	98.24000000000001%	4.77	99.11%	0.13	99.98%
C36	Barium	mg/l	0.3	5.1	0.09	98.24000000000001%	0.05	99.02%	0	100%
C47	Iron dissolved (as Fe)	mg/l	1.6	32.5	0.57	98.25%	0.29	99.11%	0.01	99.97%
C49	Manganese dissolved (as Mn)	mg/l	0.2	4.5	0.08	98.22%	0.04	99.11%	0	100%

Figure 3 (continued) Calculated Contaminants after each process treatment

Cont.	Units	Initial	Final	1 stage nanofiltration			1 stage Fe electroremediation + flocculation + dissolved air flotation/ sedimentation			1 stage pH adjustment			1 stage Fe electroremediation + flocculation + dissolved air flotation/ sedimentation			1 stage pH ad	
				min	avg	max	min	avg	max	min	avg	max	min	avg	max	min	avg
Chlorides	mg/l	103000	97850	103000	103000	103000	100837	101094.5	101352	100837	101094.5	101352	98719.42	99224.9	99730.37	98719.42	99224.
Carbonates	mg/l	6	0.3	6	6	6	0.53	1.22	1.9	0.53	1.22	1.9	0.05	0.33	0.6	0.05	0.33
Sulphates	mg/l	590	29.5	590	590	590	52.51	119.77	187.03	52.51	119.77	187.03	4.67	31.98	59.29	4.67	31.98
Sodium	mg/l	54000	51300	54000	54000	54000	52866	53001	53136	52866	53001	53136	51755.81	52020.82	52285.82	51755.81	52020.8
Magnesium	mg/l	1080	54	32.4	110.7	189	4.41	35.47	66.53	4.41	35.47	66.53	0.6	12.01	23.42	0.6	12.01
Calcium	mg/l	6360	318	190.8	651.9	1113	16.98	184.9	352.82	16.98	184.9	352.82	1.51	56.68	111.84	1.51	56.68
Strontium	mg/l	535	26.8	16.05	54.84	93.63	1.43	15.55	29.68	1.43	15.55	29.68	0.13	4.77	9.41	0.13	4.77
Barium	mg/l	5.1	0.3	0.15	0.52	0.89	0.01	0.15	0.28	0.01	0.15	0.28	0	0.05	0.09	0	0.05
Iron dissolved (as Fe)	mg/l	32.5	1.6	0.98	3.33	5.69	0.09	0.94	1.8	0.09	0.94	1.8	0.01	0.29	0.57	0.01	0.29
Manganese dissolved (as Mn)	mg/l	4.5	0.2	0.14	0.46	0.79	0.01	0.13	0.25	0.01	0.13	0.25	0	0.04	0.08	0	0.04

Execution time: 0.012s

Figure 4 Case 2 Reverse Osmosis Added to Process

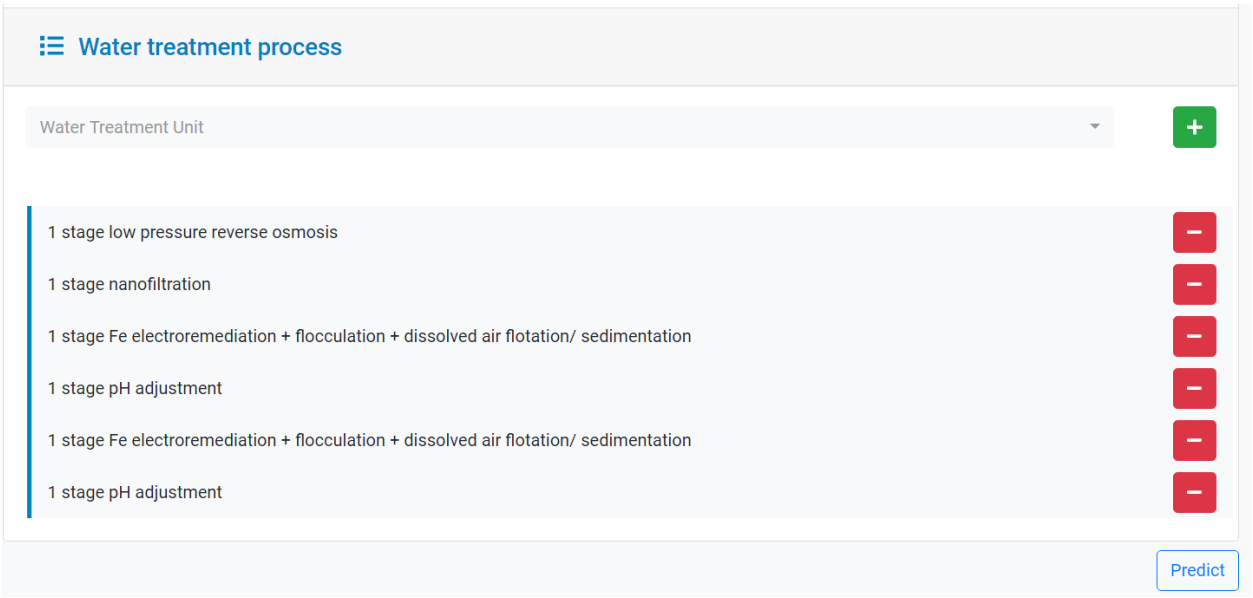
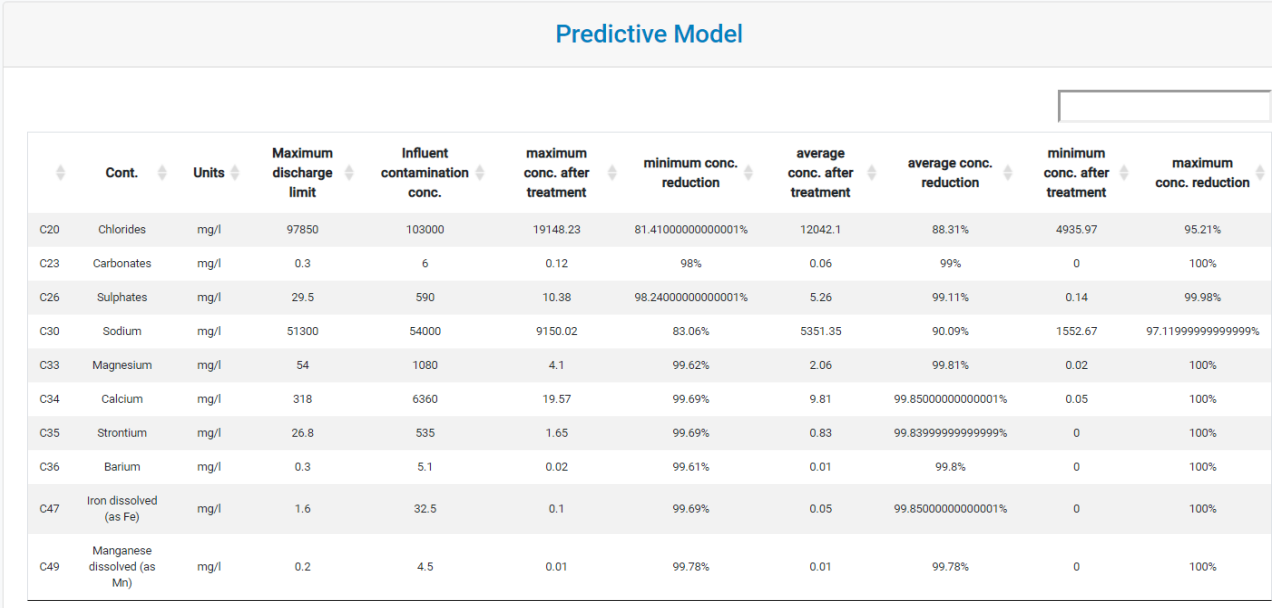


Figure 5 Case 2 Reverse Osmosis Added to Process – Predictive Model



Predictive Model

	Cont.	Units	Maximum discharge limit	Influent contamination conc.	maximum conc. after treatment	minimum conc. reduction	average conc. after treatment	average conc. reduction	minimum conc. after treatment	maximum conc. reduction
C20	Chlorides	mg/l	97850	103000	19148.23	81.41000000000001%	12042.1	88.31%	4935.97	95.21%
C23	Carbonates	mg/l	0.3	6	0.12	98%	0.06	99%	0	100%
C26	Sulphates	mg/l	29.5	590	10.38	98.24000000000001%	5.26	99.11%	0.14	99.98%
C30	Sodium	mg/l	51300	54000	9150.02	83.06%	5351.35	90.09%	1552.67	97.119999999999999%
C33	Magnesium	mg/l	54	1080	4.1	99.62%	2.06	99.81%	0.02	100%
C34	Calcium	mg/l	318	6360	19.57	99.69%	9.81	99.850000000000001%	0.05	100%
C35	Strontium	mg/l	26.8	535	1.65	99.69%	0.83	99.839999999999999%	0	100%
C36	Barium	mg/l	0.3	5.1	0.02	99.61%	0.01	99.8%	0	100%
C47	Iron dissolved (as Fe)	mg/l	1.6	32.5	0.1	99.69%	0.05	99.850000000000001%	0	100%
C49	Manganese dissolved (as Mn)	mg/l	0.2	4.5	0.01	99.78%	0.01	99.78%	0	100%

Presentation and Summary by Ron Gerlitz, Managing Director Waterhound Futures Ltd North America, Julie King, Managing Director Waterhound International and Michael Levey, Waterhound CTO. For more information, please contact:

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