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July 6, 2018

Abigail Antolovich
Denver Water
3412 1600 W 12th Avenue
Denver, CO 80204

Subject: Project Completion Confirmation PureWater Colorado Demonstration Project

Dear Abigail:

This letter includes attachments and project completion details regarding the PureWater Colorado Demonstration Project. The project is now complete, with the major milestones detailed in this letter. This letter is intended to supplement the information provided in the fifty and seventy-five percent complete progress reports sent previously. A breakdown by task of all completed goals, obstacles encountered, associated deliverables included as attachments, and final timelines is included in Table 1. Water quality results for the duration of the project and outreach materials are included as attachments.

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Table 1. Project Progress, Deliverables, Milestones, and Schedule Updates by Task.

Task	Description	Task Status	Deliverables	Deliverables Status	Milestones	Original Project Timeline	Actual Project Timeline
1	Equipment Installation and Project Kickoff	Complete	Commissioning and Test Plan Report	Complete (Included in 50% Progress Report)	• Equipment commissioned, delivered and successfully put into operation. • Equipment commissioning was delayed by one week due to additional plumbing and electrical needs during setup. • Test plan written with input and guidance from CDPHE and Carollo.	1/22/2018 - 1/26/2018	1/22/2018 - 2/2/2018
2	Pure Water Production and Pilot Operation	Complete	Pilot operation report/water quality summary	Water Quality Results (Attached)	• Pilot operation task delayed by one week as carry over from commissioning delay. • Denver Water operations staff provided training by manufacturers and Carollo. • Pilot plant successfully operated overnight and over the weekend. • Demonstration facility operation complete and all water quality results analyzed and reported.	1/29/2018 - 4/6/2018	2/5/2018 - 4/13/2018
3	Facility Tours with Target Stakeholders and Policy Makers	Complete	Summary report of attendees/feedback and Media Coverage	Complete (Media coverage report attached, attendee feedback report included in 75% progress report)	• Outreach stakeholder group determined it was better to provide tours to the target audiences when water was available for consumption, following operation and extensive analytical testing. Therefore tours with target stakeholders were delayed by ~2 weeks. • Tours with target stakeholders completed and a summary report was completed and attached in the 75% progress report. • Media and press coverage was ongoing past the 4/13/2018 date and a summary is attached.	2/26/2018 - 4/6/2018	3/16/2018 - 4/13/2018
4	Outreach	Complete	Outreach materials completed	Complete (Attached)	• Outreach materials were completed one month ahead of schedule and before target audience tours began. • All outreach materials for demonstration project have been designed and produced for outreach.	1/22/2018 - 4/30/2018	1/22/2018 - 3/15/2018
5	Beverage Production	Delivery Complete/Production Ongoing	Documentation showing completion of beverage production – requesting change to water delivery confirmation	Batch 2 CDPHE water quality report and Chain of Custody Documents (Included in 50% progress report)	• Beverage production will continue into June 2018. It is requested that the deliverable for this task be changed to pure water delivery to beverage manufacturer to comply with project schedule. • A sterilized tanker was filled with ~4600 gallons of purified water on March 14 and March 15, 2018. • Analytical testing on the pure water was completed (March 16 – April 4, 2018). • Purified water tanker was successfully delivered to beverage partner (April 5, 2018).	2/26/2018 - 4/30/2018	4/16/2018 – 5/3/2018
6	Decommission Pilot Equipment	Complete	Decommissioning document	Complete (Included in 75% progress report)	• All equipment is off site and back to manufacturers.	4/9/2018 - 4/16/2018	4/16/2018 - 4/20/2018

Task	Description	Task Status	Deliverables	Deliverables Status	Milestones	Original Project Timeline	Actual Project Timeline
					• Decommissioning started one week later than originally planned to provide additional tours to target audience members. • Decommissioning took an additional two weeks due to shipping constraints and manufacturer availability.		
7	Project Management and Final Report	Complete	Final project report	Complete	• Project management for project is complete. • Final report document is complete and ready for CWCB submission.	1/22/2018 - 5/31/2018	1/22/2018 - 7/6/2018

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Please let me know if you need additional information and follow up as needed.

Sincerely,

CAROLLO ENGINEERS, INC.

Austa M. Parker, PhD
Water Reuse Technologist

Author Initials: amp

Attachments: Water Quality and Process Performance Results
Outreach Materials Package

cc: Damian Higham, Denver Water
John Rehring, Carollo Engineers

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PureWater Colorado Demonstration Project Final Water Quality Results

This document provides process performance parameters and water quality results for all water collected at the PureWater Colorado Demonstration Project hosted at the Denver Water Recycling Facility (5650 York Street Commerce City, CO 80022). There were five collection events in total as detailed in Table 1. A 275 gallon batch of purified water was stored for outreach purposes and 4600 gallons of purified water were placed in a sterilized water tanker for transport to Declaration Brewing Company to produce beer in collaboration with Denver Water's 100th anniversary celebration, further details are provided in this letter.

Water quality results indicate excellent performance by the treatment process, meeting all regulated contaminant levels (MCLs) and health goals for contaminants of emerging concern (CECs).

Project Overview

The project demonstrates the ability to purify secondary treated wastewater effluent from the Metro Wastewater Reclamation District's Robert W. Hite Treatment Facility to drinking water quality using ozone, biologically active filtration (BAF), microfiltration (MF), granular activated carbon (GAC), and Ultraviolet Advanced Oxidation Process (UV AOP) in series (Figure 1). The demonstration project served batch tested water to 176 tour attendees for outreach purposes for a period of four weeks, and purified water was provided to a beverage distributor.

Finished water quality results demonstrate the robust performance of the treatment processes and the ability to meet all MCLs and water quality goals for a dedicated list of CECs. Virus, Giardia, and Cryptosporidium log removal credits for each treatment processes were anticipated as shown in Table 1.

Figure 1. PureWater Colorado DPR Demonstration Project Treatment Train

Table 1. Anticipated Log Removal Credits Based on Previous Research and Process Operation.

Process	Virus	*Giardia*	*Cryptosporidium*
Ozone	5-log	--	--
BAF	--	--	--
MF	--	4-log	4-log
GAC	--	--	--
UV AOP (high dose)	6-log	6-log	6-log
Total	**11-log**	**10-log**	**10-log**
Potable Water Goals[(1)]	9-log	9.1-log	7.4-log

Notes:

-- Pathogen removal credit is not expected.

1) As determined by EPA SDWA

Process Operation and Performance Monitoring

Process performance parameters were documented at the start time of collection and were monitored online for the duration of batch and tanker sample collection by Carollo (Table 2).

Table 2. Online Process Performance Parameters During Batch Water Collection

Parameter	BATCH #1	BATCH #2	BATCH #3	BATCH #4	BATCH #5	Units
Sample Date	3/7/18	3/15/18	3/21/18	3/27/18	4/11/18	
Time (Start)	2:30 PM	2:02 PM	10:40 AM	11:28 AM	9:05 AM	
Time (Stop)	3:13 PM	2:45 PM	11:26 AM	12:10 PM	9:45 AM	
Ozone Dose - Calculated	5.21	5.17	5	5.05	5.12	mg/L
Ozone Flow	15.1	15.1	15	15.1	15.1	GPM
BAF Empty Bed Contact Time (EBCT)	18.4	18.2	19.4	19.9	19.5	MIN
Microfiltration Trans Membrane Pressure (TMP)	4.1	5.2	5.1	4.6	4.7	PSI
UV Flow	5.7	4.1	6.3	4.2	4.7	GPM
UV Transmittance (UVT) - Influent to UV AOP	97.4	97.2	98.2	97.1	98.5	%
Hydrogen Peroxide Dose	4	4	5	4	4	mg/L
UVT - Finished Water	98.4	99.1	99.8	99.8	99.8	%
UV Dose	2307.4	3249.3	2107.9	3249.3	2750.1	mJ/cm^2

Lab Sampling and Water Quality Analysis

Sampling for chemical and microbial contaminants was conducted by Denver Water laboratory staff on dates listed in Table 2. Samples were taken to the Denver Water lab for analysis or sent to the contract lab (Eurofins) via overnight delivery for analysis. All regulated contaminant results, MCLs, and responsible laboratories are shown in Table 3. Results for CEC sampling are shown in Table 4 with associated water quality goals and references, where available. Sample results were provided to CDPHE and kept with batches of water while transporting to beverage distributors. Throughout the project, all water quality requirements and goals were met in all five batches of water collected.

Additionally, water quality samples were taken and measured for electrical conductivity (EC) and total organic carbon (TOC) throughout the project as an indicator of process performance. Results for EC (Figure 2) showed minimal removal of EC through the treatment process. Removal of TOC through the treatment train showed consistent removal to a final concentration between 0.2 and 0.6 mg/L during the time of operation (Figure 3).

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Table 3. Regulated Contaminant Purified Finished Water Quality Results

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results				
				MCLG[1]	MCL or TT[1]	Batch 1 (3/7/2018)	Batch 2 (3/15/2018)	Batch 3 (3/21/2018)	Batch 4 (3/27/2018)	Batch 5 (4/10/2018)
Microorganisms										
Cryptosporidium	cysts/L	Eurofins	0.093	0	TT[2]	<0.093	<0.093	<0.093	<0.093	<0.093
Giardia lamblia	cysts/L	Eurofins	0.093	0	TT[2]	<0.093	<0.093	<0.093	<0.093	<0.093
Heterotrophic plate count	CFU/mL	DW Lab	0.01	--	TT[2]	<0.01	<0.01	<0.01	<0.01	<0.01
Total Coliforms	P-A/100 mL	DW Lab	1	0	≤ 5.0%	Absent	Absent	Absent	Absent	Absent
Turbidity	NTU	DW Lab	0.05	--	TT[2]	0.4	0.33	0.19	0.29	0.14
Disinfection Byproducts										
Bromate	ug/L	Eurofins	1	0	10	2.6	1.3	2.3	3	3.3
Chlorite	mg/L	Eurofins	0.01	0.8	1	ND	ND	ND	ND	ND
Haloacetic acids (HAA5)	ug/L	Eurofins	2	--	60	ND	ND	0.02	ND	ND
Total trihalomethanes (TTHMs)	ug/L	Eurofins	2	--	80	ND	ND	ND	ND	ND
Chloramines (as Cl_2)	mg/L	Carollo - On Site	0.2	4	4	2.5	2.8	3.2	3.1	3.2
Total Chlorine (as Cl_2)	mg/L	Carollo - On Site	0.2	4	4	2.7	3.1	3.5	3.3	3.5
Chlorines Dioxide (as Cl_2)	mg/L	Eurofins	0.24	0.8	0.8	ND	ND	ND	ND	ND
Volatile Organic (VOCs)										
Benzene	ug/L	Eurofins	0.5	0	5	ND	ND	ND	ND	ND
Carbon Tetrachloride	ug/L	Eurofins	0.5	0	5	ND	ND	1.7	ND	ND
Dichloroethane (1,2-)	ug/L	Eurofins	0.5	0	5	ND	ND	ND	ND	ND
Dichloroethylene (1,1-)	ug/L	Eurofins	0.5	0	5	ND	ND	ND	ND	ND
Dichloroethylene (cis-1,2-)	ug/L	Eurofins	0.5	0.07	70	ND	ND	ND	ND	ND
Dichloroethylene (trans-1,2-)	ug/L	Eurofins	0.5	0.1	100	ND	ND	ND	ND	ND
Dichloromethane	ug/L	Eurofins	0.5	0	5	ND	ND	ND	ND	ND
Dichloropropane (1,2-)	ug/L	Eurofins	0.5	0	5	ND	ND	ND	ND	ND
Ethylbenzene	ug/L	Eurofins	0.5	0.7	700	ND	ND	ND	ND	ND
Monochlorobenzene	ug/L	Eurofins	0.5	0.1	100	ND	ND	ND	ND	ND
o-Dichlorobenzene	ug/L	Eurofins	0.5	0.6	600	ND	ND	ND	ND	ND
p-Dichlorobenzene	ug/L	Eurofins	0.5	0.075	75	ND	ND	ND	ND	ND
Styrene	ug/L	Eurofins	0.5	0.1	100	ND	ND	ND	ND	ND
Tetrachloroethylene (PCE)	ug/L	Eurofins	0.5	0	5	ND	ND	ND	ND	ND

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results				
				MCLG[1]	MCL or TT[1]	Batch 1 (3/7/2018)	Batch 2 (3/15/2018)	Batch 3 (3/21/2018)	Batch 4 (3/27/2018)	Batch 5 (4/10/2018)
Toluene	ug/L	Eurofins	0.5	1	1000	ND	ND	ND	ND	ND
Trichlorobenzene (1,2,4-)	ug/L	Eurofins	0.5	0.07	70	ND	ND	ND	ND	ND
Trichloroethane (1,1,2-)	ug/L	Eurofins	0.5	0.003	5	ND	ND	ND	ND	ND
Trichloroethane (1,1,1-)	ug/L	Eurofins	0.5	0.2	200	ND	ND	ND	ND	ND
Trichloroethylene (TCE)	ug/L	Eurofins	0.5	0	5	ND	ND	ND	ND	ND
Vinyl Chloride	ug/L	Eurofins	0.3	0	2	ND	ND	ND	ND	ND
Xylenes (Total)	ug/L	Eurofins	0.5	10	10,000	ND	ND	ND	ND	ND
Synthetic Organic Compounds (SOCs)										
2,3,7,8-TCDD (Dioxin)	pg/L	Eurofins	5	0	30	ND	ND	ND	ND	ND
2,4,5-TP (Silvex)	ug/L	Eurofins	0.2	0.05	50	ND	ND	ND	ND	ND
2,4-D	ug/L	Eurofins	0.1	0.07	70	ND	ND	ND	ND	ND
Acrylamide	ug/L	Eurofins	0.1	0	TT	ND	ND	ND	ND	ND
Adipates	ug/L	Eurofins	0.6	0.4	400	ND	ND	ND	ND	ND
Alachlor (Lasso)	ug/L	Eurofins	0.05	0	2	ND	ND	ND	ND	ND
Atrazine (Atranex, Crisazina)	ng/L	Eurofins	5	0.003	3000	ND	ND	ND	ND	ND
Benzo(a)pyrene (PAH)	ug/L	Eurofins	0.02	0	0.2	ND	ND	ND	ND	ND
Carbofuran (Furadan 4F)	ug/L	Eurofins	0.5	0.04	40	ND	ND	ND	ND	ND
Chlordane	ug/L	Eurofins	0.1	0	2	ND	ND	ND	ND	ND
Dalapon	ug/L	Eurofins	1	0.2	200	ND	ND	ND	ND	ND
Dibromochloropropane (DBCP)	ug/L	Eurofins	0.01	0	0.2	ND	ND	ND	ND	ND
Diethylhexyl Phthalate (DEHP)	ug/L	Eurofins	0.6	0	6	ND	ND	ND	ND	ND
Dinoseb	ug/L	Eurofins	0.2	0.007	7	ND	ND	ND	ND	ND
Diquat	ug/L	Eurofins	0.4	0.02	20	ND	ND	ND	ND	ND
Endothall	ug/L	Eurofins	5	0.1	100	ND	ND	ND	ND	ND
Endrin	ug/L	Eurofins	0.01	0.002	2	ND	ND	ND	ND	ND
Epichlorohydrin	ug/L	Eurofins	0.4	0	TT	ND	ND	ND	ND	ND
Ethylene Dibromide	ug/L	Eurofins	0.01	0	0.05	ND	ND	ND	ND	ND
Glyphosate	ug/L	Eurofins	6	0.7	700	ND	ND	ND	ND	ND
Heptachlor Epoxide	ug/L	Eurofins	0.01	0	0.2	ND	ND	ND	ND	ND
Heptachlor (H-34, Heptox)	ug/L	Eurofins	0.01	0	0.4	ND	ND	ND	ND	ND
Hexachlorobenzene	ug/L	Eurofins	0.05	0	1	ND	ND	ND	ND	ND

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results				
				MCLG[1]	MCL or TT[1]	Batch 1 (3/7/2018)	Batch 2 (3/15/2018)	Batch 3 (3/21/2018)	Batch 4 (3/27/2018)	Batch 5 (4/10/2018)
Hexachlorocyclopentadiene	ug/L	Eurofins	0.05	0.05	50	ND	ND	ND	ND	ND
Lindane	ug/L	Eurofins	0.04	0.0002	0.2	ND	ND	ND	ND	ND
Methoxychlor (Marlate)	ug/L	Eurofins	0.05	0.04	40	ND	ND	ND	ND	ND
Oxyamyl (Vydate)	ug/L	Eurofins	0.5	0.2	200	ND	ND	ND	ND	ND
Pentachlorophenol	ug/L	Eurofins	0.04	0	1	ND	ND	ND	ND	ND
Picloram	ug/L	Eurofins	0.1	0.5	500	ND	ND	ND	ND	ND
Polychlorinated Biphenyls						ND	ND	ND	ND	ND
PCB 1016 Aroclor	ug/L	Eurofins	0.08	0	5	ND	ND	ND	ND	ND
PCB 1221 Aroclor	ug/L	Eurofins	0.1	0	5	ND	ND	ND	ND	ND
PCB 1232 Aroclor	ug/L	Eurofins	0.1	0	5	ND	ND	ND	ND	ND
PCB 1242 Aroclor	ug/L	Eurofins	0.1	0	5	ND	ND	ND	ND	ND
PCB 1248 Aroclor	ug/L	Eurofins	0.1	0	5	ND	ND	ND	ND	ND
PCB 1254 Aroclor	ug/L	Eurofins	0.1	0	5	ND	ND	ND	ND	ND
PCB 1260 Aroclor	ug/L	Eurofins	0.1	0	5	ND	ND	ND	ND	ND
Simazine	ng/L	Eurofins	5	0.004	4000	ND	ND	ND	ND	ND
Toxaphene	ug/L	Eurofins	0.5	0	3	ND	ND	ND	ND	ND
Inorganic Chemicals (IOCs)										
Antimony	ug/L	DW Lab	1	0.006	6	0.52	0.54	0.46	0.46	0.41
Arsenic	ug/L	DW Lab	1	0	10	1	<0.5	0.6	0.6	0.8
Asbestos (fibers > 10µm)	MFL	Eurofins	0.2	7	7	ND	ND	ND	ND	ND
Barium	ug/L	DW Lab	5	2	2000	47.6	34.3	37.6	43.2	37.1
Beryllium	ug/L	DW Lab	1	0.004	4	<0.05	<0.05	<0.05	0.06	<0.05
Cadmium	ug/L	DW Lab	0.2	0.005	5	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium	ug/L	DW Lab	1	0.1	100	2.9	2.3	2.1	2.1	3.1
Copper	ug/L	DW Lab	0.5	1300	TT, Action Level 1300	5.4	3.6	4.5	4.4	5.4
Cyanide	mg/L	Eurofins	0.025	0.2	0.2	ND	ND	ND	ND	ND
Fluoride	mg/L	DW Lab	0.05	4	4	0.82	1.02	0.82	0.88	0.86
Lead	ug/L	DW Lab	0.5	0	TT, Action Level 15	<1	<1	<1	<1	<1
Mercury	ug/L	DW Lab	1	0.002	2	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrate (as N)	mg/L	DW Lab	0.05	10	10	2.58	3.06	3.57	3.61	3.91
Nitrite (as N)	mg/L	DW Lab	0.05	1	1	<0.10	<0.10	<0.10	<0.10	<0.10

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results				
				MCLG[1]	MCL or TT[1]	Batch 1 (3/7/2018)	Batch 2 (3/15/2018)	Batch 3 (3/21/2018)	Batch 4 (3/27/2018)	Batch 5 (4/10/2018)
Selenium	ug/L	DW Lab	5	0.05	50	2.4	<0.5	3.2	2.7	2
Thallium	ug/L	DW Lab	1	0.0005	2	<0.05	<0.05	<0.05	<0.05	<0.05
Radionuclides										
Combined Radium (226/228)	pCi/L	Eurofins	0.49	0	5	0.88	0.37	1.1	0.29	ND
Gross Alpha	pCi/L	Eurofins	3	0	15	ND	ND	ND	ND	ND
Beta particles and Emitters	pCi/L	Eurofins	3	0	50	12	10.3	1.5	1.48	1.91
Uranium	ug/L	DW Lab	1	0	30	0.3	0.1	<0.1	<0.1	<0.1

Notes:
MCLG = Maximum Contaminant Level Goal
MCL = Maximum Contaminant Level
MRL = Maximum Reporting Limit
TT = Treatment Technique

The EPA's SWTRs require Water Treatment Facilities to:
a. Disinfect their water, and
b. Filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:
   Cryptosporidium: 3-log removal.
   Giardia lamblia: 3-log removal.
   Viruses: 4-log removal.
   Legionella: No limit, but EPA believes that if Giardia and viruses are removed/inactivated, Legionella will also be controlled.
   Turbidity: ≤ 0.3 NTU 95 percent of the time, never to exceed 1 NTU.
   HPC: No more than 500 bacterial colonies/mL.

Regulatory levels detailed in:
SWTR = Surface Water Treatment Rule
IESWTR = Interim Enhanced Surface Water Treatment Rule
LT1 = Long-Term 1 Enhanced Surface Water Treatment Rule
LT2 = Long-Term 2 Enhanced Surface Water Treatment Rule
TCR = Total Coliform Rule
D/DBPR = Disinfectants/Disinfection By-Products Rule
SDWA = Safe Drinking Water Act and Amendments
Arsenic Rule
Radionuclide Rule

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Table 4. CECs Purified Finish Water Batch 1 Water Quality Results

Contaminant	Units	Laboratory	MRL	Water Quality Goals[9]	PureWater Colorado Batch Finished Water Results				
					Batch 1 (3/7/2018)	Batch 2 (3/15/2018)	Batch 3 (3/21/2018)	Batch 4 (3/27/2018)	Batch 5 (4/10/2018)
CECs									
1,4-dioxane	ug/L	Eurofins	0.07	1[1]	ND	ND	ND	ND	ND
NDMA	ng/L	Eurofins	2	10[1]	ND	3.1	ND	ND	2.1
PFOA/PFOS/PFC Suite									
Perfluorobutanesulfonic acid (PFBS)	ng/L	Eurofins	2	--	ND	ND	ND	ND	ND
Perfluorodecanoic acid (PFDA)	ng/L	Eurofins	2	--	ND	ND	ND	ND	ND
Perfluorododecanoic acid (PFDoA)	ng/L	Eurofins	2	--	ND	ND	ND	ND	ND
Perfluoroheptanoic acid (PFHpA)	ng/L	Eurofins	2	70 (total)[5]	ND	ND	ND	ND	ND
Perfluorohexanesulfonic acid (PFHxS)	ng/L	Eurofins	2	--	ND	ND	ND	ND	ND
Perfluorohexanoic acid (PFHxA)	ng/L	Eurofins	2	--	ND	ND	ND	ND	ND
Perfluorononanoic acid (PFNA)	ng/L	Eurofins	2	--	ND	ND	ND	ND	ND
Perfluorononanoic acid (PFOS)	ng/L	Eurofins	2	70 (total)[5]	ND	ND	ND	ND	ND
Perfluorooctanoic acid (PFOA)	ng/L	Eurofins	2	70 (total)[5]	ND	ND	ND	ND	ND
Perfluorotridecanoic acid (PFTrDA)	ng/L	Eurofins	2	--	ND	ND	ND	ND	ND
Perfluoroundecanoic acid (PFUnA)	ng/L	Eurofins	2	--	ND	ND	ND	ND	ND
Pertluorotetradecanoic acid (PFTeDA)	ng/L	Eurofins	2	--	ND	ND	ND	ND	ND
Gen X	ng/L	Eurofins	5	--	ND	ND	ND	ND	ND
4-nonylphenol	ng/L	Eurofins	100	500000[2]	ND	610	140	ND	770
Atenolol	ng/L	Eurofins	5	70000[3]	ND	ND	ND	ND	ND
Caffeine[6]	ng/L	Eurofins	5	350[3]	10	9	ND	93	ND
Carbamazepine	ng/L	Eurofins	5	1000[3]	ND	13	ND	ND	ND
Cotinine	ng/L	Eurofins	10	10000[3]	ND	ND	ND	ND	ND
DEET	ng/L	Eurofins	10	2500[3]	ND	ND	ND	ND	ND
Dilantin	ng/L	Eurofins	20	1000[3]	ND	ND	ND	ND	ND
Estradiol	ng/L	Eurofins	5	1[3]	ND	ND	ND	ND	ND
Estrone	ng/L	Eurofins	5	350[3]	ND	ND	ND	ND	ND
Ethinyl Estradiol	ng/L	Eurofins	5	280[3]	ND	ND	ND	ND	ND
Geosmin	ng/L	DW Lab	1	5[7]	<1	<1	<1	<1	<1

Contaminant	Units	Laboratory	MRL	Water Quality Goals[9]	PureWater Colorado Batch Finished Water Results				
					Batch 1 (3/7/2018)	Batch 2 (3/15/2018)	Batch 3 (3/21/2018)	Batch 4 (3/27/2018)	Batch 5 (4/10/2018)
Ibuprofen	ng/L	Eurofins	10	40000[3]	ND	ND	ND	ND	ND
Meprobamate	ng/L	Eurofins	5	260000[3]	ND	ND	ND	ND	ND
(MIB) 2-methylisoborneol	ng/L	DW Lab	1	5[7]	<1	<1	<1	<1	<1
Primidone	ng/L	Eurofins	20	840[4]	ND	ND	ND	ND	ND
Sucralose[6]	ug/L	Eurofins	0.1	150000[8]	ND	ND	ND	110	ND
TCEP	ng/L	Eurofins	10	2500[3]	ND	ND	ND	35	ND
Triclosan	ng/L	Eurofins	10	350[3]	ND	ND	ND	ND	ND

Notes:
-- = None Available
MRL = Method Reporting Limit
ND = Non-Detect

1) No EPA criteria for NDMA. CA DDW lists a notification level.
2) 2008 Australian Water Recycling Guidelines.
3) Additional health-based screening levels from 2010 SWRCB Recylced Water CEC Scientific Advisory Panel Final Report.
4) Drinking Water Equivalent Level (DWEL) developed by Intertox, Inc. (2009) for Orange County Water District.
5) Colorado Health Advisory of 70 ng/L for the total concentration of PFOA, PFOS, and PFHPA.
6) Caffeine and sucralose are surrogates for water-soluble uncharged chemicals of moderate molectular weight and not a CEC for its own health impacts, but rather for occurence.
7) No MCL exists for MIB or geosmin and they are considered CECs in this study due to public perception and taste and odor concerns. A threshold of 5 ng/L is listed based on WRF 3032 2013.
8) FDA threshold idefintifed as a health screening level in WE&RF project 11-02. FDA threshold of 5 mg/kg was converted to a drinking water concentration based on 60-kg and 2 L/day in the WE&RF project 11-02.
9) Water Quality Goals are non-regulated concentrations based on current human health research.

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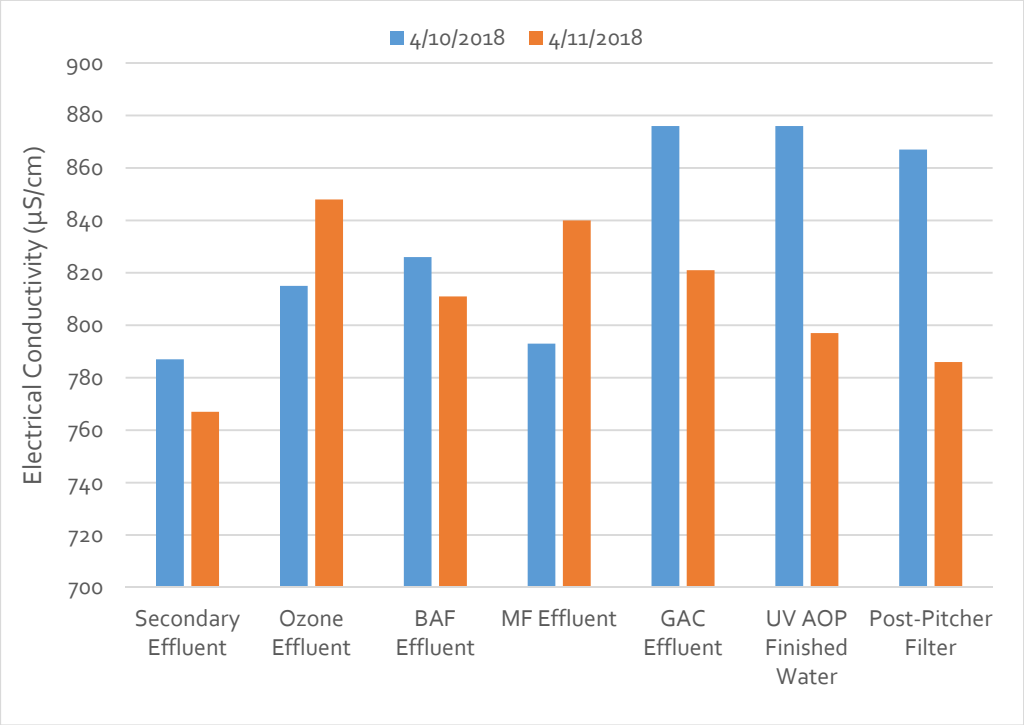

Figure 2. Electrical Conductivity removal through the PureWater Colorado DPR Demonstration Facility

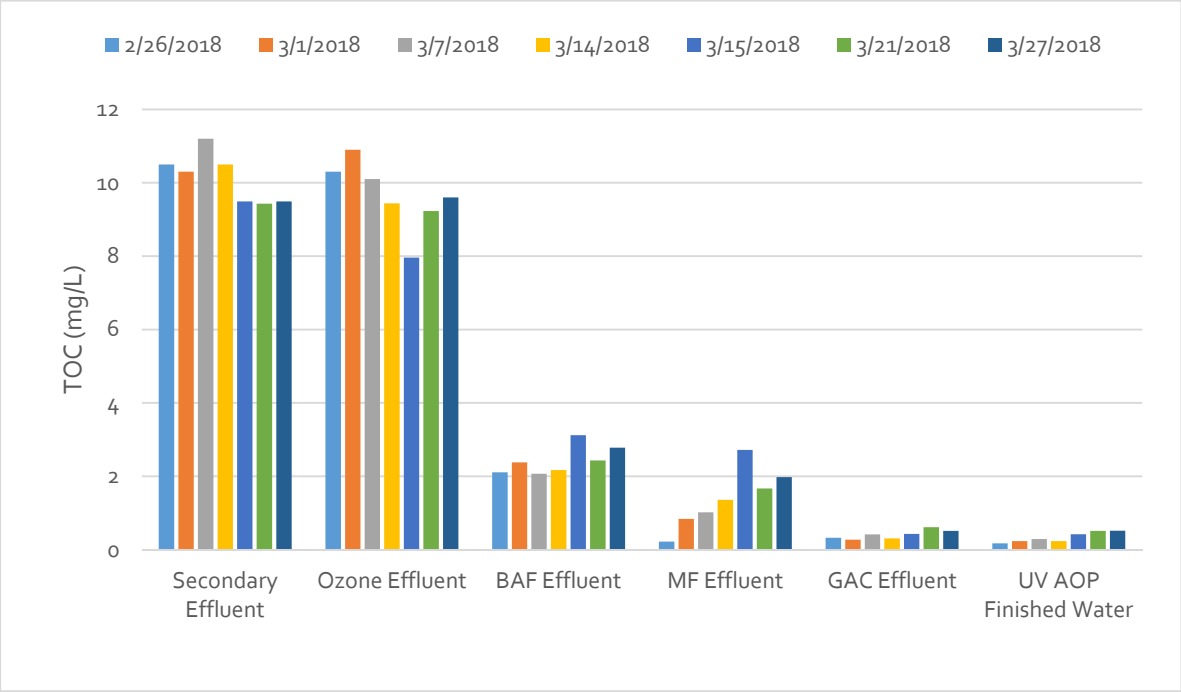

Figure 3. TOC removal through the PureWater Colorado DPR Demonstration Facility

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Outreach Materials for PureWater Colorado Demonstration Project

Outreach materials were developed for the demonstration project including pop up banners with process descriptions (Figures 1a and 1b), tour brochures (Figure 2), and the included tour script with key messaging and instructions for site visits and outreach. Two videos were produced by Denver Water for the project to use for ongoing outreach after decommissioning. An overview of the PureWater Colorado project can be found at https://www.youtube.com/watch?v=lBo7Im2Ra0I and a virtual tour video for the project can be found at https://www.youtube.com/watch?v=9VGgUH_ieDo.

There was an expansive amount of media coverage during and following the project, including:

- Denver Channel 7 on potable reuse:
  7/4/18
  https://www.thedenverchannel.com/news/local-news/singapore-could-help-colorado-s-water-woes
- KUNC/CPR on potable reuse:
  6/29/18
  http://www.kunc.org/post/more-western-cities-turn-recycled-water-they-may-face-curious-obstacle-ick-factor
- Channel 4 coverage of demonstration facilities:
  4/3/18
  https://denver.cbslocal.com/2018/04/03/denver-water-recycling/
- Channel 4 coverage of Declaration brewing:
  4/13/18
  https://denver.cbslocal.com/2018/04/13/declaration-purified-water-beer/
- Denver Business Journal coverage of demonstration facilities:
  4/3/18
  https://www.bizjournals.com/denver/news/2018/04/03/would-you-drink-recycled-water-you-might-in-the.html?ana=RSS&s=article_search&utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+industry_5+%28Industry+Energy+%26+the+Environment%29&utm_content=Google+Feedfetcher
- Fox 31 coverage of demonstration facilities:
  https://kdvr.com/2018/04/03/denver-water-working-on-way-to-turn-toilet-water-into-tap-water/

Figure 1a. Pop-up banners located in the lobby at the beginning of the PureWater Colorado Demonstration Tour

Figure 1b. Pop-up banners located in the lobby at the beginning of the PureWater Colorado Demonstration Tour

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Figure 2. Tour brochure (front and back) provided at PureWater Colorado Demonstration Tour

Innovation for Colorado's Future

The PureWater Colorado Demonstration Project is using advanced water purification technology to produce safe, high-quality drinking water. The project represents a viable and much-needed option for a future, locally controlled water supply in Colorado.

The Water Purification Process

PureWater Colorado starts with water that's been used in homes and then cleaned at a wastewater plant. The water purification process uses a multi-barrier approach of consecutive treatment steps that work together to remove or destroy contaminants. The process includes water quality monitoring, and safeguards are built into the process treatment train to ensure the resulting water is safe to drink.

The Process

Barrier 1:
Ozonation

Ozone is a gas produced by subjecting oxygen molecules to a high electrical voltage. Prior to the next steps, the ozone degrades organic matter and breaks down into dissolved oxygen. This process destroys pathogens and breaks down trace chemicals.

Barrier 2:
Biofiltration

Biologically activated carbon filters are covered with "aerobic" bacteria, which thrive in the presence of oxygen. This process consumes broken down organic matter and removes trace chemicals from the water.

Barrier 3:
Microfiltration

During the microfiltration process, water is pushed through canisters filled with straw-shaped hollow fiber membranes. The process removes microscopic particles including suspended solids, bacteria, and protozoa. The membrane pores are 100 times narrower than a human hair!

Barrier 4:
Granular Activated Carbon

During this step water flows through activated carbon granules, and trace chemicals and organic matter are removed.

Barrier 5:
UV/Advanced Oxidation

This step generates high energy ultraviolet light. When it combines with hydrogen peroxide it creates a chemical reaction that produces high energy radicals. The process damages the DNA of any microbes or viruses, leaving them unable to replicate, and destroys remaining trace chemicals.

PureWater Colorado Demonstration Project

Communications Plan

Final

Background:

Denver Water is partnering with Carollo Engineers and WateReuse Colorado (WRCO) on a project to demonstrate direct potable reuse (DPR) through a non-reverse osmosis (RO) treatment train. The project is called the "PureWater Colorado Demonstration Project" and is operating out of the Denver Water Recycling Plant.

Potable reuse is becoming more prominent across the country, particularly in areas facing the impacts of climate change and growing populations and potential water supply shortages. Even though there are hurdles associated with potable reuse, particularly when it comes to public acceptance and, in some cases, project costs, potable reuse offers a new, local water supply source that Colorado can take advantage of. Denver Water and water providers across Colorado have the responsibility to plan for a sustainable water future. WRCO has been a leader in this effort, working to raise awareness about water reuse and now creating a framework for eventual potable reuse regulations, planning tools, and education and outreach materials.

This demonstration project will undergo commissioning in early January and is expected to run through April. Some of the water produced will be used to provide opportunities to brew beer that can help raise awareness about this water source, and to show how water purification processes operate to help build confidence about the safety of this water source. Tour groups will also have an opportunity to sample the water.

Communication Goals:

- To show that potable reuse is a viable, local, future supply source in Colorado, as directed in Colorado's Water Plan, particularly to key state lawmakers, community leaders and regulators.
- To affirm all project partners as forward-thinking, responsible entities concerned about the future of Colorado's water supply.
- To have consistent messaging with all partners involved in the demonstration project and any companies that receive the DPR water.
- To address questions or concerns about potable reuse as a strategy to increase local water supplies in Colorado by focusing on the purity of the water and standards it must meet, which are the same as the rest of Denver Water's potable system. Essentially, PureWater Colorado is just drinking water from another source.
- Preserve perception of safety of current potable water practices.

Key Audiences:

- State lawmakers and regulators
- Water industry leaders and influencers
- Water industry employees and operators
- Key stakeholders in the state and in the city of Denver
- Media
- Denver Water customers and metro-area residents
- Denver Water employees
- Employees of partner agencies
- Potential users for PureWater, e.g. Declaration Brewing Company
- Environmental, business and health community group leaders

Key Messages: In addition to the main key messages, some messages should be targeted according to audience.

- WateReuse Colorado, Carollo Engineers and Denver Water are partnering on the PureWater Colorado Demonstration Project, which takes water that's been used in our homes, cleaned at a wastewater plant so it is safe to reintroduce back into the environment, and purifies it so it's safe to drink.
- PureWater Colorado demonstrates that water providers in Colorado can take existing technology and create another safe, reliable, sustainable and local drinking water supply in the future.
- It is important for Denver Water and all of Colorado to plan for ways to meet future demand for water supplies, particularly given the impact of climate change and growing populations. Potable reuse provides a new, local water source.
- PureWater Colorado demonstrates an environmentally responsible way to create a drought-proof, sustainable, local, future water supply.
- Water reuse is part of Colorado's Water Plan. It reduces the amount of water diverted from rivers and streams, it encourages efficient water use, and it's a sustainable way to extend local water supplies.

Additional tailored audience-specific messages:

- **State lawmakers and regulators** – The PureWater Colorado Demonstration project represents a viable and much-needed option for future local water supply in Colorado. State laws and regulations need to be updated to encourage future water supply development from water reuse, specifically including potable reuse, as mentioned in Colorado's Water Plan.
- **Water industry leaders and influencers** – Denver Water and WRCO are focused on future thinking to help address potential statewide gaps in future water supply. The PureWater Colorado Demonstration Project is an important step in proving the future viability of this local source of water supply.
- **Denver Water employees** – Purified water is a safe, reliable and local supply of water. In addition to the project partner tours taking place over the next month, purified water from the PureWater demonstration project will be sent to Declaration Brewery, which has committed to brewing a special beer to commemorate Denver Water's 100th anniversary. This is part of the celebration of Denver Water's storied past, as well as look into a sustainable future. Denver Water is always preparing for the future. While we don't have immediate plans to use this water purification process, it could be a viable option 40+ years from now.

Tactics:

- PureWater collateral:
    - Fact Sheet, FAQs and glossary of terms
    - Tour flier — to be sent to partner agencies for posting on their websites, etc.
    - Tour brochure — describing linear process of full scale facility, but demonstration facility processes are not laid out this way, so tour guides will need to make that distinction
    - Infographics of the process
    - Signage for demonstration facility
    - Scripts for tour guides (may need different ones for different audiences)
    - Training for tour guides
    - Template article suitable for publication in newsletters (print or electronic) or posting on websites of partner agencies
- Videos and information on TAP (Denver Water's news site, denverwaterTAP.org)
    - General project overview video and write up for TAP
    - Video explaining the beer associated with the project

    - Video and photographs of people reacting to tours of PureWater project for TAP
    - Get quotes to use on website from individuals who have toured and support the concept; can also use photographs of tour guests drinking the water
    - Virtual tour video on Denver Water's website
- Media outreach
- Briefings and site tours