APPENDIX A
REFERENCES

Adams, C., et al., *Removal of Antibiotics from Surface and Distilled Water in Conventional Water Treatment Processes.* Journal of Environmental Engineering, 2002. **128**(3): p. 8.

Anselme, C., I.H. Suffet, and J. Mallevialle, *Effects of Ozonation on Tastes and Odors.* Journal American Water Works Association, 1988. **80**(10): p. 7.

AWWA, *Problem Organisms in Water: Identification and Treatment*, in *AWWA Manual M7: Nitrifying Bacteria*, AWWA, Editor. 1995, AWWA: Denver, Colorado.

AWWA, *Water Quality & Treatment: A Handbook of Community Water Supplies*, 1999

Bartels, J.H.M., G.A. Burlingame, and I.H.M. Suffet, *Flavor Profile Analysis: Taste and Odor Control of the Future.* Journal American Water Works Association, 1986. **78**(3): p. 6.

Bartels, J.H.M., B.M. Brady, and I.H. Suffet, *Training Panelists for the Flavor Profile Analysis Method.* Journal American Water Works Association, 1987. **79**(1): p. 7.

Becker, W.C., et al. *The Use of Oxidants to Enhance Filter Performance*. in *Water Quality and Technology Conference*. 2002. Seattle, Washington: AWWA.

Bouwer, E.J., S. Goel, and R.M. Hozalski, *Removal of Natural Organic Matter in Biofilters*, A.R. Foundation, Editor. 1995, AwwaRF: Denver, Colorado. p. 224.

Briggs, D.A., et al., *Advanced Water Treatment of Estuarine Water Supplies*, A.R. Foundation, Editor. 2007, AwwaRF: Denver, Colorado. p. 440.

Cabral, Bruce (2007) Water Quality Manager, Santa Clara Valley Water District

Cabral, B. and J. Castro, *Personal Communication with S. Teefy*. 2007.

CDM, *Water Treatment Improvement Project – Stage 2, Volume 1, Technical Memorandums, Basis of Design Report*. 2000, Santa Clara Valley Water District: Santa Clara, California.

Chun, D., et al., *Personal Communication with S. Teefy*. 2007.

Coffey, B.M., et al. *Bromate Formation and Control During Ozonation to Achieve Giardia and Cryptosporidium Inactivation*. in *IOA Pan American Group Conference*. 1998. Vancouver, B.C., Canada: International Ozone Association.

Cohen, Y.K., C. Smith, and H. Baribeau, *Nitrification: Causes, Prevention, and Control*, in *Opflow*. 2001.

Del Valle Water Treatment Plant Expansion, Kennedy/Jenks/Chilton, July 1988

Del Valle Water Treatment Plant Booster Pump Station Project, Preliminary Design Report, CDM July 1999

Del Valle Water Treatment Plant Booster Pump Station Drawings (Project No. 131) CDM, December 1999

Department of Water Resources, California Cooperative Snow Surveys, Chronological Reconstructed Sacramento and San Joaquin Valley Water Year Hydrologic Classification Indices 1901 - 2007

Dyksen, J.E., et al., *In-Line Ozone and Hydrogen Peroxide Treatment for Removal of Organic Chemicals*. 1992, American Water Works Association Research Foundation: Denver, CO. p. 110.

Falconer, I.R. *Health Implications of Cyanobacterial (Blue-Green Algal) Toxins*. In *International Workshop on Toxic Cyanobacteria: Current Status of Research and Management*. 1994. Adelaide, Australia: Australian Water Quality Centre.

Ferguson, D.W., et al., *Comparing PEROXONE and Ozone for Controlling Taste and Odor Compounds, Disinfection By-Products, and Microorganisms.* Journal American Water Works Association, 1990. **82**(4): p. 11.

Ferguson, D.W., J.T. Gramith, and M.J. McGuire, *Applying Ozone for Organics Control and Disinfection: A Utility Perspective.* Journal American Water Works Association, 1991. **83**(5): p. 7.

Final Preliminary Design Report, 10-MGD DAF Project, MWH, October 2004

Gabelich, C.J., et al., *Manganese Desorption from Filter Media: Experiences with Biological Filtration*, in *AWWA Annual Conference and Exhibition*. 2005, AWWA: San Francisco, California.

Galey, C., et al., *Controlling Bromate Formation.* Journal American Water Works Association, 2001. **93**(8): p. 11.

Gillogly, T., et al., *Bromate Formation and Control During Ozonation of Low Bromide Waters*, A.R. Foundation, Editor. 2001, AwwaRF: Denver, Colorado.

Glaze, W.H. and J.W. Kang, *Advanced Oxidation Processes for Treating Groundwater Contaminated with TCE and PCE: Laboratory Studies.* Journal American Water Works Association, 1988. **88**(5): p. 6.

Glaze, W.H., et al., *Evaluation of Ozonation By-Products From Two California Surface Waters.* Journal American Water Works Association, 1989. **81**(8): p. 7.

Glaze, W.H., et al., *Evaluating Oxidants for the Removal of Model Taste and Odor Compounds From a Municipal Water Supply.* Journal American Water Works Association, 1990. **82**(5): p. 5.

Gottler, R., et al., *Addressing Concerns About Tastes and Odors and Cyanotoxins in Tap Water*, A.R. Foundation, Editor. 2007, Awwa Research Foundation: Denver, Colorado.

Graham, M., et al., *Optimization of Powdered Activated Carbon Application for Geosmin and MIB Removal*, A.R. Foundation, Editor. 2000, AwwaRF: Denver, Colorado. p. 274.

Haag, W.R. and J. Hoigne, *Ozonation of Bromide-Containing Waters: Kinetics of Formation of Hypobromous Acid and Bromate.* Environmental Science & Technology, 1983. **17**(5): p. 261-267.

Hidahl, C. and R.E. Henderson. *Operational Requirements for a Hybrid Low Pressure Membrane Treatment Process*. in *American Water Works Association California-Nevada Conference*. 2007. Sacramento, California.

Huck, P.M., et al., *Optimizing Filtration in Biological Filters*. 2000, American Water Works Association Research Foundation: Denver, Colorado.

Hurd, R.E., *Consumer Attitude Survey on Water Quality Issues*, A.R. Foundation, Editor. 1993, AwwaRF: Denver, Colorado. p. 176.

Hwang, C.J., et al., *Determination of Subnanogram per Liter Levels of Earthy-Musty Odorants in Water by the Salted Closed-Loop Stripping Method.* Environmental Science and Technology, 1984. **18**(7): p. 535-539.

Kachur, S., *Personal Communication with S. Teefy*. 2007.

Knocke, W.R., *Removal of Soluble Manganese from Water by Oxide-Coated Filter Media*. 1989, American Water Works Association Research Foundation: Denver, Colorado.

Koch, B., et al., *Control of 2-Methylisoborneol and Geosmin by Ozone and PEROXONE: A Pilot Study.* Water Science and Technology, 1992. **25**(2): p. 291-298.

Kostelecky, J. and G. Syfers, *Personal Communication with A. Mofidi*. 2006: Los Angeles, California.

Krasner, S.W., et al., *Formation and Control of Bromate During Ozonation of Waters Containing Bromide.* Journal American Water Works Association, 1993. **85**(1): p. 9.

Krasner, S.W., M.J. Sclimenti, and E.G. Means, *Quality Degradation: Implications for DBP Formation.* Journal American Water Works Association, 1994. **86**(6): p. 34-47.

Krasner, S.W., et al., *The Effect of Ozonation and Biofiltration on NOM*, in *Natural Organic Matter Workshop*. 1996, Universite de Poitiers: Poitiers, France.

Krasner, S.W., et al. *Pre-Oxidation With Chlorine Dioxide To Control Bromate Formation During Subsequent Ozonation*. in *2004 Water Quality Technology Conference*. 2004. San Antonio, Texas: AWWA.

Krasner, S.W. *Evaluation of Alternative Bromate Control Strategies*. in *AWWA Annual Conference and Exhibition*. 2007. Toronto, Ontario, Canada: AWWA.

Lalezary, S., M. Pirbazari, and M.J. McGuire, *Oxidation of Five Earthy-Musty Taste and Odor Compounds.* Journal American Water Works Association, 1986(3): p. 62-69.

Lalezary, S., M. Pirbazari, and M.J. McGuire, *Evaluating Activated Carbons for Removing Low Concentrations of Taste- and Odor-Producing Organics.* Journal American Water Works Association, 1986. **78**(11): p. 76-82.

Langlais, B. et al, *Ozone in Water Treatment – Application and Engineering*, Published by AWWARF, 1991

LeChevallier, M.W., N.J. Welch, and D.B. Smith, *Full-Scale Studies of Factors Related to Coliform Regrowth in Drinking Water.* Applied and Environmental Microbiology, 1996. **62**(7): p. 2201-2211.

Linden, K.G., et al., *Innovative UV Technologies to Oxidize Organic and Organoleptic Chemicals*. 2004, American Water Works Association Research Foundation: Denver, Colorado. p. 175 pp.

Mackenzie, J.A., M.F. Tennant, and D.W. Mazyck, *Tailored GAC for the Effective Control of 2-Methylisoborneol.* Journal American Water Works Association, 2005. **97**(6): p. 11.

Mallevialle, J. and I.H. Suffet, eds. *Identification and Treatment of Tastes and Odors in Drinking Water*. 1987, Awwa Research Foundation and Lyonnaise des Eaux: Denver, Colo..

Marda, S., et al., *Factors Affecting Monochloramine Stability in Ozone-BAC Process*, in *American Water Works Association Water Quality and Technology Conference*. 2007, AWWA: Charlotte, North Carolina.

Martin, N., et al., *Design and Efficiency of Ozone Contactors for Disinfection.* Ozone Science and Engineering, 1992. **14**(5): p. 15.

McGuire et. al (1981) Closed Loop Stripping Analysis as a Tool for Solving Taste and Odor Problems, *Journal AWWA* 73, 530-537

McMeen, C., *Personal Communication with A. Mofidi*. 2007: Los Angeles, California.

Meng, A.-K. and I.H.M. Suffet, *Assessing the Quality of Flavor Profile Analysis Data.* Journal American Water Works Association, 1992. **84**(6): p. 8.

Miettinen, I.T., T. Vartiainen, and P.J. Martikainen, *Microbial Growth and Assimilable Organic Carbon in Finnish Drinking Waters.* Water Science and Technology, 1997. **35**(11-12): p. 301-306.

Modesto Irrigation District, *Modesto Regional Water Treatment Plant (MRWTP) Phase Two Expansion Project Subsequent Environmental Impact Report*. 2004: Modesto, California.

Mofidi, A.A., *Water Quality Downstream of Ozonation at Mills Plant*. 2003, Metropolitan Water District of Southern California: Los Angeles, California.

Mofidi, A.A., et al., *Performance of Large-Scale Biological Filtration for Removal of Particles and Biodegradable Organic Matter Produced by Ozonation*, in *American Water Works Association Water Quality Technology Conference*. 2005, AWWA: Quebec, Ontario, Canada.

Mofidi, A.A. *Metropolitan's Mills and Jensen Water Treatment Plants: Ozone Case History*. in *Water Quality and Technology Conference*. 2006. Denver, Colorado: AWWA.

Mokrini, A., D. Ousse, and S. Esplugas, *Oxidation of Aromatic Compounds with UV Radiation/Ozone/Hydrogen Peroxide.* Water Science Technology, 1997. **35**(4): p. 95-102.

Montgomery Watson Harza, *Water Treatment Principles and Design*, 2005

MWDSC and JMM Consulting Engineers, *Pilot-Scale Evaluation of Ozone and PEROXONE*. 1991, AWWA Research Foundation and the AWWA.

MWDSC, *Demonstration-Scale Evaluation of Ozone and PEROXONE*. 2000, American Water Works Association Research Foundation: Denver, Colorado.

MWH. *10 MGD Dissolved Air Flotation Facility Del Valle Water Treatment Plant Drawings*, September 2005

Najm, I.N. and R.R. Trussell, *New and Emerging Drinking Water Treatment Technologies*, in *Identifying Future Drinking Water Contaminants*. 1999, National Academy Press: Washington, D. C.

Najm, I.N., et al., *Case Studies of the Impact of Treatment Changes on Biostability in Full Scale Distribution Systems*, A.R. Foundation, Editor. 2000, AwwaRF: Denver, Colorado.

Neeman, J., et al. *The Use of Injectors and Nozzles for Sidestream Ozone Addition*. in *Water Quality and Technology Conference*. 2002. Seattle, Washington: AWWA.

Nelieu, S., L. Kerhoas, and J. Einhorn, *Degradation of Atrazine into Ammeline by Combined Ozone/Hydrogen Peroxide Treatment in Water.* Environmental Science and Technology, 2000. **34**(3): p. 8.

Newcombe, G., *Removal of Algal Toxins from Drinking Water Using Ozone and GAC*, A.R. Foundation, Editor. 2002, AwwaRF: Denver, Colorado.

Nilson, J., *Cedar UV Treatment Facility: An Operational Review*, in *International Ozone Association and International Ultraviolet Association Joint World Congress*. 2007, IOA-IUVA: Los Angeles, California.

Nilson, J., *Personal Communication with A. Mofidi*. 2007.

Oh, B.S., et al., *Kinetic Study and Optimum Control of the Ozone/UV Process Measuring Hydrogen Peroxide Formed In-Situ.* Ozone Science and Engineering, 2005. **27**(6): p. 9.

Onstad, G.D. and U. Von Gunten. *Ozonation of Cyanotoxins: Chemical Kinetics and Applications*. in *American Water Works Association Water Quality and Technology Conference and Exhibition*. 2005. Quebec City, Quebec, Canada: AWWA.

Oppenheimer, J., et al., *Disinfection of Cryptosporidium: Design Criteria for North American Water Agencies*, in *1997 International Symposium on Waterborne Cryptosporidium Proceedings*, C. Fricker, J.L. Clancy, and P.A. Rochelle, Editors. 1997, AWWA, AwwaRF, MWD of Southern California, International Life Sciences Institute, USDA, and NWRI: Newport Beach, California. p. 275-280.

Ozone Feasibility Study, CDM, February 1991

Panus, P. and J. Parsons, *Personal Communication with S. Teefy*. 2007: Contra Costa Water District; Contra Costa, California.

Parsons, J., *Personal Communication with S. Teefy*. 2007.

Patterson Pass Water Treatment Plant Modernization, Volume 2 – Drawings, James M. Montgomery, January 1984

Patterson Pass Water Treatment Plant Ultra Filtration Project, Design Drawings, CDM, April 2004

Pinkernell, U. and U. von Gunten, *Bromate Minimization During Ozonation: Mechanistic Considerations.* Environmental Science and Technology, 2001. **35**(12): p. 7.

Rakness, K., *Ozone in Drinking Water Treatment: Process Design, Operation, and Optimization*, ed. A.W.W. Association. 2005, Denver, Colorado: AWWA.

Reckhow, D.A., J.K. Edzwald, and J.E. Tobiason, *Ozone as an Aid to Coagulation and Filtration*, A.R. Foundation, Editor. 1993, Awwa Research Foundation: Denver, Colorado.

Roche, P. and M. Prados, *Removal of Pesticides By Use of Ozone or Hydrogen Peroxide/Ozone.* Ozone Science and Engineering, 1995. **17**: p. 16.

Royce, A. and M. Stefan. *Application of UV in Drinking Water Treatment for Simultaneous Disinfection and Removal of Taste and Odor Compounds*. in *American Water Works Association Water Quality and Technology Conference and Exhibition*. 2005. Quebec City, Quebec, Canada: AWWA.

SBA Improvement and Enlargement Operational Analysis – Report on Impacts to Zone 7 from the SBA Enlargement Project (MWH) December 2004.

Sclimenti, M.J., *The Development of a Solid-Phase Microextraction Technique for Determining Fishy, Swampy, or Grassy Odors in Drinking Water*, in *AWWA Water Qualilty Technology Conference*. 2003, AWWA: Philadelphia, Penn.

Scott, K.N., R.L. Wolfe, and M.H. Stewart, *Pilot-Plant-Scale Ozone and PEROXONE Disinfection of Giardia muris Seeded Into Surface Water Supplies.* Ozone Science and Engineering, 1992. **14**(1): p. 71-90.

Seattle Public Utilities, *How Does Seattle Public Utilities Provide High-Quality Water from the Cedar River?* 2006, SPU: Seattle, Washington.

Shawwa, A.R. and D.W. Smith, *Kinetics of Microcystin-LR Oxidation by Ozone.* Ozone Science and Engineering, 2001. **23**(2): p. 9.

Siddiqui, M.S., G.L. Amy, and R.G. Rice, *Bromate Ion Formation: A Critical Review.* Journal American Water Works Association, 1995. **87**(10): p. 13.

Simpson and MacLeod (1991) Using Closed Loop Stripping And Jar Tests to Determine Powdered Activated Carbon Dose Needed for Removal of Geosmin: Manatee County's Experience, paper presented at the AWWA WQTC in Orlando, FL

Singer, P.C., et al., *Effectiveness of Pre- and Intermediate Ozonation on the Enhanced Coagulation of Disinfection By-Product Precursors in Drinking Water.* Ozone Science and Engineering, 2003. **25**(6): p. 18.

Snyder, S.A., et al., *Removal of EDCs and Pharmaceuticals in Drinking and Reuse Treatment Processes*, A.R. Foundation, Editor. 2007, AwwaRF, AWWA, IWA: Denver, Colorado.

South Bay Aqueduct Pilot Plant Studies, CDM, 1989

Suffet, I.H.M. and S. Segall, *Detecting Taste and Odor in Drinking Water.* Journal American Water Works Association, 1971. **63**(9): p. 4.

Suffet, I.H.M., et al., *AWWA Taste and Odor Survey.* Journal American Water Works Association, 1996. **88**(4): p. 13.

Taylor, W.D., et al. *Application of Limnological Principles for Management of Taste and Odor in Drinking Water Reservoirs: A Case Study*. in *American Water Works Association Water Quality Technology Conference*. 1994. San Francisco, Calif.

Taylor, W.D., et al., *Early Warning and Management of Surface Water Taste-and-Odor Events*, A.R. Foundation, Editor. 2006, AwwaRF: Denver, Colorado. p. 237.

Thompson, C.M., *30 Years of Experience Using Ozone in Water Treatment*, in *American Water Works Association Annual Conference and Exhibition*. 2005, AWWA: San Francisco, California.

Thompson, C.M. and J.A. Drago. *Ozone Use in the Water Treatment Industry in the United States, 1975-2005*. in *International Ozone Association Pan American Group Annual Conference*. 2005. Lake Lanier, Georgia: IOA.

Tosik, R., *Dyes Color Removal by Ozone and Hydrogen Peroxide: Some Aspects and Problems.* Ozone Science and Engineering, 2005. **27**(4): p. 6.

Treated Water Facilities Master Plan, February 2000, CDM

Urfer, D., et al., *Biological Filtration for BOM and Particle Removal: A Critical Review.* Journal American Water Works Association, 1997. **89**(12): p. 83-98.

USEPA, *Surface Water Treatment Rule (52 FR 42178)*. 1987: Washington, D.C.

Vokes, C.M., *Impact of Ozone and Biological Filtration on Water Quality Parameters in Arlington, Texas.* Ozone Science and Engineering, 2007. **29**(July-August).

von Gunten, U. and J. Hoigne. *Bromate Formation During Ozonation of Bromide-Containing Waters*. in *Eleventh Ozone World Congress*. 1993. San Francisco, California: International Ozone Association.

Weinberg, H.S., et al., *Formation and Removal of Aldehydes in Plants That Use Ozonation.* Journal American Water Works Association, 1993. **85**(5): p. 13.

Wert, E.C., et al., *Pilot-Scale and Full-Scale Evaluation of the Chlorine-Ammonia Process for Bromate Control During Ozonation.* Ozone Science and Engineering, 2007. **29**: p. 9.

Westerhoff, P., et al. *Kinetic Modeling of Bromate Formation in Ozonated Waters: Molecular Ozone Versus HO Radical Pathways*. in *American Water Works Association Annual Conference*. 1994. New York City, New York.

Westerhoff, P., et al., *NOM's Role in Bromine and Bromate Formation During Ozonation.* Journal American Water Works Association, 1998. **90**(2): p. 13.

Westerhoff, P., et al., *Ozone-Enhanced Biofiltration for Geosmin and MIB Removal*, A.R. Foundation, Editor. 2005, AwwaRF: Denver, Colorado. p. 224.

Westerhoff, P., B. Nalinakumari, and P. Pei, *Kinetics of MIB and Geosmin Oxidation During Ozonation.* Ozone Science and Engineering, 2006. **28**(5): p. 9.

Williams, M.D., B.M. Coffey, and S.W. Krasner, *Evaluation of pH and Ammonia for Controlling Bromate During Cryptosporidium Disinfection.* Journal American Water Works Association, 2003. **95**(10): p. 12.

Wojcicka, L., et al. *Investigating Pilot-Scale Dissolved Air Flotation, Ozonation, and Biological Filtration at the Mannheim WTP*. in *American Water Works Association Water Quality and Technology Conference and Exhibition*. 2005. Quebec City, Quebec, Canada: AWWA.

Wolfe, R.L., et al., *Disinfection of Model Indicator Organisms in a Drinking Water Pilot Plant by Using PEROXONE.* Applied and Environmental Microbiology, 1989. **55**(9): p. 2230-2241.

Wolfe, R.L., et al., *Ammonia-Oxidizing Bacteria in a Chloraminated Distribution System: Seasonal Occurrence, Distribution, and Disinfection Resistance.* Applied and Environmental Microbiology, 1990. **56**(2): p. 451-462.

Wolfe, R.L. and N.I. Lieu, *Nitrifying Bacteria in Drinking Water*, in *Encyclopedia of Environmental Microbiology*, G. Bitton, Editor. 2002, John Wiley & Sons, Inc.: Gainesville, Florida. p. 2167-2176.

Yates, R.S., et al., *Optimizing Coagulation/Filtration Processes for Cryptosporidium Removal*, in *1997 International Symposium on Waterborne Cryptosporidium Proceedings*, C. Fricker, J.L. Clancy, and P.A. Rochelle, Editors. 1997, AWWA, AwwaRF, MWD of Southern California, International Life Sciences Institute, USDA, and NWRI: Newport Beach, California. p. 281-290.

Zone 7 Water Quality Management Program – Implementation Plan, 2003

Zone 7 Del Valley Water Treatment Plant Future Ozonation and Water Level in DAF and Decision Factors (DRAFT) minutes from September 27, 2004 Workshop (MWH)

APPENDIX B
RAW PILOT TESTING DATA

Zone 7 Water Agency - Ozone & Peroxone Pilot Testing

Results of 1st Round of Testing - June & July 2008

						Ozone	Residual (mg/L) at HRT (min) Past 1st Chamber					CT	MIB			Geosmin				
Test ID	**Contactor**	**Water**	**pH**	**NH_2Cl**	**H_2O_2:O_3**	**Dose**	**0**	**2**	**4**	**6**	**8**	**mg-min/L**	**Influent**	**Effluent**	**% Rem.**	**Influent**	**Effluent**	**% Rem.**	**Bromide**	**Bromate**
R-2-0-7-0	**Conventional**	**Raw**	7.0	0	0	2.0	0.77	0.37	0.14	0.06	0.07	0.83	9.4	3.8	60%	9	2.8	69%	658	20
R-3-0-7-0						3.0	1.38	0.35	0.56	0.36	0.90	2.81	9.4	3.0	68%	9	2.2	76%	651	35
R-4-0-7-0						4.0	1.91	1.23	1.08	0.69	0.53	4.58	9.4	2.0	79%	9	1	89%	604	49
R-2-0-6.5-0			6.5	0	0	2.1	0.87	0.86	0.13	0.11	0.06	1.51	9.4	3.4	64%	9	2.3	74%	612	14
R-3-0-6.5-0						3.1	2.21	1.78	0.75	0.88	0.93	5.65	42	6.6	84%	33	3.9	88%	661	25
R-4-0-6.5-0						4.0	3.25	2.49	1.68	1.53	1.41	9.24	42	4.4	90%	33	2.1	94%	562	52
R-2-0-A-0.75			8.7	0.75	0	2.0	0.60	0.22	0.14	0.08	0.06	0.64	42	16	62%	33	8	76%	726	23
R-3-0-A-0.75			9.0	0.75	0	3.0	1.35	0.51	0.14	0.17	0.18	1.30	42	7.5	82%	33	3	91%	675	51
R-4-0-A-0.75			9.2	0.75	0	4.0	1.90	0.79	0.33	0.20	0.14	1.89	42	4.7	89%	33	1	97%	676	78
S-0.5-0-6.5-0		**Settled**	6.0	0	0	0.43	0.24	0.20	0.11	0.11	0.09	0.66	38	26	32%	40	27	33%	632	2.5
S-1-0-6.5-0						1.0	0.70	0.50	0.31	0.27	0.18	1.63	38	22	42%	40	20	50%	606	2.5
S-1.5-0-6.5-0						1.5	1.35	1.02	0.71	0.60	0.50	3.68	43	27	37%	38	20	47%	606	2.5
S-0.5-0-A-0			6.7	0	0	0.52	0.21	0.08	0.05	0.03	0.01	0.22	38	30	21%	40	27	33%	689	2.5
S-1-0-A-0						1.0	0.79	0.41	0.30	0.23	0.17	1.44	38	24	37%	40	18	55%	660	7.8
S-1.5-0-A-0						1.5	1.35	0.83	0.62	0.57	0.41	3.15	38	17	55%	40	14	65%	587	17
S-0.5-0-A-0.75			6.6	0.75	0	0.50	0.22	0.21	0.11	0.11	0.12	0.73	43	27	37%	38	24	37%	664	2.5
S-1-0-A-0.75						1.0	0.63	0.40	0.26	0.21	0.17	1.36	43	27	37%	38	18	53%	659	2.5
S-1.5-0-A-0.75						1.5	1.06	1.03	0.60	0.52	0.41	3.33	43	24	44%	38	18	53%	680	2.5

						Ozone	Residual (mg/L) at HRT (min) from Ozone Injection				CT	MIB			Geosmin				
Test ID	**Contactor**	**Water**	**pH**	**NH_2Cl**	**H_2O_2:O_3**	**Dose**	**0**	**1**	**1.5**	**2.6**	**mg-min/L**	**Influent**	**Effluent**	**% Rem.**	**Influent**	**Effluent**	**% Rem.**	**Bromide**	**Bromate**
R-2-0-6.5-0	**Pipeline**	**Raw**	6.5	0	0	3.0			1.9			9.4	2.3	76%	9	1	89%	594	32
R-3-0-6.5-0						3.9			2.7			42	5.0	88%	33	1	97%	549	64
R-4-0-6.5-0						4.6			3.8			42	3.1	93%	33	2.3	93%	479	105
R-2-0-7-0			7.0	0	0	3.0			1.1			9.4	3.2	66%	9	2.1	77%	643	43
R-3-0-7-0						3.8			2.1			9.4	2.0	79%	9	1	89%	545	91
R-4-0-7-0						5.1			3.8			9.4	1.0	89%	9	1	89%	468	158
R-2-0-A-0.75			8.7	0.75	0	3.0			2.5			42	13	69%	33	6.2	81%	691	39
R-3-0-A-0.75			9.0	0.75	0	4.5			2.3			42	6.4	85%	33	2.3	93%	626	89
R-4-0-A-0.75			9.2	0.75	0	6.0			2.9			42	3.4	92%	33	1	97%	608	143
R-2-0.4-6.5-0			6.5	0	0.14	2.8			1.1			30	8.5	72%	19	4.5	76%	723	33
R-3-0.6-6.5-0					0.16	3.8			1.8			30	6.5	78%	19	2.7	86%	687	45
R-4-0.8-6.5-0					0.18	4.6			2.2			30	5.6	81%	19	2.2	88%	631	69
R-2-0.4-7-0			7.0	0	0.13	3.0			1.2			30	7.3	76%	19	3.9	79%	691	45
R-3-0.6-7-0					0.15	4.0			1.4			30	6.0	80%	19	2.8	85%	672	65
R-4-0.8-7-0					0.17	4.6			2.5			30	5.4	82%	19	2.1	89%	630	90
R-2-0.4-A-0.75			8.2	0.75	0.13	3.0			0.49			30	7.7	74%	19	3.4	82%	738	50
R-3-0.6-A-0.75			8.3		0.13	4.5			0.78			30	5.4	82%	19	2.2	88%	741	72
R-4-0.8-A-0.75			8.3		0.13	6.0			1.13			30	3.8	87%	19	1	95%	719	93
R-2-1.6-6.5-0			6.5	0	0.53	3.0			0.69			24	7.6	68%	20	3.7	82%	612	19
R-3-2.4-6.5-0					0.62	3.9			1.25			24	5.1	79%	20	2.2	89%	553	38
R-4-3.2-6.5-0					0.69	4.6			1.56			24	4.4	82%	20	1	95%	528	60
R-2-1.6-7-0			7.0	0	0.53	3.0			0.64			24	6.9	71%	20	3.8	81%	622	38
R-3-2.4-7-0					0.63	3.8			1.13			24	5.8	76%	20	2.6	87%	567	65
R-4-3.2-7-0					0.69	4.6			1.50			24	4.2	83%	20	1	95%	510	101
R-2-1.6-A-0.75			8.2	0.75	0.53	3.0			0.72			24	6.8	72%	20	3.2	84%	594	28
R-3-2.4-A-0.75			8.2	0.75	0.53	4.5			1.04			24	5.3	78%	20	1	95%	588	49
R-4-3.2-A-0.75			8.3	0.75	0.53	6.0			1.36			24	4.0	83%	20	1	95%	558	71
S-0.5-0-6.5-0		**Settled**	6.0	0	0	0.95			0.91			38	22	42%	40	22	45%	621	2.5
S-1-0-6.5-0						1.62			1.03			38	18	53%	40	12	70%	567	7.3
S-1.5-0-6.5-0						2.22			2.00			43	17	60%	38	11	71%	547	18
S-0.5-0-A-0			6.7	0	0	0.93			0.63			38	26	32%	40	21	48%	663	2.5
S-1-0-A-0						1.64			1.34			38	18	53%	40	14	65%	585	21
S-1.5-0-A-0						2.25			1.57			38	13	66%	40	8.7	78%	526	42
S-0.5-0-A-0.75			6.6	0.75	0	0.75			0.43			43	26	40%	38	20	47%	596	2.5
S-1-0-A-0.75						1.5			1.42			43	21	51%	38	16	58%	589	5.2
S-1.5-0-A-0.75						2.25			1.90			43	21	51%	38	13	66%	629	2.5
S-0.5-0.1-6.5-0			6.0	0	0.13	0.8			0.76			36	20	44%	19	9.3	51%	619	2.5
S-1-0.2-6.5-0					0.14	1.4			1.42			36	14	61%	19	6.1	68%	611	5.7
S-1.5-0.3-6.5-0					0.16	1.89			1.48			36	13	64%	19	6.1	68%	509	2.5
S-0.5-0.1-A-0			6.6	0	0.11	0.93			0.44			36	25	31%	19	11	42%	714	2.5
S-1-0.2-A-0					0.13	1.52			1.16			36	16	56%	19	5.2	73%	698	17
S-1.5-0.3-A-0					0.15	1.98			1.83			36	12	67%	19	4.7	75%	486	23
S-0.5-0.1-A-0.75			6.6	0.75	0.11	0.93			0.76			36	23	36%	19	11	42%	583	2.5
S-1-0.2-A-0.75					0.13	1.52			1.35			36	19	47%	19	7.6	60%	574	2.5
S-1.5-0.3-A-0.75					0.15	1.98			2.14			24	11	54%	20	6.3	69%	538	2.5
S-0.5-0.4-6.5-0			6.0	0	0.53	0.76			0.81			24	15	38%	14	10	29%	590	2.5
S-1-0.8-6.5-0					0.51	1.56			1.17			24	13	46%	14	9	36%	515	2.5
S-1.5-1.2-6.5-0					0.56	2.16			1.73			24	8.6	64%	14	4.8	66%	487	9.1
S-0.5-0.4-A-0			6.6	0	0.43	0.93			0.80			24	14	42%	14	6.8	51%	601	2.5
S-1-0.8-A-0					0.50	1.6			1.25			24	14	42%	14	7.3	48%	545	5.7
S-1.5-1.2-A-0					0.58	2.07			1.87			24	10	58%	14	5	64%	497	23
S-0.5-0.4-A-0.75			6.5	0.75	0.43	0.93			0.75			24	14	42%	14	9.4	33%	529	2.5
S-1-0.8-A-0.75					0.50	1.6			1.38			24	13	46%	14	7.7	45%	558	2.5
S-1.5-1.2-A-0.75					0.58	2.07			1.82			24	10	58%	14	5.6	60%	567	2.5

Zone 7 Water Agency - Ozone & Peroxone Pilot Testing

Results of 2nd Round of Testing - September 2008

Test ID	Contactor	Water	pH	NH_2Cl	H2O2 Dose	$H_2O_2:O_3$	Target Ozone Dose	Transferred Ozone Dose	Transfer Efficiency	Residual (mg/L) at HRT (min) Past 1st Chamber					CT	MIB				Geosmin				Bromide	Bromate		NH_2Cl	Free NH_3-N
										0	2	4	6	8	mg-min/L	Influent	Mid PC	Effluent	% Rem.	Influent	Mid PC	Effluent	% Rem.		Mid PC	Effluent		
1	**Conventional**	**Raw**	6.5	0		0	1	1.0	96%	0.18	0.09	0.08	0.08	0.08	0.43	31		15	52%	26		10	62%	394		5.1		
2			6.5				2	1.9	95%	0.77	0.36	0.19	0.10	0.13	1.01	31		7.9	75%	26		4.1	84%	394		13		
3			6.5				3	2.7	91%	1.31	0.72	0.48	0.30	0.24	2.26	31		6.0	81%	26		3.2	88%	394		22		
4			7.5	0		0	1	1.0	97%	0.03	0.06	0.03	0.05	0.03	0.22	31		16.0	48%	26		12	54%	394		1.3		
5			7.5				2	1.9	95%	0.80	0.42	0.23	0.21	0.14	1.30	26		9.6	63%	22		6.3	71%	265		13		
6			7.5				3	2.8	93%	1.88	1.02	0.69	0.51	0.49	3.52	26		6.8	74%	22		3.5	84%	265		26		
7			7.5	0.75		0	1	1.0	95%	0.20	0.08	0.10	0.10	0.10	0.49	26		20	25%	22		13.7	38%	265		0.3	0.48	0.23
8			7.5	0.75			2	1.9	95%	0.99	0.51	0.30	0.18	0.13	1.46	26		12.6	52%	22		8.7	60%	265		4.4	0.42	0.17
9			7.5	0.75			3	2.7	91%	1.99	1.22	0.81	0.60	0.46	4.02	31		8.6	72%	28		5.5	80%	349		6.3	0.39	0.12
10			7.8	0.75		0	1	1.0	95%	0.21	0.16	0.21	0.15	0.16	0.88	31		18	42%	28		15	46%	349		0.5	0.58	0.17
11			7.8	0.75			2	1.9	93%	0.84	0.43	0.21	0.16	0.18	1.27	31		11	65%	28		7.8	72%	349		7.8	0.52	0.13
12			8.1	0.75			3	2.8	92%	1.53	1.15	0.56	0.43	0.34	3.22	31		8	74%	28		3.8	86%	349		18	0.41	0.13
13		**Settled**	6.0		0	0	0.5	0.48	96%	0.23	0.13	0.12	0.13	0.14	0.68	20		16	20%	16		10	38%	415		0.4		
14			6.0				1.5	1.4	94%	1.24	0.86	0.76	0.74	0.62	3.87	20		11	45%	16		7	58%	415		4.2		
15			6.0				3	2.7	89%	2.55	2.32	2.21	2.21	1.71	11.0	20		8	60%	16		5	67%	415		32		
16			6.5		0	0	0.5	0.48	96%	0.20	0.16	0.12	0.11	0.13	0.68	20		14	30%	16		10	38%	415		0.2		
17			6.6				1.5	1.4	93%	1.15	0.89	0.69	0.93	0.60	4.04	20		10	50%	16		6	63%	415		14		
18			6.5				3	2.7	89%	2.77	2.60	2.27	2.21	2.06	11.9	18		7	59%	17		6	67%	381		68		
19			6.46	0.75	0	0	0.5	0.48	96%	0.34	0.28	0.19	0.21	0.21	1.16	18		16	11%	17		13	24%	381		0.5	0.49	0.13
20			6.47	0.75			1.5	1.4	93%	1.30	1.09	0.81	0.84	0.64	4.39	18		12	33%	17		8	54%	381		1.1	0.21	0.14
21			6.5	0.75			3	2.6	88%	2.75	2.45	1.96	1.95	1.70	10.5	18		8	58%	17		6	68%	381		1.3	0.05	0.1

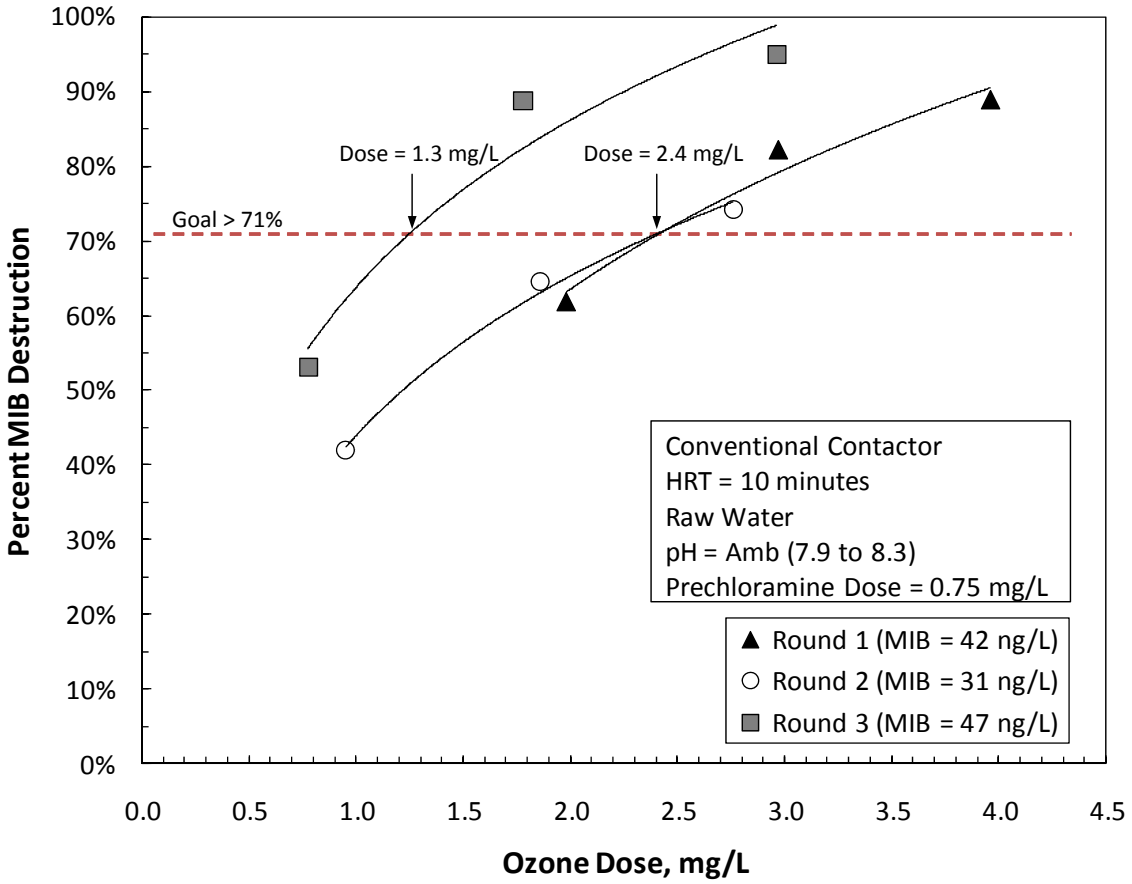
Test ID	Contactor	Water	pH	NH_2Cl	H2O2 Dose	$H_2O_2:O_3$	Ozone Dose	Ozone Dose	Transfer Efficiency	Residual (mg/L) at HRT (min) from Influent			CT	MIB				Geosmin				Bromide	Bromate		NH_2Cl	Free NH_3-N
										1	1.5	2.6	mg-min/L	Influent	Mid PC	Effluent	% Rem.	Influent	Mid PC	Effluent	% Rem.		Mid PC	Effluent		
1a	**Pipeline**	**Raw**	6.5	0		0	1	1.0	96%	0.1		0.09	0.23	31	16	14	55%	26	10	9.2	65%	394	5.5	5.7		
2a			6.5				2	1.7	87%	0.6		0.3	1.06	31	12	9.3	70%	26	7.5	5.7	78%	394	19	18		
3a			6.5				3	2.3	77%	1.0		0.96	2.40	31	9.3	9.2	70%	26	5.5	5.2	80%	394	31	27		
31			6.5	0	0.5	0.59	1	0.9	85%	0.0		0	0.03	44	21	21	52%	35	13	12	66%	524	8.2	7.7		
32			6.5		1	0.61	2	1.6	82%	0.4		0.06	0.52	44	11	7.0	84%	35	6.2	3.3	91%	524	25	34		
33			6.5		1.5	0.71	3	2.1	70%	0.7		0.06	0.75	44	7.4	3.5	92%	35	3.5	1.6	95%	524	61	55		
49			6.5	0	1	1.33	1	0.8	75%	0.20		0.21	0.50	32	15	15	53%	27	8.5	9.5	65%	498	6.5	4.2		
50			6.5		2	1.41	2	1.4	71%	0.49		0.14	0.69	32	9.4	7.2	78%	27	5.1	3.5	87%	589	15	19		
51			6.5		3	1.37	3	2.2	73%	0.50		0.21	0.80	32	5.7	3.2	90%	27	5.2	1.6	94%	589	22	25		
4a			7.5	0		0	1	0.9	87%	0.1		0.07	0.16	31	16	15	52%	26	9.4	10	62%	394	10	4.3		
5a			7.5				2	1.7	86%	0.8		0.52	1.53	26	15	12.4	52%	22	9.9	7.6	65%	265	16	16		
6a			7.5				3	2.4	81%	1.8		1.48	3.94	26	13	9.7	63%	22	7.9	6	73%	265	30	25		
7a			7.5	0.75			1	0.9	86%	0.4		0.27	0.76	26	19.8	19	29%	22	14	13.6	38%	265	2.3	3.8	0.42	0.17
8a			7.5	0.75			2	1.7	87%	1.0		0.72	2.05	26	16.7	14.6	44%	22	12.6	10.1	54%	265	5.2	4	0.43	0.14
9a			7.5	0.75			3	2.4	80%	1.7		1.9	4.42	31	17	14	55%	28	12	9.7	65%	349	13	12	0.36	0.18
34			7.5	0	0.5	0.69	1	0.7	72%	0.02		0	0.02	44	21	20	55%	35	12	12	66%	524	18	29		
35			7.5		1	0.60	2	1.7	83%	0.10		0.02	0.13	44	8.5	8.1	82%	35	4	3.8	89%	524	32	29		
36			7.5		1.5	0.69	3	2.2	72%	0.23		0.01	0.24	44	6.9	5	89%	35	3.3	2.1	94%	524	41	40		
52			7.6	0	1	1.37	1	0.7	73%	0.14		0.14	0.34	32	16	16	50%	27	10	11	59%	589	3.2	8.8		
53			7.4		2	1.22	2	1.6	82%	0.09		0.12	0.26	32	7	7.2	78%	27	3.4	3.4	87%	589	23	23		
54			7.5		3	1.37	3	2.2	73%	0.02		0.06	0.11	32	3.5	3.9	88%	27	1.6	1.7	94%	589	41	39		
10a			7.8	0.75			1	1.0	95%	0.2		0.27	0.63	31	21	19	39%	28	16	15	46%	349	1.8	0.5	0.54	0.14
11a			7.8	0.75			2	1.7	86%	0.8		0.41	1.37	31	17	14	55%	28	12	9.1	68%	349	5.7	9.3	0.4	0.12
12a			8.1	0.75			3	2.4	80%	1.2		0.81	2.37	31	8.7	7.6	75%	28	5.5	5	82%	349	22	18	0.39	0.12
37			8.4	0.75	0.5	0.68	1	0.7	73%	0.06		0.04	0.12	44	25	27	39%	35	18	19	46%	524	0.2	1.3	0.36	0.12
38			8.7	0.75	1	0.57	2	1.7	87%	0.01		0	0.01	44	17	15	66%	35	10	9.4	73%	524	4.3	1.8	0.39	0.15
39			8.7	0.75	1.5	0.63	3	2.4	80%	0.04		0.01	0.05	44	12	12	73%	35	6.1	5.8	83%	524	6.8	5.2	0.27	0.15
55			8.2	0.75	1	1.37	1	0.7	73%	0.15		0.08	0.27	32	20	19	41%	27	13	13	52%	589	0.4	0.8	0.48	0.1
56			8.4	0.75	2	1.19	2	1.7	84%	0.11		0.13	0.30	32	10	10	69%	27	5.6	5.5	80%	589	7.1	7.7	0.41	0.1
57			8.4	0.75	3	1.43	3	2.1	70%	0.08		0.17	0.33	32	4.6	4.3	87%	27	2	2	93%	589	39	36		
13a		**Settled**	6.0		0	0	0.5	0.48	96%	0.27		0.29	0.69	20	17	16	20%	16	10	12	25%	415	0.8	0.5		
14a			6.0				1.5	1.29	86%	1.10		0.89	2.39	20	9.3	10	50%	16	5.4	9	47%	415	3.3	5.8		
15a			6.0				3	2.19	73%	2.34		2.35	5.75	20	13	11	45%	16	8.7	7	55%	415	29	27		
16a			6.5	0	0		0.5	0.48	96%	0.38		0.29	0.80	20	15	13	35%	16	9.9	12	25%	415	1.1	0.7		
17a			6.6				1.5	1.32	88%	1.13		1.02	2.61	20	13	12	40%	16	8.6	8	52%	415	15	18		
18a			6.5				3	2.19	73%	2.26		1.98	5.13	18	11	10	44%	17	8.2	7.3	57%	381	50	51		
19a			6.5	0.75	0		0.5	0.48	96%	0.40		0.33	0.88	18	16	15	17%	17	14	12	29%	381	0.2	0.1	0.47	0.13
20a			6.5	0.75			1.5	1.31	87%	1.05		0.97	2.46	18	14	14	22%	17	9.6	10	44%	381	0.1	0.4	0.21	0.08
21a			6.5	0.75			3	2.19	73%	2.50		2.16	5.63	18	13	10	44%	17	10	8	55%	381	2.4	1.9	0.16	0.06
22			6.0	0	0.25	0.52	0.5	0.48	96%	0.04		0	0.04	33	23	19	42%	27	15	13	52%	531	0.1	0.4		
23			6.0		0.75	0.60	1.5	1.25	83%	0.68		0.47	1.36	33	18	17	48%	27	13	10	63%	531	2.4	1.3		
24			6.0		1.5	0.75	3	2.01	67%	1.27		0.86	2.52	33	13	8	75%	27	8.6	4.4	84%	531	16	17		
25			6.7		0.25	0.52	0.5	0.48	96%	0.09		0.04	0.15	33	24	22	33%	27	17	15	44%	531	0.6	1.2		
26			6.8		0.75	0.61	1.5	1.22	81%	0.66		0.36	1.18	33	15	10	71%	27	9.6	5.2	81%	531	19	22		
27			6.8		1.5	0.74	3	2.04	68%	1.24		0.48	1.94	33	7.6	2	93%	27	3.8	1.2	96%	531	59	56		
28			6.7	0.75	0.25	0.52	0.5	0.48	96%	0.21		0.13	0.40	33	28	27	18%	27	21	18	33%	531	0.7	1	0.5	0.11
29			6.8	0.75	0.75	0.61	1.5	1.22	81%	0.71		0.37	1.25	33	22	16	52%	27	14	10	63%	531	2.5	3.1	0.4	0.1
30			6.8	0.75	1.5	0.74	3	2.04	68%	1.25		0.49	1.96	33	12	5	84%	27	7.6	2.5	91%	531	17	13	0.35	0.07
40			6.0	0	0.5	1.04	0.5	0.48	96%	0.23		0.18	0.49	25	19	18	28%	24	14	13	46%	498	1.8	1.5		
41			6.0		1.5	1.20	1.5	1.25	83%	0.89		0.57	1.72	25	6.2	6	75%	24	3.2	3.5	85%	498	2.2	5.3		
42			6.0		3	1.43	3	2.1	70%	1.68		0.99	3.12	25	11	3.9	84%	24	6.2	1.8	93%	498	16	11		
43			6.7		0.5	1.04	0.5	0.48	96%	0.16		0.13	0.35	25	23	22	12%	24	15	15	38%	498	0.2	1.3		
44			6.7		1.5	1.20	1.5	1.25	83%	0.74		0.35	1.25	25	13	6.5	74%	24	7.6	2.9	88%	498	20	20		
45			6.8		3	1.47	3	2.04	68%	1.04		0.18	1.30	25	4.2	1.6	94%	24	1.7	1.1	95%	498	38	35		
46			6.7	0.75	0.5	1.04	0.5	0.48	96%	0.32		0.25	0.68	25	30	28	-12%	24	20	21	13%	498	0.8	0.6	0.51	0.12
47			6.7	0.75	1.5	1.23	1.5	1.22	81%	0.81		0.38	1.36	25	20	13	48%	24	13	7.4	69%	498	3.2	4.5	0.38	0.1
48			6.7	0.75	3	1.49	3	2.01	67%	0.97		0.24	1.32	25	5.2	2	92%	24	2	1.1	95%	498	31	29	0.18	0.21

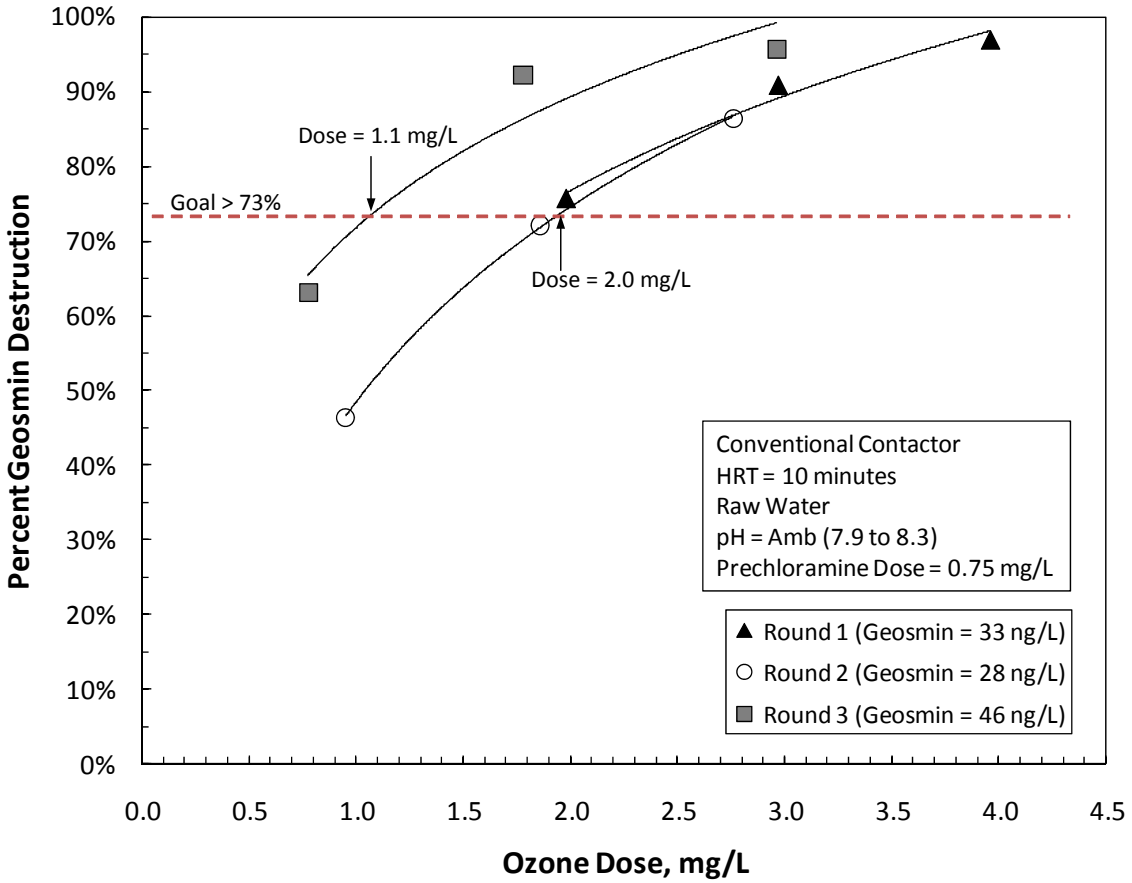
Zone 7 Water Agency - Ozone & Peroxone Pilot Testing

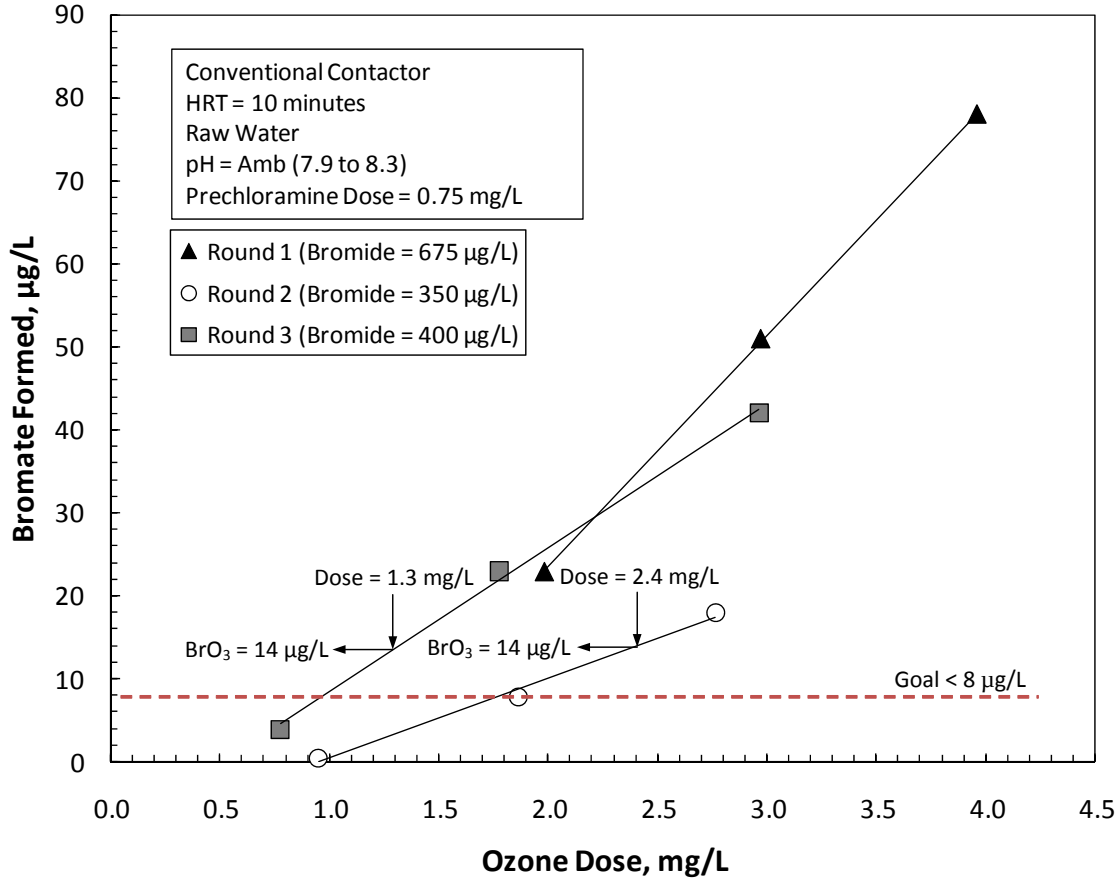
Results of 3rd Round of Testing - October 2008

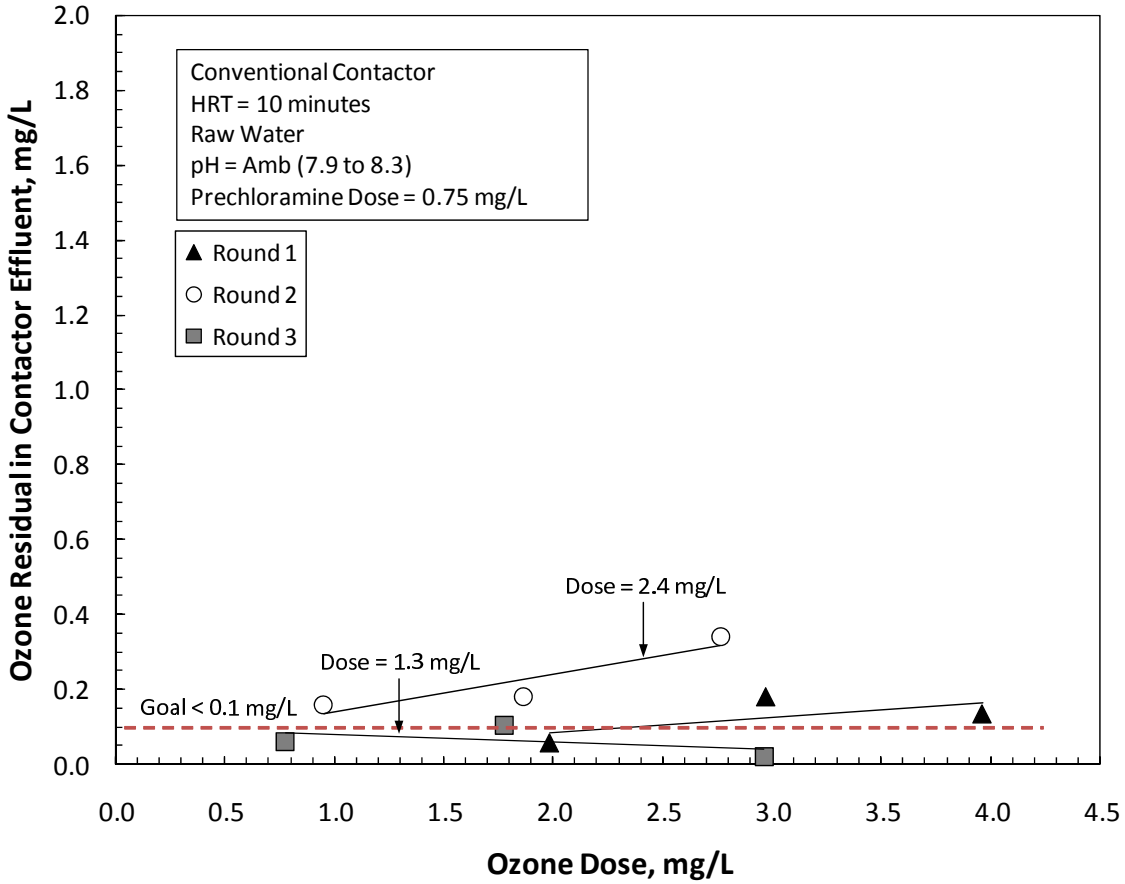
Test ID	Contactor	Water	pH	NH_2Cl	H2O2 Dose	H_2O_2:O_3	Applied Ozone Dose	Transferred Ozone Dose	Transfer Efficiency	Residual (mg/L) at HRT (min) Past 1st Chamber 0	2	4	6	8	CT mg-min/L	MIB Influent	MIB Effluent	MIB % Rem.	Geosmin Influent	Geosmin Effluent	Geosmin % Rem.	Bromide	Bromate	NH_2Cl	Free NH_3-N
1	**Conventional**	**Raw**	6.5	--	--	0	1.5	1.1	72%	0.16	0.01	0.00	0.02	0.01	0.05	40	21	48%	40	17	58%	423	0		
2			6.5	--	--	0	2.6	2.0	77%	0.89	0.61	0.41	0.24	0.19	1.89	40	13.0	68%	40	10	75%	423	12		
3			6.5	--	--	0	3.75	2.9	78%	2.18	1.90	1.39	1.06	0.64	6.49	40	9.3	77%	40	7	83%	423	31		
4			7.6	--	--	0	1.4	0.9	67%	0.07	0.01	0.00	0.02	0.11	0.19	40	23.0	43%	40	21	48%	423	3.1		
5			7.6	--	--		2.8	2.2	77%	0.84	0.47	0.19	0.08	0.01	0.97	40	6.8	83%	40	4.6	89%	423	35		
6			7.6	--	--		4.2	3.3	78%	2.10	1.03	0.60	0.45	0.38	3.21	40	4.6	89%	40	3	93%	423	82		
7			7.5	0.75	--	0	1.8	1.0	54%	0.46	0.19	0.06	0.03	0.08	0.46	47	20	57%	46	15	67%	398	3.3	NA	NA
8			7.6	0.75	--		2.8	2.0	70%	0.91	0.33	0.07	0.00	0.03	0.54	47	7	85%	46	4.6	90%	398	21	0.53	0.15
9			7.4	0.75	--		4	3.0	75%	1.47	0.47	0.13	0.02	0.09	0.93	47	2.6	94%	46	2.2	95%	398	39	0.37	0.2
10			8.3	0.75	--	0	1.25	0.8	62%	0.10	0.14	0.07	0.05	0.06	0.42	47	22	53%	46	17	63%	398	4	0.76	0.14
11			8.3	0.75	--		2.5	1.8	71%	0.43	0.08	0.06	0.12	0.10	0.48	47	5.3	89%	46	3.6	92%	398	23	0.59	0.14
12			8.7	0.75	--		4	3.0	74%	0.58	0.02	0.07	0.10	0.02	0.27	47	2.4	95%	46	2	96%	398	42	0.42	0.16

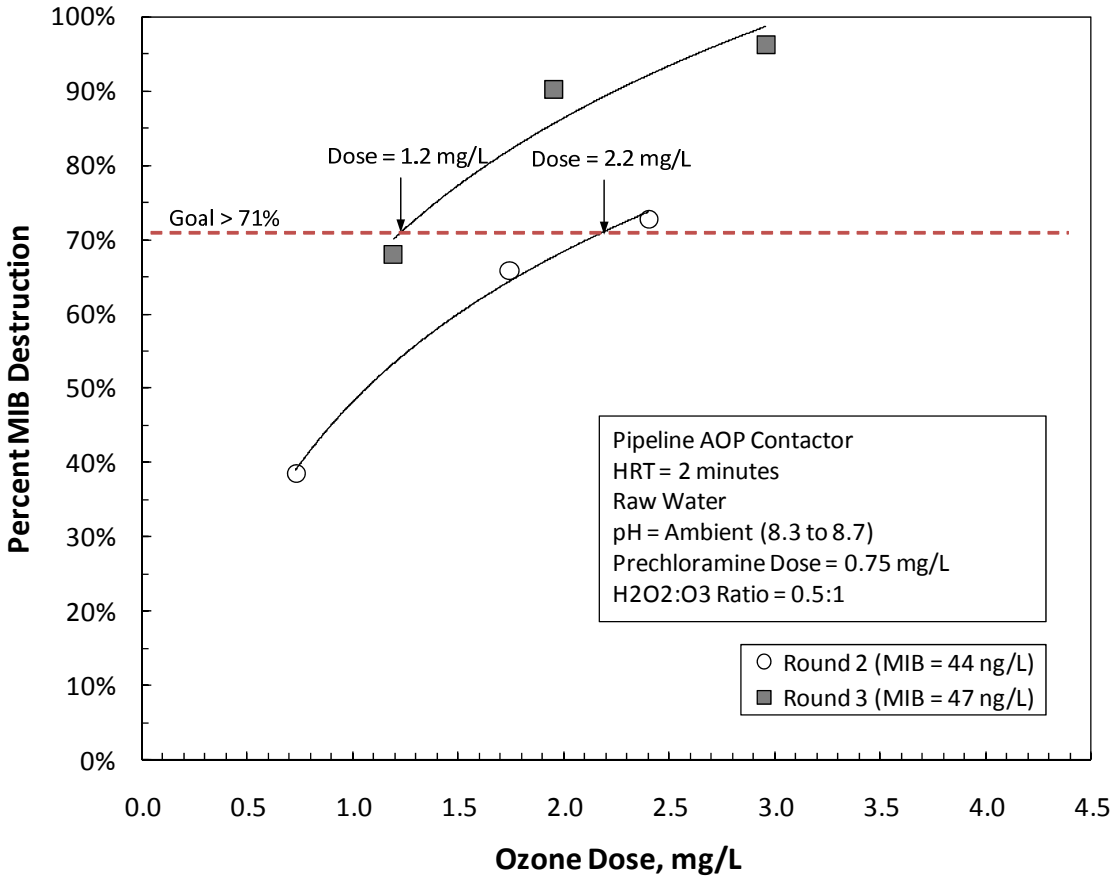
Test ID	Contactor	Water	pH	NH_2Cl	H2O2 Dose	H_2O_2:O_3	Ozone Dose	Ozone Dose	Transfer Efficiency	Residual (mg/L) at HRT (min) from Influent 1.0	1.5	2.6	CT mg-min/L	MIB Influent	MIB Effluent	MIB % Rem.	Geosmin Influent	Geosmin Effluent	Geosmin % Rem.	Bromide	Bromate	NH_2Cl	Free NH_3-N
4a	**Pipeline**	**Raw**	7.6	--	0.5	0.5	1.3	1.1	85%	0.2		0.09	0.37	40	16	60%	40	11	73%	423	13		
5a	H2O2 added		7.6	--	1	0.5	2.5	2.0	80%	0.3		0.10	0.51	40	4.8	88%	40	3.5	91%	423	40		
6a	32 seconds		7.6	--	1.5	0.5	3.75	2.9	78%	0.5		0.16	0.72	40	1.9	95%	40	1.7	96%	423	70		
7a	**DOWNSTREAM**		7.5	0.75	1	1.0	1.3	1.0	75%	0.2		0.05	0.31	47	16	66%	46	12	74%	398	2.4	0.63	0.12
8a	of ozone		7.6	0.75	2	1.0	2.4	2.0	83%	0.1		0.25	0.55	47	5.3	89%	46	3.1	93%	398	17	0.54	0.06
9a	addition		7.4	0.75	3	1.0	3.6	3.0	82%	0.2		0.07	0.36	47	2.4	95%	46	2	96%	398	37	0.31	0.02
31			7.4	0.75	0.5	0.3	2	1.5	75%	0.52		0.06	0.62	46	12	74%	44	7.4	83%	370	10	0.6	0.11
32			7.6	0.75	1	0.5	2	1.9	81%	0.77		0.01	0.78	46	5.6	88%	44	3.8	91%	370	19	0.42	0.13
33			7.5	0.75	1.5	0.5	4	3.0	75%	0.83		0.26	1.24	46	1.5	97%	44	1.76	96%	370	49	0.43	0.08
34			7.5	--	1.0	1.1	1.25	0.9	74%	0.2		0.04	0.23	46	10	78%	44	7.3	83%	370	15		
35			7.5	--	2.0	1.0	2.75	2.0	73%	0.3		0.01	0.30	46	2.6	94%	44	2.2	95%	370	54		
36			7.5	--	3.0	1.0	3.65	3.0	82%	0.1		0.01	0.10	46	1.0	98%	44	1.7	96%	370	93		
10a			8.3	0.75	0.5	0.4	1.4	1.2	85%	0.12		0.17	0.39	47	15	68%	46	11	76%	398	8	0.63	0.13
11a			8.3	0.75	1	0.5	2.5	2.0	78%	0.00		0.07	0.11	47	4.6	90%	46	2.7	94%	398	37	0.47	0.1
12a			8.7	0.75	1.5	0.5	3.4	3.0	87%	0.05		0.03	0.10	47	1.8	96%	46	1	98%	398	57	0.39	0.1
37			8.0	0.75	1.0	1.0	1.3	1.0	75%	0.13		0.03	0.18	62	25	60%	55	18	67%	354	0	0.58	0.14
38			8.0	0.75	2.0	1.0	2.4	2.0	84%	0.07		0.05	0.15	62	10	84%	55	5.3	90%	354	11	0.46	0.09
39			8.0	0.75	3.0	1.0	3.8	3.0	78%	0.03		0.00	0.03	62	3.4	95%	55	2.8	95%	354	32	0.35	0.03
40			8.1	0.75	2.0	2.1	1.3	1.0	75%	0.04		0.01	0.06	62	22	65%	55	15	73%	354	2.3	0.65	0.05
41			8.3	0.75	4.0	2.0	2.3	2.0	86%	0.00		0.01	0.01	62	8.6	86%	55	4.4	92%	354	19	0.32	0.05
42			8.4	0.75	6.0	2.0	3.6	3.0	83%	0.01		0.00	0.01	62	2.9	95%	55	1.9	97%	354	49	0.29	0.01
43	**Pipeline**	**Raw**	7.5	0.75	0.5	0.5	1.3	1.0	75%	0.24		0.03	0.29	44	25	43%	44	18	59%	381	1.3	0.47	0.14
44	H2O2 added		7.5	0.75	1	0.5	2.4	2.0	85%	0.39		0.01	0.40	44	9.1	79%	44	5.2	88%	381	11	0.34	0.12
45	2 seconds		7.5	0.75	1.5	0.5	3.8	3.0	80%	0.56		0.00	0.56	44	3.5	92%	44	2.1	95%	381	28	0.34	0.12
46	**DOWNSTREAM**		7.5	0.75	1.0	1.0	1.3	1.0	75%	0.11		0.08	0.23	44	20	55%	44	14	68%	381	2.1	0.48	0.14
47	of ozone		7.4	0.75	2.0	1.0	2.3	2.0	86%	0.07		0.00	0.06	44	10	77%	44	5.7	87%	381	6.3	0.34	0.1
48	addition		7.5	0.75	3.0	1.0	3.8	2.9	78%	0.04		0.00	0.04	44	2.4	95%	44	1.8	96%	381	24	0.3	0.06
52	**Pipeline**	**Raw**	7.5	0.75	0.5	0.5	1.4	1.1	75%		0.33	0.13	0.63	34	14	59%	35	11	69%	343	4.1	0.58	0.11
53	H2O2 added		7.5	0.75	1	0.5	2.5	1.9	74%		0.68	0.19	1.24	34	5.6	84%	35	3.5	90%	343	13	0.46	0.11
54	63 seconds		7.5	0.75	1.5	0.5	3.8	3.0	80%		1.00	0.28	1.81	34	3.0	91%	35	1.988	94%	343	26	0.44	0.09
55	**DOWNSTREAM**		7.5	0.75	1.0	1.0	1.3	1.0	75%		0.18	0.04	0.31	34	16.8	50%	35	12.7	64%	343	0.4	0.58	0.13
56	of ozone		7.6	0.75	2.0	1.0	2.5	2.0	80%		0.50	0.05	0.81	34	5.9	83%	35	3.8	89%	343	9.2	0.49	0.06
57	addition		7.6	0.75	3.0	1.1	3.8	2.7	71%		0.49	0.06	0.80	34	2.4	93%	35	1.9	95%	343	21	0.42	0.03
58	**Pipeline**	**Raw**	7.6	--	0.5	0.5	1.3	1.0	75%	0.26		0.00	0.26	33	11.35	66%	33	8.163	75%	358	14		
59	H2O2 added		7.5	--	1.0	0.5	2.5	2.0	78%	0.46		0.02	0.49	33	2.8	92%	33	2.2	93%	358	41		
60	2 seconds		7.5	--	1.5	0.5	3.8	2.9	77%	0.37		0.03	0.42	33	1.2	96%	33	1.6	95%	358	71		
61	**UPSTREAM**		7.6	--	1.0	1.0	1.3	1.0	76%	0.37		0.11	0.55	33	13.9	58%	33	11.0	67%	358	14		
62	of ozone		7.5	--	2.0	0.9	2.5	2.2	86%	1.11		0.75	2.31	33	2.5	92%	33	2.0	94%	358	29		
63	addition		7.5	--	3.0	1.0	3.7	3.0	81%	0.04		0.07	0.15	33	1.0	97%	33	1.6	95%	358	48		
	Pipeline		7.5	--	0	0.00	1.3	0.98	75%	0.3		0.04	0.36										
	no H2O2 Added		7.5	--	0	0.00	2.5	1.95	78%	1.2		0.66	2.22										
			7.5	--	0	0.00	3.89	3.00	77%	2.0		1.23	4.00										
13	**Pipeline**	**Settled**	5.9	--	0.25	0.5	0.63	0.4725	75%	0.28		0.17	0.55	44	30	32%	43	27	37%	436	0.5		
14	H2O2 added		6.0	--	0.5	0.6	1.25	0.875	70%	0.90		0.66	1.96	44	27	39%	43	22	49%	436	6		
15	32 seconds		6.0	--	1.25	0.6	3	2.16	72%	2.00		1.88	5.01	44	11	75%	43	8	81%	436	31		
16	**DOWNSTREAM**		6.0	--	0.5	1.0	0.70	0.49	70%	0.47		0.35	1.03	44	25	43%	43	22	49%	436	0		
17	of ozone		6.0	--	1	1.1	1.25	0.90	72%	0.93		0.68	2.01	44	21	52%	43	16	63%	436	3.6		
18	addition		6.0	--	2.5	1.1	3.40	2.38	70%	2.09		1.34	4.24	44	5	90%	43	3	93%	436	28		
19			6.8	--	0.25	0.48	0.7	0.53	75%	0.40		0.30	0.89	44	28	36%	43	23	47%	436	5		
20			6.8	--	0.5	0.50	1.4	0.99	71%	1.02		0.64	2.05	44	8	81%	43	5.1	88%	436	11		
21			6.7	--	1.25	0.53	3.4	2.35	69%	1.95		1.18	3.83	44	3	93%	43	2.1	95%	436	85		
22			6.7	--	0.5	0.95	0.7	0.53	75%	0.44		0.28	0.89	72	28	61%	63	19	70%	470	12		
23			6.8	--	1.0	1.19	1.25	0.84	67%	0.70		0.48	1.47	72	7	90%	63	4.1	93%	470	18		
24			6.8	--	2.5	1.08	3.1	2.33	75%	1.03		0.14	1.25	72	1	99%	63	1.6	97%	470	65		
25			6.8	0.75	0.25	0.48	0.7	0.53	75%	0.53		0.37	1.11	72	42	42%	63	33	48%	470	4.5	0.9	0.18
26			6.8	0.75	0.5	0.57	1.3	0.88	68%	1.22		0.79	2.48	72	32	56%	63	20	68%	470	1.9	0.74	0.22
27			6.8	0.75	1.25	0.53	3.3	2.34	71%	1.95		1.20	3.86	72	6	91%	63	3.2	95%	470	21	0.66	0.13
28			6.8	0.75	0.5	0.95	0.7	0.53	75%	0.54		0.34	1.08	72	28	61%	63	17	73%	470	12	0.83	0.19
29			6.7	0.75	1.0	1.05	1.3	0.95	73%	0.89		0.42	1.55	72	15	79%	63	7.9	87%	470	14	0.73	0.19
30			6.8	0.75	2.5	1.04	3.3	2.41	73%	1.02		0.14	1.24	72	2.4	97%	63	1.9	97%	470	29	0.54	0.05
49	**Pipeline**		6.9	--	0.25	0.48	0.7	0.525	75%		0.40	0.33	0.97	34	21	37%	35	20	43%	343	1.4		
50	H2O2 added		6.8	--	0.5	0.51	1.3	0.975	75%		0.89	0.77	2.18	34	16.1	53%	35	14	60%	343	18		
51	63 seconds		6.8	--	1.25	0.54	3.1	2.294	74%		1.74	1.22	3.95	34	5.6	84%	35	3	91%	343	55		
	DOWNSTREAM of ozone addition																						

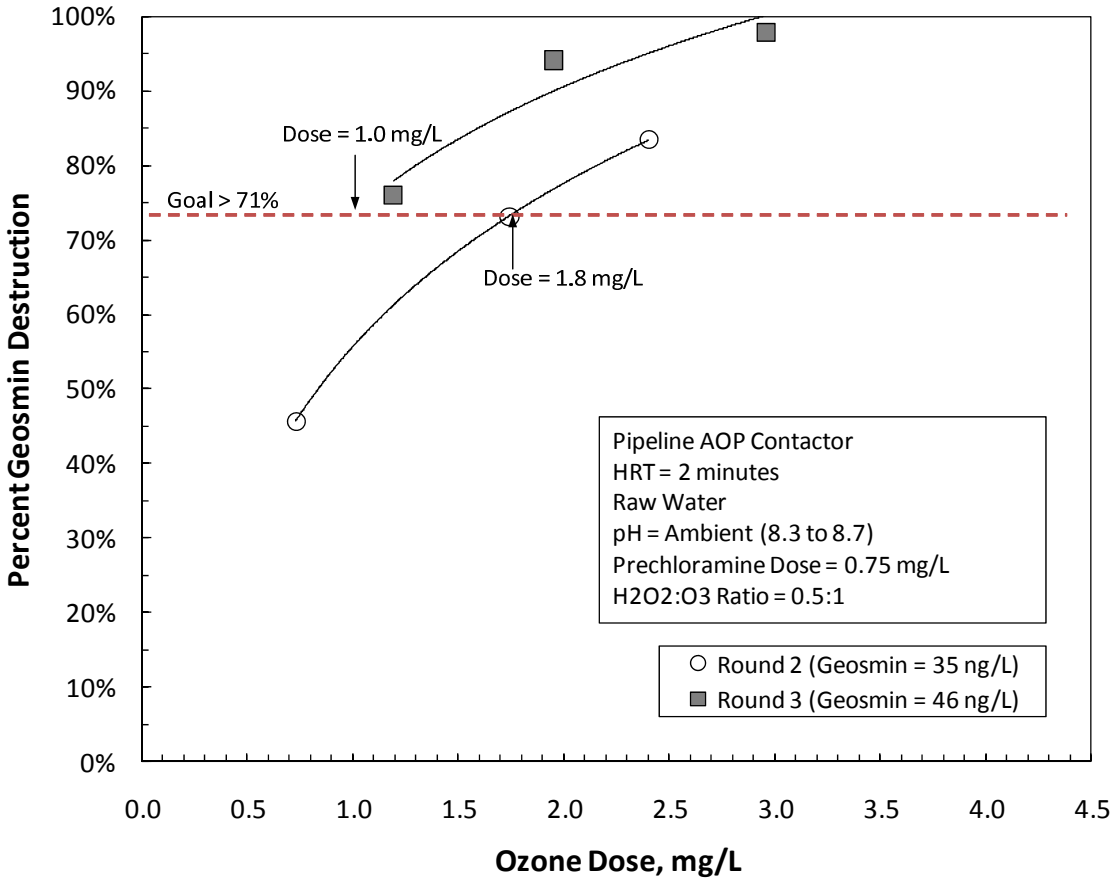

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent MIB Destruction
Dose = 1.3 mg/L
Dose = 2.4 mg/L
Goal > 71%
Conventional Contactor
HRT = 10 minutes
Raw Water
pH = Amb (7.9 to 8.3)
Prechloramine Dose = 0.75 mg/L
Round 1 (MIB = 42 ng/L)
Round 2 (MIB = 31 ng/L)
Round 3 (MIB = 47 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

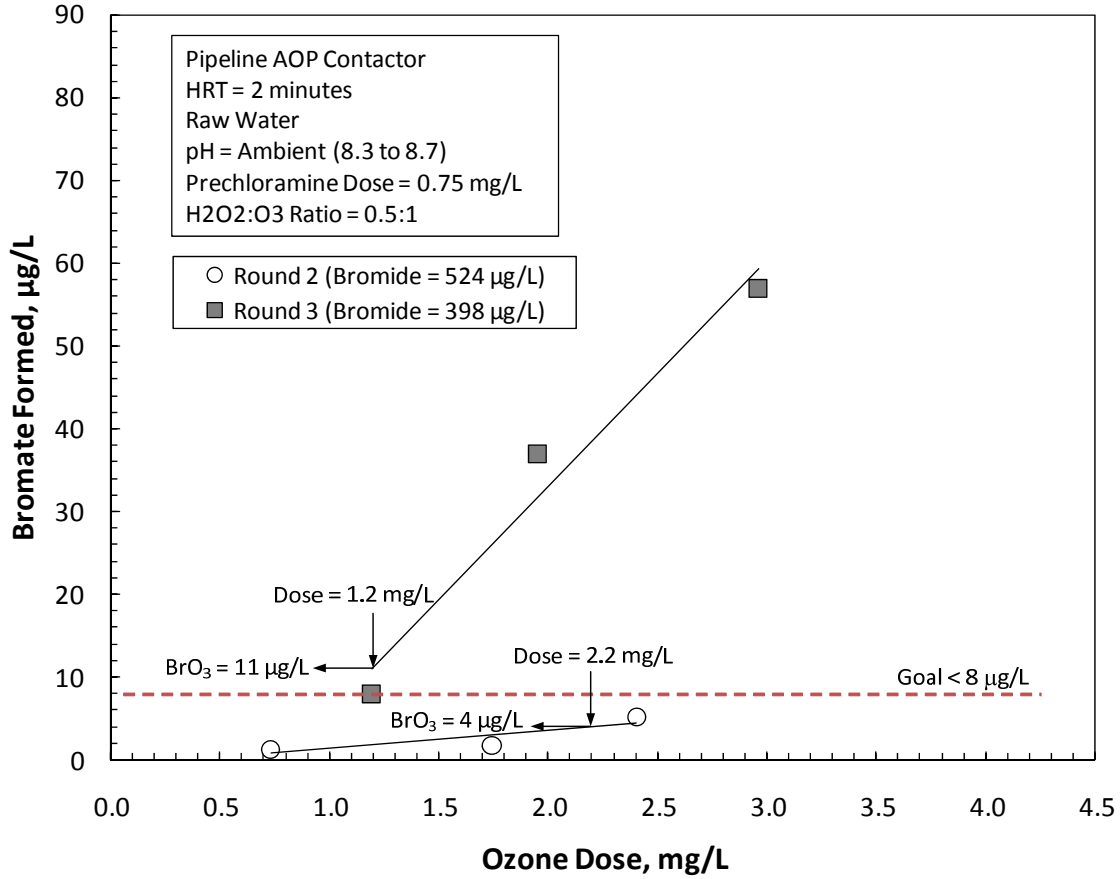

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent Geosmin Destruction
Dose = 1.1 mg/L
Goal > 73%
Dose = 2.0 mg/L
Conventional Contactor
HRT = 10 minutes
Raw Water
pH = Amb (7.9 to 8.3)
Prechloramine Dose = 0.75 mg/L
Round 1 (Geosmin = 33 ng/L)
Round 2 (Geosmin = 28 ng/L)
Round 3 (Geosmin = 46 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

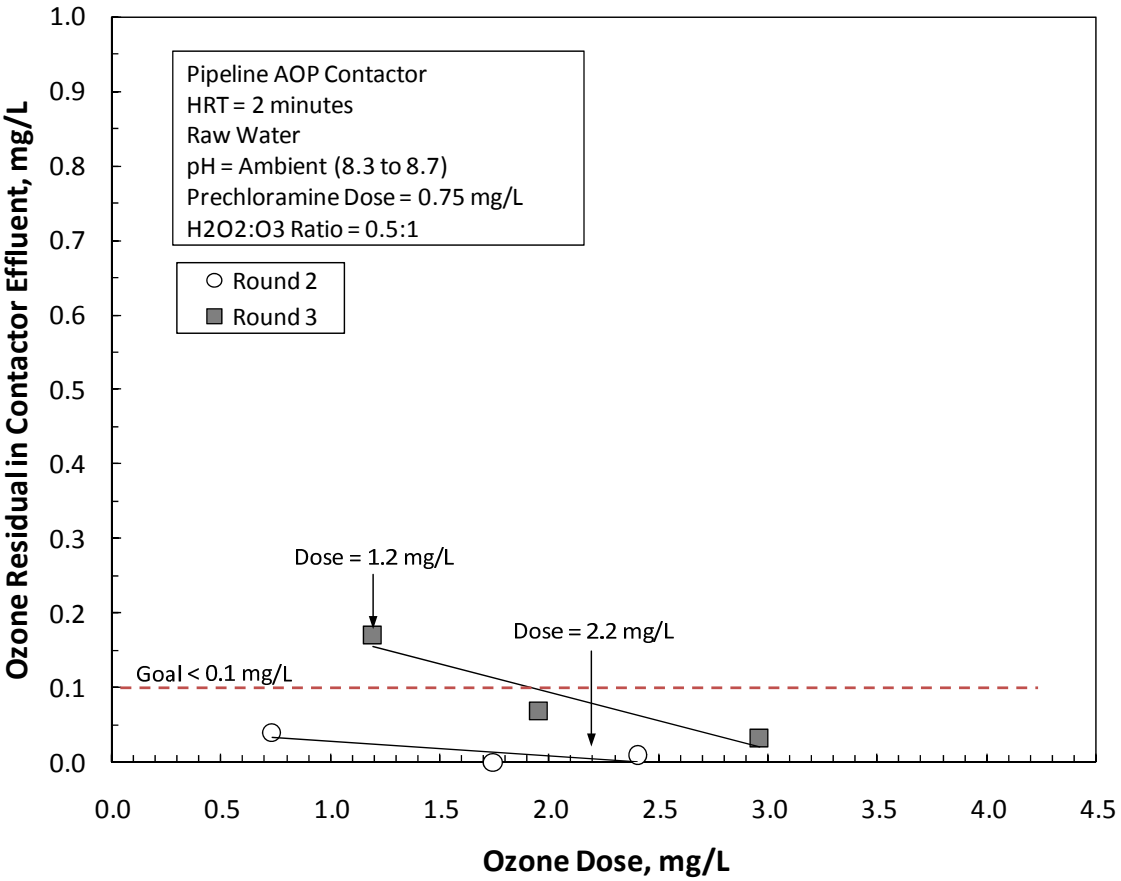

Conventional Contactor
HRT = 10 minutes
Raw Water
pH = Amb (7.9 to 8.3)
Prechloramine Dose = 0.75 mg/L
Round 1 (Bromide = 675 µg/L)
Round 2 (Bromide = 350 µg/L)
Round 3 (Bromide = 400 µg/L)
Dose = 1.3 mg/L
Dose = 2.4 mg/L
BrO3 = 14 µg/L
BrO3 = 14 µg/L
Goal < 8 µg/L
Bromate Formed, µg/L
Ozone Dose, mg/L

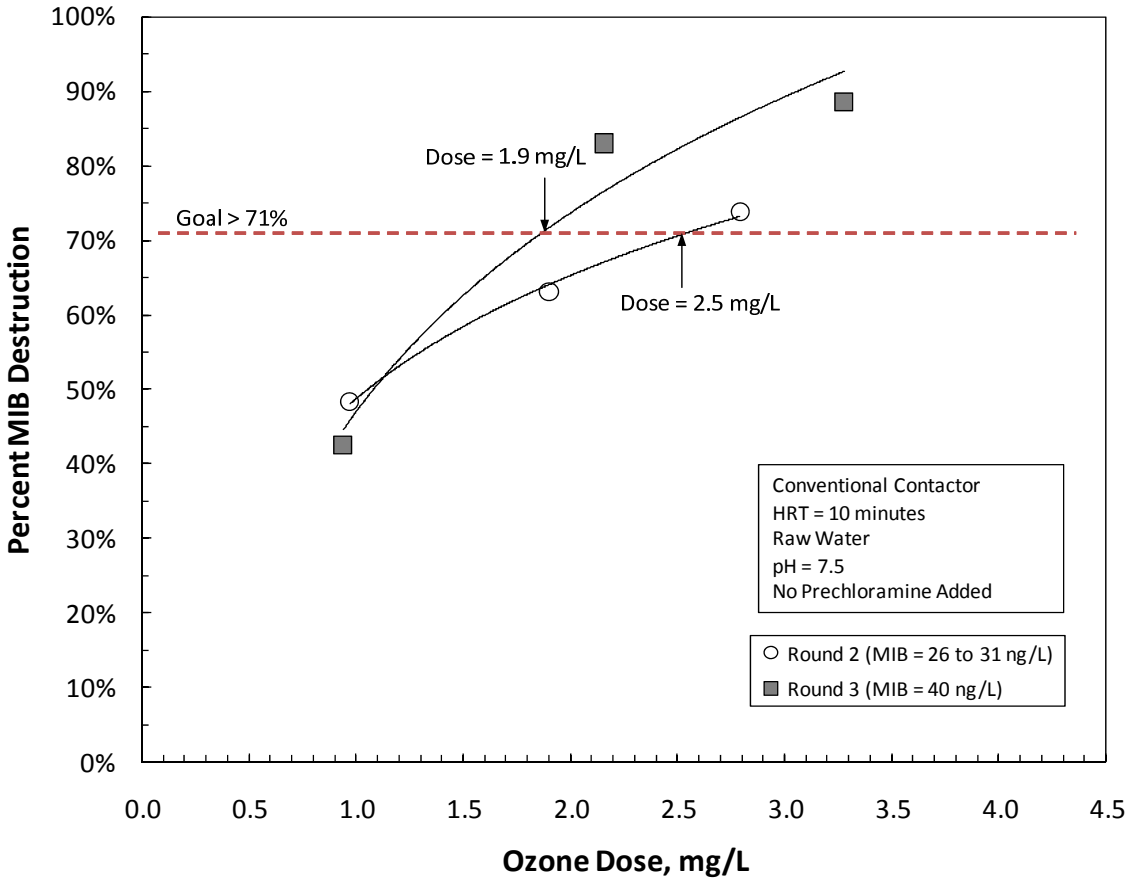

Conventional Contactor
HRT = 10 minutes
Raw Water
pH = Amb (7.9 to 8.3)
Prechloramine Dose = 0.75 mg/L
Round 1
Round 2
Round 3
Dose = 2.4 mg/L
Dose = 1.3 mg/L
Goal < 0.1 mg/L
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L

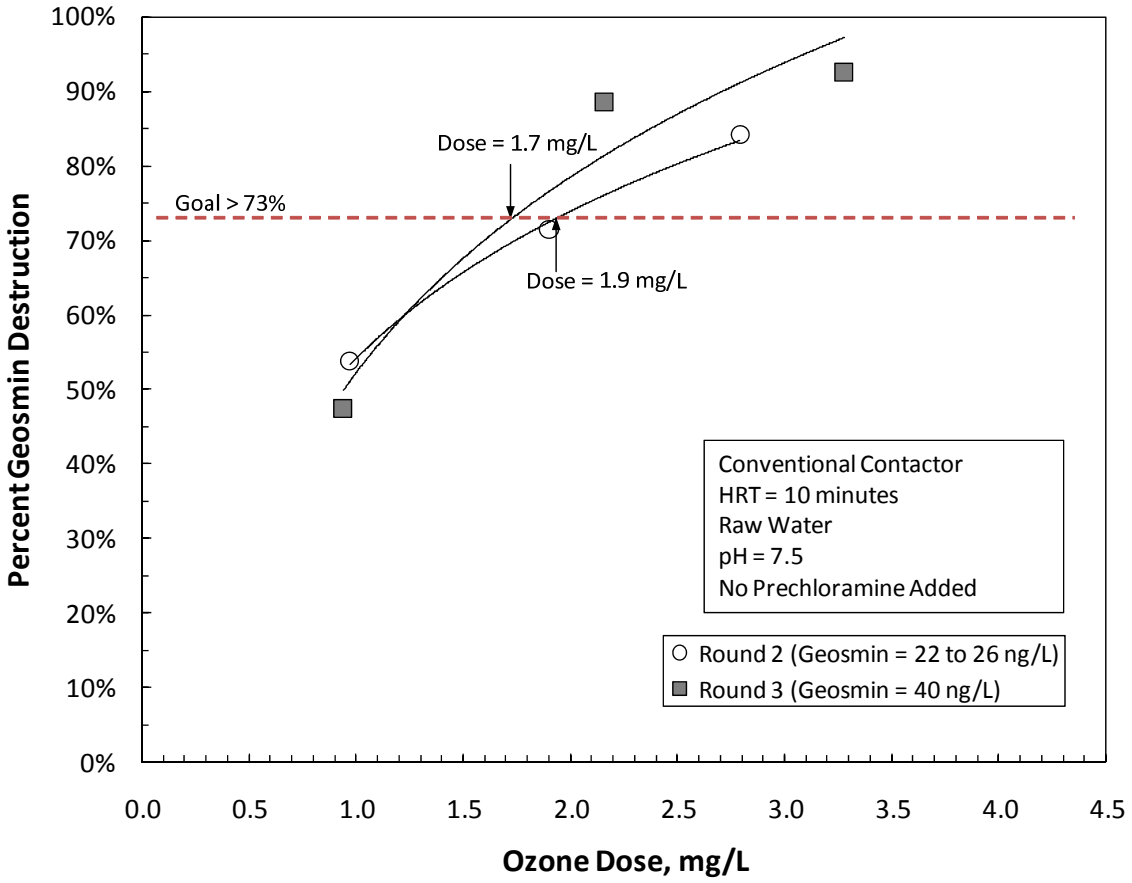

Percent MIB Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Dose = 1.2 mg/L
Dose = 2.2 mg/L
Goal > 71%
Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = Ambient (8.3 to 8.7)
Prechloramine Dose = 0.75 mg/L
H2O2:O3 Ratio = 0.5:1
Round 2 (MIB = 44 ng/L)
Round 3 (MIB = 47 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

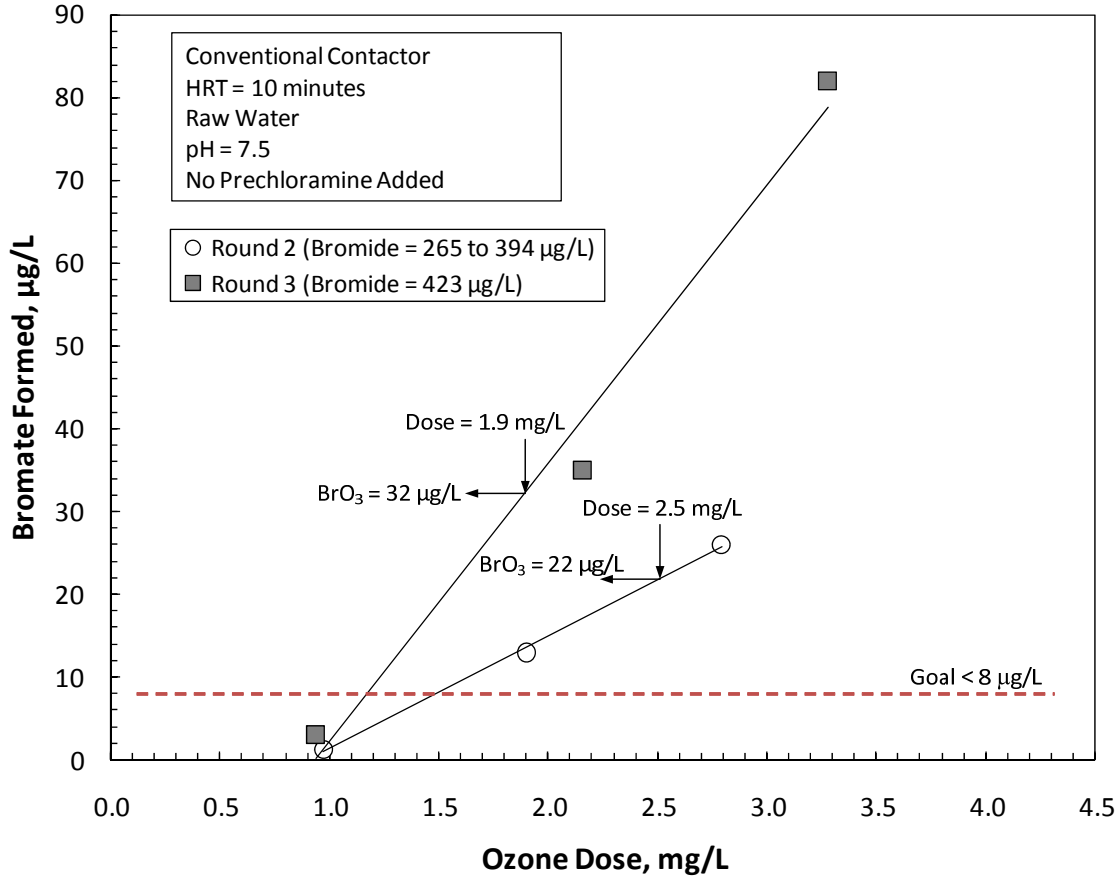

Percent Geosmin Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Dose = 1.0 mg/L
Goal > 71%
Dose = 1.8 mg/L
Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = Ambient (8.3 to 8.7)
Prechloramine Dose = 0.75 mg/L
H2O2:O3 Ratio = 0.5:1
Round 2 (Geosmin = 35 ng/L)
Round 3 (Geosmin = 46 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

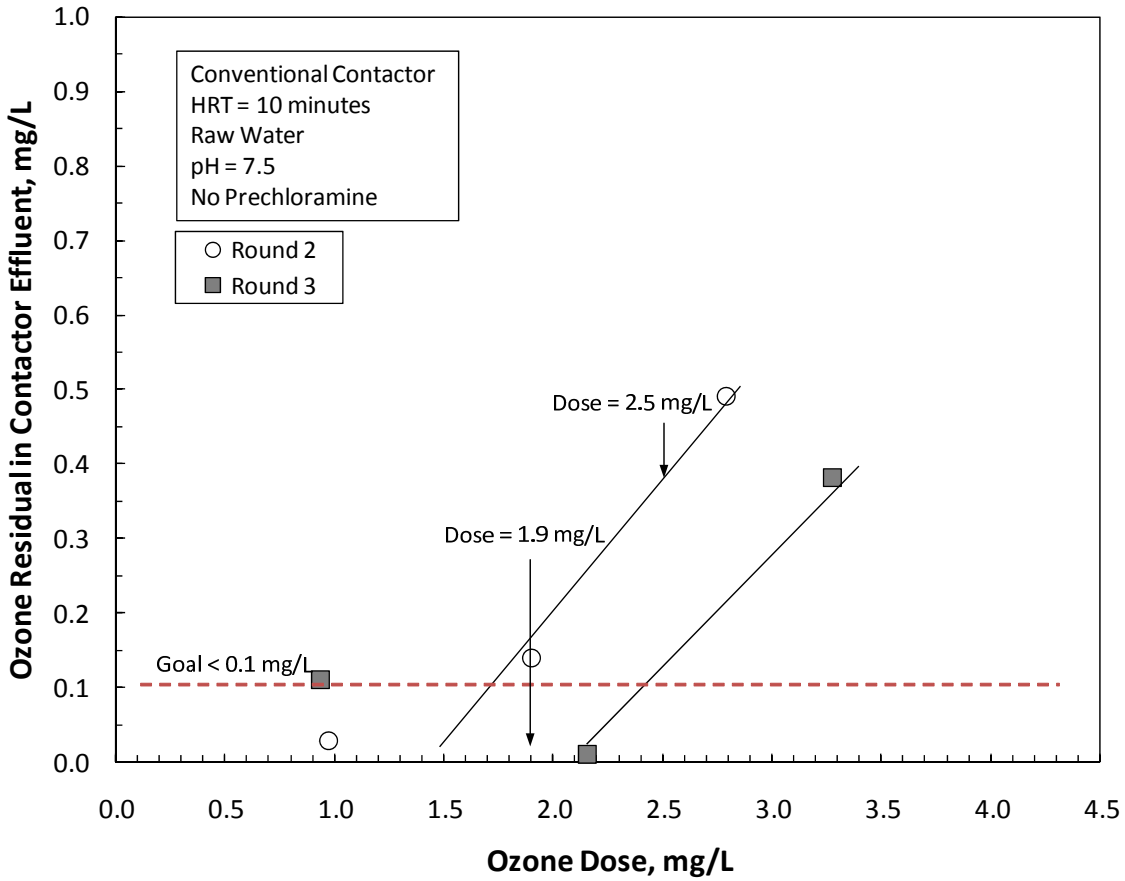

Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = Ambient (8.3 to 8.7)
Prechloramine Dose = 0.75 mg/L
H2O2:O3 Ratio = 0.5:1
Round 2 (Bromide = 524 µg/L)
Round 3 (Bromide = 398 µg/L)
Bromate Formed, µg/L
Ozone Dose, mg/L
Dose = 1.2 mg/L
Dose = 2.2 mg/L
BrO3 = 11 µg/L
BrO3 = 4 µg/L
Goal < 8 µg/L
0
10
20
30
40
50
60
70
80
90
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

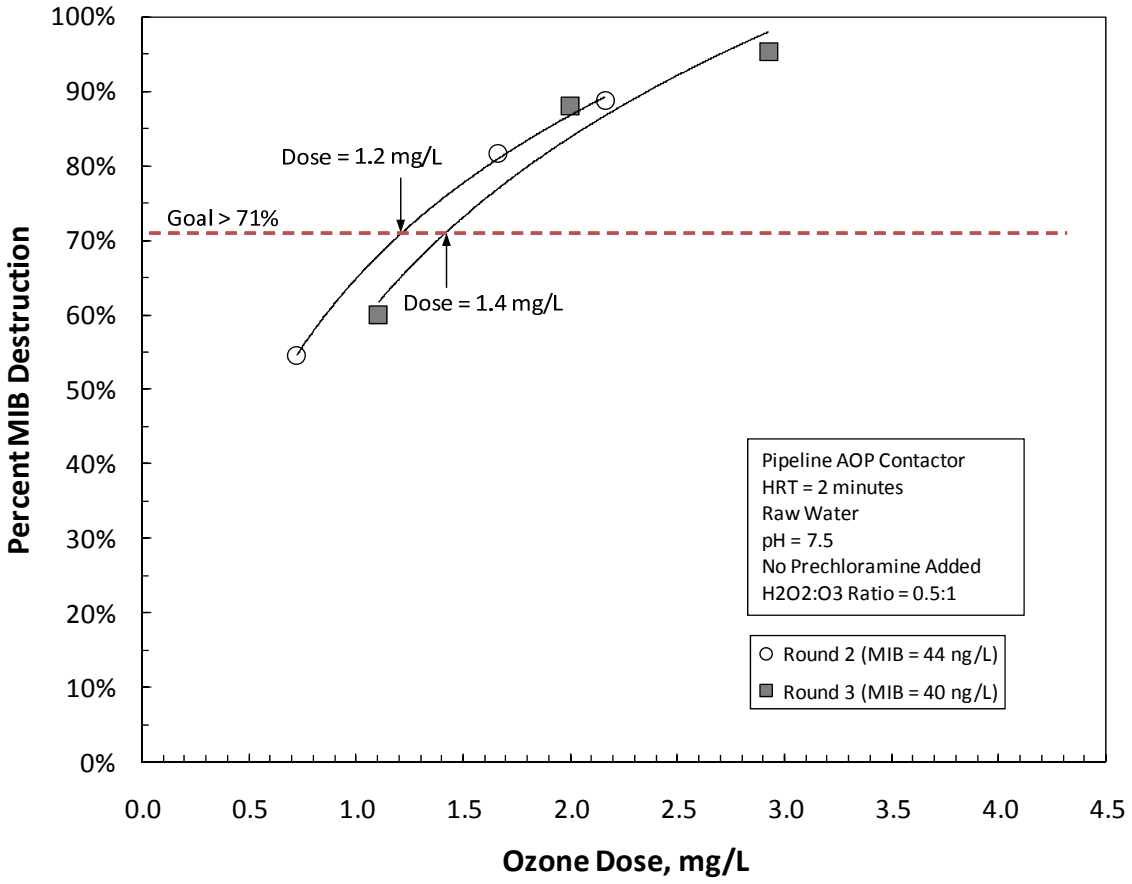

Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = Ambient (8.3 to 8.7)
Prechloramine Dose = 0.75 mg/L
H2O2:O3 Ratio = 0.5:1
Round 2
Round 3
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L
Dose = 1.2 mg/L
Dose = 2.2 mg/L
Goal < 0.1 mg/L
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

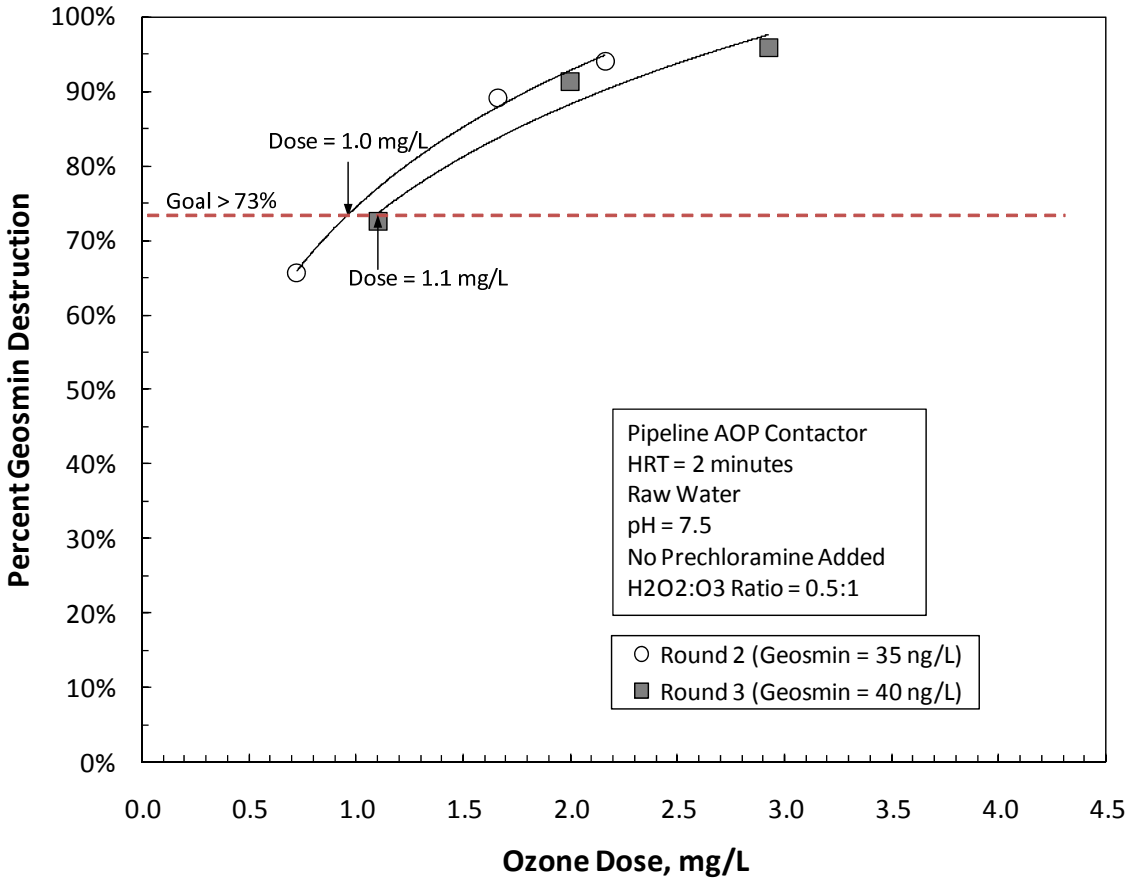

Percent MIB Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Goal > 71%
Dose = 1.9 mg/L
Dose = 2.5 mg/L
Conventional Contactor
HRT = 10 minutes
Raw Water
pH = 7.5
No Prechloramine Added
Round 2 (MIB = 26 to 31 ng/L)
Round 3 (MIB = 40 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

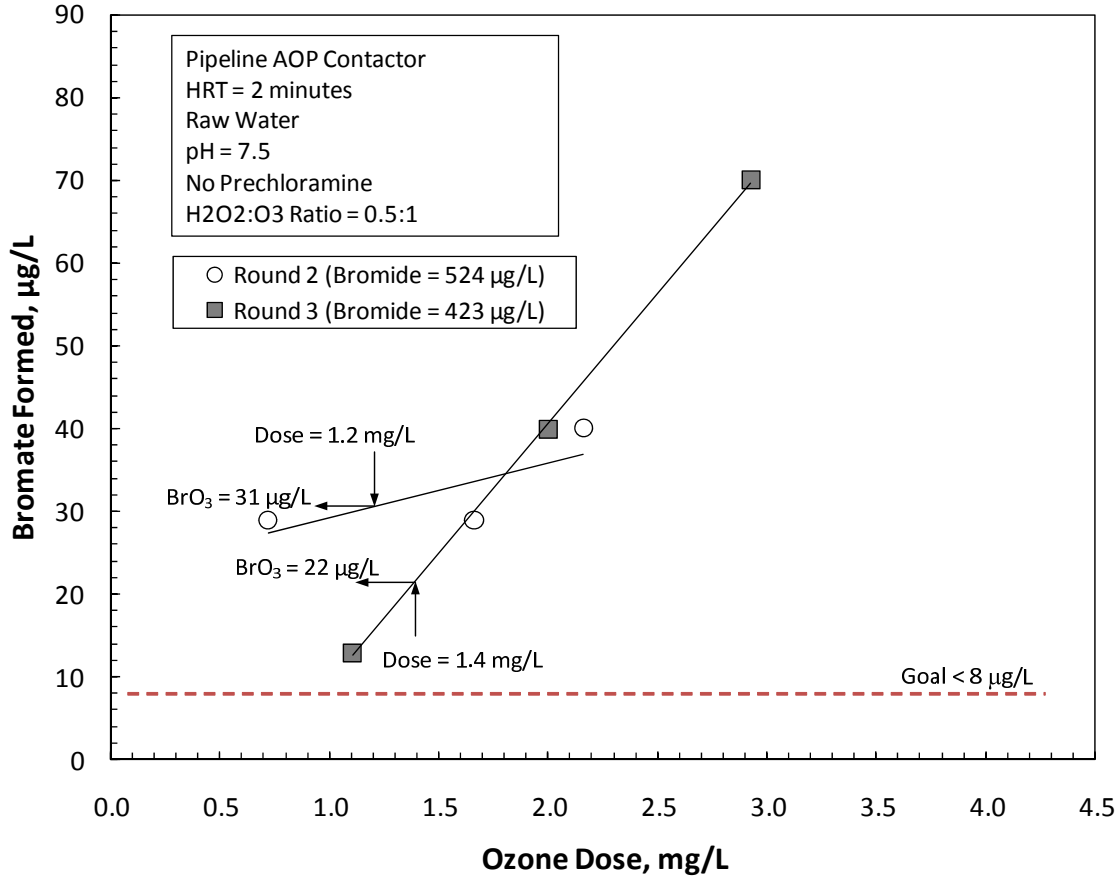

Percent Geosmin Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Goal > 73%
Dose = 1.7 mg/L
Dose = 1.9 mg/L
Conventional Contactor
HRT = 10 minutes
Raw Water
pH = 7.5
No Prechloramine Added
Round 2 (Geosmin = 22 to 26 ng/L)
Round 3 (Geosmin = 40 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

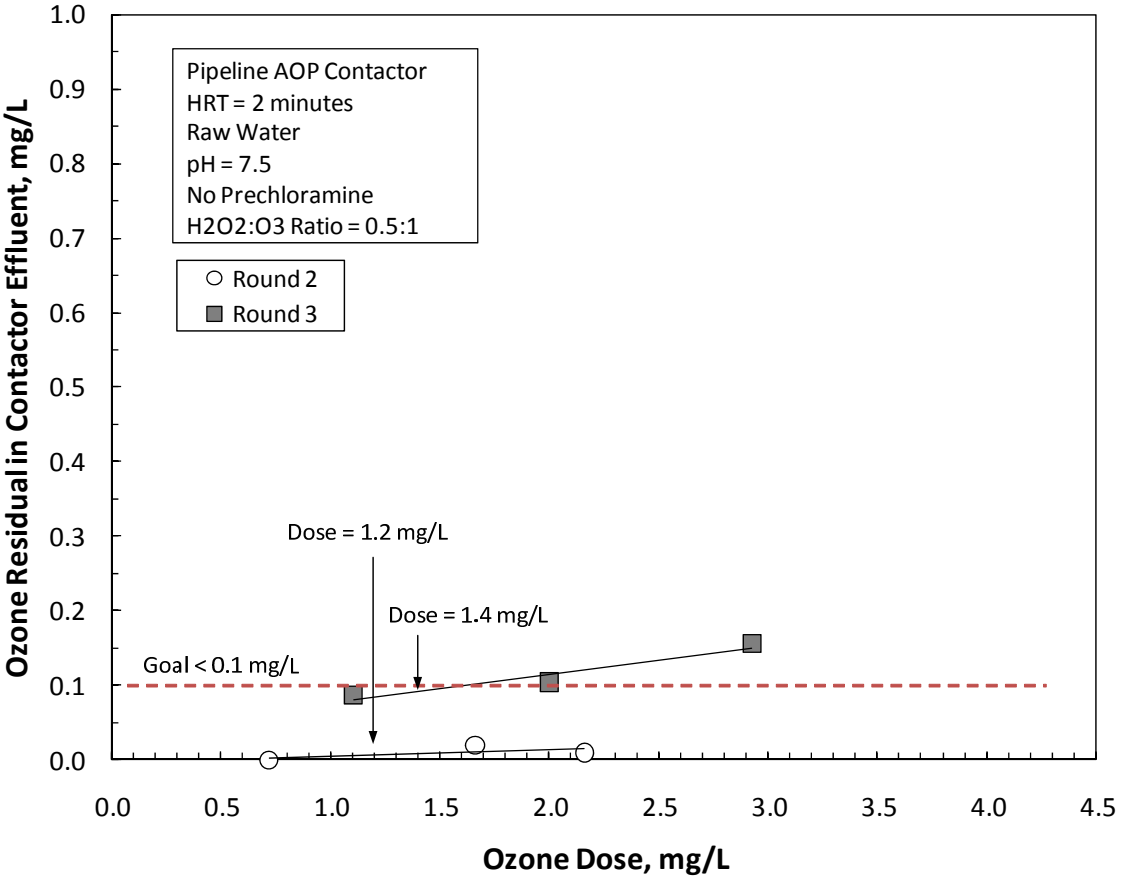

Conventional Contactor
HRT = 10 minutes
Raw Water
pH = 7.5
No Prechloramine Added
Round 2 (Bromide = 265 to 394 µg/L)
Round 3 (Bromide = 423 µg/L)
Dose = 1.9 mg/L
BrO3 = 32 µg/L
Dose = 2.5 mg/L
BrO3 = 22 µg/L
Goal < 8 µg/L
Bromate Formed, µg/L
Ozone Dose, mg/L
0
10
20
30
40
50
60
70
80
90
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

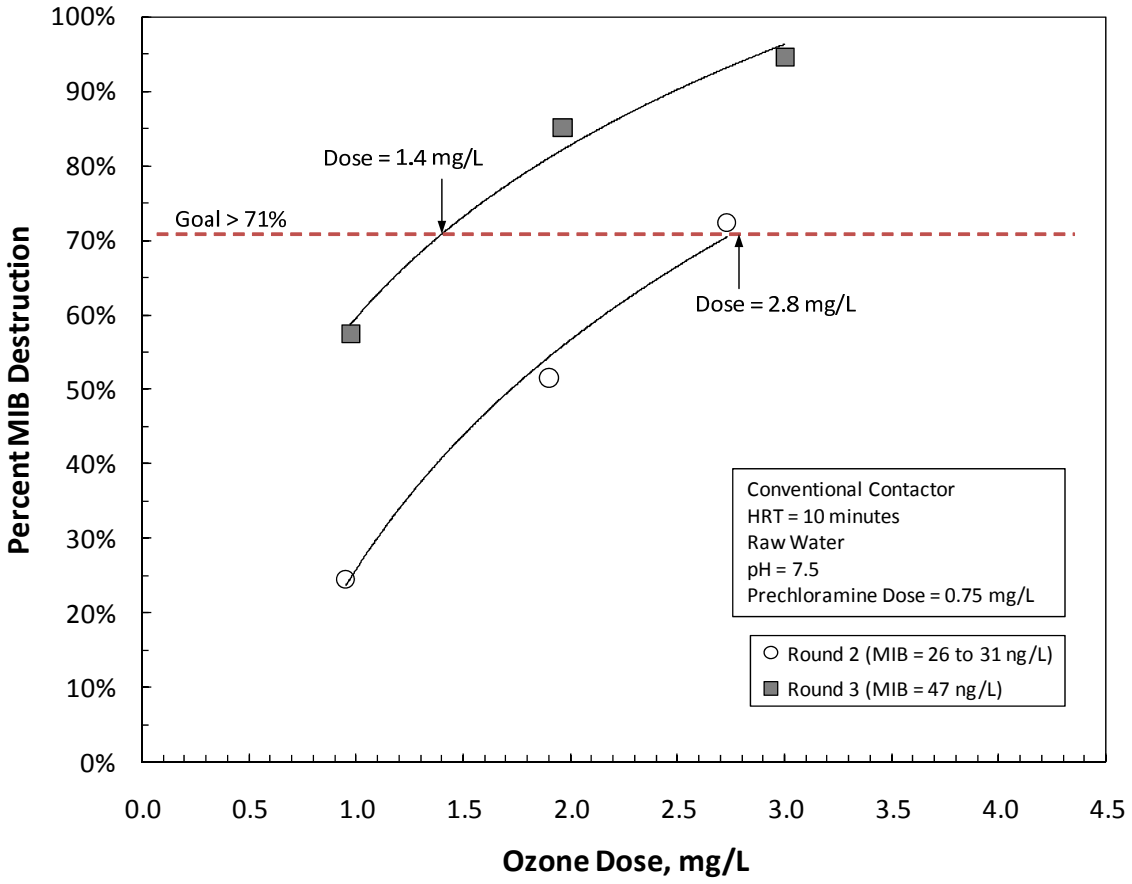

Conventional Contactor
HRT = 10 minutes
Raw Water
pH = 7.5
No Prechloramine
Round 2
Round 3
Dose = 2.5 mg/L
Dose = 1.9 mg/L
Goal < 0.1 mg/L
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

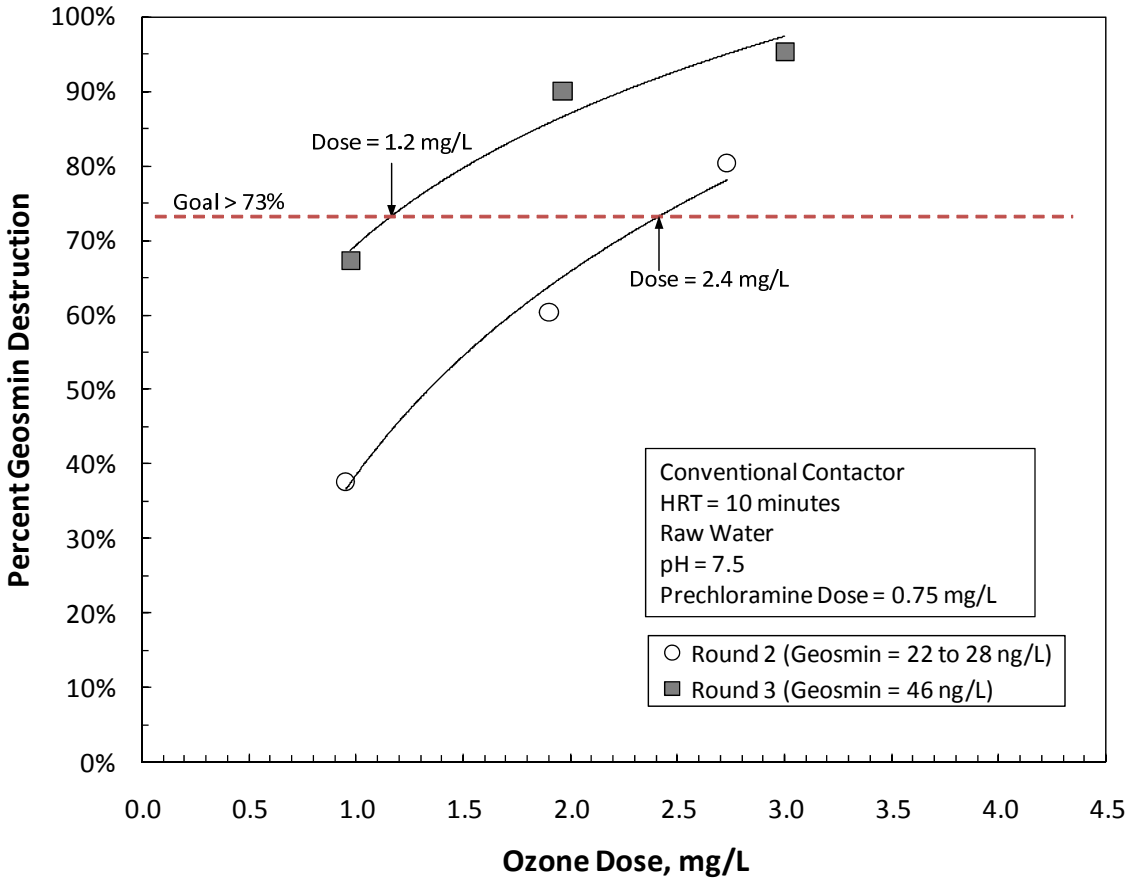

Percent MIB Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L
Dose = 1.2 mg/L
Goal > 71%
Dose = 1.4 mg/L
Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = 7.5
No Prechloramine Added
H2O2:O3 Ratio = 0.5:1
Round 2 (MIB = 44 ng/L)
Round 3 (MIB = 40 ng/L)

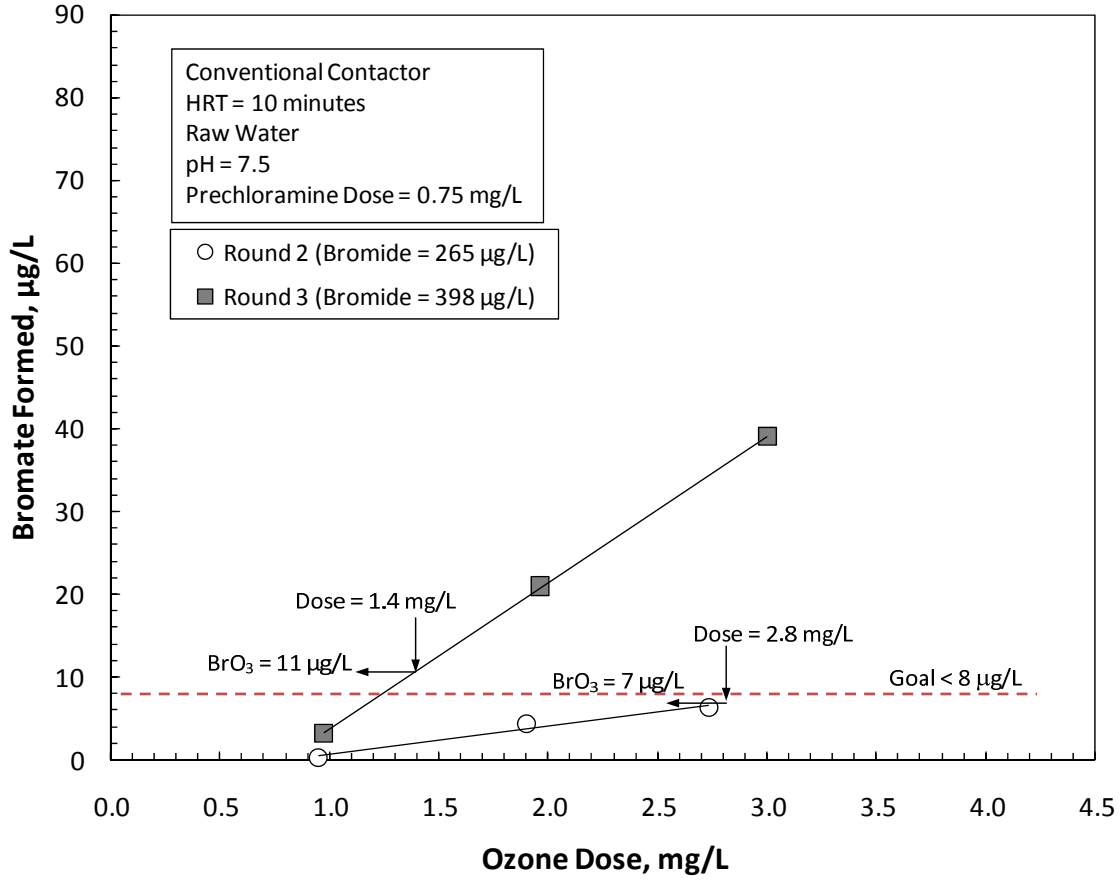

Percent Geosmin Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L
Dose = 1.0 mg/L
Goal > 73%
Dose = 1.1 mg/L
Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = 7.5
No Prechloramine Added
H2O2:O3 Ratio = 0.5:1
Round 2 (Geosmin = 35 ng/L)
Round 3 (Geosmin = 40 ng/L)

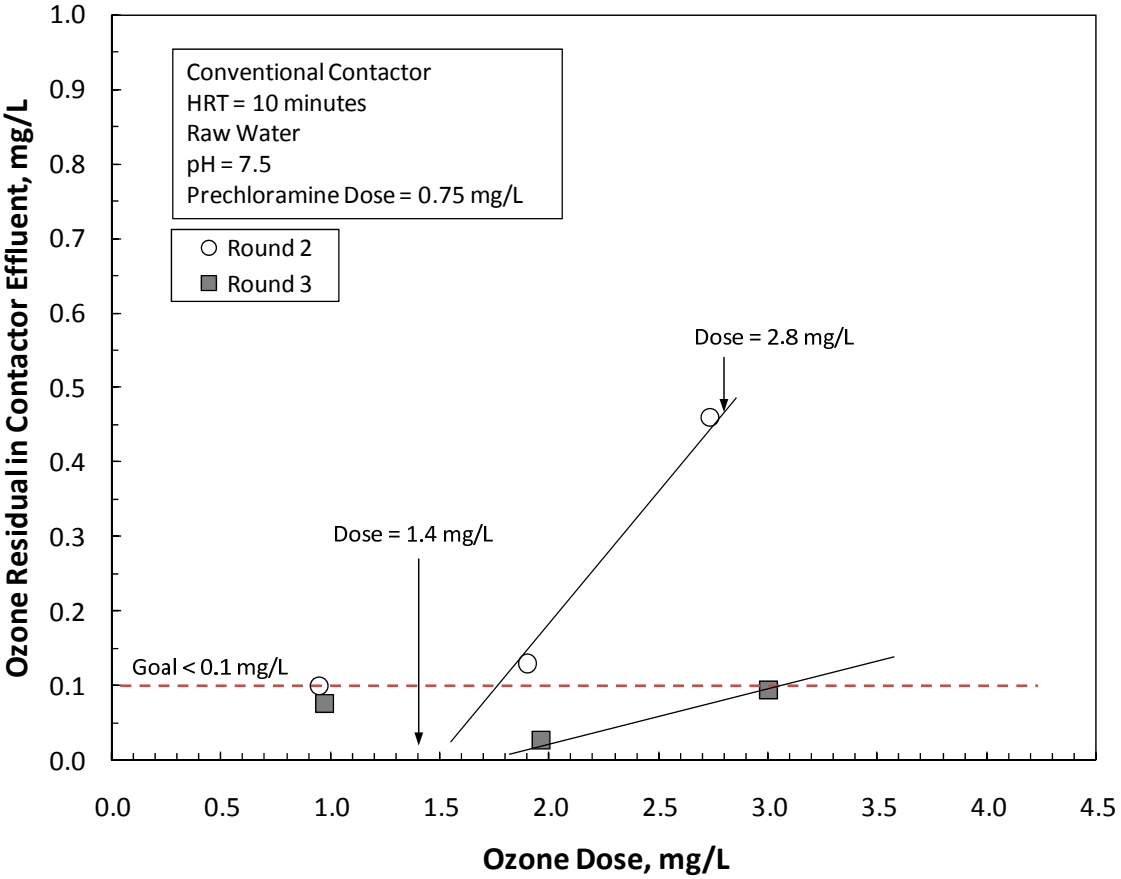

Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = 7.5
No Prechloramine
H2O2:O3 Ratio = 0.5:1
Round 2 (Bromide = 524 µg/L)
Round 3 (Bromide = 423 µg/L)
Dose = 1.2 mg/L
BrO3 = 31 µg/L
BrO3 = 22 µg/L
Dose = 1.4 mg/L
Goal < 8 µg/L
Bromate Formed, µg/L
Ozone Dose, mg/L

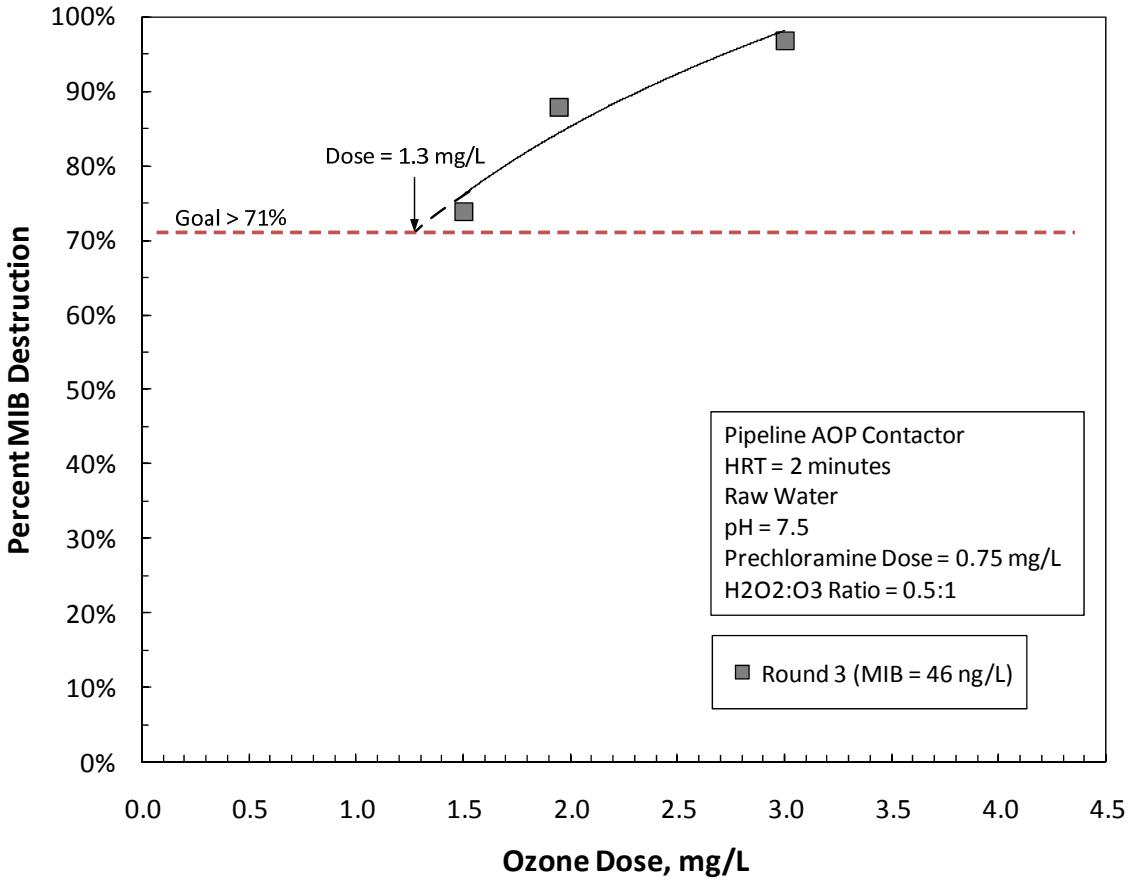

Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = 7.5
No Prechloramine
H2O2:O3 Ratio = 0.5:1
Round 2
Round 3
Dose = 1.2 mg/L
Dose = 1.4 mg/L
Goal < 0.1 mg/L
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L

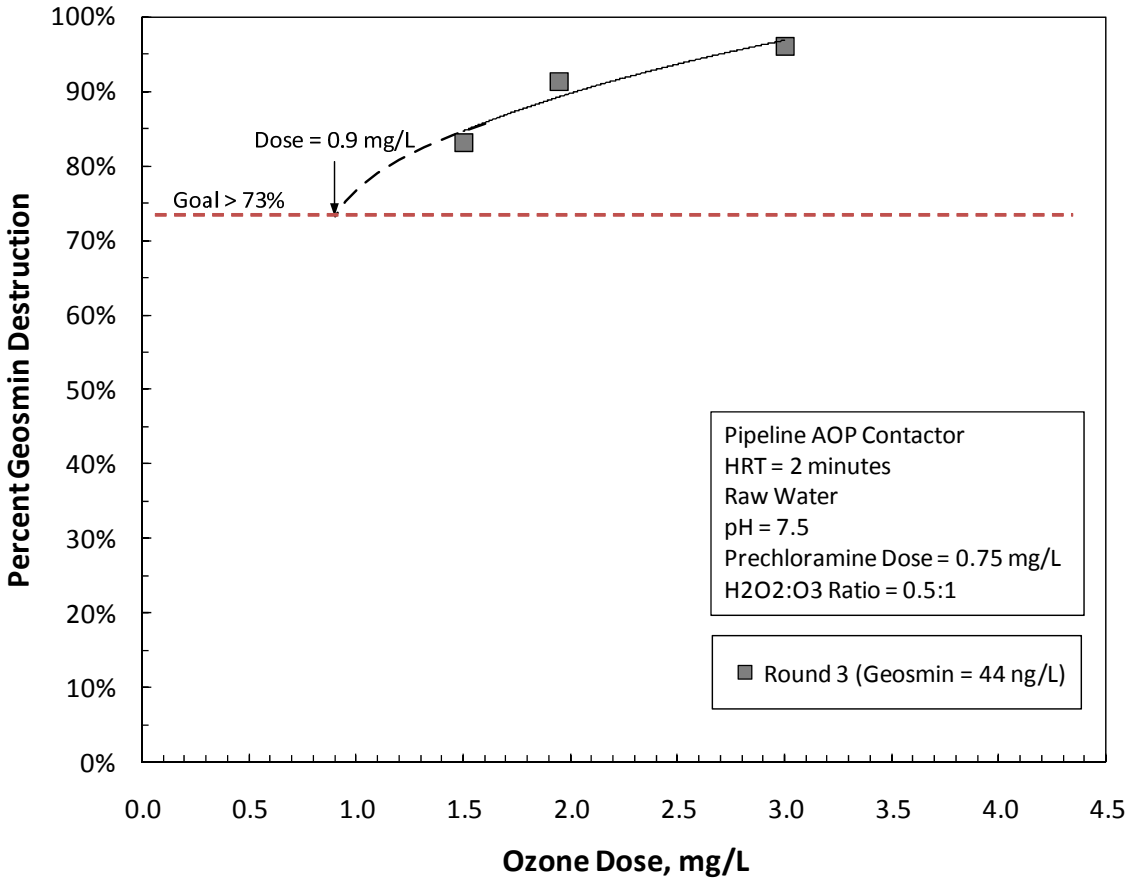

Percent MIB Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L
Dose = 1.4 mg/L
Goal > 71%
Dose = 2.8 mg/L
Conventional Contactor
HRT = 10 minutes
Raw Water
pH = 7.5
Prechloramine Dose = 0.75 mg/L
Round 2 (MIB = 26 to 31 ng/L)
Round 3 (MIB = 47 ng/L)

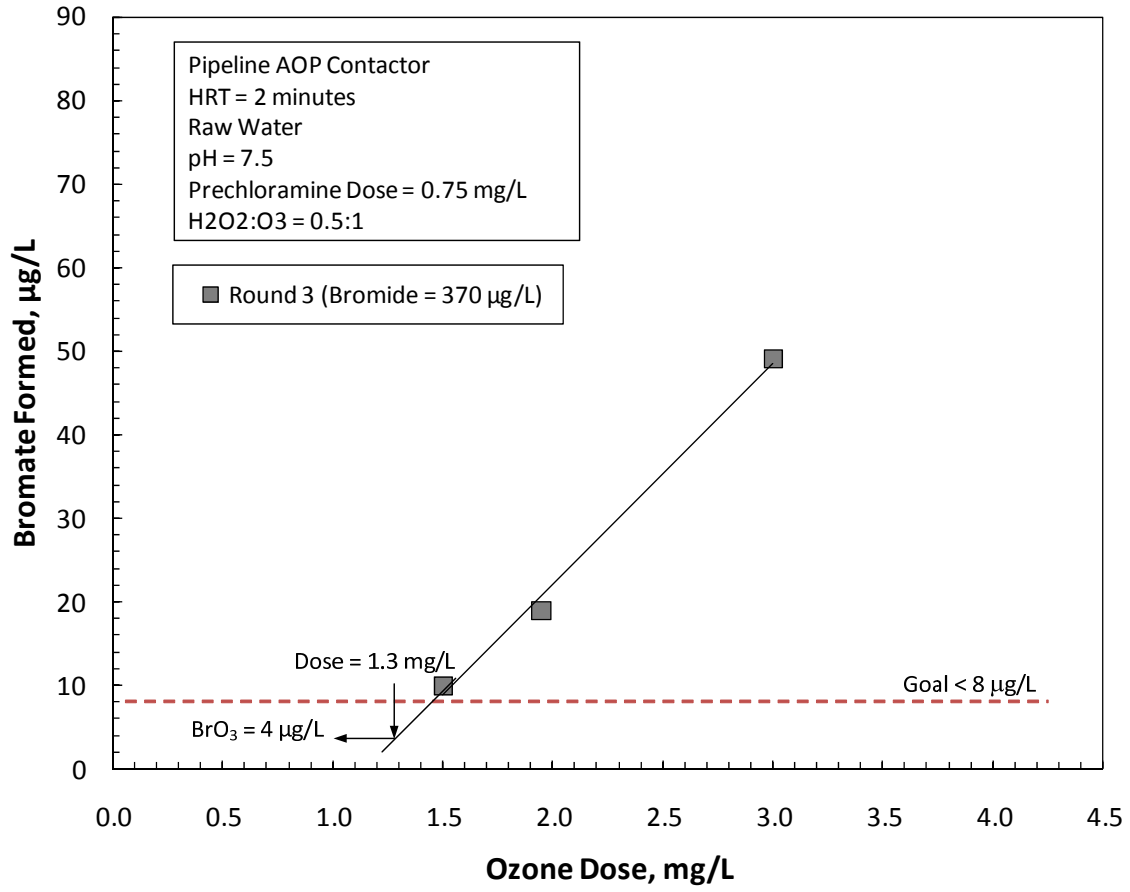

Percent Geosmin Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L
Dose = 1.2 mg/L
Goal > 73%
Dose = 2.4 mg/L
Conventional Contactor
HRT = 10 minutes
Raw Water
pH = 7.5
Prechloramine Dose = 0.75 mg/L
Round 2 (Geosmin = 22 to 28 ng/L)
Round 3 (Geosmin = 46 ng/L)

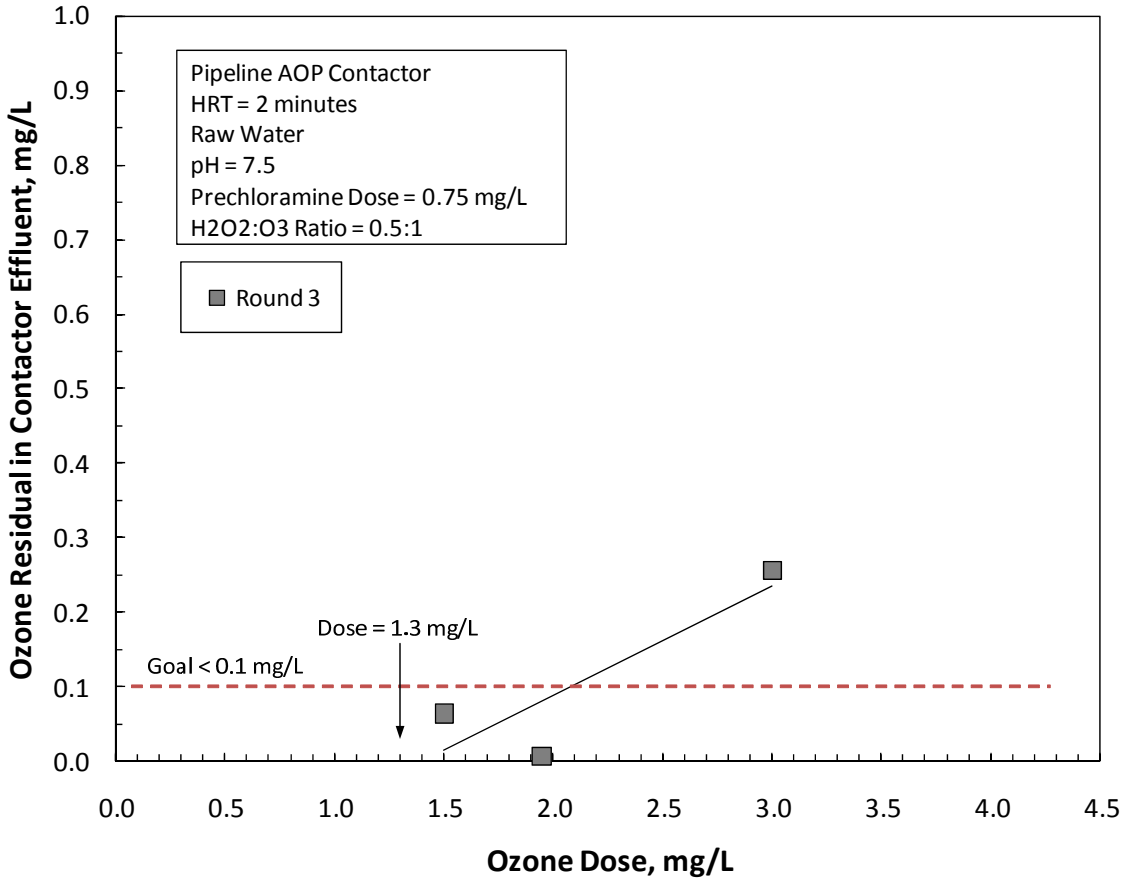

Conventional Contactor
HRT = 10 minutes
Raw Water
pH = 7.5
Prechloramine Dose = 0.75 mg/L
Round 2 (Bromide = 265 µg/L)
Round 3 (Bromide = 398 µg/L)
Bromate Formed, µg/L
Ozone Dose, mg/L
Dose = 1.4 mg/L
Dose = 2.8 mg/L
BrO3 = 11 µg/L
BrO3 = 7 µg/L
Goal < 8 µg/L
0
10
20
30
40
50
60
70
80
90
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

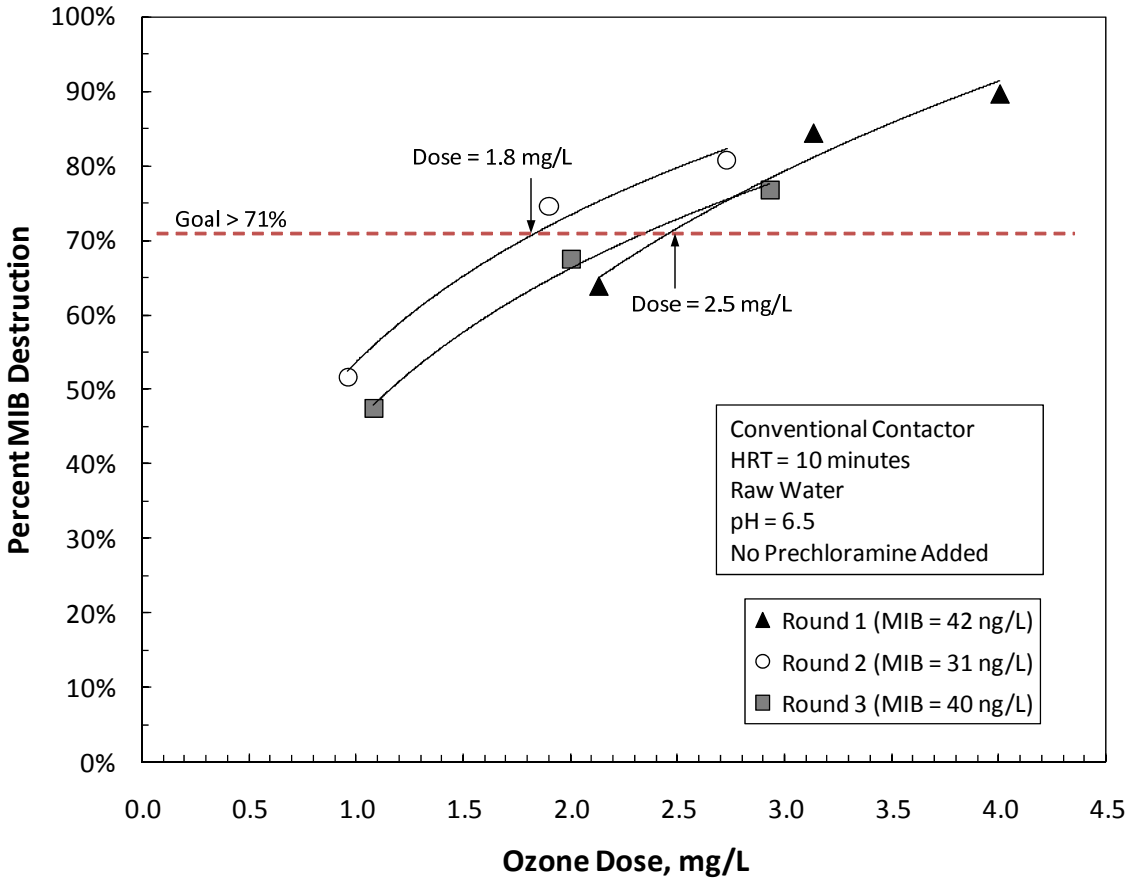

Conventional Contactor
HRT = 10 minutes
Raw Water
pH = 7.5
Prechloramine Dose = 0.75 mg/L
Round 2
Round 3
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L
Dose = 2.8 mg/L
Dose = 1.4 mg/L
Goal < 0.1 mg/L
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

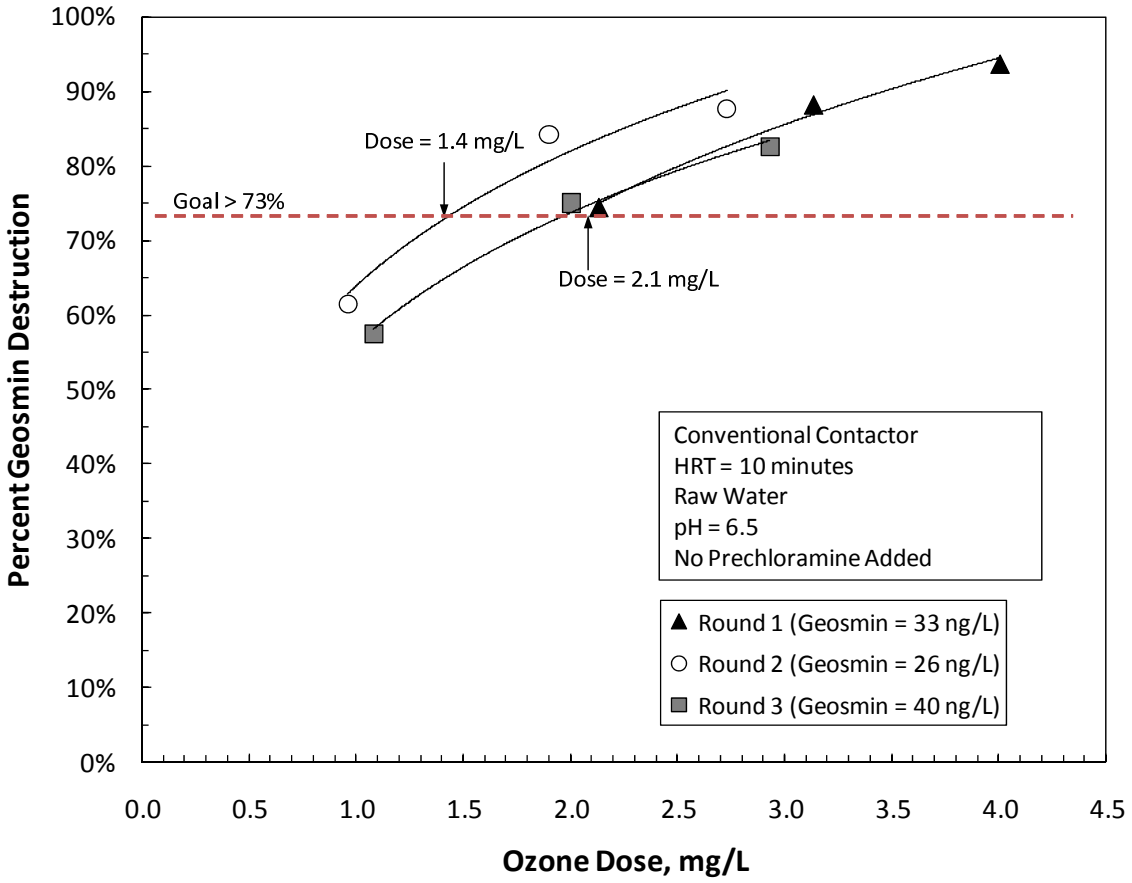

Percent MIB Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Dose = 1.3 mg/L
Goal > 71%
Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = 7.5
Prechloramine Dose = 0.75 mg/L
H2O2:O3 Ratio = 0.5:1
Round 3 (MIB = 46 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

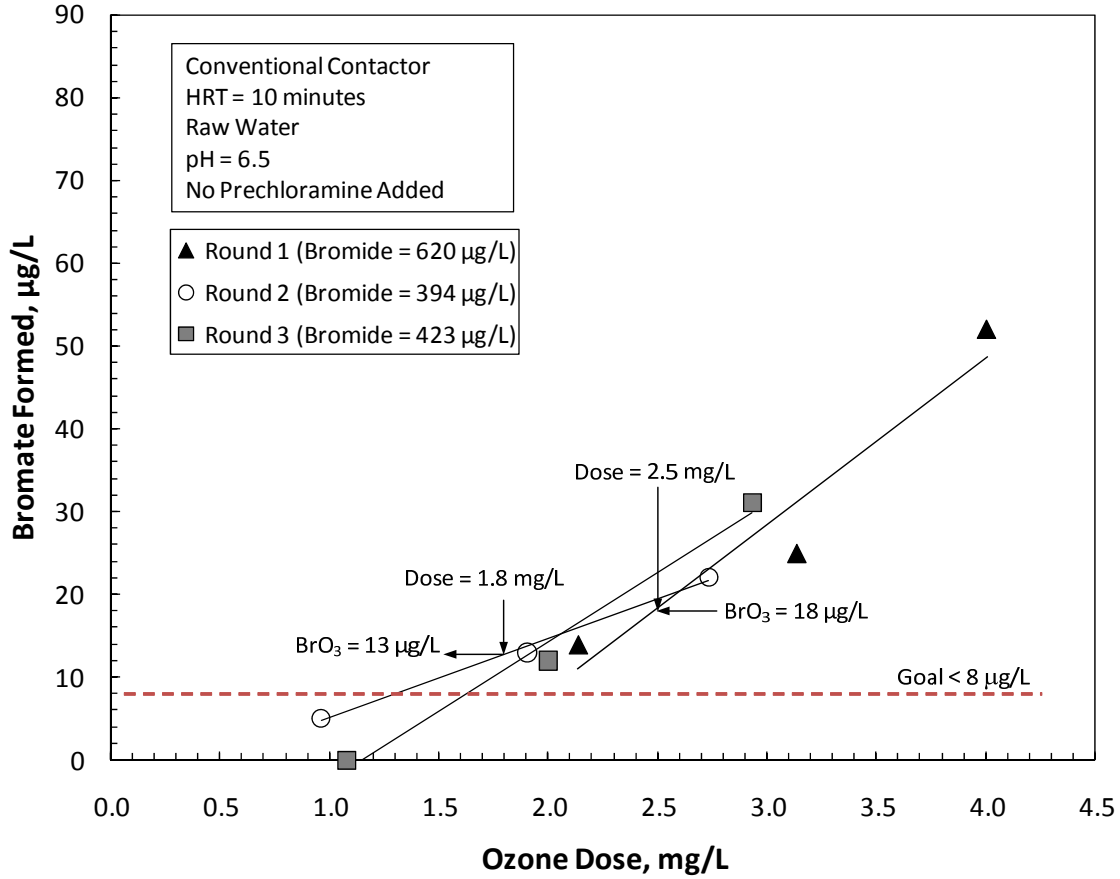

Percent Geosmin Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Dose = 0.9 mg/L
Goal > 73%
Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = 7.5
Prechloramine Dose = 0.75 mg/L
H2O2:O3 Ratio = 0.5:1
Round 3 (Geosmin = 44 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

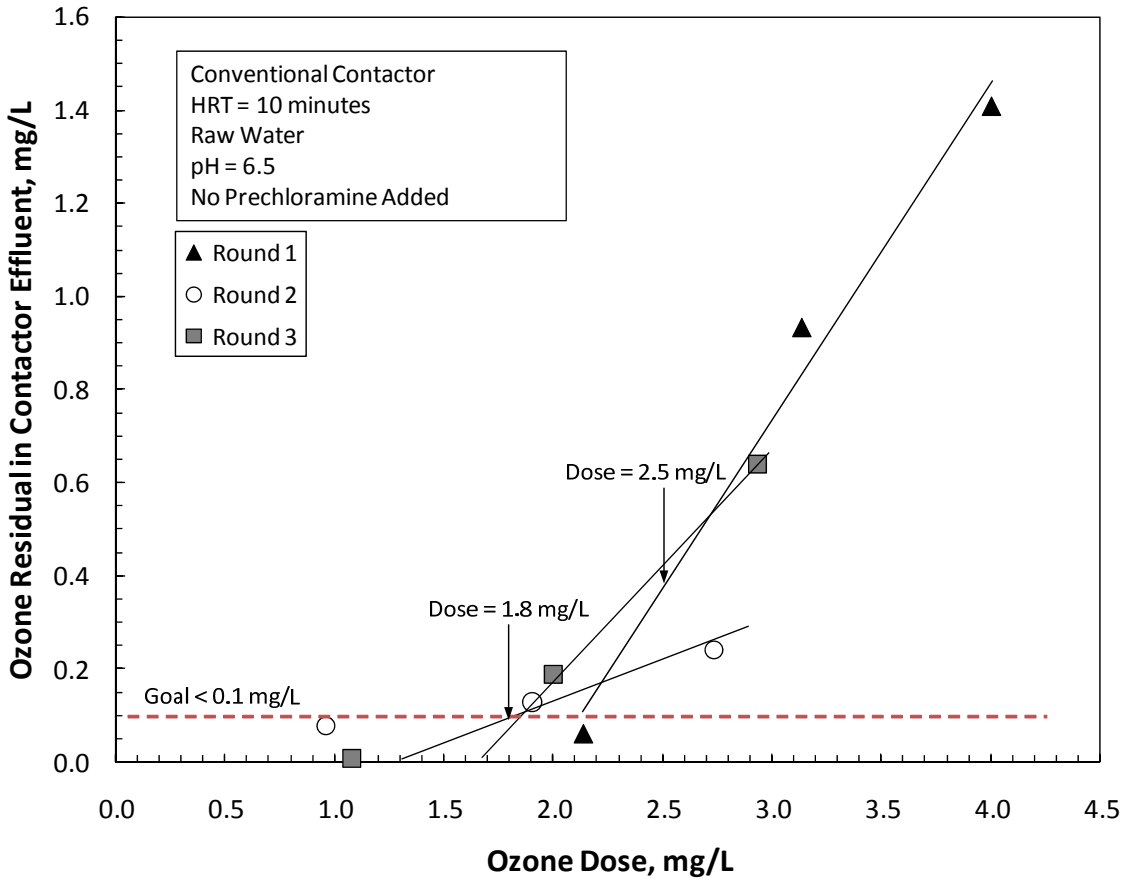

Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = 7.5
Prechloramine Dose = 0.75 mg/L
H2O2:O3 = 0.5:1
Round 3 (Bromide = 370 µg/L)
Dose = 1.3 mg/L
Goal < 8 µg/L
BrO3 = 4 µg/L
Bromate Formed, µg/L
Ozone Dose, mg/L
0
10
20
30
40
50
60
70
80
90
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

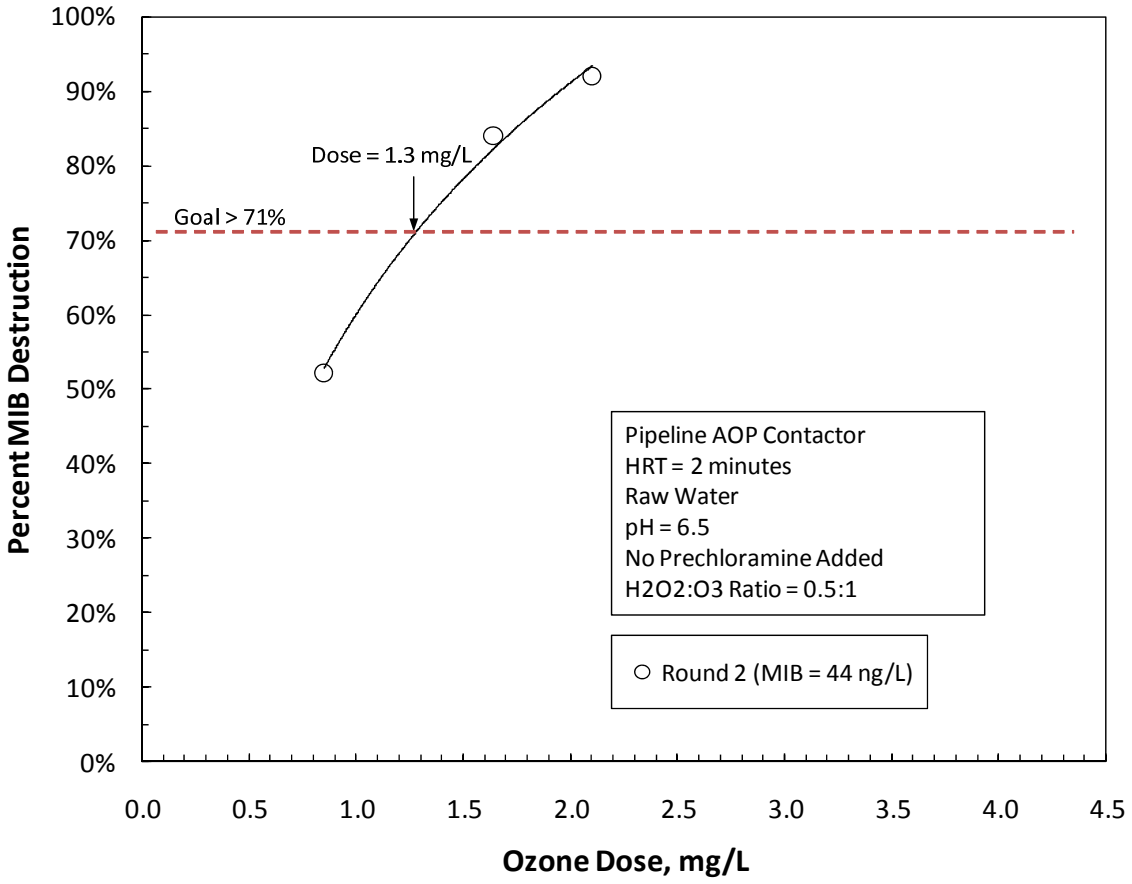

Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = 7.5
Prechloramine Dose = 0.75 mg/L
H2O2:O3 Ratio = 0.5:1
Round 3
Dose = 1.3 mg/L
Goal < 0.1 mg/L
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

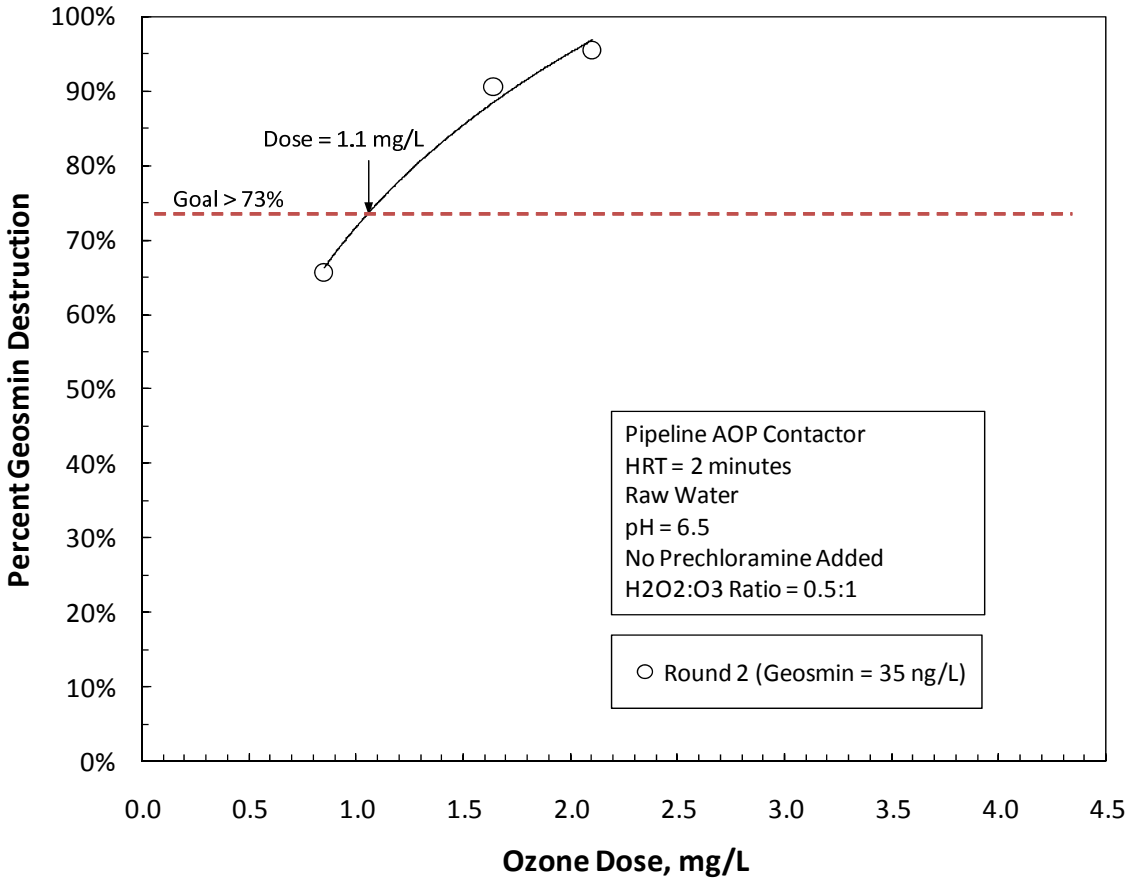

Percent MIB Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Goal > 71%
Dose = 1.8 mg/L
Dose = 2.5 mg/L
Conventional Contactor
HRT = 10 minutes
Raw Water
pH = 6.5
No Prechloramine Added
Round 1 (MIB = 42 ng/L)
Round 2 (MIB = 31 ng/L)
Round 3 (MIB = 40 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

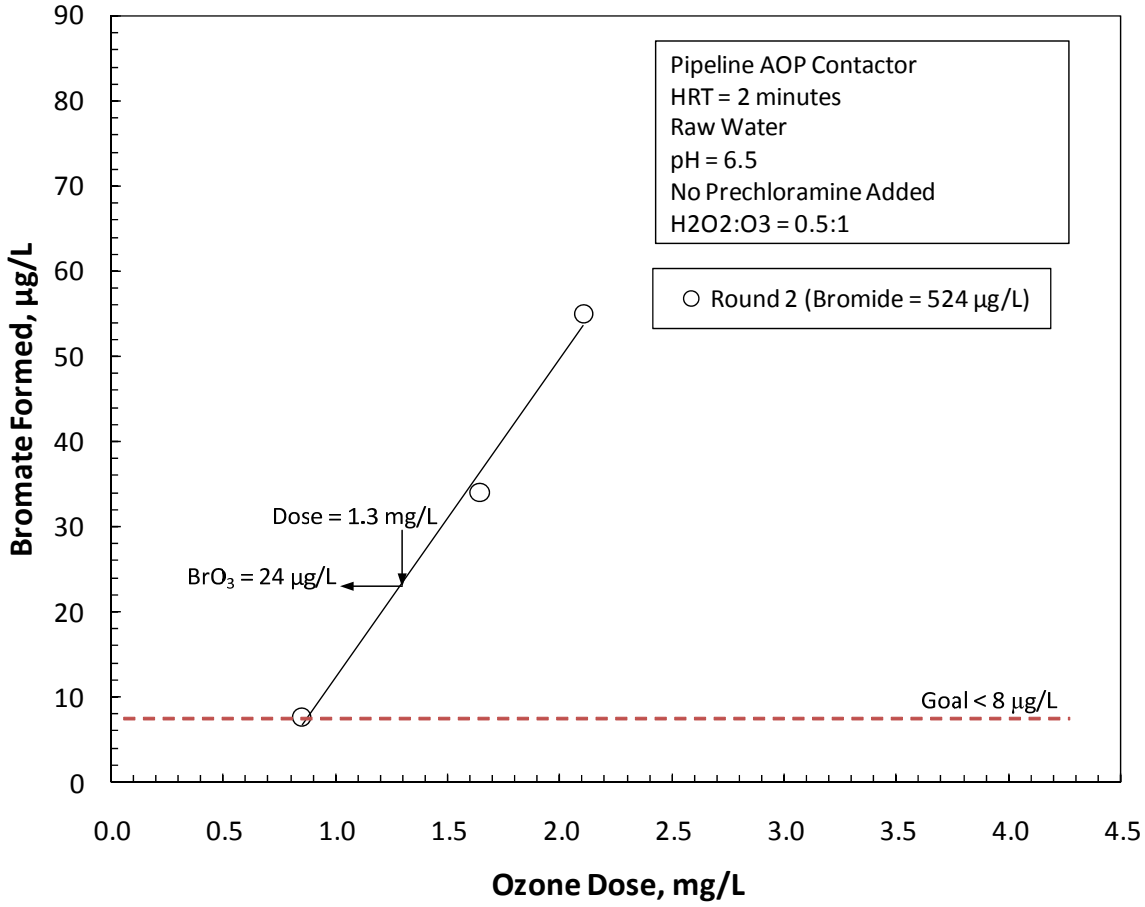

Percent Geosmin Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Goal > 73%
Dose = 1.4 mg/L
Dose = 2.1 mg/L
Conventional Contactor
HRT = 10 minutes
Raw Water
pH = 6.5
No Prechloramine Added
Round 1 (Geosmin = 33 ng/L)
Round 2 (Geosmin = 26 ng/L)
Round 3 (Geosmin = 40 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

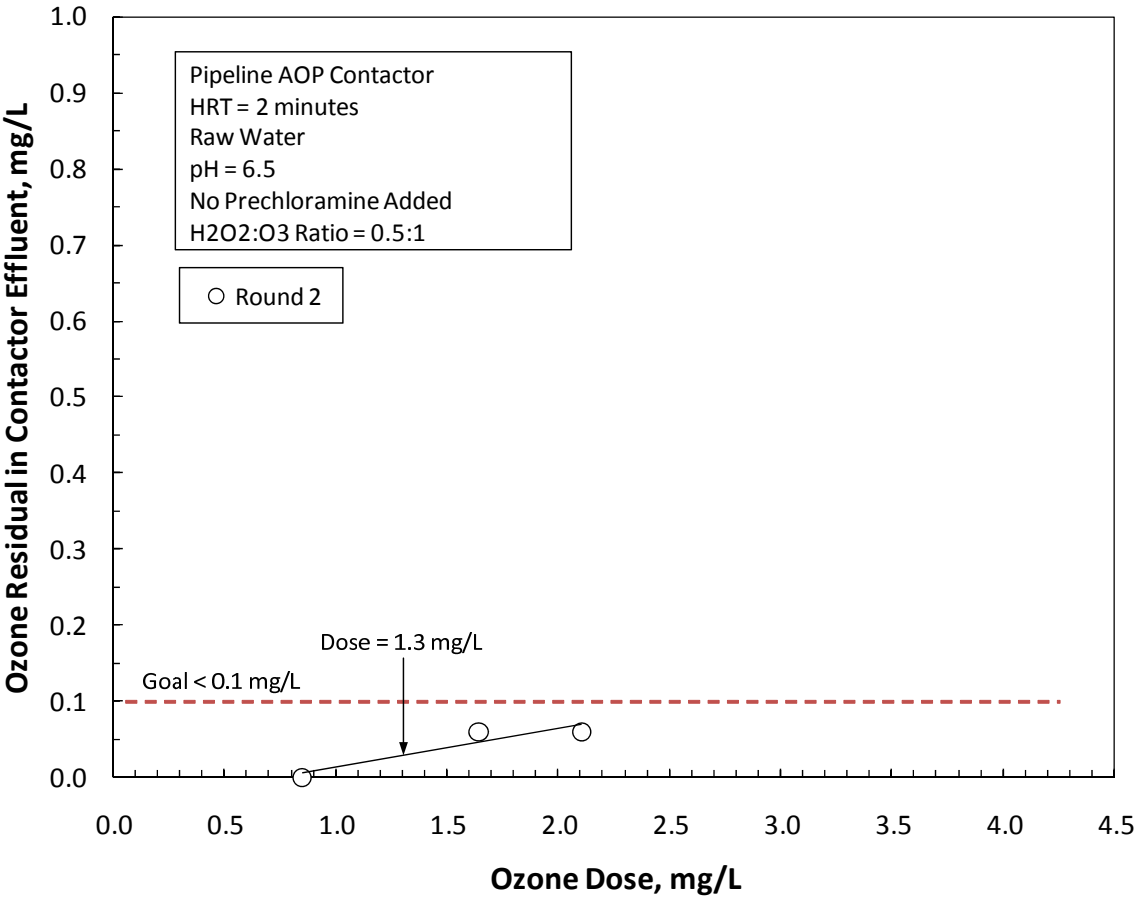

Conventional Contactor
HRT = 10 minutes
Raw Water
pH = 6.5
No Prechloramine Added
Round 1 (Bromide = 620 µg/L)
Round 2 (Bromide = 394 µg/L)
Round 3 (Bromide = 423 µg/L)
Dose = 2.5 mg/L
Dose = 1.8 mg/L
BrO3 = 18 µg/L
BrO3 = 13 µg/L
Goal < 8 µg/L
Bromate Formed, µg/L
Ozone Dose, mg/L
0
10
20
30
40
50
60
70
80
90
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

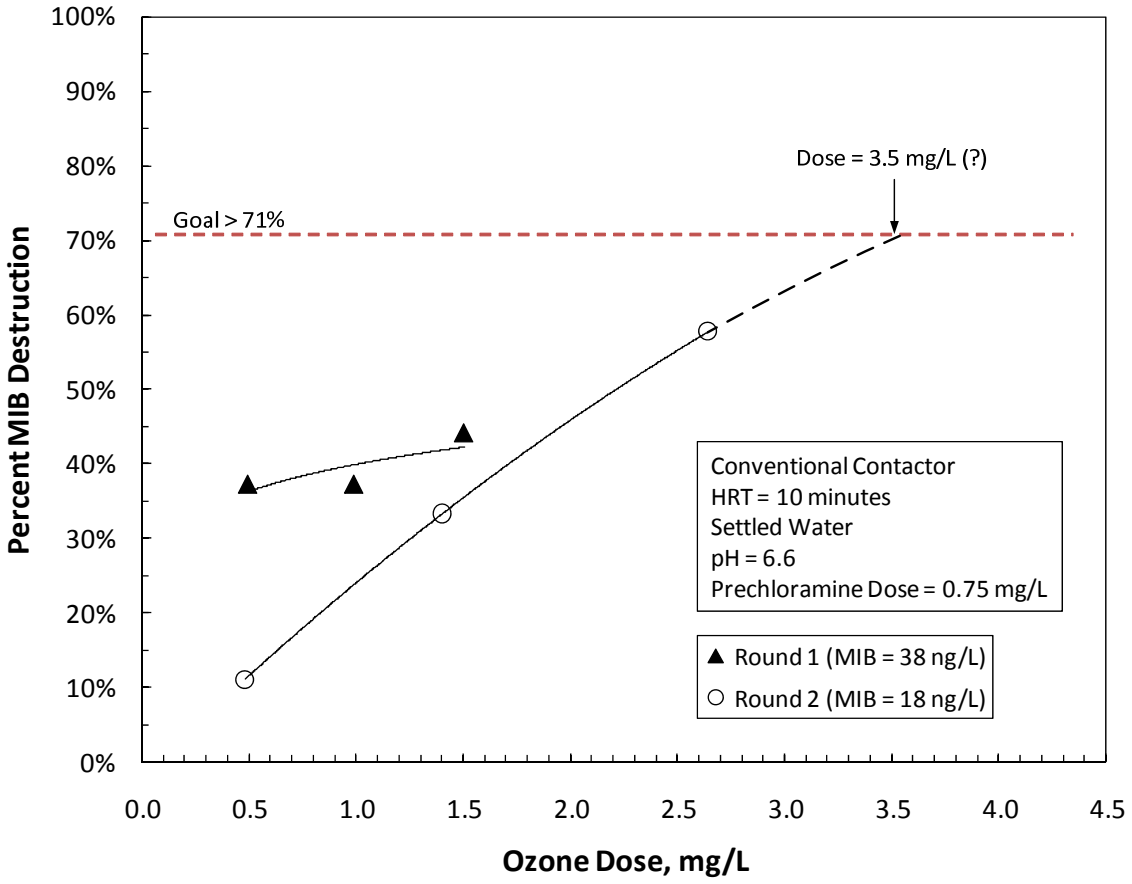

Conventional Contactor
HRT = 10 minutes
Raw Water
pH = 6.5
No Prechloramine Added
Round 1
Round 2
Round 3
Dose = 2.5 mg/L
Dose = 1.8 mg/L
Goal < 0.1 mg/L
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

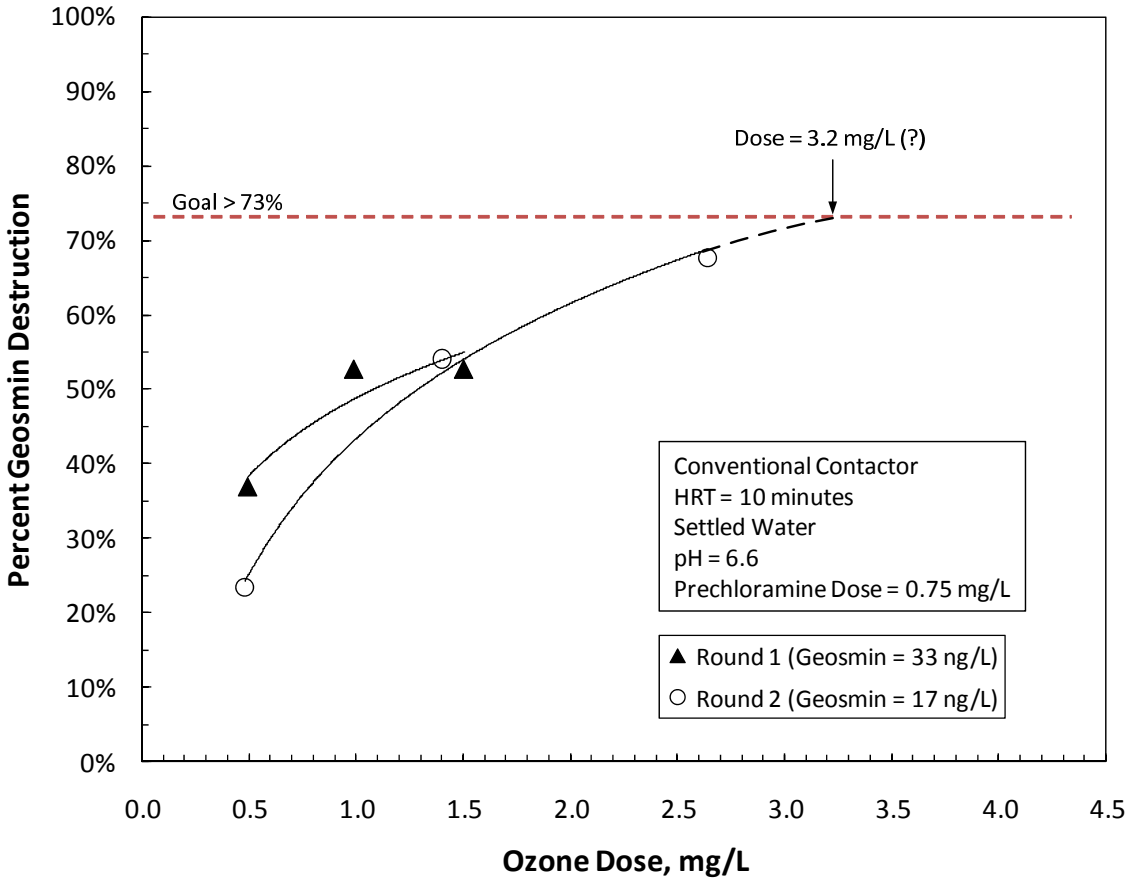

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent MIB Destruction
Dose = 1.3 mg/L
Goal > 71%
Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = 6.5
No Prechloramine Added
H2O2:O3 Ratio = 0.5:1
Round 2 (MIB = 44 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

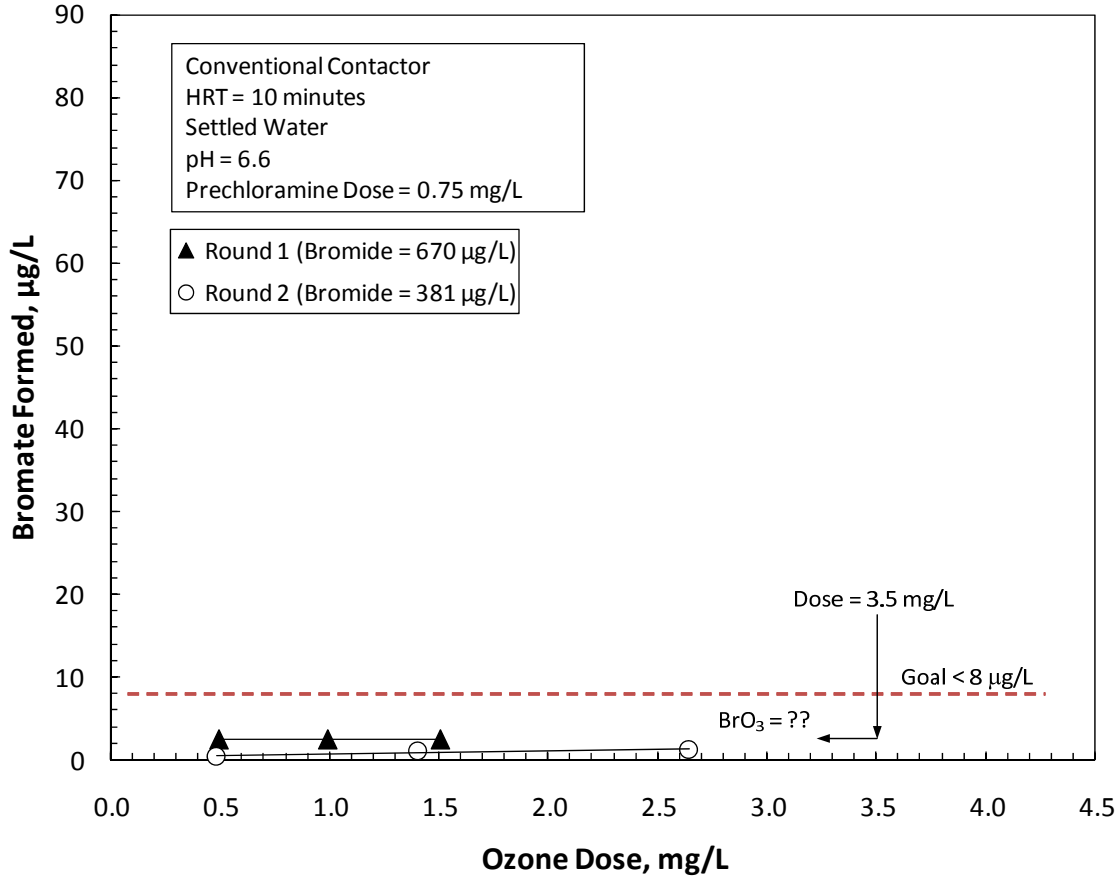

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent Geosmin Destruction
Dose = 1.1 mg/L
Goal > 73%
Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = 6.5
No Prechloramine Added
H2O2:O3 Ratio = 0.5:1
Round 2 (Geosmin = 35 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

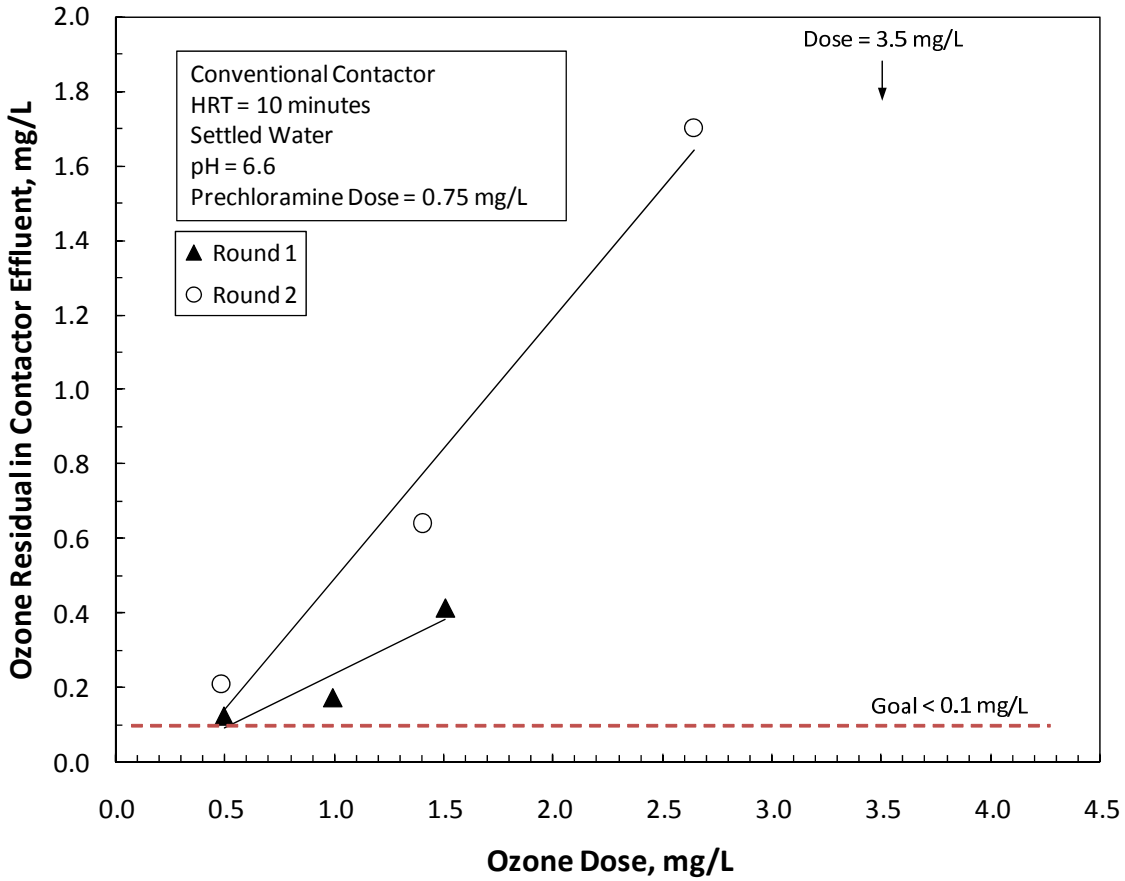

Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = 6.5
No Prechloramine Added
H2O2:O3 = 0.5:1
Round 2 (Bromide = 524 µg/L)
Dose = 1.3 mg/L
BrO3 = 24 µg/L
Goal < 8 µg/L
Bromate Formed, µg/L
Ozone Dose, mg/L
0
10
20
30
40
50
60
70
80
90
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

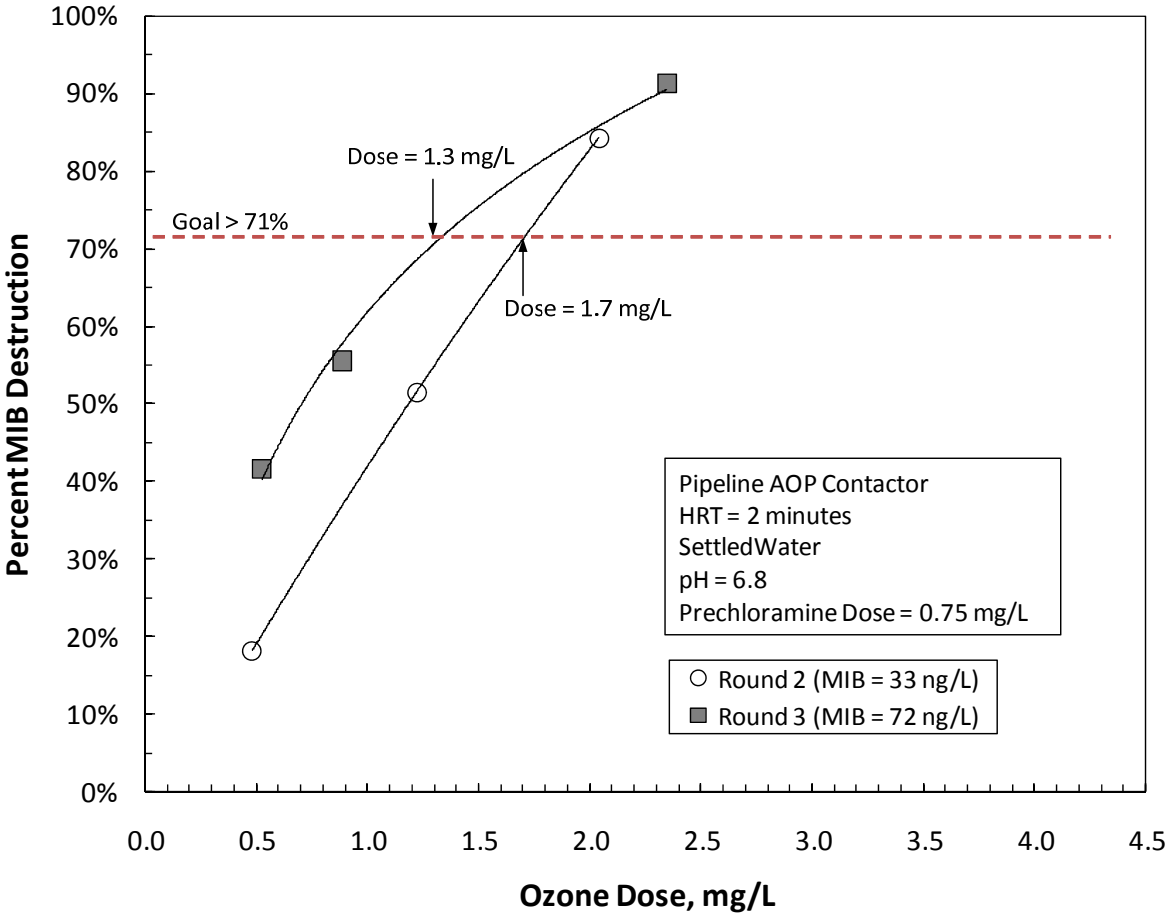

Pipeline AOP Contactor
HRT = 2 minutes
Raw Water
pH = 6.5
No Prechloramine Added
H2O2:O3 Ratio = 0.5:1
Round 2
Dose = 1.3 mg/L
Goal < 0.1 mg/L
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

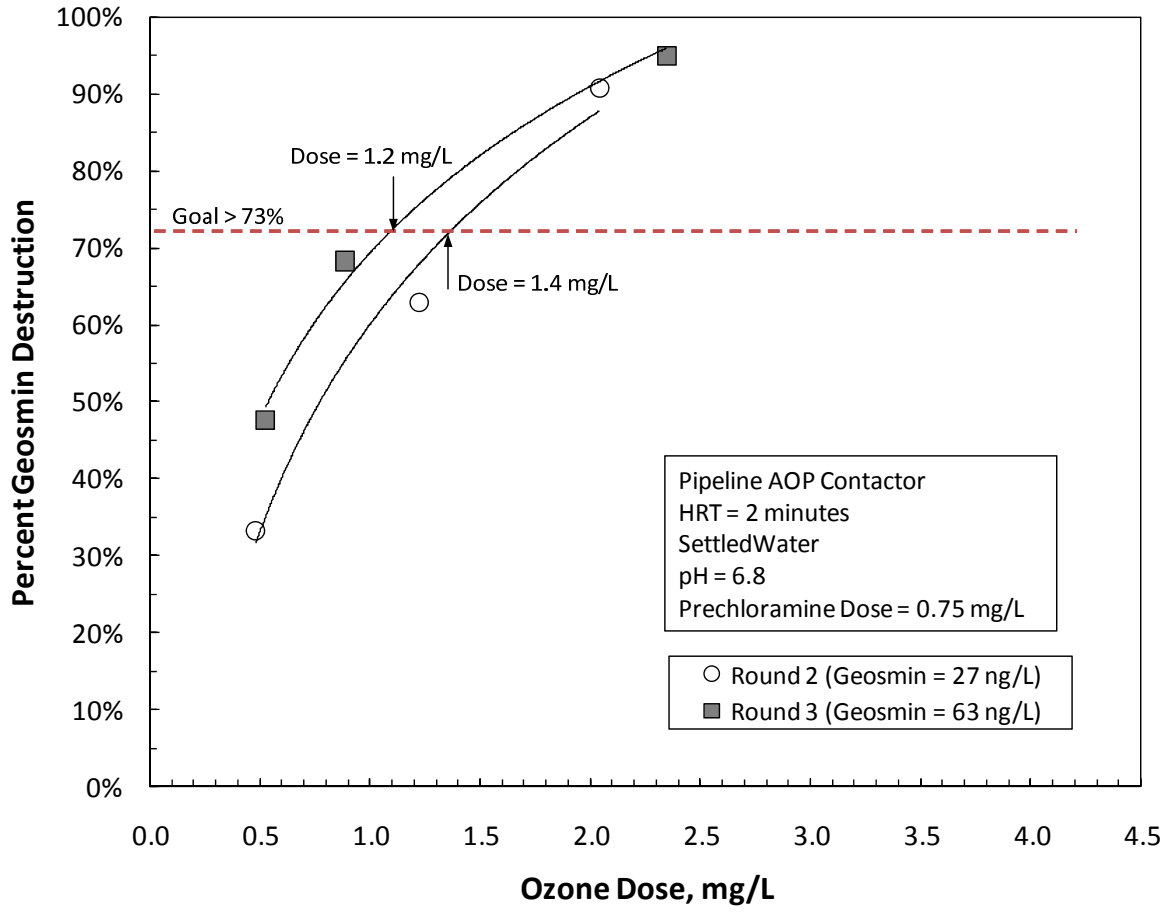

Percent MIB Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Goal > 71%
Dose = 3.5 mg/L (?)
Conventional Contactor
HRT = 10 minutes
Settled Water
pH = 6.6
Prechloramine Dose = 0.75 mg/L
Round 1 (MIB = 38 ng/L)
Round 2 (MIB = 18 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

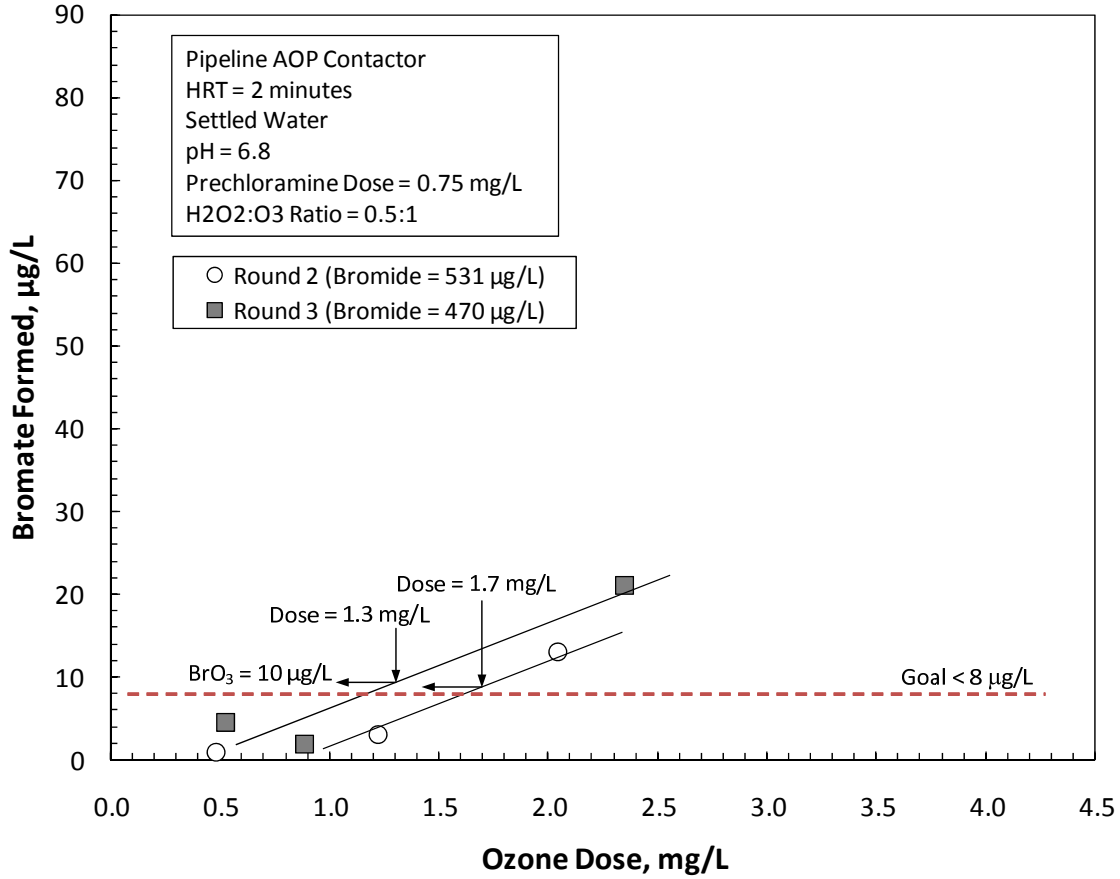

Percent Geosmin Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Goal > 73%
Dose = 3.2 mg/L (?)
Conventional Contactor
HRT = 10 minutes
Settled Water
pH = 6.6
Prechloramine Dose = 0.75 mg/L
Round 1 (Geosmin = 33 ng/L)
Round 2 (Geosmin = 17 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

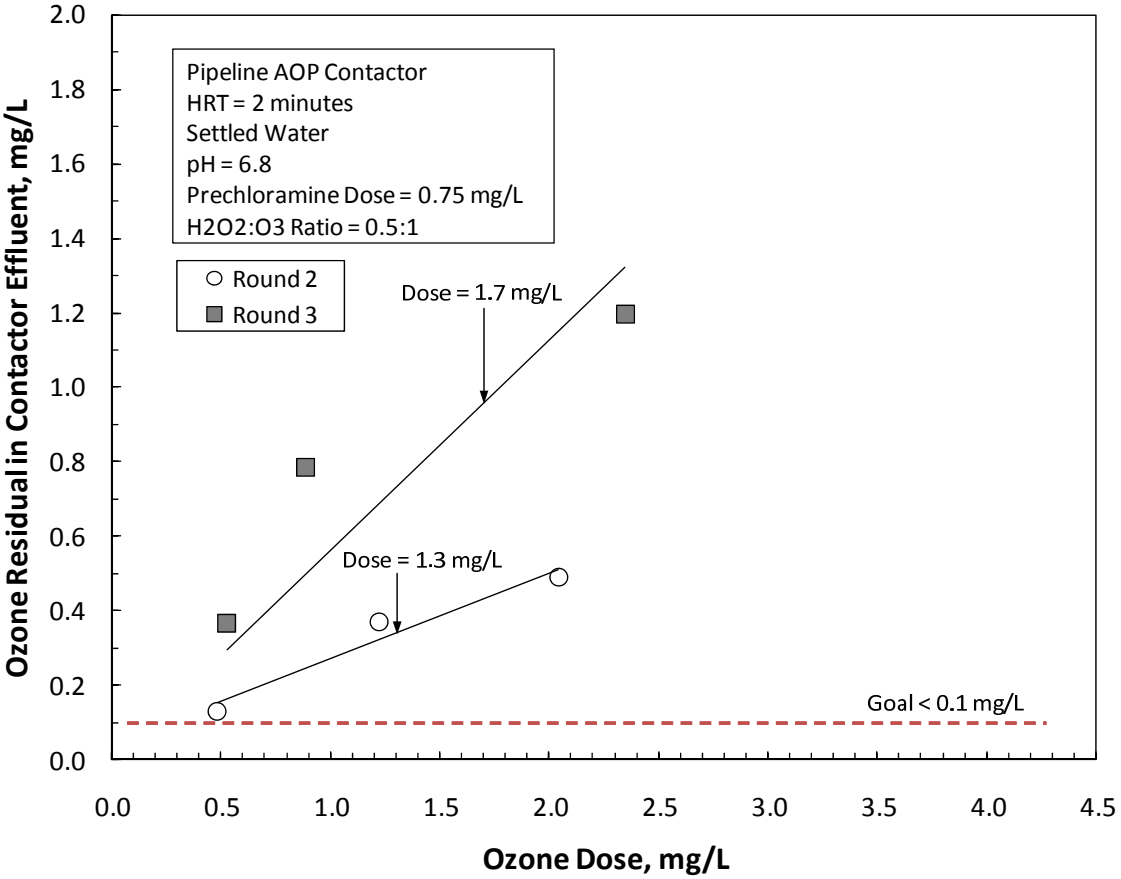

Conventional Contactor
HRT = 10 minutes
Settled Water
pH = 6.6
Prechloramine Dose = 0.75 mg/L
Round 1 (Bromide = 670 µg/L)
Round 2 (Bromide = 381 µg/L)
Dose = 3.5 mg/L
Goal < 8 µg/L
BrO3 = ??
Bromate Formed, µg/L
Ozone Dose, mg/L
0
10
20
30
40
50
60
70
80
90
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

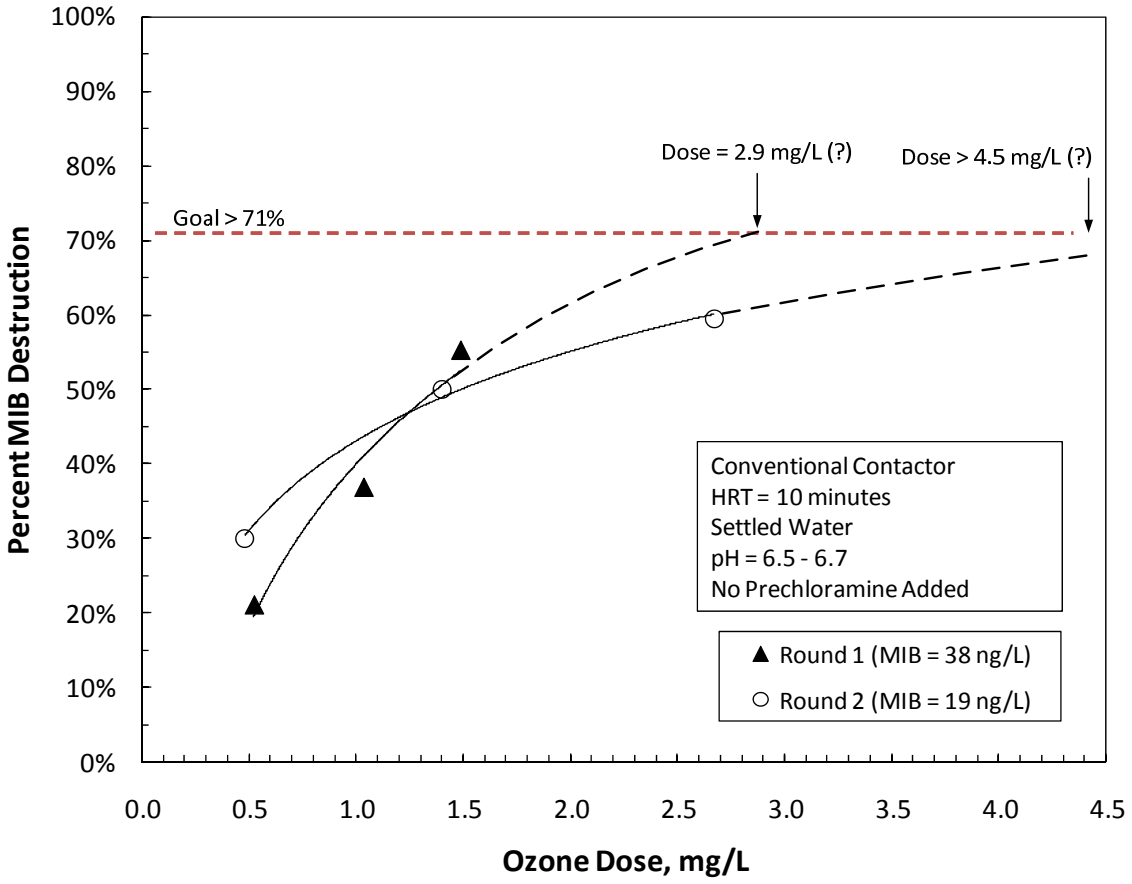

Conventional Contactor
HRT = 10 minutes
Settled Water
pH = 6.6
Prechloramine Dose = 0.75 mg/L
Round 1
Round 2
Dose = 3.5 mg/L
Goal < 0.1 mg/L
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

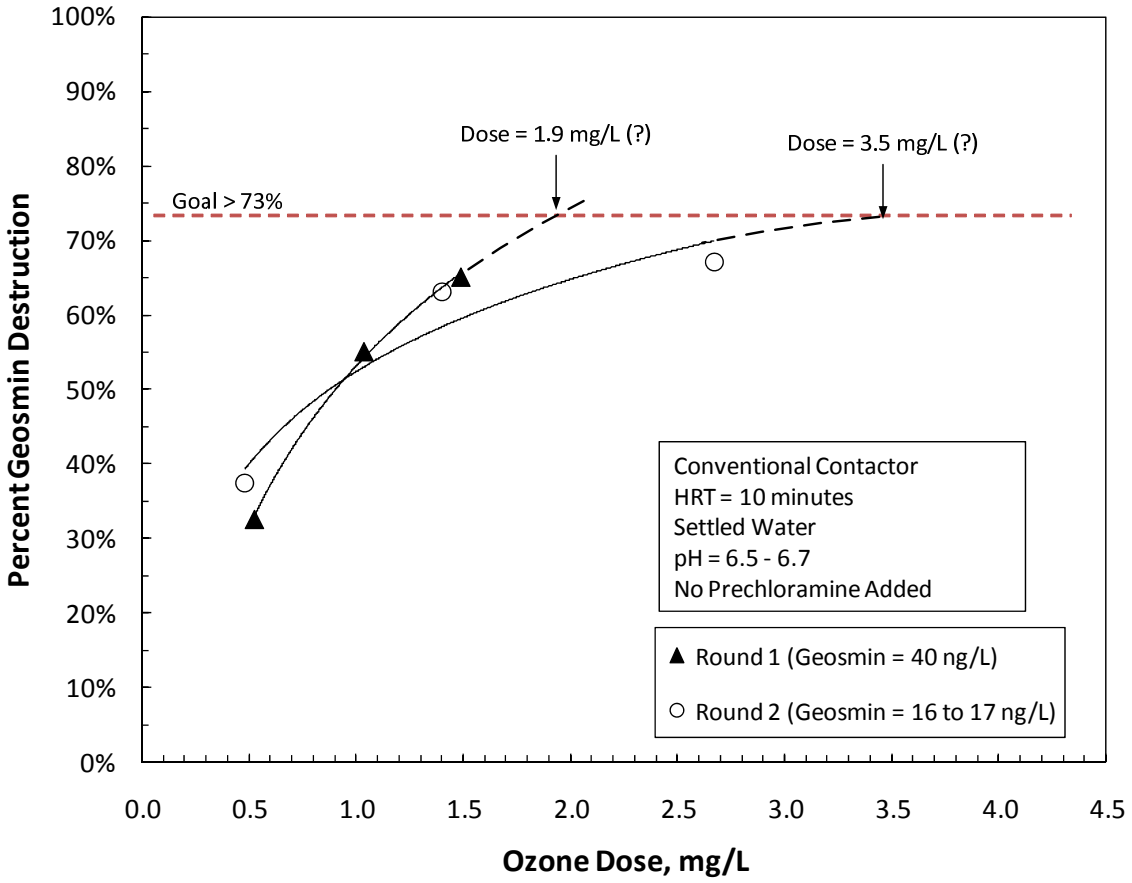

Percent MIB Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L
Dose = 1.3 mg/L
Goal > 71%
Dose = 1.7 mg/L
Pipeline AOP Contactor
HRT = 2 minutes
SettledWater
pH = 6.8
Prechloramine Dose = 0.75 mg/L
Round 2 (MIB = 33 ng/L)
Round 3 (MIB = 72 ng/L)

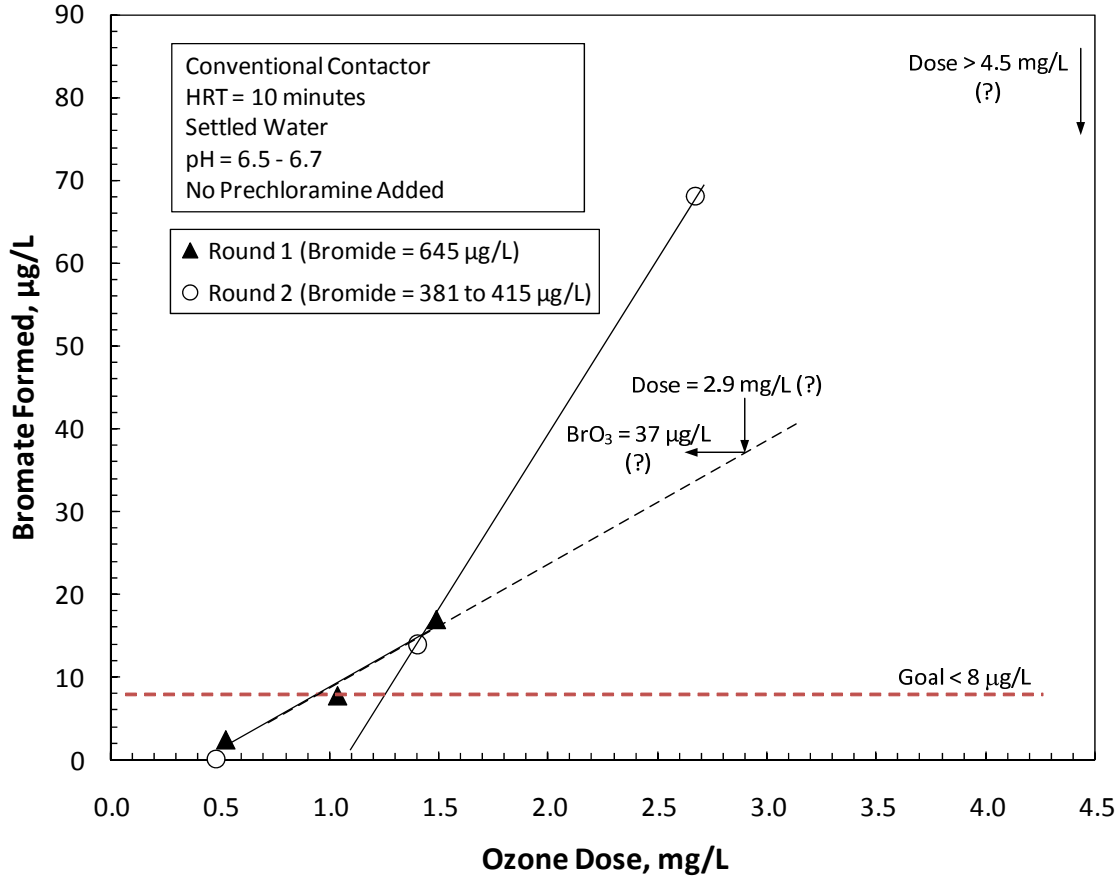

Percent Geosmin Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L
Dose = 1.2 mg/L
Goal > 73%
Dose = 1.4 mg/L
Pipeline AOP Contactor
HRT = 2 minutes
SettledWater
pH = 6.8
Prechloramine Dose = 0.75 mg/L
Round 2 (Geosmin = 27 ng/L)
Round 3 (Geosmin = 63 ng/L)

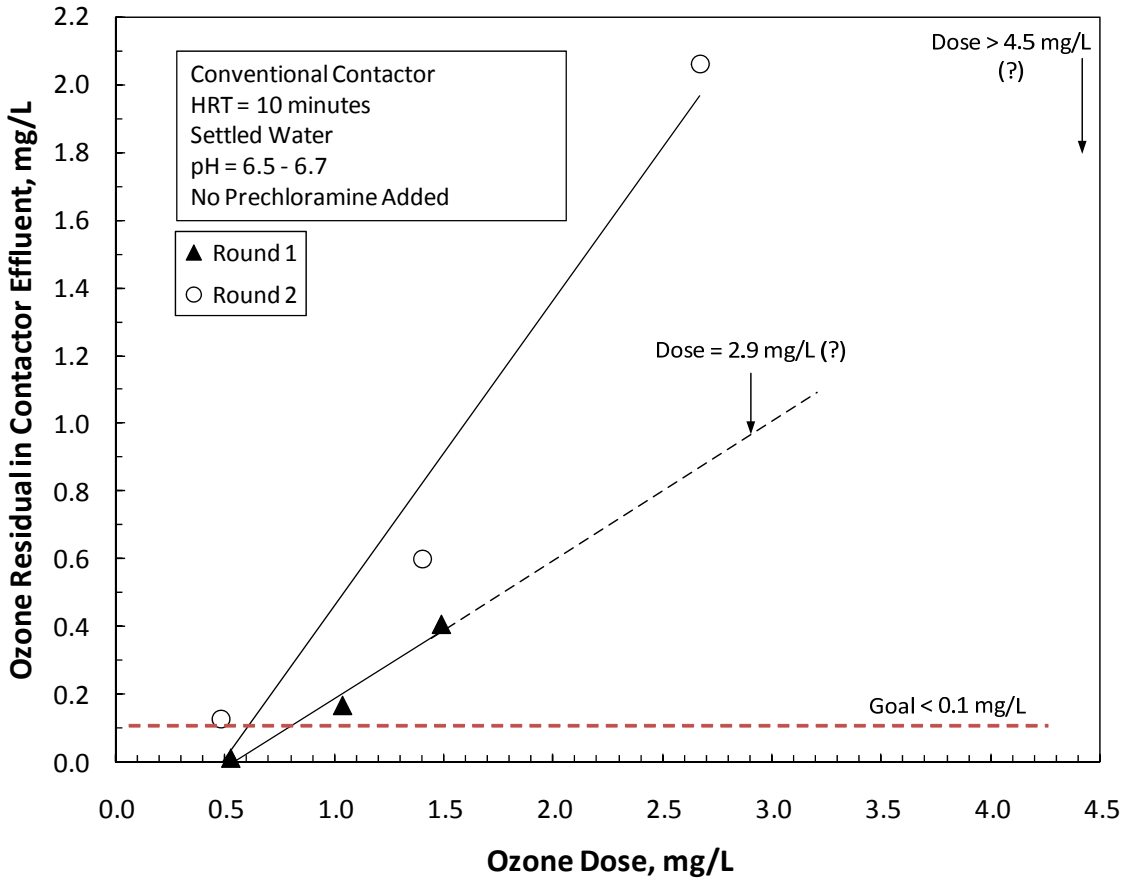

Pipeline AOP Contactor
HRT = 2 minutes
Settled Water
pH = 6.8
Prechloramine Dose = 0.75 mg/L
H2O2:O3 Ratio = 0.5:1
Round 2 (Bromide = 531 µg/L)
Round 3 (Bromide = 470 µg/L)
Dose = 1.7 mg/L
Dose = 1.3 mg/L
BrO3 = 10 µg/L
Goal < 8 µg/L
Bromate Formed, µg/L
Ozone Dose, mg/L

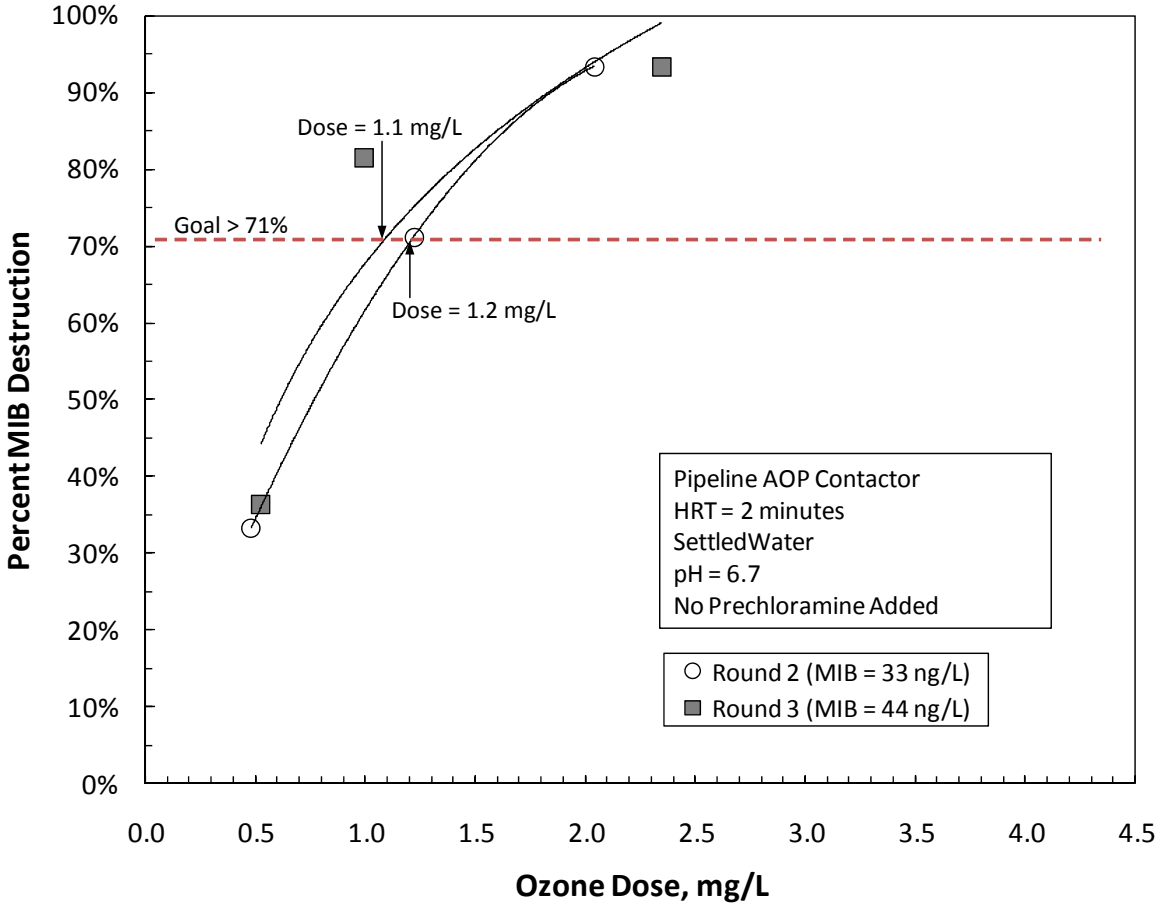

Pipeline AOP Contactor
HRT = 2 minutes
Settled Water
pH = 6.8
Prechloramine Dose = 0.75 mg/L
H2O2:O3 Ratio = 0.5:1
Round 2
Round 3
Dose = 1.7 mg/L
Dose = 1.3 mg/L
Goal < 0.1 mg/L
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L

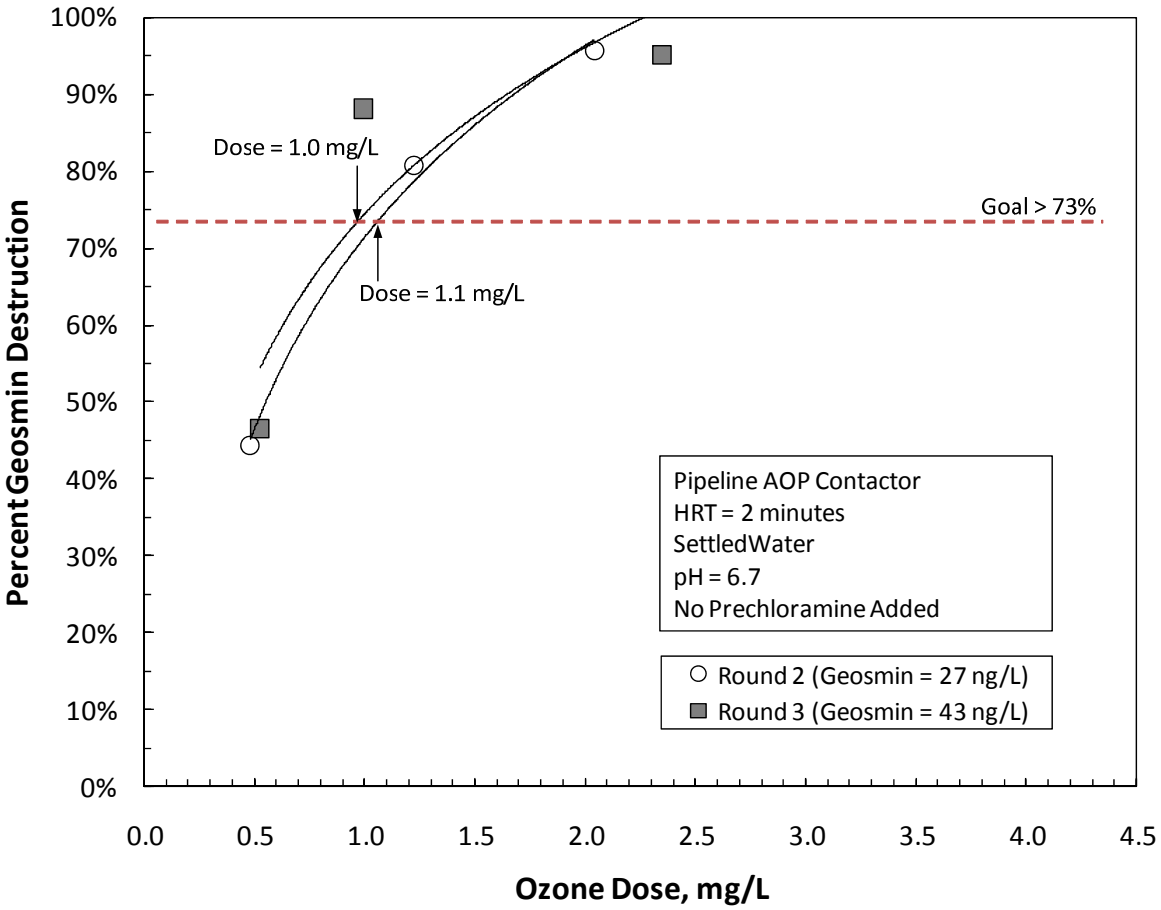

Percent MIB Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Goal > 71%
Dose = 2.9 mg/L (?)
Dose > 4.5 mg/L (?)
Conventional Contactor
HRT = 10 minutes
Settled Water
pH = 6.5 - 6.7
No Prechloramine Added
Round 1 (MIB = 38 ng/L)
Round 2 (MIB = 19 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

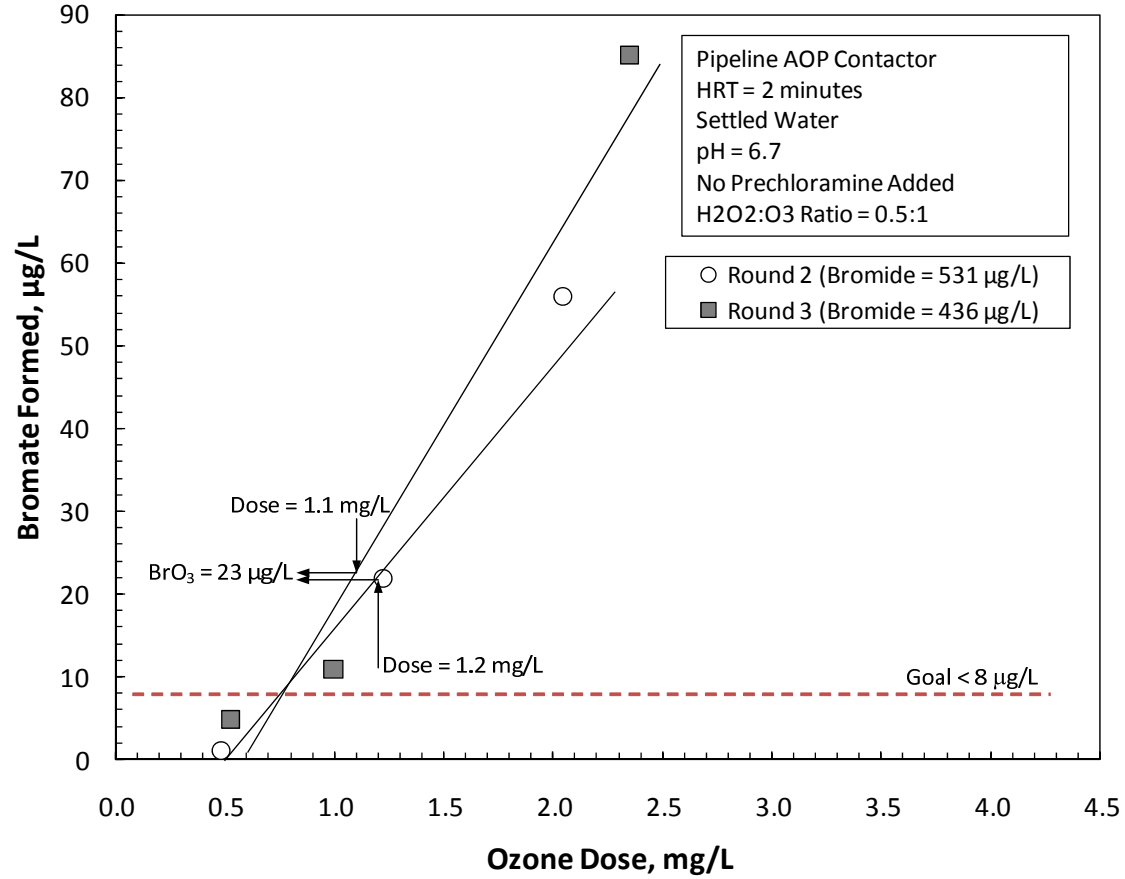

Percent Geosmin Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Goal > 73%
Dose = 1.9 mg/L (?)
Dose = 3.5 mg/L (?)
Conventional Contactor
HRT = 10 minutes
Settled Water
pH = 6.5 - 6.7
No Prechloramine Added
Round 1 (Geosmin = 40 ng/L)
Round 2 (Geosmin = 16 to 17 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

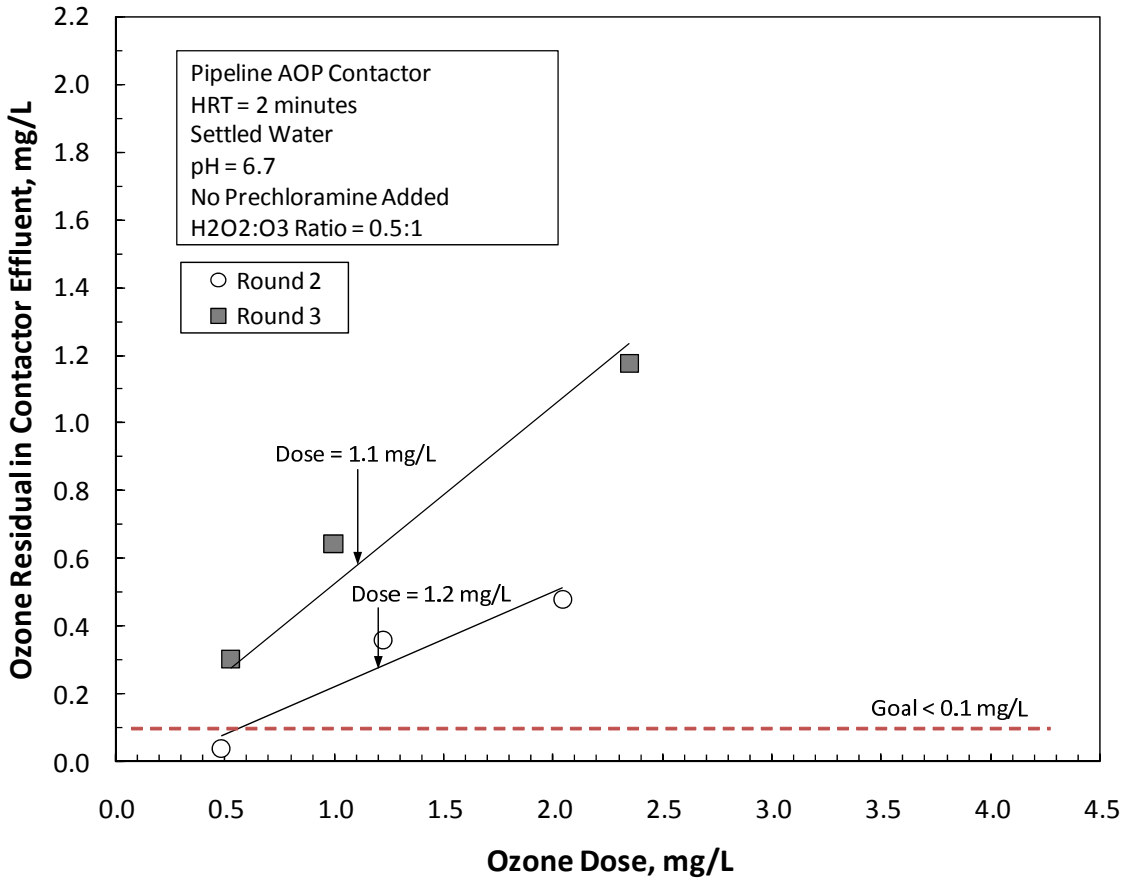

Conventional Contactor
HRT = 10 minutes
Settled Water
pH = 6.5 - 6.7
No Prechloramine Added
Round 1 (Bromide = 645 µg/L)
Round 2 (Bromide = 381 to 415 µg/L)
Dose > 4.5 mg/L (?)
Dose = 2.9 mg/L (?)
BrO3 = 37 µg/L (?)
Goal < 8 µg/L
Bromate Formed, µg/L
Ozone Dose, mg/L
0
10
20
30
40
50
60
70
80
90
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

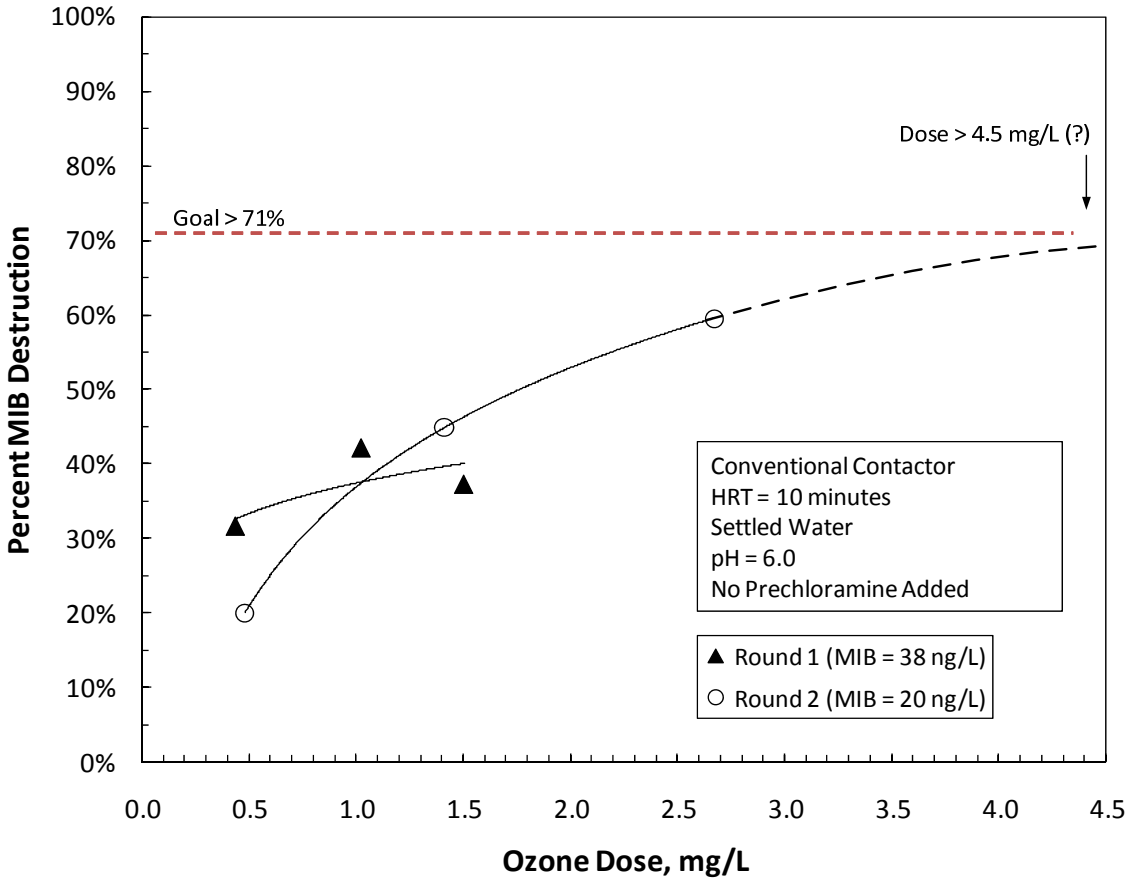

Conventional Contactor
HRT = 10 minutes
Settled Water
pH = 6.5 - 6.7
No Prechloramine Added
Round 1
Round 2
Dose > 4.5 mg/L (?)
Dose = 2.9 mg/L (?)
Goal < 0.1 mg/L
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

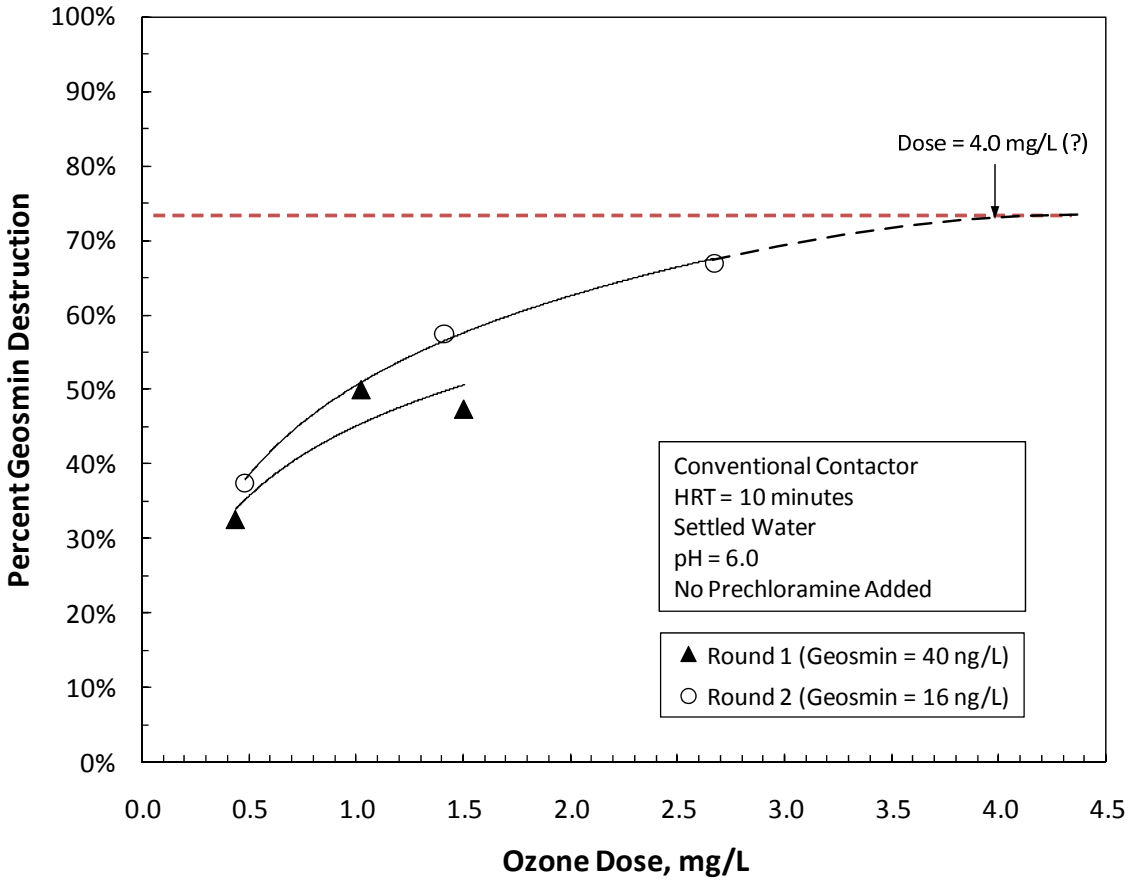

Percent MIB Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Dose = 1.1 mg/L
Goal > 71%
Dose = 1.2 mg/L
Pipeline AOP Contactor
HRT = 2 minutes
SettledWater
pH = 6.7
No Prechloramine Added
Round 2 (MIB = 33 ng/L)
Round 3 (MIB = 44 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

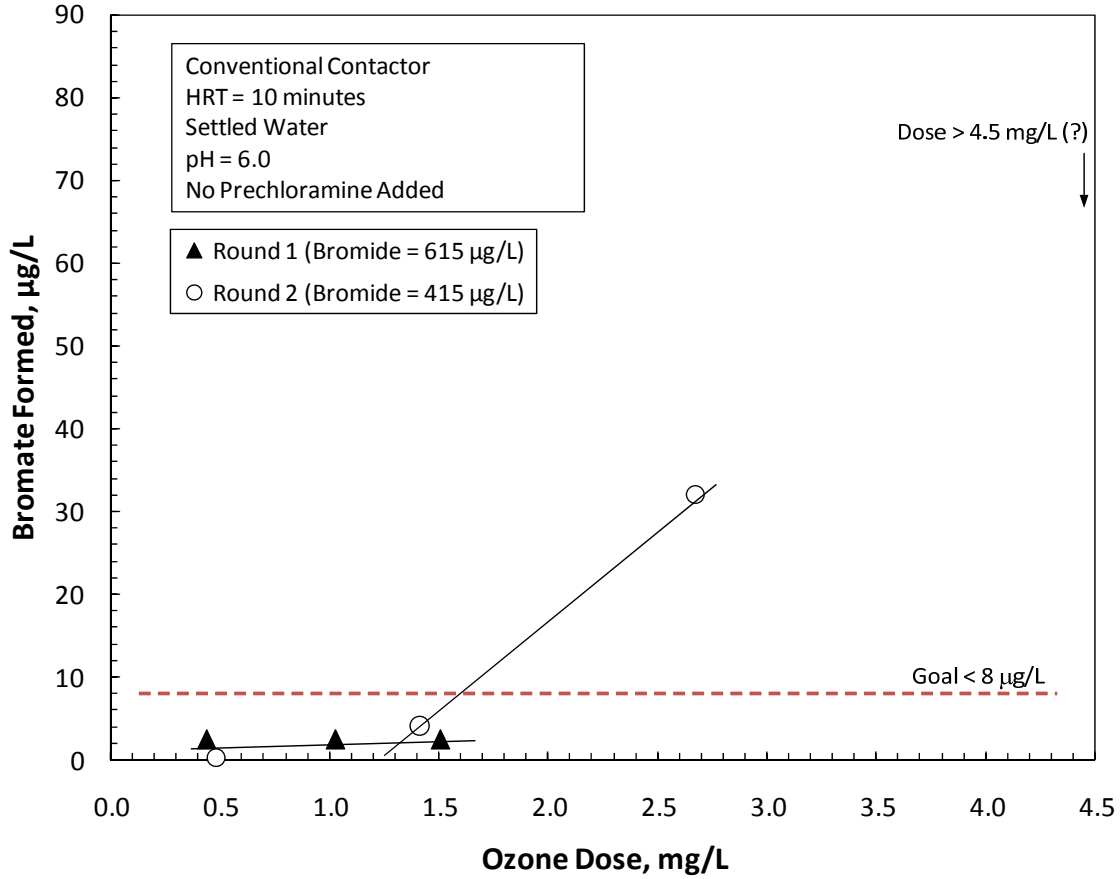

Percent Geosmin Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Dose = 1.0 mg/L
Goal > 73%
Dose = 1.1 mg/L
Pipeline AOP Contactor
HRT = 2 minutes
SettledWater
pH = 6.7
No Prechloramine Added
Round 2 (Geosmin = 27 ng/L)
Round 3 (Geosmin = 43 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

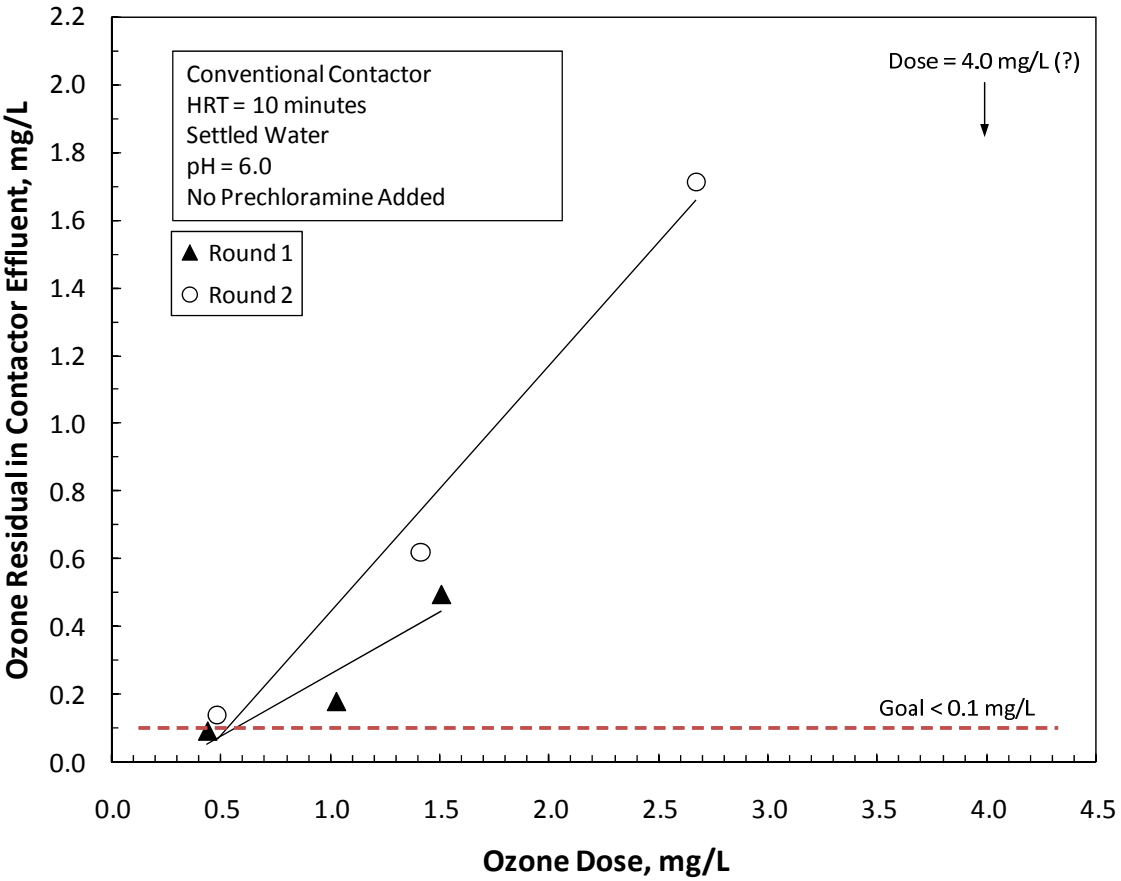

Pipeline AOP Contactor
HRT = 2 minutes
Settled Water
pH = 6.7
No Prechloramine Added
H2O2:O3 Ratio = 0.5:1
Round 2 (Bromide = 531 µg/L)
Round 3 (Bromide = 436 µg/L)
Dose = 1.1 mg/L
BrO3 = 23 µg/L
Dose = 1.2 mg/L
Goal < 8 µg/L
Bromate Formed, µg/L
Ozone Dose, mg/L

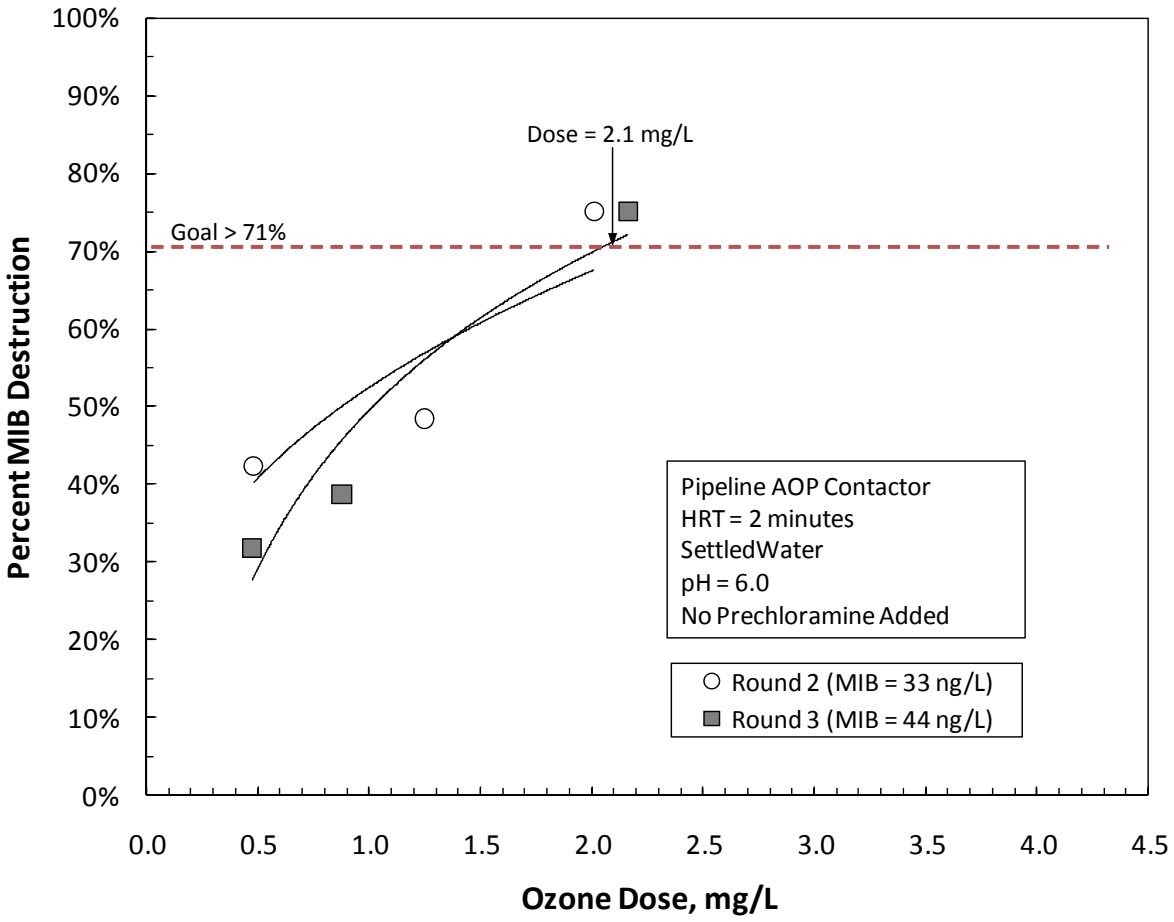

Pipeline AOP Contactor
HRT = 2 minutes
Settled Water
pH = 6.7
No Prechloramine Added
H2O2:O3 Ratio = 0.5:1
Round 2
Round 3
Dose = 1.1 mg/L
Dose = 1.2 mg/L
Goal < 0.1 mg/L
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L

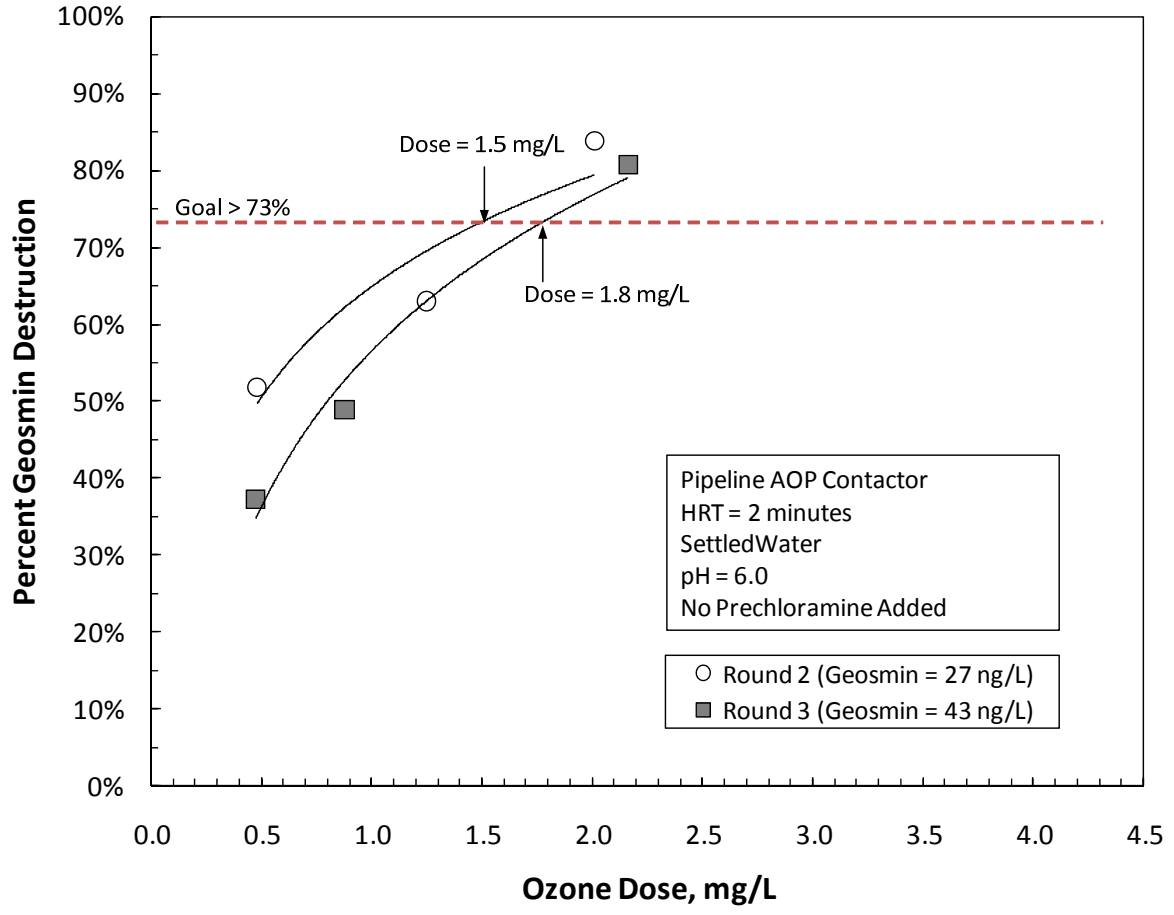

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent MIB Destruction
Goal > 71%
Dose > 4.5 mg/L (?)
Conventional Contactor
HRT = 10 minutes
Settled Water
pH = 6.0
No Prechloramine Added
Round 1 (MIB = 38 ng/L)
Round 2 (MIB = 20 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

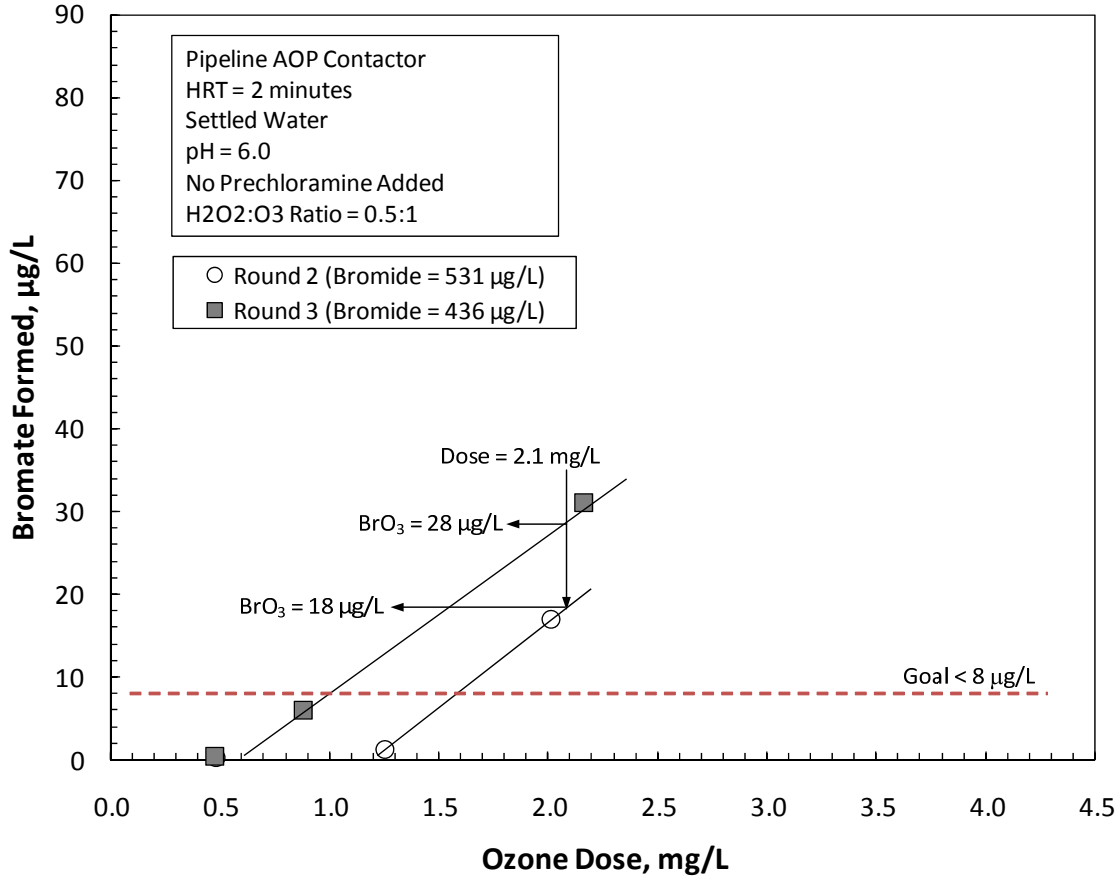

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent Geosmin Destruction
Dose = 4.0 mg/L (?)
Conventional Contactor
HRT = 10 minutes
Settled Water
pH = 6.0
No Prechloramine Added
Round 1 (Geosmin = 40 ng/L)
Round 2 (Geosmin = 16 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L

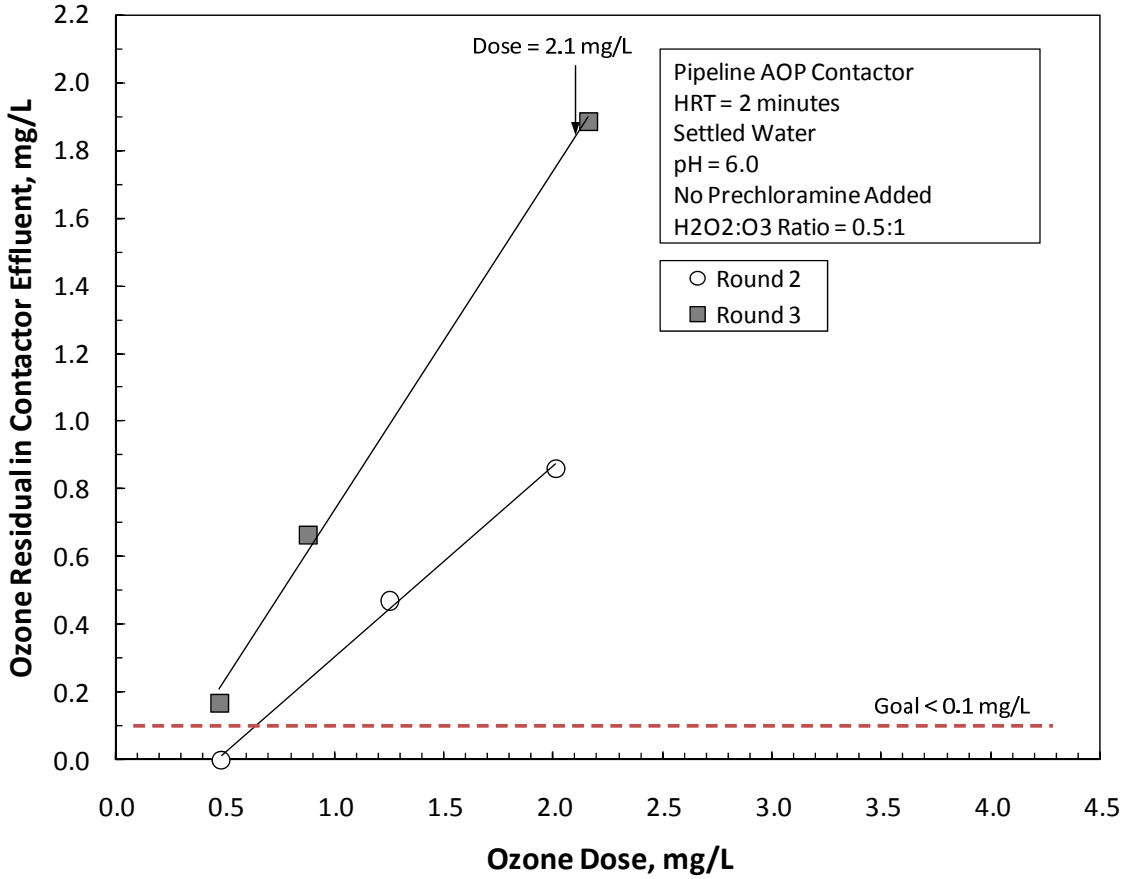

Conventional Contactor
HRT = 10 minutes
Settled Water
pH = 6.0
No Prechloramine Added
Round 1 (Bromide = 615 µg/L)
Round 2 (Bromide = 415 µg/L)
Dose > 4.5 mg/L (?)
Goal < 8 µg/L
Bromate Formed, µg/L
Ozone Dose, mg/L
0
10
20
30
40
50
60
70
80
90
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5


Conventional Contactor
HRT = 10 minutes
Settled Water
pH = 6.0
No Prechloramine Added
Round 1
Round 2
Dose = 4.0 mg/L (?)
Goal < 0.1 mg/L
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5


Percent MIB Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Dose = 2.1 mg/L
Goal > 71%
Pipeline AOP Contactor
HRT = 2 minutes
SettledWater
pH = 6.0
No Prechloramine Added
Round 2 (MIB = 33 ng/L)
Round 3 (MIB = 44 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L


Percent Geosmin Destruction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Dose = 1.5 mg/L
Goal > 73%
Dose = 1.8 mg/L
Pipeline AOP Contactor
HRT = 2 minutes
SettledWater
pH = 6.0
No Prechloramine Added
Round 2 (Geosmin = 27 ng/L)
Round 3 (Geosmin = 43 ng/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Ozone Dose, mg/L


Pipeline AOP Contactor
HRT = 2 minutes
Settled Water
pH = 6.0
No Prechloramine Added
H2O2:O3 Ratio = 0.5:1
Round 2 (Bromide = 531 µg/L)
Round 3 (Bromide = 436 µg/L)
Dose = 2.1 mg/L
BrO3 = 28 µg/L
BrO3 = 18 µg/L
Goal < 8 µg/L
Bromate Formed, µg/L
Ozone Dose, mg/L


Dose = 2.1 mg/L
Pipeline AOP Contactor
HRT = 2 minutes
Settled Water
pH = 6.0
No Prechloramine Added
H2O2:O3 Ratio = 0.5:1
Round 2
Round 3
Goal < 0.1 mg/L
Ozone Residual in Contactor Effluent, mg/L
Ozone Dose, mg/L

APPENDIX C
EMERGING DBPs SAMPLING PROTOCOL

Protocol for setting up and collecting samples to be analyzed for DBPs at Clemson

Background: A total of 20 samples will be collected from the pilot plant and sent to Clemson University for analysis of non-regulated DBPs (I-THMs and HNMs). Samples will be shipped from Zone 7's Del Valle WTP on Tuesday, October 7 for arrival at Clemson on Wednesday October 8th. For each process (i.e., ozone vs. ozone/peroxide), there will be 10 samples collected and shipped. Various conditions will be established to examine the effects of different parameters such as chemical doses and pH values consistent with expected plant operation.

Materials needed:

Ice chest	Blue ice
DBP Sample bottles (60-mL pre-cleaned amber glass vials), total of 40	Labels
1-L clean amber glass bottles, total of seven	Caustic solution for adjusting pH
Sodium hypochlorite solution (1 mg/mL)	Ammonia solution (1 mg/mL as N)
1-L glass graduated cylinder	Pipettes

Sample Description: The 20 samples will be as follows (CC means Conventional Contactor – ozone only, and PC means Pipeline Contactor – ozone + peroxide):

1-RW	Raw water		
2-CC	Raw water dosed with 0.75 mg/L chloramine	2-PC	Raw water dosed with 0.75 mg/L chloramine
3-CC	Raw water that has been pre-chloraminated and then ozonated	3-PC	Raw water that has been pre-chloraminated and then peroxone treated
4-CC	Raw water that has been pre-chloramination, ozonated, and then dosed with chlorine for 10 minutes, followed by ammonia to form chloramine. This sample will be stored at room temperature for 24 hrs before shipping.	4-PC	Raw water that has been pre-chloramination, peroxone treated, and then dosed with chlorine for 10 minutes, followed by ammonia to form chloramine. This sample will be stored at room temperature for 24 hrs before shipping.
5-CC	Raw water with pH depressed to 7.0 and ozonated	5-PC	Raw water with pH depressed to 7.0 and peroxone treated
6-CC	Raw water with pH depressed to 7.0, ozonated, then pH raised back to 8.0, dosed with chlorine for 10 minutes, and followed by ammonia to form chloramine. The sample will be stored at room temperature for 24 hrs before shipping.	6-PC	Raw water with pH depressed to 7.0, peroxone treated, then pH raised back to 8.0, dosed with chlorine for 10 minutes, and followed by ammonia to form chloramine. The sample will be stored at room temperature for 24 hrs before shipping.
7-SW	Settled water		
8-CC	Settled water dosed with 0.75 mg/L chloramine	8-PC	Settled water dosed with 0.75 mg/L chloramine
9-CC	Settled water dosed with chloramine, then ozonated	9-PC	Settled water dosed with chloramine, then peroxone treated
10-CC	Settled water dosed with chloramine, ozonated, then pH adjusted to pH 8.0, dosed with chlorine for 10 minutes, and followed by ammonia to form chloramine. This sample will be stored at room temperature for 24 hrs before shipping.	10-PC	Settled water dosed with chloramine, peroxone treated, then pH adjusted to pH 8.0, dosed with chlorine for 10 minutes, and followed by ammonia to form chloramine. This sample will be stored at room temperature for 24 hrs before shipping.
11-DV	Del Valle Plant Effluent		
12-SW	Settled water, pH adjusted to 8, dosed with chlorine for 10 minutes, and followed by ammonia to form chloramine. This sample will be stored at room temperature for 24 hrs before shipping.		

Instructions:

Day 1 (Monday, October 6th)

1. Start up both trains of pilot plant with raw water, adding chloramine to each train. Establish the following conditions:
    a. CC flow = 6.5 gpm, PC flow = 3.5 gpm
    b. Chlorine dose = 0.75 mg/L to inlet of both contactors
    c. Ammonia dose = 0.19 mg/L to inlet of both contactors
2. Allow to stabilize for 10 minutes
3. Collect the following samples
    a. 1-RW from pilot plant influent tap
    b. 2-CC from effluent of first cell (CC-1)
    c. 2-PC from mid-point of pipeline contactor (PC-3)
4. Start ozone feed to both contactors. Use an ozone dose of 2 mg/L for both contactors
5. Start peroxide feed to pipeline contactor at a dose of 1 mg/L
6. Allow to stabilize for 20 minutes
7. Collect the following samples
    a. 3-CC from the effluent of the conventional contactor (CC-5)
    b. 3-PC from the effluent of the pipeline contactor (PC-6)
    c. Fill two 1-L amber bottles, one from the effluent of each contactor (collect exactly one liter in each bottle). These will be used for 4-CC and 4-PC; set aside
8. Turn chlorine and ammonia feed off to both contactors
9. Start acid feed to source tank, adjusting until pH reaches 7.0
10. Allow to stabilize for 30 minutes (three HRT through contactor)
11. Collect the following samples
    a. 5-CC from effluent of conventional contactor (CC-5)
    b. 5-PC from effluent of pipeline contactor (PC-6)
    c. Fill two 1-L amber bottles, once from the effluent of each contactor (collect exactly one liter in each bottle). These will be used for 6-CC and 6-PC; set aside
12. Switch source water to pilot plant from raw to settled water
13. Collect sample 7-SW from source water tank. At the same time, collect exactly 1-L of settled water into a 1-L amber glass bottle, this will be used for 12-SW
14. Start up chlorine and ammonia feeds to each contactor
    a. Chlorine dose = 0.75 mg/L
    b. Ammonia dose = 0.19 mg/L
15. Allow to stabilize for 10 minutes
16. Collect the following samples
    a. 8-CC from effluent of first chamber (CC-1)
    b. 8-PC from mid-point of pipeline contactor (PC-3)
17. Start ozone feed to both contactors at 1.0 mg/L
18. Start peroxide feed to pipeline contactor at 0.5 mg/L
19. Allow to stabilize for 20 minutes
20. Collect the following samples
    a. 9-CC from effluent of conventional contactor (CC-5)
    b. 9-PC from effluent of pipeline contactor (PC-6)

c. Fill two 1-L amber glass bottles, one from each contactor (collect exactly one liter in each bottle). These will be used for 10-CC and 10-PC; set aside

21. Collect sample 11-DV from plant effluent tap into DBP bottle
22. Shut down both contactors and all chemical feeds
23. Take the seven 1-L bottles (4-CC, 4-PC, 6-CC, 6-PC, 10-CC, 10-PC, and 12-SW) to the lab
24. Place the 13 filled 60-mL DBP samples in the refrigerator (those starting with 1, 2, 3, 5, 7, 8, 9, 11)
25. For bottles 6-CC, 6-PC, 10-CC, 10-PC, and 12-SW perform the following steps:
    a. Place bottle on magnetic stirrer, add stir bar and mix
    b. Make sure pH probe is clean, place pH probe in bottle
    c. Slowly add caustic solution and measure pH. Continue adding caustic solution until pH reaches 8.0 ± 0.2
    d. Continue mixing for 5 more minutes, ensure that pH is stable at 8.0 ± 0.2
    e. Measure and record pH of each bottle

Sample ID	pH after caustic addition
6-CC	8.06
6-PC	8.04
10-CC	8.01
10-PC	7.98
12-SW	7.96

26. For all seven samples in amber bottles, perform the following steps:
    a. Add 2.5 mg of hypochlorite, gently stir
    b. Wait 10-minutes
    c. Add 0.63 mg of ammonia, gently stir
    d. Cap bottle and store at room temperature overnight
27. Make sure there is sufficient frozen blue ice in freezer, add more if needed

Day 2 (Tuesday, October 7th)

1. Twenty-four hours after completion of step 26, measure and record the following from each amber glass bottle: pH, temperature, total chlorine residual

Sample ID	temperature	pH	Total chlorine, mg/L
4-CC	20.7	2.01	1.01
4-PC	20.6	7.61	0.53
6-CC	20.6	7.86	0.82
6-PC	20.6	7.87	0.12
10-CC	20.6	7.77	0.75
10-PC	20.6	7.73	0.30
12-SW	20.6	7.65	1.10

2. Pour samples from each of the 1-L bottles into the corresponding 60-mL DBP bottles
3. Pack all 20 60-mL sample bottles in ice chest and add frozen blue ice
4. Ship ice chest via overnight carrier to Clemson University

APPENDIX D
DATA FROM SIMULATED DISTRIBUTION SYSTEM DBP TESTS

Simulated Distribution System Testing Results

						Chlorine Dose, mg/L			1-hr free Chlorine Residual, mg/L			24-hr total Chlorine Residual, mg/L			N Concentration, mg/L			THMs Formed, ug/L			HAA5 Formed, ug/L		
Date	source	pH	Conventional Contactor Ozone Dose, mg/L	Pipeline Contactor Ozone Dose, mg/L	Pipeline AOP Contactor H2O2 Dose, mg/L	Source Water	Conventional Contactor Effluent	Pipeline AOP Contactor Effluent	Source Water	Conventional Contactor Effluent	Pipeline AOP Contactor Effluent	Source Water	Conventional Contactor Effluent	Pipeline AOP Contactor Effluent	Source Water	Conventional Contactor Effluent	Pipeline AOP Contactor Effluent	Source Water	Conventional Contactor Effluent	Pipeline AOP Contactor Effluent	Source Water	Conventional Contactor Effluent	Pipeline AOP Contactor Effluent
6/4/2008	raw	7.8	1.8	2.5	2	5.0	5.0	5.0	0.95	2.06	1.72	3.89	3.53	3.09	0.02	0.15	0.00	99.8	71.7	82.6	42.2	31.1	37.9
6/10/2008	raw	8.1	4	4	0.8	3.5	3.5	3.5	0.98	0.96	0.96	0.93	0.94	0.34	0.17	0.10	0.07	98.0	74.7	82.9	29.0	21.9	22.3
7/11/2008	raw	7.7	2.5	2.5	1.3	2.4	2.4	2.4	0.55	0.51	0.49	0.51	0.34	0.42	0.09	0.07	0.03	68.2	62.1	63.9	23.0	18.9	17.2
7/22/2008	raw	7.9	2.5	2.5	1.3	3.0	3.0	3.0	1.67	1.66	1.62	1.67	1.51	1.79	0.11	0.14	0.03	67.3	42.0	44.2	25.5	19.9	21.2
8/5/2008	settled	6.6	1.5	1.5	0.75	3.0	3.0	3.0	2.16	2.46	2.64	1.07	1.06	1.42	0.15	0.22	0.25	37.8	19.7	19.9	10.1	7.9	8.0
9/3/2008	settled	6.7	3	3	3	2.2	2.2	2.2	1.36	1.78	0.03	0.46	0.82	0.07	0.29	0.41	0.00	60.7	43.1	6.4	11.1	10.9	4.2
9/16/2008	settled	6.8	2	2	2	3.4	3.4	3.4	1.86	2.32	0.07	1.57	1.59	0.19	0.12	0.16	0.04	71.3	46.1	12.2	13.6	10.3	1.1
9/30/2008	settled	6.7	1.5	1.5	0.75	3.6	3.6	3.6	1.06	2.62	1.15	0.14	1.73	0.83	0.00	0.28	0.13	97.1	36.4	56.3	10.6	9.3	9.7
10/28/2008	raw	7.8	3	3	1.5	3.5	3.5	3.5	0.97	0.95	0.94	0.94	0.93	0.78	0.12	0.18	0.21	102.0	86.4	81.2	23.4	17.7	19.1