Memorandum

To: Concerned Parties

Cc: Chapin Spencer (Director)

From: Steve Roy (Senior Water Resources Engineer), Megan Moir (Asst. Director)

Date: August 5, 2016, Revision A

Re: Water Quality Review and Plan for Sanexen Water Main Relining Process

While part of our vetting process on this technology was contacting a number of clients from Sanexen's reference list and obtaining Vermont's first construction permit from Water Supply, the intent of this memo is to focus on water quality questions raised by City Council and our customers regarding the Sanexen/ Aqua-Pipe process. This memo includes a discussion of both temporary water lines as well as the finished relined water main product. While there is some information available in the FAQ section of Sanexen's website (www.aqua-pipe.com), this memo provides additional information with regard to water quality questions during and after the project.

There are several standards that we use when evaluating safety of drinking water materials.

1. National Sanitation Foundation (NSF): The NSF (www.nsf.org) is an accredited third-party certification that provides all stakeholders – industry, regulators, users and the general public – assurance that a certified product, material, component or service complies with the technical requirements of the referenced standard. The NSF certification process is specific to the product, process or service being certified and the type of certification, but generally follows seven steps:

1. Application and information submission
2. Product evaluation
3. Product testing in lab
4. Manufacturing facility inspection, production confirmation and product sampling
5. Test results review and acceptance
6. Contract signed and products listed
7. Annual plant inspection and retesting

2. American National Standards Institute (ANSI): The ANSI (www.ansi.org) is a separate, private non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems, and personnel in the United States.

3. American Water Works Association (AWWA): Established in 1881, the AWWA (www.awwa.org) is the largest nonprofit, scientific and educational association dedicated

to managing and treating water. AWWA publishes over 170 ANSI/AWWA standards that provide valuable information on design, installation, disinfection, treatment, and manufacturing of products including pipe, chemicals, storage tanks, valves, meters and other appurtenances; industry-recognized consensus prerequisites; and practices for water utility management and operations.

4. Food and Drug Administration (FDA): The FDA (www.fda.gov) is responsible for protecting the public health by assuring the safety, efficacy and security of human and veterinary drugs, biological products, medical devices, our nation's food supply, cosmetics, and products that emit radiation. Products that are "FDA compliant" means they are made with materials that have been determined to be safe for use by the public. In the case of rubber hoses below, compliance means they meet the requirements of the Code of Federal Regulations standard 21 CFR 177.2600.

Sanexen's Temporary Water Lines

Depending on user needs, above-grade temporary water lines laid by Sanexen consist of 4" rigid PVC pipe, 2" potable water rubber hose and ¾" reinforced potable water PVC tubing. The 2" and 4" lines are disinfected and tested in accordance with the latest edition of AWWA standard C651. This standard requires chlorination of water lines at either 50 mg/l for 3 hours, 25 mg/l for 12 hours or 10 mg/l for 24 hours. Sanexen conservatively disinfects at 50 mg/l for around 24 hours. These lines are then flushed to remove the super-chlorinated water and then sampled in multiple locations for Total Coliform and *E. Coli* bacteria. The above pipes, hoses, gaskets and other materials in contact with water are either NSF or FDA approved for potable water use.

Relined Water Mains

The reconditioned water main meets NSF 61 and ANSI requirements and will be disinfected/tested in the same manner as the Temporary Water Lines.

Sanexen/Aqua-Pipe offers a more specific description of their product and the NSF/ANSI certification procedure:

For pipes of 6 to 12 inches in diameter; the Aqua-Pipe Liner is made up of two woven polyester jackets. The interior jacket is fused to a polymeric membrane (a thermoplastic film). This membrane being in contact with the drinking water, ensures that the water does not come in contact with epoxy prior to the cure process. NSF/ANSI Standard 61 includes criteria for testing and evaluating products to ensure they do not leach contaminants into the water that would be a health concern. These contaminants include those regulated by the United States Environmental Protection Agency (USEPA), as well as any other non-regulated compounds that may be of concern. The NSF Certification process has several steps to approve the material, including the following:

- Application: NSF/ANSI Standard 61 requires a disclosure by the manufacturer of all water contact materials in the product and a disclosure by the manufacturer's material suppliers of all chemical ingredients in the materials. This includes the lining material as well as the epoxy that is used to adhere the liner to the existing pipe.
- Formulation, toxicology and product use information: Client and suppliers complete and submit NSF's Product Information Form. This provides formulation (liner and epoxy), toxicology and product use information.

- NSF formulation review: NSF toxicologists perform a formulation review for each water contact material to determine any possible ingredients, contaminants, or reaction by-products that may potentially leach from the material into drinking water. This formulation review then determines the battery of chemical analyses that will be performed on a particular material.
- Plant audit and sample collection: NSF then conducts an inspection of the production facility annually to verify the product formulation and production process and to ensure adequate quality control procedures are in place to prevent the use of unauthorized materials. Product samples are collected during the inspection and sent to NSF laboratories to be tested to the appropriate exposure protocol of NSF/ANSI Standard 61.
- Laboratory testing: Devices or materials are evaluated according to the exposure and analysis methods in Annex B of NSF/ANSI Standard 61. Most products undergo a 3-week to 3-month exposure process where the products are exposed to various formulated waters designed to extract specific types of contaminants. Contaminant concentrations are determined from chemical analyses of the exposure water samples. (See below under additional testing for our attempt to safeguard against any unanticipated long term breakdown of the liner).
- Toxicology evaluation - These contaminant concentrations are then evaluated by a toxicologist to the pass/fail criteria in Annex D and E of NSF/ANSI Standard 61. Products that meet the requirements of the standard are then certified and appear in the NSF Listings. If products fail to meet the requirements of the standard, the manufacturer may identify the source of the failure and resubmit a reformulated product for certification.
- Attached at the end of this memo is Sanexen's NSF/ANSI 61 certification.

Additional Testing

Questions were raised by Vermont Water Supply and a member of our own City Council, a registered nurse, regarding the potential for leaching of compounds from the final product into our drinking water. Special Condition C.5 of our approved VTDEC Water Supply construction permit requires Volatile Organic Compound (VOC) testing using Method 524.2 to verify conformance with NSF/ANSI Standard 61 prior to transfer of water from the temporary above-grade to the newly rehabilitated underground main. At the end of this memo are the compounds tested as part of Method 524.2. While our construction permit doesn't get specific as to the number or location of samples, I suggest a single sample be taken along with bacteria testing at the end of the lined water main where maximum contact time between the liner and drinking water has occurred. A second sample shall also be taken on a nearby unlined main (control sample) and used for comparison purposes. Some compounds like trihalomethanes (disinfection by-products) will be present in both samples but should be below MCL standards.

To address any potential for long-term liner breakdown, I'm recommending that a sample be taken annually to start from all reconditioned water mains in Burlington as well as a control sample, tested for VOCs using Method 524.2 and compared with EPA's Maximum Contaminant Levels (MCL). If results are good, we can move to longer periods of time between sampling intervals.

The Public Health and Safety Organization

NSF Product and Service Listings

These NSF Official Listings are current as of **Tuesday, March 08, 2016** at 12:15 a.m. Eastern Time. Please contact NSF International to confirm the status of any Listing, report errors, or make suggestions.

Alert: NSF is concerned about fraudulent downloading and manipulation of website text. Always confirm this information by clicking on the below link for the most accurate information:
http://info.nsf.org/Certified/PwsComponents/Listings.asp?Company=0L190&Standard=061&

NSF/ANSI 61
Drinking Water System Components - Health Effects

NOTE: Unless otherwise indicated for Materials, Certification is only for the Water Contact Material shown in the Listing. Click here for a list of Abbreviations used in these Listings. Click here for the definitions of Water Contact Temperatures denoted in these Listings.

Sanexen Environmental Services Inc.
9935 Catania Avenue
Entrance 1 - Suite 200
Brossard, QC J4Z 3V4
Canada
800-263-7870
450-652-9990

Facility : Brossard, Québec, Canada

Protective (Barrier) Materials

Trade Designation	Water Contact Size Restriction	Water Contact Temp	Water Contact Material
Pipe Liner - Immediate Return to Service [G]			
Aqua-Pipe 14+[1] [2]	>= 14"	CLD 23	MLTPL

Aqua-Pipe PU[1] [3]	6" - 12"	CLD 23	MLTPL

[1] Evaluated for Immediate Return to Service.
[2] This product requires the following cure time, temperature, and flush:
Day 1: Cure at 65° C and 25 psi water pressure for 2 hours when using APH01 or for 4 hours when using APH02, followed by a cool-down period of 18 hours at ambient temperature.
Day 2: Flush at 2.8 liters per minute for 24 hours at ambient temperature.
Day 3: Cure for 24 hours at ambient temperature.
[3] This product requires the following cure time, temperature, and flush:
Day 1: Cure 1.5 hours at 65° C and 25 psi water pressure, then a cool-down period for 18 hours at ambient temperature.
Day 2: Flush at 2.8 liters per minute for 24 hours at ambient temperature
Day 3: Cure for 24 hours at ambient temperature
[G] Product is Certified to NSF/ANSI 372 and conforms with the lead content requirements for "lead free" plumbing as defined by California, Vermont, Maryland, and Louisiana state laws and the U.S. Safe Drinking Water Act.

Number of matching Manufacturers is 1
Number of matching Products is 2
Processing time was 0 seconds

EPA METHOD 524.2
MEASUREMENT OF PURGEABLE ORGANIC COMPOUNDS IN WATER BY CAPILLARY COLUMN GAS CHROMATOGRAPHY/MASS SPECTROMETRY

Analyte	Chemical Abstract Service Registry Number	Primary/Secon. MCL/Notes
Acetone*	67-64-1	700 ppb (same units below)
Acrylonitrile*	107-13-1	5
Allyl chloride*	107-05-1	
Benzene	71-43-2	5
Bromobenzene	108-86-1	
Bromochloromethane	74-97-5	80 total trihalomethanes [1]
Bromodichloromethane	75-27-4	
Bromoform	75-25-2	
Bromomethane	74-83-9	10
2-Butanone*	78-93-3	
n-Butylbenzene	104-51-8	
sec-Butylbenzene	135-98-8	
tert-Butylbenzene	98-06-6	
Carbon disulfide*	75-15-0	
Carbon tetrachloride	56-23-5	5
Chloroacetonitrile*	107-14-2	
Chlorobenzene	108-90-7	100
1-Chlorobutane*	109-69-3	
Chloroethane	75-00-3	
Chloroform	67-66-3	
Chloromethane	74-87-3	
2-Chlorotoluene	95-49-8	100
4-Chlorotoluene	106-43-4	100
Dibromochloromethane	124-48-1	
1,2-Dibromo-3-chloropropane	96-12-8	0.2
1,2-Dibromoethane	106-93-4	
Dibromomethane	74-95-3	
1,2-Dichlorobenzene	95-50-1	600
1,3-Dichlorobenzene	541-73-1	
1,4-Dichlorobenzene	106-46-7	75
trans-1,4-Dichloro-2-butene*	110-57-6	
Dichlorodifluoromethane	75-71-8	1000
1,1-Dichloroethane	75-34-3	5
1,2-Dichloroethane	107-06-2	5
1,1-Dichloroethene	75-35-4	7
cis-1,2-Dichloroethene	156-59-2	70
trans-1,2-Dichloroethene	156-60-5	100
1,2-Dichloropropane	78-87-5	5
1,3-Dichloropropane	142-28-9	
2,2-Dichloropropane	590-20-7	
1,1-Dichloropropene	563-58-6	
1,1-Dichloropropanone*	513-88-2	
cis-1,3-Dichloropropene	10061-01-5	0.5
trans-1,3-Dichloropropene	10061-02-6	

Chemical Abstract Service

Analyte	Registry Number	Primary/Secon. MCL/Notes
Diethyl ether*	60-29-7	
Ethylbenzene	100-41-4	700
Ethyl methacrylate*	97-63-2	
Hexachlorobutadiene	87-68-3	1
Hexachloroethane*	67-72-1	
2-Hexanone*	591-78-6	
Isopropylbenzene	98-82-8	
4-Isopropyltoluene	99-87-6	
Methacrylonitrile*	126-98-7	
Methylacrylate*	96-33-3	
Methylene chloride	75-09-2	5
Methyl iodide*	74-88-4	
Methylmethacrylate*	80-62-6	
4-Methyl-2-pentanone*	108-10-1	
Methyl-t-butyl ether* (MTBE)	1634-04-4	40
Naphthalene	91-20-3	20
Nitrobenzene*	98-95-3	
2-Nitropropane*	79-46-9	
Pentachloroethane*	76-01-7	
Propionitrile*	107-12-0	
n-Propylbenzene	103-65-1	
Styrene	100-42-5	100
1,1,1,2-Tetrachloroethane	630-20-6	5
1,1,2,2-Tetrachloroethane	79-34-5	70
Tetrachloroethene	127-18-4	5
Tetrahydrofuran*	109-99-9	
Toluene	108-88-3	1000
1,2,3-Trichlorobenzene	87-61-6	
1,2,4-Trichlorobenzene	120-82-1	70
1,1,1-Trichloroethane	71-55-6	200
1,1,2-Trichloroethane	79-00-5	5
Trichloroethene	79-01-6	5
Trichlorofluoromethane	75-69-4	2100
1,2,3-Trichloropropane	96-18-4	5
1,2,4-Trimethylbenzene	95-63-6	5
1,3,5-Trimethylbenzene	108-67-8	4
Vinyl chloride	75-01-4	2
o-Xylene	95-47-6	10,000 total Xylenes [2]
m-Xylene	108-38-3	
p-Xylene	106-42-3	

NOTES

1. Total trihalomethanes, a disinfection byproduct, consists of the sum of bromoform, chloroform, chlorodibromomethane and bromodichloromethane.
2. Total Xylenes consists of the sum of o-, m- and p- Xylene.