Uni-Bell PVC Pipe Association

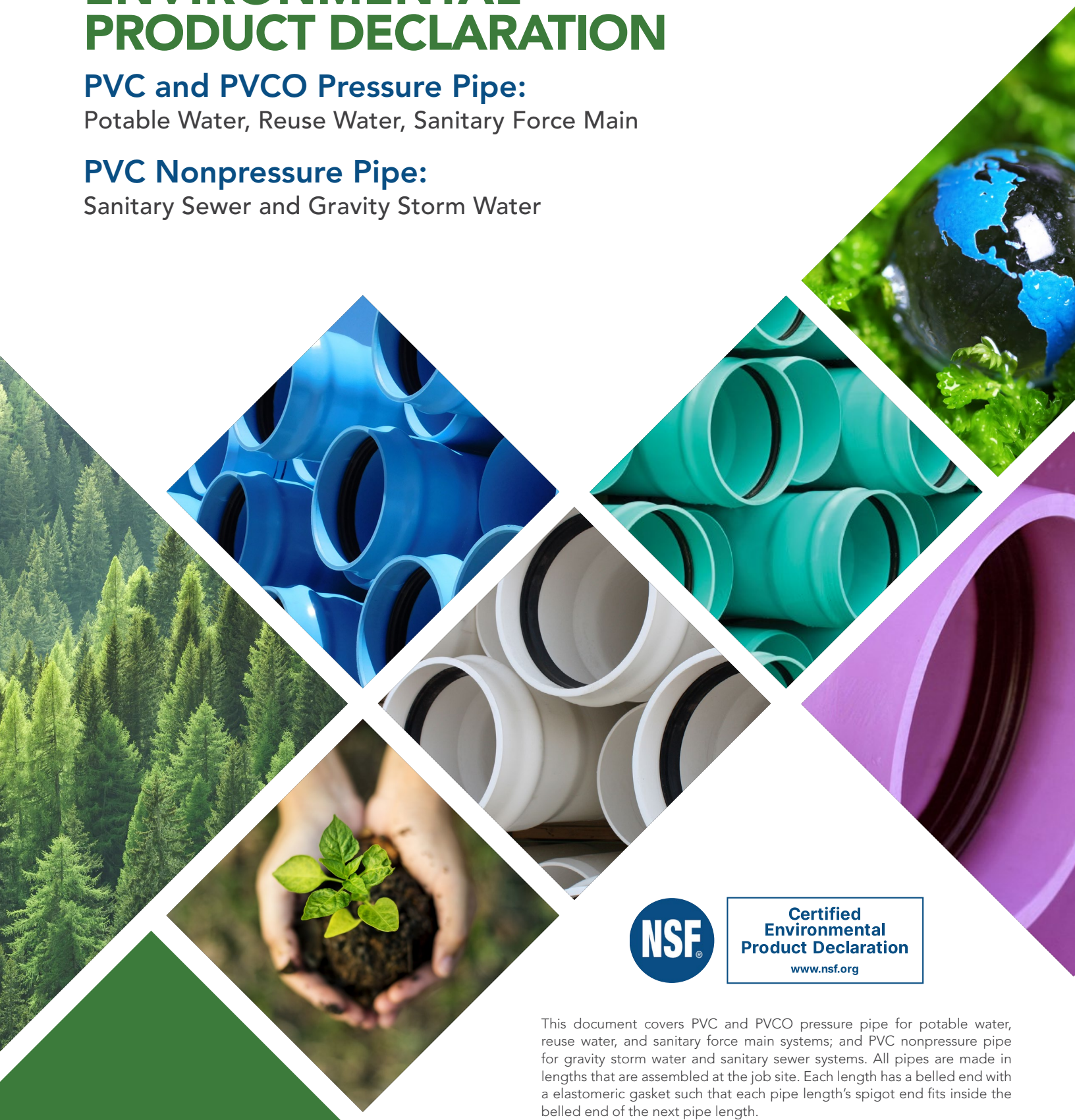
ENVIRONMENTAL PRODUCT DECLARATION

PVC and PVCO Pressure Pipe:

Potable Water, Reuse Water, Sanitary Force Main

PVC Nonpressure Pipe:

Sanitary Sewer and Gravity Storm Water



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This document covers PVC and PVCO pressure pipe for potable water, reuse water, and sanitary force main systems; and PVC nonpressure pipe for gravity storm water and sanitary sewer systems. All pipes are made in lengths that are assembled at the job site. Each length has a belled end with a elastomeric gasket such that each pipe length's spigot end fits inside the belled end of the next pipe length.

Verified LCA Conformity to Product Category Rule (PCR-1002) and ISO 14025

ENVIRONMENTAL PRODUCT DECLARATION (EPD) VERIFICATION

EPD Information

Program Operator		NSF International	
Declaration Holder		Uni-Bell PVC Pipe Association 201 E. John Carpenter Freeway, Suite 750 Irving, TX 75062	
Product: PVC Pipe	Date of Issue: March 21, 2023	Period of Validity: 5 Years	Declaration Number: EPD10047

This EPD was independently verified by NSF International in accordance with ISO 14025: ☐ Internal ☒ External	Jack Geibig, EcoForm, LLC jgeibig@ecoform.com
This life cycle assessment (LCA) was independently verified in accordance with ISO 14044, ISO 21930, and the reference Product Category Rule (PCR).	Jack Geibig, EcoForm, LLC jgeibig@ecoform.com

LCA Information

Basis LCA	Potable Water, Reuse Water, Gravity Storm Water, Sanitary Force Main and Sanitary Sewer Pipe Systems, March, 2022
LCA Preparer	Cara Vought, Technical Manager Sustainable Solutions Corporation cara@sustainablesolutionscorporation.com

PCR Information

Program Operator	ICC Evaluation Services (ICC-ES) (https://icc-es.org/environmental-program/)
Reference PCR	Product Category Rules for Rigid and Flexible Building Piping Systems in North America (PCR-1002)
Date of Issue	02-01-2019
PCR review was conducted by:	Greg Johnson – Johnson & Associates Consulting Services Allan Bilka, R.A. – Senior Staff Architect, ICC Mark Reddin – Uponor

This document is intended for Business-to-Customer (B2C) applications. EPDs according to different PCR documents or programs may not be comparable. The details within this document represent industry-averaged performance and data. Only EPDs that are prepared from cradle-to-grave life cycle results and based on the same function, reference service life (RSL) quantified by the same functional unit, and meeting all the conditions in ISO 14025, Section 6.7.2 shall be permitted to be used to assist purchasers and users in making informed comparisons between products.

EXECUTIVE SUMMARY

PVC pipe has low cradle-to-grave environmental impacts. For pressure pipe, the most important drivers for environmental impacts are pipe installation and use phase. Although the use phase has the largest impact on the life cycle, PVC pipe is designed to minimize use-phase impacts due to the smooth surface of the pipe wall that reduces the frictional energy loss from pumping pressurized water through the system. For nonpressure pipe, installation of pipe is the primary driver of impacts. For both pressure and nonpressure pipe, PVC resin is a significant contributor. It is important to realize that PVC pipe's use phase is not impacted by decline of pipe properties, since PVC's hydraulic characteristics do not deteriorate with age.

There has been an overall 6% reduction of embodied carbon and most other environmental impacts compared to the 2015 EPD, owing to improvements in PVC pipe manufacturing and upstream production of PVC resin. This reduction does not include use phase impacts from pumping, since it is not included in embodied energy carbon calculations. Also, there was a 20% reduction in electricity use during the extrusion process, as well as a 66% reduction in water use during PVC pipe manufacturing. Electricity is the dominant driver in manufacturing, so any reductions here are significant for the manufacturing stage. Efforts by the participating manufacturers to reduce their impacts include production increases, energy efficiency projects, and increased water tracking and reuse.

SUMMARY OF EMBODIED CARBON AND ENERGY

The following table provides a summary of the cradle-to-gate embodied carbon (that is, the A1-A3 global warming potential) as well as the cradle-to-gate embodied energy (cumulative energy demand) of the products. Please note that the embodied energy includes renewable and non-renewable energy sources used for fuel as well as for feedstock materials. For further breakdown among energy sources, please see each use of resources tables per product.

TABLE 1: SUMMARY OF EMBODIED CARBON AND ENERGY

Product	Embodied Carbon A1-A3	Embodied Energy A1-A3
	kg CO_2 eq / 1,000 ft	MJ / 1,000 ft
8" DR 18 AWWA C900	9.10E+03	2.64E+05
8" DR 25 AWWA C900	6.70E+03	1.95E+05
24" DR 25 AWWA C900	5.89E+04	1.69E+06
8" PC 235 AWWA C909	6.38E+03	1.79E+05
24" PS 46 (Profile) ASTM F794 / AASHTO M304	3.19E+04	9.34E+05
8" PS 46 (Profile) ASTM F794	2.67E+03	7.71E+04
8" DR 35 ASTM D3034	4.31E+03	1.18E+05
24" PS 46 ASTM F679	3.06E+04	8.88E+05

ADDITIONAL ENVIRONMENTAL INFORMATION

Environmental and Health During Manufacture:
There are no known environmental or health concerns associated with the physical manufacture of PVC pipe. Additionally, no known per- and polyfluoroalkyl substances (PFAS) are associated with PVC pipe production.

Environmental and Health During Installation:
There are no known environmental or health concerns related to installation of PVC pipe.

Environmental and Health During Use:
PVC pipe and fittings are resistant to chemicals generally found in water and sewer systems, preventing any leaching or releases to ground and surface water during the use of the piping system. No known chemicals are released internally into the water system. No known toxicity effects occur in the use of the product. Additionally, no known microplastics are associated with PVC pipe use.

Extraordinary Effects:
There are no known, relevant, extraordinary effects from water, fire, or mechanical destruction of these products. This includes wildfires, which do not impact PVC water and sewer infrastructure pipe since it is buried underground, insulated from heat generated above ground. Pressure and nonpressure pipe are designed to meet performance characteristics as cited in specific standards defined in the Product Description section. Any relevant testing data may be requested from individual manufacturers.

DISCLAIMER

This EPD was not written to support comparative assertions. Even for similar products, EPD results might not be comparable because of differences in data quality, functional units, use, and end-of-life stage assumptions. It is not recommended to compare EPDs with another organization as there may be differences in methodology, assumptions, allocation methods, data quality such as variability in datasets, and results of variability in assessment software tools used. This declaration represents an average performance based on production values of an industry-wide study for a calendar year.

FIGURE 1: IMAGE OF PVC PIPE

PRODUCT DESCRIPTION

The PVC pipe industry recognizes the benefits of communicating credible, science-based, and transparent environmental information about its products. This EPD covers cradle-to-grave impacts of municipal piping systems in North America using a functional unit of 1,000 feet for eight different pipe products, used in various applications, to assist with measuring and understanding the environmental impacts of PVC pipe across the life cycle. The eight PVC pipe products examined are used for both pressure applications (potable water pipes, reuse water pipes, and sanitary force mains), and nonpressure applications (sanitary sewer and gravity storm water). These products are listed in Table 2. Explanatory materials regarding product information may be found at uni-bell.org.

TABLE 2: PRODUCTS INCLUDED IN STUDY

Application	Standard	Nominal Diameter	Dimension Ratio/ Pipe Stiffness	Product Mass of Functional Unit
Pressure Pipe	AWWA C900[1]	8 in.	DR 18	3,974 kg/1,000 ft
Pressure Pipe	AWWA C900	8 in.	DR 25	2,900 kg/1,000 ft
Pressure Pipe	AWWA C900	24 in.	DR 25	24,036 kg/1,000 ft
Pressure Pipe	AWWA C909[2]	8 in.	PC 235	2,499 kg/1,000 ft
Storm Water	ASTM F794[3]/ AASHTO M304[4]	24 in. (profile wall)	PS 46	14,211 kg/1,000 ft
Storm Water	ASTM F794	8 in. (profile wall)	PS 46	1,228 kg/1,000 ft
Sanitary Sewer	ASTM D3034[5]	8 in. (solid wall)	DR 35	1,931 kg/1,000 ft
Sanitary Sewer	ASTM F679[6]	24 in. (solid wall)	PS 46	16,343 kg/1,000 ft

[1] AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm). 2022.
[2] AWWA C909 Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. (100mm) and Larger. 2022.
[3] ASTM F794 Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter. 2021.
[4] AASHTO M304 Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter. 2011.
[5] ASTM D3034 Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings. 2021.
[6] ASTM F679 Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings. 2021.

FUNCTIONAL UNIT

The environmental impacts are reported per functional unit of a product, and the functional unit is the basis for comparison in an LCA. For PVC pipe, the functional unit for this EPD is 1,000 feet of installed pipe with belled ends every 20 feet for every 8- and 24-inch pipe, over a 50-year building life. Per the Product Category Rule (PCR), a building service life is assumed at 50 years; however, PVC pipe used for water and sewer infrastructure is designed to service systems for 100 years. In fact, research studies, and dig-ups after 70 years of use confirm that PVC pipe lasts in excess of 100 years.[7,8] For this EPD, the pumping energy required to pump water through the pipe during the use stage is considered for 50 years. Per the PCR, fittings must also be included. As these piping systems are belled, fittings are not required to join the pipes together and are only used as needed for a project installation. A typical PVC water or sewer pipe system uses far fewer fittings than required for this PCR. However, for the purposes of this EPD, 258 fittings were assumed as required by the PCR standard for pressure pipe systems and 234 fittings were used for sanitary sewer. These values are reported in a separate Appendix at the end of this document as systems are variable in the number and type of fittings required.

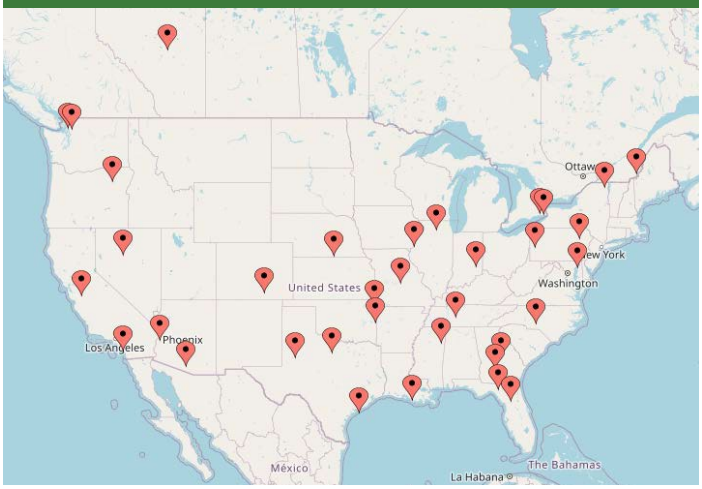
MANUFACTURING LOCATIONS

This study uses data from Uni-Bell PVC Pipe Asssociation (PVCPA) members including seven manufacturers and 35 facilities representing roughly 90% of municipal water and sewer PVC pipe product capacity in the United States and Canada. The participating manufacturers are listed in Table 3 and shown on a map in Figure 2. PVCPA is the non-profit trade association representing North America's PVC water and sewer infrastructure pipe manufacturers. The Association is the authoritative source on PVC pipe and has served the engineering, regulatory, public health, and standardization communities since 1971.

TABLE 3: PARTICIPATING PVC PIPE MANUFACTURERS

Diamond Plastics Corporation
IPEX, Inc.
Jet Stream by PipeLife
JM Eagle Corporation
National Pipe & Plastics Corporation
Sanderson Pipe Corporation
Westlake Pipe & Fittings

FIGURE 2: PVC PIPE LCA STUDY PARTICIPANTS' MANUFACTURING LOCATIONS



[7] Folkman, Steven. PVC Pipe Longevity Report: Affordability & the 100+ Year Benchmark Standard. Utah State University Buried Structures Laboratory. May 2014.

[8] Burn, S. et. al., "Long-term Performance Prediction for PVC Pipes," AWWARF Report 91092F, May 2006.

SYSTEM BOUNDARY

The system boundary of this EPD is cradle-to-grave. This project considers the life cycle activities from resource extraction through installation and end-of-life effects. The boundary covers the product, construction process, use, and end-of-life stages, as seen in Table 4. Capital goods and infrastructure flows have been excluded from the unit processes used to model the LCIA, as these goods do not significantly impact the LCA.

MATERIAL CONTENTS

PVC pipe compound ingredients are given in the units Parts per Hundred Resin (PHR). This means that for every 100 pounds of resin, the PHR amount should be added to the compound when mixing. This ensures consistency throughout the industry. The industry average PVC pipe formations are listed in Table 5. Any hazardous or toxic materials or any substances that were intentionally added to the product system were considered and included in the life cycle inventory.

TABLE 4: SYSTEM BOUNDARY

Product	Raw Material Extraction and Processing	A1	X
	Transport	A2	X
	Manufacturing	A3	X
Construction Installation	Transport	A4	X
	Construction/Installation	A5	X
Use	Use	B1	X
	Maintenance	B2	X
	Repair	B3	X
	Replacement	B4	X
	Refurbishment	B5	X
	Operational Energy Use	B6	X
	Operational Water Use	B7	X
End-of-Life	Deconstruction/ Demolition	C1	X
	Transport	C2	X
	Waste Processing	C3	X
	Disposal	C4	X
Benefits of Loads Beyond the System Boundary	Reuse	D	MND
	Recovery	D	MND
	Recycling	D	MND

*MND = module not disclosed

TABLE 5: AVERAGE PVC PIPE PRODUCT FORMULATIONS (A1)								
Product Recipe	**Parts per Hundred Resin (PHR)**							
	AWWA C900			**AWWA C909**	**ASTM F794 / AASHTO M304**	**ASTM F794**	**ASTM D3034**	**ASTM F679**
	8" DR 18	**8" DR 25**	**24" DR 25**	**8" PC 235**	**24" PS 46 Profile**	**8" PS 46 Profile**	**8" DR 35**	**24" PS 46**
PVC	100	100	100	100	100	100	100	100
Stabilizer	0.59	0.56	0.64	0.50	0.61	0.50	0.54	0.57
Titanium Dioxide	1.03	1.28	0.78	0.55	0.17	0.19	0.89	0.74
Calcium Carbonate	4.96	3.90	5.09	5.30	13.57	9.94	16.71	23.10
Pigments/Colorants	0.15	0.15	0.08	0.03	0.64	0.59	0.32	1.61
Calcium Stearate	0.77	0.80	0.88	0.40	0.54	0.61	6.05	0.89
Polyethylene Wax	0.30	0.07	0.18	0.19	0.18	0.20	0.31	0.27
Wax	0.99	0.47	1.32	0.94	1.36	1.46	1.00	1.01
Combined Wax	0.24	0.33	0.09	—	—	—	0.18	0.07
Impact Modifier	—	—	—	—	0.28	—	0.03	—
Processing Aid	—	—	0.12	—	0.32	—	—	—
Recycled PVC	—	—	—	—	—	—	3.43	—
Total	**109**	**108**	**109**	**108**	**118**	**113**	**129**	**128**
Total Weight (kg/1,000 ft)	**3,970**	**2,900**	**24,030**	**2,500**	**14,210**	**1,230**	**1,930**	**16,350**

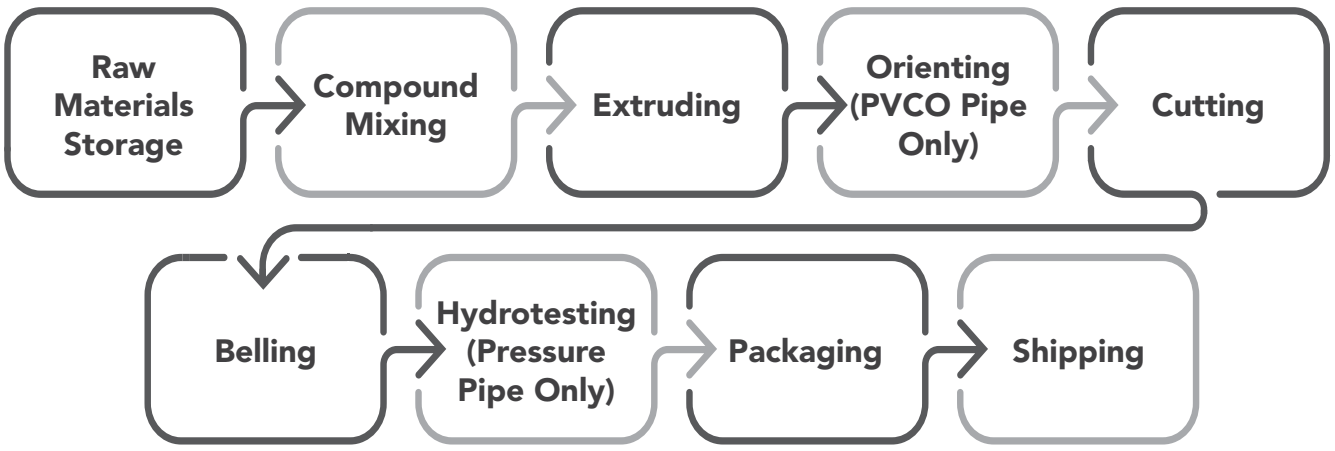
**Please note that the parts per hundred value by ingredient may be divided by the total parts to determine the percentage in the formulation.*

Fitting formulations are considered to be similar; formulations are similar for C900 fittings with the weight of a fitting being 12.5 lbs (5.7 kg) or 130 lbs (59 kg) for an 8- and 24-inch pressure pipe, respectively. For sanitary sewer and storm water, 8-inch fittings are assumed to be 4.5 lbs (2.0 kg) and 24-inch fittings are assumed to be 60 lbs (27.2 kg) per piece. Packaging materials are pallets with other procedural materials, such as paper labels. The main components of the pallets are wood, metal, plastic, cardboard, and paper. Packaging amounts are provided in Table 7.

MANUFACTURING

The production process begins when the raw materials are blended together, after which the compound flows into an electrically heated extruder. The compound passes through a die at the end of the extruder, where it is formed into a pipe shape. The pipe then moves through a sizing sleeve that provides dimensional accuracy. Solid-wall pipe is then water cooled, cut to length, and labeled as the pipe moves to the end of the production line. PVCO pipe has an additional step to form it to the final dimensions. Profile-wall pipe undergoes additional processing to form the profile shape. At the end of the production line, the pipe is belled and pressure tested (for pressure-class pipe). The pipe is then packaged and prepared for shipment from the manufacturing facility. The packaging is typically a set of wooden frames that hold the bundle of pipes together. Packaged pipe is loaded onto trucks for shipping. Figure 3 details the process flow.

FIGURE 3: PVC PIPE MANUFACTURING PROCESS



DISTRIBUTION

The final PVC pipes are shipped throughout North America. Each participating facility provided average transportation distances for the products investigated in this study. A weighted average was taken for each product in this study as seen in Table 6. All manufacturing facilities ship the PVC pipe via truck.

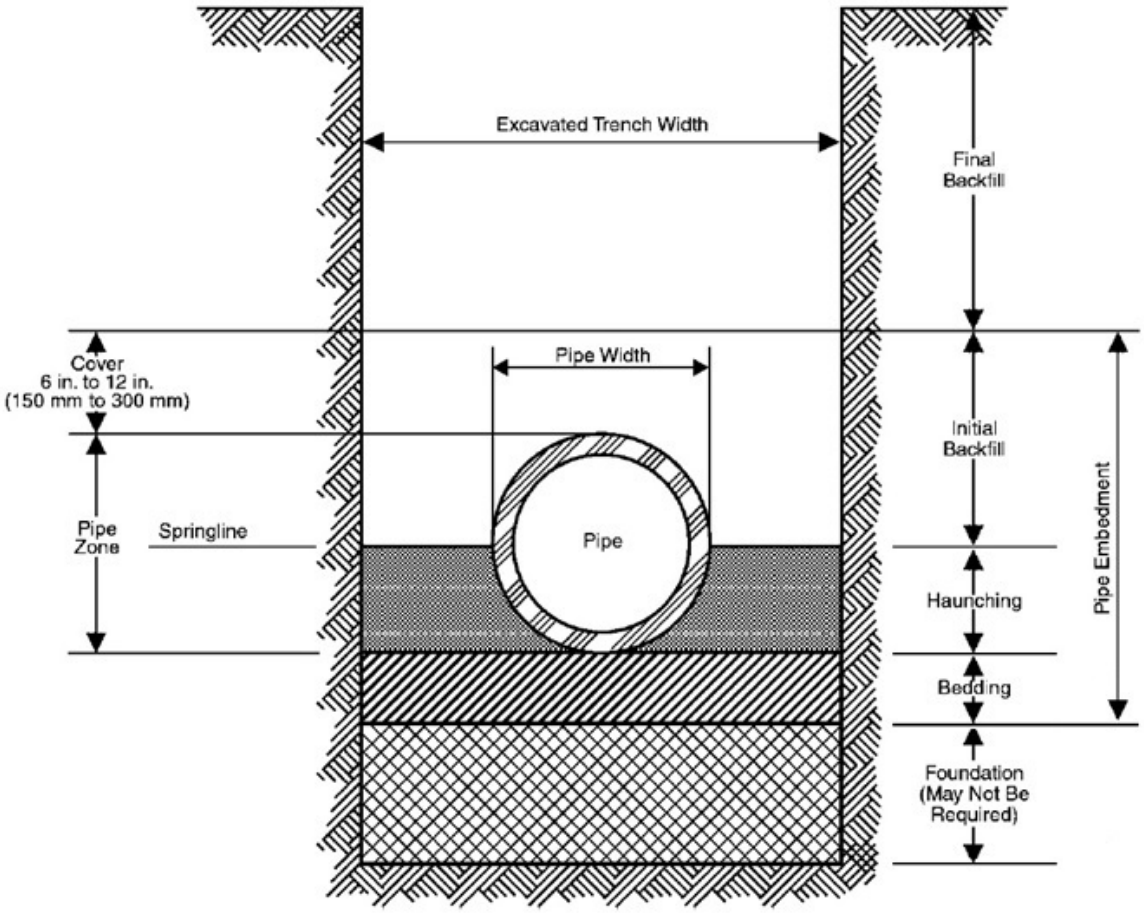
TABLE 6: TRANSPORT TO THE CONSTRUCTION SITE (A4)

Product	Unit	8″ DR 18 C900	8″ DR 25 C900	24″ DR 25 C900	8″ PC 235 C909	24″ PS 46 Profile	8″ PS 46 Profile	8″ DR 35 D3034	24″ PS 46 F679
Fuel Type	**Diesel**								
Vehicle Type	**Truck**								
Average Transport Distance	km	461	430	416	762	614	655	475	263
Capacity Utilization	% by mass	90	90	90	90	90	90	90	90
Weight of Pipe Products Transported	kg	3,970	2,900	24,030	2,500	14,210	1,230	1,930	16,350
Weight of Pipe Fittings Transported	kg	1,463	1,463	15,213	1,463	6,368	478	478	6,368
Volume of Pipe Products Transported	m^3	21.2	21.2	56.6	21.2	56.6	21.2	21.2	56.6

INSTALLATION

The vast majority of PVC pipe is installed via open-cut; however, PVC pipe can also be installed via trenchless methods. For the purposes of this EPD, only open-cut installation methods were considered. Alternative installation methods would change EPD values. Installation of PVC pipe is assumed to be similar to other open-cut pipe installation, requiring the digging and refilling of a trench. The trench depth and time required to dig and refill it varies widely per region, soil type, climate, existing infrastructure, equipment operator, local convention, and other factors, so the actual installation time and effort is widely variable. For 8-inch pipe, the trench width used was at least 24 inches. For 24-inch pipe, the trench width extended at least 36 inches. Typically, a hydraulic digger is used to dig the trench, and a small loader refills the trench. After installation, any packaging for the product is discarded.

FIGURE 4: TRENCH CROSS-SECTION DIAGRAM



Two scenarios were identified for this study. The first scenario represents a trench depth of 4 feet for the 8-inch diameter pipe, with an estimated 15 hours of machine runtime for 1,000 feet of pipe. The second scenario represents a trench depth of 10 feet for the 24-inch diameter pipe, with an estimated 25 hours of machine runtime for 1,000 feet of pipe.

INSTALLATION *cont.*

Diesel fuel usage rates are estimated to be 8 gallons/hour (30.3 liters/hour) for the digger[9] and 2 gallons/hour (7.6 liters/hour) for the loader[10]. Therefore the 15-hour baseline scenario assumes 150 gallons (567.8 liters) of diesel is required to install 1,000 feet of pipe. The longer 25-hour scenario assumes 360 gallons (1,362.8 liters) of diesel is required to install 1,000 feet of pipe. No shoring was considered. Gravel and sand were assumed to be used in the bedding and haunching of the trench, per the *Handbook of PVC Pipe: Design & Construction* manual. A combined bulk density of 120 lb/ft^3 was assumed.[11] Not all pipe installations require bedding, and most pressure pipe installations can use native soil. According to these scenarios and the functional unit of the products, 30 hours of labor have been assumed for the installation phase.

TABLE 7: CONSTRUCTION / INSTALLATION ASSUMPTIONS (A5)

Product	Unit	8" DR 18 C900	8" DR 25 C900	24" DR 25 C900	8" PC 235 C909	24" PS 46 Profile	8" PS 46 Profile	8" DR 35 D3034	24" PS 46 F679
Ancillary Materials									
Gravel	t	61.9	61.9	80	61.9	80	61.9	61.9	80
Sand	t	12.4	12.4	16.2	12.4	16.2	12.4	12.4	16.2
Disinfectant	kg	0.32	0.32	2.6	0.32	n/a	n/a	n/a	n/a
Net Freshwater Consumption	m^3	10.4	10.4	10.4	10.4	n/a	n/a	n/a	n/a
Diesel	gal	150	150	366	150	366	150	150	366
Electricity	kWh	0.3	0.3	13.0	0.3	n/a	n/a	n/a	n/a
Other Energy Carriers	MJ	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Product Loss	kg	199	145	1,202	125	711	61	97	817
Waste Materials	kg	199	145	1,202	125	711	61	97	817
Output Materials (Landfill)	kg	199	145	1,202	125	711	61	97	817
Packaging Materials									
Paper	kg	3.19E-02	4.56E-02	2.28E-01	1.99E-01	3.48E+00	9.94E-01	4.94E-03	3.67E+00
Plastic	kg	5.93E+00	6.11E+00	5.26E+01	2.94E+01	5.00E+00	7.91E-01	1.98E+00	1.09E+01
Cardboard	kg	3.03E-02	1.68E-02	1.90E-01	0.00E+00	1.07E-02	4.06E-03	1.81E-02	8.85E-02
Metal	kg	4.91E-01	3.14E-01	6.88E+00	1.97E+00	8.21E+00	1.04E+00	3.36E-01	2.42E+00
Wood	kg	5.80E+01	7.15E+01	1.43E+02	3.57E+02	3.47E+02	2.69E+01	1.72E+01	6.00E+01
Biogenic Carbon Contained in Packaging	kg CO_2	1.06E+02	1.31E+02	2.62E+02	6.54E+02	6.35E+02	4.93E+01	3.16E+01	1.10E+02
Direct Emissions	kg	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
VOC Emissions	kg	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

[9] Forum on Heavy Equipment. https://www.heavyequipmentforums.com/showthread.php?5804-Fuel-Consumption. Accessed March 2013.

[10] Forum on Forestry Forum. https://www.forestryforum.com/board/index.php?topic=14063.0. Accessed March 2013.

[11] SI Metric. Density of Dry Material Table. https://www.simetric.co.uk/si_materials.htm. Accessed September 25, 2013.

REFERENCE SERVICE LIFE

The following assumptions were made for this study.

TABLE 8: REFERENCE SERVICE LIFE

Subject	Unit	Potable Water	Storm Water	Sanitary Sewer
Reference Service Life (RSL)	Years	50	50	50
Estimated Service Life (ESL)	Years	100	100	100
Declared Product Properties	Click here for resources on installation practices for PVC pressure pipe.		Click here for resources on installation practices for PVC nonpressure pipe.	
Design Application Parameters & Use Conditions				
Quality of Work				
Outdoor Environment				
Indoor Environment		n/a	n/a	n/a
Water Loss	Liters	—	—	—
Number of Replacements	#	0	0	0
Maintenance	Please refer to the maintenance guides provided by the manufacturer, or on PVCPA's resource page.			

USE

It is assumed that replacements or repairs of pipes will not be necessary during the course of 50 years, which is the service life per the PCR. In pressure-pipe systems, pumping energy is required to overcome friction between the pipe wall and the flowing fluid. To calculate the amount of energy required of the pumps for the friction head from the PVC pipe, the following assumptions were made. Note that 8,760 annual operating hours equal 24-hour, 365-day pumping.

TABLE 9: OPERATIONAL USE ASSUMPTIONS	
Parameter	**Value**
Water Flow Velocity in PVC Pipe	2 feet/second
Pump Efficiency	75%
Operating Hours Per Year	8,760
Length of Pipe	1,000 feet
Elevation Increase	0 feet
Hazen-Williams Coefficient for PVC	150[12]

The friction head loss through 1,000 feet of pipe was calculated using the Hazen-Williams equation. The assumed PCR service life is 50 years; however, the pipe product's estimated service life is actually longer and designed for 100 years. The selected service life used in the project reflects the PCR requirements; however, industry experts and studies by Utah State University[13] as well as the American Water Works Association and Water Research Foundation (AWWARF)[14] confirm that PVC pipe has a service life in excess of 100 years.

TABLE 10: OPERATIONAL ENERGY USE CALCULATION RESULTS FOR C900 & C909 PVC PIPES				
Product	**8" DR 18 C900**	**8" DR 25 C900**	**24" DR 25 C900**	**8" PC 235 C909**
Hazen-Williams Coefficient	150	150	150	150
Inside Diameter (inch)	8.04	8.33	23.74	8.44
Flow Rate (gpm) at 2 ft/s velocity	317	339	2,758	349
Pumping Energy (kWh/yr)	1,150	1,190	2,860	1,200
Operational Energy Use for 50 years (MJ)	20,700	21,420	51,480	21,600

END-OF-LIFE

While products are traditionally left in the ground, this study assumes that piping systems are replaced after their reference service life with a new piping system. However, most water and sewer systems are left in place without removal. For deconstruction, no additional energy was assumed as typically when pipe is actively removed a replacement system is being installed; therefore, the installation energy of the next system would capture any removal of a piping system. To avoid double counting of diesel impacts, all energy is assumed in the installation of the new system. PVC pipe is 100% recyclable so if the product is removed from the ground after its service life the preferred end-of-life is recycling. PVC pipe can be recycled back into itself up to eight times without a reduction in mechanical properties. However, owing to its longevity, most of it has yet to enter the recycling stream. Disposal in a municipal landfill is permissible and should be done in accordance with local, state, and federal regulations. For this study, disposal was modeled in compliance with the PCR and is not a significant contributor to environmental impacts.

[12] *Handbook of PVC Pipe: Design and Construction*. Fifth Edition. Uni-Bell. (2012) 9.7.

[13] Folkman, Steven. PVC Pipe Longevity Report: Affordability & the 100+ Year Benchmark Standard. Utah State University Buried Structures Laboratory. May 2014.

[14] Burn, S. et. al., "Long-term Performance Prediction for PVC Pipes," AWWARF Report 91092F, May 2006.

TABLE 11: END-OF-LIFE ASSUMPTIONS (C1-C4)						
Product		**Unit**	**8″ DR 18 C900**	**8″ DR 25 C900**	**24″ DR 25 C900**	**8″ PC 235 C909**
Collection Process	Collected Separately (Pipe)	kg	3,974	2,900	24,036	2,499
	Collected Separately (Fittings)	kg	1,463	1,463	15,213	1,463
	Collected with Mixed Construction Waste	kg	n/a	n/a	n/a	n/a
Distance Traveled to Disposal		km	50	50	50	50
Recovery and Disposal	Reuse	kg	n/a	n/a	n/a	n/a
	Recycling	kg	n/a	n/a	n/a	n/a
	Landfill (Pipe)	kg	3,974	2,900	24,036	2,499
	Landfill (Fittings)	kg	1,463	1,463	15,213	1,463
	Incineration	kg	n/a	n/a	n/a	n/a
	Incineration (with Energy Recovery)	kg	n/a	n/a	n/a	n/a
	Energy Conversion	kg	n/a	n/a	n/a	n/a
Removals of Biogenic Carbon		kg	n/a	n/a	n/a	n/a
Product		**Unit**	**24″ PS 46 Profile**	**8″ PS 46 Profile**	**8″ DR 35 D3034**	**24″ PS 46 F679**
Collection Process	Collected Separately (Pipe)	kg	14,211	1,228	1,931	16,343
	Collected Separately (Fittings)	kg	6,368	478	478	6,368
	Collected with Mixed Construction Waste	kg	n/a	n/a	n/a	n/a
Distance Traveled to Disposal		km	50	50	50	50
Recovery and Disposal	Reuse	kg	n/a	n/a	n/a	n/a
	Recycling	kg	n/a	n/a	n/a	n/a
	Landfill (Pipe)	kg	14,211	1,228	1,931	16,343
	Landfill (Fittings)	kg	6,368	478	478	6,368
	Incineration	kg	n/a	n/a	n/a	n/a
	Incineration (with Energy Recovery)	kg	n/a	n/a	n/a	n/a
	Energy Conversion	kg	n/a	n/a	n/a	n/a
Removals of Biogenic Carbon		kg	n/a	n/a	n/a	n/a

METHODOLOGY

Allocation: Per production mass at each facility; a weighted average based on production totals among manufacturers was conducted.

Cut-Off Rules: Cut-off rules were followed as defined by ISO 14044. All known flows were included in the system boundary, and no flows were excluded. No hazardous and toxic materials are added to the piping systems; any hazardous substances were considered and included in the life cycle inventory. The following items were cut-off using the cut-off criteria listed in the PCR:

- Construction of capital equipment
- Maintenance of operation and support equipment
- Human labor and employee commute
- Casings for pipe installed under structures
- Shoring, soil compaction during installation of pipe

Data Sources: ecoinvent v3.7 and US LCI

Data Quality:

- Primary Data: 2019 calendar year
- Secondary Data: Representative of North America, based on the ecoinvent v3.7 recycled content database and the US LCI datasets, with datasets developed or updated within 10 years.
  - Vinyl resin data was leveraged from the 2021 published LCA study by Franklin Associates (a divison of ERM) as published in the Federal LCA Commons and US LCI database.
- Secondary data were evaluated with regards to precision, completeness, consistency, reproducibility, representativeness, and uncertaintly. Based on these criteria, the data quality used throughout this study is considered high.

Software: SimaPro v9.3

Period Under Review: Data from 2019 was collected and average based on production from each participating facility.

Estimates and Assumptions:

- Products are assumed to travel 500 miles in a diesel-powered truck to the building site.
- Manual installation occurs with a 5% scrap rate.
- Underground pipe is predominantly left in the ground at the end of the service life and not recovered for disposal in a landfill or incinerator nor recycled.

LIFE CYCLE IMPACT ASSESSMENT (LCIA)

The impact categories analyzed for this EPD include: global warming potential, ozone depletion, acidification, eutrophication, and smog formation. The TRACI 2.1 version 4.1 and CML impact assessment methodologies were used to calculate the environmental impacts in this LCA.

PRESSURE PIPE: 8" DR 18 AWWA C900

TABLE 12: 8" DR 18 AWWA C900 LIFE CYCLE IMPACT ASSESSMENT

TRACI v2.1		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
GWP	Global Warming Potential	kg CO_2 eq	7.94E+03	1.28E+02	1.04E+03	1.69E+02	2.52E+03	2.72E+04	3.92E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	1.30E-03	4.87E-09	7.43E-05	6.45E-09	5.48E-05	2.10E-03	9.02E-06
AP	Acidification Potential	kg SO_2 eq	6.65E+01	1.83E+00	2.89E+00	1.01E+00	2.86E+01	6.88E+01	4.24E-01
EP	Eutrophication Potential	kg N eq	3.56E+00	1.10E-01	3.39E+00	5.62E-02	3.17E+00	8.20E+01	4.95E-02
POCP	Photochemical Ozone Creation Potential	kg O_3 eq	3.43E+02	5.86E+01	4.37E+01	2.76E+01	8.42E+02	1.12E+03	1.08E+01
CML 2 Baseline 2001		**Unit (per 1,000 ft)**	**Product Stage**			**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	8.06E+03	1.28E+02	1.05E+03	1.69E+02	2.54E+03	2.74E+04	3.94E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	4.36E-04	4.83E-09	5.12E-05	6.38E-09	3.96E-05	1.42E-03	6.77E-06
AP	Acidification Potential	kg SO_2 eq	7.35E+01	1.40E+00	2.68E+00	8.33E-01	2.22E+01	6.17E+01	3.39E-01
EP	Eutrophication Potential	kg PO_4 eq	2.91E+00	3.10E-01	1.62E+00	1.48E-01	5.13E+00	4.00E+01	7.38E-02
POCP	Photochemical Ozone Creation Potential	kg C_2H_4 eq	4.05E+00	3.13E-02	1.46E-01	3.84E-02	7.78E-01	3.18E+00	-3.43E-02
ADPF	Abiotic Depletion Potential for Fossil Resources	MJ	2.39E+05	1.64E+03	1.35E+04	2.17E+03	3.39E+04	3.56E+05	8.47E+02

TABLE 13: 8" DR 18 AWWA C900 USE OF RESOURCES

Use of Resources		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
NRPRE	Non-renewable Primary Resources Used as an Energy Carrier	MJ	2.36E+05	1.64E+03	1.92E+04	2.17E+03	3.62E+04	5.15E+05	8.53E+02
RPRE	Renewable Primary Resources Used as an Energy Carrier	MJ	1.54E+03	0.00E+00	1.16E+03	0.00E+00	4.81E+02	4.88E+04	4.69E+00
NRPRM	Non-renewable Primary Resources with Energy Content Used as a Material	kg	3.96E+03	0.00E+00	2.36E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPRM	Renewable Primary Resources with Energy Content Used as a Material	kg	1.10E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	Use of Secondary Materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	Use of Non-renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	Fresh Water Consumption	m^3	2.62E+01	0.00E+00	4.15E+00	0.00E+00	2.34E+02	1.03E+02	6.19E-01
NRN	Non-renewable Nuclear	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 14: 8" DR 18 AWWA C900 OUTPUT FLOWS

Parameter		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
HWD	Disposed-of Hazardous Waste	kg	0.00E+00	0.00E+00	9.46E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	Disposed-of Non-Hazardous Waste	kg	0.00E+00	0.00E+00	2.94E+01	0.00E+00	2.10E+02	0.00E+00	3.96E+03
RWD	Disposed-of Radioactive Waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	Components for Reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Materials for Recycling	kg	0.00E+00	0.00E+00	2.07E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MET	Materials for Energy Recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	Exported Electrical Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	Exported Thermal Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPr	Bio-Based Products	kg CO_2 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPk	Bio-Based Packaging	kg CO_2 eq	-5.79E+01	0.00E+00	0.00E+00	0.00E+00	5.79E+01	0.00E+00	0.00E+00

PRESSURE PIPE: 8" DR 25 AWWA C900

TABLE 15: 8" DR 25 AWWA C900 LIFE CYCLE IMPACT ASSESSMENT									
TRACI v2.1		**Unit (per 1,000 ft)**	**Product Stage**			**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	5.86E+03	1.56E+02	6.89E+02	1.14E+02	2.50E+03	2.81E+04	2.84E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	9.61E-04	2.47E-06	4.49E-05	4.36E-09	5.32E-05	2.17E-03	6.54E-06
AP	Acidification Potential	kg SO_2 eq	4.91E+01	2.21E+00	2.03E+00	6.83E-01	2.86E+01	7.12E+01	3.08E-01
EP	Eutrophication Potential	kg N eq	2.80E+00	1.84E-01	2.90E+00	3.81E-02	3.09E+00	8.48E+01	3.59E-02
POCP	Photochemical Ozone Creation Potential	kg O_3 eq	2.53E+02	6.88E+01	3.10E+01	1.87E+01	8.41E+02	1.15E+03	7.80E+00
CML 2 Baseline 2001		**Unit (per 1,000 ft)**	**Product Stage**			**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	5.95E+03	1.56E+02	6.97E+02	1.15E+02	2.51E+03	2.83E+04	2.85E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	3.24E-04	2.28E-06	3.12E-05	4.32E-09	3.85E-05	1.47E-03	4.91E-06
AP	Acidification Potential	kg SO_2 eq	5.42E+01	1.71E+00	1.90E+00	5.64E-01	2.21E+01	6.39E+01	2.46E-01
EP	Eutrophication Potential	kg PO_4 eq	2.22E+00	3.87E-01	1.36E+00	9.98E-02	5.10E+00	4.14E+01	5.35E-02
POCP	Photochemical Ozone Creation Potential	kg C_2H_4 eq	3.01E+00	4.16E-02	9.84E-02	2.60E-02	7.75E-01	3.29E+00	-2.48E-02
ADPF	Abiotic Depletion Potential for Fossil Resources	MJ	1.75E+05	2.19E+03	8.48E+03	1.47E+03	3.37E+04	3.68E+05	6.14E+02

TABLE 16: 8" DR 25 AWWA C900 USE OF RESOURCES

Use of Resources		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
NRPRE	Non-renewable Primary Resources Used as an Energy Carrier	MJ	1.24E+05	2.21E+03	1.29E+04	1.47E+03	3.59E+04	5.33E+05	6.18E+02
RPRE	Renewable Primary Resources Used as an Energy Carrier	MJ	1.17E+03	1.56E+01	2.55E+03	0.00E+00	4.33E+02	5.05E+04	3.40E+00
NRPRM	Non-renewable Primary Resources with Energy Content Used as a Material	kg	5.21E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPRM	Renewable Primary Resources with Energy Content Used as a Material	kg	1.34E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	Use of Secondary Materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	Use of Non-renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	Fresh Water Consumption	m^3	1.93E+01	3.26E-01	2.88E+00	0.00E+00	1.29E+02	1.06E+02	4.48E-01
NRN	Non-renewable Nuclear	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 17: 8" DR 25 AWWA C900 OUTPUT FLOWS

Parameter		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
HWD	Disposed-of Hazardous Waste	kg	0.00E+00	0.00E+00	6.85E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	Disposed-of Non-Hazardous Waste	kg	0.00E+00	0.00E+00	2.13E+01	0.00E+00	1.57E+03	0.00E+00	2.87E+04
RWD	Disposed-of Radioactive Waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	Components for Reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Materials for Recycling	kg	0.00E+00	0.00E+00	1.50E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MET	Materials for Energy Recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	Exported Electrical Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	Exported Thermal Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPr	Bio-Based Products	kg CO_2 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPk	Bio-Based Packaging	kg CO_2 eq	-4.19E+01	0.00E+00	0.00E+00	0.00E+00	4.19E+01	0.00E+00	0.00E+00

PRESSURE PIPE: 24" DR 25 AWWA C900

TABLE 18: 24" DR 25 AWWA C900 LIFE CYCLE IMPACT ASSESSMENT									
TRACI v2.1		**Unit (per 1,000 ft)**	**Product Stage**			**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	4.79E+04	1.56E+03	9.45E+03	9.28E+02	5.52E+03	6.76E+04	2.38E+02
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	7.85E-03	2.51E-05	6.50E-04	3.54E-08	1.06E-04	5.22E-03	5.48E-05
AP	Acidification Potential	kg SO_2 eq	4.01E+02	2.13E+01	2.73E+01	5.54E+00	6.63E+01	1.71E+02	2.58E+00
EP	Eutrophication Potential	kg N eq	2.05E+01	1.80E+00	3.54E+01	3.09E-01	6.32E+00	2.04E+02	3.01E-01
POCP	Photochemical Ozone Creation Potential	kg O_3 eq	2.06E+03	6.60E+02	3.90E+02	1.52E+02	2.00E+03	2.77E+03	6.54E+01
CML 2 Baseline 2001		**Unit (per 1,000 ft)**	**Product Stage**			**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	4.86E+04	1.56E+03	9.55E+03	9.30E+02	5.54E+03	6.81E+04	2.39E+02
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	2.61E-03	2.32E-05	4.47E-04	3.50E-08	7.80E-05	3.53E-03	4.11E-05
AP	Acidification Potential	kg SO_2 eq	4.43E+02	1.64E+01	2.58E+01	4.57E+00	5.08E+01	1.53E+02	2.06E+00
EP	Eutrophication Potential	kg PO_4 eq	1.72E+01	3.73E+00	1.66E+01	8.10E-01	1.17E+01	9.94E+01	4.48E-01
POCP	Photochemical Ozone Creation Potential	kg C_2H_4 eq	2.44E+01	4.15E-01	1.32E+00	2.11E-01	1.76E+00	7.90E+00	-2.08E-01
ADPF	Abiotic Depletion Potential for Fossil Resources	MJ	1.44E+06	2.15E+04	1.19E+05	1.19E+04	7.67E+04	8.84E+05	5.15E+03

TABLE 19: 24" DR 25 AWWA C900 USE OF RESOURCES

Use of Resources		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
NRPRE	Non-renewable Primary Resources Used as an Energy Carrier	MJ	1.01E+06	2.17E+04	1.77E+05	1.19E+04	7.99E+04	1.28E+06	5.18E+03
RPRE	Renewable Primary Resources Used as an Energy Carrier	MJ	9.90E+03	1.50E+02	2.59E+04	0.00E+00	8.53E+02	1.21E+05	2.85E+01
NRPRM	Non-renewable Primary Resources with Energy Content Used as a Material	kg	4.37E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPRM	Renewable Primary Resources with Energy Content Used as a Material	kg	2.72E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	Use of Secondary Materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	Use of Non-renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	Fresh Water Consumption	m^3	1.54E+02	3.36E+00	4.42E+01	0.00E+00	2.71E+02	2.56E+02	3.76E+00
NRN	Non-renewable Nuclear	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 20: 24" DR 25 AWWA C900 OUTPUT FLOWS

Parameter		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
HWD	Disposed-of Hazardous Waste	kg	0.00E+00	0.00E+00	5.74E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	Disposed-of Non-Hazardous Waste	kg	0.00E+00	0.00E+00	1.78E+02	0.00E+00	1.40E+03	0.00E+00	2.40E+04
RWD	Disposed-of Radioactive Waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	Components for Reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Materials for Recycling	kg	0.00E+00	0.00E+00	1.26E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MET	Materials for Energy Recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	Exported Electrical Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	Exported Thermal Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPr	Bio-Based Products	kg CO_2 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPk	Bio-Based Packaging	kg CO_2 eq	-2.64E+02	0.00E+00	0.00E+00	0.00E+00	2.64E+02	0.00E+00	0.00E+00

PRESSURE PIPE: 8" PC 235 AWWA C909

TABLE 21: 8" PC 235 AWWA C909 LIFE CYCLE IMPACT ASSESSMENT									
TRACI v2.1		**Unit (per 1,000 ft)**	**Product Stage**			**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	4.88E+03	1.20E+03	3.00E+02	1.76E+02	2.52E+03	2.84E+04	2.48E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	8.17E-04	6.87E-05	1.42E-05	6.73E-09	5.48E-05	2.19E-03	5.70E-06
AP	Acidification Potential	kg SO_2 eq	4.14E+01	5.15E+00	1.71E+00	1.05E+00	2.86E+01	7.18E+01	2.68E-01
EP	Eutrophication Potential	kg N eq	1.61E+00	5.18E+00	3.75E-01	5.87E-02	3.17E+00	8.55E+01	3.12E-02
POCP	Photochemical Ozone Creation Potential	kg O_3 eq	2.09E+02	9.23E+01	2.40E+01	2.88E+01	8.42E+02	1.16E+03	6.79E+00
CML 2 Baseline 2001		**Unit (per 1,000 ft)**	**Product Stage**			**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	4.96E+03	1.21E+03	2.99E+02	1.77E+02	2.54E+03	2.86E+04	2.49E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	2.69E-04	4.83E-05	1.31E-05	6.67E-09	3.96E-05	1.48E-03	4.27E-06
AP	Acidification Potential	kg SO_2 eq	4.58E+01	4.75E+00	1.70E+00	8.69E-01	2.22E+01	6.44E+01	2.14E-01
EP	Eutrophication Potential	kg PO_4 eq	1.54E+00	2.59E+00	2.65E-01	1.54E-01	5.13E+00	4.17E+01	4.66E-02
POCP	Photochemical Ozone Creation Potential	kg C_2H_4 eq	2.49E+00	2.00E-01	1.14E-01	4.01E-02	7.78E-01	3.32E+00	-2.16E-02
ADPF	Abiotic Depletion Potential for Fossil Resources	MJ	1.50E+05	1.48E+04	4.79E+03	2.27E+03	3.39E+04	3.71E+05	5.35E+02

TABLE 22: 8" PC 235 AWWA C909 USE OF RESOURCES

Use of Resources		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
NRPRE	Non-renewable Primary Resources Used as an Energy Carrier	MJ	1.48E+05	2.30E+04	4.69E+03	2.27E+03	3.62E+04	5.37E+05	5.39E+02
RPRE	Renewable Primary Resources Used as an Energy Carrier	MJ	5.05E+02	5.52E+03	8.60E+01	0.00E+00	4.81E+02	5.10E+04	2.96E+00
NRPRM	Non-renewable Primary Resources with Energy Content Used as a Material	kg	2.50E+03	0.00E+00	2.11E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPRM	Renewable Primary Resources with Energy Content Used as a Material	kg	1.17E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	Use of Secondary Materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	Use of Non-renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	Fresh Water Consumption	m^3	1.48E+01	6.36E+00	1.91E+00	0.00E+00	2.34E+02	1.07E+02	3.91E-01
NRN	Non-renewable Nuclear	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 23: 8" PC 235 AWWA C909 OUTPUT FLOWS

Parameter		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
HWD	Disposed-of Hazardous Waste	kg	0.00E+00	0.00E+00	5.97E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	Disposed-of Non-Hazardous Waste	kg	0.00E+00	0.00E+00	1.85E+01	0.00E+00	5.13E+02	0.00E+00	2.50E+03
RWD	Disposed-of Radioactive Waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	Components for Reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Materials for Recycling	kg	0.00E+00	0.00E+00	1.31E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MET	Materials for Energy Recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	Exported Electrical Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	Exported Thermal Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPr	Bio-Based Products	kg CO_2 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPk	Bio-Based Packaging	kg CO_2 eq	-5.79E+01	0.00E+00	0.00E+00	0.00E+00	5.79E+01	0.00E+00	0.00E+00

STORM WATER PIPE: 24" PS 46 ASTM F794 / AASHTO M304 (PROFILE WALL) PVC PIPE

TABLE 24: 24" PS 46 ASTM F794 / AASHTO M304 (PROFILE WALL) LIFE CYCLE IMPACT ASSESSMENT

TRACI v2.1		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
GWP	Global Warming Potential	kg CO_2 eq	2.58E+04	1.66E+03	3.13E+03	8.09E+02	5.46E+03	0.00E+00	7.28E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	4.26E-03	2.02E-06	2.02E-04	3.09E-08	1.04E-04	0.00E+00	3.24E-05
AP	Acidification Potential	kg SO_2 eq	2.17E+02	2.14E+01	9.22E+00	4.83E+00	6.60E+01	0.00E+00	6.25E-01
EP	Eutrophication Potential	kg N eq	8.10E+00	1.29E+00	1.16E+01	2.69E-01	6.22E+00	0.00E+00	1.24E-01
POCP	Photochemical Ozone Creation Potential	kg O_3 eq	1.10E+03	6.61E+02	1.60E+02	1.32E+02	2.00E+03	0.00E+00	1.55E+01
CML 2 Baseline 2001		**Unit (per 1,000 ft)**	**Product Stage**			**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	2.62E+04	1.67E+03	3.17E+03	8.12E+02	5.49E+03	0.00E+00	7.30E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	1.39E-03	1.82E-06	1.39E-04	3.06E-08	7.64E-05	0.00E+00	2.43E-05
AP	Acidification Potential	kg SO_2 eq	2.40E+02	1.66E+01	8.38E+00	3.99E+00	5.06E+01	0.00E+00	5.32E-01
EP	Eutrophication Potential	kg PO_4 eq	8.03E+00	3.51E+00	5.59E+00	7.06E-01	1.16E+01	0.00E+00	1.15E-01
POCP	Photochemical Ozone Creation Potential	kg C_2H_4 eq	1.30E+01	4.37E-01	4.38E-01	1.84E-01	1.73E+00	0.00E+00	2.18E-02
ADPF	Abiotic Depletion Potential for Fossil Resources	MJ	7.93E+05	2.17E+04	3.90E+04	1.04E+04	7.60E+04	0.00E+00	2.07E+03

TABLE 25: 24" PS 46 ASTM F794 / AASHTO M304 (PROFILE WALL) USE OF RESOURCES

Use of Resources		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
NRPRE	Non-renewable Primary Resources Used as an Energy Carrier	MJ	5.52E+05	2.18E+04	5.78E+04	1.04E+04	7.91E+04	0.00E+00	2.09E+03
RPRE	Renewable Primary Resources Used as an Energy Carrier	MJ	2.08E+03	1.34E+02	4.68E+03	0.00E+00	7.98E+02	0.00E+00	1.68E+01
NRPRM	Non-renewable Primary Resources with Energy Content Used as a Material	kg	2.43E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPRM	Renewable Primary Resources with Energy Content Used as a Material	kg	6.59E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	Use of Secondary Materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	Use of Non-renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	Fresh Water Consumption	m^3	8.95E+01	2.60E-01	1.37E+01	0.00E+00	1.52E+02	0.00E+00	2.22E+00
NRN	Non-renewable Nuclear	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 26: 24" PS 46 ASTM F794 / AASHTO M304 (PROFILE WALL) OUTPUT FLOWS

Parameter		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
HWD	Disposed-of Hazardous Waste	kg	0.00E+00	0.00E+00	3.40E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	Disposed-of Non-Hazardous Waste	kg	0.00E+00	0.00E+00	1.05E+02	0.00E+00	1.07E+03	0.00E+00	1.42E+04
RWD	Disposed-of Radioactive Waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	Components for Reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Materials for Recycling	kg	0.00E+00	0.00E+00	7.44E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MET	Materials for Energy Recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	Exported Electrical Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	Exported Thermal Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPr	Bio-Based Products	kg CO_2 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPk	Bio-Based Packaging	kg CO_2 eq	-3.50E+02	0.00E+00	0.00E+00	0.00E+00	3.50E+02	0.00E+00	0.00E+00

SANITARY SEWER PIPE: 8" PS 46 ASTM F794 (PROFILE WALL) PVC PIPE

TABLE 27: 8" PS 46 ASTM F794 (PROFILE WALL) LIFE CYCLE IMPACT ASSESSMENT

TRACI v2.1		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
GWP	Global Warming Potential	kg CO_2 eq	2.20E+03	2.06E+02	2.64E+02	8.09E+02	5.46E+03	0.00E+00	7.28E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	3.67E-04	1.83E-07	1.67E-05	3.09E-08	1.04E-04	0.00E+00	3.24E-05
AP	Acidification Potential	kg SO_2 eq	1.86E+01	2.15E+00	8.01E-01	4.83E+00	6.60E+01	0.00E+00	6.25E-01
EP	Eutrophication Potential	kg N eq	6.57E-01	1.31E-01	1.03E+00	2.69E-01	6.22E+00	0.00E+00	1.24E-01
POCP	Photochemical Ozone Creation Potential	kg O_3 eq	9.39E+01	6.46E+01	1.33E+01	1.32E+02	2.00E+03	0.00E+00	1.55E+01
CML 2 Baseline 2001		**Unit (per 1,000 ft)**	**Product Stage**			**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	2.24E+03	2.07E+02	2.68E+02	8.12E+02	5.49E+03	0.00E+00	7.30E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	1.20E-04	1.58E-07	1.15E-05	3.06E-08	7.64E-05	0.00E+00	2.43E-05
AP	Acidification Potential	kg SO_2 eq	2.06E+01	1.69E+00	7.40E-01	3.99E+00	5.06E+01	0.00E+00	5.32E-01
EP	Eutrophication Potential	kg PO_4 eq	6.69E-01	3.45E-01	4.91E-01	7.06E-01	1.16E+01	0.00E+00	1.15E-01
POCP	Photochemical Ozone Creation Potential	kg C_2H_4 eq	1.12E+00	5.18E-02	3.83E-02	1.84E-01	1.73E+00	0.00E+00	2.18E-02
ADPF	Abiotic Depletion Potential for Fossil Resources	MJ	6.81E+04	2.70E+03	3.27E+03	1.04E+04	7.60E+04	0.00E+00	2.07E+03

TABLE 28: 8" PS 46 ASTM F794 (PROFILE WALL) USE OF RESOURCES

Use of Resources		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
NRPRE	Non-renewable Primary Resources Used as an Energy Carrier	MJ	4.75E+04	2.71E+03	4.84E+03	9.46E+02	3.56E+04	0.00E+00	2.65E+02
RPRE	Renewable Primary Resources Used as an Energy Carrier	MJ	6.98E+02	3.54E+01	0.00E+00	0.00E+00	4.27E+02	0.00E+00	1.45E+00
NRPRM	Non-renewable Primary Resources with Energy Content Used as a Material	kg	2.08E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPRM	Renewable Primary Resources with Energy Content Used as a Material	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	Use of Secondary Materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	Use of Non-renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	Fresh Water Consumption	m^3	7.18E+00	2.13E-02	1.18E+00	0.00E+00	1.15E+02	0.00E+00	1.92E-01
NRN	Non-renewable Nuclear	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 29: 8" PS 46 ASTM F794 (PROFILE WALL) OUTPUT FLOWS

Parameter		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
HWD	Disposed-of Hazardous Waste	kg	0.00E+00	0.00E+00	2.94E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	Disposed-of Non-Hazardous Waste	kg	0.00E+00	0.00E+00	9.11E+00	0.00E+00	9.12E+01	0.00E+00	1.23E+03
RWD	Disposed-of Radioactive Waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	Components for Reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Materials for Recycling	kg	0.00E+00	0.00E+00	6.43E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MET	Materials for Energy Recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	Exported Electrical Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	Exported Thermal Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPr	Bio-Based Products	kg CO_2 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPk	Bio-Based Packaging	kg CO_2 eq	-2.79E+01	0.00E+00	0.00E+00	0.00E+00	2.79E+01	0.00E+00	0.00E+00

SANITARY SEWER PIPE: 8" DR 35 ASTM D3034 (SOLID WALL) PVC PIPE

TABLE 30: 8" DR 35 ASTM D3034 (SOLID WALL) LIFE CYCLE IMPACT ASSESSMENT

TRACI v2.1		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
GWP	Global Warming Potential	kg CO_2 eq	3.71E+03	1.30E+02	4.71E+02	8.45E+01	2.48E+03	0.00E+00	1.90E+00
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	5.58E-04	8.02E-07	3.37E-05	3.22E-09	5.29E-05	0.00E+00	4.38E-07
AP	Acidification Potential	kg SO_2 eq	2.89E+01	1.82E+00	1.28E+00	5.05E-01	2.85E+01	0.00E+00	2.06E-02
EP	Eutrophication Potential	kg N eq	2.85E+00	1.23E-01	1.63E+00	2.81E-02	3.08E+00	0.00E+00	2.40E-03
POCP	Photochemical Ozone Creation Potential	kg O_3 eq	1.54E+02	5.68E+01	2.00E+01	1.38E+01	8.40E+02	0.00E+00	5.22E-01
CML 2 Baseline 2001		**Unit (per 1,000 ft)**	**Product Stage**			**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	3.76E+03	1.30E+02	4.75E+02	8.48E+01	2.49E+03	0.00E+00	1.91E+00
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	1.89E-04	7.40E-07	2.30E-05	3.19E-09	3.83E-05	0.00E+00	3.28E-07
AP	Acidification Potential	kg SO_2 eq	3.18E+01	1.40E+00	1.18E+00	4.17E-01	2.20E+01	0.00E+00	1.65E-02
EP	Eutrophication Potential	kg PO_4 eq	1.90E+00	3.07E-01	7.79E-01	7.38E-02	5.09E+00	0.00E+00	3.58E-03
POCP	Photochemical Ozone Creation Potential	kg C_2H_4 eq	1.88E+00	3.41E-02	6.13E-02	1.92E-02	7.65E-01	0.00E+00	-1.66E-03
ADPF	Abiotic Depletion Potential for Fossil Resources	MJ	1.02E+05	1.74E+03	6.01E+03	1.09E+03	3.35E+04	0.00E+00	4.11E+01

TABLE 31: 8" DR 35 ASTM D3034 (SOLID WALL) USE OF RESOURCES

Use of Resources		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
NRPRE	Non-renewable Primary Resources Used as an Energy Carrier	MJ	8.10E+04	1.74E+03	5.25E+01	1.09E+03	3.56E+04	0.00E+00	4.14E+01
RPRE	Renewable Primary Resources Used as an Energy Carrier	MJ	3.70E+03	4.50E+00	0.00E+00	0.00E+00	4.27E+02	0.00E+00	2.27E-01
NRPRM	Non-renewable Primary Resources with Energy Content Used as a Material	kg	3.08E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPRM	Renewable Primary Resources with Energy Content Used as a Material	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	Use of Secondary Materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	Use of Non-renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	Fresh Water Consumption	m^3	1.61E+01	1.06E-01	1.24E+00	0.00E+00	1.15E+02	0.00E+00	3.00E-02
NRN	Non-renewable Nuclear	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 32: 8" DR 35 ASTM D3034 (SOLID WALL) OUTPUT FLOWS

Parameter		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
HWD	Disposed-of Hazardous Waste	kg	0.00E+00	0.00E+00	4.59E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	Disposed-of Non-Hazardous Waste	kg	0.00E+00	0.00E+00	1.42E+01	0.00E+00	1.15E+02	0.00E+00	1.92E+03
RWD	Disposed-of Radioactive Waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	Components for Reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Materials for Recycling	kg	0.00E+00	0.00E+00	1.00E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MET	Materials for Energy Recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	Exported Electrical Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	Exported Thermal Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPr	Bio-Based Products	kg CO_2 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPk	Bio-Based Packaging	kg CO_2 eq	-1.71E+01	0.00E+00	0.00E+00	0.00E+00	1.71E+01	0.00E+00	0.00E+00

SANITARY SEWER PIPE: 24" PS 46 ASTM F679 (SOLID WALL) PVC PIPE

TABLE 33: 24" PS 46 ASTM F679 (SOLID WALL) LIFE CYCLE IMPACT ASSESSMENT

TRACI v2.1		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
GWP	Global Warming Potential	kg CO_2 eq	2.58E+04	1.66E+03	3.13E+03	8.09E+02	5.46E+03	0.00E+00	7.28E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	4.26E-03	2.02E-06	2.02E-04	3.09E-08	1.04E-04	0.00E+00	3.24E-05
AP	Acidification Potential	kg SO_2 eq	2.17E+02	2.14E+01	9.22E+00	4.83E+00	6.60E+01	0.00E+00	6.25E-01
EP	Eutrophication Potential	kg N eq	8.10E+00	1.29E+00	1.16E+01	2.69E-01	6.22E+00	0.00E+00	1.24E-01
POCP	Photochemical Ozone Creation Potential	kg O_3 eq	1.10E+03	6.61E+02	1.60E+02	1.32E+02	2.00E+03	0.00E+00	1.55E+01
CML 2 Baseline 2001		**Unit (per 1,000 ft)**	**Product Stage**			**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	2.62E+04	1.67E+03	3.17E+03	8.12E+02	5.49E+03	0.00E+00	7.30E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	1.39E-03	1.82E-06	1.39E-04	3.06E-08	7.64E-05	0.00E+00	2.43E-05
AP	Acidification Potential	kg SO_2 eq	2.40E+02	1.66E+01	8.38E+00	3.99E+00	5.06E+01	0.00E+00	5.32E-01
EP	Eutrophication Potential	kg PO_4 eq	8.03E+00	3.51E+00	5.59E+00	7.06E-01	1.16E+01	0.00E+00	1.15E-01
POCP	Photochemical Ozone Creation Potential	kg C_2H_4 eq	1.30E+01	4.37E-01	4.38E-01	1.84E-01	1.73E+00	0.00E+00	2.18E-02
ADPF	Abiotic Depletion Potential for Fossil Resources	MJ	7.93E+05	2.17E+04	3.90E+04	1.04E+04	7.60E+04	0.00E+00	2.07E+03

TABLE 34: 24" PS 46 ASTM F679 (SOLID WALL) USE OF RESOURCES

Use of Resources		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
NRPRE	Non-renewable Primary Resources Used as an Energy Carrier	MJ	5.52E+05	2.18E+04	5.78E+04	1.04E+04	7.91E+04	0.00E+00	2.09E+03
RPRE	Renewable Primary Resources Used as an Energy Carrier	MJ	2.08E+03	1.34E+02	4.68E+03	0.00E+00	7.98E+02	0.00E+00	1.68E+01
NRPRM	Non-renewable Primary Resources with Energy Content Used as a Material	kg	2.43E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPRM	Renewable Primary Resources with Energy Content Used as a Material	kg	6.59E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	Use of Secondary Materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	Use of Non-renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	Fresh Water Consumption	m^3	8.95E+01	2.60E-01	1.37E+01	0.00E+00	1.52E+02	0.00E+00	2.22E+00
NRN	Non-renewable Nuclear	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 35: 24" PS 46 ASTM F679 (SOLID WALL) OUTPUT FLOWS

Parameter		Unit (per 1,000 ft)	Product Stage			Construction Stage		Use Stage	Disposal Stage
			A1	A2	A3	A4	A5	B1-B7	C1-C4
HWD	Disposed-of Hazardous Waste	kg	0.00E+00	0.00E+00	3.40E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	Disposed-of Non-Hazardous Waste	kg	0.00E+00	0.00E+00	1.05E+02	0.00E+00	1.07E+03	0.00E+00	1.42E+04
RWD	Disposed-of Radioactive Waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	Components for Reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Materials for Recycling	kg	0.00E+00	0.00E+00	7.44E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MET	Materials for Energy Recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	Exported Electrical Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	Exported Thermal Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPr	Bio-Based Products	kg CO_2 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPk	Bio-Based Packaging	kg CO_2 eq	-3.50E+02	0.00E+00	0.00E+00	0.00E+00	3.50E+02	0.00E+00	0.00E+00

CONTACT INFORMATION

Practitioner:
This EPD and corresponding LCA were prepared by Sustainable Solutions Corporation of Royersford, Pennsylvania. To contact, please reach out at www.sustainablesolutionscorporation.com/contact-us.

Association Description:
PVCPA is the owner of this declaration. Their mission is to promote use of longer-life, lower-maintenance, corrosion-proof PVC piping in water and wastewater systems – for real sustainability, strength and long-term asset management. For more information, please reach out at info@unibell.org.

REFERENCES

Note: clickable links are blue and underlined.

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18. ISO 21930:2017 Sustainability in Building Construction — Environmental Declaration of Building Products
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APPENDIX: FITTINGS LIFE CYCLE ASSESSMENT RESULTS

Per the Product Category Rule, fittings must also be included in the EPD. As these piping systems are belled, fittings are not required to join the pipes together; however, 258 fittings were assumed as instructed by the PCR standard for the pressure pipe systems and 234 fittings were assumed for sanitary sewer. The life cycle impact assessment results are reported in separately in this Appendix as systems are variable in the number and type of fittings required.

PRESSURE PIPE: 8" AWWA C900 FITTINGS

Pressure pipe is designed with belled joints at the end of each pipe with a gasket provided so that individual pipe units can be installed easily. However, the Product Category Rule states that 258 fittings must be included in each system. Since fittings vary a weight of 12 pounds per piece were included. Please note that the number of fittings per system vary and that each pipe can be joined together without an additional fitting. Similar distances traveled for modules A2, A4 and C2 were assumed. No installation scrap was assumed since fittings are designed by piece. Module B's energy use are assumed to be included in each individual pipe system described above and therefore not included in the fittings tables.

TABLE 36: 8" AWWA C900 FITTINGS LIFE CYCLE IMPACT ASSESSMENT

TRACI v2.1		Unit (per 258 fittings)	Product Stage	Construction Stage		Use Stage	Disposal Stage
			A1-A3	A4	A5	B1-B7	C1-C4
GWP	Global Warming Potential	kg CO_2 eq	3.21E+03	6.00E+01	0.00E+00	0.00E+00	1.39E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	4.88E-04	2.29E-09	0.00E+00	0.00E+00	3.20E-06
AP	Acidification Potential	kg SO_2 eq	2.52E+01	3.58E-01	0.00E+00	0.00E+00	1.51E-01
EP	Eutrophication Potential	kg N eq	2.48E+00	2.00E-02	0.00E+00	0.00E+00	1.76E-02
POCP	Photochemical Ozone Creation Potential	kg O_3 eq	1.56E+02	9.81E+00	0.00E+00	0.00E+00	3.82E+00
CML 2 Baseline 2001		**Unit (per 258 fittings)**	**Product Stage**	**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1-A3	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	3.26E+03	6.02E+01	0.00E+00	0.00E+00	1.40E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	1.72E-04	2.27E-09	0.00E+00	0.00E+00	2.40E-06
AP	Acidification Potential	kg SO_2 eq	2.74E+01	2.96E-01	0.00E+00	0.00E+00	1.21E-01
EP	Eutrophication Potential	kg PO_4 eq	1.70E+00	5.24E-02	0.00E+00	0.00E+00	2.62E-02
POCP	Photochemical Ozone Creation Potential	kg C_2H_4 eq	1.50E+00	1.36E-02	0.00E+00	0.00E+00	-1.22E-02
ADPF	Abiotic Depletion Potential for Fossil Resources	MJ	8.99E+04	7.72E+02	0.00E+00	0.00E+00	3.01E+02

TABLE 37: 8" AWWA C900 FITTINGS USE OF RESOURCES

Use of Resources		Unit (per 258 fittings)	Product Stage	Construction Stage		Use Stage	Disposal Stage
			A1-A3	A4	A5	B1-B7	C1-C4
NRPRE	Non-renewable Primary Resources Used as an Energy Carrier	MJ	6.90E+04	0.00E+00	0.00E+00	0.00E+00	3.03E+02
RPRE	Renewable Primary Resources Used as an Energy Carrier	MJ	6.91E+02	0.00E+00	0.00E+00	0.00E+00	1.66E+00
NRPRM	Non-renewable Primary Resources With Energy Content Used as a Material	kg	2.40E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPRM	Renewable Primary Resources With Energy Content Used as a Material	kg	6.52E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	Use of Secondary Materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	Use of Non-Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	Fresh Water Consumption	m^3	1.06E+01	0.00E+00	0.00E+00	0.00E+00	2.20E-01
NRN	Non-renewable Nuclear	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 38: 8" AWWA C900 FITTINGS OUTPUT FLOWS

Parameter		Unit (per 258 fittings)	Product Stage	Construction Stage		Use Stage	Disposal Stage
			A1-A3	A4	A5	B1-B7	C1-C4
HWD	Disposed-of Hazardous Waste	kg	3.36E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	Disposed-of Non-hazardous Waste	kg	1.04E+01	0.00E+00	1.06E+02	0.00E+00	1.41E+03
RWD	Disposed-of Radioactive Waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	Components for Reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Materials for Recycling	kg	7.35E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MET	Materials for Energy Recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	Exported Electrical Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	Exported Thermal Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPr	Bio-Based Products	kg CO_2 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPk	Bio-Based Packaging	kg CO_2 eq	-3.46E+01	0.00E+00	3.46E+01	0.00E+00	0.00E+00

PRESSURE PIPE: 24" AWWA C900 FITTINGS

Pressure pipe is designed with belled joints at the end of each pipe with a gasket provided so that individual pipe units can be installed easily. However, the Product Category Rule states that 258 fittings must be included in each system. Since fittings vary a weight of 130 pounds per piece were included. Please note that the number of fittings per system vary and that each pipe can be joined together without an additional fitting. Similar distances traveled for modules A2, A4 and C2 were assumed. No installation scrap was assumed since fittings are designed by piece. Module B's energy use are assumed to be included in each individual pipe system described above and therefore not included in the fittings tables.

TABLE 39: 24" AWWA C900 FITTINGS LIFE CYCLE IMPACT ASSESSMENT

TRACI v2.1		Unit (per 258 fittings)	Product Stage	Construction Stage		Use Stage	Disposal Stage
			A1-A3	A4	A5	B1-B7	C1-C4
GWP	Global Warming Potential	kg CO_2 eq	3.48E+04	6.50E+02	0.00E+00	0.00E+00	1.39E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	5.29E-03	2.48E-08	0.00E+00	0.00E+00	3.20E-06
AP	Acidification Potential	kg SO_2 eq	2.73E+02	3.88E+00	0.00E+00	0.00E+00	1.51E-01
EP	Eutrophication Potential	kg N eq	2.69E+01	2.16E-01	0.00E+00	0.00E+00	1.76E-02
POCP	Photochemical Ozone Creation Potential	kg O_3 eq	1.69E+03	1.06E+02	0.00E+00	0.00E+00	3.82E+00
CML 2 Baseline 2001		**Unit (per 258 fittings)**	**Product Stage**	**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1-A3	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	3.53E+04	6.52E+02	0.00E+00	0.00E+00	1.40E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	1.87E-03	2.46E-08	0.00E+00	0.00E+00	2.40E-06
AP	Acidification Potential	kg SO_2 eq	2.97E+02	3.20E+00	0.00E+00	0.00E+00	1.21E-01
EP	Eutrophication Potential	kg PO_4 eq	1.84E+01	5.68E-01	0.00E+00	0.00E+00	2.62E-02
POCP	Photochemical Ozone Creation Potential	kg C_2H_4 eq	1.62E+01	1.48E-01	0.00E+00	0.00E+00	-1.22E-02
ADPF	Abiotic Depletion Potential for Fossil Resources	MJ	9.74E+05	8.36E+03	0.00E+00	0.00E+00	3.01E+02

TABLE 40: 24" AWWA C900 FITTINGS USE OF RESOURCES

Use of Resources		Unit (per 258 fittings)	Product Stage	Construction Stage		Use Stage	Disposal Stage
			A1-A3	A4	A5	B1-B7	C1-C4
NRPRE	Non-renewable Primary Resources Used as an Energy Carrier	MJ	9.84E+05	0.00E+00	0.00E+00	0.00E+00	3.03E+02
RPRE	Renewable Primary Resources Used as an Energy Carrier	MJ	1.39E+04	0.00E+00	0.00E+00	0.00E+00	1.66E+00
NRPRM	Non-renewable Primary Resources With Energy Content Used as a Material	kg	2.40E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPRM	Renewable Primary Resources With Energy Content Used as a Material	kg	6.52E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	Use of Secondary Materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	Use of Non-Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	Fresh Water Consumption	m^3	1.15E+02	0.00E+00	0.00E+00	0.00E+00	2.20E-01
NRN	Non-renewable Nuclear	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 41: 24" AWWA C900 FITTINGS OUTPUT FLOWS

Parameter		Unit (per 258 fittings)	Product Stage	Construction Stage		Use Stage	Disposal Stage
			A1-A3	A4	A5	B1-B7	C1-C4
HWD	Disposed-of Hazardous Waste	kg	3.36E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	Disposed-of Non-hazardous Waste	kg	1.04E+01	0.00E+00	1.06E+02	0.00E+00	1.41E+03
RWD	Disposed-of Radioactive Waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	Components for Reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Materials for Recycling	kg	7.35E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MET	Materials for Energy Recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	Exported Electrical Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	Exported Thermal Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPr	Bio-Based Products	kg CO_2 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPk	Bio-Based Packaging	kg CO_2 eq	-3.46E+01	0.00E+00	3.46E+01	0.00E+00	0.00E+00

SANITARY SEWER PIPE: 8" SOLID-WALL ASTM D3034 FITTINGS

Nonpressure pipe is designed with belled joints at the end of each pipe with a gasket provided so that individual pipe units can be installed easily. However, the Product Category Rule states that 234 fittings must be included in each system. Since fittings vary a weight of 4.5 pounds per piece were included. Please note that the number of fittings per system vary and that each pipe can be joined together without an additional fitting. Similar distances traveled for modules A2, A4 and C2 were assumed. No installation scrap was assumed since fittings are designed by piece. Module B's energy use are assumed to be included in each individual pipe system described above and therefore not included in the fittings tables.

TABLE 42: 8" SOLID-WALL ASTM D3034 FITTINGS LIFE CYCLE IMPACT ASSESSMENT

TRACI v2.1		Unit (per 234 fittings)	Product Stage	Construction Stage		Use Stage	Disposal Stage
			A1-A3	A4	A5	B1-B7	C1-C4
GWP	Global Warming Potential	kg CO_2 eq	1.07E+03	2.11E+01	0.00E+00	0.00E+00	4.74E+00
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	1.47E-04	8.03E-10	0.00E+00	0.00E+00	1.09E-06
AP	Acidification Potential	kg SO_2 eq	7.94E+00	1.26E-01	0.00E+00	0.00E+00	5.13E-02
EP	Eutrophication Potential	kg N eq	1.14E+00	7.01E-03	0.00E+00	0.00E+00	5.98E-03
POCP	Photochemical Ozone Creation Potential	kg O_3 eq	5.72E+01	3.44E+00	0.00E+00	0.00E+00	1.30E+00
CML 2 Baseline 2001		**Unit (per 234 fittings)**	**Product Stage**	**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1-A3	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	1.08E+03	2.11E+01	0.00E+00	0.00E+00	4.76E+00
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	5.28E-05	7.96E-10	0.00E+00	0.00E+00	8.18E-07
AP	Acidification Potential	kg SO_2 eq	8.54E+00	1.04E-01	0.00E+00	0.00E+00	4.10E-02
EP	Eutrophication Potential	kg PO_4 eq	7.41E-01	1.84E-02	0.00E+00	0.00E+00	8.92E-03
POCP	Photochemical Ozone Creation Potential	kg C_2H_4 eq	4.90E-01	4.78E-03	0.00E+00	0.00E+00	-4.14E-03
ADPF	Abiotic Depletion Potential for Fossil Resources	MJ	2.73E+04	2.71E+02	0.00E+00	0.00E+00	1.02E+02

TABLE 43: 8" SOLID-WALL ASTM D3034 FITTINGS USE OF RESOURCES

Use of Resources		Unit (per 234 fittings)	Product Stage	Construction Stage		Use Stage	Disposal Stage
			A1-A3	A4	A5	B1-B7	C1-C4
NRPRE	Non-renewable Primary Resources Used as an Energy Carrier	MJ	2.03E+04	0.00E+00	0.00E+00	0.00E+00	1.03E+02
RPRE	Renewable Primary Resources Used as an Energy Carrier	MJ	7.81E+02	0.00E+00	0.00E+00	0.00E+00	5.66E-01
NRPRM	Non-renewable Primary Resources With Energy Content Used as a Material	kg	8.17E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPRM	Renewable Primary Resources With Energy Content Used as a Material	kg	2.22E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	Use of Secondary Materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	Use of Non-Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	Fresh Water Consumption	m^3	4.33E+00	0.00E+00	0.00E+00	0.00E+00	7.47E-02
NRN	Non-renewable Nuclear	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 44: 8" SOLID-WALL ASTM D3034 FITTINGS OUTPUT FLOWS

Parameter		Unit (per 234 fittings)	Product Stage	Construction Stage		Use Stage	Disposal Stage
			A1-A3	A4	A5	B1-B7	C1-C4
HWD	Disposed-of Hazardous Waste	kg	1.14E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	Disposed-of Non-hazardous Waste	kg	3.55E+00	0.00E+00	3.61E+01	0.00E+00	4.78E+02
RWD	Disposed-of Radioactive Waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	Components for Reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Materials for Recycling	kg	2.50E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MET	Materials for Energy Recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	Exported Electrical Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	Exported Thermal Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPr	Bio-Based Products	kg CO_2 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPk	Bio-Based Packaging	kg CO_2 eq	-1.18E+01	0.00E+00	1.18E+01	0.00E+00	0.00E+00

SANITARY SEWER PIPE: 24" SOLID-WALL ASTM F679 FITTINGS

Nonpressure pipe is designed with belled joints at the end of each pipe with a gasket provided so that individual pipe units can be installed easily. However, the Product Category Rule states that 234 fittings must be included in each system. Since fittings vary a weight of 60 pounds per piece were included. Please note that the number of fittings per system vary and that each pipe can be joined together without an additional fitting. Similar distances traveled for modules A2, A4 and C2 were assumed. No installation scrap was assumed since fittings are designed by piece. Module B's energy use are assumed to be included in each individual pipe system described above and therefore not included in the fittings tables.

TABLE 45: 24" SOLID-WALL ASTM F679 FITTINGS LIFE CYCLE IMPACT ASSESSMENT

TRACI v2.1		Unit (per 234 fittings)	Product Stage	Construction Stage		Use Stage	Disposal Stage
			A1-A3	A4	A5	B1-B7	C1-C4
GWP	Global Warming Potential	kg CO_2 eq	1.45E+04	2.85E+02	0.00E+00	0.00E+00	6.42E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	2.00E-03	1.09E-08	0.00E+00	0.00E+00	1.48E-05
AP	Acidification Potential	kg SO_2 eq	1.08E+02	1.70E+00	0.00E+00	0.00E+00	6.95E-01
EP	Eutrophication Potential	kg N eq	1.55E+01	9.50E-02	0.00E+00	0.00E+00	8.11E-02
POCP	Photochemical Ozone Creation Potential	kg O_3 eq	7.75E+02	4.67E+01	0.00E+00	0.00E+00	1.76E+01
CML 2 Baseline 2001		**Unit (per 234 fittings)**	**Product Stage**	**Construction Stage**		**Use Stage**	**Disposal Stage**
			A1-A3	**A4**	**A5**	**B1-B7**	**C1-C4**
GWP	Global Warming Potential	kg CO_2 eq	1.47E+04	2.86E+02	0.00E+00	0.00E+00	6.45E+01
ODP	Depletion Potential of the Stratospheric Ozone Layer	kg CFC-11 eq	7.16E-04	1.08E-08	0.00E+00	0.00E+00	1.11E-05
AP	Acidification Potential	kg SO_2 eq	1.16E+02	1.41E+00	0.00E+00	0.00E+00	5.56E-01
EP	Eutrophication Potential	kg PO_4 eq	1.00E+01	2.49E-01	0.00E+00	0.00E+00	1.21E-01
POCP	Photochemical Ozone Creation Potential	kg C_2H_4 eq	6.64E+00	6.48E-02	0.00E+00	0.00E+00	-5.61E-02
ADPF	Abiotic Depletion Potential for Fossil Resources	MJ	3.70E+05	3.67E+03	0.00E+00	0.00E+00	1.39E+03

TABLE 46: 24" SOLID-WALL ASTM F679 FITTINGS USE OF RESOURCES

Use of Resources		Unit (per 234 fittings)	Product Stage	Construction Stage		Use Stage	Disposal Stage
			A1-A3	A4	A5	B1-B7	C1-C4
NRPRE	Non-renewable Primary Resources Used as an Energy Carrier	MJ	2.75E+05	0.00E+00	0.00E+00	0.00E+00	1.40E+03
RPRE	Renewable Primary Resources Used as an Energy Carrier	MJ	1.06E+04	0.00E+00	0.00E+00	0.00E+00	7.68E+00
NRPRM	Non-renewable Primary Resources With Energy Content Used as a Material	kg	1.11E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RPRM	Renewable Primary Resources With Energy Content Used as a Material	kg	3.00E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	Use of Secondary Materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	Use of Non-Renewable Secondary Fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	Fresh Water Consumption	m^3	5.87E+01	0.00E+00	0.00E+00	0.00E+00	1.01E+00
NRN	Non-renewable Nuclear	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 47: 24" SOLID-WALL ASTM F679 FITTINGS OUTPUT FLOWS

Parameter		Unit (per 234 fittings)	Product Stage	Construction Stage		Use Stage	Disposal Stage
			A1-A3	A4	A5	B1-B7	C1-C4
HWD	Disposed-of Hazardous Waste	kg	1.55E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	Disposed-of Non-hazardous Waste	kg	4.81E+01	0.00E+00	4.90E+02	0.00E+00	6.48E+03
RWD	Disposed-of Radioactive Waste	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	Components for Reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	Materials for Recycling	kg	3.39E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MET	Materials for Energy Recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	Exported Electrical Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	Exported Thermal Energy (Waste to Energy)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPr	Bio-Based Products	kg CO_2 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BBPk	Bio-Based Packaging	kg CO_2 eq	-1.60E+02	0.00E+00	1.60E+02	0.00E+00	0.00E+00

Environmental Product Declaration

Uni-Bell PVC Pipe Association – PVC Pipe Products

Certified Environmental Product Declaration
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