



Memorandum

January 30, 2014

To Mr. Sal Misiti – North Castle

From Joseph Awald, P.E.

Tel 315.679.5779

Subject Pipe Comparisons

Job no. 8616265.350

We have evaluated several types of pipe for potential application in the Water District No. 2 distribution system replacement project. Ductile Iron, Polyvinyl Chloride (PVC), and High Density Polyethylene (HDPE) are materials commonly used in potable water distribution systems that were evaluated.

1. Pipe Properties

1.1 Material

Ductile Iron

Ductile iron is centrifugally cast pipe manufactured in conformance with AWWA C150 & C151. The piping is available in push-on joint, restrained joint, mechanical joint, and flanged joint assemblies. Ductile iron pipe (DIP) interior is lined with a cement mortar lining for water piping. DIP can be designated as a Pressure Class (PC) or a Special Thickness Class (CL). PC designations refer to the pipe's ability to hold pressure, whereas CL refers only to wall thickness, with no direct correlation to pressure rating. Standard pressure classes are defined as the rated working pressure in pounds per square inch (psi) of the pipe. The nominal thickness for standard PCs is adequate for the rated working pressure, plus a surge allowance of 100 psi. In other words, PC 350 pipe can accommodate a working pressure of 350 psi and a surge pressure up to 450 psi. CL 52 is a typical thickness class of DIP. CL piping is typically used for high loading conditions. For example, a 12-inch diameter pipe with a PC of 350 has a nominal wall thickness of 0.28-inch compared to CL 52 pipe, which has a wall thickness of 0.37-inch. The table below illustrates the pipe pressure rating and wall thickness.

Table 1 Pipe Material

Type of Pressure Pipe Material	Pressure Rating	Wall Thickness
DIP, PC 350	350 psi	8" Nominal Size – 0.25" 12" Nominal Size – 0.28"
DIP, CL 52	350 psi	8" Nominal Size – 0.3" 12" Nominal Size – 0.37"
DIP, CL 56	350 psi	8" Nominal Size – 0.45" 12" Nominal Size – 0.49"

Standard DIP fittings can be used for all three pipe materials.

Bedding is required to establish line and grade and to provide firm, pipe support. Compacted granular material over a flat trench foundation should be spread evenly and compacted uniformly to a firm, but not hard, support. Bedding materials may be Class I (clean, manufactured aggregates), II (clean coarse grained soils,) III (clean coarse grained soils with fines), or Class IV (fine-grained inorganic soils).



Memorandum

Some of the other key properties of DIP are as follows:

- DIP is not affected by temperature changes.
- DIP is able to withstand internal pressure and external loads.
- Buried DIP can be located with magnetic locating equipment and no tracer wire is required.
- DIP's structural integrity to withstand vacuum conditions is rated as excellent¹.
- DIP may be prone to corrosion problems when installed in corrosive soils.
- DIP has an anticipated service life of 75-100 years.
- DIP can be direct tapped for water services.
- DIP is ductile and can tolerate some deflection.

PVC

PVC pressure pipe conforms to American Water Works Association (AWWA) C900 (4-inches – 12-inches in diameter). PVC pipe is available in cast iron outside diameters (CIOD) rated by a dimension ratio (DR) and pressure class. The push-on joint pipe assembly is a bell with a rubber gasket and spigot. Provisions are made for expansion and contraction with an elastomeric seal at each joint. The interior of PVC pipe has a smooth finish which reduces friction losses and eliminates the tuberculation common in iron pipes. The table below illustrates the pipe pressure rating and wall thickness.

Table 2 Pipe Material

Type of Pressure Pipe Material	Pressure Rating	Wall Thickness
C900 PVC DR 18	235 psi	8" Nominal Size – 0.50" 12" Nominal Size – 0.73"
C900 PVC DR 14	305 psi	8" Nominal Size – 0.65" 12" Nominal Size – 0.94"

PVC fittings or standard DIP fittings can be used with PVC piping because the piping conforms with cast iron outside diameters.

Bedding is required to establish line and grade and to provide firm, pipe support. Compacted granular material over a flat trench foundation should be spread evenly and compacted uniformly to a firm, but not hard, support. Bedding materials may be Class I (clean, manufactured aggregates), II (clean course grained soils) or III (clean course grained soils with fines).

Some of the other key properties of PVC are as follows:

- PVC is very corrosion resistant from aggressive soils and galvanic action. It is not a conductor and will not have an electrochemical reaction with acids and bases that it comes in contact with.
- PVC requires locating wires be installed in the pipe trench.
- Tapping of PVC for service and other connections is recommended using a tapping saddle.
- PVC's structural integrity to withstand vacuum conditions is rated as good.¹
- PVC has an anticipated service life of 50-100 years.¹

¹ EPA's "Distribution Manual for Operators" Adapted by the Kentucky Department of Environmental Protection



Memorandum

HDPE

HDPE pipe is manufactured from polyethylene (PE) 4710 resin and conforms to AWWA C906. DR ratings range from DR 32.5 (50 PSI working pressure) to DR 7.3 (265 PSI working pressure).

HDPE pressure pipe is joined by heat fused ends known as 'butt welding'. This is where the ends of two sections of pipe are melted and then pushed and held together, forming a single pipe. The 'butt welding' process requires specialized equipment.

HDPE is considered a flexible piping and can be susceptible to expansion or contraction. However, with buried HDPE piping, expansion or contraction due to temperature change is minimal. Pipe bedding for HDPE pipe should be on crushed stone material, with the material tamped under the haunches of the pipe.

HDPE piping has a thicker wall than DIP or PVC. Thus, a larger nominal pipe size may need to be considered in order to provide sufficient inside diameter to achieve adequate supply throughout the distribution system. The table below illustrates the pipe pressure rating and wall thickness.

Table 3 Pipe Material

Type of Pressure Pipe Material	Pressure Rating	Wall Thickness
HDPE DR 9	200 psi	8" Nominal Size – 1.00" 12" Nominal Size – 1.47"
HDPE DR 7.3	265 psi	8" Nominal Size – 1.20" 12" Nominal Size – 1.84"

Fittings for HDPE pipe are fabricated, and manufacturers typically recommend a de-rating factor of 25 percent for any fabricated fitting which requires a miter joint (bends and tees). In a DR 9 mitered fitting, would only be rated for only 150 psi and DR7.3 would be rated for 200 psi.

Some of the other key properties of HDPE are as follows:

- HDPE can be installed with large radius due to its flexibility.
- HDPE laying lengths can be up to 50 feet.
- HDPE requires locating wires to be installed in the trench.
- HDPE has an anticipated service life of 50 years¹.
- HDPE has a lower pressure rating.



Memorandum

1.2 Installation

The installation methods for the pipe types are similar, however there are some differences. Some of the key differences are as follows:

Ductile Iron Pipe

- Is not vulnerable to the effects of exposure to sunlight or weathering.
- Push on-joints have a joint deflection of up to 5-degrees and mechanical-joint of up to 8.3-degrees.
- Direct tapping of ductile iron pipe can be made, no need for service saddles.
- To provide a level of protection against corrosive soils, polyethylene wrapping can be installed around the piping.
- Additional rigging and labor may be required for installation.

PVC

- Recommended the use of a tapping saddle for joining pipe sections and for water services connections.
- Sand bedding is required to control deflection.
- Special precautions must be taken when PVC pipe is exposed to sunlight for an extended period of time. When subjected to long-term exposure to ultraviolet (UV) radiation from sunlight, PVC pipe can suffer ultraviolet (UV) degradation. According to AWWA C605, if plastic pipe is stored outdoors, it may require protection from weathering in accordance with manufacturers' recommendations. Any covering should allow air circulation in and around the pipe.

HDPE

- Most sizes can be handled manually, due to the materials' lighter weight, so there is no need for large installation equipment.
- Requires the use of special equipment for the installation of water services. Sidewall fusion is used to install service connections on HDPE pipe. The fusion process requires a saddle fusion machine, heater saddle adapters, heater plate, AC power source, surface temperature measuring device, utility cloth and denatured alcohol.
- Angular bedding is required.
- Can be installed in large and small radius bends instead of deflections.



Memorandum

2. Cost

Material

The following table summarizes the average pipe material cost per linear foot. Based on conversations with several suppliers in November 2013, the cost of material can fluctuate depending on various conditions. These costs do not include installation of the pipe or other material costs such as fittings, valves or services (saddles, corporation stops, etc.).

Table 4 Pipe Cost by material

Pipe size/type	DIP PC 350	DIP Class 52	DIP Class 56	PVC C900 DR18	PVC C900 DR14	HDPE DR9	HDPE DR7.3
8 inch	\$20	\$24	\$34	\$10	\$15	\$18	\$30
12 inch	\$32	\$40	\$55	\$20	\$28	\$25	\$40

Installation

A cost associated with the installation of each pipe material varies. Both PVC and DIP are bell and spigot, push-on joints. However, DIP is heavier, therefore may require larger equipment for installation, however the same equipment is typically used to excavate the trench. Furthermore HDPE is a heat fused joint, which requires special tools. The table below illustrates the approximate installation costs per linear foot associated with each pipe material evaluated:

Table 5 Installation Cost*

Pipe size/type	DIP	PVC	HDPE
8 inch	\$40	\$40	\$60
12 inch	\$50	\$50	\$80

*Installation costs only include trench excavation, bedding material, piping, pressure testing/disinfection and backfill of trench. The costs do not include rock excavation or over excavation for pipe foundation, pavement cutting/restoration, water services, hydrants, valves or sampling ports.



Memorandum

3. Summary & Recommendation

Summary

The following is a summary of the pipe comparison:

Pipe Type	Cost per LF (Material & Installation*)	Distinctive Pipe Properties	Service Life	Maintenance & Operational Considerations
PVC (8"-12") DR 18 DR 14	\$50-\$70 \$55-\$80	<ul style="list-style-type: none"> Recommended tapping saddles for services on PVC pipe PVC is very corrosion resistant from aggressive soils PVC pipe can become brittle in colder temperatures and weaker in higher temperatures 	50-100 years	Some special tools or appurtenances required for maintenance and pipe line repairs
DIP (8"-12") PC 350 CL 52 CL 56	\$60-\$82 \$65-\$90 \$75-\$105	<ul style="list-style-type: none"> Does not require locating wires be installed in the trench like PVC or HDPE DIP can deteriorate in some aggressive, corrosive soil conditions. DIP is not affected by temperature changes. Direct tapping of ductile iron pipe can be done 	75-100 years	No special tools or appurtenances required for maintenance and pipe line repairs
HDPE (8"-12") DR 9 DR 7.3	\$80-\$105 \$90-\$120	<ul style="list-style-type: none"> HDPE cannot be direct tapped HDPE is very corrosion resistant from aggressive soils 	50 years	Special tools and appurtenances required for maintenance and pipe line repairs.

*Installation costs only include trench excavation, bedding material, piping, pressure testing/disinfection and backfill of trench. The costs do not include rock excavation or over excavation for pipe foundation, pavement cutting/restoration, water services, hydrants, valves or sampling ports.



Memorandum

Recommendation

Based on the information reviewed and the site conditions of the project area, GHD recommends ductile iron piping be installed for this project. We recommend that DIP CL 52 be installed for the distribution system replacement project to provide additional wall thickness for improved pipe longevity.

The Town has used CL 56 on previous projects in areas with high truck traffic volume. Since the project area is not located within a high truck traffic area, DIP CL 56 and the additional cost associated with the CL 56, are not believed to be warranted.

JBA:JSS/mrv