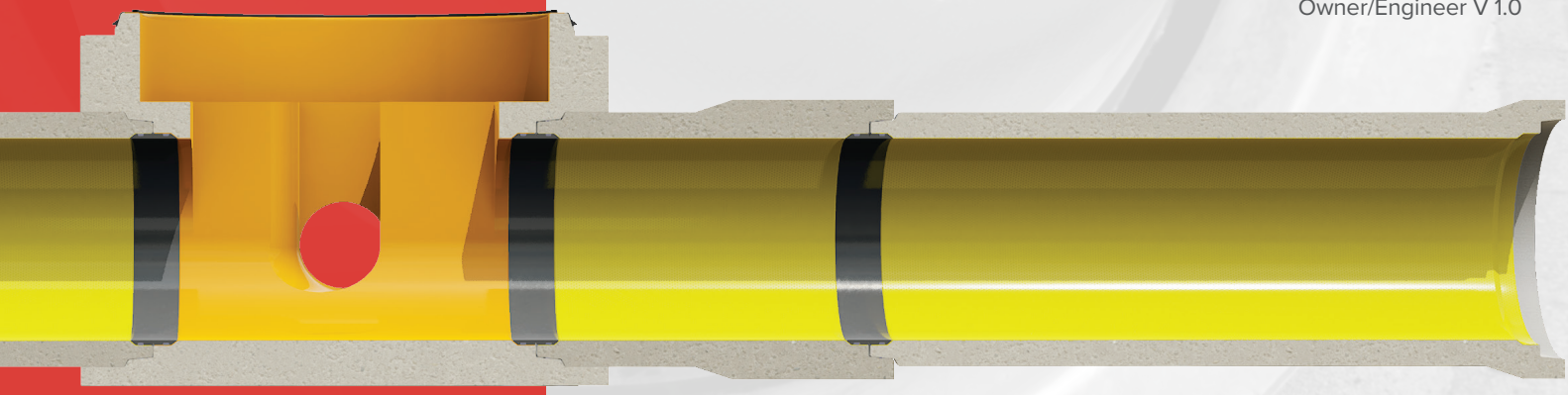
Geneva Pipe and Precast
A Northwest Pipe Company

Perfect Lined Manhole System

Technical Handbook

Owner/Engineer V 1.0



PERFECT

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KOMATSU

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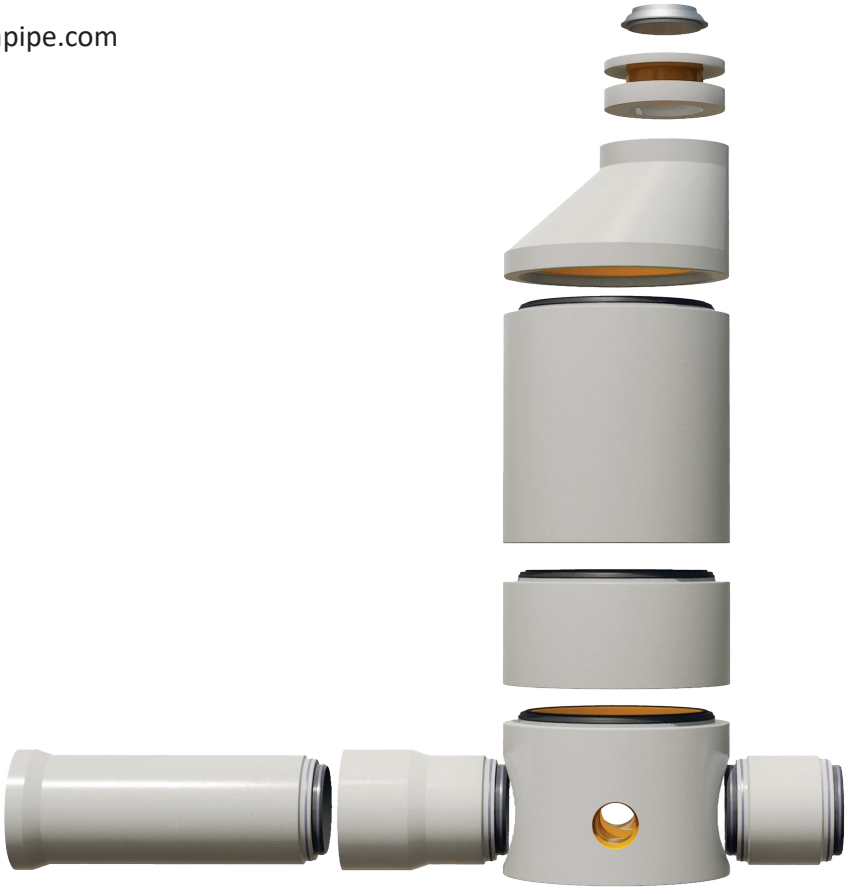
Welcome to the Perfect Lined System

Perfect Pipe and Perfect Lined Manholes offer cutting-edge corrosion resistance for municipal sewer infrastructure. An integrated liner provides 100% coverage and creates a tight seal and a smooth laminar flow for long-lasting performance in sanitary sewer and wastewater environments.

Both Perfect Pipe and Perfect Lined Manhole Systems can be used in conjunction with almost any existing system and the innovative joint design enables connection without field welds in most sizes. This translates to rapid installation and long-term savings.

If you have any questions about the contents of this handbook or about the Perfect Pipe and Perfect Lined Manhole products please let us know. We're here to help!

Alena Mikhaylova, Ph.D.
Lined Concrete Product Manager
817-201-2900
amikhaylova@genevapipe.com



Handbook Contents

PART 1
The Perfect Plant

Statement of Qualifications

We manufacture all of our concrete products in the controlled setting of our plants from locally sourced aggregates and cementitious materials with domestic steel. Our tight quality production and testing standards following ASTM and AASHTO specifications. Mastering the combination of mix design, computer-controlled batching, and the curing process, we add a bit of artistry to manufacture custom structures for your project.

We put quality as one of our highest priorities. We have been a UDOT Gold Quality Producer consecutively for 6 years (since 2013) and have been a National Precast Concrete Association (NPCA) Quality Certified plant ever since 2003 with outstanding scores on all quality reviews done by the third-party organization.

In-House Engineering

Mike Blackham, PE
Director of Engineering and Technical Services
O: 801-505-6296
M: 208-713-8551
mblackham@genevapipe.com

Manufacturing Capabilities

PERFECT PIPE

- Ability to produce 24”-60” diameter Perfect Pipe with no-weld joints
- Ability to produce 72”-96” diameter HDPE -lined RCP

PERFECT LINED MANHOLE

- Ability to produce Perfect manholes in sizes 48”-96” diameter no-weld joints with eccentric or concentric cones or flat lids

CUSTOM LINED PRECAST STRUCTURES

- Ability to manufacture lined vaults, wet wells, and junction boxes

Production Equipment and Molds

Founded in 1964 the Austrian technology developer Schlusselbauer Technology has been a global supplier of innovative systems and plants for the production of precast concrete products for more than 50 years. Schlusselbauer is the developer of the Perfect Pipe HDPE-Lined Concrete Sanitary Pipe technology and production process, and produces the equipment and automation used to manufacture Perfect Pipe for Geneva Pipe and Precast.

The use of Self Consolidating Concrete (SCC) creates a product differentiated from conventionally manufactured precast concrete pipe in terms of strength (6,000 PSI), density and finish. Unlike drycast concrete pipe production, SCC is a highly flowable, non-segregating concrete with a slump flow of 20 to 30 inches that can spread into place, fill the formwork, encapsulate the reinforcement and stud-anchors of the HDPE-protective lining without introducing vibration.

The Schlusselbauer production molds are machined and assembled in Austria by experienced technicians. The tooling produced for Geneva Pipe and Precast is laser-cut with tolerances within + 0.036 inches and machined to the U.S. ASTM C-76 C-Wall standard. The production molds are designed and manufactured for a lifecycle of 100,000 pours.

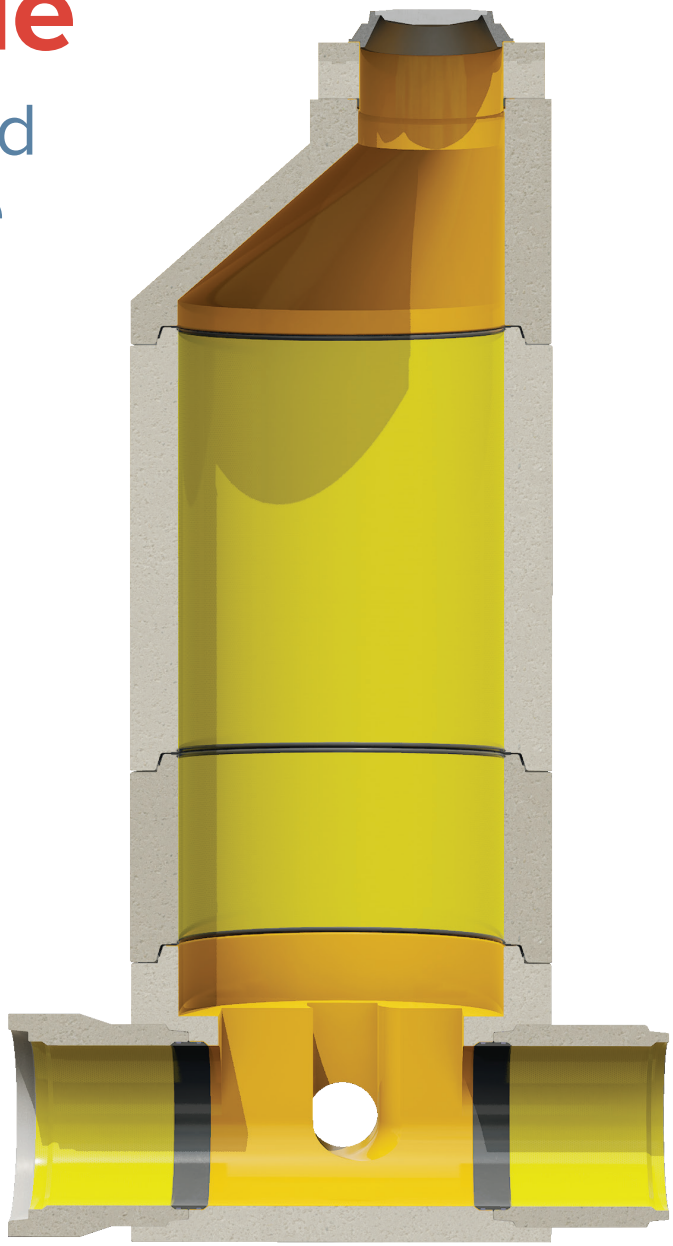
PART 3

Perfect Lined Manhole

Geneva Pipe and Precast
A Northwest Pipe Company

Perfect Lined Manhole Product Guide

FRP- and HDPE-Lined Reinforced Concrete Precast Manholes



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APPLICATIONS

Sanitary Sewer
Industrial Wastewater
Deep Installations
High Ground Water

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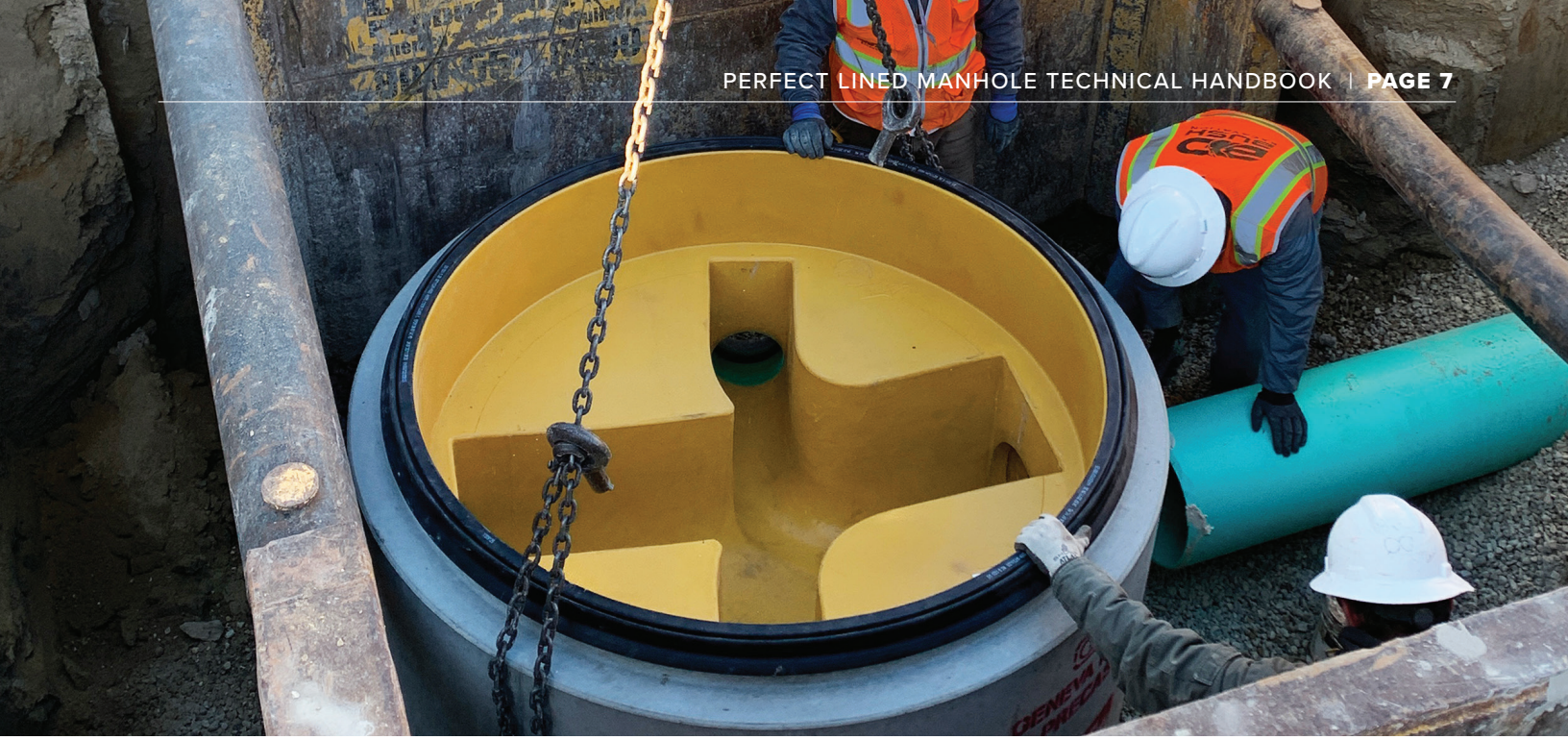


Product Guide Contents

SECTION 1

Product Description

Perfect Lined Manhole is a reinforced precast concrete manhole that meets ASTM C478 and is lined with high-quality synthetic polymer liners which are anchored into the concrete during the casting process. The synthetic polymer liners protect the concrete from Microbial Induced Corrosion (MIC) when exposed to municipal and industrial wastewater providing vastly higher service life for the manhole.

The Perfect Lined Manhole system consists of a PMA-Lined Base and a combination of Perfect Lined Risers, Cones or Flat Lids, and chimney protection systems. The interior of the manhole sections can be cast in heights up to 8 feet tall. Tall sections enable for a reduced number of components needed for a complete manhole structure and, in turn, minimizes the structure joints to reduce potential for leakage and corrosion. The joints between manhole sections are equipped with rubber gaskets protecting concrete structure from wastewater elements. The Perfect Lined Manhole has been tested to withstand up to 13 psi hydrostatic pressure.

Product Features & Benefits

PRECAST CONCRETE

- Strength
- Structure
- Durability
- Sustainability

FRP & HDPE LINER

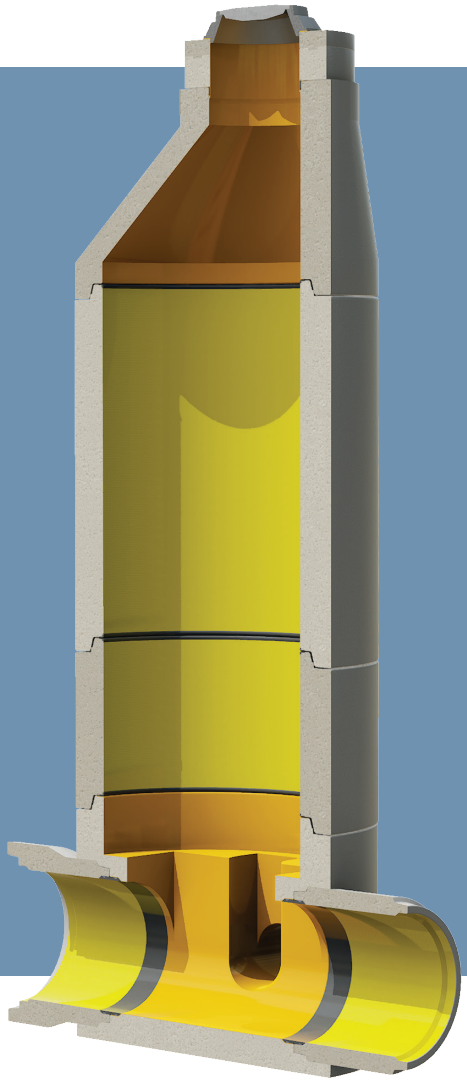
- Chemical resistant
- Smooth surface for maximum hydraulics
- Prevents interior build-up for lower maintenance and operational costs

WATERTIGHT JOINT

- Quick install time with no field welding
- Joints tested to 13 psi

MAINTENANCE

- Low maintenance for long-term savings
- 100+ year design life
- Corrosion and abrasion resistant interior after decades of use
- No age-related decline in pressure
- Easy inspection with a bright view and clear joint location



SECTION 2

Application

The Perfect Lined Manhole is intended to provide long-term resistance to MIC in precast concrete sanitary sewer collection systems. While Perfect Lined Manholes are a sustainable solution for all sanitary sewer collection systems, here are some of the applications in which the qualities of Perfect Lined Manholes provide exceptional performance and value:

SANITARY SEWER & WASTEWATER COLLECTION SYSTEMS

The reinforced concrete and synthetic polymer composite design of the Perfect Lined Manhole allows for the structure to maintain resistance to chemical attack. The perfectly sloped and curved channel shapes paired with the smooth surface of the FRP liner improves hydraulic flow, reduces turbulence, provides protection against system corrosion, and prevents sliming or build ups to reduce maintenance and operation costs. The reinforced concrete exterior of the manhole provides an ideal structure and the ability to endure high project loading with minimized installation costs. When Life Cycle Cost Analysis is being considered by the agency in the purchasing decision, the Perfect Lined Manhole provides the best value amongst all manhole products.

AREAS IN SANITARY SEWER SYSTEMS WITH HIGHER CORROSION RATES DUE TO SEWAGE AGITATION

The Perfect Lined Manhole is the ideal corrosion resistant concrete product any time sewer systems aerate or grind sewage. As raw sewage is agitated, H2S gas is released which is found to deposit itself on the interior walls of the manhole structure where it can then be converted to sulfuric acid through a microbial process. The Perfect Lined Manhole protects the concrete from the acidic conditions that can develop. Some areas of a sewer system in which higher corrosion rates can occur are:

- Force Mains
- Drop Bowels
- Lift Stations
- Grease Interceptor Sample Boxes
- Macerator Pumps

DEEP BURY OR HIGH LOADING CONDITIONS

The reinforced concrete structure of the Perfect Lined Manhole allows the product to resist higher loading conditions than all other manhole materials. A circular precast concrete manhole is the ideal material for constructing deep buried vertical structures. Concrete is strong in compression and since the lateral earth and hydrostatic forces endured by a buried circular manhole result in ring compression, the structure is at its optimum performance. Calculations show that the maximum depth for a precast concrete circular manhole that is manufactured in accordance with ASTM C478 is more than 500 feet below grade!

HIGH GROUNDWATER CONDITIONS

In cases where a sewer pipe must be installed below the groundwater table, The Perfect Lined Manhole is the solution to provide watertight pipe to manhole connection. The robust concrete structure has a specific gravity of 2.4 which allows the manhole to resist flotation better than all other manhole materials. Rubber gasketed joints of the manhole prevent ground water infiltration and inflow. The Perfect Lined Manhole joint has been tested up to 13 psi hydrostatic pressure or approximately 30 feet of head.

SECTION 3

Sizing and Availability

Perfect Lined Manhole is available in standard sizes ranging from 48” up to 96” diameter. For sizes larger than 96” diameter, lined vaults, lined wet wells or other lined precast structures please reach out to a Geneva Pipe and Precast representative.

SECTION 4

Design

DESIGN LIFE

Studies have shown that precast concrete products can provide a service life more than 100 years. Whether concrete is buried or exposed, it is immune to the attack of most elements, and it will not burn, rust, tear, buckle, or deflect. The protective HDPE liner in the manhole and FRP liner in the base shield concrete from the elements typically found in sanitary sewers, enabling the precast structure to last its full design life in a corrosive environment. Perfect Lined Manholes are expected to have a design life that meets or exceeds 100 years under normal sanitary sewer conditions.

MANHOLE SIZING

Depth

Like all other circular precast concrete manholes, the Perfect Lined Manhole can be designed to reach depths of 500 feet below the ground surface or greater.

Diameter

The necessary diameter of a Perfect Lined Manhole will depend mostly on the number, size, and configuration of pipes that are being connected to it. See Figure 1 for the minimum structural leg required between the pipe openings. It is important to remember that the opening needed for a pipe connection will always be larger than the outside diameter of the pipe being connected to allow room for the connector or grout. The National Precast Concrete Association (NPCA) has developed a Manhole Sizing Recommendations sheet which provides additional guidance on determining the correct diameter for a manhole. For assistance in selecting the diameter of Perfect Lined Manhole needed for your project, please reach out to a Geneva Pipe and Precast representative.

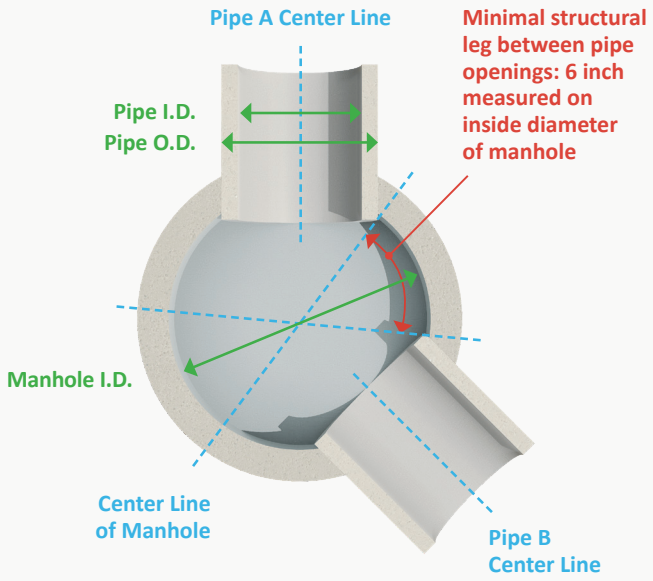


Figure 1: *6-inch minimum structural Leg between pipe openings*

FLOTATION

The impacts of buoyancy forces should be considered in all underground infrastructure projects that may be submerged below groundwater. Due to the inherent self-weight of precast concrete, the Perfect Lined Manhole is an ideal solution to counteract flotation forces. However, it is still important to perform the necessary calculations to determine the buoyancy forces on each underground structure submerged below groundwater. ACPA's Design Data 41 sheet on Manhole Flotation provides further details on how to calculate the buoyancy forces for a buried precast concrete manhole. In rare cases where the calculated buoyancy forces surpass the structure's weight, the Perfect Lined Manhole can easily be equipped with an extended base slab to resist flotation. Please consult with a Geneva Pipe and Precast representative if assistance is needed.

SECTION 5

Materials and Components

The Perfect Lined Manhole is a composite structure consisting of different materials and components. Each material and component used in the Perfect Lined Manhole, along with the manufacturing process used to fabricate each product component are described in this section of the Product Guide.

MATERIALS & COMPONENTS

Reinforced Self-Consolidating Concrete

Reinforced Self-Consolidating Concrete (SCC) provides the structural component of the Perfect Lined Manhole. SCC is a highly flowable, non-segregating concrete that can flow in the formwork and through the reinforcement under its own weight and without any mechanical consolidation. The highly flowable nature of SCC allows for the concrete to fill all voids between the anchors of the liner to enable a secure connection between the liner and the concrete.

Synthetic Plastic Lining

HDPE liner for the riser sections and Fiber Reinforced Plastic (FRP) for the manhole base, and cone or flat lid are mechanically embedded with anchors to protect concrete from corrosive environment. The smooth interior surface improves system hydraulics.

Liner Clips

An EPDM liner clip is used at each end of the manhole joint to seal the concrete-liner interface giving extra protection of concrete from potential corrosive gases.

Load Distributing SDV Seal Gaskets

Perfect Manhole utilizes a joint with SDV seal gasket to eliminated the need for field welding. Self-lubricating gasket with unique design allows for the weight of riser sections to be uniformly distributed, providing a secure seal in the joint against infiltration and exfiltration. The joint with SDV seal has been tested to withstand up to 13 psi of hydrostatic pressure.

SECTION 6

Testing and Quality Control

As an NPCA certified and UDOT Gold Class manufacturer, quality control is a main focus of Geneva Pipe and Precast. All products are manufactured in a controlled environment with every step of the process carefully measured and verified. The following inspections are carried out for each product manufactured by our team.

PRE-POUR INSPECTIONS

Prior to pouring the concrete into the form, the Quality Control team at Geneva Pipe and Precast performs verifications to ensure the equipment, materials and product components are correctly prepared and ready to be poured.

POST-POUR INSPECTIONS

Additional inspections of each product are carried out after the concrete has been poured, cured, and stripped from the form. Listed below are some of the items that are checked after the concrete product has cured.

- **Concrete Strength:** The concrete cylinders mentioned in the pre-pour inspection section are tested for compressive strength at day 1, 7 and 28 after pouring to ensure concrete has gained sufficient strength prior to stripping, handling, and mobilization.
- **Visual Quality:** Each product is examined visually to ensure quality of finish and that any deficiencies are within specified acceptance criteria in relevant standards. If product does not meet specified acceptance criteria, it may be rejected.
- **Geometry:** Products are measured to ensure that geometry is within the industry tolerance requirements.
- **Components and Appurtenances:** Product appurtenances such as lifting devices, plates, and inserts are checked to verify that they have been embedded into the concrete satisfactorily.

PERFECT LINED MANHOLE TESTING

In addition to the Pre- and Post-Pour inspections mentioned above, which are carried out for all products manufactured by Geneva Pipe and Precast, some other quality control measures are taken for the Perfect Lined Manhole specifically.

Hydrostatic Tests

- **ASTM C1244 -** A hydrostatic test of the manhole stack to confirm its resistance to exfiltration of liquid through the joints.
- **ASTM C443 -**The hydrostatic performance of the Perfect Lined Manhole joint design was tested in accordance with ASTM C443. Perfect Lined Manhole joint is suitable for internal hydrostatic pressures of at least 13 psi.

Spark Test

A spark test per ASTM D6365 is conducted on all factory-made plastic welds in Perfect Lined Manhole to ensure that the plastic HDPE is completely sealed. This test verifies that the concrete portion of the pipe is completely protected by the plastic liner prior to shipping such that no corrosive gases can reach the concrete in an installed sewer condition.

THIRD-PARTY TESTING

In addition to the testing described above, Perfect Lined Manhole has had several tests completed by third party organizations over time. Some of the key tests are described below.

Vacuum Test

A vacuum test was performed on the Perfect Lined Manhole joint configuration per ASTM C1244. As per the testing specification, a manhole stack was vacuum tested to a negative air pressure of 10 inch Hg. The total time it took for the pressure to reduce to 9 inch Hg was recorded and compared against the passing criteria listed in the testing specification. As per ASTM C1244, the minimum time needed for the vacuum pressure to drop from 10 inch Hg to 9 inch Hg (a total of 1 inch permissible drop) was 45 seconds. The vacuum test was held at 10 inch Hg for five minutes (300 seconds) with a pressure drop of only 3/8 inch Hg. The vacuum pressure was then increased to 12 inch Hg and held for 10 minutes in which a total pressure drop of 1/10 inch was observed.

Pullout Resistance

Following ASTM D7853, the HDPE liner anchored into the self-consolidating concrete was tested for hydraulic pullout resistance. A hole was drilled, and water pressure was applied between the concrete and the liner until the liner detached from the concrete. Water pressure was held at 30 psi for 200 hours and then increased 5 psi of pressure every hour until failure. Figure 2 shows the apparatus used to conduct the test along with the quality of the concrete at failure.

Figure 2: *Hydraulic Pullout Resistance of HDPE liner*

SECTION 7

Installation Recommendations

Handling and installing Perfect Lined Manholes is very similar to installing traditional precast concrete manholes. While all installation requirements specified for traditional precast concrete manholes should be followed, additional care should be taken to ensure that the products are properly handled, installed, and inspected to allow for the superior product performance. In addition to the requirements set forth in ASTM C1821, the following mobilization, handling and installation instructions should be followed.

MOBILIZATION AND HANDLING

On-Site Handling

Perfect Lined Manholes shall be handled with reasonable care. The contractor must take all necessary precautions to ensure the handling method recommended in this guide is followed. When moving the manhole, avoid allowing the manhole to contact hard surfaces such as the trench box. All Perfect Lined Manhole sections are equipped with lifting pins. When moving or lifting the manhole, always use all lifters provided with a maximum sling angle not exceeding 60 degrees. Transporting the manhole shall be done in a manner that prevents excessive impact or dynamic loads. When lifting or handling, contacting the inside of the manhole is prohibited.

Perfect Lined Manhole sewer base shells can be offloaded with forklifts, Gradalls with forks, or by using the proper lifting devices and contractor-supplied chains or slings. All lifting operations shall comply with the applicable OSHA regulation 1926. Perfect Lined Manhole sewer base shells shall be placed on clean leveled soil at the site.

Offload the risers and cones using the supplied lifting pins and contractor-supplied chains, wire rope or slings. For risers and cones contractor supplied chains or slings shall be used, do not off load with forklifts or Gradalls with forks touching the bottom joint of the riser or cone. Perfect Lined Manhole risers and cones shall be stacked on suitable wooden dunnage placed on clean leveled soil at the site.

Visual Inspection Upon Receiving

Upon arrival of the goods at site obtain the packing list and ensure that all components on the truck match the packing list. Visibly inspect the load and note any damage or irregularities to the product on the packing list and bill of lading.

Any Perfect Lined Manhole delivered to a job site has undergone all quality control processes specified in Testing and Quality Control section of this document and has been labeled to indicate product size, identification number, and manufacturing date. Contractor shall visually inspect the product for any potential deficiency listed below which can occur during handling and mobilization:

- Ensure rubber clip is not missing or damaged on the top and bottom of each manhole joint.
- Ensure gasket is provided and not damaged.
- Check for any concrete damage such as chips, spalls, or cracks.
- Check the liner to ensure there is no damage.

When the Perfect Lined Manhole sewer bases, risers and cones are properly stacked at the site visually inspect the liner on the interior of the components for tears, slits or handling damage and note on the bill of lading. Report any product damage or deficiencies to a Geneva Pipe and Precast representative and set product aside.

On-Site Storage

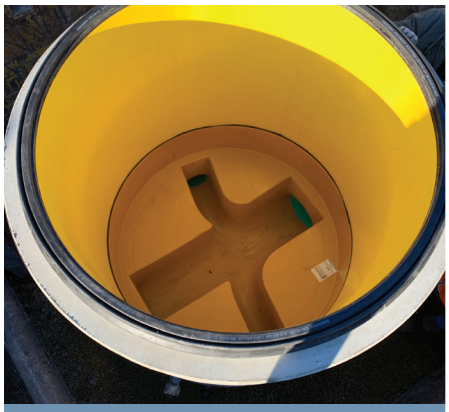
Perfect Lined Manholes shall be stored in a location such that they are protected from traffic and construction equipment. Manholes shall be stored on a flat surface, preferably on a layer of aggregates. Contact a Geneva Pipe and Precast representative for information on UV exposure limits.

INSTALLATION RECOMMENDATIONS

Pre-Installation

- Read the Perfect Lined Manhole installation instructions completely and discuss with the crew.
- Identify the correct Perfect Lined Manhole sewer base and determine the orientation of the inlet and outlet pipes. Identify the correct Perfect Lined Manhole risers and cones in the order that they will be placed in the manhole stack.
- Verify the proper lifting connection devices and contractor supplied chains, wire rope or slings.
- Verify that the base elevation is correct, has been filled with the proper granular material and compacted to the specified standard proctor.
- Install the SDV Seal Gasket prior to connecting the rigging. This will require at least two craftsmen to stretch the gasket around the joint.
- Connect the rigging and lower the base into place. Locate the next section in the stack.
- Connect the rigging and lower the next section into place.
- Visually inspect the external joint gap between the upper and lower segments and ensure that the gap is consistent, and the two surfaces are parallel. *(continued on next page)*

Figure 3: Seal Installation Recommendations



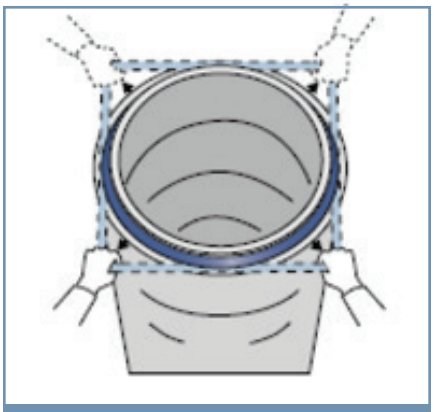
Make sure that the load distribution element of the rubber gasket is facing up.

External gasket lubricant is not required.

If needed, consult with a Geneva Pipe and Precast representative for proper gasket installation training.

Load distribution element is facing up.

Check that the internally lubricated skin is sitting against the vertical joint shoulder.



Stretch the seal in several places to equalize the material.

Failure to do so may result in cracking to the joint.

Pre-installation (continued)

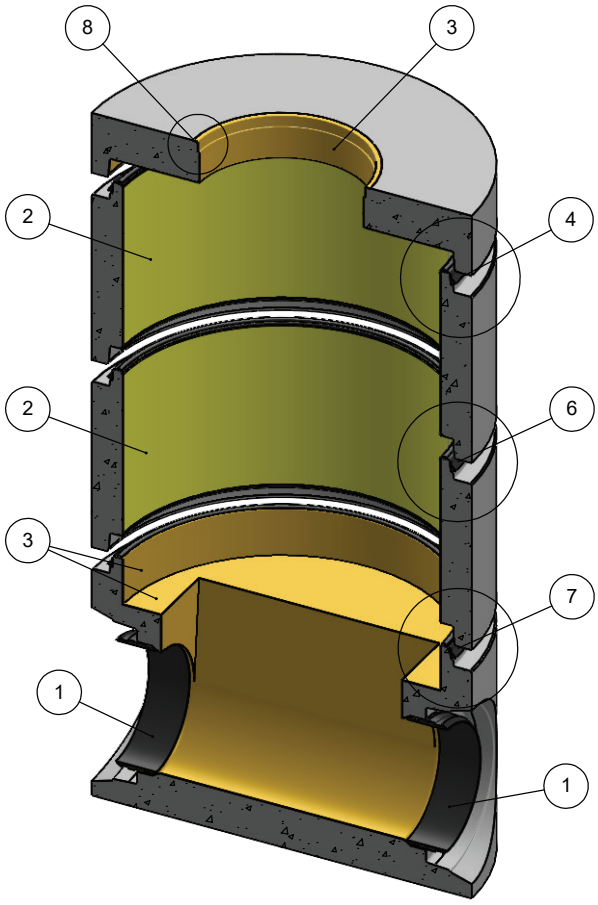
- The Perfect Lined Manhole is designed to have a joint gap of 15 mm. Contractor is to ensure that the 15mm joint gap measurement tool provided does not fit into the joint at any of the four interior locations, 90-180-270-360 degrees.
- Visually inspect the interior surfaces of the lining ensuring that there are no tears, slits, or handling damage. If damage is found, stop the installation and contact your Geneva Pipe and Precast representative, do not attempt to seal with any 3rd party product or repair yourself. If the visual inspection passes have the craftsman disconnect the lifting devices and remove the manhole ladder and continue placing product in this manner until it is stacked out.

SECTION 8

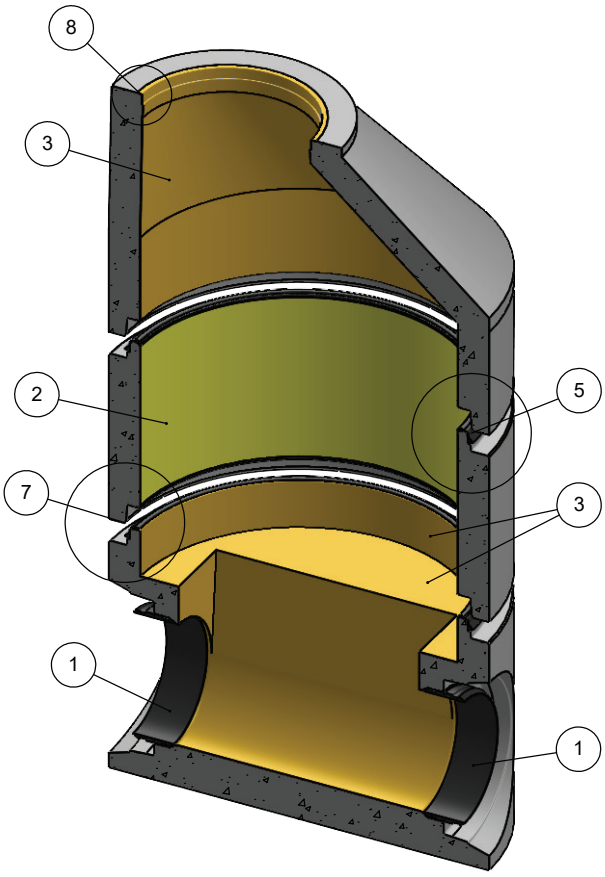
Product Drawings

On the following pages are six sheets of technical drawings, including:

- Overview of Perfect Lined Manhole System
- Perfect Pipe Connections to Manhole Detail
- Joint Detail
- Grade Ring Protection Detail



MANHOLE WITH FLAT LID



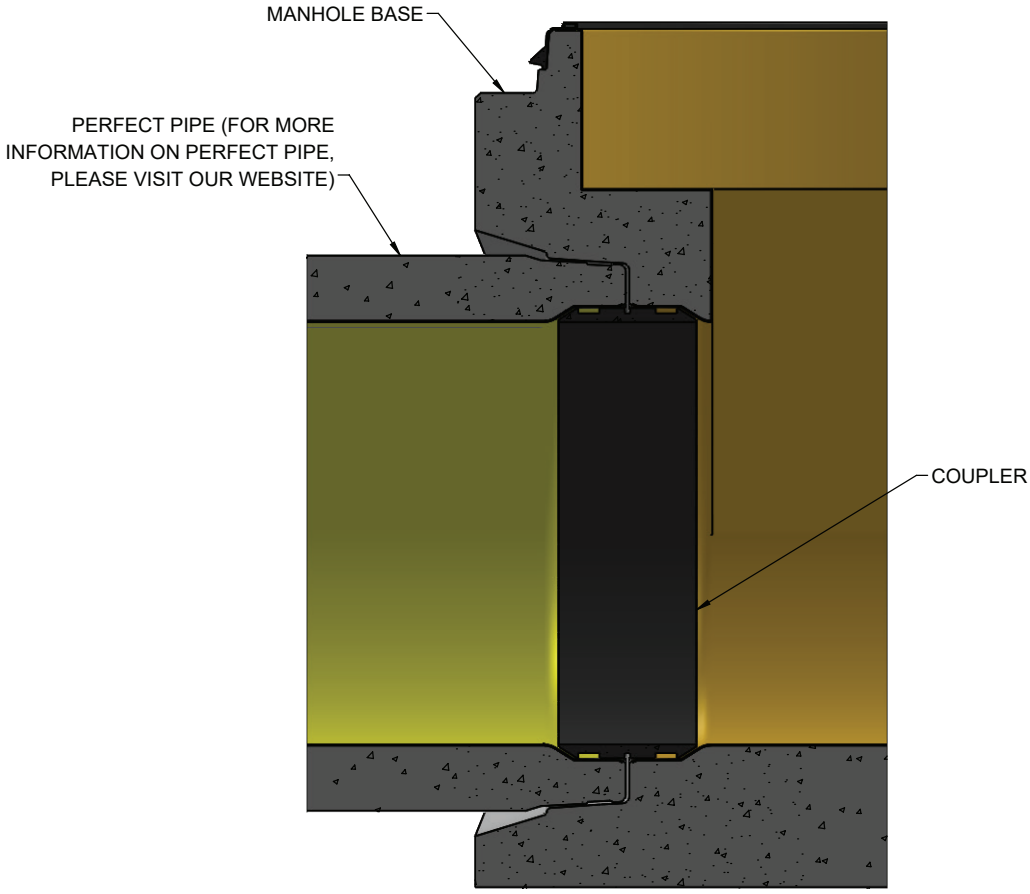
MANHOLE WITH CONE

GENERAL:

1. INTERNAL COUPLER PERFECT PIPE CONNECTOR (SHEET 2)
2. PERFECT HDPE LINER
3. FRP LINER
4. RISER TO FLAT LID JOINT DETAIL (SHEET 3)
5. RISER TO CONE JOINT DETAIL (SHEET 3)
6. RISER TO RISER JOINT DETAIL (SHEET 3)
7. BASE TO RISER JOINT DETAIL (SHEET 3)
8. TOP DETAIL (SHEET 4)

Geneva Pipe and Precast A Northwest Pipe Company	PRODUCT:	PERFECT LINED MANHOLE			
	DRAWN BY:	DMANNING	DATE: 3/16/2021	LOADING:	PER ASTM C478
	CONTACT:	(801) 225-2416 or info@genevapipe.com	WEBSITE: www.genevapipe.com	SHEET:	1

COUPLER



INTERNAL COUPLER
PERFECT PIPE CONNECTOR

Geneva Pipe and Precast A Northwest Pipe Company	PRODUCT:	PERFECT PIPE CONNECTION DETAILS					
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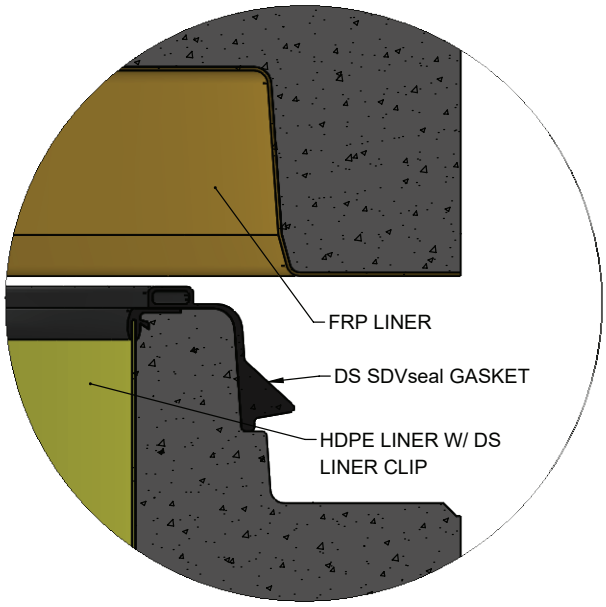
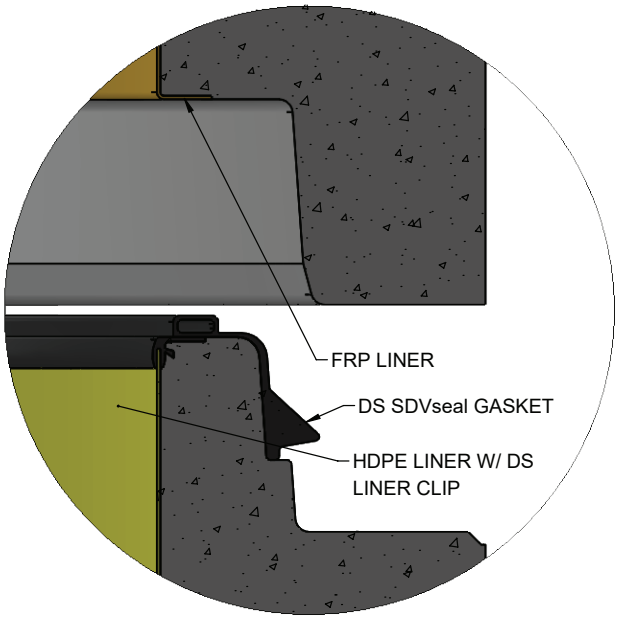
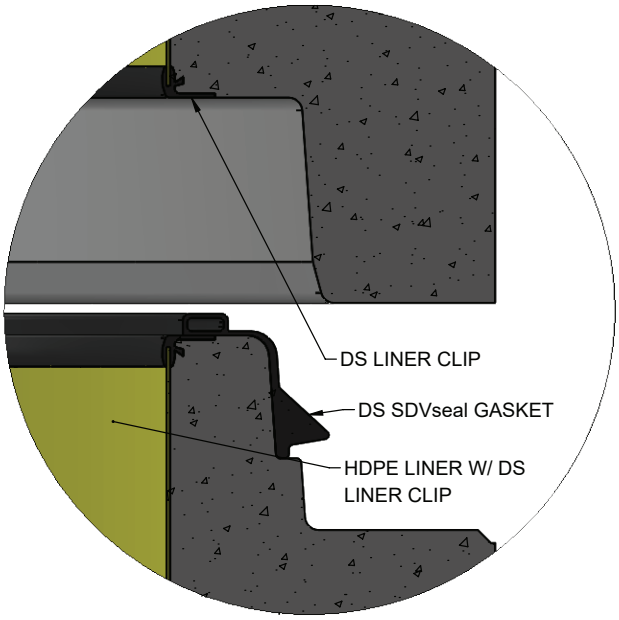
	CONTACT:	(801) 225-2416 or info@genevapipe.com	WEBSITE:	www.genevapipe.com	SHEET:	2	



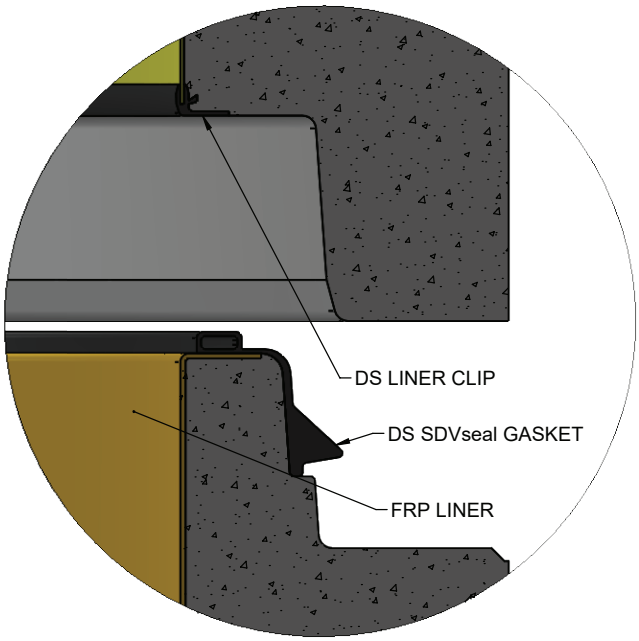
RISER TO FLAT LID JOINT DETAIL



RISER TO CONE JOINT DETAIL



RISER TO RISER JOINT DETAIL



BASE TO RISER JOINT DETAIL

Geneva Pipe and Precast A Northwest Pipe Company	PRODUCT:	JOINT DETAILS			
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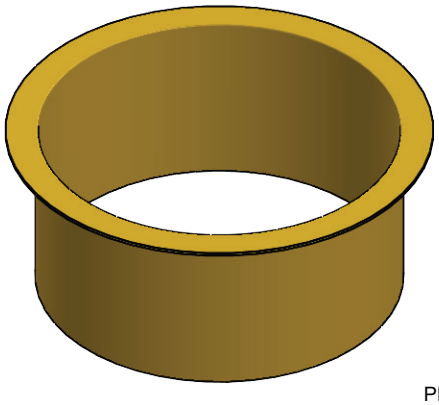
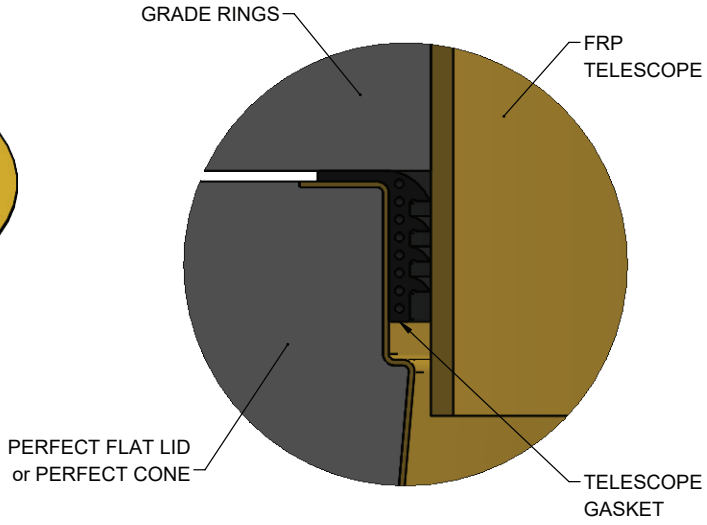
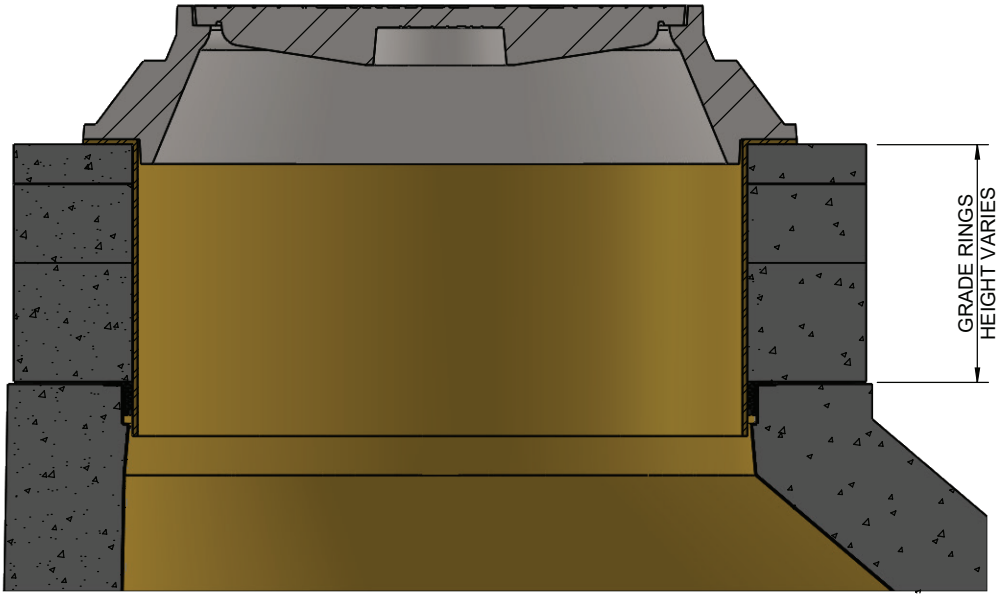


FRP TELESCOPE ISOMETRIC VIEW

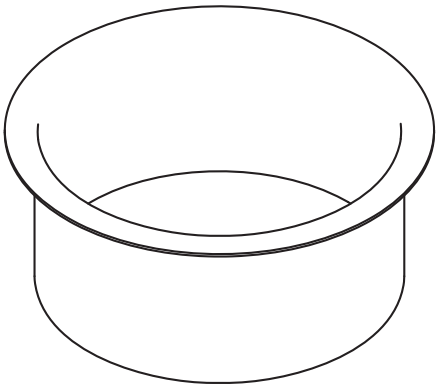


TOP DETAIL

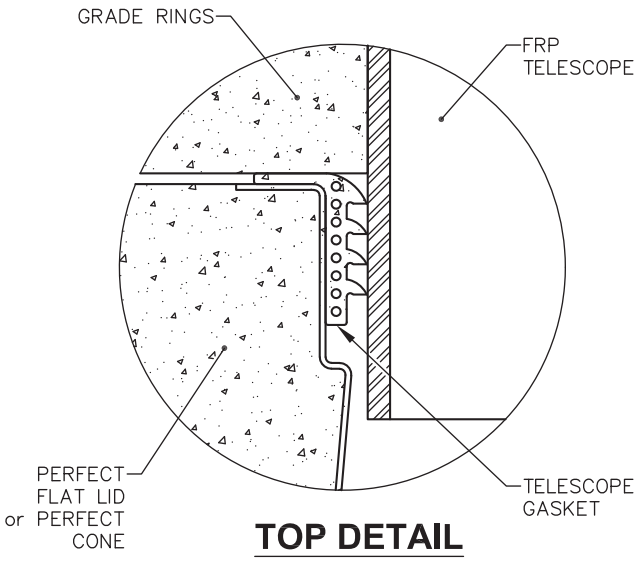


FRP TELESCOPE DETAIL

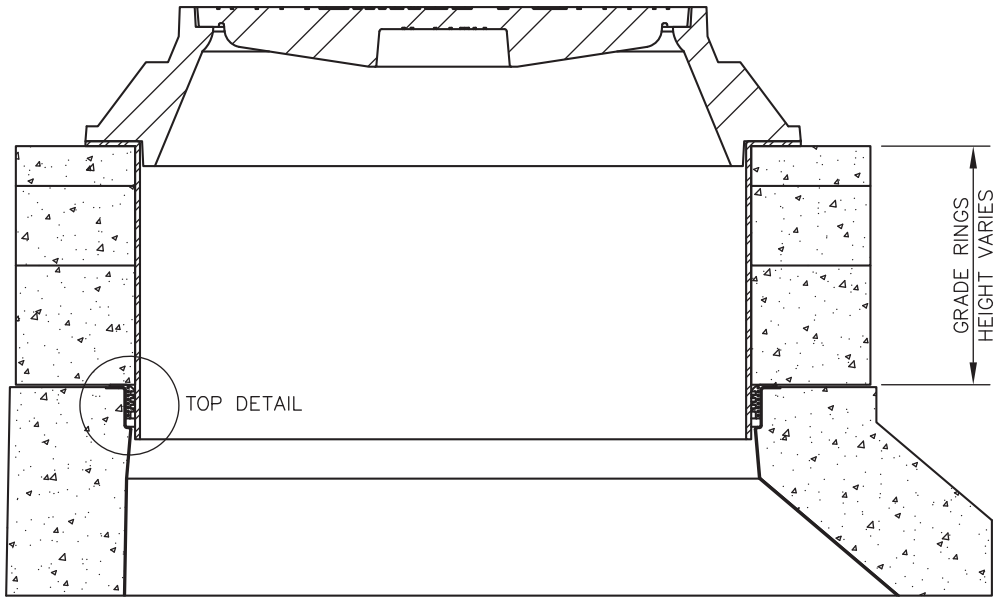
Geneva Pipe and Precast A Northwest Pipe Company	PRODUCT:	GRADE RING PROTECTION DETAILS			
	DRAWN BY:	DMANNING	DATE: 3/16/2021	LOADING:	PER ASTM C478
	CONTACT:	(801) 225-2416 or info@genevapipe.com	WEBSITE: www.genevapipe.com	SHEET:	4



FRP TELESCOPE ISOMETRIC VIEW



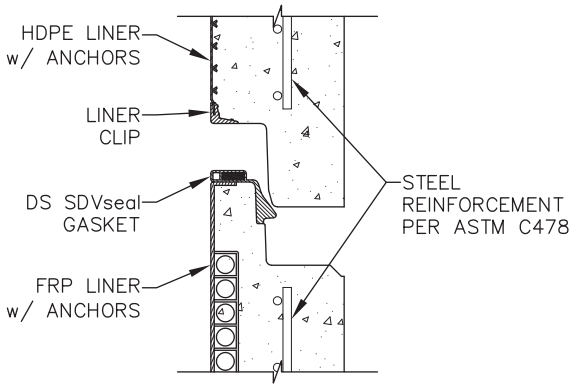
TOP DETAIL



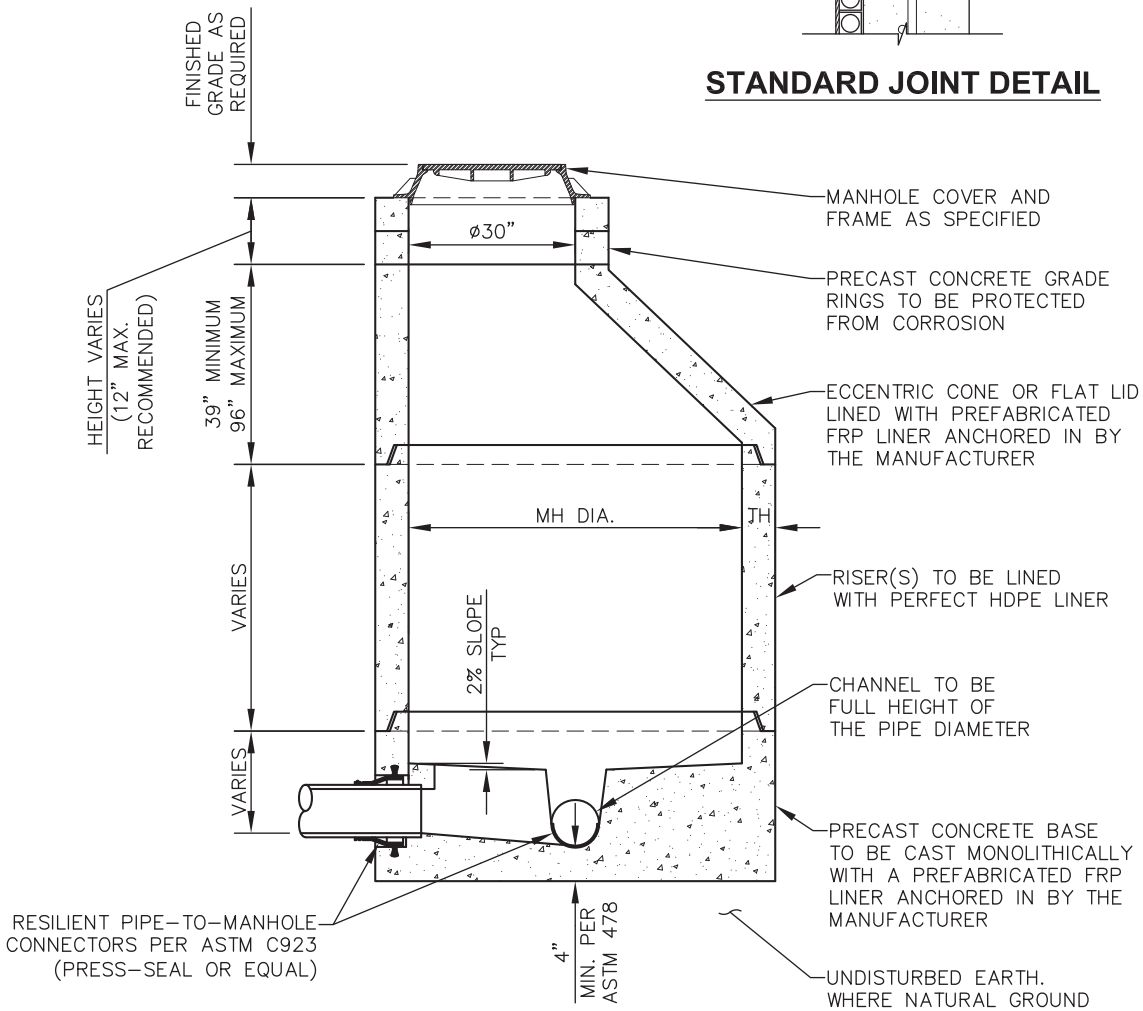
FRP TELESCOPE DETAIL

Geneva Pipe and Precast, A Northwest Pipe Company	STRUCTURE: GRADE RING PROTECTION DETAIL		PROJECT: PERFECT LINED MANHOLE DETAIL		
	SCALE: N.T.S.	DRAWN: DDM	LOCATION: SALT LAKE - OREM - ST. GEORGE PH: 801-225-2416		SHEET: Sheet 1
	DATE: 7/15/2021	TITAN #: –			

MANHOLE DIA. (MH DIA.)	WALL THICKNESS (TH)
ø48"	5"
ø60"	6"
ø72"	7"
ø84"	8"
ø96"	9"
ø120"	11"



STANDARD JOINT DETAIL



SECTION VIEW

NOTES:
1. MANHOLE TO CONFORM TO ASTM C478
2. PRECAST MANHOLE BASE TO BE CAST MONOLITHICALLY
3. EXTENDED BASE CAN BE PROVIDED IF FLOTATION CALCULATION INDICATE RISK OF BUOYANCY
4. ALL MANHOLE SECTIONS SHALL BE CLEARLY MARKED ON THE EXTERIOR AS TO MANUFACTURER AND DATE OF MANUFACTURE PER ASTM C478 AS A MINIMUM REQUIREMENT
5. ALL SEWER MANHOLES MUST HAVE 24 HOUR ALL-WEATHER ACCESS (PAVED SURFACE OR ACCESS ROAD)
6. ALL LIFTING HOLES MUST BE FILLED WITH NON-SHRINK GROUT AFTER INSTALLATION

Geneva Pipe and Precast A Northwest Pipe Company	STRUCTURE: STANDARD SEWER MANHOLE			PROJECT: PERFECT LINED MANHOLE DETAIL	
	SCALE: N.T.S.	DRAWN: DDM		LOCATION: SALT LAKE - OREM - ST. GEORGE PH: 801-225-2416	SHEET: Sheet 1
	DATE: 7/15/2021	TITAN #: –			

SECTION 9

Perfect Lined Manhole System Specification HDPE/FRP Lined Concrete Manholes for Sewers

Part 1 - General

1.01 SCOPE

This section covers Perfect Lined Manhole system, a high density polyethylene (HDPE) lined reinforced concrete manholes with a fiber reinforced polymer (FRP) lined base section intended for use in sanitary sewers, storm sewers and water transmission lines where corrosion resistance or high abrasion resistance in required.

1.02 SPECIFICATIONS AND STANDARDS

ASTM C 33: Standard Specification for Concrete Aggregates

ASTM C 150: Specification for Portland Cement

ASTM C 443: Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gasket

ASTM C 478: Standard Specification for Circular Precast Reinforced Concrete Manhole Sections

ASTM C 497: Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile

ASTM C 990 (most current) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections using Preformed Flexible Joint Sealants

ASTM C 1619: Standard Specification for Elastomeric Seals for Joining Concrete Structures

ASTM A 1064: Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

ASTM D570: Standard Test Methods for Water Absorption of Plastics

ASTM D638: Standard Test Methods for Tensile Properties of Plastics.

ASTM D 968: Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive

ASTM D7853: Standard Test Methods for Hydraulic Pullout Resistance of a Geomembrane with Locking Extensions Embedded in Concrete

ASTM D6365: Standard Test Methods for Nondestructive Testing of Geomembrane Seams using the Spark test

1.03 SUBMITTALS

A. Submit technical data in accordance with the General Conditions.

B. Submit manufacturer's affidavit of compliance with referenced standards as modified herein.

C. Submit cut sheets detailing manhole dimensions, wall thickness, and joints.

D. Submit manufacturer's data and details of frames, grates, rings and covers.

E. Submit test reports on all shop testing required herein and in referenced standards.

F. Submit certificate that cement complies with ASTM C 150, designating type II-V.

G. Submit mill test certificates identifying chemical and physical properties of each lot of reinforcing steel delivered.

H. Submit concrete mix designs.

1.04 SPECIALS

A special is defined as any part of a manhole section that is not a standard part. Special sections require their own unique cut sheets and, in some cases, when requested by the engineer may require structural calculations.

1.05 INSPECTION

All manholes furnished under this specification are subject to inspection in the manufacturer's plant by the Owner's Representative.

1.06 QUALITY ASSURANCE

The producer shall be an NPCA Plant Certified.

Part 2 - Products

2.01 PERFECT LINED MANHOLE

A. Provide Perfect Lined Manhole System components which include monolithic base, risers, conical tops or flat lids and grade rings designed and manufactured in accordance with ASTM C478.

B. Monolithic concrete base section shall be lined with prefabricated one-piece homogeneous fiber reinforced polymer (FRP) compound with a minimum thickness of 0.197-in (5mm)

C. The sanitary sewer baseliner shall include:

1. Full flow channels with side walls to the crown of the pipe(s).
2. A non-skid pattern on inner bench surfaces.
3. Pipe connections with specified invert elevations and slopes for incoming pipes.
4. The standard vertical side wall (skirt) height above the bench shall be 2-in minimum. Other skirt heights, as agreed upon between the purchaser and the manufacturer.

D. Riser sections to be lined with HDPE Perfect Liner sheets with a minimum thickness of 0.065-in (1.65mm).

E. Manhole flat lids and cones to be lined with FRP.

F. Manhole joints shall be assembled with a bell and spigot with SDV seal gaskets per ASTM C443. Joint sealing surfaces shall be free of dents, gouges, and other surface irregularities. The joints and complete assembly shall pass vacuum test per ASTM C1244.

G. The minimum clear distance between two wall penetrations shall be 6 inches. Minimum clear distance between penetrations and joint seams shall be 3 inches.

2.02 BASIS OF DESIGN

A. Concrete sewer manholes shall be manufactured from self-consolidating concrete (SCC) with a minimum compressive strength of 4,000 PSI conforming to material and performance standards of ASTM C-478.

B. Cement for the manholes shall conform to ASTM C-150, Type II-V. All sand and aggregate shall be nonreactive in an acid environment.

C. Perfect Manhole system to support AASHTO HL-93 or HS-20 loads.

2.03 JOINTS

A. Elastomeric gasket material shall be produced from EPDM 5055 rubber and manufactured by D+S SDV Seal.

B. Installed joints shall be capable of holding constant internal pressure of 30 PSI.

2.04 PRODUCT MARKING

Plainly mark each manhole section with the manufacturer's name, project and customer name, date of manufacture, nominal diameter, section height and structure ID and concrete type.

2.05 HDPE LINING

A. The interior of the manhole risers shall be lined with a High-Density Polyethylene (HDPE) concrete protective liner (CPL) with a minimum thickness of 1.65 mm. The CPL shall have a minimum of (94 qty) anchors per square foot extruded as one homogeneous piece.

B. All edges of the HDPE CPL shall be covered with a EPDM liner clip manufactured by D+S Sealants.

C. HDPE CPL shall be capable of resisting groundwater pressure up to 30 PSI.

2.06 FRP LINING

A. The interior of the manhole base section and flow channels shall be coated prior to casting with a FRP factory spray coating a minimum of 0.197-in (5 mm) thickness.

B. FRP coating shall have spray bonded embeds on the back side of the base liner section.

C. When monolithically cast into the base shell the structure the FRP liner shall be capable of resisting groundwater pressure up to 30 PSI.

D. At the discretion of the manufacturer the FRP coating may be used in all or part of the liner fabrication for the cone.

Part 3 - Execution

3.01 INSTALLATION

A. Segments to be manufactured with self-aligning segment joints.

B. All segments to have external lifting devices.

C. When segment is placed gasket to be secured around the spigot. Once in place the gasket must be equalized by pulling it away from the spigot 1-2” on all sides and releasing.

D. Field-welding of joints shall not be required for the Perfect Liner Manhole System.

E. Pipe-to-Manhole Connections shall be accomplished in accordance with the following options:

1. With direct drive boot connector for all pipe types
2. Perfect connector when connecting Perfect Pipe to Perfect Lined Manhole
3. Cast-in gasket when using 4-in through 52-in internal diameter pipes
4. Other connection methods approved by a manufacturer
5. Approved Connector Manufacturers:
6. Press-Seal Corporation, PSX Direct Drive compression connector.
7. Hamilton Kent, Tylox compression connector.
8. Vertex, Inc., V-0216 4” to 12”, V-0226 14” to 52”.

F. Approved Connector Manufacturers:

1. Press-Seal Corporation, PSX Direct Drive compression connector.
2. Hamilton Kent, Tylox compression connector.
3. Vertex, Inc., V-0216 4” to 12”, V-0226 14” to 52”.

3.02 CAUSES FOR REJECTION

Manhole can be rejected for any of the following reasons:

A. Exposure of any wires and positioning spacers or chairs used to hold the reinforcement cage in position or steel reinforcement in any surface of the manhole.

B. Tears in the liner greater than 2-in in width on any segment.

C. Bubble voids on the exterior surface of the manhole exceeding 3/8” in diameter.

D. Missing or bent external lifting devices.

3.03 MANUFACTURER

Manufactured by:

Geneva Pipe and Precast, A Northwest Pipe Company
1465 N. 400th Street, Orem
UT 84057. 801-225-2416
www.nwpipe.com

SECTION 10

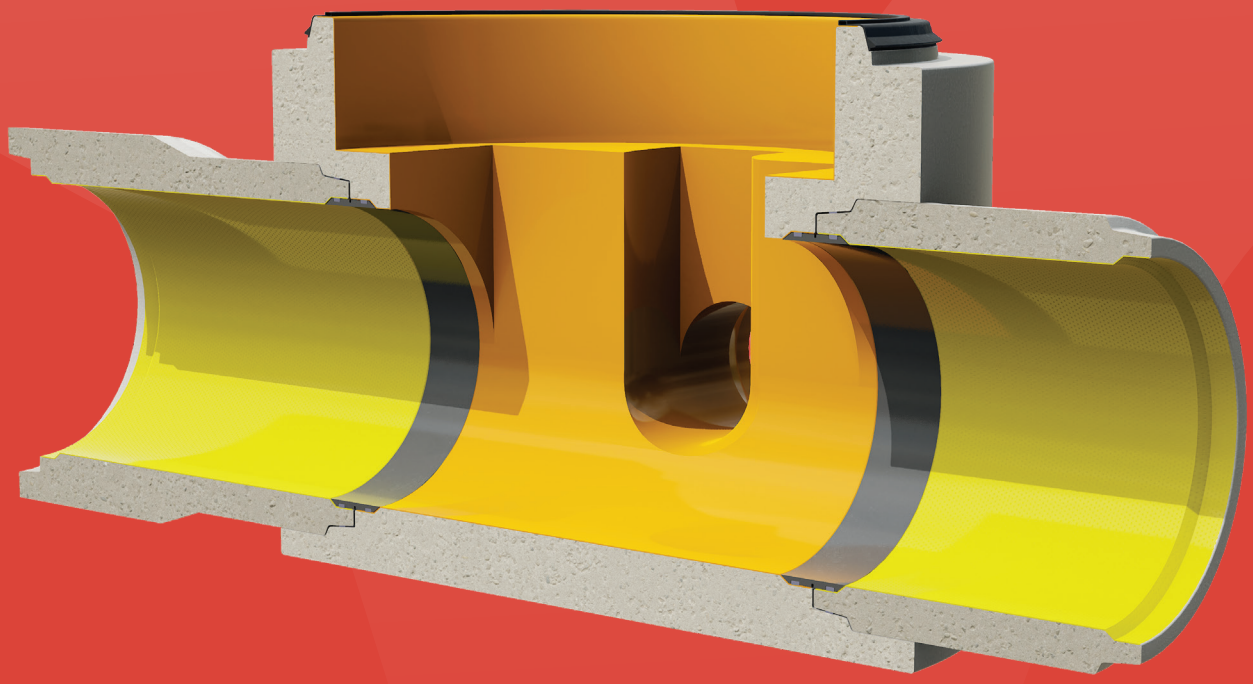
North America Installations

Table 1: *Perfect Lined Manhole Installations in North America Project Summary*

Installation Date	Quantity	Location	Client/Contact Person	Total Construction Cost	Years in Service
11/24/2020	60" SMH 12' Deep	Vineyard City, UT Vineyard Town Center	Chris Wilson, Vineyard City 125 S Main Street Vineyard City, UT 84059 801-226-1929	$12,850	1 year, 1 month
12/28/2020	60" SMH 19.5' Deep	Riverton, UT Mtn Ridge 4	South Valley Sewer District 1253 Jordan Basin Lane Bluffdale, UT 84065 801-571-1166	$10,400	11 months
5/1/2021	3-60" SMH 1-84" SMH 30' Deep	Bluffdale, UT Sage Estates	South Valley Sewer District 1253 Jordan Basin Lane Bluffdale, UT 84065 801-571-1166	$84,947.36	6 months
6/24/2021	5-60" SMH 8-17' Deep	Duck Creek, UT Duck Creek SS	Kane County Water Conservancy District 723 East Kaneplex Drive Kanab, UT 84741 435-644-3997	$49,979	6 months
7/2/2021	4-72" SMH 4-17' Deep	Riverton, UT River Ridge	South Valley Sewer District 1253 Jordan Basin Lane Bluffdale, UT 84065 801-571-1166	$48,289	5 months
8/4/2021	72" SMH 8' Deep	Draper, UT Big Willow 6	South Valley Sewer District 1253 Jordan Basin Lane Bluffdale, UT 84065 801-571-1166	$9,882	4 months
9/23/2021	60" SMH 14' Deep	Riverton, UT The Silos @ Riverbend	South Valley Sewer District 1253 Jordan Basin Lane Bluffdale, UT 84065 801-571-1166	$11,448	2 months
8/1/2021	6-60" SMH 3-6' Deep	Springville, UT Wavetronix	Springville City S&W 700 North 500 West Springville, UT 84663 801-489-2745	$37,524	2 months
8/20/2021	72" SMH 20' Deep	Riverton, UT Riverton Costco	South Valley Sewer District 1253 Jordan Basin Lane Bluffdale, UT 84065 801-571-1166	$13,195	2 months

NOTES

APPENDIX
Material Data Sheets



Thermoplastic Lining

General

For precast concrete pipes in sewer applications it is an essential requirement to protect the inside surface. The protection of the inside surface is necessary to ensure water proofing, good flow characteristics and high chemical resistance.
Past experience has shown that unprotected concrete surfaces as well as chemical based linings such as coatings, sprayed linings are not providing the life duration which is required for such investment intensive life lines for cities and industrial installations.
Lining with thermoplastic material which is based on mechanical bonding in the concrete substrate is providing much superior properties for such applications. This report will discuss the main benefits of such linings and various methods of construction.

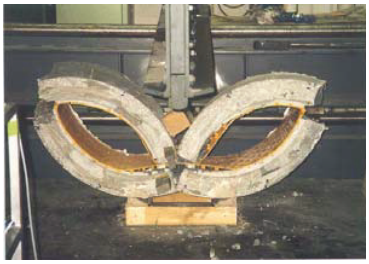
Advantages of Thermoplastic Lining

Thermoplastic lining based on already widely used material such as **High density polyethylene (PEHD)** is applied to the concrete substrate during the construction of the system. This provides major advantages over other lining systems.

- Immediate implementation of the lining material ensuring better bonding capabilities and faster construction cycles (coatings can only be applied after concrete is completely dry and clean which will increase construction time)
- Mechanical anchoring by means of anchor studs which are applied on the thermoplastic liner during manufacturing provides high bonding strength between the lining material and the concrete (high pull out strength and ground water pressure resistance)

Thermoplastic lining provides further major advantages for such kind of applications such as:

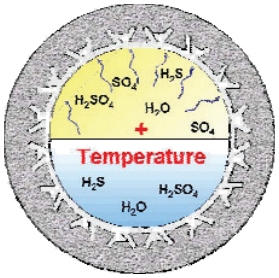
- **Full leak tightness**



The material has excellent mechanical properties including high elongation behaviour. These properties provide in the application the benefit that cracks of the concrete structure will not create a leak of the lining material.Cracks of the concrete substrate will be bridged.The picture shows destructive tests performed on CPL lined concrete pipes where thisbehaviour of the lining material is demonstrated.

- **Very good chemical resistance**

Unprotected concrete structures are heavily deteriorated by chemical attack resulting in many cases that the structures are collapsing or heavily leaking. Similar behaviour is also happening on coated concrete structures whereby the lifetime is slightly higher than for unlined systems. Especially in regions where environment temperatures are consistently higher than 25 °C chemical resistance of concrete structures play a significant factor for the life time of the system.



Thermoplastic materials such as PEHD are chemically resistant against diluted solutions of salts,acids and alkalis if these are not strong oxidizing agents. Good resistance is also given against many solvents, such as alcohols, esters and ketones. This ensures that thermoplastic systems are not deteriorated by any chemical attack of long periods and will therefore play a significant factor for the long life duration of sewer systems.

- **Very good abrasion resistance**

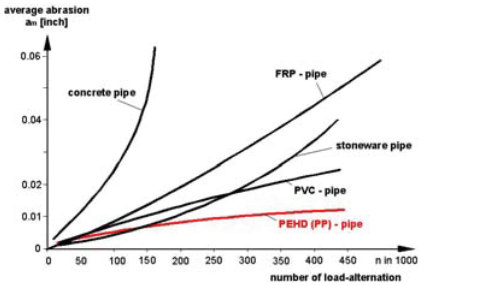
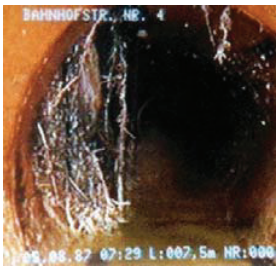


Figure 1: Comparison of the abrasion of Polyethylene (PEHD) & Polypropylen (PP) with other materials, tested acc. "Darmstädter" test method

Unlined concrete surfaces do not have very good resistance against abrasion. In operation this will create pretty fast deterioration of the installed system. Reduced flow capabilities, build up of sediments in the tunnel have been detected in many occasions. Abrasion tests have verified that various material types do provide very different properties. As the best materials, thermoplastic materials such as PEHD have by far the highest abrasion resistance.

- **very good resistance against root growth**



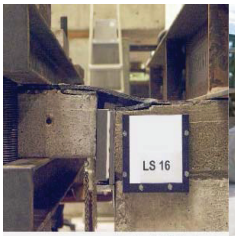
Unlined or uncoated surfaces do not provide resistance against penetration of roots.
Especially joint sections showing such problems. The growth of roots into piping system will cause reduction of the static condition of the installed underground system and is causing significant reduction of flow capability. Cracks which are leading to leaking require significant efforts in maintenance, causing high operation cause downtime periods in operation.

- **Good surface smoothness**

Quelle: MPA Karlsruhe

Plastic lining provides the further bid advantage of very smooth surface characteristic.
The above given properties and benefit of plastic ensure also that the surface properties remain consistent for the service life
A further advantage is that cleaning of the system does not require a lot of effort and is possible up to 120bar.

- **Settlements**



Quelle: MPA Karlsruhe

For pipelines settlements must be considered in weak soil conditions which can cause cracks or joint problems. Thermoplastic liners can take settlements by its high elongation properties.

Long-term analyses based on actual testing also identified that PEHD lined surfaces are suitable to withstand life durations more than 100 years.

The SURE GRIP CPL System meets the requirements of national and international standards. National approvals are qualifying this system for the application for precast pipes for the transport and storage of drinking and waste water.

Österreichisches Normungsinstitut
Austrian Standards Institute

DS Dichtungstechnik GmbH informs

Recommendations for storage of seals

As far as possible, the following points should be noted for the storage of loose gaskets (DIN EN 681-1, appendix D):

- The storage temperature should be below 25°C.
- The seals should be protected against light, especially against strong sunlight and artificial light with a high ultraviolet content.
- The seals should not be stored in a room that contains equipment that can produce ozone, such as mercury arc lamps or appliances with electric high voltage which can cause sparks or silent electrical discharges.
- The seals should be stored relaxed without tension, pressure or other deformations. They should not be hung on any part of the seal.
- The seals should be kept clean all the time.

In principle, the DS sealing material made of styrene-butadiene rubber (SBR) and ethylene-propylene-diene rubber (EPDM) is adequately weather- and aging-resistant for outdoor storage for up to **2 years**.
For example, rubber matrices are added to the rubber matrix, which migrate to the profile surface after vulcanization and provide protection against ozone and UV radiation as well as heat radiation as a surface film.
Like a depot effect they provide for a repair of injured surface films.
For seals installed in the pipe, it exists a sufficient amount of protection against weathering and aging.

Loose seals should be mounted just before delivery to the site.
Weather and high tensile stress in the sealing-ring endanger especially the joint of the both ends of the sealing-ring.

Recommendations:

1. **Storage of the loose gaskets before installation is weather-protected in accordance with DIN EN 681-1 (see above)**
2. **Mount the loose seal rings just before delivery to the site**

Aging resistance before installation

If the storage recommendations described above will be observed, our seals in the non-installed state keep their full operability up to **5 years** from their production date.

Lifetime of elastomer seals

- An aging of elastomeric seals is accelerated by the action of UV radiation and ozone. Once a seal has been installed, these factors are excluded.
- Our seals are tested according to the aging tests of DIN EN 681-1.
- In the installed state, the pressure forces will be relaxed.
  This relaxation is taken into account by the minimum grouting of 25%.
- Seals taken from us, which were installed 45 years ago, fulfilled the physical values of DIN 4060.
- In the case of appropriate treatment and standard mounting on the site, we assume a lifetime of our seals from 80 to 100 years.

DS Dichtungstechnik GmbH, Nottuln, 26.01.2015

PERFECT PIPE

PERFECT Connector DN250 – 600

- **PERFECT Connector**
  injected molded
  plug-in-connection

- **PP-B black**

Technical properties for PPB material for PERFECT Connector as per DIBT Approval Z-42.5-552.

	Property	Standard	Unit	PP-B
MECHANICAL PROPERTIES	Density	DIN EN ISO 1183-1	g/cm³	0,911 – 0,922
	Melt Flow Rate (230°C / 5 kg)	DIN EN ISO 1133	g/10 min	1,20 – 1,70
	Tensile Strength	DIN EN ISO 527-1	MPa	≥ 28
	Tensile Strain at Break	DIN EN ISO 527-1	%	≥ 26
	Flexural Modulus	DIN EN ISO 178	MPa	≥ 1.440
	Flexural Strength	DIN EN ISO 178	MPa	≥ 41
	Charpy Impact Strength (23°C)	DIN EN ISO 179-1	kJ/m²	≥ 120

Ecotechnic GmbH & Co.KG, 4673 Gaspoltshofen
Phone (+43) 7735 7320 0 Fax (+43) 7735 7320 58
support@ecotechnic.at | www.ecotechnic.at

PERFECT PIPE

PERFECT Connector DN700 – 1500

- **PERFECT Connector**
  injected molded
  plug-in-connection
- **PP-GF black**

Technical properties for PPB material for PERFECT Connector as per DIBT Approval Z-42.5-552.

	Property	Standard	Unit	PP-GF
MECHANICAL PROPERTIES	Density	DIN EN ISO 1183-1	g/cm³	1,215 – 1,285
	Melt Flow Rate (MFR 230°C / 2,16 kg)	DIN EN ISO 1133	g/10 min	3,0 – 6,0
	Oxidation Induction Time (OIT bei 210°C)	DIN EN ISO 11357-6	min	> 40
	Tensile Strength	DIN EN ISO 527-1	MPa	≥ 95
	Tensile Strain at Break	DIN EN ISO 527-1	%	≥ 2
	Flexural Modulus	DIN EN ISO 178	MPa	≥ 6.500
	Flexural Strength	DIN EN ISO 178	MPa	≥ 138
	Charpy Impact Strength (23°C)	DIN EN ISO 179-1	kJ/m²	≥ 35

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support@ecotechnic.at | www.ecotechnic.at

PERFECT PIPE

Material Datasheet - Load Transmission Ring DN250 - 1500

- **Polymer:** NBR
- **Quality designation:** 70-N-03 E
- **Colour:** black

Tested Characteristic	Testing Method	Unit	NBR
Hardness	DIN 53505	Shore A	71
Density	DIN 53479	g/cm³	1,23
Tensile strength	DIN 53504	N/mm²	11,6
Elongation at break	DIN 53504	%	309
Compression Set 70°C 24 H at 25% deformation	DIN ISO 815	%	31
Ozon resistance 50 PPHM, 23°C, 72 H, 20% elongation	DIN 53509	-	No cracks

Temperature resistance (short-term)	from -40°C	to	+100°C
Permanent Temperature resistance	from -30°C	to	+90°C

Oil resistant

The material data is based on laboratory tests and should not be construed as a specification. The properties measured on finished products can be different to the material data based on laboratory test. The standardized sampling of specimens from finished products is not always possible.

Subject to errors and modifications.

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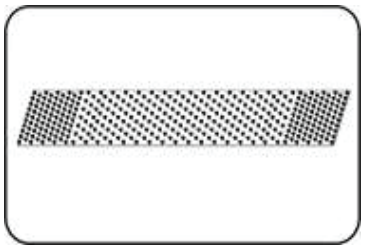
Phone (+43) 7735 7320 0 Fax (+43) 7735 7320 58
support@ecotechnic.at | www.ecotechnic.at

ecoTECHNIC TECHNOLOGY THAT SEPARATES

HDPE Perfect Liner
Concrete Protective Liner

- **Perfect Liner**
  - Stud type: 7.8 mm
  - Extruded



- **Hot gas extrusion welding**
- **HDPE yellow (~RAL 1018)**
- **Type code 21.559**

Property	Standard	Unit	Product
Specific density at 23 °C	ISO 1183	g/cm^3	0.94 - 0.96
Melt flow rate MFR 190/5	ISO 1133	g/10min	1.6 - 2.0
Tensile stress at yield	ISO 527	MPa	≥ 12
Elongation at yield	ISO 527	%	≥ 8
Elongation at break	ISO 527	%	≥ 400
Modus of elasticity	ISO 527	MPa	≥ 620
Pull-out resistance at 23°C Tensile test 5 mm/min (short term)	In accordance to DIN ISO 4624	N/Stud kN/m²	≥ 500* 854
Anchor stud arrangement	-	Studs/m²	~1709 central section ~2324 edge section
Backpressure resistance at 23 °C	DIBt-test methode	1,5 bar/ 1000h	fulfilled
Max. Working temperature	-	°C	60**
Linear coefficient of thermal expansion	DIN 53752	$K^{-1} \times 10^{-4}$	1.8***
Flammability	UL 94 DIN 4102 EN 13501	-	94-HB B2 Class E
UV stabilized	-	-	3 years Central Europe 15 monthSouth-western Asia
Colour	-	-	Yellow (~RAL 1018)

18.11.2020_003

*… Pull-out test were carried out with self-compacting concrete and a 1.65 mm Perfect Liner
**… Depending on media/ consultation with AGRU
***… guide value

The data in this table are approximate values and based upon results of the internal inspection, data of raw material suppliers as well as tests in the course of approval procedures and external inspections. The results can differ slightly from the indicated mean values in longitudinal and transverse direction and due to different nominal thicknesses and raw materials. In any case requirements relating to a special project (tender documents) have to be agreed with AGRU. Independent of the indicated test standards, internal tests and data on test certificates are generally carried out in accordance with the appropriate test procedures according to OENORM (Austrian Standard) resp. DIN (German Standard) or EN ISO. AGRU assumes no liability in connection with the use of this data. The specifications on these sheets are subject to change without notice.

A G R U
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A-4540 Bad Hall Austria
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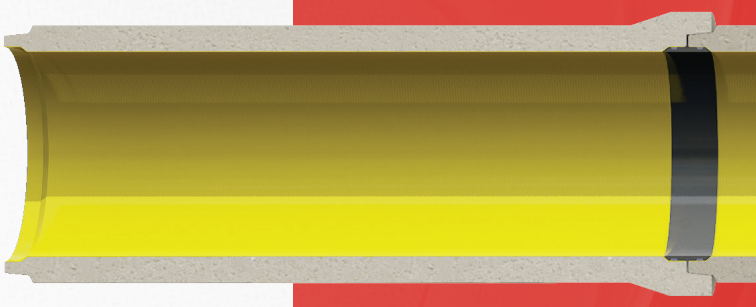
Firmenbuchgericht: LG Steyr

NOTES



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