



ISO 9001



Committed to Quality

CRT LABORATORIES, INC.

1680 North Main Street, Orange, CA 92867

(714) 283-2032 • (800) 597-LABS (5227) • Fax (714) 283-1365

www.crtlabs.com • e-mail: crtlabs@pacbell.net

ASTM Physical & Mechanical • Chemical-Thermal Analysis • IAPMO Cell Class

Geosynthetic Materials • Plumbing & Faucet Assemblies • Resin & Finished Product Testing

TEST REPORTPAGE 1 OF 3

FOR: Perma-Liner Industries, Inc.
 5196 126th Ave. North
 Largo, FL 33773
 Tel: (727) 507-9749/ Fax: (727) 507-9849
 ATTN: Mr. Eric Baum

LWR NO.: 16149 DATE: February 14, 2005**BACKGROUND:**

Customer submitted one (1) sample for flow comparison analysis. The sample arrived at CRT on 02/02/2005 via customer supplied courier. Visual inspection was performed on 02/02/2004 and no product defects were noted. Sample submitted to compare theoretical flow rate to similar size clay and cast iron sewer pipe. Analysis to be performed per customer P.O. # 1794 received on 02/12/2005 and signed CRT quotation dated 02/12/2005. The following additional information is provided:

CRT Order Entry Log Date: 02/14/2005

Sample Description:

- 1) 4" clay pipe with Perma-Liner lateral lining system
- 2) 4" clay pipe with joint
- 3) 4" cast iron pipe with joint

SPECIFICATION:

ASTM F1216-03 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube

ASTM C 700-02 Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated

ASTM A888-04a Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

PROCEDURES:

Flow (q) – per Manning formula and Williams-Hazen formula
Coefficients of flow – per PPI Technical Reports

TEST SUMMARY:

According to CRT's calculations, the reduced diameter of the Perma-Liner product does not reduce flow. The Perma-Liner product flows better than clay pipe with a joint every 5-feet and cast iron with a joint every 10-feet due to the smoothness of the interior and the lack of turbulence.

RESULTS:

Test results are shown in Table 2, attached.

Specimen Retain Bin: #BB (30 day hold only)

CRT LABORATORIES, INC.*UL Registered Firm / ISO 9001:2000 Certified / ISO 17025 Compliant*

Ken A. Le Jeune
 Laboratory Director / President

Tom J. Parsons
 General Manager



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DATA

Pipe size was obtained from referenced ASTM specifications for the vitrified clay and cast-iron products. Perma-Liner I.D. was determined by measurements of the product in 4" clay pipe.

<i>Pipe size (D)</i>	4" nominal
Perma-Liner	0.310' (3.72")
Vitrified clay	0.333' (4.00")
Cast-Iron	0.328' (3.94")

Manning coefficients were obtained from Plastic Pipe Institute (PPI) Technical Reports. Cast-Iron coefficients were obtained from County of San Benito, CA Dept. of Public Works, Appendix D, Chapter 3.

<i>Manning coefficients (n)</i>	
Perma-Liner	0.010
Vitrified clay	0.015 (good condition)
Cast-Iron	0.013 (new, unlined)

Hazen Williams coefficients were obtained from LMNO Engineering, Research, and Software, Ltd. and PPI Technical Reports.

<i>H-W Pipe coefficients (C)</i>	
Perma-Liner	150
Vitrified clay	110 – 140 (good condition)
Cast-Iron	130 (new, unlined)
	107 – 113 10 yr. old
	89 – 100 (20 yr. old)
	75 – 90 (30 yr. old)
	64 – 83 (40 yr. old)

The friction loss value for insert couplings was obtained from PPI Technical Report *Water Flow Characteristics of Thermoplastic Pipe*. These factors occur every so many feet of pipe. The friction loss was divided by this occurrence to obtain values in ft./ft.

<i>Friction loss</i>	
Insert couplings	12D/occurrence
Perma-Liner	0.0
Vitrified clay	0.800
Cast-Iron	0.394

The slope for a standard installation is 0.25"/' per UPC Code. The friction loss detracts from the effectiveness of the slope. Without friction loss, slope is the same. With friction, the slope effectively decreases as a factor of $1 / (1 + \text{Friction loss})$.

<i>Effective Slope (S) (0.25"/')</i>	0.02083 / (1 + Friction loss)
Perma-Liner	0.02083
Vitrified clay	0.01157
Cast-Iron	0.01492



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TABLE 2 FLOW CALCULATIONS

Manning Calculations

Flow (pipes flowing full), q (gpm) = $(207.8/n) \times D^{2.667} \times S^{0.5}$

Perma-Liner	131.9 gpm
Vitrified clay	79.4 gpm
Cast-Iron	99.9 gpm

Hazen-Williams Calculations

Flow (pipes flowing full), q (gpm) = $193.9 \times C \times D^{2.63} \times S^{0.54}$

Perma-Liner	165.1 gpm
Vitrified clay	106.5 – 135.5 gpm
Cast-Iron	68.3 – 138.7 gpm