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650 SOUTH SPRING ST., SUITE 200
LOS ANGELES, CA 90014-1911

April 30, 2003

Joanne Hughes, Vice President
Raven Lining Systems
1024 North Lansing
Tulsa, Oklahoma 74106

Dear Ms. Hughes:

Re: **CHEMICAL RESISTANCE TESTING OF RAVEN 405 EPOXY LINING**

Attached is Lab No. 2003-514-91, dated April 10, 2003, showing the results of chemical resistance testing for the above maintenance hole product. The lining system responded to chemical exposure as follows:

*Weight change: **Excellent***

*Hardness change: **Excellent***

*Tensile strength change: **Excellent***

*Elongation: **Satisfactory**, with reactions to sulfuric acid, nitric acid, ferric chloride, detergent, biological and bleach exposures and a notable reaction to sodium hydroxide and ammonium hydroxide exposures.*

The lining system is identified as follows:

Trade Name: Raven 405

Approved Use: Sanitary Sewer Maintenance Rehabilitation

Installation: SSPWC Section 500-2 as modified by City of Los Angeles Brownbook

Resin: Blue-colored solid epoxy

The overall summary is that this material **passed** SSPWC Section 210-2.3 Chemical Resistance Test. To complete the evaluation process, a trail demonstration must be arranged where we may observe and verify an installation of the system. If you have any questions, please call me at (213)847-8776.

Sincerely,

Hugh S. Lee, Group Manager
Design Standards and Investigations Group
650 S. Spring Street, Suite 400
Los Angeles, California 90014-1913

<HSL:hl/raven4.wpd>

Attachment (Lab No. 2003-514-91)

Chemical Resistance Test of
Raven Lining Systems
Raven 405 Blue
Epoxy Resin

Project Title: Maintenance Shaft & Sewer Rehabilitation
Project Number: BD001748
Engineer: Hugh Lee
Source: Raven Lining Systems
Date Received: 10/16/2002
Specification: SSPWC 210-2.3.3, 1997
Description: Raven 405 Blue Epoxy Resin

SOLUTION	RESULTS CONDITIONED WEIGHT CHANGE % maximum				REQUIREMENTS CONDITIONED WEIGHT CHANGE %
	Days Immersion				
	28	56	84	112	
<i>Sulfuric Acid, 20%</i>	0.2239	0.3685	0.6617	0.6543	All Solutions and Periods ± 1.5% max
<i>Sodium Hydroxide, 5%</i>	-0.0435	0.0532	0.1263	0.1700	
<i>Ammonium Hydroxide, 5%</i>	0.0231	0.1234	0.2410	0.2754	
<i>Nitric Acid, 1%</i>	0.0706	0.1708	0.3070	0.3531	
<i>Ferric Chloride, 1%</i>	0.0382	0.1305	0.2120	0.2824	
<i>Soap, 0.1%</i>	0.0351	0.1289	0.2087	0.2865	
<i>Detergent, 0.1%</i>	0.0222	0.1260	0.2322	0.2694	
<i>BOD, ≥ 700ppm</i>	0.0230	0.1314	0.2179	0.2889	
<i>Bleach, 1%</i>	-0.0580	-0.0988	-0.3358	0.2835	
<i>Sodium Hydroxide Buffer to PH 10</i>	0.0203	0.1313	0.2182	0.2703	

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 Description: Raven 405 Blue Epoxy Resin

SOLUTION	RESULTS CONDITIONED HARDNESS CHANGE maximum	REQUIREMENTS
	112 Days Immersion	
Sulfuric Acid, 20%	1	For Information Only
Sodium Hydroxide, 5%	1	
Ammonium Hydroxide, 5%	2	
Nitric Acid, 1%	2	
Ferric Chloride, 1%	1	
Soap, 0.1%	-1	
Detergent, 0.1%	-3	
BOD, > 700ppm	2	
Bleach, 1%	-1	
Sodium Hydroxide Buffer to PH 10	-1	
PHYSICAL PROPERTY	INITIAL RESULTS	
Hardness, Shore "D" ASTM D2240	85	For Information Only

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SOLUTION	RESULTS		REQUIREMENTS
	Tensile Strength, psi	Elongation %	
	112 Days Immersion		
<i>Sulfuric Acid, 20%, Type I</i>	8,974	1.7	For Information Only
<i>Sodium Hydroxide, 5%, Type I</i>	8,752	2.1	
<i>Ammonium Hydroxide, 5%, Type I</i>	8,428	1.8	
<i>Nitric Acid, 1%, Type I</i>	8,698	1.7	
<i>Ferric Chloride, 1%, Type I</i>	8,907	1.8	
<i>Soap, 0.1%, Type I</i>	8,615	1.6	
<i>Detergent, 0.1%, Type I</i>	8,568	1.7	
<i>BOD, ≥ 700ppm, Type I</i>	8,668	1.7	
<i>Bleach, 1%, Type I</i>	8,395	1.7	
<i>Sodium Hydroxide Buffer to PH 10, Type I</i>	8,540	1.7	
PHYSICAL PROPERTIES	INITIAL RESULTS		
<i>Initial Tensile Strength, psi</i>	9,034		For Information Only
<i>Initial Elongation, %</i>	1.5		