



University of Pittsburgh

*Swanson School of Engineering
Department of Civil and Environmental Engineering*

742 Benedum Hall
3700 O'Hara Street
Pittsburgh, PA 15261
412-624-9870
412-624-0135 (fax)

18 November, 2013

Warren Environmental Inc.
P.O. Box 1206
Carver, MA 02330

RE : Warren Environmental epoxy system-service life

To Whom It May Concern:

I am an Associate Professor of Structural Engineering and Mechanics at the University of Pittsburgh. I am an internationally recognized expert on repairs bonded to concrete and steel substrates, having co-authored the accepted state of the art review on the latter. In my previous position at the University of South Carolina, I served as Principal Investigator on three projects testing the structural properties of the Warren Environmental epoxy system. More recently, I conducted a large test program investigating aspects of bond and performance of the Warren Environmental epoxy system used as an intimately-bonded lining system for deteriorated large diameter concrete pipe.

Based on my knowledge of the Warren system, it is my opinion that the intimately-bonded epoxy lining obtained using this product has a service life exceeding 75 years when applied to welded steel or concrete having in service conditions typical for processed domestic waste water (non-caustic materials and little sediment/abrasives to cause erosion). In such an application, ensuring sound bond of the epoxy to the steel substrate is of critical importance. The Warren-specified preparation of a steel substrate to "SP10 white metal blast with a minimum surface profile of 1-1.5 mils", or in the case of concrete, "acid etching followed by high pressure water blasting at 4,000-5,000 psi" is, in my opinion, adequate to ensure the necessary bond properties particularly given the spray method of application used for this product.

Sincerely,

A handwritten signature in blue ink, consisting of several overlapping, sweeping strokes that form a stylized, elongated shape.

Kent A. Harries, Ph.D., F.A.C.I., P.Eng.
Associate Professor, Structural Engineering and Mechanics
Editor, *Journal of Construction and Building Materials* (Elsevier)
Associate Editor, *ASCE Journal of Bridge Engineering*