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An Analysis of Wastewater Generated During Water Jetting Tests on the I - 65 John F. Kennedy Bridge at Louisville

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16. Abstract
High pressure water jetting was evaluated as a surface preparation tool for bridge maintenance painting. The tests were conducted on the John F. Kennedy Bridge, which has lead containing existing paint system. The primary concerns were the surface preparation and the lead levels of the wastewater. Test areas were washed at 10,000 psi, 15,000 psi, and 20,000 psi and wastewater was collected for analysis. Lead tests were conducted on unfiltered wastewater and wastewater filtered through a variety of filter fabrics. High-pressure water jetting produces and excellent surface for painting but, on bridges with existing lead paint, the wastewater lead levels are too high for conventional KyDOH filtering requirements.

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Painting, Overcoating, Water Jetting, Wastewater, and Filter

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EXECUTIVE SUMMARY

The objectives of this study were to evaluate the effectiveness of high-pressure water jetting for surface preparation of bridges to receive maintenance painting, to evaluate the effectiveness of a variety of filters in reducing the lead content of wastewater produced by this method, and to evaluate any problems associated with this surface preparation method. The tests were conducted on the John F. Kennedy Bridge because the Special Notes for Washing and Cleaning were being prepared for maintenance painting of that bridge.

Study results indicate that high-pressure water jetting, from 10,000 to 20,000 psi, provides a very good surface for painting. The chloride content of the existing paint was ranged from 100 to 200 ppm before the wash test. Chloride content of the paint remaining after the tests was reduced to below less than 25 ppm. The paint remaining after the wash test had significantly higher adhesion than before washing. Wastewater was analyzed for total lead content using EPA test methods. Pulverization of lead based existing paint through high-pressure water jetting can be problematic in that the filter materials currently specified by KyDOH, non-woven fabric with Apparent Opening Size of 0.15 mm and 0.212 mm, do not sufficiently reduce the lead content of the wastewater.

BACKGROUND

Over the past eight years the Kentucky Department of Highways (KyDOH) has actively pursued more cost-effective bridge maintenance projects. Since 1992, overcoating has been used for maintenance painting instead of the practice of "remove and replace". Abrasive blasting typically used for coatings removal poses environmental and worker safety hazards when used on leaded bridges. A majority of KyDOH steel bridges possess lead in paint including some with inorganic zinc/vinyl coatings systems. A primary reason for KyDOH adopting overcoating was to avoid potential adverse environmental impacts like those encountered in past remove-and-replace projects that did not employ containment. Also, maintenance-painting projects incorporating complete removal/containment are typically three to five times as expensive as those using overcoating. Overcoating is also more cost-effective from a life-cycle perspective. KyDOH is seeking more effective overcoating procedures to enhance the life-cycle performance of its overcoating projects. New surface preparation methods and coatings are constantly being formulated and evaluated.

The effort to optimize the KyDOH bridge overcoating program has been managed by a multi-disciplinary team comprised of KyDOH and University of Kentucky Transportation Center (KTC) personnel. Team members from the KyDOH represent the Divisions of Operations, Construction, Materials, and Environmental Analysis. KTC personnel from the Environmental Analysis Section also participate. Approximately 50 experimental bridge overcoating projects have been let since 1992. Special Notes for the experimental overcoating projects have continually evolved over that period reflecting advances in surface preparation and coatings technology. Surface cleaning, consisting of washing and mechanical surface preparation, is a critical part of an overcoating project.

The typical Special Note for Washing and Cleaning used in early overcoating projects required washing at 50 psi with no provision for mechanical surface preparation. That non-invasive approach to cleaning was used to avoid the generation of hazardous wastes. It relied on the ability of the overcoating paint to penetrate and seal both porous substrates and partially disbonded coatings, and to encapsulate the entire substrate. Due to the poor performance of some of those early experimental projects, the Special Note was revised to incorporate higher washing pressures and mechanical surface preparation of areas not having adherent paint after washing. By 1998, 7,000 psi pressure washing was specified to both clean the surface and to "proof test" the existing coating. The increase in washing pressure necessitated containment and collection of coating debris and filtering of the wastewater to capture particles of lead paint. Power tools required for mechanical surface preparation had to be equipped with vacuum shrouds to collect generated debris, which might be hazardous.

WATER JETTING

Two promising approaches to surface cleaning entail the use of high pressure water jetting (10,000 to 25,000 psi) and ultra-high pressure water jetting (above 25,000 psi). Both methods are capable of removing existing coatings. High pressure water jetting is capable of removing light rust, while ultra-high pressure water jetting may be used to remove heavy stratified rust and mill scale (1). The KyDOH Paint Team was interested in investigating the use of water jetting methods to obtain better, faster pressure washing and to eliminate the need for mechanical surface preparation. This would save one work step for painting contractors. If either of those methods were viable, the resulting cost savings might 1) offset the extra cost of the water jetting equipment, 2) result in quicker project completion, 3) better clean/prepare substrates prior to painting, 4) provide more durable paint jobs, and 5) result in lower project costs. The I-65 John F. Kennedy Bridge was scheduled for maintenance painting in 1999 and Paint Team members wanted to investigate the use of water jetting methods with the intent of applying them to that bridge if water jetting proved practical.

A demonstration of ultra-high pressure water jetting had been performed by the Flow Corporation in 1997 on girders and diaphragms of the I-64 Riverside Parkway on Span 4 near 17th Street. The equipment employed provided up to 45,000-psi wash pressure at a flow rate of 2.5 g.p.m (operating multiple wands). Most of the tests were performed at 40,000 psi and 2 g.p.m. The unit was housed on a large trailer and incorporated a 100 horsepower diesel engine to drive the pumps. A splitter manifold was used to provide two washing operations. Several 100 ft-long high-pressure wash lines were used. The lines were connected to 4-ft long wands equipped with 6-nozzle spinner tips. The spinner tips were rotated by compressed air. A demonstration of the cleaning power of this method was provided when Flow Corporation personnel used water jetting to rapidly strip mill scale from a small steel plate placed on the ground.

Access was provided by several man-lifts furnished by a painting contractor working on the Parkway. Impermeable tarps lay on the ground to collect the wastewater. Both Flow and the contractor's personnel operated two wash wands concurrently. They were directed to remove the existing paint to mill scale in several areas and to attempt to strip the two aluminum topcoats from the primer in several other areas. During washing, large clouds of mist were generated that obscured the work areas and made the test areas difficult to clean (Figure 1). The work progressed slowly due, in part, to the good condition of the paint. Ultrahigh pressure washing jetting was able to strip most of the paint from the mill scale substrate (Figure 2). Due to the high inter-coat adhesion between the layers of paint, it was impossible to differentially strip the topcoats from the primer. Another drawback was observed when examining the wash water. The washing operation had pulverized the primer and topcoats creating a red-tinted wastewater (Figure 3). Paint Team members were concerned that the wastewater could not be properly filtered using the 85 percent tarpaulins that were specified as filters by KyDOH at that time. A final wash test using 20,000-psi pressure proved more promising. The existing paint was not stripped away and all the grime was removed from the topcoat yielding a shiny aluminum surface.

The demonstration indicated the ultrahigh pressure water jetting might not be suitable for cleaning the I-65 Bridge. The paint on that structure was known to be more brittle than the paint tested on the Riverside Parkway. Paint Team members decided that a more thorough test program focusing on high-pressure water jetting at pressures between 10,000 psi to 20,000 psi was necessary. KyDOH was also changing its filtration method, incorporating the use of non-woven geotextile fabrics to filter out smaller particle sizes from the wastewater. To get a true indication of the behavior of high pressure water jetting a decision was made to conduct a series of tests on the I-65 John F. Kennedy Bridge (Figure 4).

As part of this study, in September 1997, a contract was awarded to Cavi-Tech Inc. of Kennesaw, Georgia to perform water jetting on the bridges. The original coating on the bridge was a red lead primer with a leafing aluminum intermediate coat and a non-leafing aluminum topcoat. The last maintenance painting of the Kennedy Bridge main span was performed in 1976. At that time, all rusted areas and areas with coating degradation through the primer were brush blasted and spot coated with a lead primer (615 D) followed by a lead-based gray topcoat.

The Kennedy Bridge has as many as four layers of coatings containing lead. While removal of the lead-based coatings is a concern, the Kennedy Bridge is a large structure with a high traffic volume and good overcoating performance is imperative to preclude frequent maintenance painting operations. The water jetting test was planned to correlate various the surface preparation conditions with wastewater lead levels for a series of washing pressures and filter combinations. The decision as whether to use water jetting in the forthcoming overcoating project on this bridge would be based upon the results of these tests.

PRE-WASH ANALYSIS

Traffic control was arranged for October 7 and 8, 1997. Paint team members surveyed the truss and identified test areas to be washed on the 7th and the demonstration was conducted on the 8th. The test areas were approximately 10 ft^2 and were located on both vertical and diagonal members, primarily in areas where much of the coating was still intact (identified as Paint #3 etc.). Two test areas were located where most of the existing coating was completely deteriorated (identified as Rust #1 and #2). In the areas where the coating was intact, there were numerous rust spots (Figure 5. The coating on the Kennedy Bridge is seriously degraded over the entire structure with the splash zone above the deck and at joints below the deck being in the worst condition. Prior to washing, the test areas were assessed for adhesion (pull-off test per ASTM D-4541 (Figure 6) and tape test per ASTM D-3359 (Figure 7), surface chloride content, and existing coating Dry Film Thickness (DFT) per ASTM D-4138 (Figure 8). Chloride content was assessed using a commercially available titration kit (Figure 9). At some test areas, it was not possible to distinguish all the individual coating layers, but generally there was an alkyd topcoat over 615D lead primer which covered the original aluminum topcoat and red lead primer. Total coating DFT ranged from 8 to 18 mils (1 mil = 0.001 inch). Pull-off tests results ranged from 0 to 590 psi with five of ten tests at or below 100 psi. Tape adhesion test results ranged from 1A to 3A. Most pull-off failures occurred in the 615D lead primer. Chloride content tests results ranged from 125 to 200 $\mu g/cm^2$.

Those test results indicated that the existing coating was marginal for overcoating and that surface chlorides were a possible concern. It should be noted however, the KyDOH overcoated coatings in equivalent condition (or worse) based upon prevalent adhesion criteria for overcoating.

WATER JETTING TESTS

The outside southbound lane (west) of the bridge was closed to traffic for the tests. Since several previous overcoating projects had specified 5,000 psi washing pressure and 40,000 psi washing had been demonstrated, the test areas were washed at 20,000 psi, 15,000 psi, and 10,000 psi. Those water-jetting pressures were employed to minimize pulverization of the existing lead-based paint. Two rusted test areas were washed at 20,000 psi (Rust #1) and 15,000 psi (Rust #2). Areas with mostly intact coating were washed at 20,000 psi (Paint #4, #5, and #10), 15,000 psi (Paint #6 and #7), and 10,000 psi (Paint #3, #8, and #9). Plastic trays were placed between the surface to be washed and the concrete barrier wall (Figure 10). The trays were taped in place to capture wastewater running down the washed surface.

Three different filter fabrics were used to remove lead paint particles from the wastewater. Non-woven fabrics with Apparent Opening Sizes (AOS) of 0.212 mm and 0.15 mm were used. One woven fabric with an AOS of 0.300 mm was employed. That woven fabric had not been (nor would it be specified) and its inclusion was incidental to the test matrix. Each tray of wastewater was agitated and portions poured through filter patches placed over the sample containers. The testing plan was to obtain four wastewater samples from each test area; one unfiltered, one filtered through an AOS of 0.15 mm, one filtered through an AOS of 0.212 mm, and one filtered through a layered AOS of 0.212 mm and 0.15 mm. Due to the time constraints, not all filtered samples planned were obtained. A sample of the potable water used in the washing test and a sample of the Ohio River water at the bridge were also obtained for lead testing. Filtered and unfiltered samples of wastewater collected from each test area were stored in approved containers and tested for lead content.

POST-WASH PAINT ANALYSIS

After washing operations were completed and the test areas had dried, additional coatings tests were conducted on most test areas (Figure 11). Post wash tests included pull-off, chloride content, and surface profile (per ASTM D-4417). One of the objectives of the water-jetting test was to evaluate the impact of the "level of work" and the resulting wastewater lead content. For this report "level of work" is defined as the amount of work done to an existing paint system during pressure washing or water jetting. It reflects the amount of energy over time applied to existing paint. It is a complex function of applied water pressure, water volume, angle of impingement, time of application, etc. The "level of work" applied to an existing coating will impact is cleanliness and can determine whether the coating remains attached to its substrate. Level of work may also impact the fineness of any paint debris that is removed from the substrate.

The first test area (Rust #1 @ 20,000 psi) was washed with considerable effort, with the wash nozzle within six inches of the surface, cleaning at a rate of approximately eight ft^2/min. (Figure 12). This “level of work” resulted in the removal of all the topcoat and much of the 615D primer. Wastewater from Rust #1 contained mostly pulverized paint. Subsequent washing tests were conducted at lower “levels of work”. After the washing was completed and all test areas were surface dry, pull-off, chloride content, and profile tests were performed. Post-wash pull-off adhesion test values were higher than pre-wash tests in all test areas and ranged from 50 to 900 psi.

Surface chloride tests performed after washing indicated lower than detectable levels for the titration tests. Profile tests on the exposed coating, alkyd topcoat and 615 D at the areas tested, indicated profiles from 3 to 4.5 mils. All pre-wash and post-wash test results are shown in Table 1.

Waste, potable, and river water samples were analyzed for "total lead" content using EPA test methods (2). Natural Resources and Environmental Protection Cabinet (NREPC) regulations for water quality refer to "total recoverable lead". The test methods for "total lead" and "total recoverable lead" vary slightly, but in the opinion of NREPC laboratory experts both tests would yield the total lead in the sample.

The "level of work" appears to have had a greater impact on wastewater lead levels than the filtering variables. Rust #1 (20,000 psi. and higher level of work) had total lead levels ranging from 1,048 ppm for the unfiltered sample to 625 ppm for the filtered (AOS of 0.15 mm) samples. Paint #10 had a lower "level of work" and a corresponding lower total lead level of 595 ppm for the unfiltered sample and 310 ppm for the filtered sample. Paint #4 and #5 had the lowest "level of work" (approximately 16 ft^2/min) and had wastewater total lead levels ranging from 298 to 49 ppm. Rust #2, Paint #6, and Paint #7 were washed at 15,000 psi and had lead levels ranging from 710 to 132 ppm. Paint # 8 was washed at 10,000 psi and total lead levels ranged from 209 ppm for the unfiltered sample to 125 ppm for a filtered sample. Filtering the wastewater reduced the lead level but the filter AOS did not have a consistent effect on the lead level (Figure 13). The relationship of wash pressure and "level of work" to wastewater lead levels is shown in Figure 14. The wastewater lead levels and test area variables are shown in Table 2.

SUMMARY

The existing coating on the Kennedy Bridge is in a deteriorated condition. The alkyd topcoat is very brittle with very poor adhesion (1A for tape adhesion and often less than 100 psi for pull-off tests) to the underlying 615 D primer. The 615 D primer, where exposed, has powdery texture with weak inter-coat cohesion. The existing coating varies from 8 to 18 mils in thickness due to the earlier overcoating scheme and weathering erosion of the coating in areas exposed to the elements. The existing coating has a high lead content and is prone to pulverization at wash pressure at or above 10,000 psi. The existing coating in the splash zone and below the deck at joints has chloride contents greater than 200 ppm. A washing pressure of 20,000 and elevated level of work (8 ft^2/min) pulverized the alkyd topcoat and 615 D primer producing very high lead levels in both unfiltered (greater than 1,000 ppm) and filtered wastewater samples (greater than 800 ppm). Pressure, and "level of work" have a direct relationship to lead levels in wastewater. Filter AOS's of 0.15 mm and 0.212 mm do not appear to have a significant impact on the wastewater total lead level.

CONCLUSIONS

The washing test of high pressure water jetting (10-20,000 psi) on the I 65 Kennedy Bridge and the prior demonstration of ultra-high pressure water jetting (25,000 psi and higher) have indicated a potential for improving surface preparation on overcoating projects. Water jetting can be specified in terms of a result (or results) providing a final result approach to surface preparation instead of the combination process/result specifications currently used by KyDOH in pressure washing specifications. Also, it shows potential for eliminating the mechanical surface preparation of rusted surfaces. The resulting savings might offset the additional cost of water jetting versus high-pressure washing (at pressures below 10,000 psi).

Pressure washing results can be specified in terms of visual appearance of previously rusted steel [per SSPC-VIS 4(I) *Interim Guide and Visual Reference Photographs for Steel Cleaned by Water Jetting*]. Edge adherence, apparent tightness, pull-off adhesion, and surface chloride levels or a combination thereof can be used to specify retained paint.

Water jetting may be used in several ways. The conventional approach is to place the wash nozzle relatively close to the work piece and remove all attached materials (chalk, soils, rust and existing paint). This can be conducted to a visual standard. There are several drawbacks to using water jetting for bridge maintenance painting. First, it is relatively slow (depending on the adhesion and toughness of the attached materials. Abrasive blasting with containment would probably be a more viable option. Secondly, water jetting has the tendency to pulverize existing paint. If the existing paint contains lead, water jetting will result in lead contaminated wastewater that cannot be filtered sufficiently to be discharged directly into receiving waters.

Another approach is to allow the contractor to wash to a final result, allowing him to back the wash nozzle away from the work piece when washing paint to remove only soils and weakly adherent paint. This would speed up the surface preparation operation on most bridges. When the contractor encountered rust or tenacious soils, he could move the wash nozzle closer to remove surface rust. The inspection of this second approach is more involved than for the first approach to water jetting, but it is no more complicated than inspections in current KyDOH specifications (including those for mechanical surface preparation). This approach will require some initial work by the contractor and KyDOH to "calibrate" the washing procedure. Trial wash tests would be required to assess how well a contractor's equipment/workers cleaned the existing paint and KyDOH would need to perform visual inspection and adhesion and surface chloride tests to ensure that a desirable substrate was obtained. The test patch process would become more important.

An alternate to this approach would be to specify that contractors wash the existing paint by current specifications (i.e., at 7,000 psi) and then water jet rusted areas. This would eliminate the need to "calibrate" the contractor washing process, but would add another pass across the bridge and offset the cost savings achieved by the other water jetting approaches.

The Kennedy Bridge tests revealed that high pressure water jetting is able to significantly reduce retained surface chlorides. The levels of surface chlorides on the bridge (100 to 200 PPM) are sufficient to pose a risk to the durability of subsequent paint applications. After water jetting, even at different levels of cleaning, the surface chloride levels were lowered to a concentration (<25 PPM) considered acceptable for painting.

The high-pressure water jetting tests on the Kennedy Bridge revealed that the procedure produces high concentrations of lead in the wastewater that cannot be removed by the current KyDOH filtering process. As long as that filtering process is used, high pressure water jetting should be limited to bridges that do not contain hazardous levels of lead (i.e., some bridges that have inorganic zinc/vinyl paint systems) and those with alkyd paint systems in good condition (i.e., basic lead silico-chromate primers with aluminum topcoats). For the alkyd systems, water jetting must not be used to remove all the paint. It must be used in described in the second approach to water jetting noted above. In any case, complete paint removal by water jetting is impractical from a cost standpoint.

It is impractical to collect lead-contaminated wastewater, process it, possibly recycle it, and finally transport it to sewage systems for disposal. The wastewater must be cleaned at the job site and deposited on the ground or into receiving waters to keep overcoating cost effective. On-site treatment must be considered an integral part of the washing operation or the NREPC will require that the operation be permitted as a treatment, storage and disposal facility, which is an involved, expensive process.

Two possibilities exist to extend the use of water jetting to more KyDOH maintenance painting operations. One entails the use of multiple filters to mechanically separate lead particles from the wastewater. Currently, questions exist as to whether layered filters would work as very fine pore sizes appear to be necessary and water may not pass through the pore sizes needed to filter out the pulverized lead paint. A second method would be to use a chemical bed in conjunction with conventional mechanical filters. The mechanical filters would process out the coarse paint chips and particles. The fine lead particles, which pose a problem with water jetting, would chemically react with the material in the bed and be retained therein. The treated wastewater would have a sufficiently low lead content to allow its disposal into the ground or receiving waters. KyDOH and KTC are currently pursuing this approach in cooperation with the Georgia Tech Research Institute.

Water jetting offers the promise of improved overcoating projects on KyDOH bridges. Technical problems were identified in this test. Work is being conducted to address those problems and allow water jetting to be employed on a widespread basis.

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2. "Methods for Chemical Analysis of Water and Wastes" 1983; Environmental Monitoring Systems Support Laboratory, Office of Research and Development. U.S. Environmental Protection Agency; Cincinnati, Ohio 45268. Methods 239.1/2 and 4.1.3/4.1.4.

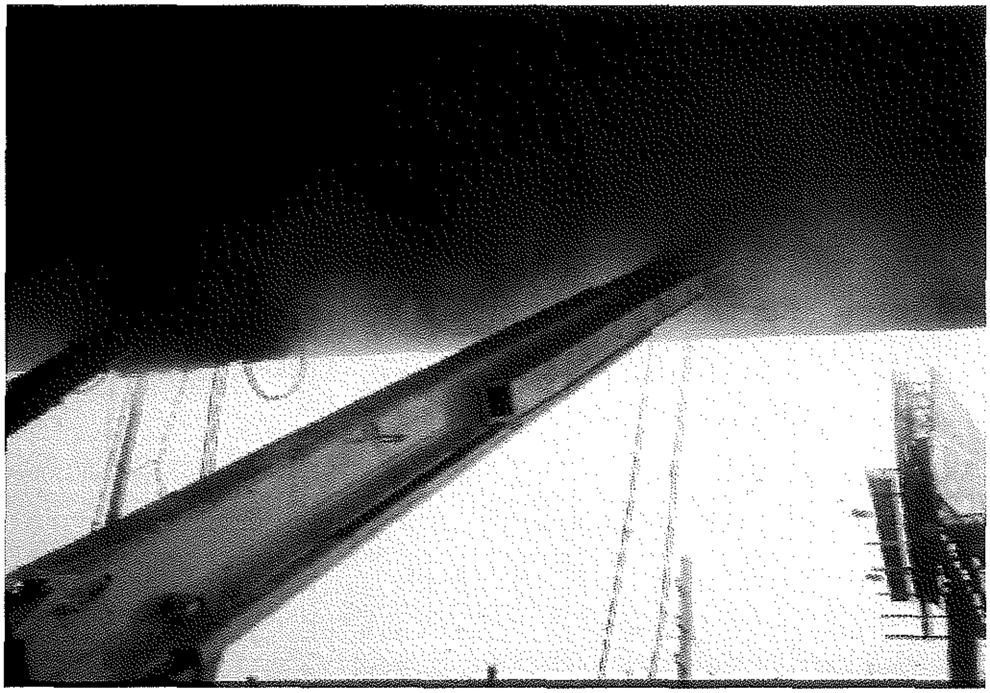

Figure 1. Mist created by the high pressure water jetting reduces visibility in the work area.

Figure 2. Water jetting removed the topcoat and much of the red lead primer.

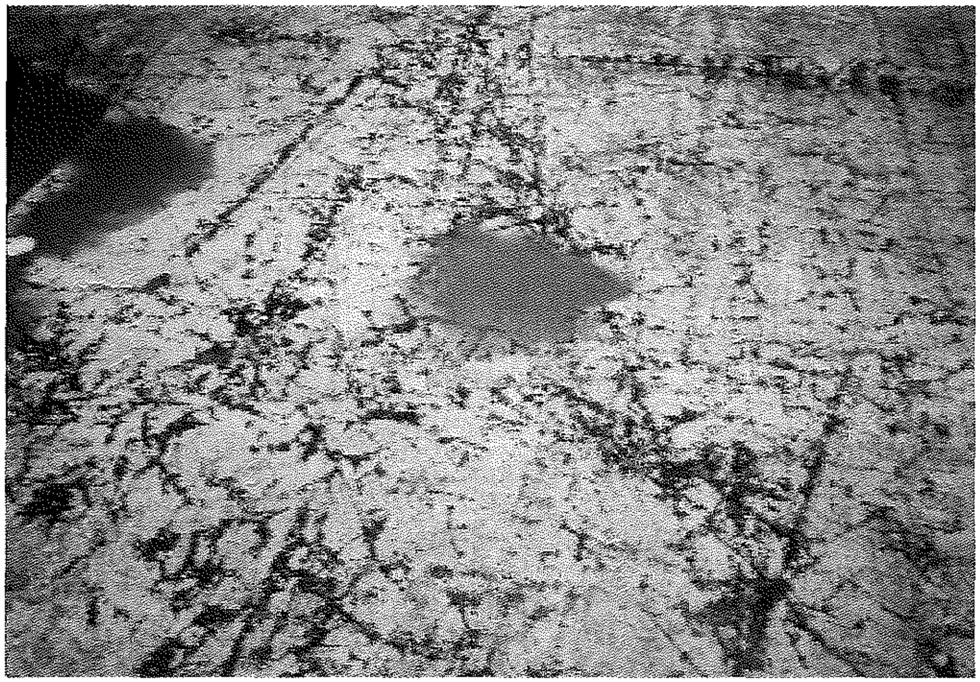

Figure 3. Water jetting pulverized the existing paint resulting in wastewater with a high lead content.

Figure 4. The I-65 (Kennedy Bridge) bridge over the Ohio River.

Figure 5. Close-up of Kennedy Bridge (note extensive rust in splash zone).

Figure 6. Pre-wash surface analysis (note pull-off dolly).

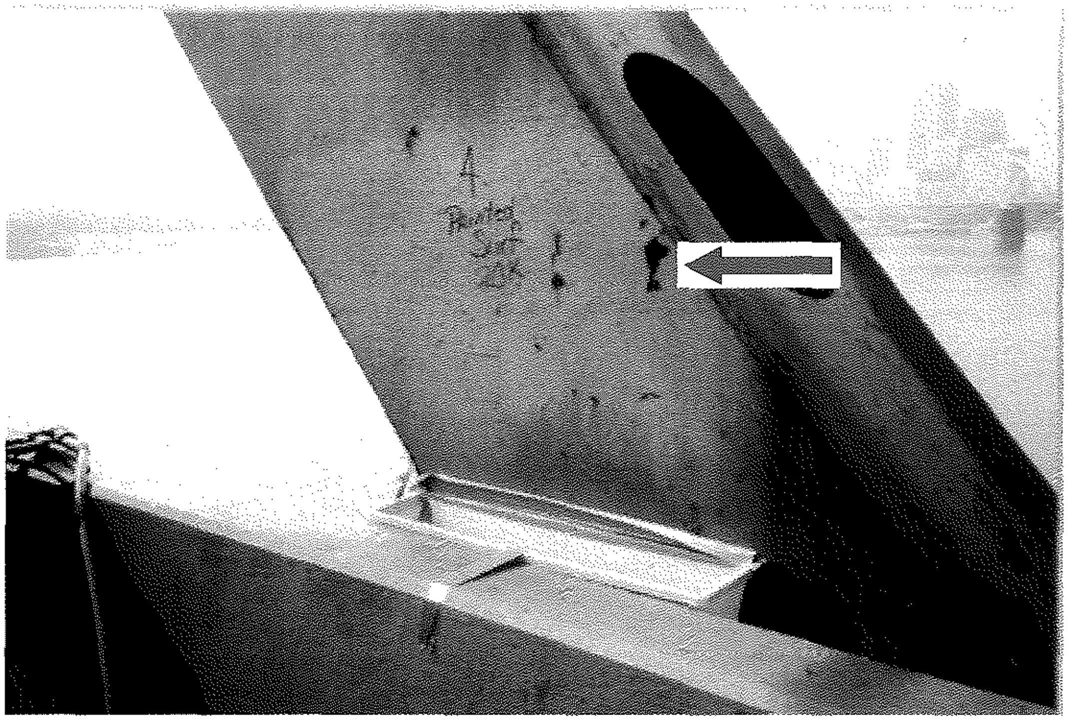

Figure 7. Pre-wash tape adhesion test (right side of test area) indicated brittle paint.

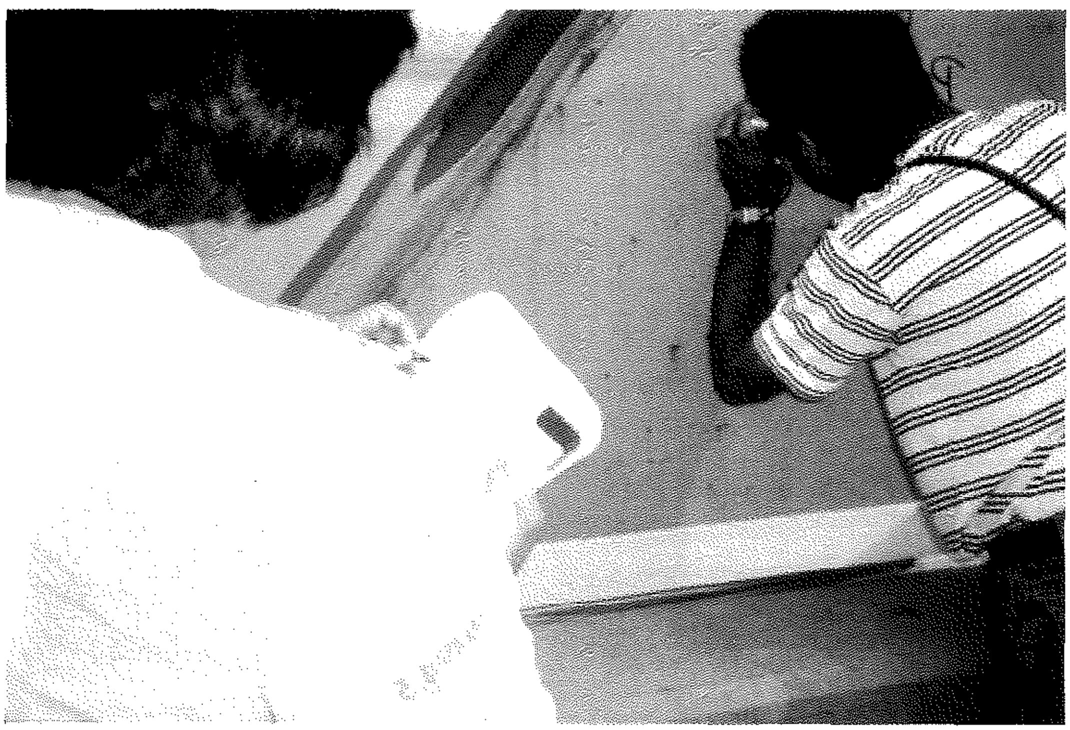

Figure 8. Measurement of Dry Film Thickness (DFT) of existing paint.

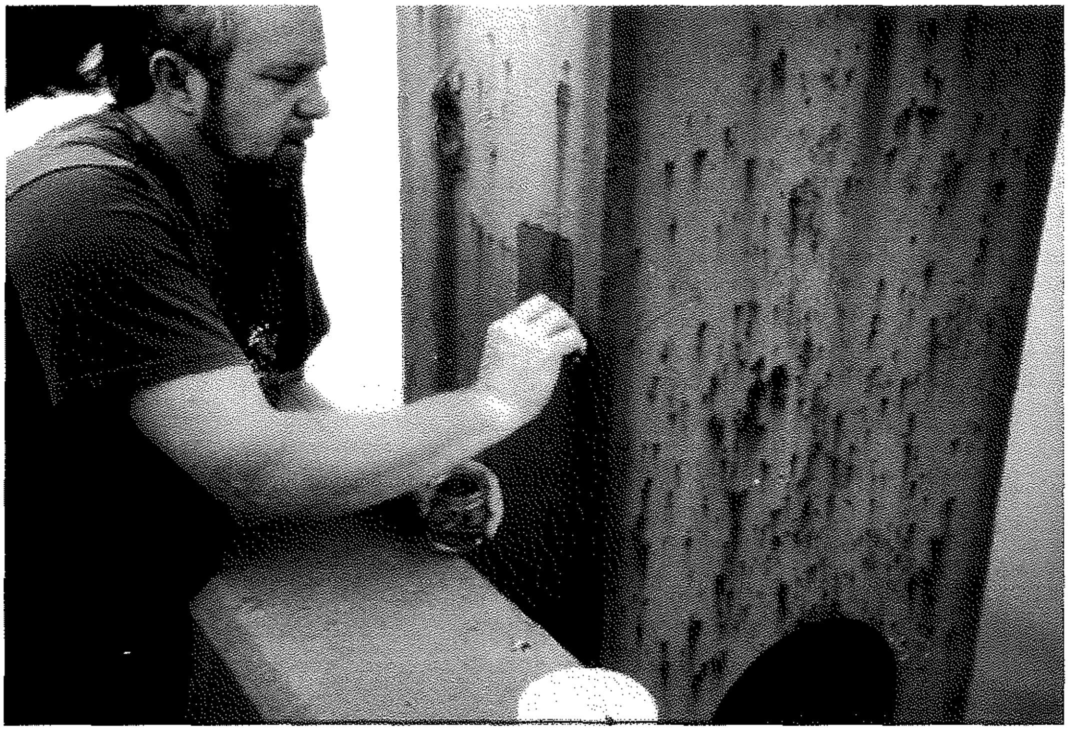

Figure 9. Determination of chloride content of a pre-wash surface.

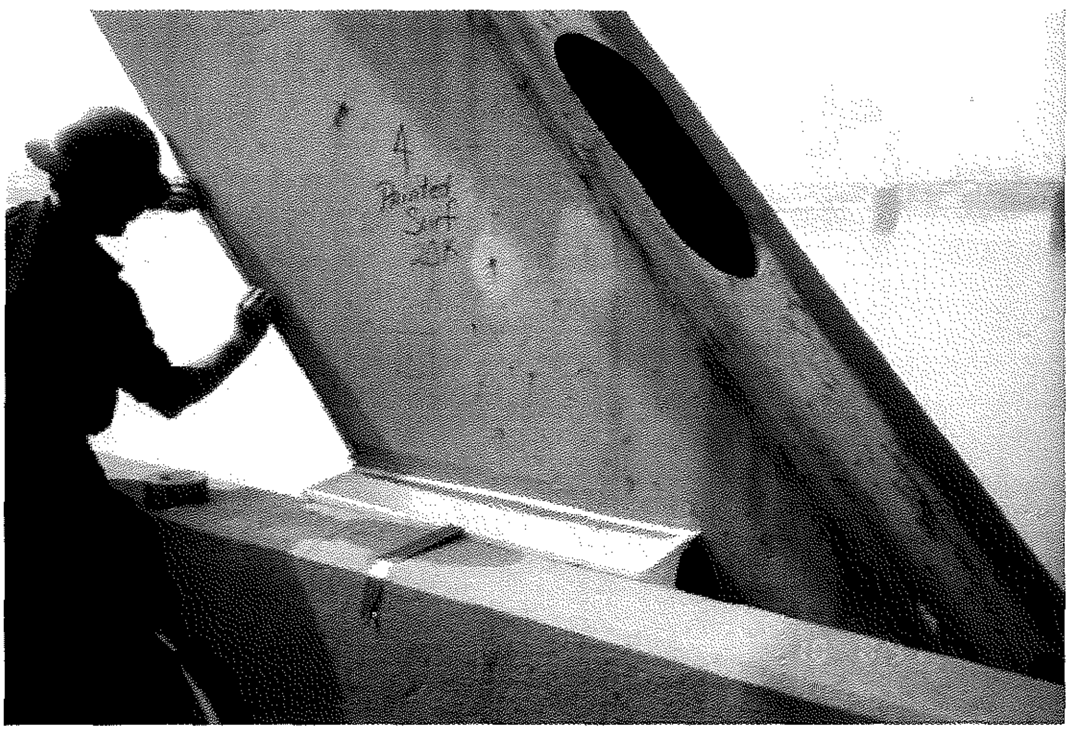

Figure 10. Tray used to collect wastewater for lead content analysis.

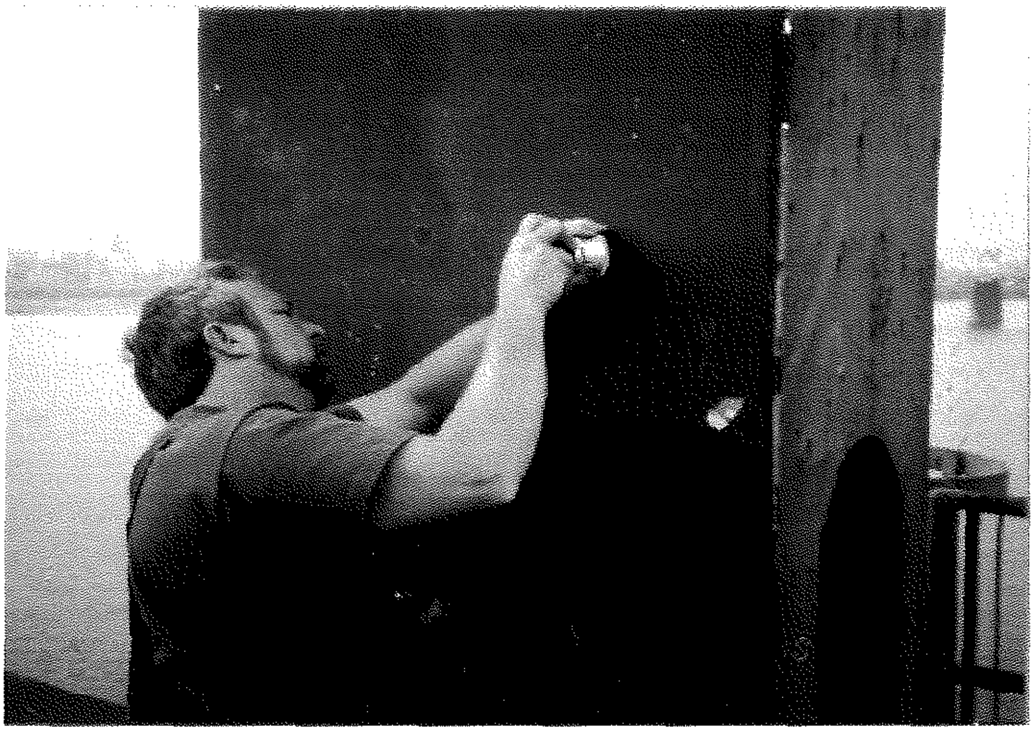

Figure 11. Post-wash tests on 615D primer.

Figure 12. Washing at 6 inches from surface.

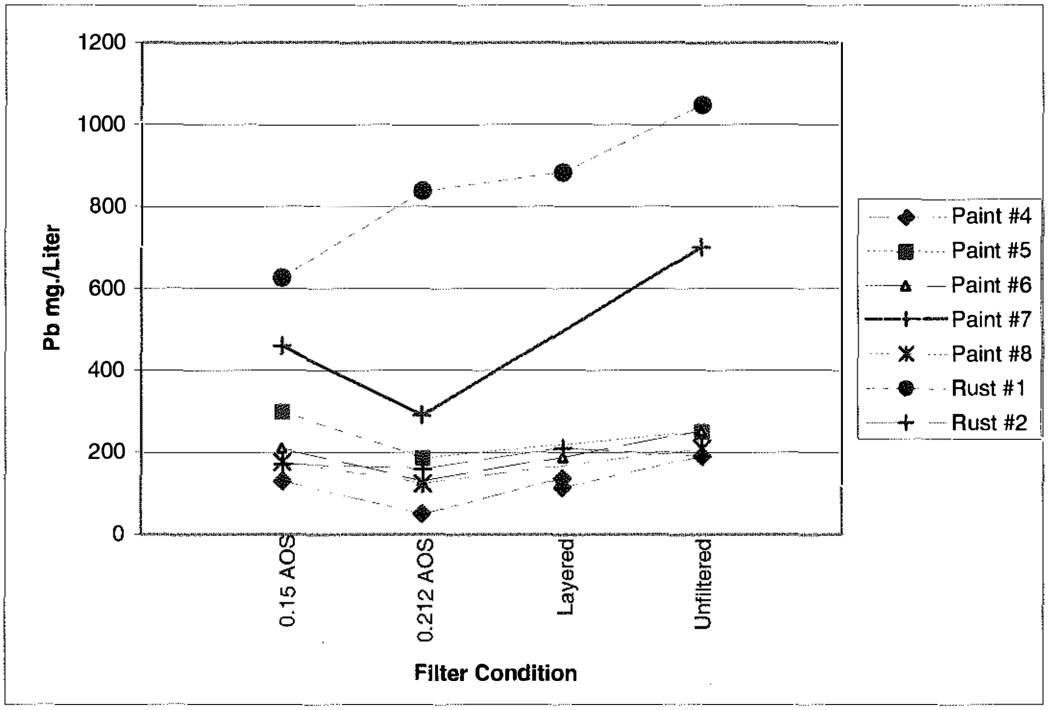

Figure 13. Wastewater lead levels for different filter conditions.

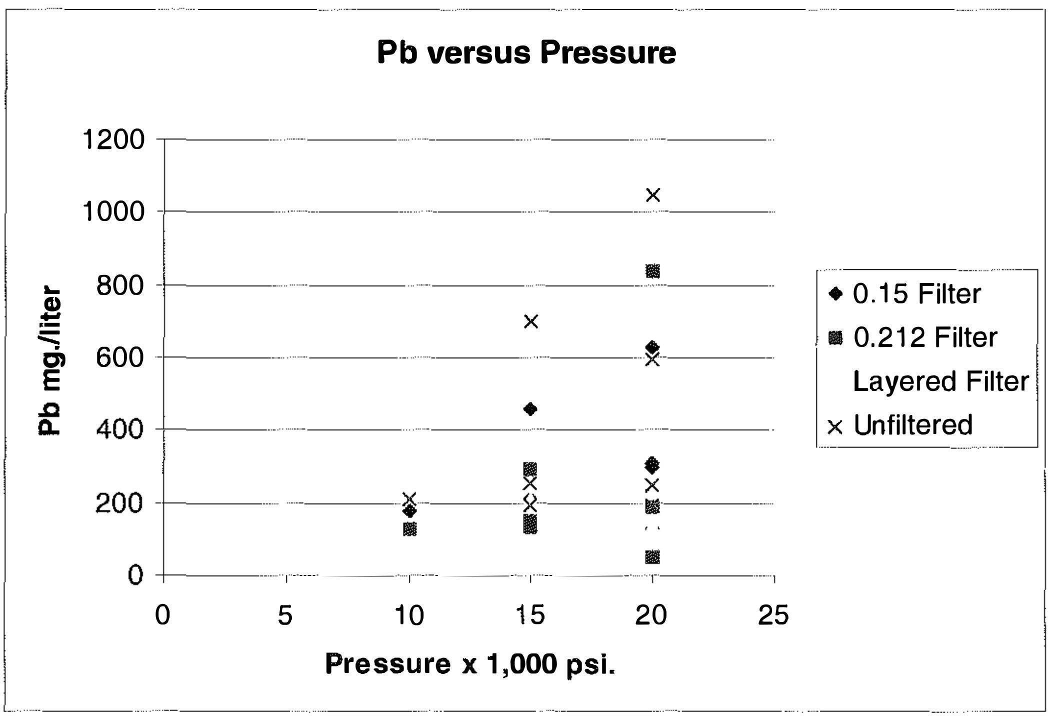

Figure 14. Wastewater lead levels at various wash pressures.

	Wash Pressure psi	Location	DFT mil	Pre-wash Pull-off (*) psi	Chloride ppm	Tape Adhesion	Chloride ppm	Post-wash Pull-off (*) psi	Profile mm
Rust #1	20,000	Diag. B/t Vert. 60 & 61	1-Alkyd 3-615D 1-Al 3-Red Pb	100 (615D)	190	1A	<25		
Rust #2	15,000	Vert. 62	1.5-Alkyd 7.5-615D 3-Al 5-Red Pb	0 (Red Pb)	200	1A	<25	550 (Alkyd) 50 (Red Pb)	3.75
Paint #3	10,000	Vert. 60	.5-Alkyd 2-615D 3-Al 5-Red Pb	100 (Alkyd)	200	1A	<25		
Paint #4	20,000	Diag. B/t Vert. 62 & 63	10-total to Red Pb 5- Red Pb	0 (615D)		2A	NA	100 (615D) 400 (Alkyd) 300 (Red Pb) 325 (Red Pb)	4-615D 4.5-top
Paint #5	20,000	Vert. 63	5-Alkyd 5-615D 5-Red Pb	150		3A	NA	200	
Paint #6	15,000	Diag. B/t Vert. 56 & 57	4-Alkyd 5-615D 4-Red Pb	100 (615D)		1A	NA	625 (epoxy) 110 (615D)	
Paint #7	15,000	Vert. 56	2-Alkyd 5-615D 5-Red Pb	600 (Alkyd)	180	3A	<25	175(adhesion) 615D & Pb 900 (Alkyd)	
Paint #8	10,000	Vert. 55	3-Alkyd 5-615D 3-Al 7-Red Pb	150		2A	NA	900 (Alkyd)	3
Paint #9	10,000	Vert. 66	2-Alkyd 3-615D 3-Al 4-Red Pb	250 (615D) 125 (Alkyd)	180	2A	<25		
Paint #10	20,000	Diag. B/t Vert. 55 & 56						300 (615D)	

Table 1. Test area location and coating condition before and after hydro-blasting.
(*) – Adhesion failure location

GLN. NO.	DOM NO.	Pb mg/l	Field ID	Press 1000 psi	Filter AOS (mm)	Filt / Unf
980210	30	310	Paint # 10	20	0.15	FILT
980209	29	595	Paint # 10	20	N/A	UNF
980194	14	129	Paint # 4	20	0.15	FILT
980193	13	49.1	Paint # 4	20	0.212	FILT
980192	12	136	Paint # 4	20	.212+.150	FILT
980195	15	114	Paint # 4	20	.212+.30	FILT
980191	11	191	Paint # 4	20	N/A	UNF
980197	17	298	Paint # 5	20	0.15	FILT
980198	18	187	Paint # 5	20	0.212	FILT
980196	16	250	Paint # 5	20	N/A	UNF
980201	21	210	Paint # 6	15	0.15	FILT
980202	22	132	Paint # 6	15	0.212	FILT
980200	20	188	Paint # 6	15	.212+.150	FILT
980199	19	253	Paint # 6	15	N/A	FILT
980205	25	459	Paint # 7	15	0.15	FILT
980204	24	291	Paint # 7	15	0.212	FILT
980203	23	701	Paint # 7	15	N/A	UNF
980208	28	176	Paint # 8	10	0.15	FILT
980207	27	125	Paint # 8	10	0.212	FILT
980206	26	209	Paint # 8	10	N/A	UNF
980185	5	625	Rust # 1	20	0.15	FILT
980186	6	837	Rust # 1	20	0.212	FILT
980183	3	883	Rust # 1	20	.212+.150	FILT
980184	4	1048	Rust # 1	20	N/A	UNF
980188	8	170	Rust # 2	15	0.15	FILT
980189	9	160	Rust # 2	15	0.212	FILT
980190	10	210	Rust # 2	15	.212+.150	FILT
980187	7	190	Rust # 2	15	N/A	UNF
980181	1	0.0045	Potable	N/A	N/A	N/A
980182	2	0.0095	River water	N/A	N/A	N/A

Table 2. Lead levels at various wash and filter conditions.