

AHB Alliance
Historic Coatings Study
Pilot
June 2016

Quality Assurance Statement

Prepared by:	Liz Coombes, Senior Environmental Consultant, Opus
Reviewed by:	Kat McDonald, Senior Environmental Consultant, Opus
Approved for issue by:	Alex Ingram, Asset Manager, AHB Alliance

Revision Schedule

Rev. No	Date	Description	Prepared by	Reviewed by	Approved by
0.1	22 May 2016	Final draft for management review	Liz Coombes	Kat McDonald	Alex Ingram
1.0	24 June 2016	Final version of report	Liz Coombes	Kat McDonald	Alex Ingram



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Executive Summary

Lead based paint is known to be present in some limited areas the Auckland Harbour Bridge (some parts of Span 7 and inside the box girders and internal chords). However, lead is also present in historic coatings in other areas of the bridge albeit at levels lower than would constitute a 'lead-based' paint layer. The current environmental and health & safety controls are based on the assumption that lead is not present at significant levels anywhere on the bridge except for those areas noted above, and were calculated following one round of air sampling during dry abrasive blasting.

This pilot study was undertaken to increase our understanding of the relationship between source contaminants in bridge coatings (in particular lead) and the levels of contaminants in dry abrasive blasting discharge, and to verify whether existing environmental and H&S controls are adequate for the protection of human health (general public and workplace exposure).

The study involved sampling the historic coatings within the study site post (before and after waterblasting), waterblasting washwater, and air concentrations during dry abrasive blasting. Results were analysed to determine how much the paint composition varied across the post, and to verify environmental and health and safety controls are adequate. If additional rounds of sampling are to be undertaken the results will be used to determine whether any relationship can be established between source concentrations and air concentrations during dry abrasive blasting.

The key conclusions from this investigation are:

- The current buffer zones were found to be acceptable for the levels of key metals present in the paint at the site.
- Waterblasting did not make any discernable difference to levels of key contaminants found in the paint samples.
- Washwater contamination was found to be consistent with the levels found during the previous sampling investigation.
- The composition of paint was found to vary moderately across the post sampled; the levels of lead were found to vary considerably across the post.
- For the abrasive blasting layout set up on the day of sampling, occupational exposure for key contaminants was below the workplace exposure standard.

Recommendations are:

- Review procedure for testing lead prior to dry abrasive blasting (update sampling density if necessary).
- Undertake another round of sampling in an area of the bridge outside of Span 7, to allow comparison of paint composition between spans. Samples from after waterblasting would not be necessary.
- Any additional sampling rounds should test paint samples for hexavalent chromium.



1 Introduction

1.1 Background

Lead based paint is known to be present on the Auckland Harbour Bridge in some areas of the external faces of Span 7 on the truss bridge, the internal faces of the truss bridge chords, and also inside the box girder extension bridges. It was previously assumed that no additional sources of lead were present in other areas of the bridge. However, in 2011 paint sampling from various locations on the bridge indicated that lead was present in other spans (Flinders Cook, 2011). Although the results were inconclusive in terms of the source of lead, a review by coating specialists suggested that the results were likely to indicate lower levels of lead being present in the historic paints rather than a lead-based paint layer (defined as having lead content of more than 5000ppm). Air sampling further verified these findings; lead was detected in dry abrasive blasting discharges in areas of the bridge outside Span 7, such as Span 3 (Air Matters, 2013).

The current environmental and health and safety controls are based on the assumption that lead is not present at significant levels anywhere on the bridge except for some parts of Span 7 and inside the box girders and internal chords. The buffer zones used to mitigate impacts from dry abrasive blasting, are not linked to actual contaminant concentrations in paint layers at the source of blasting as the paint was not sampled when the 2013 abrasive blasting air sampling was carried out. This creates uncertainty about whether the current buffer zones provide sufficient protection of human health, in terms of ambient air quality and also whether occupational exposure controls are adequate.

Since dry abrasive blasting is permitted (under current environmental controls) in areas where there may be a paint layer present with a substantial lead content (albeit with no layer that exceeds 5000ppm lead), it was necessary to carry out further sampling to confirm that the buffer zones were adequate. Note that dry abrasive blasting is not permitted in areas where the lead content of any layer exceeds 5000ppm (this is lead content of any single paint layer, not an average of the lead content in all layers). Other contaminants of interest potentially present and also investigated during this study include chromium, zinc and iron (all of which have the potential to reach hazardous levels in the air during dry abrasive blasting).

In addition, samples of washwater were taken to get an understanding of the proportional amount of contaminants that are removed during water blasting. The intention of this was to see (for example) whether waterblasting prior to dry abrasive blasting might be expected to reduce the levels of any contaminants.

This pilot study was undertaken to increase our understanding of the relationship between at source contaminants in bridge coatings (in particular lead) and the levels of contaminants in dry abrasive blasting discharge.



1.2 Purpose and Scope

The purpose of the historic coatings pilot sampling investigation is to further our understanding of whether existing environmental and H&S controls are adequate for the protection of human health (workplace exposure and general public), and begin to link source concentrations of contaminants to the levels detected in air during dry abrasive blasting.

The scope of the study was to sample the historic coatings within the study site (before and after waterblasting), waterblasting washwater, and air concentrations during dry abrasive blasting, and analyse results to determine how much the paint composition varied across the post, and to verify environmental and health and safety controls are adequate. If additional rounds of sampling are to be undertaken the results will be used to determine whether any relationship can be established between source concentrations and air concentrations during dry abrasive blasting.

It was recognised during the initiation stage of this study that further phases of sampling may be necessary to establish any relationship, and so this phase was proposed as a pilot to determine the usefulness of the results and recommendations for further testing.



2 Site Description

The pilot site was selected as Post 10 located in Span 7.

Dry abrasive blasting is not permitted under the current maintenance discharge consent in any area where there is a historic layer of lead-based paint. Consequently, during the selection of the pilot site the paint was cut back and tested to ensure that no visible lead paint layer was present (the known historic lead-based paint is bright orange), and 3M Lead Check sticks were used to confirm this. The initial site selected (Span 7, Post 11) was found to be not suitable due to presence of a lead paint layer.

The pilot site post was in average condition, with some rust and general dirt. It was considered to be generally representative of elements that might be scheduled to have this type of maintenance carried out.



Photo 1: Sampling site



3 Methodology

Field sampling was carried out on 4th April 2016.

The stages of the testing methodology were:

1. Four paint samples were collected, evenly spaced down the height of the post
2. The post was waterblasted, and washwater samples were collected
3. Four more paint samples were collected from directly next to the first round of paint samples
4. The post was spot dry abrasive blasted (of rusty surfaces) and air monitoring was carried out at various points down-wind of the post and on the operators carrying out and assisting the blasting.

The methodologies for each type of sampling and the analysis carried out are described in more detail below.

3.1 Paint

Eight paint samples in total were collected. Four samples were collected prior to water blasting (labelled Sample A) and four samples were collected directly next to the first four samples after water blasting had finished (labelled Sample B). Each sample was collected from an area of approximately 10cm², which was scraped back to bare steel using a linbide scraper; the samples were collected in a zip-lock bag for analysis. Due to access difficulties, the paint samples were collected by the maintenance crew enlisted to undertake the abrasive blasting.

Field Sampling Sheets are provided in Appendix A.

The paint samples were analysed for metals using X-Ray Fluorescence (XRF) by CRL Energy Ltd in Wellington.

3.2 Washwater

Two composite samples were collected during the waterblasting. An 'Initial Sample' (labelled IS) was taken at the start of the waterblasting, and an 'End Sample' (labelled ES) taken towards the end of the waterblasting. Two samples were taken in order to understand the range of contaminants that are produced during waterblasting.

Samples were collected into dedicated buckets, which had been cleaned and rinsed with de-ionized water prior to sampling. Samples were decanted into laboratory-provided sample bottles (ensuring



Photo 2: Paint sampling



Photo 3: Initial Sample (IS) on the left, End Sample (ES) on the right

sediment was re-mobilised prior to sampling). Dissolved metals samples were field filtered.

Field Sampling Sheets are provided in Appendix A.

Washwater samples were sent for analysis to Hill Laboratories in Hamilton under standard Chain-of-Custody procedures. Samples were analysed for total and dissolved metals (arsenic, cadmium, chromium, copper, lead, nickel, zinc), and hexavalent chromium.

3.3 Air

Field sampling was undertaken by Air Matters.

Data was collected for inhalable dust and metal content (time-weighted average) over the period of the dry abrasive blasting for this work (samples were collected at source, downwind and upwind), and particulate data as PM₁₀ (real-time method) was collected across the period of the works by shifting a real time dust monitor to various locations for short periods of time. Samples were collected from:

- A personal sample on the abrasive blaster
- A personal sample on the “pot person” Upper platform (post 7.10)
- Downwind (location 6.1 west side of bridge)
- Downwind (location 6.1 east side of bridge)
- Downwind (location 6.0 west side of bridge)
- Upwind (location 7.8 west side of bridge)
- Upper platform by garnet loading (location 7.0)
- Upper platform by garnet loading (location 7.8)

Samples were sent to Hill Laboratories for testing of metals.

A more detailed description of the methodology and sampling results are provided in the Air Matters report, which is provided in Appendix C.



4 Results

4.1 Paint

The results for key contaminants chromium, iron, lead and zinc are summarised in Table 1 and Charts 1a-d. Laboratory reports are provided in Appendix B.

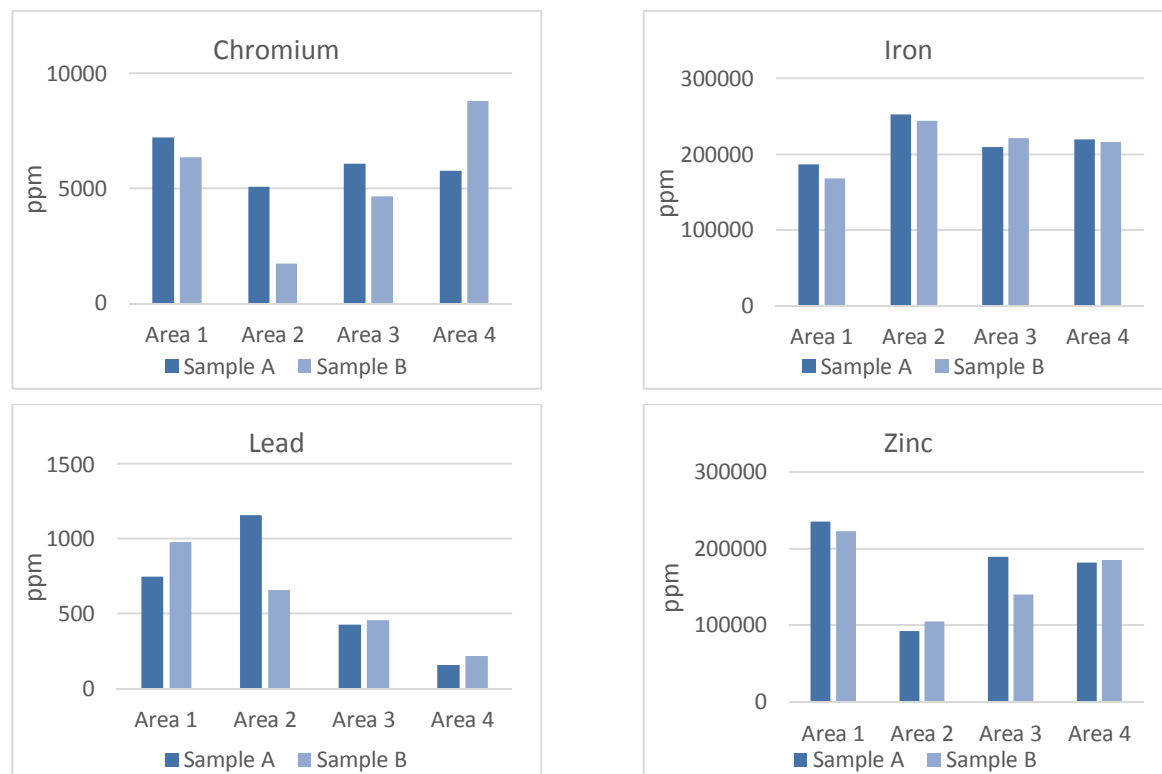
The results for Sample A and Sample B were generally similar for each area. There did not appear to be a relationship between the level of an element detected and whether or not the area has been waterblasted prior to sample collection. Level of iron was relatively consistent across the samples (coefficient of variation (CoV) 13%), the level of lead varied much more significantly (CoV 59%), and variation of chromium and zinc was in between (CoV 36% and 31% respectively).

Table 1: Results for key elements in paint samples

	Chromium		Iron		Lead		Zinc	
	Sample A	Sample B	Sample A	Sample B	Sample A	Sample B	Sample A	Sample B
Area 1	7220	6340	186670	168390	750	980	235950	222730
Area 2	5060	1730	252640	244300	1160	660	92640	105680
Area 3	6060	4660	210200	221660	430	460	189920	140350
Area 4	5770	8790	219950	216940	160	220	182430	185910
Mean		5704		215094		603		169451
SD		2058		27635		353		52006
CoV		36%		13%		59%		31%

Notes: All results in ppm, SD = Standard Deviation, CoV = Coefficient of Variation

Charts 1a-d: Paint Sample results for key elements



4.2 Washwater

All metals decreased in concentration in the end sample compared with the initial sample, with the exception of hexavalent chromium which was not found in the Initial Sample, but was present in the End Sample at 0.033 ppm (parts per million). The contaminants that were found at the highest concentrations in the washwater were zinc, chromium, lead, and copper.

While the results of the washwater sampling from this study are not directly comparable to those from the 2013 washwater study (due to the historic layers being exposed), the results were found to generally be within the same range. The exception was hexavalent chromium, which was not detected during the 2013 sampling (AHBA, 2013).

The results are summarised in Table 2. Laboratory reports are provided in Appendix B.

Table 2: Washwater Results

	Initial Sample	End Sample	Mean
Hexavalent Chromium	<0.010	0.033	0.019
Total Arsenic	0.011	0.0018	0.0064
Total Cadmium	0.0019	0.00053	0.0012
Total Chromium	0.4	0.081	0.24
Total Copper	0.119	0.0118	0.065
Total Lead	0.28	0.024	0.15
Total Nickel	0.026	0.0034	0.015
Total Zinc	33	8.7	21

Notes: All results in ppm

4.3 Air

The results of the personal samples for dust indicated that the abrasive blaster experienced elevated levels but with the PPE that is worn this was below exposure guidelines. On this day of testing the level of dust exposure for the potboy was well below the workplace exposure standard. The exposure to the metal component of the dust was below the workplace exposure standard for both the blaster and the pot boy.

The results for environmental dust indicate that the levels were above the guideline as background particulate. However, the levels had reduced considerably for samples collected 30 metres away from the blasting. Zinc levels were above the environmental standard close to the blasting but by 30 metres away had reduced to an acceptable level. Lead and chromium were not above the environmental guidelines for any of the samples.

Real-time samples for PM₁₀ indicated that the level was above the environmental standard of 50µm/m³ when the monitor was within 15 metres of the blasting. This is a 24 hour average and as the actual blasting is short term, would not have exceeded the standard on this day of work.

Further details are available in the air report (Appendix C).



5 Discussion

Presence of lead appeared to be relatively variable across the post. This may be due to previous maintenance works having removed or reduced lead-containing paints in some areas, or due to varying lead contamination in non-lead-based paints that have been used for touch-ups over the years. A consequence of this is that when lead testing is carried out prior to abrasive blasting (to confirm no lead-based paint layer >5000ppm), the sampling density may need to be reviewed, to ensure that the area to be blasted has been characterised sufficiently.

The washwater results indicated that the level of contamination of the washwater was within the range previously found during washwater sampling. The presence of hexavalent chromium in one of the washwater samples is likely to be due to the historic layers being exposed during the paint sampling, and would not normally be found in washwater. The presence of it in the washwater during this investigation confirms the presence of hexavalent chromium in historic layers of paint.

The results of the air sampling indicate that the levels of some contaminants were above the environmental standards at source but by 30 metres distance had dispersed to acceptable levels. This confirms the current buffers zones under the Maintenance Discharge Consent EMP are adequate to meet the threshold values for the contaminants (lead, chromium and zinc in particular) for the levels detected in the paint during this investigation.

The personal samples indicate that with the set-up used for this work, the contaminants were below the workplace exposure standard for the “pot boy” on the upper platform, and there was no requirement for PPE for anyone on the upper platform. However, it must be noted that this will vary with each abrasive blasting layout. A more in-depth discussion of the air sampling results is provided in the Air Report in Appendix C.

The current investigation examined the variability of paint composition for a post in Span 7. It is known that the composition of the historic paints in Span 7 is different from elsewhere on the bridge. It would be useful to undertake a similar sampling exercise for another area on the bridge to see how variable the paint compositions are between spans, and to determine whether lead is present in significant amounts elsewhere on the bridge. If an additional sampling round is undertaken it is recommended that hexavalent chromium is specifically analysed in the paint samples (the XRF methodology used in this sampling investigation allows only for the detection of elemental forms of metals).



6 Conclusions and Recommendations

The key conclusions from this investigation are:

- The current buffer zones were found to be acceptable for the levels of key metals present in the paint at the site.
- Waterblasting did not make any discernable difference to levels of key contaminants found in the paint samples.
- Washwater contamination was found to be consistent with the levels found during the previous sampling investigation.
- The composition of paint was found to vary moderately across the post sampled; the levels of lead were found to vary considerably across the post.
- For the abrasive blasting layout set up on the day of sampling, occupational exposure for key contaminants was below the workplace exposure standard.

Recommendations are:

- Review procedure for testing lead prior to dry abrasive blasting (update sampling density if necessary).
- Undertake another round of sampling in an area of the bridge outside of Span 7, to allow comparison of paint composition between spans. Samples from after waterblasting would not be necessary.
- Any additional sampling rounds should test paint samples for hexavalent chromium.



7 References

AHBA, 2013. *Auckland Harbour Bridge State of the Environment Washwater Sampling Report*. June 2013.

Air Matters 2013. Air Matters Report 13001. January-February 2013.

Flinders Cook, 2011. Fax from Matthew Dakins (Flinders Cook Ltd) to Total Bridge Services. Re: Paint Bridge Samples. Ref: 76533.





Appendix A – Field Sampling Sheets



AHB Bridge Maintenance Washwater Sampling Site Visit Form

Date: 4/4/16	Sampler(s): Liz Coomber & Kat McDonald
Site name: Auckland Harbour Bridge	Location on bridge: Span 7
Part of bridge: Span 7 - Post 7-10	Equipment: Bucket
Site ID:	Photos taken: Yes / No

Weather conditions: SW breeze

Method of sample collection: Bucket against post while hot water blasting. Richard and JP move bucket around to collect rough water

Time water blasting begins: 11.26am

Time of first sample initial sample (IS): Green bucket
11.37am

Time of second sample end stream (ES): Grey bucket
11.42am

Time water blasting ends: 11:55am

Amount of stopped time during blasting: 15.40secs + 25secs + 22secs + 10secs + 20secs
ES: 18secs + 42secs + 22secs + 40secs + 10secs + 2mins + 20 + 10

Volume of water sampled: IS ~ 2 litres. ES ~ 3-4 litres

Sample procedures onsite: Rinse bucket of deionised water. Place bucket inside post and collect runoff. Swap buckets to collect IS and ES. Sample for contaminants from composite bucket samples

Sample appearance at time of collection (e.g. colour, clarity, odour):

IS: Dark, no odour, very murky. ES: clear, no odour, some sediment + paint flake.
See sediments

Details of preservation techniques (filtered etc):

Difficult to filter IS sample due to heavy sedimentation

Samples taken and labelled:

Filtered:

Non-filtered:

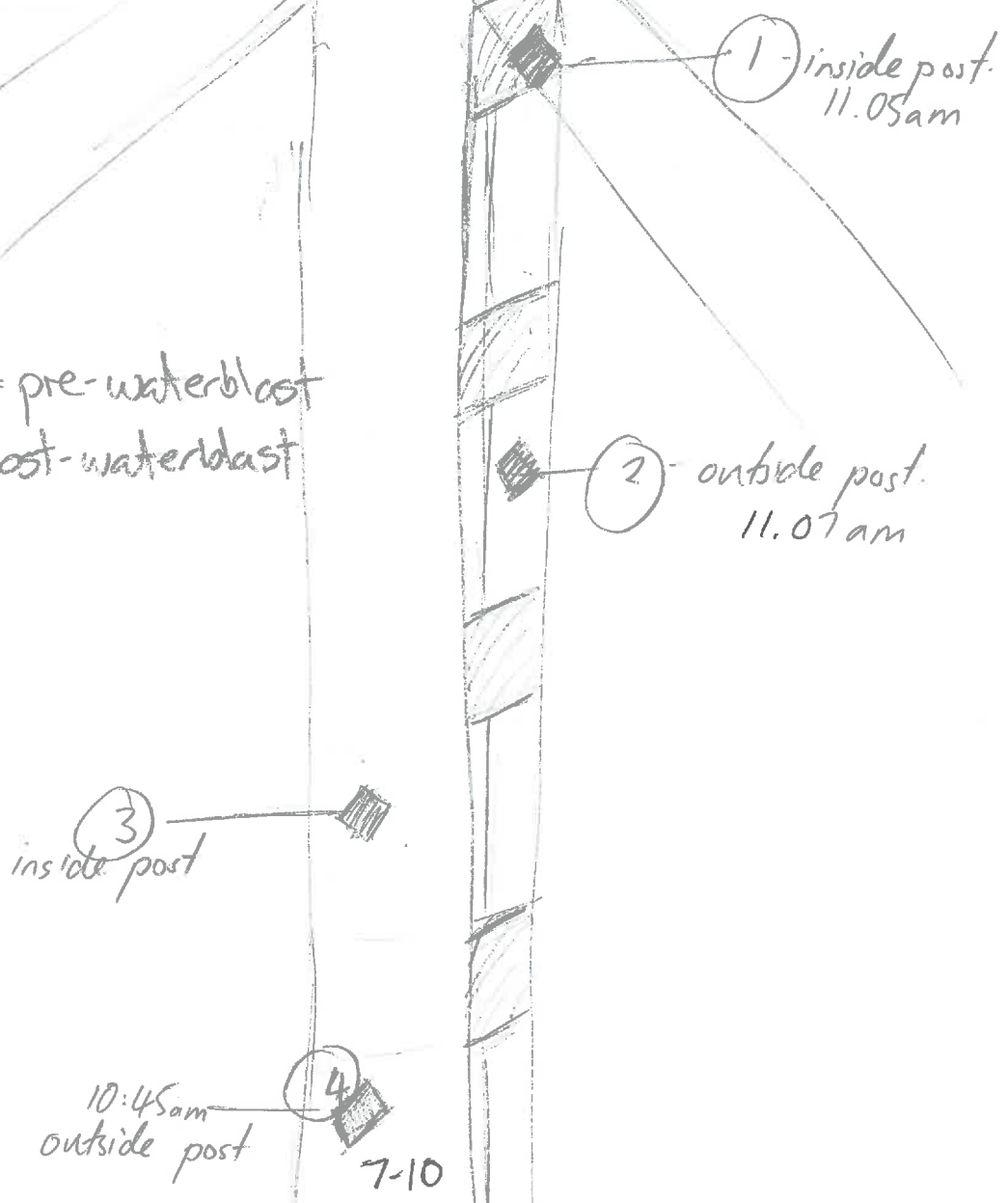
Cr VI:

Total Suspended Solids:

Total Petroleum Hydrocarbons:

AHB Historic coatings study 4/4/16

Sample A = pre-waterblast
Sample B = post-waterblast



Sample locations
- paint scrapings

Appendix B – Laboratory Reports





ANALYSIS REPORT

Client:	OPUS International Consultants	Lab No:	1562225	SPV1
Contact:	Liz Coombes C/- OPUS International Consultants PO Box 5848 Auckland 1141	Date Registered:	05-Apr-2016	
		Date Reported:	13-Apr-2016	
		Quote No:	75939	
		Order No:		
		Client Reference:		
		Submitted By:	Liz Coombes	

Sample Type: Aqueous

Sample Name:	IS001-IS003 04-Apr-2016 11:37 am	ES01-ES003 04-Apr-2016 11:42 am			
Lab Number:	1562225.1	1562225.2			
Individual Tests					
Hexavalent Chromium	g/m ³	< 0.010	0.033 #1	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn					
Dissolved Arsenic	g/m ³	0.0019	< 0.0010	-	-
Dissolved Cadmium	g/m ³	0.00049	0.00024	-	-
Dissolved Chromium	g/m ³	0.059	0.0198 #1	-	-
Dissolved Copper	g/m ³	0.047	0.0032	-	-
Dissolved Lead	g/m ³	0.0149	0.00190	-	-
Dissolved Nickel	g/m ³	0.0083	0.0007	-	-
Dissolved Zinc	g/m ³	3.4	1.06	-	-
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn					
Total Arsenic	g/m ³	0.011	0.0018	-	-
Total Cadmium	g/m ³	0.00190	0.00053	-	-
Total Chromium	g/m ³	0.40	0.081	-	-
Total Copper	g/m ³	0.119	0.0118	-	-
Total Lead	g/m ³	0.28	0.024	-	-
Total Nickel	g/m ³	0.026	0.0034	-	-
Total Zinc	g/m ³	33	8.7	-	-

Analyst's Comments

#1 It has been noted that the result for Hexavalent Chromium was significantly greater than that for the Dissolved Chromium. It is suspected that this may be due to a positive interference during the colorimetric Hexavalent Chromium method. The Cr6 has been confirmed by repeat analysis.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, trace level. APHA 3125 B 21 st ed. 2005.	0.00005 - 0.0010 g/m ³	1-2
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, trace level	0.000053 - 0.0011 g/m ³	1-2
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 22 nd ed. 2012 (modified).	-	1-2
Hexavalent Chromium	Diphenylcarbazide colorimetry. Discrete Analyser. APHA 3500 Cr B (modified from manual analysis) 22 nd ed. 2012.	0.010 g/m ³	1-2



These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This report must not be reproduced, except in full, without the written consent of the signatory.

A handwritten signature in blue ink that reads "Carole Rodgers-Carroll". The signature is written in a cursive style with a large initial 'C'.

Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental Division

CLIENT : **OPUS INTERNATIONAL CONSULTANTS LTD**
ADDRESS : PO BOX 5848, AUCKLAND 1141
EMAIL : s9(2)(a) [REDACTED]
PHONE : s9(2)(a) [REDACTED]
ATTENTION : RAED EL SARRAF **JOB REFERENCE** : SA18695

CLIENT REFERENCE : not supplied
SAMPLE TYPE[S] : PAINT FLAKES
DATE OF SAMPLE RECEIPT : 15/04/2016 **CONDITION** : PAINT FLAKES-DRY
ANALYSES CARRIED OUT : MULTI-ELEMENT ANALYSIS
REPORTING BASIS : AS-RECEIVED

The analytical results presented in this report apply to the sample(s) received by SpectraChem Analytical.

Analysis	Method used	LLD	Unit
Multi- element*	Pressed Powder / X-ray spectrometry / Spectra ^{plus}	-	%

Comments
**Multi-element analysis should be considered semi-quantitative.
 Detection limits vary with element and sample matrix.*

IANZ ACCREDITED LABORATORY
 SpectraChem Analytical is an IANZ accredited analytical laboratory. All analyses presented in this report other than those indicated (*), have been carried out by SpectraChem or by a sub-contracted laboratory in accordance with the requirements of International Accreditation New Zealand. This report may not be reproduced either in part or whole without the prior consent of the undersigned.

Date : 12/05/2016 **Signed :** Craig Fraser Signatory

SpectraChem Analytical, CRL Energy Ltd : 68 Gracefield Rd : Lower Hutt
 P O Box 31-244 Lower Hutt : Tel. 04 570-3799 : Email. spectra@crl.co.nz

CLIENT : OPUS INTERNATIONAL CONSULTANTS LTD
PROJECT : SA18695

SAMPLE :
ELEMENT

	Paint Flakes Post 7-10	Sample 1A	Sample 1B	Sample 2A	Sample 2B	Sample 3A	Sample 3B	Sample 4A	Sample 4B
Fluorine F	nd	nd	nd	nd	nd	nd	nd	nd	nd
Sodium Na	(ND)	(ND)	(ND)	(ND)	(ND)	(ND)	(ND)	(ND)	(ND)
Magnesium Mg	2.78	2.96	3.69	2.31	2.34	2.85	2.52	2.66	2.68
Aluminium Al	5.93	4.88	4.92	5.65	6.00	5.11	5.63	4.63	4.28
Silicon Si	7.78	7.45	9.10	7.61	8.28	8.60	8.21	9.08	8.62
Phosphorus P	0.073	0.158	0.205	0.028	0.022	0.022	0.027	0.017	0.018
Sulphur S	1.01	0.985	0.624	1.57	1.52	0.968	1.41	0.865	0.962
Chlorine Cl	1.68	2.06	3.59	3.05	1.90	0.461	1.32	0.104	0.141
Potassium K	0.857	0.681	0.751	0.713	0.621	0.773	0.706	0.851	0.923
Calcium Ca	1.63	1.13	0.577	1.78	1.67	1.17	1.48	1.22	1.34
Scandium Sc	nd	nd	nd	nd	nd	nd	nd	nd	nd
Titanium Ti	2.55	1.75	2.46	3.05	3.03	3.12	3.33	3.15	3.25
Vanadium V	0.004	0.004	0.004	0.005	0.008	0.005	0.008	0.005	0.004
Chromium Cr	0.891	0.722	0.634	0.506	0.173	0.606	0.466	0.577	0.879
Manganese Mn	0.035	0.027	0.017	0.040	0.033	0.024	0.029	0.031	0.030
Iron Fe	22.7	18.7	16.8	25.3	24.4	21.0	22.2	22.0	21.7
Cobalt Co	0.033	0.028	0.021	0.053	0.039	0.035	0.041	0.038	0.034
Nickel Ni	nd	0.010	0.007	0.030	0.048	0.020	0.050	0.038	0.027
Copper Cu	0.011	0.010	0.010	0.012	0.012	0.011	0.011	0.009	0.009
Zinc Zn	15.3	23.6	22.3	9.26	10.6	19.0	14.0	18.2	18.6
Gallium Ga	0.008	0.009	0.011	nd	nd	0.007	nd	0.006	nd
Germanium Ge	nd	nd	nd	nd	nd	nd	nd	nd	nd
Arsenic As	nd	nd	nd	nd	nd	nd	nd	nd	nd
Selenium Se	nd	nd	nd	nd	nd	nd	nd	nd	nd
Bromine Br	nd	nd	nd	0.011	0.008	0.005	0.007	nd	nd
Rubidium Rb	nd	nd	nd	nd	nd	nd	nd	nd	nd
Strontium Sr	0.025	0.032	0.022	0.050	0.051	0.019	0.042	0.018	0.022
Yttrium Y	nd	nd	nd	nd	nd	nd	nd	nd	nd
Zirconium Zr	0.016	0.007	0.008	0.015	0.016	0.016	0.015	0.016	0.012
Niobium Nb	0.003	nd	nd	nd	nd	0.004	0.004	0.004	0.004
Molybdenum Mo	nd	nd	nd	nd	nd	nd	nd	nd	nd
Cadmium Cd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Tin Sn	nd	nd	nd	nd	nd	nd	nd	nd	nd
Antimony Sb	nd	nd	nd	nd	nd	nd	nd	nd	nd
Barium Ba	2.23	2.16	0.660	4.48	4.07	1.94	3.67	1.71	2.16
Lead Pb	0.085	0.075	0.098	0.116	0.066	0.043	0.046	0.016	0.022
Bismuth Bi	nd	nd	nd	nd	nd	nd	nd	nd	nd
Thorium Th	nd	nd	nd	nd	nd	nd	nd	nd	nd
Uranium U	nd	nd	nd	nd	nd	nd	nd	nd	nd
Total	65.7	67.4	66.5	65.6	64.9	65.8	65.2	65.3	65.7

Sodium not determined (ND) due to significant Zinc line overlap. Other nd indicates not detected.

Values are weight %, on as-received basis.

100% - Total = sum of unmeasured elements [e.g.H,B,C,N,O]

Appendix C – Air Matters Report 16026



AUCKLAND HARBOUR BRIDGE ALLIANCE DRY ABRASIVE BLASTING EMISSIONS

AIR MATTERS REPORT 16026

Monitoring of dust and metals during dry abrasive blasting for operator exposure and
environmental assessment

Test Date: 4/04/2016

Report Date: 28/06/2016

Report prepared for Auckland Harbour Bridge Alliance by Air Matters Limited

Report written by:



Carol McSweeney
Principal

Air Matters Report: 16026
Date: 28/06/2016
Status: FINAL

Report Checked by:



Robert Murray
Environmental Scientist

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1 OBJECTIVES

1.1 DUST

1. To measure the average total inhalable dust concentration exposure for the abrasive blasting operator and pot person working on a lower vertical structure of the Auckland Harbour Bridge.
2. To measure concentrations of particulate in the environment during dry abrasive blasting.

1.2 METALS

1. To measure the average concentration exposure of lead, chromium, zinc and iron for the abrasive blasting operator and the pot person working on a lower vertical structure of the Auckland Harbour Bridge.
2. To measure concentrations of lead, chromium, zinc and iron in the environment during dry abrasive blasting.

1.3 REPORTING

1. Report all findings. Compare personal monitoring data with occupational exposure and threshold limits set out by WorkSafe New Zealand and other international agencies if appropriate.
2. Compare environmental monitoring against appropriate standards and guidelines.
3. Compare environmental monitoring against the threshold values and buffer zones set out in the Consent Documents for Auckland Harbour Bridge Maintenance and the associated Adaptive Management Framework (AMF).

2 INTRODUCTION

Monitoring for particulates and the metal content of those particulates produced from abrasive blasting, has been used in the assessment of discharges from maintenance activities on the Auckland Harbour Bridge. This data was then used in the assessment of effects provided as part of the consent application. Previous monitoring was undertaken over two different days in 2013 when dry abrasive blasting took place. Results were compared with environmental guidelines (Air Matters Report 13001). Buffer zones for abrasive blasting work on the bridge were developed based on this testing and were used to ensure that the level of contaminants in air from dry abrasive blasting did not exceed the environmental threshold levels proposed in the consent application. This current round of testing (4 April 2016) is being used as another data set to verify that the proposed buffer zones are in fact meeting that requirement. The results of any testing of airborne contaminants from dry abrasive blasting will be variable based on weather conditions (especially wind direction), the base material being prepared and the type of bridge structure being prepared by dry abrasive blasting.

A second objective for this round of testing was to ascertain the level of airborne contaminants around the dry abrasive blasting operator and the "potboy" who feeds the garnet into the blasting drum (workplace exposure monitoring).

On a day of sampling, dry abrasive blasting took place north of Span 7 at post 7.10. Other experimental work to identify metals in paint scrapings and wash water was carried out at the same location before dry abrasive blasting (DAB) took place. The DAB carried on the day of sampling was spot blasting of rusty surfaces of a lower vertical structure. The paint coatings on the vertical post that was sandblasted has been identified as "non-lead paint" but there is still a base level of lead present.

The pot was loaded from the upper platform and the abrasive operator dropped into the work position on the diagonal. There was restricted access from the blasting area to the pot filling area. Two 20kg bags of garnet were used for the blasting on the day of testing. Spot blasting took place over 2.75 hours.

Figure 1: Location of works on the Auckland Harbour Bridge during DAB at span 7.

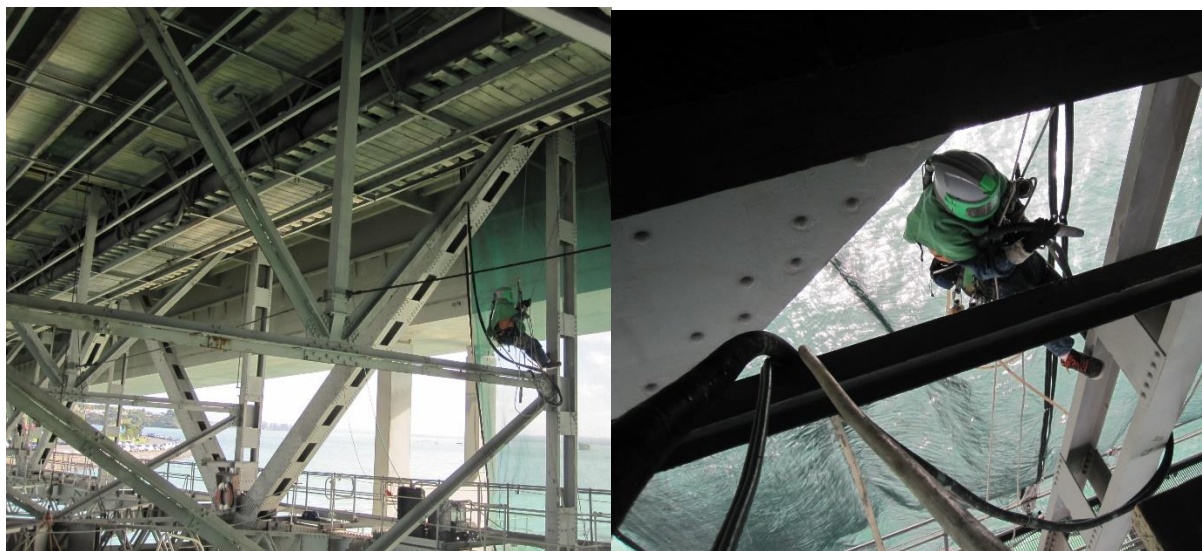


Fig 1.1 and 1.2 Abrasive Blaster operator spot blasting on vertical steel structure



Fig 1.3: Location of the blasting pot and garnet on the upper walkway (location 7.10)

Fig 1.4: Pot person on upper platform wearing dust/metal sampler

3 METHODOLOGY

Inhalable dust and metals

Sampling was carried out in accordance with AS/NZS 3640-2009 for particulates. A sample was collected using a Button Samplers for collection of DAB dust and a 0.8µm MCE filter (SKC 226-3-01) with a sampling pump calibrated at 3.4L/minute. Personal samplers were attached to the operators, as close as possible to the normal breathing zone. The environmental samples were set up at the locations below. Sampling was carried out for 2 hours 45 minutes. The filters, along with the control blank filter, were subsequently weighed by Air Matters following the Australian Standard method for inhalable particulate. This method was used for environmental monitoring as opposed to Total Suspended Particulate (TSP) method due to the nature of the works and the sampling locations making ambient standard method samplers impracticable in this situation.

Filters were subsequently analysed for lead, chromium zinc and iron by Hill Laboratories using ICP Mass Spectrometry in accordance with NIOSH Method 7300.

Samples were collected from:

- A personal sample on the abrasive blaster (post 7.10)
- A personal sample on the "pot person" Upper platform (post 7.10)
- Downwind (location 6.1 west side of bridge)
- Downwind (location 6.1 east side of bridge)
- Downwind (location 6.0 west side of bridge)
- Upwind (location 7.8 west side of bridge)
- Upper platform by garnet loading (location 7.10)
- Upper platform by garnet loading (location 7.8)

DustTrak - static sampling for PM₁₀

Dust levels were monitored using a DustTrak™ Aerosol Monitor DRX 8533. The DustTrak™ gives a real-time digital readout of dust concentration using a laser photometer. The DustTrak™ was set up to measure PM₁₀ for comparison against the environmental guidelines. The unit takes a reading every second and was set to data log 60-second averages. On 4 April 2016 the unit was set up during DaB operation at the following locations:

- Pier 6 (West Side) 1400-1435. Background, no DAB.
- Pier 6 (East Side) 14:46-15:21. Opposite DAB Cross wind.
- Span 7 Location 7.10 passing bay (East Side) 15:26 – 15:51. Downwind.
- Span 7 Location 6.1/6.2 passing bay (West side) 15:56-1657. Downwind.

4 Results

Inhalable Dust and Metals - Workplace Exposure

Inhalable dust and metal results are summarised in Table 2 below. All personal samples for inhalable dust, lead, chromium, zinc and iron were below the relevant workplace exposure standards. Inhalable dust was elevated for the abrasive blasting operator. (It is noted that the monitor head became twisted during the sampling time and this result will be undersampled). Background information around the

workplace exposure standards (WES) is supplied in Appendix 1.

Dust and Metals - Environmental

The results for the environmental monitoring are summarised in Table 3 below. Inhalable dust, lead, chromium and iron were all below the environmental standards at all locations including at location 6.1 (approximately 30 metres downwind from the DAB). Zinc concentrations were above the environmental standards of $25\mu\text{g}/\text{m}^3$ at 15 metres downwind from the DAB on both the east side of the bridge ($43\mu\text{g}/\text{m}^3$) and west side of the bridge ($25\mu\text{g}/\text{m}^3$). From previous sampling, a buffer zone for zinc of 216 metres has been established based on the worst case sampling situation. This buffer zone, which is part of the current consent, is adequate for the metal emissions from DAB in this round of sampling.

PM₁₀ Environmental Sampling

Real time results for DustTrak PM₁₀ dust concentrations are shown below in Table 1 and Chart 1. The concentrations are compared against the National Environmental Standard (NES) for PM₁₀ which is a 24 hour average concentration. There were short periods of time during DAB when the PM₁₀ was above $50\mu\text{g}/\text{m}^3$. The highest levels of PM₁₀ were measured 15 metres downwind of the DAB where the average concentration was $57\mu\text{g}/\text{m}^3$. However, when the 24 hour average is calculated the levels are well within the environmental standard and close to the background levels. (24 hour averaged calculated based on the concentration and time for DAB and the concentration and time at background levels)

Table 1: DustTrak PM₁₀ results for dry abrasive blasting 4/4/2016.

Location	Sampling duration (minutes)	Average PM ₁₀ concentration over sampling time ($\mu\text{g}/\text{m}^3$)	Calculated 24 hour PM ₁₀ concentration ($\mu\text{g}/\text{m}^3$)
Pier 6 Westside Upwind background (no DAB)	68	36	36
Pier 6 Eastside crosswind (DAB underway)	35	36	36
Span 7 - 7.10 passing bay Eastside downwind (DAB underway)	25	34	36
Span 7 - 6.1 passing bay Westside downwind (DAB underway)	61	57	37
National Environmental Standard for PM₁₀ (24 hour average)	NA	50 $\mu\text{g}/\text{m}^3$	

All raw data is available on request. Hill Laboratory Report presented in Appendix 2.

Table 2: Concentrations of inhalable dust and metals for operators during dry abrasive blasting work

Sample type	Sampling Location	General Wind Direction & Speed m/s	Measured Concentration Lead $\mu\text{g}/\text{m}^3$	Measured Concentration Chromium VI $\mu\text{g}/\text{m}^3$	Measured Concentration Zinc $\mu\text{g}/\text{m}^3$	Measured Concentration Iron $\mu\text{g}/\text{m}^3$	*Inhalable dust mg/m^3
Workplace Exposure Personal Samples	Personal sampler on abrasive blaster North of Pier 6 at diagonals (location 7.10)	2.5 - 4 m/s SE to some gusts from the SW	0.6	2.0	189	260	3.3
	Personal sample on pot person – Upper platform (post 7.10)	1.4 SW	0.1	0.7	18	19	0.9
Workplace Exposure Standard (WES-8hr) $\mu\text{g}/\text{m}^3$			100	50	5000	5000	10
	Good Practice		NA	NA	NA	NA	5

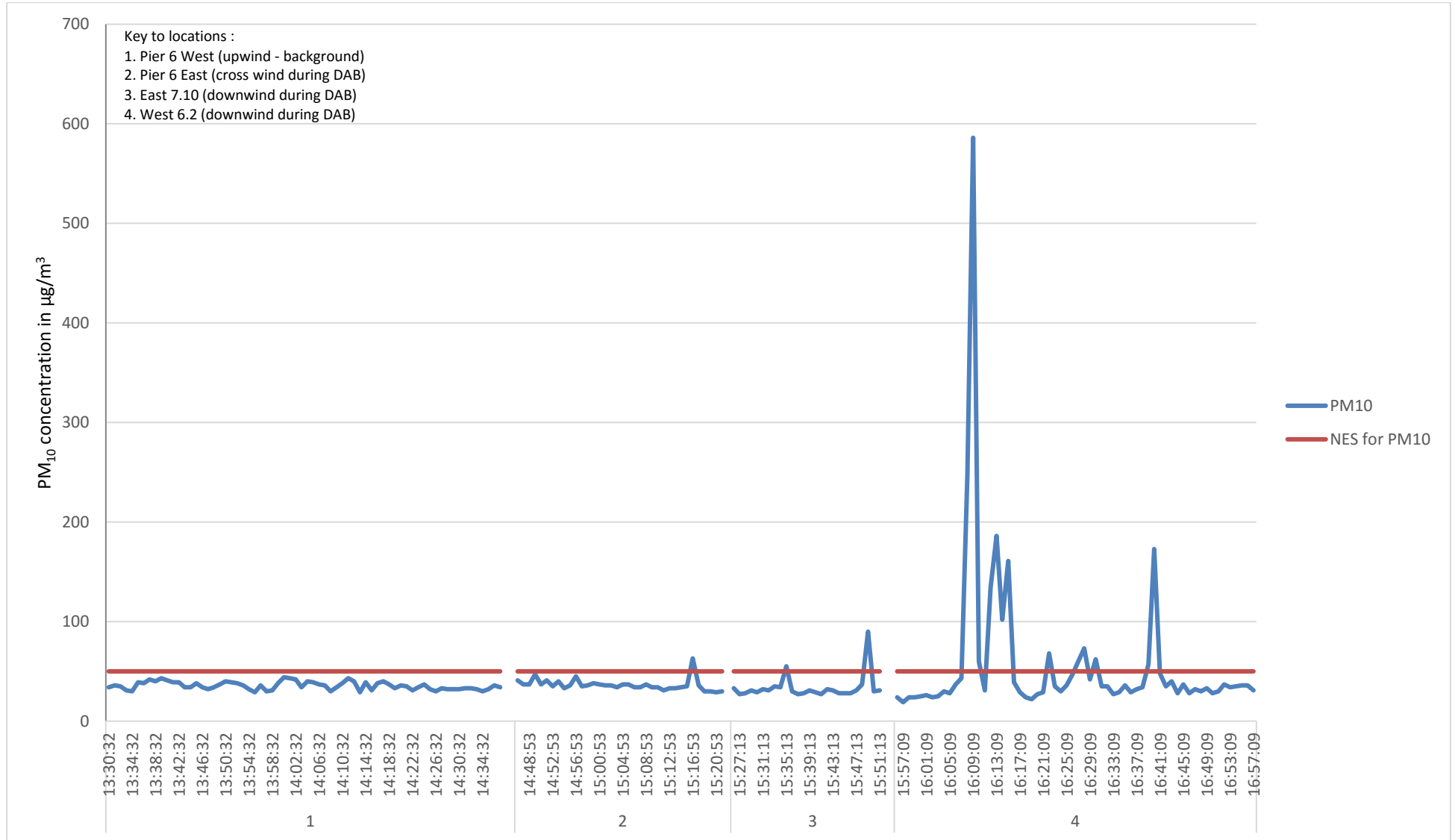
* Note inhalable dust results and guidelines are in mg/m^3 whereas all metal results and guidelines are in $\mu\text{g}/\text{m}^3$. NA Not Applicable

Table 3: Concentrations of inhalable dust and metals at various locations during dry abrasive blasting work

Sample type	Sampling Location	General Wind Direction & Speed m/s	Measured Concentration Lead $\mu\text{g}/\text{m}^3$	Measured Concentration Chromium VI $\mu\text{g}/\text{m}^3$	Measured Concentration Zinc $\mu\text{g}/\text{m}^3$	Measured Concentration Iron $\mu\text{g}/\text{m}^3$	*Inhalable dust mg/m^3
Environmental Samples	Downwind (location 6.1 west side of bridge)	2.5 - 4 m/s SE to some gusts from the SW	0.03	0.8	25	23	1.1
	Downwind (location 6.1 east side of bridge)		0.08	1.2	43	31	2.5
	Downwind (location 6.0 east side of bridge)		<0.01	0.9	10	7	0.8
	Upwind (location 7.8 west side of bridge)		<0.01	0.9	0.1	<1	0.4
	Upper platform by garnet loading (location 7.10)		0.01	0.7	0.2	<1	0.2
	Upper platform by garnet loading (location 7.8)		<0.01	0.5	0.9	<1	0.2
Environmental Standard $\mu\text{g}/\text{m}^3$			Ontario half hour average 1.5 Ontario 24 hour average 0.5	TCEQ 1 hour average 3.6	TCEQ 1 hour average 20	TCEQ 1 hour average 50	NA

* Note inhalable dust results and guidelines are in mg/m^3 whereas all metal results and guidelines are in $\mu\text{g}/\text{m}^3$. NA Not Applicable

Chart 1: PM₁₀ concentrations (1 minute average) at various locations during dry abrasive blasting compared against the 24 hr NES for PM₁₀



5 CONCLUSIONS

Workplace Exposure:

No workplace exposure standards were exceeded in this round of testing, however, there was under sampling on the dry abrasive blasting operator. This operator is protected with filtered air provided inside the blasting helmet. This is appropriate protection for a blasting operator.

The personal samples indicated that with the set-up used for this work, the “pot person” on the upper platform, the contaminants were below the workplace exposure standard and there was no requirement for PPE for any operator on the upper platform. However, it must be noted that this will vary with each abrasive blasting layout along with meteorological conditions. It is understood that there is a procedure for PPE use when the garnet loading is on the same level as the DAB. The use of a P1 or P2 dust masks would provide protection in most instances. The static samples for inhalable dust indicate at this site and with this work, upwind dust levels are well below the workplace exposure standard for any operators in the area. Downwind the levels are elevated close to the works but soon drop off to acceptable levels. As this is not the worst case DAB situation, it is suggested that the current procedure for buffer distances for other workers on the bridge continues to be followed.

Environmental Sampling

These results give another data set for evaluating the offsite environmental effects of dust and metal contamination from abrasive blasting. These results indicate that the levels of zinc are above the environmental standards at source but by 30 metres have dispersed to acceptable levels. This confirms the buffer zones established in earlier work as part of the consent application, are adequate to meet the threshold values for the contaminants (lead, chromium, iron and zinc in particular). Table 4 below summarises the environmental sampling and its implications.

Table 4: Monitoring summary and outcomes based on consented activities and products used for AHB maintenance

Maintenance Activity	Key Contaminant	Compliance	Implication
Abrasive Blasting	Dust	Downwind dust samples were collected during DAB in Span 7, Short term concentrations close to the DAB were above the Auckland Council Dust Trigger Level for Highly Sensitive Receiving Environments. However, away from the blasting the levels dropped.	Threshold for dust was met under the current regime. Buffer zones created for metals will ensure that compliance is ongoing.
	PM ₁₀	Downwind dust samples were collected during DAB in Span 7 and calculation carried out for 24 hour average. Concentrations calculated were below the NES of 50µg/m ³ .	Threshold can be met for PM ₁₀ under the current regime.
	Chromium	Concentrations of chromium measured downwind from the DAB were below the Effects Screening Level.	An estimated buffer zone for chromium of 183m from land has been established from previous work. Where works are undertaken at 183m or more from land wind direction controls are not required for chromium. This round of testing confirmed the buffer will ensure that concentrations measured on land will be below the Effects Screening Level.
	Iron	Concentrations of iron measured down-wind were below the Effects Screening Level.	An estimated buffer zone for iron of 49m from land has been calculated from previous work. Where works are undertaken at 49m or more from land wind direction controls are not required for iron. This round of testing confirmed the buffer will ensure that concentrations measured on land will be below the Effects Screening Level.
	Lead	Lead concentrations at all locations were below the Ontario Guideline.	An estimated buffer zone for lead of 343m from land has been calculated from previous work. Where works are undertaken at 343m or more from land wind direction controls are not required for lead This round of testing confirmed the buffer will ensure that concentrations measured on land will be below the Ontario Guideline. The coating at this testing location is considered lead free.
	Zinc	Concentrations of zinc measured at 30 metres were above the Effects Screening Level. However, with dispersion the levels will drop.	An estimated buffer zone for zinc of 216m from land has been calculated from previous work. Where works are undertaken at 216m or more from land wind direction controls are not required for zinc. This round of testing confirmed the buffer set will ensure that concentrations measured on land will be below the Effects Screening Level.

6 REFERENCES

1. Air Matters Report 13001, 16/4/2013. Total Bridge Services Auckland Harbour Bridge
2. Air Matters Report 14502, 18/9/2014. Assessment of discharges to Air from the Auckland Harbour Bridge. Maintenance.

APPENDIX 1: Workplace Exposure Standards

Workplace Exposure Standards (WES) can only be used as guidelines in making decisions regarding safe levels of exposure to various chemical agents found in the workplace. The standards are based on available information and suggest a level of exposure that the typical worker can experience without adverse health effects. There is no fine line between safe and dangerous exposures and the recommendation of agencies publishing these figures is that the concentrations should be kept as low as possible.

Compliance with the designated values does not guarantee protection from discomfort or possible ill health for workers. Individual susceptibility and exposure outside the workplace may lead to a varying response. More importantly there is an expectation in the legislation that employee exposure to hazardous substances will be controlled to a level as far below the relevant WES as practicable by applying the hierarchy of control required by the Health and Safety at Work Act 2015 (HSWA), i.e. eliminate the hazard where possible, then minimise the hazard by substituting, isolating and using engineering controls. Administrative controls can then be implemented. At the bottom of the hierarchy is personal protective equipment.

Airborne particulates, or aerosols, encountered in the workplace include dusts, fumes and mists. Dust in the workplace is measured in two forms:

- *Inhalable dust*. The portion (or fraction) of airborne dust that is taken in through the mouth and nose during breathing.
- *Respirable dust*. Corresponds to the fraction of total inhalable dust that is able to penetrate and deposit in the lower bronchioles and alveolar region.

The results below can be compared with the WorkSafe New Zealand WES, published in 2013 by the Ministry of Business, Innovation and Employment. Workplace Exposure Standards for airborne contaminants in New Zealand may exist in the following forms:

- an 8-hour time weighted average (WES-TWA); and/or
- a 15-minute period short-term exposure limit (WES-STEL); and/or
- a ceiling limit that cannot be exceeded at any time during the work day (WES-Ceiling)

All Workplace Exposure Standards should be viewed in light of the comments above.

Table 5: Workplace Exposure Standards for Dust

Contaminant	WES-TWA 8-hour (mg/m ³)
Inhalable Dust	10
Respirable Dust	3

There is also increasing evidence in the literature that exposure to low toxicity dusts can cause or worsen chronic obstructive pulmonary disease (COPD). It is considered best practice by many international agencies for employers to aim to keep exposure to respirable dust below 1mg/m³ and inhalable dust below 5mg/m³ (Institute of Occupational Medicine, Edinburgh, 2011). This is considerably less than the NZ WES for dust but gives some direction for employers as to the level of dust that is currently thought to be that which will not cause harm.

APPENDIX 2: LABORATORY ANALYSIS SHEETS



Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Page 1 of 1

Client: Air Matters Limited	Lab No: 1565075	SPv1
Contact: Carol McSweeney	Date Registered: 08-Apr-2016	
C/- Air Matters Limited	Date Reported: 21-Apr-2016	
PO Box 96256	Quote No:	
Balmoral	Order No:	
Auckland 1342	Client Reference: 16026	
	Submitted By: Carol McSweeney	

Sample Type: Miscellaneous filter type less than 50 mm diameter

	Sample Name:	16026 AA	16026 AB	16026 AC	16026 AD	16026 AE
	Lab Number:	1565075.1	1565075.2	1565075.3	1565075.4	1565075.5
Chromium	µg/sample	1.16	0.41	0.18	0.27	0.24
Iron	µg/sample	151	11.1	< 1.0	3.0	7.2
Lead	µg/sample	0.35	0.059	< 0.005	0.006	0.014
Zinc	µg/sample	109	9.6	0.10	3.2	6.9

	Sample Name:	16026 AF	16026 AG	16026 AI	16026 AJ	16026 AK
	Lab Number:	1565075.6	1565075.7	1565075.8	1565075.9	1565075.10
Chromium	µg/sample	0.26	0.30	0.24	0.18	0.25
Iron	µg/sample	< 1.0	8.4	< 1.0	< 1.0	< 1.0
Lead	µg/sample	< 0.005	0.025	0.008	< 0.005	< 0.005
Zinc	µg/sample	0.13	10.4	0.16	0.39	< 0.05

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Miscellaneous filter type less than 50 mm diameter			
Test	Method Description	Default Detection Limit	Sample No
Chromium	Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified).	0.05 µg/sample	1-10
Iron	Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified).	1.0 µg/sample	1-10
Lead	Modified aqua regia digestion of client filter, analysis by ICP-MS (see NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified).	0.005 µg/sample	1-10
Zinc	Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified).	0.05 µg/sample	1-10

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Ara Heron BSc (Tech)
Client Services Manager - Environmental Division