AHB Alliance

Historic Coatings – Additional Monitoring and Investigations Summary Report

November 2018

NZ TRANSPORT AGENCY
WAKA KOTAHI

Auckland Harbour Bridge
PART OF THE AUCKLAND MOTORWAY ALLIANCE

Document Control

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Executive Summary

This report presents the findings of the Historic Coatings Further Investigations project (OoS133). This is the third phase of the Historic Coatings Study, which has also included the Historic Coatings Pilot Study (AHBA, March 2016), Historic Coatings Characterisation Study (AHBA, October 2018).

The paint systems used on the Auckland Harbour Bridge (AHB) in the past are known to have contained lead and zinc chromate, exposure to which can cause health effects.

The purpose of this study was to increase knowledge of composition and variability of historic paints on the bridge, and how these relate to concentrations in air during abrasive blasting, confirm that existing environmental controls and H&S are adequate, and confirm that dust is not building up to toxic levels within smoko huts and bungy pod. The scope of this study included testing the composition of paint scheduled for abrasive blasting, undertaking air sampling during the abrasive blasting, and undertaking dust sampling in key areas.

The paint sampling found that the levels of chromium in the paint tested were higher than those found during paint testing carried out in other areas of the AHB during earlier phases of this historic coatings study. Levels of lead were slightly higher than (non-lead-based) paints tested previously, and levels of zinc were similar.

The air sampling found that the existing environmental controls (buffer zones) were confirmed as being acceptable for the work being carried out during the testing, to ensure compliance with consent conditions (air thresholds). Current H&S controls were found to be acceptable to meet the current NZ Workplace Exposure Standard (WES) for hexavalent chromium. However this WES is currently under review and this may be lowered in the future.

The results of the air sampling taken in conjunction with the results of the paint sampling indicate that levels detected in paint cannot be closely correlated with levels detected in air during blasting. This is likely due to the variability of the physical environmental conditions (e.g. wind speed and direction, localised effects of the structure on from gusts), during air testing. This means that development of variable controls for future blasting events based on paint sampling results does not appear to be feasible at this time.

The dust sampling found that levels of the tested contaminants were low in the bungy pod and did not exceed the adopted guidelines. Dust in the smoko huts and on the central walkway was found to contain lead at levels that exceeded the adopted guidelines.

Key recommendations include:

- Review work site exclusion zone and other H&S controls for compliance if Worksafe NZ WES for hexavalent chromium is amended.
- The smoko huts should be decontaminated if they are to be put back into use.
- Good hygiene practices should be reinforced and re-communicated regularly.
- Undertake surface dust testing in the bungy pod following abrasive blasting in the area and/or arrange for the pod to be cleaned following completion of the works as a precaution.

1 Introduction

This report presents the findings of the Historic Coatings Further Investigations project (OoS133).

This is the third phase of the Historic Coatings Study, which has included:

- Historic Coatings Pilot Study (OoS33), which involved paint sampling and air sampling of a non-lead paint post in Span 7 (AHBA, March 2016)
- Historic Coatings Characterisation Study (OoS60), which involved paint sampling and dust sampling at several locations in Span 1, Span 2, and Span 7 (AHBA, October 2018); and
- Historic Coatings Further Investigations (OoS133, this study), which has involved paint sampling, and air sampling in Span 5, and dust sampling.

1.1 Background

1.1.1 Contaminants in Paint

The paint systems used on the Auckland Harbour Bridge (AHB) in the past are known to have contained lead and zinc chromate, exposure to which can cause health effects.

The recently released Guide to Hazardous Paint Management Part 1: Lead and other hazardous metallic pigments in industrial applications (AS/NZS 4361.1:2017) contains advice for managing hazardous metallic pigments (including lead and zinc chromate) in paints. The standard classifies paint removal projects as hazardous based on the size of the removal project and the concentration of the key contaminant in the paint to be removed. The relevant thresholds are as follows in Table 1.

Table 1: AS/NZS 4361.1:2017 Threshold concentration criteria for hazardous paint projects (% by weight) for lead and zinc chromate

	Total Mass of Paint		
Hazard	>250kg paint	50-250kg paint	<50kg paint
Lead	0.1%	0.25%	1%
Zinc Chromate (as Cr)	0.05%	0.1%	0.25%

In 2016 a study was undertaken (OoS 60 AHB Historic Coatings Characterisation Study, AHBA October 2018) to increase our knowledge on the presence and variability of these components in historic coatings on the Auckland Harbour Bridge. It showed that Span 7 has the highest lead concentration and remains a hotspot for historic lead-based[1] paints, which was expected from prior studies; although some parts of Span 7 are free of lead-based paints due to removal during previous maintenance activities. Outside of Span 7, concentrations of lead were still found in some areas at levels that would be considered hazardous under the AS/NZS guidelines, if removing >250kg of paint. Chromium is present across all the areas of the bridge that were tested at levels that are considered hazardous (under the guidelines) for projects of any size.

[1] >5000ppm lead

The current environmental and health and safety controls are based on assumptions regarding the composition of the historic coatings on the bridge (such as that lead is not present in significant amounts anywhere on the bridge except for Span 7 and the box girders). Additionally, 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 this was not tested during the air sampling that was used to calculate the buffer zones. The assumption made at the time was that the composition of coatings over the length of the bridge was relatively consistent (with the exception of the lead presence in Span 7).

Now that we know that the coatings are quite variable in composition across the bridge, there is uncertainty about whether the current controls (buffer zones and H&S) provide sufficient protection of human health both in terms of ambient air quality and occupational exposure. The consent application investigations undertaken in 2013 acknowledged that air buffer zones may need to be adjusted based on future investigations due to unknowns around the exact composition of historic coatings.

1.1.2 Contaminants in Air

The current buffer zones were calculated based on air sampling carried out during blasting in Span 7 in 2013 (Air Matters 2013). Our investigations to date indicate that while levels of lead in this area are likely to represent the higher end of the range of lead that is likely to be present on the bridge (where abrasive blasting occurs), they may not represent the highest levels of chromate or zinc that could be released during abrasive blasting.

Recent investigations have shown that concentrations of other contaminants can be highly variable across the bridge. For example, the Historic Coatings Characterisation Study (AHBA, October 2018) found:

- Levels of chromium in samples from Span 1 and Span 2 were up to three times higher than the levels of chromium found in the sample from Span 7; and
- Levels of zinc in samples from Span 1 and Span 2 were up to ten times higher than zinc in the sample from Span 7.

There has only been limited air testing during abrasive blasting to-date, and only one sampling event where the concentration of key contaminants in the source historic coating was measured (“Historic Coatings Pilot Study”, AHBA March 2016). Because of this, our knowledge on how this variability affects the levels of key contaminants released to air during blasting is limited.

Because of this, additional air sampling was proposed during scheduled abrasive blasting if the historic coatings to be blasted were found to contain higher concentrations of key contaminants than levels found in areas where previous air testing has been carried out to see if levels measured in air could be related back to levels measured in coatings.

1.1.3 Contaminants in Dust

Over time dust can build up on surfaces, so even if the concentrations in air are acceptable, areas where people travel often or work for long periods of time could be collecting dust that then presents a health risk when touched or disturbed, inhaled or ingested. Areas such as the bungy pod or the smoko huts on the bridge are examples of areas where this risk could be present. These are also areas where personnel using the space may not take precautions about presence of contamination.

Dust sampling was undertaken in 2009 (Paragon Health & Safety Consultants) which found that levels of hexavalent chromate in dust in the bungy pod were below the relevant workplace exposure standards. At the time of the sampling, the bungy pod had been in place for 6 years, however dust may have been building up over the past 9 years since this testing was done. The smoko huts haven't been tested previously. Because of the time since testing, additional dust sampling was proposed to determine whether further personnel H&S controls would be needed for contaminants in dust.

1.2 Purpose and Scope

The purpose of this study was to:

1. Increase knowledge of composition and variability of historic paints on the bridge, and how these relate to concentrations in air during abrasive blasting.
2. Confirm that existing environmental controls (buffer zones) are adequate to comply with consent conditions, and that operator H&S controls are sufficient if paint scheduled for blasting is found to have high levels of key contaminants.
3. Confirm that dust is not building up to toxic levels within smoko huts and bungy pod.

The scope of this study was to:

1. Test the composition of paint scheduled for upcoming abrasive blasting in Span 5 (an area not previous tested).
2. Undertake air sampling during abrasive blasting in Span 5 if high levels of key contaminants were found in the paint samples, to test compliance with consent thresholds and H&S requirements.
3. Undertake dust sampling in the bungy pod and surfaces in the smoko huts to confirm whether contaminated dust is building up, and to determine whether additional H&S controls are required in these areas.

2 Paint Sampling

2.1 Methodology

Paint samples were collected on 18 September 2018 from six locations scheduled for dry abrasive blasting. Samples were collected by scraping back the paint from an area of approximately 100x100mm to bare steel into a zip-lock bag. Samples were sent to CRL Laboratories in Wellington for analysis by XRF.

2.2 Results

The results of the paint sampling for key contaminants are presented in Table 2. Laboratory reports are provided in Appendix A. A summary of the results from the pilot study and the characterisation study are also included in Table 2 for comparison.

Table 2: Paint sampling results for key contaminants

	Lab ref	Chromium %	Lead %	Zinc %
Span 5 EP4	9208.1	0.722	0.058	7.28
Span 5 ED2-3	9208.2	1.37	0.172	18.80
Span 5 WD2-3	9208.3	0.966	0.050	13.20
Span 5 ED3-4	9208.4	1.10	0.071	9.74
Span 5 WP4	9208.5	0.725	0.068	6.71
Span 5 WD3-4	9208.6	1.28	0.100	9.23
Results summary	Min	0.722	0.050	6.71
	Max	1.37	0.172	18.8
	Mean	1.03	0.087	10.8
Pilot study* results summary	Min	0.173	0.016	9.26
	Max	0.879	0.116	23.6
	Mean	0.570	0.060	16.9
Characterisation study results** summary	Min	0.010	0.016	3.32
	Max	0.891	0.139	34.4
	Mean	0.515	0.069	17.5

0.722	Result exceeds mean result from the pilot study
1.37	Result exceeds the maximum result in the pilot study

*Sampling location Span 7, Post 10, non-lead-based paint
** Sampling locations from Span 1, Span 2, and Span 7 (excludes lead-based paint sample)

The levels of chromium in all samples from Span 5 exceeded the mean result from the pilot study, and most samples also exceeded the maximum found during the pilot study.

The level of lead in most of the samples from Span 5 exceeded the mean for lead recorded in previous paint testing (excluding lead-based paint), and one sample exceeded the maximum previously found.

The levels of zinc in samples from Span 5 were generally within the range found during previous testing while one sample slightly exceeded the mean from the pilot study.

Paint sampling results from all three phases of this Historic Coatings Investigation (Pilot Study, Characterisation Study, and Further Investigations) have been stored in a database for future reference (R:\Environmental\Projects\Historic Coatings Study\Paint Sample Results Database\PaintSamplingResultsDatabse.xlsx).

2.3 Discussion

Chromium in the paint samples was significantly higher than found in any other paint sampling carried out during previous phases of this investigation. Consequently, the decision was made to undertake air sampling during the abrasive blasting to test the buffer zones and H&S controls for the blasting operator. The air sampling is described in the following section.

To date, much of the air sampling and paint sampling undertaken on the bridge has been carried out in Span 7 due to concerns related to the historic lead-based paint in that area. Paint sampling undertaken during the previous phase of this investigation (“Characterisation Study”, AHBA October 2018) and the current sampling indicate that the chromium content of historic paints tends to be higher in areas of the bridge other than in Span 7. Anecdotally this has been suggested to be due to the fact that the lead-based paints in Span 7 have been very durable and thus required less additional overcoats and maintenance during the period when zinc-chromate primer was in use (1956-1994).

3 Air Sampling

The air sampling investigation report is included in Appendix B. This section provides a summary of the methodology and findings.

3.1 Methodology

Field sampling was undertaken by Air Matters during abrasive blasting on two diagonals in Span 5 (ED2-3 and ED3-4). The wind speed and direction during the works was 2-4m south-westerly.

Data was collected for metal content (time-weighted average) over the period of the dry abrasive blasting for this work (samples were collected at source, downwind and upwind). Samples were collected from:

- Within area of the works (post 5.2 east side of bridge)
- Downwind (post 5.3 east side of bridge) -works on diagonals around 5.3
- Downwind (post 5.4 east side of bridge)
- Downwind (post 5.5 east side of bridge)
- Downwind (post 5.6 east side of bridge)
- Downwind (post 5.3 west side of bridge)

Samples were sent to Hill Laboratories for testing of total chromium, lead, zinc, and chromium VI (chromate).

3.2 Summary of Results

The zinc concentrations in air close to the works (within 2-3 panel points of the work) were considerably lower than concentrations found during the pilot study.

The levels of lead measured during this round of sampling were slightly lower than the levels of lead measured during the pilot study. Although, the sample to be taken closest to the blasting operation, which is assumed to have the highest concentration of lead, was unable to be analysed due to the filter being destroyed by blasting garnet.

Hexavalent chromium levels detected in air during the blasting were consistently higher than the levels of non-hexavalent chromium detected. Hexavalent chromium results were similar to the results of the air sampling during the pilot study, and were below the 24hr environmental standard when normalised for a 4-5 hour work period.

The results also indicated that metal concentration in air reduces quickly as distance from the blasting increases.

3.3 Discussion

The results indicate that the levels of all metals were below the environmental guideline values for the blasting work carried out during the air sampling. This confirms that the buffer zones established in earlier work as part of the consent application are adequate to meet the threshold values for the contaminants tested (lead, chromium and zinc) under the conditions experienced during the testing.

Hexavalent chromium levels detected were consistently higher than the non-hexavalent chromium levels, indicating that the majority of the total chromium in the historic paints is in the form of hexavalent chromium. This is as expected based on the fact that the presence of chromium in historic coatings is due to the use of zinc chromate, which has chromium in the hexavalent form.

The zinc concentrations were considerably lower than those recorded during the pilot study, with some results varying by as much as a factor of 10. Air Matters (2018) have described this as being due to “the variability in the method used for testing which is subject to wind speed and direction on the day as well the actual movement of the operators in relation to the location of the samplers” (pg. 8). This appears to be more of an issue for samples taken close to the blasting (i.e. localised variability near the blasting operator), while samples at distance (2 or more panel points away) are more consistent and possibly less affected by the variability in environmental conditions and personnel movement.

4 Dust Sampling

The dust sampling investigation report is included in Appendix C. This section provides a summary of the methodology and findings.

4.1 Methodology

Dust sampling was carried out on 6 November 2018. Samples were collected from:

- Northern smoko hut (Span 1 and Span 3)
- Bungy pod
- Southern smoko hut
- PP1-11 central walkway

Samples were collected by dust wipe and dry swab, and sent to Envirolab in Sydney, Australia, for analysis for hexavalent chromium, total chromium, and lead.

4.2 Summary of Results

Total chromium and lead were detected in all samples. No hexavalent chromium was detected in any sample.

Levels of total chromium and lead detected in the bungy pod were significantly lower than the results from the other areas. The dust in the southern smoko hut had the highest concentrations of lead and total chromium.

Guidelines ('adopted acceptance criteria') have been adopted for lead and hexavalent chromium from international guidelines for contaminants in surface dust (details are provided in Appendix C).

Swab sampling results for lead in dust indicated that there were three results above the adopted acceptance criteria (80 µg/100cm^2):

- Northern break hut: 100 µg/100cm^2
- Southern break hut: 310 µg/100cm^2
- Point 1-11 – Central walkway: 140 µg/100cm^2

All results for hexavalent chromium in dust were below the laboratories level of reporting, (<1 µg/100cm^2), which is well below the adopted acceptance criteria (47 µg/100cm^2).

4.3 Discussion

The results of the dust sampling indicate that dust from abrasive blasting is not building up in the bungy pod, however this may be (at least in part) due to the fact that very little abrasive blasting has been carried out near the bungy pod in recent years.

The other areas tested (smoko huts and central walkway) contained lead in dust at levels that exceeded the adopted guidelines, and total chromium at much higher levels than those found in the bungy pod. This indicates that dust is building up in these areas following abrasive blasting.

No hexavalent chromium was detected in the dust in any area tested, which indicates that hexavalent chromium dust is not building up in the tested areas following blasting. This is likely to be due to hexavalent chromium oxidising to trivalent chromium after a short period of time (which was then detected as total chromium).

5 Conclusions and Recommendations

The paint sampling results from this investigation have confirmed that the paint composition is variable in different areas on the bridge. This is likely to be due to changes in maintenance regimes over the years, and differing performance of different coatings systems used at different times. The paint sampling results confirmed the findings of the characterisation study that paint removal jobs of any size would be considered hazardous under the AS/NZS Guide to Hazardous Paint Management, due to the levels of zinc chromate in the historic paints, and that projects involving removal of >250kg paint would be considered hazardous based on the levels of lead found.

The results of the air sampling taken in conjunction with the results of the paint sampling indicate that levels detected in paint cannot be closely correlated with levels detected in air during blasting. This is likely due to the variability of the physical environmental conditions (e.g. wind speed and direction, localised effects of the structure on from gusts), during air testing. This means that development of variable controls for future blasting events based on paint sampling results does not appear to be feasible at this time.

The existing environmental controls (buffer zones) were confirmed as being acceptable for the work being carried out during the testing, to ensure compliance with consent conditions (air thresholds).

In terms of compliance with workplace exposure (H&S) requirements, blasting operators are required to wear full respirators, so are well protected from contaminants in dust generated during the blasting. The current H&S controls for personnel other than the blasting operator includes a work area exclusion zone that requires a dust mask to be worn within 15m (approximately one panel point) of abrasive blasting works if personnel are going to be within the exclusion zone for more than 30 minutes. The air sampling carried out in this investigation and in the pilot study confirm that this control would allow compliance with the current WorkSafe NZ Workplace Exposure Standards (WES) (8-hr) for the key contaminants tested. However, WorkSafe NZ has made a recommendation (WorkSafe NZ, 2013) that the WES for hexavalent chromium be reduced from 50ug/m^3 to 0.2ug/m^3. Air sampling results indicate this could be exceeded at a distance of greater than two panel points downwind of the blasting works (depending on the length of time of exposure). Consequently, the work site exclusion zone should be reviewed to ensure compliance if a new WES is confirmed.

The dust sampling indicates that dust is building up following abrasive blasting in some areas on the bridge including the smoko huts. The smoko huts on the bridge are currently not in use, however the levels of lead detected in the dust indicate that they should be thoroughly cleaned prior to being brought back into use to prevent exposure of workers using them during breaks (and cleaned regularly during use to prevent dust building up).

The dust in the bungy pod did not contain the tested contaminants at levels of concern. However, as a precaution, if abrasive blasting was to be carried out near to the bungee pod then it is recommended that surface testing be carried out to confirm if dust has entered, or the pod be cleaned following blasting to remove any residue that may have entered during the blasting works.

The following recommendations are made:

- Review work site exclusion zone and other H&S controls for compliance if Worksafe NZ WES for hexavalent chromium is amended, and consider the need for additional personnel monitoring.
- The smoko huts should be decontaminated if they are to be put back into use, and it should be made clear to all staff that they should not be used at this time.
- Good hygiene practices should be reinforced – anyone who has been on the bridge must thoroughly wash their hands once they have exited. Consider putting up signage as a reminder.
- Personal hygiene procedures should be re-communicated regularly to personnel working on the bridge to ensure that dermal / ingestion of dust is kept to a minimum.
- Undertake surface dust testing in the bungy pod following abrasive blasting in the area and/or arrange for the pod to be cleaned following completion of the works as a precaution.

6 References

AHBA (June 2016). *Historic Coatings Pilot Study*.

AHBA (October 2018). Historic Coatings Characterisation Study.

Air Matters (April 2013). *Monitoring of particulate and metals from abrasive blasting and total volatile organic compounds and isocyanates from painting during maintenance*.

AS/NZS 4361.1:2017, *Guide to Hazardous Paint Management Part 1: Lead and Other Hazardous Metallic Pigments in Industrial Applications*.

Paragon Health & Safety Consultants, 2009. *Occupational Hygiene Assessment, Exposure to Hexavalent Chromium.*

WorkSafe NZ, 2018. Workplace Exposure Standard Review – Chromium (VI) Compounds (CAS: No:7440-47-3). Retrieved from: https://worksafe.govt.nz/dmsdocument/3498-workplace-exposure-standard-wes-review-chromium-vi

Appendices

Appendix A: Paint Sampling Lab Report

SPECTRACHEM ANALYTICAL

CRL Energy Ltd

X-RAY FLUORESCENCE ANALYTICAL REPORT

CLIENT : **OPUS INTERNATIONAL CONSULTANTS LTD**

ADDRESS : PO BOX 5848, AUCKLAND 1141

EMAIL : s9(2)(a) [redacted]

PHONE : s9(2)(a) [redacted]

ATTENTION : LIZ COOMBES ***JOB REFERENCE :*** **SA20585**

CLIENT REFERENCE : not supplied

SAMPLE TYPE[S] : **6** X PAINT FLAKES

DATE OF SAMPLE RECEIPT : 19-09-18 ***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.

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Date : 21-09-18 ***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

SPECTRACHEM ANALYTICAL

CRL Energy Ltd

CLIENT : **OPUS INTERNATIONAL CONSULTANTS LTD**

PROJECT : **SA20585**

SAMPLE : / ELEMENT		Span 5 EP4	Span 5 ED2-3	Span 5 WD2-3	Span 5 ED3-4	Span 5 WP4	Span 5 WD3-4
		9208.1	9208.2	9208.3	9208.4	9208.5	9208.6
		1	2	3	4	5	6
Fluorine	F	nd	nd	nd	nd	nd	nd
Sodium	Na	(ND)	(ND)	(ND)	(ND)	(ND)	(ND)
Magnesium	Mg	3.13	2.89	3.22	2.90	2.50	2.68
Aluminium	Al	6.27	6.89	7.46	6.17	7.46	6.65
Silicon	Si	9.29	6.59	7.89	7.66	7.33	7.06
Phosphorus	P	0.020	0.025	0.027	0.020	0.029	0.025
Sulphur	S	0.590	0.393	0.515	0.547	0.606	0.533
Chlorine	Cl	0.068	0.149	0.144	0.097	0.079	0.085
Potassium	K	1.02	0.978	0.886	1.01	0.796	1.01
Calcium	Ca	1.50	0.892	1.46	1.36	1.82	1.55
Scandium	Sc	nd	nd	nd	nd	nd	nd
Titanium	Ti	4.18	3.35	3.32	3.74	3.12	3.71
Vanadium	V	0.006	0.004	0.004	0.011	0.010	0.013
Chromium	Cr	**0.722**	**1.37**	**0.966**	**1.10**	**0.725**	**1.28**
Manganese	Mn	0.037	0.035	0.035	0.036	0.045	0.044
Iron	Fe	28.6	23.2	24.8	29.6	32.1	30.1
Cobalt	Co	0.037	0.035	0.038	0.040	0.041	0.043
Nickel	Ni	nd	nd	nd	nd	nd	nd
Copper	Cu	0.006	0.009	0.008	nd	0.007	0.007
Zinc	Zn	7.28	18.8	13.2	9.74	6.71	9.23
Gallium	Ga	nd	0.007	0.006	nd	nd	nd
Germanium	Ge	nd	nd	nd	nd	nd	nd
Arsenic	As	nd	nd	nd	nd	nd	nd
Selenium	Se	nd	nd	nd	nd	nd	nd
Bromine	Br	nd	nd	nd	nd	nd	nd
Rubidium	Rb	nd	nd	nd	nd	nd	nd
Strontium	Sr	0.003	nd	0.004	0.004	0.003	0.006
Yttrium	Y	nd	nd	nd	nd	nd	nd
Zirconium	Zr	0.020	0.011	0.015	0.019	0.022	0.017
Niobium	Nb	nd	nd	nd	0.004	0.005	0.004
Molybdenum	Mo	nd	nd	nd	nd	nd	nd
Cadmium	Cd	nd	nd	nd	nd	nd	nd
Tin	Sn	nd	nd	nd	nd	nd	nd
Antimony	Sb	nd	nd	nd	nd	nd	nd
Barium	Ba	0.028	0.093	0.164	0.098	0.176	0.204
Lead	Pb	**0.058**	**0.172**	**0.050**	**0.071**	**0.068**	**0.100**
Bismuth	Bi	nd	nd	nd	nd	nd	nd
Thorium	Th	nd	nd	nd	nd	nd	nd
Uranium	U	nd	nd	nd	nd	nd	nd
	Total	**62.9**	**65.8**	**64.1**	**64.2**	**63.6**	**64.3**

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 B: Air Sampling Investigation Report

AUCKLAND HARBOUR BRIDGE ALLIANCE

DRY ABRASIVE BLASTING EMISSIONS

AIR MATTERS REPORT 18185

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

Test Date: 16/10/2018

Report Date: 13/11/2018

Amended Report: 18/01/2019

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Report prepared for Auckland Harbour Bridge Alliance by Air Matters Limited

Report written by:

Carol McSweeney
Principal

Air Matters Report: 18185
Date: 13/11/2018
Status: FINAL
Amended 18/01/2019: Additional information in Table 1 footnotes on Chromium VI standards and measurements

Report Checked by:

Robert Murray
Environmental Scientist

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1 OBJECTIVES

1.1 METALS

1. To measure concentrations of lead, hexavalent chromium, non-hexavalent chromium and zinc in the environment close to dry abrasive blasting of diagonal struts containing historic paint with high chrome content.

1.2 REPORTING

1. Report all findings.
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 the metal content of the dust 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 and 2016 when dry abrasive blasting took place. Results were compared with environmental guidelines (Air Matters Report 13001 and 16026). 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 (October 2018) 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. On this day of sampling, blasting was taking place in an area of the bridge where the historic coating had been identified as having a high hexavalent chromium (Chromium VI) content. This was on diagonals on the eastern side of Span 5.

On the day of sampling, dry abrasive blasting (DAB) took place at Span 5 on two diagonals either side of Post 5.3. The DAB carried out on the day of sampling was spot blasting of rusty surfaces the length of the diagonal including inside the structure where needed.

The pot was loaded from the upper platform and the two abrasive operators dropped into the work position on the diagonals. The complete length of each diagonal was blasted. There was restricted access from the blasting area to the pot filling area. Eighteen 15kg bags of garnet were used for the blasting on the day of testing. Spot blasting took place over 4 hours.

Figure 1: Location of works on the Auckland Harbour Bridge during DAB at Span 5.

Fig 1.1 and 1.2 Abrasive Blaster operators spot blasting on diagonals on each side of post 5.3 on eastern side of bridge

3 METHODOLOGY

Inhalable metals

Sampling was carried out in accordance with AS/NZS 3640-2009 for particulates. The environmental samples were set up at the locations below. Sampling was carried out for 4 hours 15 minutes. The filters, along with the control blank filter, were subsequently analysed for lead, chromium (non-hexavalent) and zinc by Hill Laboratories using ICP Mass Spectrometry in accordance with NIOSH Method 7300. Separate samples were collected for chromium VI (hexavalent chromium) using PVC filters as per NIOSH Method 7600 and analysed by Hill Laboratories by colorimetric analysis based on the NIOSH 7600 Method for Chromium VI.

Samples were collected from:

- Within area of the works (post 5.2 east side of bridge)
- Downwind (post 5.3 east side of bridge) -works on diagonals around 5.3
- Downwind (post5.4 east side of bridge)
- Downwind (post 5.5 east side of bridge)
- Downwind (post 5.6 east side of bridge)
- Downwind (post 5.3 west side of bridge)
-

Limitations of the Method

- The main method limitation is based on the constraints around sampling locations. The samples should be set up downwind of the work with an upwind sample used for comparison. However, on the day of sampling the wind was blowing from the south west which was slightly across and along the bridge. The plume from the DAB was observed and was not directly along the length of the bridge where the downwind samples were set up.

- Variation arises based on the location of the blasting works. Work moved down the diagonal across the day and the plume moved with the work. However, the plume is generally wide close to the works with velocity provided to the particles in the plume from the blasting gun.
- Results were across one day of work only. Data can be reviewed in conjunction with similar work carried out in 2016 and 2013.
- Sampling took place over a 4 hour period. The Chromium VI standard is based on a 24 hour period.

4 Results

Table 1 below provides a summary of the results.

All raw data is available on request. Hill Laboratory Report is presented in Appendix 1.

Table 1: Concentrations of inhalable metals at various locations during dry abrasive blasting work

Sample type	Sampling Location	General Wind Direction & Speed m/s	Measured Concentration Lead µg/m³	Measured Concentration Total Chromium * µg/m³	Measured Concentration Chromium VI µg/m³	Measured Concentration Zinc µg/m³
Environmental Samples	Within area of the works (post 5.2 east side of bridge)	2 - 4m/SW	Filter destroyed by blasting garnet	Filter destroyed by blasting garnet d	***1.57 (over 4 hours)	Filter destroyed by blasting garnet
	Downwind (post 5.3 east side of bridge) works on diagonals around 5.3		0.01	0.04	0.45	3.75
	Downwind (post 5.4 east side of bridge)		Filter destroyed by blasting garnet	Filter destroyed by blasting garnet	0.31	Filter destroyed by blasting garnet
	Downwind (post 5.5 east side of bridge)		<0.01	0.06	<0.1	4.13
	Downwind (post 5.6 east side of bridge)		0.01	0.08	0.15	4.78
	"Upwind" (post 5.3 west side of bridge)		<0.01	0.05	0.33	0.94
Environmental Standard µg/m³			**Ontario half hour average 1.5 Ontario 24 hour average 0.5**	**TCEQ 1 hour average 3.6**	**TCEQ **24 hour average 1.3**	**TCEQ 1 hour average 20**

** Total chromium concentrations are less than the hexavalent chromium concentrations. This is mainly due to the uncertainly of the total chromium analysis when the value is close to the level of detection for the analytical method. The presence of iron and other particulate matter in these samples adds to the uncertainty at these low levels. There is more sensitivity around the chromium VI method.*

*** Toxicology studies for Chromium VI for short term exposures (1hr averaging period) are very limited. The research is based on a 24 hour averaging period. The TCEQ has adopted a conservative 24-hour reference value. The same value has been used in previous reports.*

**** The measured concentration of 1.57µg/m³ for Chromium VI is the average measured across a 4 hour period. For comparison against the 24 hour standard, the time weighted average across a 24 hour period would be 0.22µg/m³, which is below the standard*

5 CONCLUSIONS

These results give another data set for evaluating the offsite environmental effects of metal contamination from abrasive blasting. Two of the metal samples were effected by abrasive blasting garnet puncturing the filters. However, the remaining samples provide good information of the metal levels downwind of the works.

These results indicate that the levels of all metals were below the environmental guideline values for the work on this day. Hexavalent chromium concentrations are above the 24 hour average environmental value at source while DAB was taking place. However this is misleading as dry abrasive blasting only ever occurs for a maximum of 4-5 hours (the area needs to be recoated immediately). With 5 hours of DAB and no other source of hexavalent chromium entering the surrounding air, the concentration across a 24 hour period would be 0.28µg/m^3 which is below the environmental guideline for hexavalent chromium (1.3µg/m^3.) The concentration also drops away quickly from the source of the blasting. 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 and zinc in particular). The zinc concentrations were considerably lower than the previous round of testing (maximum measured at 43µg/m^3). This indicates some of the variability in the method used for testing which is subject to wind speed and direction on the day as well the actual movement of the operators in relation to the location of the samplers. The buffer zones calculated for the consent may appear conservative with this round of testing, but the variability indicates that the more conservative approach is appropriate.

Table 2 below summarises the environmental sampling and its implications.

No personal monitoring was carried out in this round of testing. It should be noted at in December 2018, the workplace exposure standard for hexavalent chromium (Chromium VI) was reduced from 0.05mg/m^3 to 0.01mg/m^3. (50µg/m^3 to 10µg/m^3). Personal exposure monitoring for the "pot boy" was carried out in 2016 and low levels of hexavalent chromium were measured. (2µg/m^3). This area was not identified as an area high in chromium. Consideration should be given to measuring personal exposure to workers during abrasive blasting especially if this is carried out in areas known to be high in chromium.

Table 2: Monitoring summary and outcomes based on consented activities and products used for AHB maintenance

Maintenance Activity	**Key Contaminant**	**Compliance**	**Implication**
Abrasive Blasting	Chromium	Concentrations of hexavalent chromium measured in the area of the DAB were elevated, however, 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.
	Lead	Lead concentrations at all locations were below the Ontario Environmental 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 were all below the Effects Screening Level.	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 16026, 28/6/2016. Auckland Harbour Bridge Alliance
2. Air Matters Report 13001, 16/4/2013. Auckland Harbour Bridge Alliance
3. Air Matters Report 14502, 18/9/2014. Assessment of discharges to Air from the Auckland Harbour Bridge. Maintenance.
4. TCEQ, Toxicology Division, Development Support Document, Final, August 4, 2014, Hexavalent Chromium (Particulate Compounds). Prepared by Joseph T. Haney, Jr., M.S. Neeraja K. Erraguntla, Ph.D.,

APPENDIX 1: LABORATORY ANALYSIS SHEETS AND DATA CALCULATIONS

Date	16/Oct/18
Industry:	Auckland Harbour Bridge
Project Number:	
Contaminant:	Metals
Task:	Abrasive Blasting

Sample number		Contaminant	Time		Sampling Details			Sample mass (µg)	Blank	Blank corrected (µg)	Contaminant Concentration (µg/m³)
			On	Off	Minutes on	Flow rate (L/min)	Volume (m³)				
18185	M2	Total chromium	9:13	13:35	261	2.556	0.667	0.18	0.15	0.03	0.04
18185	M2	Lead	9:13	13:35	261	2.556	0.667	0.01	0.005	0.005	0.01
18185	M2	Zinc	9:13	13:35	261	2.556	0.667	2.6	0.1	2.5	3.75

Sample number		Contaminant	Time		Sampling Details			Sample mass (µg)	Blank	Blank corrected (µg)	Contaminant Concentration (µg/m³)
			On	Off	Minutes on	Flow rate (L/min)	Volume (m³)				
18185	M4	Total chromium	9:11	13:28	257	2.542	0.653	0.19	0.15	0.04	0.06
18185	M4	Lead	9:11	13:28	257	2.542	0.653	0.008	0.005	0.003	0.00
18185	M4	Zinc	9:11	13:28	257	2.542	0.653	2.8	0.1	2.7	4.13

Sample number		Contaminant	Time		Sampling Details			Sample mass (µg)	Blank	Blank corrected (µg)	Contaminant Concentration (µg/m³)
			On	Off	Minutes on	Flow rate (L/min)	Volume (m³)				
18185	M5	Total chromium	9:10	13:25	254	2.555	0.649	0.2	0.15	0.05	0.08
18185	M5	Lead	9:10	13:25	254	2.555	0.649	0.01	0.005	0.005	0.01
18185	M5	Zinc	9:10	13:25	254	2.555	0.649	3.2	0.1	3.1	4.78

Sample number		Contaminant	Time		Sampling Details			Sample mass (µg)	Blank	Blank corrected (µg)	Contaminant Concentration (µg/m³)
			On	Off	Minutes on	Flow rate (L/min)	Volume (m³)				
18185	M6	Total chromium	9:43	13:47	243	2.503	0.608	0.18	0.15	0.03	0.05
18185	M6	Lead	9:43	13:47	243	2.503	0.608	0.005	0.005	0	0.00
18185	M6	Zinc	9:43	13:47	243	2.503	0.608	0.67	0.1	0.57	0.94

Sample number		Contaminant	Time		Sampling Details			Sample mass (µg)	Blank	Blank corrected (µg)	Contaminant Concentration (µg/m³)
			On	Off	Minutes on	Flow rate (L/min)	Volume (m³)				
18185	C1	Chromium VI	9:14	13:31	263	2.427	0.638	1.1	0.1	1	1.57
18185	C2	Chromium VI	9:13	13:35	261	2.553	0.666	0.4	0.1	0.3	0.45
18185	C3	Chromium VI	9:12	13:33	258	2.477	0.639	0.3	0.1	0.2	0.31
18185	C4	Chromium VI	9:11	13:28	255	2.526	0.644	0.1	0.1	0	0.00
18185	C5	Chromium VI	9:10	13:25	255	2.577	0.657	0.2	0.1	0.1	0.15
18185	C6	Chromium VI	9:43	13:47	242	2.533	0.613	0.3	0.1	0.2	0.33
18185	C7	Chromium VI						0.1		0.1	blank

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Certificate of Analysis

Client:	Air Matters Limited	**Lab No:**	2067107	SPv1
Contact:	Shymala Sidharth	**Date Received:**	18-Oct-2018	
	C/- Air Matters Limited	**Date Reported:**	30-Oct-2018	
	PO Box 96256	**Quote No:**		
	Balmoral	**Order No:**		
	Auckland 1342	**Client Reference:**		
		Submitted By:	Shymala Sidharth	

Sample Type: Miscellaneous filter type less than 50 mm diameter

	Sample Name:	18185 - M2	18185 - M4	18185 - M5	18185 - M6	18185 - M7
	Lab Number:	2067107.8	2067107.9	2067107.10	2067107.11	2067107.12
Chromium	µg/sample	0.18	0.19	0.20	0.18	0.15
Lead	µg/sample	0.010	0.008	0.010	< 0.005	< 0.005
Zinc	µg/sample	2.6	2.8	3.2	0.67	0.10

Sample Type: PVC filter <50 mm diameter

	Sample Name:	18185 - C1	18185 - C2	18185 - C3	18185 - C4	18185 - C5
	Lab Number:	2067107.1	2067107.2	2067107.3	2067107.4	2067107.5
Chromium (hexavalent) insoluble	µg/sample	1.1	0.4	0.3	0.1	0.2

	Sample Name:	18185 - C6	18185 - C7			
	Lab Number:	2067107.6	2067107.7			
Chromium (hexavalent) insoluble	µg/sample	0.3	0.4	-	-	-

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.
Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

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	8-12
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	8-12
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	8-12

Sample Type: PVC filter <50 mm diameter

Test	Method Description	Default Detection Limit	Sample No
Chromium (hexavalent) insoluble	Hot carbonate extraction under N2, colorimetric analysis based on NIOSH 7600.	0.1 µg/sample	1-7

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 certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental

Appendix C: Dust Sampling Investigation Report

AUCKLAND HARBOUR BRIDGE ALLIANCE

SURFACE DUST SWAB SAMPLING REPORT

AUCKLAND HARBOUR BRIDGE

DECEMBER 2018

wsp | OPUS

Question today
Imagine tomorrow
Create for the future

Surface Dust Swab Sampling Report
Auckland Harbour Bridge

Auckland Harbour Bridge Alliance

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A	06/12/2018	Final

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Approved by:	Nathan Redfern, COH	06/12/2018	

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EXECUTIVE SUMMARY

Opus International Consultants Limited, trading as WSP Opus and herein referred to as such was commissioned by the Auckland Harbour Bridge Alliance (AHBA) to conduct surface dust sampling to determine the presence of metals within pre-determined areas of the Auckland Harbour Bridge (AHB) (the Site).

AHBA's objectives are to understand the loadings of three metals (Lead, Total Chromium and Hexavalent Chromium) contained within surface dust at two smoko huts along the main service corridor and the A.J. Hackett bungy pod. The loadings are to be compared against adopted acceptance limits.

WSP Opus attended site on 6 November, 2018 to conduct swab sampling from surfaces to determine the presence of Lead, Total Chromium and Hexavalent Chromium. Swab samples were to be collected from areas pre-determined by AHBA. In total 4 sample locations were sampled, with all locations being sampled and analysed for all four metals. The laboratory conducted analysis on a total of 8 samples; 4 samples for Hexavalent Chromium and 4 for Total Lead and Total Chromium.

Results from the swab sampling are addressed in section 4 of this report. Below is a table summarising results above the adopted acceptance criteria (outlined in section 4) for each compound:

COMPOUND	ACCEPTANCE LIMIT	NORTHERN SMOKO HUT	SOUTHERN SMOKO HUT	PP1-11 CENTRAL WALKWAY
Lead	**80 µg/100cm2**	**100 µg/100cm^2**	**310 µg/100cm^2**	**140 µg/100cm^2**

Due to the potential health hazard of the sampled compounds good hygiene practices should be reinforced to ensure that dust concentrations are kept to a minimum on surfaces in work and break areas. A reduction in dust concentrations on surfaces will in turn decrease the risk of exposure via ingestion or inhalation.

Subsequently consideration should be given to decontaminating the smoko huts as these areas exceed the adopted acceptance criteria. These are areas where workers stop work and consume food, increasing the risk of ingestion of contaminants. Personal hygiene procedures should be re-communicated regularly to personnel working on the bridge to ensure that dermal / ingestion of dust is kept to a minimum. Washing facilities on the bridge should be maintained and monitored and should be cleaned regularly.

The dust in the bungy pod did not contain the tested contaminants at levels of concern. However, as a precaution, if abrasive blasting was to be carried out near to the bungee pod then it is recommended that surface testing be carried out to confirm if dust has entered, or the pod be cleaned following blasting to remove any residue that may have entered during the blasting works.

1 INTRODUCTION

Opus International Consultants Limited, trading as WSP Opus and herein referred to as such was commissioned by the Auckland Harbour Bridge Alliance (AHBA) to conduct surface dust sampling to determine the presence of metals within pre-determined areas of the Auckland Harbour Bridge (AHB) (the Site).

1.1 BACKGROUND INFORMATION

WSP Opus understands that previous dust sampling was undertaken in 2009 by Paragon Health and Safety Consultants which found that levels of hexavalent chromate in dust in the bungy pod were below the relevant workplace exposure. The smoko huts haven't been tested previously. Because of the time since testing, additional dust sampling was proposed to determine whether further personnel H&S controls would be needed for contaminants in dust.

1.2 SCOPE OF WORKS

WSP Opus attended site on 6 November, 2018 to conduct swab sampling from surfaces to determine the presence of Lead, Total Chromium and Hexavalent Chromium. Swab samples were to be collected from areas pre-determined by AHBA based on their increased occupancy. In total 4 sample locations were sampled, with all locations being sampled and analysed for all four metals. Below is a summary of the analysis conducted by a NATA accredited laboratory:

— 4 samples were analysed for Hexavalent Chromium.

— 4 samples were analysed for Lead and Total Chromium.

2 OCCUPATIONAL HEALTH IMPACTS

2.1 CHROMIUM

The primary states of Chromium are Trivalent Chromium and Hexavalent Chromium. Trivalent Chromium (Cr^{3+}) is considered an essential nutrient to the human body, promoting the action of insulin and is widely found in nature. Hexavalent Chromium (Cr^{6+}) is predominately industrially made and is listed by the International Agency for Research on Cancer (IARC) as a Group 1 carcinogen and is therefore classified as carcinogenic to humans. Exposure to Hexavalent Chromium can also impact the nose, throat, lung and respiratory tract, causing irritations when breathed at high levels, and irritation and damage to eyes and the skin if high concentrations of particles encounter these organs. With contact with skin, common health effects including irritation, ulcers, skin sensitisation, and allergic contact dermatitis.

2.2 LEAD

Inorganic Lead has been listed by the International Agency for Research on Cancer (IARC) as a Group 2A carcinogen and is therefore classified as being probably carcinogenic to humans. Occupational exposure to Lead occurs via inhalation of Lead-containing dust and fume and ingestion from contact with Lead-contaminated surfaces. Symptoms of Lead poisoning include weakness, excessive tiredness, irritability, constipation, anorexia, abdominal discomfort (colic), fine tremors, and "wrist drop”. Overexposure to Lead may also result in damage to the kidneys, anaemia, high blood pressure, impotence, and infertility in both genders.

3 METHODOLOGY

3.1 METAL SWAB SAMPLING

Swab samples were collected in accordance with NIOSH Manual of Analytical Methods 2102 (Elements on Wipes). A total of 4 swab samples were taken from 4 sampling locations on 6 November 2018. Sampling locations are shown in Appendix A. The swab procedure is outlined below:

- A clean pair of disposable gloves were worn for each sample.
- A clean a 10cm x 10cm template was taped to the sample surface.
- A fresh Lead dust wipe (ghost wipe) was used and pressed firmly down in the top corner of the sample template. The wipe was moved from side to side in an 'S' like motion until the entire sample area was wiped.
- The dirty wipe was folded (dirty side in) and place in a clean sealed bag with a sample number on the outside.
- This process was repeated at each sample location.
- The samples were analysed by Envirolab Services (ES) in Sydney, Australia; a laboratory that holds accreditation for sample analysis by the National Association of Testing Authorities (NATA).
- One sample blank was analysed by the laboratory during their internal QA/QC procedure.

3.2 HEXAVALENT CHROMIUM SWAB SAMPLING

Swab samples were collected in accordance with Occupational Safety and Health Administration (OSHA) a part of the United States Department of Labour. A total of 4 swab samples were taken from 4 sampling locations on 6 November 2018. Sampling locations are shown in Appendix A. The sample method was OSHA W4001 and the procedure used is outlined below:

- A clean pair of disposable gloves were worn for each sample.
- A clean a 10cm x 10cm template was taped to the sample surface.
- A fresh 37-mm binderless quartz fibre filter was used and wiped across the area from side to side in an 'S' like motion until the entire sample area was wiped.
- This process was repeated at each sample location.
- The samples were analysed by Envirolab Services (ES) in Sydney, Australia; a laboratory that holds accreditation for sample analysis by the National Association of Testing Authorities (NATA).
- One sample blank was analysed by the laboratory during their internal QA/QC procedure.

4 RESULTS

4.1 ADOPTED ACCEPTANCE CRITERIA

4.1.1 *LEAD*

The acceptance limit for surface dust loading has been adopted from the Australian Standard AS 4361.2-1998 Guide to lead paint management; Part 2: Residential and commercial buildings. Note this standard was superseded in 2017 and set limits are no longer provided as they have moved to a risked based approach, however for the purpose of this report it has been determined that the most appropriate acceptance limit for 'Exterior window sills' is used as an equivalent to this working environment.

The acceptance limits are presented in the table below:

Table 4.1 Acceptance limit for surface dust Lead loadings

LOCATION	ACCEPTANCE LIMIT
	µg/100cm^2
Floors – residential	10
Floors – workplace clean areas	20
Interior window sills	50
Exterior window sills	**80**

4.1.2 *HEXAVLENT CHROMIUM AND TOTAL CHROMIUM*

The acceptance limit for Hexavalent Chromium surface dust loading is adopted from the Contaminants of Potential Concern (COPC) Committee of the World Trade Centre Indoor Air Task Force Working Group, and U.S Army Public Health Command Technical Guide 312, which is adopted within the Australian Defence Force. The acceptance limit for work zones (non-office areas) is presented in the table below:

Table 4.2 Acceptance limit for Hexavalent Chromium

METAL	ACCEPTANCE LIMIT
	Work Zones (µg/100cm^2)
Hexavalent Chromium	47

There are no acceptance limits in place for Total Chromium. Chromium (III) is an essential nutrient for the human body and occurs naturally in the environment.

4.2 FINDINGS

The results of the swab sampling program are summarised in this section of the report and the full set of results are tabulated and presented in Appendix B and the NATA accredited laboratory report provided in Appendix C.

4.2.1 LEAD

Swab sampling results for Lead in dust indicated that there were 3 results above the adopted acceptance criteria presented in section 4.1 of this report. The exceedances are identified in table 4.3 below:

Table 4.3 Summary of Lead in dust exceedances

LOCATIONS	RESULTS
Northern smoko hut	100 µg/100cm^2
Southern smoko hut	310 µg/100cm^2
Point 1-11 – Central walkway	140 µg/100cm^2

4.2.2 HEXAVELENT CHROMIUM AND TOTAL CHROMIUM

All results for Hexavalent Chromium in dust were below the laboratories level of reporting (LOR) of <1 µg/100cm^2.

Total Chromium was detected within all samples, suggesting that any surface Hexavalent Chromium that may have been present has oxidised.

5 RECOMMENDATIONS

Exceedances have been observed for Lead as outlined in Section 4. Due to the potential health hazard of this compound good hygiene practices should be reinforced to ensure that dust concentrations are kept to a minimum on surfaces in work and break areas. A reduction in dust concentrations on surfaces will in turn decrease the risk of exposure via ingestion or inhalation.

Subsequently consideration should be given to decontaminating the smoko huts as these areas exceed the adopted acceptance criteria. These are areas where workers stop work and consume food, increasing the risk of ingestion of contaminants. Personal hygiene procedures should be re-communicated regularly to personnel working on the bridge to ensure that dermal / ingestion of dust is kept to a minimum. Washing facilities on the bridge should be maintained and monitored and should be cleaned regularly.

The dust in the bungy pod did not contain the tested contaminants at levels of concern. However, as a precaution, if abrasive blasting was to be carried out near to the bungee pod then it is recommended that surface testing be carried out to confirm if dust has entered, or the pod be cleaned following blasting to remove any residue that may have entered during the blasting works.

6 LIMITATIONS

This Report is provided by Opus International Consultants Limited (trading as WSP Opus and further referred to as such) for the Auckland Harbour Bridge Alliance (Client) in response to specific instructions from the Client and in accordance with WSP Opus's proposal dated 27 April 2018 and agreement with the Client dated 18 June 2018 (Agreement).

PERMITTED PURPOSE

This Report is provided by WSP Opus for the purpose described in the Agreement and no responsibility is accepted by WSP Opus for the use of the Report in whole or in part, for any other purpose (Permitted Purpose).

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APPENDIX A

PHOTOGRAPHS OF SAMPLING LOCATIONS

A1 PHOTOGRAPHS OF SAMPLING LOCATIONS

Southern smoko hut

Bungy pod

Northern smoko hut

Point 1-11 Central walkway

APPENDIX B

RESULT TABLE

		Sampling Location			
Contaminant	Acceptance Level (µg/100cm2)	Bungy Pod (µg/100cm2)	Northern Smoko Hut (µg/100cm2)	Southern Smoko Hut (µg/100cm2)	Point 1-11 Central Walkway (µg/100cm2)
Lead	80	4	100	310	140
Total Chromium		17	89	240	150
Hexavalent Chromium	47	<1	<1	<1	<1

APPENDIX C

LABORATORY ANALYSIS REPORT

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ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 205439

Client Details

Client	WSP Opus
Attention	Nick Pothecary
Address	Level 3, 100 Beaumont St, Westhaven

Sample Details

Your Reference	**Auckland Harbour Bridge**
Number of Samples	4 filter, 4 swab
Date samples received	13/11/2018
Date completed instructions received	13/11/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	19/11/2018
Date of Issue	19/11/2018

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Results Approved By
Giovanni Agosti, Group Technical Manager
Priya Samarawickrama, Senior Chemist

Authorised By

Jacinta Hurst, Laboratory Manager

Metals in swabs					
Our Reference		205439-2	205439-4	205439-6	205439-8
Your Reference	UNITS	WSP-AHB002	WSP-AHB004	WSP-AHB006	WSP-AHB008
Type of sample		swab	swab	swab	swab
Date prepared	-	14/11/2018	14/11/2018	14/11/2018	14/11/2018
Date analysed	-	14/11/2018	14/11/2018	14/11/2018	14/11/2018
Chromium	µg/swab	89	17	240	150
Lead	µg/swab	100	4	310	140

Misc Soil - Inorg					
Our Reference		205439-1	205439-3	205439-5	205439-7
Your Reference	UNITS	WSP-AHB001	WSP-AHB003	WSP-AHB005	WSP-AHB007
Type of sample		filter	filter	filter	filter
Date prepared	-	16/11/2018	16/11/2018	16/11/2018	16/11/2018
Date analysed	-	16/11/2018	16/11/2018	16/11/2018	16/11/2018
Hexavalent Cr in swab	μg/swab	<1	<1	<1	<1

Method ID	Methodology Summary
Inorg-024	Hexavalent Chromium (Cr6+) - determined colourimetrically.
Metals-005	Digestion of Dust wipes/swabs and /or miscellaneous samples for Metals determination by ICP-AES/MS and/or CV-AAS

QUALITY CONTROL: Metals in swabs					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-2	[NT]
Date prepared	-			14/11/2018	[NT]	[NT]	[NT]	[NT]	14/11/2018	[NT]
Date analysed	-			14/11/2018	[NT]	[NT]	[NT]	[NT]	14/11/2018	[NT]
Chromium	µg/swab	0.5	Metals-005	<0.5	[NT]	[NT]	[NT]	[NT]	103	[NT]
Lead	µg/swab	1	Metals-005	<1	[NT]	[NT]	[NT]	[NT]	104	[NT]

QUALITY CONTROL: Misc Soil - Inorg					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-2	[NT]
Date prepared	-			16/11/2018	[NT]	[NT]	[NT]	[NT]	16/11/2018	[NT]
Date analysed	-			16/11/2018	[NT]	[NT]	[NT]	[NT]	16/11/2018	[NT]
Hexavalent Cr in swab	μg/swab	1	Inorg-024	<1	[NT]	[NT]	[NT]	[NT]	97	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

ABOUT US

WSP is one of the world's leading engineering professional services consulting firms. We are dedicated to our local communities and propelled by international brainpower. We are technical experts and strategic advisors including engineers, technicians, scientists, planners, surveyors, environmental specialists, as well as other design, program and construction management professionals. We design lasting Property & Buildings, Transportation & Infrastructure, Resources (including Mining and Industry), Water, Power and Environmental solutions, as well as provide project delivery and strategic consulting services. With 36,000 talented people in more than 500 offices across 40 countries, we engineer projects that will help societies grow for lifetimes to come.