Ardill Payne & PARTNERS

ENGINEERS PLANNERS SURVEYORS ENVIRONMENTAL PROJECT MANAGEMENT

PRELIMINARY CONTAMINATED SITE INVESTIGATION

Submission to Ballina Shire Council

Lots 1 & 2 DP 620838
9 Byron Bay Road, Lennox Head

for:
Ballina Shire Council

December 2018

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0	Original Issue
1	
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1. Executive Summary

Ardill Payne and Partners has been engaged by Ballina Shire Council to undertake a Stage 1 Preliminary Contaminated Site Investigation for Lots 1 and 2 DP 620838, No. 9 Byron Bay Rd, Lennox Head, to determine if the site is suitable for the proposed change in land zoning with or without remediation.

The Department of Planning by letter dated 16th October 2017 issued a conditional Gateway Determination in respect of Planning Proposal PP_2017_BALLI_007_00 with Condition 1 requiring:

"1. Council is to obtain and have regard to a report specifying the findings of a preliminary investigation of the land carried out in accordance with the contaminated land planning guidelines, prior to the plan being made."

Council by letter dated 20th October 2017 advised of the Gateway Determination and required the provision of certain reports/documentation including:

- *Land Contamination Assessment prepared in accordance with the requirements of SEPP 55 and Council's Management of Contaminated Land Policy. The assessment is to demonstrate that the site is suitable for the proposed change in zoning with or without remediation. Consideration should be had to past land uses and the existing dwelling house, Telstra exchange, and other structures on the site which may have resulted in the contamination of the land.*

This investigation has been undertaken as required above to support and inform the progress and public exhibition of the Planning Proposal.

A desk-top site history review was undertaken of the site and surrounding properties to determine the historical land uses and to ascertain whether potentially contaminating activities had occurred historically. The desktop study was compiled using maps, aerial photography and on-line resources. Site specific sampling was also undertaken.

2. Objective & Scope of Works

The objective of this report is to determine if the subject site has been contaminated by prior or current land uses and subsequently if it is suitable for a proposed rezoning to residential and change to the minimum lot size/subdivision standard under the BLEP 2012.

Section 7(1) of the NSW State Environment Planning Policy No. 55 – Remediation of Land states that:

"A consent authority must not consent to the carrying out of any development on land unless:

a) *it has considered whether the land is contaminated; and*

b) *if the land is contaminated, it is satisfied that the land is suitable in its contaminated state (or will be suitable, after remediation) for the purpose for which the development is proposed to be carried out; and*

c) *if the land requires remediation to be made suitable for the purpose for which the development is proposed to be carried out, it is satisfied that the land will be remediated before the land is used for that purpose."*

This contaminated site investigation is a Stage 1 – Preliminary Investigation, in accordance with the *Managing Land Contamination Planning Guidelines* (DUAP & EPA, 1998).

The purpose of this investigation is to:

- identify all past and present potentially contaminating activities
- identify potential contamination types
- discuss the site conditions
- provide a preliminary assessment of site contamination
- assess the need for further investigations

This report has been written in accordance with the NSW EPA (2000, reprinted 2011) *Guidelines for Consultants Reporting on Contaminated Sites.*

3. Proposed Development & Site Identification

The investigation is to confirm that Lots 1 & 2 DP 620838 are suitable for the proposed rezoning of the land from RU1 – Primary Production Zone with a 40ha minimum lot size/subdivision standard to R2 – Low Density Residential Zone with a 600m^2 minimum lot size/subdivision standard.

Table 1 describes the details and characteristics of the site and a site locality plan is provided overleaf as Figure 1.

Table 1 – Subject Lot Identification Details

Site Address	9 Byron Bay Rd, Lennox Head
Site Area	Approx. 1.2ha
Title	Lots 1 and 2 DP 620838
Local Government Area	Ballina Shire Council
Zoning (BLEP 2012)	RU1 – Primary Production Zone
Site Features	The site is predominated by cleared 'yard' area. A dwelling house and associated shed and garage are located centrally on the site with a Telstra exchange located in the eastern corner of the site. A densely vegetated buffer exists between the dwelling and the exchange.
Elevation	~20m – 30m AHD
Site Location Co-ordinates	Latitude: -28.801371 Longitude: 153.591707
Existing Land Use	Residential and Telstra exchange
Surrounding Environment	The site is bounded by rural residential type properties to the north and south and residential properties to the east and west.

Figure 1: Site Locality (Google Earth 2018)

4. Site Condition and Surrounding Environment

4.1. Geology & Hydrogeology

The soils of the subject site are mapped by Morand 1994 as 'Bangalow (bg)' soil landscape grouping, viz:

- Bangalow (bg)
  - Landscape – low rolling hills on basalt. Relief 40-100m, elevation 100-150m. Slopes are 15-25%. Extensively cleared closed-forest, now closed sod grassland.
  - Soils – moderately deep to deep (100->200cm), well-drained Krasnozems and brownish red Krasnozems (Uf5.21, Uf5.22, GN3.11, Gn4.11). Deep (>200cm), poorly drained alluvial Krasnozems in drainage lines.

5. Site History

A desktop site history review was undertaken to determine the chronological history of site uses and any possible sources and locations of contamination.

5.1. Land Use Investigation Methods

Prior land uses have been determined from:

- On-line records search:
  - NSW Primary Industries Science and Research: Cattle dip site locator
  - NSW Office of Environment and Heritage Contaminated Land: POEO Public Register
  - NSW Office of Environment and Heritage Contaminated Land: Record of Notices
- Reviewing historical aerial photographs
- Reviewing Torrens Title History

5.2. Online Records Search Outcomes

5.2.1. Cattle Dip Sites

There are two dip sites recorded for 'Lennox Head'. All dip sites were located greater than 500m for the closest lot boundary.

5.2.2. POEO Register

The suburb of 'Lennox Head' returned fifteen results. None of the results were for the subject site or any sites within a notable proximity.

5.2.3. Contaminated Land Register

A search of the NSW Office of Environment & Heritage Contaminated Land Records was undertaken for all notice types, which include:

- Declaration of Significant Contaminated Land
- Approved Voluntary Management Proposal
- Management Order
- On-going Maintenance Order
- Repeal, Revocation and Variation Notice
- Site Audit Statement

One of the abovementioned notice types was listed for the suburb of 'Lennox Head', being the Spoors Dip at 13 Figtree Hill Drive, located approximately 3km to the north-west.

5.3. Aerial Photographs

Table 2 presents a summary of the review of historical aerial photographs relating to the site. Copies of aerial photographs are presented below, with the approximate cadastral features of the site being shown for reference on appropriate aerials.

Table 2 – Summary of Aerial Photograph Observations

Year	Description
1980	Cleared land with dwelling house in the lower central portion of the site. Unidentifiable objects in the north-western portion of the site.
1989	Telstra exchange evident in eastern corner of the site. Unidentifiable objects no longer evident.

1994	Construction of Byron Bay Road commenced along the northern boundary. Residential development progressing to east and west.
2006	Developed vegetation around the dwelling house. Shed and garage addition to dwelling house evident.
2018	Residential development progressing to the west.

Figure 2: Historical Aerial of Subject Site and Indicative Site Boundaries (1980)

Figure 3: Historical Aerial of Subject Site and Indicative Site Boundaries (1989)

Figure 4: Historical Aerial of Subject Site and Indicative Site Boundaries (1994)

Figure 5: Historical Aerial of Subject Site and Indicative Site Boundaries (2006)

Figure 6: Historical Aerial of Subject Site and Indicative Site Boundaries (2018)

5.4. Discussion of Site History

Below are the concluded findings of the site history search:

- No dip sites in the vicinity of the subject site.
- The POEO search returned no sites of concern.
- The Contaminated Land Register returned no results for the subject site or surrounds.
- The aerial photographs of the subject site and surrounds show possible contaminating activities in the form of possible agricultural activities (cattle grazing or dairying) due to the nature and extent of the cleared land prior to 1980 as well as the structures located on site (dwelling, sheds and the Telstra exchange).

6. Areas of Environmental Concern

A number of potential contaminants could be located on the site as a result of the agricultural activities that may have been undertaken on the site (due to the extent of cleared land and common undertaking in the region) and the dwelling, associated structures and the Telstra exchange. The potential contaminants of concern are discussed below.

6.1. Potential Contaminants of Concern

6.1.1. Heavy Metals

Due to the findings of the site history investigation, the site has the potential to be affected by heavy metal contamination. Heavy metals include lead and arsenic as a result of pesticides and herbicides used commonly in the 1940's to 1980's.

6.1.2. Pesticides

The site also has the potential to be affected by organochlorine and organophosphate pesticides.

6.1.3. Asbestos

Due to the age of the dwelling house, it is possible that asbestos is located on site.

7. Preliminary Sampling and Analysis Plan

7.1. Field Investigations

At the time of the inspection, the site had healthy vegetative cover and there were no visible signs of contamination.

7.2. Sampling Rationale

An indicative sampling map is included in Attachment 1.

7.2.1. Soils

A soil sampling regime has been employed to determine the presence of potential COCs in the proposed vicinity of the more sensitive structures, being:

- a systematic soil sampling pattern[1] was employed – samples taken at surface (0-150mm)
- 25 preliminary screening soil samples were taken and sent to the NATA accredited Environmental Analysis Laboratory at Southern Cross University, Lismore
- 25 preliminary screening soil samples were composited into 7 composite samples by the laboratory
- the sample results will enable an assessment of background contamination to be reported in the vicinity of any future structure and an assessment of whether further, more specific testing is required

The pattern of sampling was in accordance with the 'Environmental Protection Authority NSW: *Contaminated Sites – Sampling Design Guidelines*' to provide a detailed analysis of the soil condition in the area of concern.

7.2.2. Asbestos

Fibrous cement chips were identified when collecting a soil sample near the dwelling. One sample of possible asbestos containing material was taken and sent to the NATA accredited Australian Safer Environment & Technology Laboratory in Sydney.

[1] Section 2.3 Contaminated Sites – Sampling Design Guidelines (EPA, NSW) 1995

7.3. Sampling Methodology

Sampling was carried out with a hand auger. Equipment was cleaned with potable water and phosphate free detergent (Decon 90), with demineralised water being used for a final rinse before each sample was taken. Samples were placed in new zip-lock bags and were stored and transported on ice (where required) to their respective laboratories for analysis. Chain of Custody documentation is appended.

7.4. Quality Assurance and Quality Control

7.4.1. Field QA/QC

Samples were collected in the field by suitably qualified and experienced staff members. Cross-contamination was prevented by thoroughly washing the auger with phosphate free detergent and wearing fresh gloves between collecting each sample.

Due to the nature of this investigation and the relatively small number of samples, duplicates, splits and blanks were not collected during sampling. Field sampling procedures are discussed below.

Samples were stored in an esky with ice bricks and then taken to the EAL once sampling had been completed. Chain of Custody (COC) documents were recorded for each sample and are included in Attachment 2. COC indicates the sample number, storage method and analytical requirements.

7.4.2. Laboratory QA/QC

The Environmental Analysis Laboratory (EAL) at Southern Cross University and the Australian Safer Environment & Technology Laboratory in Sydney are both NATA accredited laboratories. Details of analytical methods are described in the laboratory certificates included in Attachment 3.

Due to the preliminary nature of this investigation and the relatively small number of samples analysed (<20), inter- and intra-laboratory duplicate testing was not conducted.

8. Investigation Levels

8.1. Soil Health Based Investigation Levels

Adopted Investigation Levels are in accordance with the *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No.1)*, dated 11 April 2013.

The NEPM states that *"Investigation levels and screening levels are the concentrations of a contaminant above which further appropriate investigation and evaluation will be required."*

An exceedance of an investigation level does not indicate that there is a definite risk to human health, but rather that further site specific assessment may be required to quantify the potential risks to human health.

Health Investigation Levels (HILs) were considered for the site. HIL – Residential (HIL-A) was used for the site as this reflected the proposed future use.

8.1.1. Investigation Levels Summary

Table 1A(1) Health investigation levels for soil contaminants

Chemical	Health-based investigation levels (mg/kg)			
	Residential[1] A	Residential[1] B	Recreational[1] C	Commercial/ industrial[1] D
Metals and Inorganics				
Arsenic[2]	100	500	300	3 000
Beryllium	60	90	90	500
Boron	4500	40 000	20 000	300 000
Cadmium	20	150	90	900
Chromium (VI)	100	500	300	3600
Cobalt	100	600	300	4000
Copper	6000	30 000	17 000	240 000
Lead[3]	300	1200	600	1 500
Manganese	3800	14 000	19 000	60 000
Mercury (inorganic)[5]	40	120	80	730
Methyl mercury[4]	10	30	13	180
Nickel	400	1200	1200	6 000
Selenium	200	1400	700	10 000
Zinc	7400	60 000	30 000	400 000
Cyanide (free)	250	300	240	1 500
Polycyclic Aromatic Hydrocarbons (PAHs)				
Carcinogenic PAHs (as BaP TEQ)[6]	3	4	3	40
Total PAHs[7]	300	400	300	4000
Phenols				
Phenol	3000	45 000	40 000	240 000
Pentachlorophenol	100	130	120	660
Cresols	400	4 700	4 000	25 000
Organochlorine Pesticides				
DDT+DDE+DDD	240	600	400	3600
Aldrin and dieldrin	6	10	10	45
Chlordane	50	90	70	530
Endosulfan	270	400	340	2000
Endrin	10	20	20	100
Heptachlor	6	10	10	50
HCB	10	15	10	80
Methoxychlor	300	500	400	2500
Mirex	10	20	20	100
Toxaphene	20	30	30	160
Herbicides				
2,4,5-T	600	900	800	5000
2,4-D	900	1600	1300	9000
MCPA	600	900	800	5000

Chemical	Health-based investigation levels (mg/kg)			
	Residential[1] A	Residential[1] B	Recreational[1] C	Commercial/ industrial[1] D
MCPB	600	900	800	5000
Mecoprop	600	900	800	5000
Picloram	4500	6600	5700	35000
Other Pesticides				
Atrazine	320	470	400	2500
Chlorpyrifos	160	340	250	2000
Bifenthrin	600	840	730	4500
Other Organics				
PCBs[8]	1	1	1	7
PBDE Flame Retardants (Br1–Br9)	1	2	2	10

Notes:

(1) Generic land uses are described in detail in Schedule B7 Section 3

HIL A – Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools.

HIL B – Residential with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments.

HIL C – Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. This does not include undeveloped public open space where the potential for exposure is lower and where a site-specific assessment may be more appropriate.

HIL D – Commercial/industrial, includes premises such as shops, offices, factories and industrial sites.

(2) Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability may be important and should be considered where appropriate (refer Schedule B7).

(3) Lead: HIL is based on blood lead models (IEUBK for HILs A, B and C and adult lead model for HIL D where 50% oral bioavailability has been considered. Site-specific bioavailability may be important and should be considered where appropriate.

(4) Methyl mercury: assessment of methyl mercury should only occur where there is evidence of its potential source. It may be associated with inorganic mercury and anaerobic microorganism activity in aquatic environments. In addition the reliability and quality of sampling/analysis should be considered.

(5) Elemental mercury: HIL does not address elemental mercury. A site-specific assessment should be considered if elemental mercury is present, or suspected to be present,

(6) Carcinogenic PAHs: HIL is based on the 8 carcinogenic PAHs and their TEFs (potency relative to B(a)P) adopted by CCME 2008 (refer Schedule B7). The B(a)P TEQ is calculated by multiplying the concentration of each carcinogenic PAH in the sample by its B(a)P TEF, given below, and summing these products.

PAH species	TEF	PAH species	TEF
Benzo(a)anthracene	0.1	Benzo(g,h,i)perylene	0.01
Benzo(a)pyrene	1	Chrysene	0.01
Benzo(b+j)fluoranthene	0.1	Dibenz(a,h)anthracene	1
Benzo(k)fluoranthene	0.1	Indeno(1,2,3-c,d)pyrene	0.1

Where the B(a)P occurs in bitumen fragments it is relatively immobile and does not represent a significant health risk.

(7) Total PAHs: HIL is based on the sum of the 16 PAHs most commonly reported for contaminated sites (WHO 1998). The application of the total PAH HIL should consider the presence of carcinogenic PAHs and naphthalene (the most volatile PAH). Carcinogenic PAHs reported in the total PAHs should meet the B(a)P TEQ HIL. Naphthalene reported in the total PAHs should meet the relevant HSL.

(8) PCBs: HIL relates to non-dioxin-like PCBs only. Where a PCB source is known, or suspected, to be present at a site, a site-specific assessment of exposure to all PCBs (including dioxin-like PCBs) should be undertaken.

Table 1A(2) Interim soil vapour health investigation levels for volatile organic chlorinated compounds

Chemical	Interim soil vapour HIL (mg/m^3)			
	Residential[1] A	Residential[1] B	Recreational[1] C	Commercial / Industrial[1] D
TCE	0.02	0.02	0.4	0.08
1,1,1-TCA	60	60	1200	230
PCE	2	2	40	8
cis-1,2-dichloroethene	0.08	0.08	2	0.3
Vinyl chloride	0.03	0.03	0.5	0.1

Notes:

1. Land use settings are equivalent to those described in Table 1A(1) Footnote 1 and Schedule B7, though secondary school buildings should be assessed using residential 'A/B' for vapour intrusion purposes.
2. Interim HILs for VOCCs are conservative soil vapour concentrations that can be adopted for the purpose of screening sites where further investigation is required on a site-specific basis. They are based on the potential for vapour intrusion using an indoor air-to-soil vapour attenuation factor of 0.1 and an outdoor air-to-soil vapour attenuation factor of 0.05.
3. Application of the interim HILs is based on a measurement of shallow (to 1 m depth) soil vapour (or deeper where the values are to be applied to a future building with a basement) or sub-slab soil vapour.
4. The applicability of the interim HILs needs to be further considered when used for other building types such as homes with a crawl-space and no slab, which may require site-specific assessment.
5. Use of the interim HILs requires comparison with data that has been collected using appropriate methods and meets appropriate data quality requirements.
6. Oral and dermal exposure should be considered on a site-specific basis where direct contact exposure is likely to occur.

Figure 7: National Environment Protection Amendment Measure 2013 – Schedule B1 HILs

8.1.2. Assumptions and Limitations of Criteria

The selected criteria have been sourced from guidelines which are currently endorsed by the NSW EPA. The investigation levels contained in these documents have been established through toxicity tests and field and laboratory experiments. In some cases, insufficient data exists to provide thresholds. In these cases, the data is simply used as an indicator of the presence and extent of contamination.

The adopted composite HIL thresholds are assumed to be a fraction of the single sample threshold to account for the possibility that a high concentration in one sample may be diluted by a low concentration in another sample within the composite. This is considered standard practice when using composite sampling.

9. Results

9.1. Soils

Composite samples analysed by the laboratory generally had concentrations of the tested metals less than the adopted composite health investigation level (HIL-A), the most stringent health investigation level. Chromium and manganese were above the composite HIL-A in all composites, cobalt was above the composite HIL-A in five of the seven composites and lead was above the composite HIL-A in three of the seven composites. No organochlorine or organophosphate pesticides were present above the limit of detection.

The *Contaminated Land Management Act 1997* clearly identifies contamination as 'above the concentration at which the substance is normally present in, on or under land in the same locality' confirming that the elevated naturally occurring Mn and Cr concentrations in North Coast soils is not identified as 'contamination' and hence does not warrant further investigation or remediation.

Furthermore, *Assessment of Total Soil Manganese and Chromium in Basaltic Soils of the North Coast, NSW* (Lancaster, 2006) (included in Attachment 3) states that:

> *"All Mn and Cr analysis results in North Coast soils need to be disregarded unless an identifiable source of Mn or Cr soil contamination has been identified."*

Anthropological activities associated with chromium contamination include leather, textile, and steel manufacturing. As none of the abovementioned industries were located on or near the site, there is no identifiable source of the contamination. Elevated chromium and manganese are present around the Northern Rivers and are attributed to the heavy volcanic activity in the area approximately 23 million years ago.

Table 3 below shows the elevated cobalt results of the soil analysis.

Table 3 – Elevated Cobalt Results

Sample	Cobalt (mg/kg)	Composite HIL-A	Individual HIL-A
C1 (S1, S2, S11)	39	33.3	100
C2 (S3, S4, S9, S10)	38	25	
C4 (S12, S13, S18, S19)	48	25	
C5 (S14, S15, S16, S17)	32	25	
C6 (S20, S21, S22)	48	33.3	

Sources of environmental cobalt are both natural and anthropogenic. Natural sources include erosion, weathering of rocks and soil, seawater spray, volcanoes, forest fires, extraction by plants and continental and marine biogenic emissions (Kim et. al., 2006). The major anthropogenic sources of environmental cobalt include mining and processing (smelting) of cobalt-bearing ores, the use of cobalt-containing sludge or phosphate fertilizers on soil, the disposal of cobalt-containing waste, and atmospheric deposition from activities such as burning of fossil fuels and smelting and refining of metals.

The only anthropogenic source of elevated cobalt that is likely to have occurred on site is the use of phosphate fertilisers on soil. However, no organophosphate concentration was identified above the detection limit. No other anthropogenic sources of contamination were located on or near the site and therefore it is considered that the source of cobalt is naturally occurring. The most likely cause for the elevated levels is the heavy volcanic activity in the area approximately 23 million years ago, which also causes elevated levels of chromium and manganese. No further investigation into the elevated cobalt is proposed.

The composite samples with elevated lead concentrations (C2, C4 and C5) were analysed individually. Individual samples S10, S13 and S14 exceed the individual HIL-A for lead (300 mg/kg), having concentrations of 620 mg/kg, 3674 mg/kg and 2430 mg/kg respectively. Results of the individual analysis are summarised below with exceedances indicated in red.

Table 4 – Preliminary Individual Soil Sample Results

Composite	Sample	Lead (mg/kg)	HIL-A
C1	S3	43	300
	S4	27	
	S9	230	
	S10	**620**	
C4	S12	46	
	S13	**3674**	
	S14	**2430**	
	S15	78	
C5	S16	23	
	S17	17	
	S18	24	
	S19	21	

The source of lead at this site is likely due to lead-based paints historically used on the residence and/or other painted objects that were stored on the site. Natural background levels of lead are between 2-200 mg/kg (ANZECC 1992).

The contamination levels are above the 'Residential –A' HIL with a maximum concentration of 3674 mg/kg reported.

Laboratory results are included in Attachment 2.

9.2. Asbestos

The fibrous cement sheeting analysed by Australian Safer Environment & Technology Laboratory in Sydney identified chrysotile asbestos within the sample provided.

Laboratory results are included in Attachment 2.

10. Conclusion & Recommendations

Ardill Payne & Partners (APP) has undertaken a Preliminary Contaminated Site Investigation to determine if the subject lots are suitable for a proposed rezoning to a residential zone and have not been contaminated from current or prior land uses.

The desk-top site history review found a number of potentially contaminating activities on the site resulting from possible agricultural pursuits on the land and surrounds, the Telstra exchange structure and the dwelling house and associated structures. Sampling focused on a systematic screening approach with twenty-five individual soil samples being collected to form seven composite samples to be analysed by EAL Lismore. Chromium and manganese were above the adopted composite HIL-A for all composite samples and cobalt was elevated in five of the seven composite samples, however, these results were determined to be as a result of naturally occurring, elevated background levels as a result of the heavy volcanic activity that occurred in the area approximately 23 million years ago. Elevated lead was identified in three of the seven composites (C2, C4 and C5) and when analysed individually, three of the twelve individual samples (S10, S13 and S14), were above the individual HIL-A with a maximum concentration of 3674 mg/kg.

During the site investigation, a small fragment of fibrous cement sheeting was located and sent for analysis at the Australian Safer Environment & Technology Laboratory in Sydney where it was identified to contain chrysotile asbestos.

The results of this investigation determine that a *Stage 2: Detailed Contaminated Site Investigation* is to be undertaken with focus on the areas covered by samples S10, S13 and S14. The findings of the *Stage 2* investigation will determine what remediation and subsequent validation processes are to be implemented.

11. References

Kim, JH, Gibb, HJ, Howe, PD 2006, *Concise International Chemical Assessment Document 69: Cobalt and Inorganic Cobalt Compounds*, WHO, Geneva, Switzerland

Lancaster, G 2006, *Assessment of Total Soil Manganese and Chromium in Basaltic Soils of the North Coast, NSW*, EAL, Lismore, New South Wales

12. General Notes

General

Geotechnical and environmental reports present the results of investigations carried out for a specific project and usually for a specific phase of the project (e.g. preliminary design). The report is based specific criteria, such as the nature of the project, underground utilities or scope of service limitations imposed by the Client. The report may not be relevant for other phases of the project (e.g. construction), after some time or where project details and clients change.

Soil and Rock Description

Soil and rock descriptions are based on AS1726-1993 using visual and tactile assessment except at discrete locations where field and/or laboratory tests have been carried out. Refer to the terms and symbols sheet for definitions.

Groundwater

The water levels indicated are taken at the time of measurement and depending on material permeability may not reflect the actual groundwater level at those specified locations. Also groundwater levels can vary with time due to seasonal or tidal fluctuation, construction activities and other external factors.

Interpretation of Results

The discussion and recommendations in the accompanying report are based on extrapolation/interpolation from data obtained at discrete locations and other external sources and guidelines. The actual interface between the materials may be far more gradual or abrupt than indicated. Also actual conditions in areas not sampled may differ from those predicted.

The report is based on significant background details that only the authors can be aware off, and therefore implementation of the recommendations by others may lead to misinterpretation and complications. Therefore this company should be consulted to explain the reports implications to other involved parties.

Reporting relies on interpretation of often limited factual information based on judgement and opinion which has a level of uncertainty and ambiguity attached to it, and is far less exact than other design disciplines. This should be considered by users of the report when assessing the implications of the recommendations.

Change in Conditions

Subsurface conditions can change with time and can vary between test locations. Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations can also affect subsurface conditions.

13. Scope of Engagement

This report has been prepared by Ardill Payne & Partners (APP) at the request of Ballina Shire Council for the purpose of a Preliminary Contaminated Site Investigation and is not to be used for any other purpose or by any other person or corporation.

This report has been prepared from the information provided to us and from other information obtained as a result of enquiries made by us. APP accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this document for a purpose other than that described above.

APP declares that it does not have, nor expects to have, a beneficial interest in the subject project.

To avoid this advice being used inappropriately it is recommended that you consult with APP before conveying the information to another who may not fully understand the objectives of the report. This report is meant only for the subject site/project and should not be applied to any other.

14. Attachments

Attachment 1	Site Sampling Map
Attachment 2	Laboratory Results
Attachment 3	*Assessment of Total Soil Manganese and Chromium in Basaltic Soils of the North Coast, NSW* (Lancaster, 2006)

ATTACHMENT 1

Attachment 1: Site Sampling Map

Issue	Date	Description	App'd
A	31/10/2018	Original Issue	APP

Client: Mark Condon

Project: Proposed Re-Zoning
9 Byron Bay Road, Lennox Head
Lot 2 DP 620838

Title: SEPP55 Systematic Sampling Map

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Design	RMCG	Scale	1:400 @ A1, 1:800 @ A3
Drawn	RMCG		0 4 8 12 16 20
Checked	PS	Datum	NA
Approved	APP	Drafting File	8116 2018 SEPP55.dwg
Date	31/10/2018	Design File	
Job No.	8116	Dwg No.	FIG.1
		Issue	A

ATTACHMENT 2

Attachment 2: Laboratory Results

EAL Environmental Analysis Laboratory

PO Box 157 (Military Road)
LISMORE NSW 2480
T: 02 6620 3678 E: eal@scu.edu.au W: www.scu.edu.au

Submitting Client Details

Quote Id:
Job Ref: 8116
Company: APP
Contact: ROWENA MCLEARY
Phone:
Mobile:
Email: rowenam@ardillpayne.com.au
Postal address:

Billing Client Details

☐ Tick if same as submitting details
ABN:
Company: APP
Contact: GAYLE EVTUSHENKO
Phone:
Mobile:
Email: gaylee@ardillpayne.com.au
Postal address:

Payment Method:

☐ Purchase Order
☐ Cheque
☐ Credit/Debit Card (EAL staff will phone for details)
☒ Invoice (prior approval)

Relinquished: R. McCleary Date: 6/11/18
Received: Date: 7.11.18

Preservation: none - freezer bricks - ice - acidified - filtered - other
Condition on receipt: ambient - cool - frozen - other

Comments: Please composite:
C1: S1, S2, S11
C2: S3, S4, S9, S10
C3: S5, S6, S7, S8
C4: S12, S13, S18, S19
C5: S14, S15, S16, S17
C6: S20, S21, S22
C7: S23, S24, S25
Thank you

Likelihood and nature of Hazardous material: minimal.

Lab ID	Sample ID	Sample Depth	Sampling Date	Sampler	Your Client	Crop ID	Sample Type (e.g. water, leaf, soil)	Total number of samples: 25 / 7 for analysis	Sample Analysis Request: Price list code (e.g. SW-PACK-06) SS-PACK-008					
	C1	0-150	5/11/18	RMcL	8116	—	SOIL		X					
	↓	↓	↓	↓	↓		↓		X					
	↓	↓	↓	↓	↓		↓		X					
	C7	↓	↓	↓	↓		↓		X					

EAL Project Reference: H5615 - 25 soil → 7 comp.

RESULTS OF SOIL ANALYSIS

25 soil samples supplied by Ardill Payne & Partners on 7th November, 2018 - Lab Job No. H5615

Soil samples supplied were composited by EAL into 7 composite samples for analysis

Analysis requested by Rowena McGeary, Your Job: 8116

PO Box 20 BALLINA NSW 2478

ANALYTE	METHOD REFERENCE	Composite Sample 1 C1 (S1, S2, S11)	Composite Sample 2 C2 (S3, S4, S9, S10)	Composite Sample 3 C3 (S5, S6, S7, S8)	Composite Sample 4 C4 (S12, S13, S18, S19)	Composite Sample 5 C5 (S14, S15, S16, S17)	Composite Sample 6 C6 (S20, S21, S22)	Composite Sample 7 C7 (S23, S24, S25)	RESIDENTIAL A Guideline Limit Composite -Column A	RESIDENTIAL A Guideline Limit Individual -Column A	COMMERCIAL/ INDUSTRIAL D Guideline Limit Composite -Column D	COMMERCIAL/ INDUSTRIAL D Guideline Limit Individual -Column D	Background Range
	Job No.	H5615/C1	H5615/C2	H5615/C3	H5615/C4	H5615/C5	H5615/C6	H5615/C7	See note 1a	See note 1a	See note 1d	See note 1d	See note 2
TEXTURE (SAND, CLAY, SILT)	** inhouse	Silt	Silt	Silt	Silt	Silt	Silt	Silt	..	..	..	..	..
MOISTURE %	** c	24	24	28	24	21	28	22	..	..	..	..	..
SILVER (mg/kg DW)	a	<1	<1	<1	<1	<1	<1	<1	na	na	na	na	na
ARSENIC (mg/kg DW)	a	2	4	3	2	4	2	1	25	100	750	3,000	0.2-30
LEAD (mg/kg DW)	a	67	199	28	877	681	20	65	75	300	375	1,500	<2-200
CADMIUM (mg/kg DW)	a	<0.5	1	<0.5	<0.5	<0.5	<0.5	<0.5	5	20	225	900	0.04-2.0
CHROMIUM (mg/kg DW)	a	92	110	79	82	100	101	76	(<25)	(<100)	(<900)	(<3,600)	0.5-110
COPPER (mg/kg DW)	a	34	50	24	47	34	27	25	1,500	6,000	60,000	240,000	1-190
MANGANESE (mg/kg DW)	a	2286	2138	2554	3272	3114	4025	2051	950	3,800	15,000	60,000	4 - 12,600
NICKEL (mg/kg DW)	a	25	30	25	31	28	33	27	100	400	1,500	6,000	2-400
SELENIUM (mg/kg DW)	a	1	2	2	1	1	1	1	50	200	2,500	10,000	na
ZINC (mg/kg DW)	a	154	715	169	185	382	163	79	1,850	7,400	100,000	400,000	2-180
MERCURY (mg/kg DW)	a	0.25	0.23	0.16	0.22	0.34	0.13	0.05	10	40	183	730	0.001-0.1
IRON (% DW)	a	9.57	11.98	10.11	8.79	10.74	11.10	8.43	na	na	na	na	na
ALUMINIUM (% DW)	a	3.02	3.25	4.04	3.50	4.02	4.50	3.33	na	na	na	na	na
BERYLLIUM (mg/kg DW)	a	1	1	1	1	1	1	1	15	60	125	500	na
BORON (mg/kg DW)	a	6	5	8	7	7	5	6	1,125	4,500	75,000	300,000	na
COBALT (mg/kg DW)	a	39	38	21	48	32	48	32	25	100	1,000	4,000	na
PESTICIDE ANALYSIS SCREEN													
DDT+DDE+DDD (mg/kg)	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	60	240	900	3,600	<0.1
Aldrin + Dieldrin (mg/kg)	c	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	2	6	11	45	<0.1
Chlordane (mg/kg)	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	13	50	133	530	<0.1
Endosulfan (mg/kg)	c	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	68	270	500	2,000	<0.1
Endrin (mg/kg)	c	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	3	10	25	100	<0.1
Heptachlor (mg/kg)	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2	6	13	50	<0.1
HCB (mg/kg)	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	3	10	20	80	<0.1
Methoxychlor (mg/kg)	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	75	300	625	2,500	<0.1
Other Organochlorine Pesticides (mg/kg)	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	..	..	..	..	<0.1

METHODS REFERENCE

a. [1,2] Nitric/HCl digest - APHA 3125 ICPMS

b. [1,2] Nitric/HCl digest - APHA 3120 ICPOES

c. Analysis sub-contracted - SGS report no. SE 185938

** denotes these test procedure or calculation are as yet not NATA accredited but quality control data is available

NOTES

1a. HIL A ⁑ Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools.

1b. HIL B ⁑ Residential with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments.

1c. HIL C ⁑ Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. This does not include undeveloped public open space.

1d. HIL D ⁑ Commercial/industrial, includes premises such as shops, offices, factories and industrial sites.

(REFERENCE: Health Investigation Guidelines from NEPM (National Environmental Protection, Assessment of Site Contamination, Measure), 2013; Schedule B1).

2. Environmental Soil Quality Guidelines, Page 40, ANZECC, 1992.

3. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal or on request).

Additional NOTES

DW = Dry Weight, na = no guidelines available

Organochlorine pesticide (OC's) screen: (HCB, alpha-BHC, Heptachlor, delta-BHC, Aldrin, Heptachlor Epoxide, gamma-Chlordane, alpha-chlordane, Lindane, trans-Nonachlor, Endrin Ketone, Isodrin, Mirex Alpha Endosulfan, p,p'-DDE, Dieldrin, Endrin, p,p'-DDD, Beta Endosulfan, p,p'-DDT, Endrin Aldehyde, Endosulfan Sulphate, Methoxychlor)

checked:.....

RESULTS OF SOIL ANALYSIS

25 soil samples supplied by Ardill Payne & Partners on 7th November, 2018 - Lab Job No. H5615

12 individual samples requested for further testing by Ardill Payne & Partners on 20th November, 2018 - Lab Job No. H6053
Analysis requested by Rowena McGeary. **Your Project: 8116**
PO Box 20 BALLINA NSW 2478

SAMPLE ID	*Job No.*	LEAD (mg/kg)
	Method	1:3 Nitric/HCl digest - APHA 3125 ICPMS
S3	*H6053/1*	43
S4	*H6053/2*	27
S9	*H6053/3*	230
S10	*H6053/4*	620
S12	*H6053/5*	46
S13	*H6053/6*	3674
S14	*H6053/7*	2430
S15	*H6053/8*	78
S16	*H6053/9*	23
S17	*H6053/10*	17
S18	*H6053/11*	24
S19	*H6053/12*	21

Notes:

1. ppm = mg/Kg dried sample
2. All results as dry weight DW - samples were dried at 40oC for 24-48hrs prior to crushing and analysis.
3. Methods from Rayment and Lyons, Soil Chemical Methods - Australasia
4. Metals analysed by ICP-MS (Inductively Coupled Plasma - Mass Spectrometry)
5. Analysis conducted between sample arrival date and reporting date.
6. ** NATA accreditation does not cover the performance of this service.
7. .. Denotes not requested.
8. This report is not to be reproduced except in full.
9. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal or on request).

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked:.....
Graham Lancaster

Ardill Payne Partners

45 River Street
PO Box 20
BALLINA NSW 2478
(02) 6686 3280

TO: Australian Safer Environment Technology
Suite 710, 90 George Street
HORNSBY NSW 2077

Chain of Custody

ASET69215/72395/1-1

Engineer: Rowena McGeary Site: BYRON RD, LENNOX HEAD.
Email: rowenam@ardillpayne.com.au
Job No.: 8116
Ph: (02) 6686 3280 Date: 5/11/18

Lab Sample No.	Sample ID	Sampling Date	Your Client	Sample Type	Sample Analysis Request: ASBESTOS IDENTIFICATION						
1	S26	5/11/18	8116	FC SHEET	X						

RECEIVED
09 NOV 2018
BY:

Requested by: R.McG. Time: 13:30 Date: 5/11/18 Received by: Kishani ASET Time: Date: 09/11/18

\\fp01\redirected-folders\rowenam\Desktop\ENVIRON\ASBESTOS\Asbestos Chain of Custody.xlsx

AUSTRALIAN SAFER ENVIRONMENT & TECHNOLOGY PTY LTD

ABN 36 088 095 112

Our ref : ASET69215/ 72395/ 1 - 1
Your ref : 8116 – Byron Road, Lennox Head
NATA Accreditation No: 14484

9 November 2018

Ardill Payne Partners
79 Tamar Street
Ballina NSW 2478

Attn: Ms Rowena McGeary

Dear Rowena

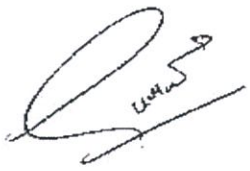
Asbestos Identification
This report presents the results of one sample, forwarded by Ardill Payne Partners on 9 November 2018, for analysis for asbestos.

1.Introduction: One sample forwarded was examined and analysed for the presence of asbestos.

2. Methods : The sample was examined under a Stereo Microscope and selected fibres were analysed by Polarized Light Microscopy in conjunction with Dispersion Staining method**(Australian Standard AS 4964 - 2004 and Safer Environment Method 1 as the supplementary work instruction) (Qualitative Analysis only).**

3. Results : **Sample No. 1. ASET69215 / 72395 / 1. 8116 - S26.**
Approx dimensions 1.25 cm x 1.0 cm x 0.45 cm
The sample consisted of a fragment of a fibre cement material.
Chrysotile asbestos detected.

Analysed and reported by,



Mahen De Silva. BSc, MSc, Grad Dip (Occ Hyg)
Occupational Hygienist / Approved Identifier.
Approved Signatory

NATA
WORLD RECOGNISED
ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

The results contained in this report relate only to the sample/s submitted for testing. Australian Safer Environment & Technology accepts no responsibility for whether or not the submitted sample/s is/are representative. Results indicating "No asbestos detected" indicates a reporting limit specified in AS4964 -2004 which is 0.1g/ Kg (0.01%). Any amounts detected at assumed lower level than that would be reported, however those assumed lower levels may be treated as "No asbestos detected" as specified and recommended by A4964-2004. Trace / respirable level asbestos will be reported only when detected and trace analysis have been performed on each sample as required by AS4964-2004. When loose asbestos fibres/ fibre bundles are detected and reported that means they are larger handpicked fibres/ fibre bundles, and they do not represent respirable fibres. Dust/soil samples are always subjected to trace analysis except where the amounts involved are extremely minute and trace analysis is not possible to be carried out. When trace analysis is not performed on dust samples it will be indicated in the report that trace analysis has not been carried out due to the volume of the sample being extremely minute.

Ardill Payne & PARTNERS

ATTACHMENT 3

Attachment 3: *Assessment of Total Soil Manganese and Chromium in Basaltic Soils of the North Coast, NSW* (Lancaster, 2006)

ASSESSMENT OF TOTAL SOIL MANGANESE AND CHROMIUM IN BASALTIC SOILS OF THE NORTH COAST, NSW

An assessment of Manganese and Chromium possible soil contamination as required for State Environmental Planning Policy 55

PREPARED BY: GRAHAM LANCASTER
SOUTHERN CROSS UNIVERSITY A.B.N. 41 995 651 524
SCHOOL OF ENVIRONMENTAL SCIENCE AND MANAGEMENT
ENVIRONMENTAL ANALYSIS LABORATORY

Military Road, East Lismore, NSW, 2480
Ph: 02 6620 3678
Fax: 02 6620 3957
Email: glancast@scu.edu.au

FOR: NEWTON DENNY CHAPELLE
REPORT NO.: **Contamination Reports**
DATE: July, 2006

EXECUTIVE SUMMARY

The objective of the investigation is to assess typical and average soil total manganese (Mn) and chromium (Cr) concentrations in North Coast soils, NSW (ie. Grafton to the south, Kyogle to the west, Mullumbimby to the North and Ballina to the east). These soils are typically of a basaltic origin and these volcanic soils are shown to be naturally elevated in some metals.

The assessment of Mn and Cr assessment in North Coast soils has been conducted on a random 200 composite soil samples, which is equivalent to 800 individual soils. This number of soils is considered representative of North Coast soils and for the assessment of average metal concentrations.

The results of the soil analysis were compared with Column 1 of the NSW EPA (1998) '*Contaminated Sites – Guidelines for the NSW Site Auditor Scheme'*. Column 1 presented Human - Based Investigation Levels (HBIL) for developments being 'residential with gardens and accessible soil'. The guidelines are also typically modified by dividing them by the number of samples that make up the composite sample (ie. typically the guideline divided by four).

The average Mn in the 800 soils is 1800ppm Mn with a standard deviation of 1162ppm. These levels are 'naturally' well above the guideline level of 1500ppm or 375ppm Mn for composite samples (ie. 92% of the 200 composite soils analysed exceed the 375ppm guideline).

The average Cr in the 800 soils is 56ppm Cr with a standard deviation of 32ppm. These levels are 'naturally' well above the composite guideline level of 25ppm Cr (ie. 91% of the 200 composite soils analysed exceed the 25ppm guideline).

The background levels of metals analysed, obtained from ANZECC and NHMRC (1992) Table 3 "Environmental Soil Quality Guidelines" page 40, state that background levels of Mn range from 4 – 12,600ppm and total Cr from 0.5 – 110ppm. This large range for background Mn and Cr in soils further confirms the results obtained for naturally elevated Mn and Cr in North Coast soils.

All Mn and Cr analysis results in North Coast soils need to be disregarded unless an identifiable source of Mn or Cr soil contamination has been identified. The Contaminated Land Management Act 1997 clearly identifies contamination as 'above the concentration at which the substance is normally present in, on or under land in the same locality' and hence confirming that the elevated naturally occurring Mn and Cr concentrations in North Coast soils is not identified as 'contamination' and hence does not warrant further investigation or remediation.

1.0 INTRODUCTION

The Environmental Analysis Laboratory has been commissioned by Newton Denny Chapelle to undertake a investigation for Contaminated Lands in regard to soil total Mn and Cr concentrations.

The objective of the investigation is to assess typical and average soil total Mn and Cr concentrations in North Coast soils, NSW (ie. Grafton to the south, Kyogle to the west, Mullumbimby to the North and Ballina to the east). These soils are typically of a basaltic origin and these volcanic soils are shown to be naturally elevated in some metals.

The purpose of this report is to determine if north coast soils are contaminated from current or past land usage or have 'naturally' occurring Cr and Mn. To determine if a site has been contaminated, soil samples have been collected and analysed for a range of contaminants. A large number of soil composite samples from random sites were collated for this assessment. If contaminated, the results of the analysis are required to be higher than that of the relevant EPA acceptable levels. Most of the contamination reports involve residential and hence the soil analysis results are compared with the NSW EPA (1998) Columns 1 of the Table "Soil Investigation Levels for Urban Redevelopment Sites in NSW" page 30 and ANZECC and National Health and Medical Research Council (1992) Table 2 "Environmental Soil Quality Guidelines" page 40.

This investigation is Stage 1 of the *Managing Land Contamination Planning Guidelines* (DUAP and EPA, 1998). If contamination levels exceed the EPA acceptable levels, a detailed investigation is then required in accordance with DUAP and EPA (1998), being Stage 2. If the contamination levels are below the relevant acceptable levels and information gathered as part of the investigation also supports that contamination was unlikely to have occurred, Stage 1 would only be required.

2.0 METHODOLOGY

The assessment of Mn and Cr in North Coast soils has been conducted on a random 200 composite soil samples, which is equivalent to 800 individual soils. This number of soils is considered representative of North Coast soils and for the assessment of average metal concentrations.

Samples were analysed for a full range of heavy metals and the data analysed in this review is the total Mn, Cr, iron (Fe) and aluminium (Al).

2.1 Sampling Methodology

Samples were collected using a hand auger and spade, with soil being placed in plastic sample bags.

All soil samples were placed into an esky with ice bricks, and delivered to the Environmental Analysis Laboratory at Southern Cross University, Lismore. Metals analysis was conducted by the Environmental Analysis Laboratory (EAL) and quality control included blanks, duplicates and certified NIST reference soil in every batch. Analysis is conducted using a Perkin Elmer DV4300 ICPOES (Inductively Coupled Plasma Optical Emission Spectrometry) with confirmation and level analysis of all samples using a Perkin Elmer ELAN6000 ICPMS (Inductively Coupled Plasma Mass Spectrometry).

Chain of custody forms, laboratory quality assurance and laboratory quality control documentation are available on request.

3.0 BASIS FOR ASSESSMENT CRITERIA

The acceptable limits of the parameters tested are based on the NSW EPA (1998) *Contaminated Sites - Guidelines for the NSW Site Auditor Scheme*. In particular Column 1 of table "Soil Investigation Levels for Urban Redevelopment Sites in NSW" page 30. Column 1 relates to "Residential with gardens and accessible soil including children's daycare centres, preschools, primary schools, town houses or villas". The tested parameters are presented in Table 1.

Table 1: Soil Investigation Levels for Urban Redevelopment Sites in NSW: Column 1 "Residential with gardens and accessible soil including children's daycare centres, preschools, primary schools, town houses or villas" (NSW EPA 1998)

Substance	Acceptable Limit Column 1 (mg/kg)	Modified Acceptable Limit Column 1 (mg/kg) (divided by 4 for composites of 4 samples)
Arsenic	100	**25**
Cadmium	20	**5**
Chromium (VI)	100	**25**
Copper	1000	**250**
Manganese	1500	**375**
Nickel	600	**150**
Lead	300	**75**
Zinc	7000	**1750**
Mercury	15	**3.75**
OC's (aldrin and dieldrin)	10	**2.5**
OC's (DDT)	200	**50**

Background Levels

Metals occur naturally within soils and are a natural constituent of geological materials that erode and assist in the formation of soils. The background levels of metals analysed, obtained from ANZECC and NHMRC (1992) Table 3 "Environmental Soil Quality Guidelines" page 40, are presented in Table 2.

Table 2: Background Ranges for Potential Contaminants

Pollutant	Background Range (mg/kg)
Arsenic	0.2 – 30
Lead	<2 – 200
Cadmium	0.04-2
Copper	1-190
Nickel	2-400
Zinc	2-180
Manganese	4 – 12,600
Chromium	0.5 – 110 *(possible underestimate)*
Mercury	0.001-0.1

Table 3: Average Abundance of Manganese and Chromium in Basalt and other minerals

AVERAGE ABUNDANCE OF ELEMENTS IN THE EARTHS CRUST AND IN THREE COMMON ROCKS
(IN PARTS PER MILLION) (10,000ppm = 1%)

ELEMENT	CRUST	GRANITE	BASALT (Crusher Dust)	SHALE
O	464,000	485,000	441,000	495,000
Si	**282,000**	**323,000**	**230,000**	**238,000**
Al	81,000	77,000	84,000	92,000
Fe	**54,000**	**27,000**	**86,000**	**47,000**
Ca	**41,000**	**16,000**	**72,000**	**25,000**
Na	24,000	28,000	19,000	9,000
Mg	**23,000**	**4,000**	**45,000**	**14,000**
K	**21,000**	**32,000**	**8,000**	**25,000**
Ti	5,000	2,100	9,000	4,500
H	1,400	..	..	..
P	**1,100**	**700**	**1,400**	**750**
Mn	**1,000**	**500**	**1,700**	**850**
F	650	800	400	600
Ba	500	700	300	600
Sr	375	300	450	400
S	**300**	**300**	**300**	**2,500**
C	**220**	**320**	**120**	**1,000**
Zr	165	180	140	180
Cl	130	200	60	170
V	110	50	250	130
Cr	100	20	200	100
Rb	90	150	30	140
Ni	75	0.8	150	80
Zn	**70**	**50**	**100**	**90**
Ce	70	90	30	70
Cu	**50**	**12**	**100**	**50**
Y	35	40	30	35
La	35	55	10	40
Nd	30	32	20	30
Co	**22**	**3**	**48**	**20**
Li	20	30	12	60
N	**20**	**20**	**20**	**60**
Sc	20	8	35	15
Nb	20	20	20	15
Ga	18	18	18	25
Pb	12.5	20	3.5	20
B	**10**	**15**	**5**	**100**
Th	8.5	20	1.5	12

ELEMENT	CRUST	GRANITE	BASALT (Crusher Dust)	SHALE
Pr	8	10	4	9
Sm	7	9	5	7
Gd	7	8	6	6
Dy	6	6.5	4	5
Er	3.5	4.5	3	3.5
Yb	3.5	4	2.5	3.5
Be	3	5	0.5	3
Cs	3	5	1	7
Hf	3	4	1.5	4
U	2.7	5	0.5	3.5
Br	2.5	0.5	0.5	5
Sn	2.5	3	2	6
Ta	2	3.5	1	2
As	1.8	1.5	2	10
Ge	1.5	1.5	1.5	1.5
Mo	**1.5**	**1.5**	**1**	**2**
Ho	1.5	2	1	1.5
Eu	1.2	1	1.5	1.4
W	1.2	1.5	0.8	1.8
Tb	1	1.5	0.8	1
Tl	0.8	1.2	0.2	1
Lu	0.6	0.7	0.5	0.6
Tm	0.5	0.6	0.5	0.6
Sb	0.2	0.2	0.2	1.5
I	0.2	0.2	0.1	1
Cd	0.15	0.1	0.2	0.3
Bi	0.15	0.2	0.1	0.2
In	0.06	0.05	0.07	0.06
Ag	0.07	0.04	0.1	0.1
Se	0.05	0.05	0.05	0.6
Hg	0.02	0.03	0.01	0.3
Au	0.003	0.002	0.004	0.003

Reference: Krauskopf, K, 1996. Introduction to Geochemistry, McGraw-Hill Internation.

4.0 RESULTS

The results from the soil testing regime are graphically represented on the following pages.
The raw data table with over 200 entries and identifiable job numbers is presented in Exhibit 1.

Figure 1- Graphical presentation of Manganese Soil Results

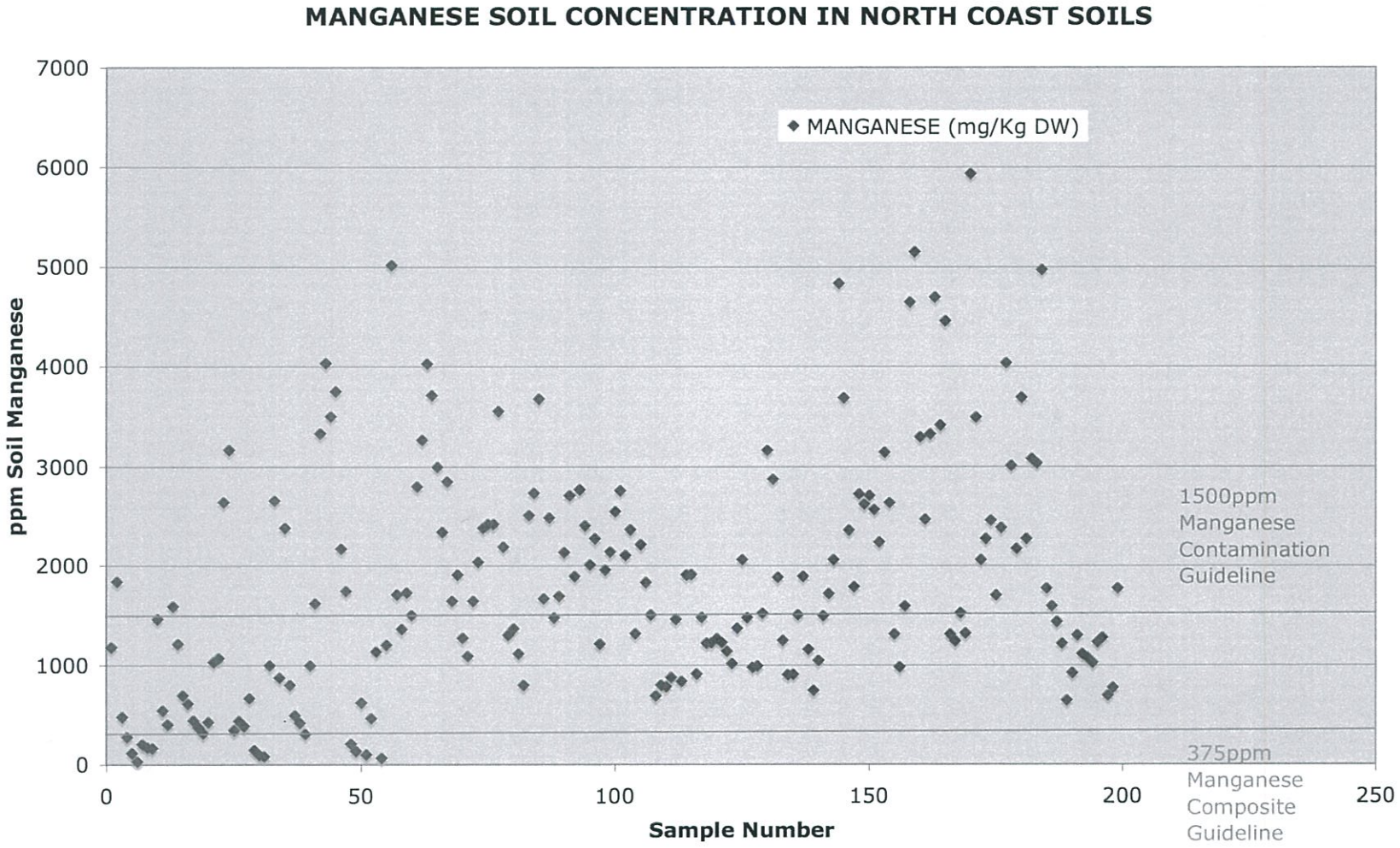


Figure 2- Graphical presentation of Chromium Soil Results

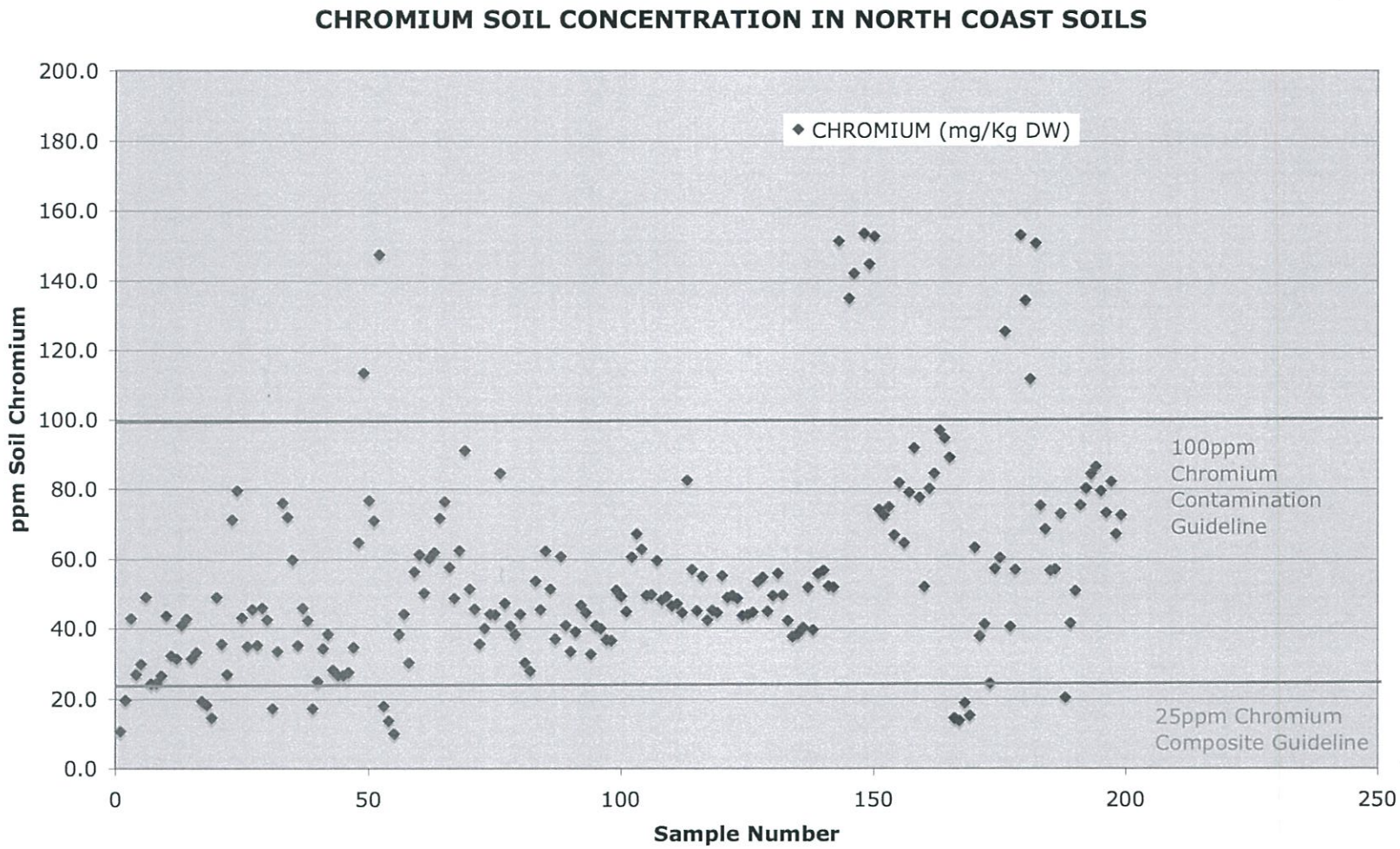


Figure 3- Relationship between Iron and Manganese in North Coast Soils

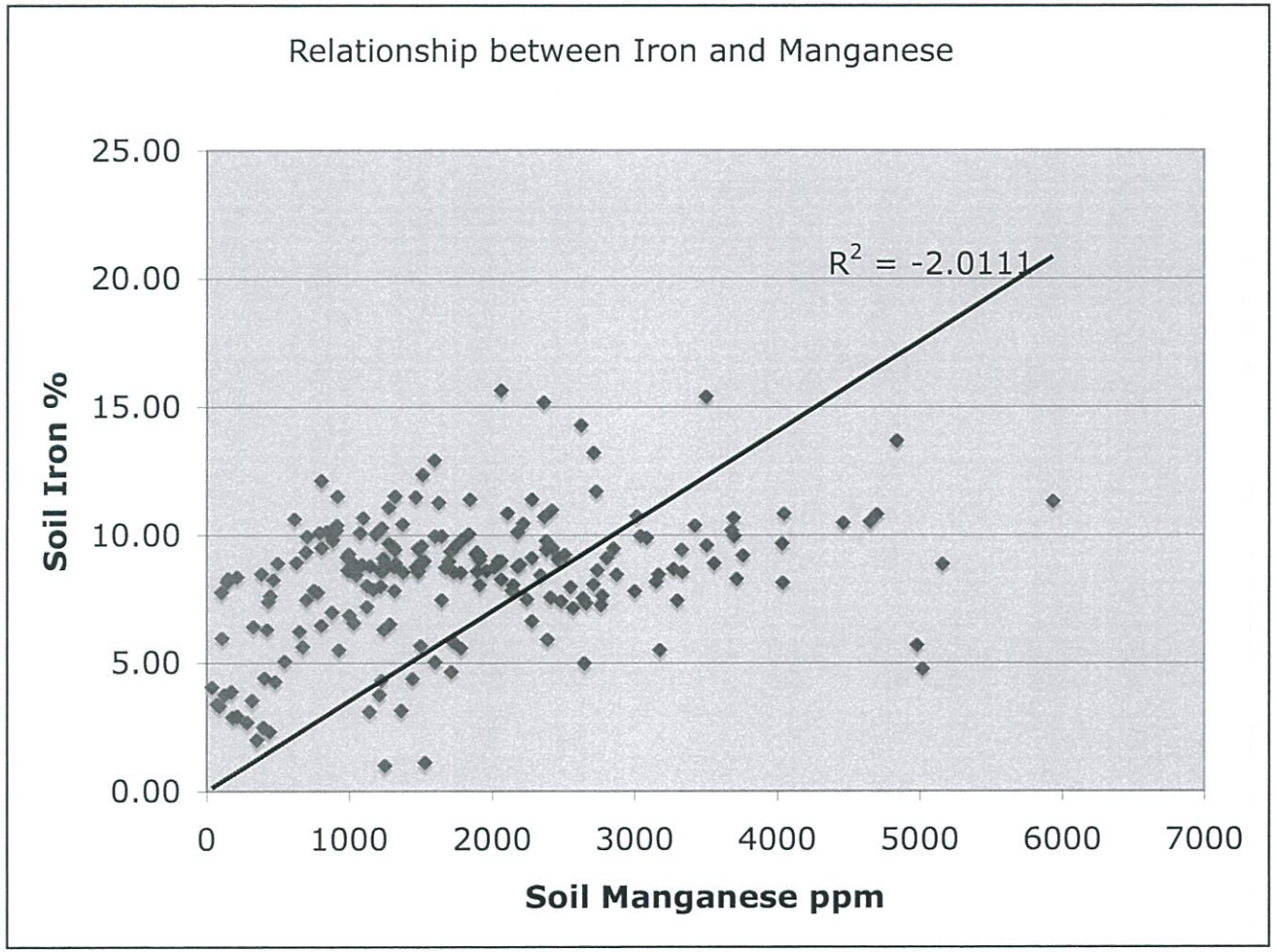
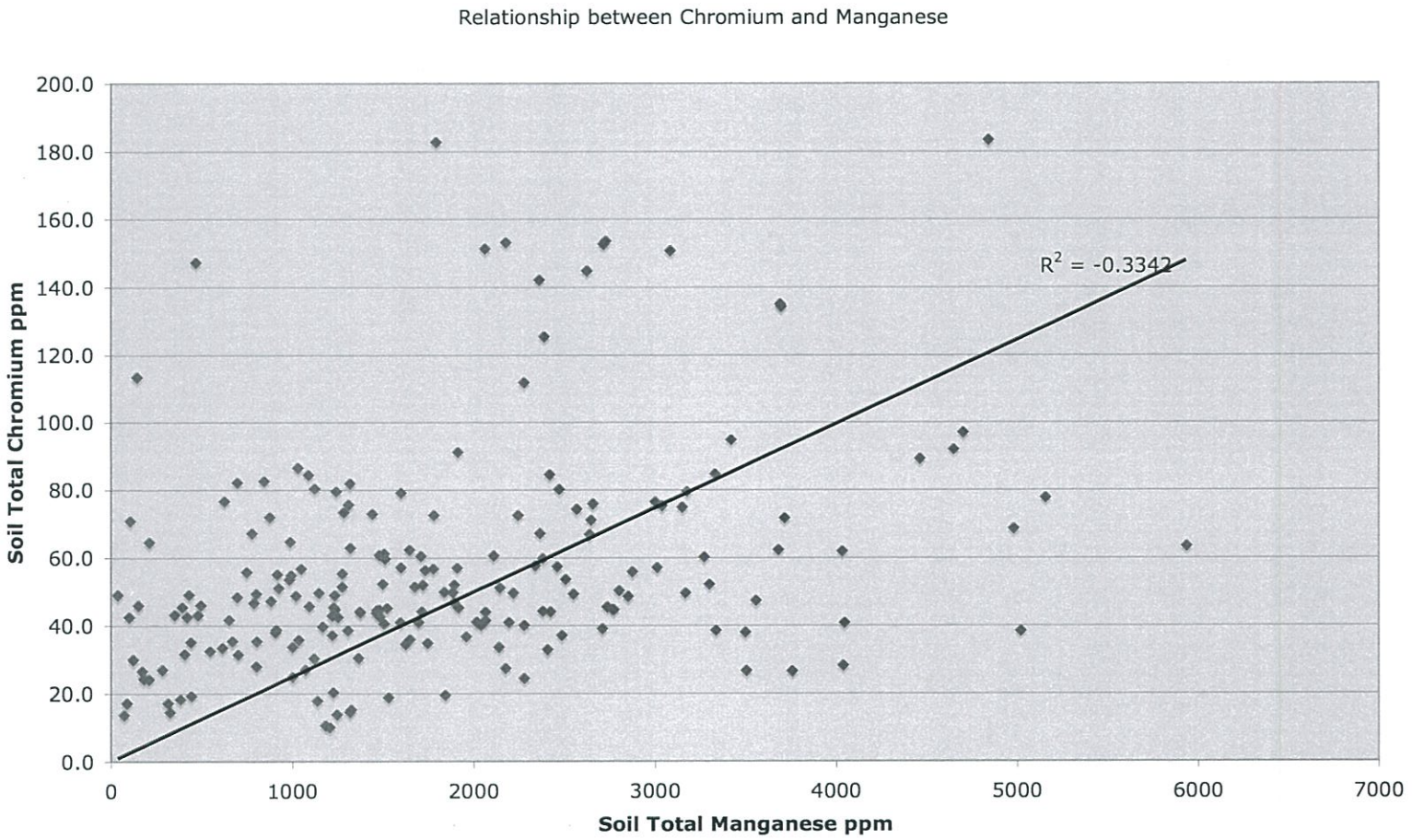


Figure 4- Relationship between Chromium and Manganese in North Coast Soils



5.0 DISCUSSION

The assessment of Mn and Cr assessment in North Coast soils has been conducted on a random 200 composite soil samples, which is equivalent to 800 individual soils. This number of soils is considered representative of North Coast and for the assessment of average metal concentrations.

The results of the soil analyses were compared with Column 1 of the NSW EPA (1998) '*Contaminated Sites – Guidelines for the NSW Site Auditor Scheme*'. Column 1 presented Human - Based Investigation Levels (HBIL) for developments being 'residential with gardens and accessible soil'. The guidelines are also typically modified by dividing them by the number of samples that make up the composite sample (ie. typically the guideline divided by four).

The average Mn in the 800 soils is 1800ppm Mn with a standard deviation of 1162ppm (refer Figure 1). These levels are 'naturally' well above the guideline level of 1500ppm or 375ppm Mn for composite samples(ie. 92% of the 200 composite soils analysed exceed the 375ppm guideline). Table 3 provides the average Mn in basalt rock at 1700ppm Mn. Basalt is the bedrock mineral for the formation of most North Coast soils. The Mn ranges from 37 to 5934ppm in the soils analysed and hence an explanation for the elevated Mn in some soils is required.

The physical features of Mn oxides and hydroxides, such as small size of crystals and large surface area has important geochemical implications. Mn^{2+} is known to replace the sites of some divalent cations (Fe^{2+}, Mg^{2+}) in silicates and oxides. Also, during weathering Mn compounds are oxidised and the released Mn oxides are reprecipitated and readily concentrated in the form of secondary Mn minerals (Alina Kabata-Pendias, 1985). Both of these processes account for the accumulation of Mn at various sites on the North Coast. Higher Mn levels are often reported in soils rich in iron and/or organic matter, which is also characteristic of North Coast soils (refer Figure 3). Mn is detected in the field by the presence of small, hard, characteristically dark-coloured nodules and identified by a vigorous effervescence with hydrogen peroxide.

The average total Cr in the 800 soils is 56ppm Cr with a standard deviation of 32ppm (refer Figure 2). These levels are 'naturally' well above the composite guideline level of 25ppm Cr (ie. 91% of the 200 composite soils analysed exceed the 25ppm guideline). The Cr ranges from 10 to 183ppm in the soils analysed. No data is available for hexavalent Cr (Cr (VI)) in North Coast soils but this valiancy of Cr is expected to show much lower concentrations than total Cr. The guidelines do relate to the Cr (VI) hence total Cr analysis is a 'worst case' scenario for contamination. Accumulation of total Cr in soils can occur with similar reasons to above but to a far lesser extent. A relationship between Mn and Cr is evident (refer to Figure 4).

The background levels of metals analysed, obtained from ANZECC and NHMRC (1992) Table 3 "Environmental Soil Quality Guidelines" page 40, state that background levels of Mn range from 4 – 12,600ppm and total Cr from 0.5 – 110ppm. This large range for background Mn and Cr in soils further confirms the results obtained for naturally elevated Mn and Cr in North Coast soils.

The Mn and Cr in North Coast soils are considered to be tightly bound to the clays and organic matter, which typically have very high cation exchange. The soils of the North Coast are typically acidic and hence lithiophorite $(Al,Li)MnO_2(OH)_2$ is the most likely Mn mineral present in the soils (Alina Kabata-Pendias, 1985). Human health impacts from total Mn and Cr have not been clearly identified and if this was considered an issue, than a very large percentage of the North Coast including all towns and residential areas would need to be assessed and investigated. Human health effects from Mn are historically from breathing airborne particles of Mn ores during mining ores such as pyrolusite, MnO_2, and causing acute respiratory disease and a severe chronic neurotoxicity ("manganism") (Crosby, 1998). Manganism also resulted from drinking water that contained 16-18ppm of dissolved Mn.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The average Mn in the 800 soils is 1800ppm Mn with a standard deviation of 1162ppm. These levels are 'naturally' well above the guideline level of 1500ppm or 375ppm Mn for composite samples. The average Cr in the 800 soils is 56ppm Cr with a standard deviation of 32ppm. These levels are 'naturally' well above the composite guideline level of 25ppm Cr.

The background levels of metals analysed, obtained from ANZECC and NHMRC (1992) Table 3 "Environmental Soil Quality Guidelines" page 40, state that background levels of Mn range from 4 – 12,600ppm and total Cr from 0.5 – 110ppm. This large range for background Mn and Cr in soils further confirms the results obtained for naturally elevated Mn and Cr in North Coast soils.

All Mn and Cr analysis results in North Coast soils need to be disregarded unless an identifiable source of Mn or Cr soil contamination has been identified. The Contaminated Land Management Act 1997 clearly identifies contamination as 'above the concentration at which the substance is normally present in, on or under land in the same locality' and hence confirming that the elevated naturally occurring Mn and Cr concentrations in North Coast soils is not identified as 'contamination' and hence does not warrant further investigation or remediation.

The Mn and Cr in North Coast soils are considered to be tightly bound to the clays and organic matter which typically have very high cation exchange. Human health impacts from total Mn and Cr have not been clearly identified and if this was considered an issue, than a very large percentage of the North Coast including all towns and residential areas would need to be assessed and investigated.

7.0 REFERENCES

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Summary of Experience and Qualifications.

The Environmental Analysis Laboratory, which is part of Southern Cross University, consists of a large range of analysts, chemists, environmental managers and scientists. The qualifications, held by the persons of the company, include:

- Doctorate of Applied Science (Environmental Management)
- Bachelor of Applied Science (Coastal Management)
- Honours in Applied Science
- Diploma in Chemistry

We have a wide range of experience and worked on a number of varied projects, which include:

- Contamination Assessment Reports for Residential, Industrial and Commercial Sites
- Acid Sulfate soil assessment and management
- Petrochemical assessment and rehabilitation
- Analysis and Rehabilitation of dipsites
- Assessment of former banana plantations
- Assessment of disposal and reuse of Biosolids
- Assessment of general agricultural and residential sites.

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EAL has made no allowance to update this report and has not taken into account events occurring after the time its assessment was conducted.

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EXHIBIT 1: RAW DATA