

***Soil Contamination Risk
Stage 3 – Remediation Action Plan***

***150 Dunbars Road
Halswell, Christchurch***

February 2016



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Stormwater Solutions • Soil Contamination Investigations • Environmental Planning

CONTENTS

1	Executive Summary.....	3
2	Objectives of the Investigation	3
3	Scope of Work Undertaken.....	3
4	Site Identification	3
5	Summary of Site Description, History and DSI.....	4
6	Geology and Hydrology.....	5
7	Basis for Soil Guideline Values (SGV)	5
7.1	Activity Description	5
7.2	Current Zoning and Proposed Uses	5
7.3	Soil Guideline Values.....	5
8	Results Analysis and Summary.....	6
9	Site Characterisation and Recommendation	6
10	Planning Status.....	6
11	Remedial Actions	7
11.1	Remediation Goals.....	7
11.2	Remediation Options and Discussion	7
11.3	Proposed Methodology	7
11.4	Regulatory Requirements	7
11.5	Unexpected Contaminated Material	8
11.6	Contact Details during Remediation	8
12	Site Remediation Management Plan	8
12.1	Site Setup	8
12.2	Stormwater and Soil Management.....	8
12.3	Dust Control	8
12.4	Occupational Safety and Health Issues and Measures	9
13	Validation Sampling	9
14	Conclusion.....	9
15	Limitations.....	9

APPENDICES

- A Malloch Environmental Ltd DSI report – dated September 2015
- B Remediation Location Plan

1 Executive Summary

The subject site involves two adjacent lots with the street address 150 Dunbars Road, Halswell, Christchurch. It is proposed to subdivide the site for residential use. This will result in a change of use and disturbance of soils. The Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Health) Regulations 2011 (NES) require an assessment of the likelihood of soil contamination being present.

A Preliminary Site Investigation and a subsequent Detailed Site Investigation were undertaken to assess the risks. The investigations revealed the past uses at the site have caused some arsenic contamination of the soil, just above the residential SGV, in an area approximately 30m² in size around sample location SS6. This is likely from a former burn pile area, as traces of ash were seen in the soils. Remediation and validation of the arsenic affected area around the former burn pile is recommended. This report details the proposed remediation actions and appropriate site management and validation procedures.

The area affected is shown on the plan in **Appendix B**. It is proposed that the affected area be remediated by excavating the affected soil and disposing of it to Burwood landfill as part of the proposed redevelopment. The remainder of the site is considered to be suitable for the proposed future subdivision and intensified residential use with no further investigations required.

In terms of planning status at the time of writing of this report, the NES does apply to the site. As this investigation has found that soil contamination does exceed the applicable standard in Regulation 7 of the NES in some areas of the site, the proposed activities are not considered to be permitted or controlled activities and therefore are subject to regulation 10 of the NES for Assessing and Managing Contaminants in Soil to Protect Human Health, under which consent is required as a restricted discretionary activity.

2 Objectives of the Investigation

This report has been prepared in accordance with the Ministry for the Environment's "Contaminated Land Management Guidelines No 1: Reporting on Contaminated Sites in New Zealand". This report includes all requirements for a Stage 3 Remediation Action Plan. The objectives have included summarising the detailed site investigation report and developing an appropriate remediation action plan for the contamination found.

3 Scope of Work Undertaken

The scope of the work undertaken has included:

- Summary of the Malloch Environmental Ltd DSI Report dated September 2015
- Recommendations of further actions
- Preparation of report in accordance with MfE guidelines

4 Site Identification

The site is located at 150 Dunbars Road, Halswell, Christchurch as shown on the plan in **Figure 1** below. The site is legally described as Lot 2 DP 340918 and Lot 3 DP 14098, and has a total area of approximately 21,537 m², of which only a very small area is proposed to be remediated.

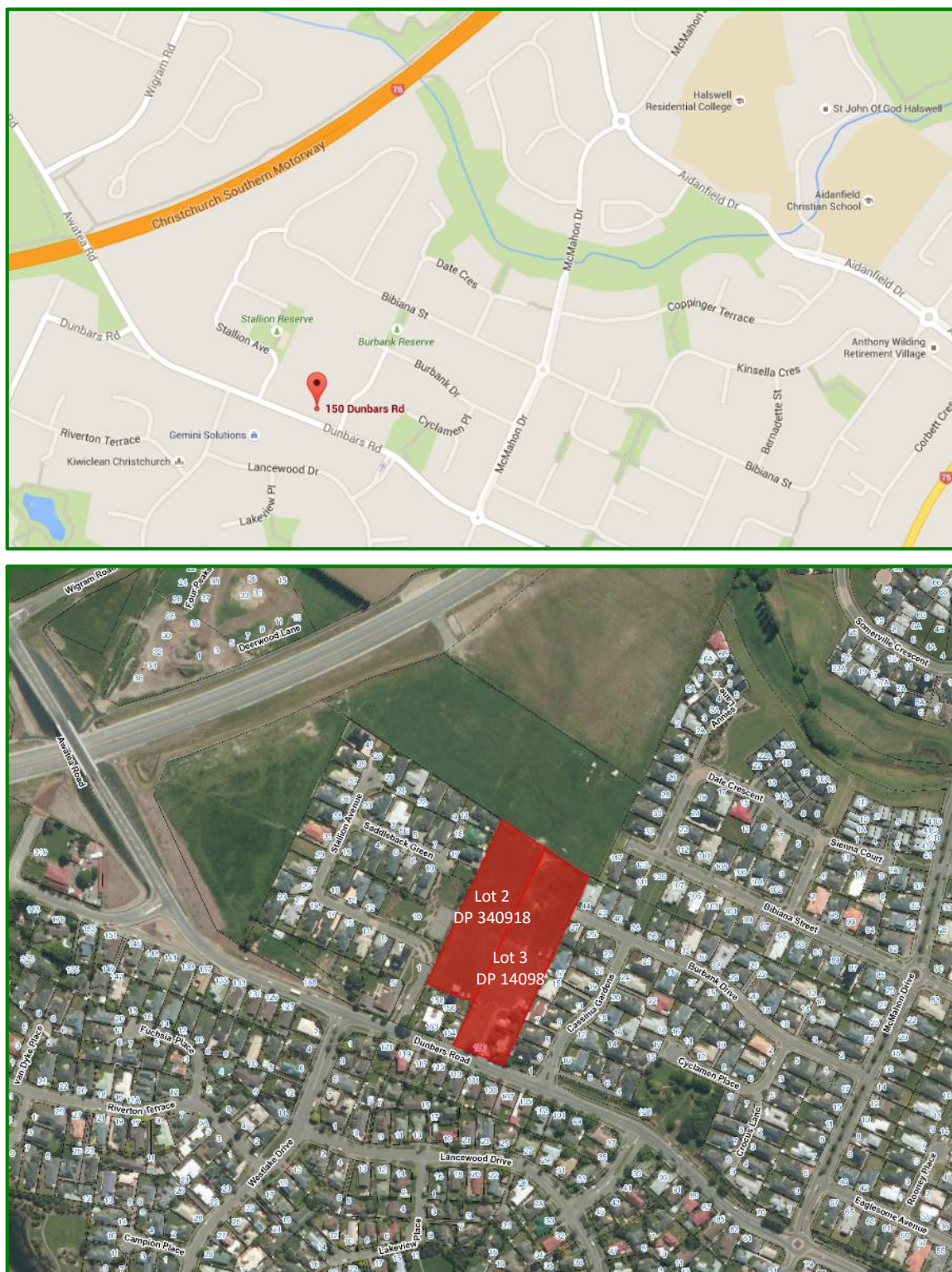


Figure 1 – Location Plan

5 Summary of Site Description, History and DSI

The subject site is flat farmland divided into paddocks with a residential dwelling, associated sheds and outbuildings on the Dunbars Rd frontage. The subject site is defined by existing hedges and fences. It is bounded on all sides by residential dwellings. The subject site appears to have been used for farming pasture for most of its known history.

A PSI report was prepared for the site by Malloch Environmental Ltd in August 2015 and a subsequent DSI in September 2015. The DSI found that there are minor levels of arsenic contamination above background values, at the rear of the existing house. This is limited to an oval area approximately 4m x 7.6m in the yard behind the house, at depths no greater than 300mm. The concentrations of arsenic are not considered to be a significant risk to human health with most results only just above the SGV, however the contamination affects a large enough area to pose a risk, based on the section size proposals, and it is proposed that remediation will occur as part of the proposed redevelopment.

A copy of the DSI report is attached in **Appendix A**.

6 Geology and Hydrology

The ECan GIS describes the soils as Kaiapoi deep silty loam. Wells in the area indicate that topsoils are underlain by 12m of sand and sandy gravels with a layers of clay at around 12m and 18m deep. Soil trace elements are 'Regional, Recent'.

The site is over the unconfined/semi confined aquifer system and ground water levels are around 2.5 – 4 m deep. The direction of ground water flow is generally in an easterly direction. An open drain (Dunbars Drain) runs along the southern boundary of the subject site.

7 Basis for Soil Guideline Values (SGV)

7.1 Activity Description

This report has been written for the following proposed activities:

- Subdivision for residential use,
- Earth disturbing activities associated with the activities above.

7.2 Current Zoning and Proposed Uses

The current zoning is Residential Living 1.

7.3 Soil Guideline Values

Human health soil contaminant standards for a group of 12 priority contaminants were derived under a set of five land-use scenarios, and are legally binding under The Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Health) Regulations 2011 (NES). These standards have been applied where applicable. For contaminants other than the 12 priority contaminants, the hierarchy as set out in the Ministry for the Environment Contaminated Land Management Guidelines No 2 has been followed. For soil, guideline values are predominantly risk based, in that they are typically derived using designated exposure scenarios that relate to different land uses. For each exposure scenario, selected pathways of exposure are used to derive guideline values. These pathways typically include soil ingestion, inhalation and dermal adsorption. The guideline values for the appropriate land use scenario relate to the most critical pathway.

The land-use scenarios applicable for this site and the proposed earth disturbing activities include 'residential 10% produce', and 'outdoor workers' as a proxy value for the protection of construction workers involved in disturbing the soils.

8 DSI Results Analysis and Summary

The initial results showed that the only soil sample location out of the original eight which exceeded the residential SGVs was SS6 for arsenic, in the yard behind the house. There were also elevated lead results around the existing house, but these were below residential SGVs and ecological receptors. There were also some slightly elevated zinc results at a few locations.

The laboratory results confirmed that soil sample location SS6 had arsenic contamination above residential soil guideline values of 20mg/kg, with an average result of 25 mg/kg.

Further sampling and testing was performed on the 11th September, 2015. The results showed that the area of arsenic contamination around sample location SS6 was contained within an oval shaped area approximately 4m x 7.6m. The highest lab result for arsenic was 34mg/kg and the highest XRF result (with error added) was 42.1mg/kg. The source of this contamination is most likely residue ash from burning of rubbish, which possibly included treated timbers. A very slight depression in the ground was evident in this area and fragments of ash were found in the affected soil. Testing at depths of 200mm and 300mm at SS10 showed that the contaminated soil was limited to less than 300mm depth.

Laboratory results were compared with the Level 1 “Regional” background concentrations for the soil type “Recent” listed in the report, “Background concentrations of selected trace elements in Canterbury soils, 2007”, prepared for Environment Canterbury by Tonkin and Taylor Ltd. Where tested, arsenic, cadmium, chromium, copper, lead and zinc were all above background concentrations.

A Table of Laboratory Results and the Laboratory Reports are included in the DSI report in **Appendix A**.

9 Site Characterisation and Recommendation

The results have indicated that there are minor levels of heavy metal contamination above background values, which is likely limited to the house and outbuilding areas. At one location arsenic levels are above the residential SGV. This is limited to an oval area approximately 4m x 7.6m in the yard behind the house. The concentrations of arsenic are not considered to be a significant risk to human health with most results only just above the SGV, however the contamination affects a large enough area to pose a risk, based on the proposed section sizes, and it is recommended that remediation occur as part of the proposed redevelopment. The recommended area for remediation is shown on the Sample Location Plan in the DSI report in **Appendix A**.

With exception of the arsenic affected area, the measured contaminant concentrations are all below ecological guideline values so the risk to the environment is considered to be very low. Arsenic binds well to silty soils and with the contaminated soils limited to the surface soils, it is not considered they pose any significant environmental risk.

10 Planning Status

In terms of the NES section 5 (7) states that the land is considered to be covered if an activity or industry described in the HAIL is being undertaken on it; or has been undertaken on it; or it is more likely than not that an activity is being or has been undertaken on it.

Section 6 describes the methods for determining whether the land is as described in section 7. Method 6 (3) is to rely on a Preliminary Site Investigation. The Detailed Site Investigation has found that an activity or industry described in the HAIL has been undertaken on the site.

As this investigation has found that soil contamination does exceed the applicable standard in Regulation 7 of the NES in some areas of the site, the proposed activities are not considered to be permitted or controlled activities and therefore are subject to regulation 10 of the NES for Assessing and Managing Contaminants in Soil to Protect Human Health, under which consent is required as a restricted discretionary activity.

11 Remedial Actions

11.1 Remediation Goals

- Ensure that the remaining soils in the identified contaminated area have arsenic levels below the residential 10% produce SGV after remediation
- Ensure that any excess soil removed from the site is disposed of to an approved facility.

11.2 Remediation Options and Discussion

The options available for remediation of the yard area include:

- Leaving the contaminated soils in-situ
- Excavate and mix with 'clean' site soils to dilute contaminants
- Excavating and removing all contaminated soils and disposal to an approved landfill

Given that the proposed subdivision is small and there is no suitable area to contain the contaminated soil it is not considered to be practical to leave the soils in-situ and manage the contamination in another method such as sealing the area to prevent access to the soils by the public. As the levels of contaminants are relatively low and the volume of soil small, diluting the soils with "clean" soils from elsewhere on the site is considered practical, but the preferred option is to excavate the affected area and dispose of the contaminated soil to an approved disposal facility. As the average arsenic contamination will be under the Burwood Landfill limit of the 'recreational' SGV, disposal at Burwood Landfill would be the most economic option.

11.3 Proposed Methodology

It is proposed to excavate and dispose of the approximately 30m² of contaminated soil from this area, to a depth of up to 300mm. The **Remediation Location Plan** in **Appendix B** shows the area to be remediated. It is proposed to carry out the remediation in conjunction with the use of a portable XRF to ensure all contaminated soils within the identified area are removed and that the volume of material removed is kept to the minimum required to achieve the remediation objective. The objective is to ensure that the remaining soils have arsenic levels below the residential (10% produce) SGV of 20mg/kg. The contaminated soil is proposed to be disposed of at Burwood landfill under an approved waste manifest. The work will be carried out on one day and will not be done during heavy rainfall or high winds. All excavated material will be loaded directly onto covered trucks and will not be stockpiled on the site.

11.4 Regulatory Requirements

Resource consent is required in terms of the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health Regulations. This consent is required

to be in place prior to disturbing the soil by excavation. It is not considered that any relevant rules in the Regional Plan are triggered by the proposed remediation works, as the contaminated soil is highly unlikely to cause any discharge to surface or groundwater.

11.5 Unexpected Contaminated Material

During the excavation works if any other hazardous material is encountered in significant volumes that pose a threat to the health of workers on site, all works will be ceased until they have been assessed in accordance with MfE guidelines.

11.6 Contact Details during Remediation

Environmental Consultant:

Nicola Peacock, Malloch Environmental Ltd, ph 021 132 0321

Engineer:

Dean Gregory, Gillman Wheelans Ltd, ph 021 433 457

12 Site Remediation Management Plan

12.1 Site Setup

Prior to any works commencing the following should be in place on site:

- Contaminated areas should be identified and site entry and exits planned before works commence
- Appropriate washing facilities should be put in place to clean any equipment exposed to contaminated soils if required
- Hand washing facility must be available for all workers, in the immediate area of the work site
- Contaminated areas should be remediated in a staged approach / methodical manner to ensure that vehicles do not track contaminated soils onto clean areas
- Water for dust suppression must be available on site

12.2 Stormwater and Soil Management

Remediation work will not take place during heavy rain or high wind. As the work is predominantly excavation below the ground surface, it is expected that any rainfall occurring after the excavation is completed, will be trapped within the excavated area and not run off to any other part of the site. If rainfall occurs during the activities and tracking of wet contaminated soils to other parts of the site becomes a risk, work will cease.

12.3 Dust Control

A water supply will be made available at the site and if required will be used to keep the dust emissions to an acceptable level to protect human health. All vehicles moving soil off-site will use tarpaulins to prevent dust emissions.

12.4 Occupational Safety and Health Issues and Measures

The earthworks contractor shall prepare a site specific Health and Safety Plan covering all relevant matters and all workers will be inducted prior to site remediation works beginning. As a minimum the following matters will need to be included:

- Appropriate personal protection gear which should include as a minimum, head to toe clothing, the use of gloves for any worker handling soil, dust masks to prevent ingestion of contaminated dust particles, safety footwear, hard hats and hi-vis vests
- Appropriate hand washing measures to prevent ingestion of contaminated soil particles
- Consideration of machinery tracking contaminants
- Truck loading procedures and spill prevention
- Decontamination measures for all equipment

13 Validation Sampling

The use of a portable XRF during the remediation will be used to validate that the soils are below the residential SGV. When the remediation is complete, laboratory sampling will be undertaken to confirm the XRF results, and also to confirm that the site has been suitably remediated. Samples will be submitted to Hill Laboratories for testing for arsenic.

14 Conclusion

The investigations have shown that the past uses at the site have caused some arsenic contamination above the residential SGV at one isolated area of approximately 30m² to a depth of 300mm. The area affected is shown on the plan in **Appendix B**. It is recommended that the affected area be remediated by excavating the affected soil and disposing of it to Burwood landfill as part of the proposed redevelopment.

The remainder of the site is considered to be suitable for the proposed future subdivision and intensified residential use with no further investigations required.

15 Limitations

Malloch Environmental Limited has performed services for this project in accordance with current professional standards for environmental site assessments, and in terms of the client's financial and technical brief for the work. Any reliance on this report by other parties shall be at such party's own risk. It does not purport to completely describe all the site characteristics and properties. Where data is supplied by the client or any third party, it has been assumed that the information is correct, unless otherwise stated. Malloch Environmental Limited accepts no responsibility for errors or omissions in the information provided. Should further information become available regarding the conditions at the site, Malloch Environmental Limited reserves the right to review the report in the context of the additional information.

Opinions and judgments expressed in this report are based on an understanding and interpretation of regulatory standards at the time of writing and should not be construed as legal opinions. As regulatory standards are constantly changing, conclusions and recommendations considered to be acceptable at the time of writing, may in the future become subject to different regulatory standards which cause them to become unacceptable. This may require further assessment and/or remediation of the site to be suitable for the existing or

proposed land use activities. There is no investigation that is thorough enough to preclude the presence of materials at the site that presently or in the future may be considered hazardous.

This report does not attempt to describe all risks or possible outcomes resulting from carrying out remediation works. Any party carrying out remediation works shall be responsible for all such works, including implementing all health and safety precautions as appropriate. Malloch Environmental Limited disclaims all liability whatsoever for any loss or damages, if any, suffered by any party as a result of any remediation works undertaken.

Report written by:



Chris Peacock
Environmental Engineer

Report reviewed and certified by a suitably qualified and experienced practitioner as prescribed under the NES (soil):



Nicola Peacock, CEnvP
Principal Environmental Engineer

***Appendix A – Malloch Environmental Ltd DSI report – dated
September 2015***

***Soil Contamination Risk
Stage 2 - Detailed Site Investigation Report***

***150 Dunbars Road
Halswell, Christchurch***

September 2015



Malloch Environmental Ltd

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CONTENTS

1	Executive Summary	2
2	Objectives of the Investigation	2
3	Scope of Work Undertaken	2
4	Site Identification	3
5	Summary of Site Description, History and PSI	4
6	Geology and Hydrology	4
7	Sampling and Analysis Plan and Sampling Methodology	4
8	Basis for Guideline Values	5
8.1	Activity Description	5
8.2	Zoning	5
8.3	Soil Guideline Values	5
9	Field Quality Assurance and Quality Control	5
10	Laboratory Quality Assurance and Quality Control	5
11	XRF Quality Assurance Measures	6
12	Results Analysis and Summary	6
13	Site Characterisation and Recommendations	7
14	Planning Status	7
15	Conclusions	8
16	Limitations	8

Appendices

A	Sample Location Plan
B	Table of XRF Results
C	Table of Laboratory Results
D	Laboratory Reports

1 Executive Summary

The subject site involves two adjacent lots with the street address 150 Dunbars Road, Halswell, Christchurch. It is proposed to subdivide the site for residential use. This will result in a change of use and disturbance of soils. The Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Health) Regulations 2011 (NES) require an assessment of the likelihood of soil contamination being present. This report details the work undertaken to assess that risk.

The Preliminary Site Investigation undertaken revealed that a part of the site around the existing buildings have likely HAIL activities (Category I – any other activity), with pre 1955 buildings likely to have had lead paint on them in the past, posing a risk of soil contamination having occurred. It was recommended that a Detailed Site Investigation, in terms of the Ministry for the Environment's Contaminated Land Management Guidelines, be undertaken on this risk area. It also found that remainder of the site had been used for general pastureland and is unlikely to pose a risk to human health should the land be developed in the future for residential use and no further investigation is considered to be required.

Soil sampling and testing by portable XRF and lab testing was undertaken at the site with a total of twenty sample locations tested. The investigations have shown that the past uses at the site have caused some arsenic contamination of the soil, just above the residential SGV in an area approximately 30m² in size around sample location SS6. This is likely from a former burn pile area, as traces of ash were seen in the soils. Remediation and validation of the arsenic affected area around the former burn pile is recommended. The contaminated area poses a moderate risk to human health until this remediation is complete. The area affected is shown on the plan in **Appendix A**. The remainder of the site is considered to be suitable for the proposed future subdivision and intensified residential use with no further investigations required.

In terms of planning status at the time of writing of this report, the NES does apply to the site. As this investigation has found that soil contamination does exceed the applicable standard in Regulation 7 of the NES in some areas of the site, the proposed activities are not considered to be permitted or controlled activities and therefore are subject to clause 10 of the NES for Assessing and Managing Contaminants in Soil to Protect Human Health, under which consent is required as a restricted discretionary activity.

2 Objectives of the Investigation

This report has been prepared for the purposes of residential subdivision with associated earth disturbing activities, and has been completed in accordance with the Ministry for the Environment's "Contaminated Land Management Guidelines No 1: Reporting on Contaminated Sites in New Zealand", (CLMG). This report includes all requirements for a Stage 2 Detailed Site Investigation Report. The objective is to determine whether the activities that have been carried out in the past have caused soil contamination that would affect the proposed development.

3 Scope of Work Undertaken

The scope of the work undertaken has included:

- Summary of the Malloch Environmental Ltd PSI Report dated August 2015
- Undertaking soil sampling and XRF testing
- Analysis of results in accordance with MfE Guidelines
- Recommendations of further actions
- Preparation of report in accordance with MfE guidelines

4 Site Identification

The site is located at 150 Dunbars Road, Halswell, Christchurch as shown on the plan in **Figure 1** below. The site is legally described as Lot 2 DP 340918 and Lot 3 DP 14098, and has a total area of approximately 21,537 m².

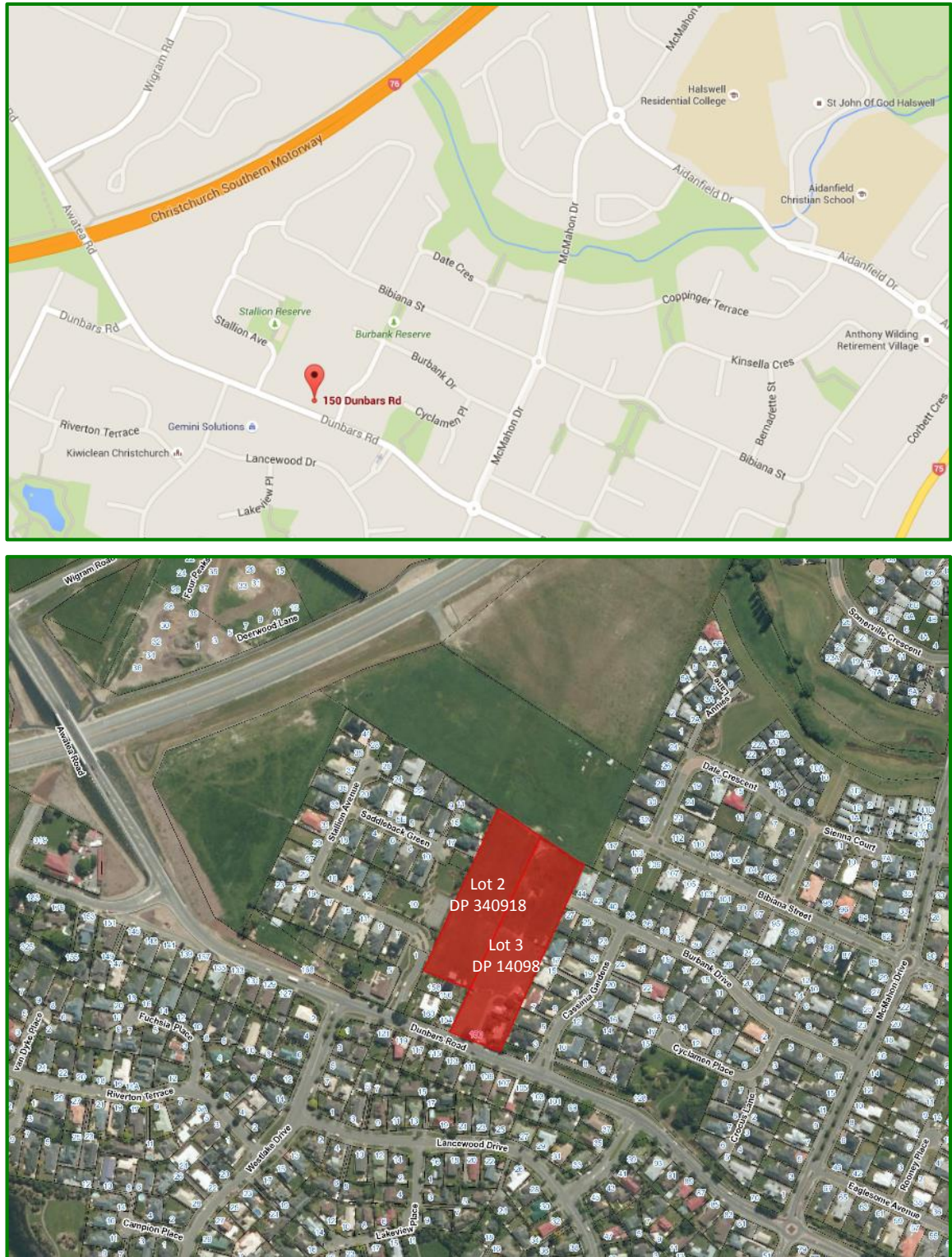


Figure 1 – Location Plan

5 Summary of Site Description, History and PSI

The subject site is flat farmland divided into paddocks with a residential dwelling, associated sheds and outbuildings on the Dunbars Rd frontage. The subject site is defined by existing hedges and fences. It is bounded by similar farmland to the north and residential dwellings to the south, east and west. The subject site appears to have been used for farming pasture for most of its known history.

A Preliminary Site Investigation report was prepared for the subject site by Malloch Environmental Ltd in August 2015 and concluded that part of the site around the existing buildings is likely to have been used in a manner which could have resulted in soil contamination. Contaminants of concern were considered to be lead. It was recommended that further detailed site investigations are carried out around the existing buildings, which is the subject of this DSI report.

For further details refer to the full report “Soil Contamination Risk – Stage 1 Preliminary Site Investigation report, 150 Dunbars Rd, Halswell, Christchurch” by Malloch Environmental Ltd, August 2015.

6 Geology and Hydrology

The ECan GIS describes the soils as Kaiapoi deep silty loam. Wells in the area indicate that topsoils are underlain by 12m of sand and sandy gravels with a layers of clay at around 12m and 18m deep. Soil trace elements are ‘Regional, Recent’.

The site is over the unconfined/semi confined aquifer system and ground water levels are around 2.5 – 4 m deep. The direction of ground water flow is generally in an easterly direction. An open drain (Dunbars Drain) runs along the southern boundary of the subject site.

7 Sampling and Analysis Plan and Sampling Methodology

A judgement sampling methodology was used, targeting areas most likely to have been affected if lead paint had been used on the existing buildings. Additionally a few samples were tested in the outer yard area of the subject site to ensure no further contamination was present.

As it was proposed to use an XRF analyser for the majority of heavy metal testing and the device reads 23 metals, the contaminants to focus on were narrowed down to those likely to be present based on the risk profile and the limitations of the XRF. It is noted that the XRF does not have a low enough limit of detection for cadmium with the LOD of the device being higher than the SGV for a residential use. As high cadmium is primarily associated with fertiliser storage it was considered unlikely to be a contaminant of concern, however was included in three of the laboratory tests. The results from the XRF for arsenic, chromium, copper, lead, mercury, nickel and zinc were all analysed in detail. As the arsenic results were close to the SGV the XRF result plus the reported error was assessed.

Soil samples and XRF readings were taken just below the turf layer, at each of the eight initial sample locations. At all locations three in situ XRF readings were taken. Each set of three readings was taken across approximately 10 cm of the width of the turf excavation. The soil samples taken for lab testing included soil from all three measurement points.

The samples were submitted to Hill Laboratory. Initially three samples (including one duplicate) were analysed for the full suite of seven heavy metals with the samples chosen based on the XRF results.

On receipt of the laboratory results, SS6 was found to have arsenic contamination above the residential soil guideline values. Further sampling and testing was performed to delineate this

area. A further twelve sample locations were tested with the XRF and five of those samples were sent to Hill Laboratory for arsenic analysis. At one location samples were tested at depth to determine the vertical extent of the contamination.

The plan included in **Appendix A** shows the sample locations.

8 Basis for Guideline Values

8.1 Activity Description

This report has been written for the following proposed activities:

- Subdivision for residential use
- Earth disturbing activities associated with the above use and development of the site.

8.2 Zoning

The subject site is currently zoned Residential Living 1.

8.3 Soil Guideline Values

Human health soil contaminant standards for a group of 12 priority contaminants were derived under a set of five land-use scenarios, and are legally binding under The Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Health) Regulations 2011 (NES). These standards have been applied where applicable. For contaminants other than the 12 priority contaminants, the hierarchy as set out in the Ministry for the Environment Contaminated Land Management Guidelines (CLMG) No 2 has been followed. For soil, guideline values are predominantly risk based, in that they are typically derived using designated exposure scenarios that relate to different land uses. For each exposure scenario, selected pathways of exposure are used to derive guideline values. These pathways typically include soil ingestion, inhalation and dermal adsorption. The guideline values for the appropriate land use scenario relate to the most critical pathway.

The land-use scenarios applicable for this site and the proposed earth disturbing activities include 'residential 10% produce', and 'outdoor workers'.

9 Field Quality Assurance and Quality Control

The Contaminated Land Management Guidelines No 5, Ministry for the Environment was followed for all aspects of the investigation. Field quality control and decontamination procedures were followed. Samples were taken using a stainless steel trowel or fresh disposable nitrile gloves. All equipment was decontaminated between samples using Decon 90 and rinsed with tap water.

Samples were collected in laboratory supplied containers and immediately placed in chilled bins. Following sampling, the samples were delivered to Hill Laboratory under chain-of-custody documentation.

Relative percentage difference values (RPD) were calculated for the blind replicate sample and all values were well below the accepted values of 30 – 50%.

10 Laboratory Quality Assurance and Quality Control

All samples were submitted to Hill Laboratories in Christchurch for analysis. Hill Laboratories hold IANZ accreditation. As part of holding accreditation the laboratory follows appropriate testing and quality control procedures. No quality control issues were identified.

11 XRF Quality Assurance Measures

The XRF used was a Thermo Scientific Niton XL2 GOLDD. The manufacturer's instructions were followed in the use of the device. Calibration samples were tested prior to each days testing and compared with the manufacturers specifications, and silicon blank readings were taken approximately every 20 samples to ensure there was no contamination of the XRF window.

The US EPA Method 6200 - Field Portable X-ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment (2007) was used as guidance for the use of the XRF and quality assurance measures. This method recommends that 5% of XRF tests should be verified through lab testing. Approximately 32% of the samples were sent to the laboratory for analysis.

A regression analysis was performed on the XRF readings and laboratory results to determine a statistical R^2 error result. Arsenic was analysed as it was the only contaminant with elevated results affecting the proposed use of residential. The analysis showed that the R^2 value was 0.9. These results are above the minimum acceptable value of 0.70. **Figure 2** below shows the correlation graph.

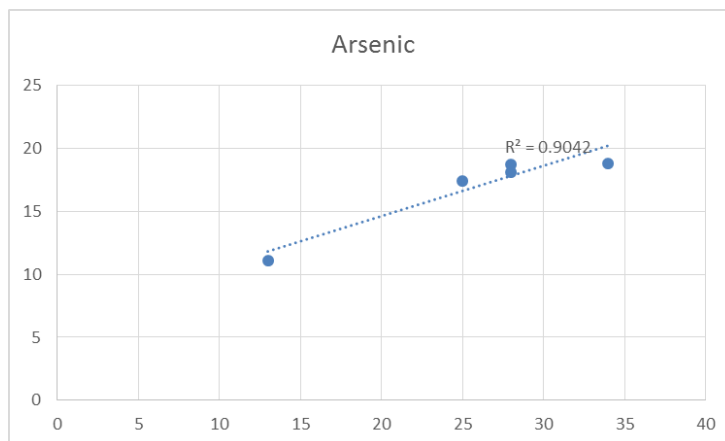


Figure 2 – Correlation analysis of lab (x-axis) vs XRF (y-axis) results for arsenic

The uncertainty in analytical variation was calculated using the method described in 5.8 and Appendix J of the Contaminated Land Management Guidelines No. 5, based on number of sets of multiple readings. This indicated that XRF readings of 15.8 mg/kg for arsenic, 199 mg/kg for lead or 7,161 mg/kg for zinc, or below could be reliably expected to be below the residential SGVs.

12 Results Analysis and Summary

A Table of XRF Results for arsenic, chromium, copper, lead, mercury, nickel and zinc is included in **Appendix B**. The table of results reports the actual XRF reading, the reported error, and for arsenic, the max value which includes the reported error.

The initial results showed that the only soil sample location out of the original eight which exceeded the residential SGVs was SS6 for arsenic, in the yard behind the house. There were also elevated lead results around the existing house, but these were below residential SGVs and ecological receptors. There were also some slightly elevated zinc results at a few locations.

The laboratory results confirmed that soil sample location SS6 had arsenic contamination above residential soil guideline values of 20mg/kg, with an average result of 25 mg/kg.

Further sampling and testing was performed on the 11th September, 2015. The results showed that the area of arsenic contamination around sample location SS6 was contained within an area approximately 4m x 7.6m. The highest lab result for arsenic was 34mg/kg and the highest XRF result (with error added) was 42.1mg/kg. The source of this contamination is most likely residue ash from burning of rubbish, which possibly included treated timbers. A very slight depression in the ground was evident in this area, in the shape of an oval, and fragments of ash were found in the affected soil. Testing at depths of 200mm and 300mm at SS10 showed that the contaminated soil was limited to less than 300mm depth.

Laboratory results were compared with the Level 1 “Regional” background concentrations for the soil type “Recent” listed in the report, “Background concentrations of selected trace elements in Canterbury soils, 2007”, prepared for Environment Canterbury by Tonkin and Taylor Ltd. Where tested, arsenic, cadmium, chromium, copper, lead and zinc were all above background concentrations.

A Table of Laboratory Results is included in **Appendix C** and a full copy of the laboratory reports are included in **Appendix D**.

13 Site Characterisation and Recommendations

The results have indicated that there are minor levels of heavy metal contamination above background values, which is likely limited to the house and outbuilding areas. In a small area arsenic levels are above the residential SGV. This is limited to an oval area approximately 4m x 7.6m in the yard behind the house. The concentrations of arsenic are not considered to be significantly high, with most results only just above the SGV, however the contamination affects a large enough area to pose a moderate risk to human health and it is recommended that remediation occur as part of the proposed redevelopment. The recommended area for remediation is shown on the Sample Location Plan in **Appendix A**.

With exception of the arsenic affected area, the measured contaminant concentrations are all below ecological guideline values so the risk to the environment is considered to be very low. Arsenic binds well to silty soils and with the contaminated soils limited to the surface soils, it is not considered they pose any significant environmental risk.

14 Planning Status

In terms of the NES section 5 (7) states that the land is considered to be covered if an activity or industry described in the HAIL is being undertaken on it; or has been undertaken on it; or it is more likely than not that an activity is being or has been undertaken on it.

Section 6 describes the methods for determining whether the land is as described in section 7. Method 6 (3) is to rely on a Preliminary Site Investigation. The PSI found that an activity or industry described in the HAIL has been undertaken on the site.

As this investigation has found that soil contamination does exceed the applicable standard in Regulation 7 of the NES in some areas of the site, the proposed activities are not considered to be permitted or controlled activities and therefore are subject to clause 10 of the NES for Assessing and Managing Contaminants in Soil to Protect Human Health, under which consent is required as a restricted discretionary activity.

15 Conclusions

The investigations have shown that the past uses at the site have caused some arsenic contamination above the residential SGV at one isolated area of approximately 30m², with arsenic present. The area affected is shown on the plan in Appendix A. It is recommended that the affected area be remediated as part of the proposed redevelopment.

The remainder of the site is considered to be suitable for the proposed future subdivision and intensified residential use with no further investigations required.

16 Limitations

Malloch Environmental Limited has performed services for this project in accordance with current professional standards for environmental site assessments, and in terms of the client's financial and technical brief for the work. Any reliance on this report by other parties shall be at such party's own risk. It does not purport to completely describe all the site characteristics and properties. Where data is supplied by the client or any third party, it has been assumed that the information is correct, unless otherwise stated. Malloch Environmental Limited accepts no responsibility for errors or omissions in the information provided. Should further information become available regarding the conditions at the site, Malloch Environmental Limited reserves the right to review the report in the context of the additional information.

Opinions and judgments expressed in this report are based on an understanding and interpretation of regulatory standards at the time of writing and should not be construed as legal opinions. As regulatory standards are constantly changing, conclusions and recommendations considered to be acceptable at the time of writing, may in the future become subject to different regulatory standards which cause them to become unacceptable. This may require further assessment and/or remediation of the site to be suitable for the existing or proposed land use activities. There is no investigation that is thorough enough to preclude the presence of materials at the site that presently or in the future may be considered hazardous.

Report written by:



Chris Peacock
Environmental Engineer

Report reviewed and certified by a suitably qualified and experienced practitioner as prescribed under the NES (soil):



Nicola Peacock, CEnvP
Principal Environmental Engineer

Appendix A – Sample Location Plan



LEGEND

- ⊙ SS3 Soil sample location XRF and Lab tested
- ⊙ SS3 Soil sample location XRF tested
- ⊙ SS3 Soil sample location that exceeds Residential SGV

Notes:

1. This plan has been prepared for soil contamination risk assessment purposes only. No liability is accepted if the plan is used for any other purposes.
2. Any measurements taken from this plan which are not dimensioned on the electronic copy are at the risk of the user.
3. Soil sample locations are approximate only.



Malloch Environmental Ltd
 801 East Maddisons Road, Rolleston
 021 132 0321
 nicola@mallochenviron.co.nz

Sample Location Plan
 150 Dunbars Rd, Halswell, Christchurch

Scale: NTS

Date: 8 September, 2015

Drawing No: 01056/1



LEGEND

- SS3 Soil sample location XRF and lab tested
- SS3 Soil sample location XRF tested
- SS3 Soil sample location that exceeds Residential SGV for arsenic
- Recommended remediation area

Notes:

1. This plan has been prepared for soil contamination risk assessment purposes only. No liability is accepted if the plan is used for any other purposes.
2. Any measurements taken from this plan which are not dimensioned on the plan are at the risk of the user.



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Sample Location Plan – Inset A
 150 Dunbars Rd, Halswell, Christchurch

Scale: NTS

Date: 14 September, 2015

Drawing No: 01056/2

Appendix B – Table of XRF Results

Table of XRF Results - 150 Dunbars Rd, Halswell
Date of testing: 27th August & 11th September, 2015

Sample ID	Sample Depth	XRF Reading No	Date & Time	Test Duration (secs)	Total Recoverable Arsenic			Total Recoverable Chromium		Total Recoverable Copper		Total Recoverable Lead		Total Recoverable Mercury		Total Recoverable Nickel		Total Recoverable Zinc	
					Result	Error	Max	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
SS1.1	0 -50mm	22	27/08/2015 9:31	61	<LOD	8.97	<LOD	<LOD	75.99	<LOD	18.5	46.9	7.63	<LOD	7.24	<LOD	46.59	154.41	11.92
SS1.1	0 -50mm	23	27/08/2015 9:32	60	<LOD	9.15	<LOD	<LOD	82.85	<LOD	19.27	40.05	7.65	<LOD	7.79	<LOD	48.96	182.81	13.24
SS1.1	0 -50mm	24	27/08/2015 9:33	60	<LOD	8.61	<LOD	<LOD	78.29	<LOD	17.69	41.97	7.4	<LOD	7.4	<LOD	45.94	154.64	11.81
SS2.1	0 -50mm	25	27/08/2015 9:36	60	<LOD	10.88	<LOD	<LOD	65.92	<LOD	15.89	122.58	9.28	<LOD	6.64	<LOD	39.75	75.98	8.44
SS2.1	0 -50mm	26	27/08/2015 9:37	60	<LOD	11.65	<LOD	<LOD	74.07	<LOD	17.33	125.22	9.96	<LOD	7.49	<LOD	43.66	69.55	8.78
SS2.1	0 -50mm	27	27/08/2015 9:38	61	<LOD	10.39	<LOD	<LOD	71.09	<LOD	15.75	103.82	8.92	<LOD	6.76	<LOD	41.26	80.58	8.68
SS3.1	0 -50mm	28	27/08/2015 9:41	60	<LOD	10.59	<LOD	<LOD	84.93	<LOD	18.9	68.36	8.9	<LOD	7.84	<LOD	49.26	78.15	9.81
SS3.1	0 -50mm	29	27/08/2015 9:43	60	<LOD	10.7	<LOD	<LOD	84.21	<LOD	18.87	78.76	9	<LOD	8.03	59.6	33.15	83.76	9.78
SS3.1	0 -50mm	30	27/08/2015 9:44	60	<LOD	9.66	<LOD	<LOD	83.81	<LOD	18.98	59.35	8.28	<LOD	7.85	<LOD	48.35	84.64	9.78
SS4.1	0 -50mm	31	27/08/2015 9:48	61	<LOD	13.47	<LOD	<LOD	75.92	<LOD	20.23	141.92	11.35	<LOD	8.17	<LOD	48	86.18	10.31
SS4.1	0 -50mm	32	27/08/2015 9:49	60	<LOD	13.16	<LOD	<LOD	94.58	23.81	15.81	101.66	11.12	<LOD	9.38	<LOD	55.5	95.1	11.73
SS4.1	0 -50mm	33	27/08/2015 9:50	60	<LOD	11.34	<LOD	<LOD	76.02	<LOD	18.44	108.44	9.73	<LOD	7.44	<LOD	44.71	74.16	9.18
SS5.1	0 -50mm	43	27/08/2015 10:09	75	<LOD	6.08	<LOD	<LOD	65.1	<LOD	14.6	10.23	5.32	<LOD	6.29	<LOD	38.85	55.8	7.16
SS5.1	0 -50mm	44	27/08/2015 10:10	60	<LOD	7.85	<LOD	<LOD	79.37	<LOD	18.91	16.17	6.68	<LOD	7.94	<LOD	49.13	54.99	8.5
SS5.1	0 -50mm	45	27/08/2015 10:11	60	<LOD	7.28	<LOD	<LOD	79.83	<LOD	19.34	<LOD	9.26	<LOD	8.05	<LOD	46.79	43.55	8.16
SS6.1	0 -50mm	46	27/08/2015 10:14	90	17.89	5.75	23.6	<LOD	69.72	24.55	11.86	45.75	6.9	<LOD	6.96	<LOD	40.98	107.15	9.43
SS6.1	0 -50mm	47	27/08/2015 10:15	92	16.01	5.12	21.1	<LOD	63.24	<LOD	14.48	52	6.2	<LOD	5.75	<LOD	35.98	94.98	7.89
SS6.1	0 -50mm	48	27/08/2015 10:17	90	18.38	5.36	23.7	<LOD	65.32	<LOD	16.09	36.74	6.38	<LOD	6.46	<LOD	39.43	89.36	8.47
SS7.1	0 -50mm	49	27/08/2015 10:22	61	7.47	4.9	12.4	<LOD	73.97	<LOD	16.66	17.47	6.11	<LOD	7.1	64.02	29.93	84.7	8.96
SS7.1	0 -50mm	50	27/08/2015 10:23	61	11.09	4.92	16.0	<LOD	70.15	<LOD	15.56	23.77	6.05	<LOD	6.3	<LOD	41.08	94.54	8.8
SS7.1	0 -50mm	51	27/08/2015 10:24	60	<LOD	8.58	<LOD	<LOD	88.95	<LOD	21.22	12.97	7.07	<LOD	8.74	74.23	36.89	79.58	10.52
SS8.1	0 -50mm	53	27/08/2015 10:30	60	<LOD	7.5	<LOD	<LOD	79.56	<LOD	18.47	11.99	6.39	<LOD	7.97	<LOD	46.84	50.56	8.3
SS8.1	0 -50mm	54	27/08/2015 10:31	60	7.49	4.72	12.2	<LOD	75.84	<LOD	16.99	<LOD	8.77	<LOD	7.03	<LOD	45.17	59.42	8.31
SS8.1	0 -50mm	55	27/08/2015 10:33	60	<LOD	8.09	<LOD	<LOD	83.55	<LOD	19.83	<LOD	10.12	<LOD	8.42	<LOD	49.7	58.08	9.34
SS9.1	0 -50mm	154	11/09/2015 13:05	60	<LOD	7.1	<LOD	<LOD	67.15	<LOD	16.86	12.17	6.03	<LOD	6.94	<LOD	41.48	50.01	7.71
SS9.1	0 -50mm	155	11/09/2015 13:07	60	<LOD	6.92	<LOD	<LOD	67.05	<LOD	14.9	18.57	5.86	<LOD	6.42	<LOD	40.27	55.82	7.39
SS9.1	0 -50mm	156	11/09/2015 13:08	61	<LOD	8.11	<LOD	<LOD	81.92	<LOD	19.15	15.16	6.74	<LOD	7.79	<LOD	48.28	53.66	8.63
SS10.1	0 -50mm	157	11/09/2015 13:09	60	19.95	6.46	26.4	<LOD	64.56	18.94	10.42	83.23	7.8	<LOD	6.21	<LOD	37.13	99.52	8.86
SS10.1	0 -50mm	158	11/09/2015 13:10	60	16.16	5.69	21.9	<LOD	71.54	19.46	11.65	35.28	6.81	<LOD	7.01	<LOD	42.74	144.59	11.1
SS10.1	0 -50mm	159	11/09/2015 13:14	180	18.24	3.49	21.7	<LOD	42	16.82	7.02	36.63	4.14	<LOD	4.12	<LOD	24.73	118.95	6.2
SS10.2	200mm	160	11/09/2015 13:23	91	18.59	4.27	22.9	<LOD	58.33	<LOD	13.23	21.34	5.01	<LOD	5.37	<LOD	34.1	94.9	7.43
SS10.2	200mm	161	11/09/2015 13:25	90	16.67	4.08	20.8	<LOD	58.46	<LOD	13.33	16.06	4.8	<LOD	5.27	<LOD	34.02	91.12	7.28
SS10.2	200mm	162	11/09/2015 13:27	91	11.63	5.07	16.7	<LOD	73.2	<LOD	18	18.25	6.13	<LOD	7.07	<LOD	43.49	71.64	8.48
SS10.3	300mm	163	11/09/2015 13:31	60	<LOD	9.43	<LOD	<LOD	101.62	<LOD	25.69	<LOD	11.63	<LOD	10.43	<LOD	61.6	47	10.44
SS10.3	300mm	164	11/09/2015 13:32	60	6.87	4.52	11.4	<LOD	79.85	<LOD	17.46	<LOD	8.44	<LOD	7.3	<LOD	46.34	57.63	8.21
SS10.3	300mm	165	11/09/2015 13:33	60	<LOD	7.33	<LOD	<LOD	82.59	<LOD	18.2	<LOD	9.31	<LOD	7.83	<LOD	48.01	56.36	8.71
SS11.1	0 -50mm	166	11/09/2015 13:16	120	20.46	4.63	25.1	<LOD	53.56	14.88	8.74	50.88	5.49	<LOD	5.18	<LOD	32.43	100.3	7.16
SS11.1	0 -50mm	167	11/09/2015 13:19	121	18.22	4.67	22.9	<LOD	54.1	17.62	8.95	52.67	5.61	<LOD	5.12	<LOD	32.59	100.48	7.21
SS11.1	0 -50mm	168	11/09/2015 13:21	121	17.76	4.8	22.6	<LOD	54.57	14.56	8.72	63.03	5.81	<LOD	5.29	<LOD	32.05	101.31	7.18
SS12.1	0 -50mm	169	11/09/2015 13:35	61	11.91	6.17	18.1	<LOD	89.64	<LOD	21.82	19.6	7.45	<LOD	8.87	<LOD	49.59	63.36	9.89
SS12.1	0 -50mm	170	11/09/2015 13:36	60	<LOD	9.39	<LOD	<LOD	89.94	<LOD	22.19	22.57	7.8	<LOD	9.06	<LOD	52.75	71.6	10.56
SS12.1	0 -50mm	171	11/09/2015 13:37	60	10.28	5.76	16.0	<LOD	83.24	<LOD	19.6	19.9	7.06	<LOD	8.03	<LOD	49.24	58.48	9.07
SS13.1	0 -50mm	172	11/09/2015 13:39	90	21.87	4.29	26.2	<LOD	60.58	34.5	9.56	21.72	4.93	<LOD	5.47	36.43	23.01	78.68	6.91
SS13.1	0 -50mm	173	11/09/2015 13:41	90	34.42	4.81	39.2	<LOD	52.57	43.18	9.04	48.82	5.4	<LOD	5.02	<LOD	30.36	115.33	7.48
SS13.1	0 -50mm	174	11/09/2015 13:43	91	36.94	5.14	42.1	<LOD	56.23	38.91	9.48	50.83	5.73	<LOD	5.23	<LOD	32.12	96.98	7.35
SS14.1	0 -50mm	176	11/09/2015 13:47	90	23.78	7.71	31.5	<LOD	78.59	21.92	13.45	98.42	9.27	<LOD	7.97	<LOD	46.11	85.12	9.58
SS14.1	0 -50mm	177	11/09/2015 13:49	120	14.51	6.27	20.8	<LOD	65.65	29.86	11.2	101.78	7.76	<LOD	6.13	<LOD	37.77	85.17	7.88
SS14.1	0 -50mm	178	11/09/2015 13:51	97	17.9	5.91	23.8	<LOD	60.84	<LOD	13.92	99.45	7.25	<LOD	5.63	<LOD	32.94	91.28	7.55
SS15.1	0 -50mm	179	11/09/2015 13:54	91	26.75	5.54	32.3	<LOD	61.71	<LOD	14.9	55.55	6.44	<LOD	5.9	<LOD	36.16	131.5	9.13
SS15.1	0 -50mm	180	11/09/2015 13:56	90	22.7	5.05	27.8	<LOD	54.49	22.51	8.56	72.39	6.03	<LOD	5.04	<LOD	31.33	155.62	8.51
SS15.1	0 -50mm	181	11/09/2015 13:57	91	25.12	4.89	30.0	<LOD	51.25	20.39	8.17	69.79	5.77	<LOD	4.83	<LOD	30.41	146.61	8.06
SS16.1	0 -50mm	182	11/09/2015 13:59	60	<LOD	8.29	<LOD	<LOD	78.97	<LOD	17.42	29.89	6.94	<LOD	7.05	<LOD	44.76	63.77	8.57
SS16.1	0 -50mm	183	11/09/2015 14:00	60	<LOD	8.08	<LOD	<LOD	73.24	<LOD	17.09	27.49	6.77	<LOD	7.16	<LOD	43.04	50.21	7.83
SS16.1	0 -50mm	184	11/09/2015 14:01	60	<LOD	8.93	<LOD	<LOD	81.18	<LOD	18.82	30.81	7.44	<LOD	8.08	<LOD	48.8	60.65	8.96
SS17.1	0 -50mm	185	11/09/2015 14:04	91	20.69	5.23	25.9	<LOD	53.06	<LOD	13.01	69.42	6.27	<LOD	5.29	<LOD	32.58	127.77	8.27
SS17.1	0 -50mm	186	11/09/2015 14:05	78	15.19	6.06	21.3	<LOD	68.83	<LOD	16.81	62.21	7.38	<LOD	6.67	<LOD	40.88	112.8	9.57
SS17.1	0 -50mm	187	11/09/2015 14:07	85	12.43	5.07	17.5	<LOD	56.96	<LOD	13.14	68.58	6.28	<LOD	5.35	<LOD	33.01	112.3	7.87
SS18.1	0 -50mm	188	11/09/2015 14:08	60	10.75	4.96	15.7	<LOD	81.53	<LOD	17.82	<LOD	9	<LOD	7.39	<LOD	46.45	85.93	9.65
SS18.1	0 -50mm	189	11/09/2015 14:09	60	7.46	4.74	12.2	<LOD	76.99	<LOD	16.87	<LOD	8.85	<LOD	7.32	<LOD	45.66	90.12	9.53
SS18.1	0 -50mm	190	11/09/2015 14:11	62	<LOD	7.14	<LOD	<LOD	82.94	<LOD	18.08	<LOD							

Appendix C – Table of Laboratory Results

Table of Results -150 Dunbars Rd, Halswell

Date of testing: 27th August & 11th September, 2015

Analyte	Sample Name:	2.1	6.1	6.2	9.1	10.1	11.1	12.1	14.1	RPD Value (6.1 & 6.2)	Soil Guideline values					
Soil Results	Lab Number: Depth:	1468138.2 0 - 50mm	1468138.6 0 - 50mm	1468138.7 0 - 50mm	1474731.1 0 - 50mm	1474731.2 0 - 50mm	1474731.3 0 - 50mm	1474731.4 0 - 50mm	1474731.5 0 - 50mm		Residential 10% produce	Commercial/ Outdoor Worker	Reference	Ecological receptors	Reference	Background ₁
Heavy Metals																
Total Recoverable Arsenic	mg/kg dry wt	6	27	23	9	28	34	13	28	15%	20	70	NES	17	CCME	11.5
Total Recoverable Cadmium	mg/kg dry wt	0.17	0.29	0.26	-	-	-	-	0.23	10%	3.0	1,300	NES	10	CCME	0.18
Total Recoverable Chromium	mg/kg dry wt	17	23	24	-	-	-	-	27	4%	460	6,300	NES	64	CCME	20.8
Total Recoverable Copper	mg/kg dry wt	14	29	29	-	-	-	-	27	0%	>10,000	>10,000	NES	63	CCME	18.8
Total Recoverable Lead	mg/kg dry wt	173	89	88	-	-	-	-	181	1%	210	3,300	NES	300	CCME	37.4
Total Recoverable Nickel	mg/kg dry wt	13	14	14	-	-	-	-	13	0%	130	1,800	EAUK	50	CCME	19
Total Recoverable Zinc	mg/kg dry wt	118	143	147	-	-	-	-	138	3%	7,400	400,000	NEPM	200	CCME	86.5

Analyte	Sample Name:	R1
Aqueous Results (Rinse Water)	Lab Number:	1468138.1
Heavy Metals		
Arsenic	g/m³	< 0.0011
Cadmium	g/m³	< 0.000053
Chromium	g/m³	0.00063
Copper	g/m³	0.0126
Lead	g/m³	0.00032
Nickel	g/m³	< 0.00053
Zinc	g/m³	0.009

Indicates result exceeds residential guideline value

Indicates result exceeds ecological guideline value

Indicates result exceeds background value for soil type

NES - National Environmental Standard for Assessing and Managing Contaminants in Soils, MFE
NEPM - National Environmental Protection Measures 2013, Formerly NEPC, Australia
EAUK - Soil guideline values for nickel - Environment Agency UK 2009
CCME - Canadian Environmental Quality Guidelines, CCME (updated 2012)
₁ Concentrations for "Recent Regional" soil group from Background concentrations of selected trace elements in Canterbury soils, Tonkin and Taylor, July 2007

Appendix D – Laboratory Reports



ANALYSIS REPORT

Page 1 of 2

Client:	Malloch Environmental Limited	Lab No:	1468138	SPV1
Contact:	Nicola Peacock	Date Registered:	28-Aug-2015	
	C/- Malloch Environmental Limited	Date Reported:	09-Sep-2015	
	801 East Maddisons Road	Quote No:		
	ROLLESTON 7614	Order No:		
		Client Reference:	GW Dunbars	
		Submitted By:	Nicola Peacock	

Sample Type: Soil						
Sample Name:	SS2.1	SS6.1	SS6.2			
	27-Aug-2015 9:27 am	27-Aug-2015 10:14 am	27-Aug-2015 10:15 am			
Lab Number:	1468138.2	1468138.6	1468138.7			
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	6	27	23	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.17	0.29	0.26	-	-
Total Recoverable Chromium	mg/kg dry wt	17	23	24	-	-
Total Recoverable Copper	mg/kg dry wt	14	29	29	-	-
Total Recoverable Lead	mg/kg dry wt	173	89	88	-	-
Total Recoverable Nickel	mg/kg dry wt	13	14	14	-	-
Total Recoverable Zinc	mg/kg dry wt	118	143	147	-	-

Sample Type: Aqueous						
Sample Name:	R.1 27-Aug-2015 10:37 am					
Lab Number:	1468138.10					
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m ³	< 0.0011	-	-	-	-
Total Cadmium	g/m ³	< 0.000053	-	-	-	-
Total Chromium	g/m ³	0.00063	-	-	-	-
Total Copper	g/m ³	0.0126	-	-	-	-
Total Lead	g/m ³	0.00032	-	-	-	-
Total Nickel	g/m ³	< 0.00053	-	-	-	-
Total Zinc	g/m ³	0.0090	-	-	-	-

SUMMARY OF METHODS

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

Sample Type: Soil			
Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	2, 6-7
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	2, 6-7
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	2, 6-7
Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, trace level	0.000053 - 0.0011 g/m ³	10
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 22 nd ed. 2012 (modified).	-	10



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

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

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

A handwritten signature in blue ink, appearing to be 'Ara Heron', written over a horizontal line.

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



ANALYSIS REPORT

Page 1 of 1

Client:	Malloch Environmental Limited	Lab No:	1474731	SPv1
Contact:	Nicola Peacock C/- Malloch Environmental Limited 801 East Maddisons Road ROLLESTON 7614	Date Registered:	12-Sep-2015	
		Date Reported:	17-Sep-2015	
		Quote No:		
		Order No:		
		Client Reference:	Dunbars	
		Submitted By:	Nicola Peacock	

Sample Type: Soil						
Sample Name:	SS9.1 11-Sep-2015 1:02 pm	SS10.1 11-Sep-2015 1:10 pm	SS11.1 11-Sep-2015 1:13 pm	SS12.1 11-Sep-2015 1:31 pm	SS14.1 11-Sep-2015 1:45 pm	
Lab Number:	1474731.1	1474731.2	1474731.3	1474731.4	1474731.5	
Individual Tests						
Total Recoverable Arsenic	mg/kg dry wt	9	28	34	13	-
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	-	-	-	-	28
Total Recoverable Cadmium	mg/kg dry wt	-	-	-	-	0.23
Total Recoverable Chromium	mg/kg dry wt	-	-	-	-	27
Total Recoverable Copper	mg/kg dry wt	-	-	-	-	27
Total Recoverable Lead	mg/kg dry wt	-	-	-	-	181
Total Recoverable Nickel	mg/kg dry wt	-	-	-	-	13
Total Recoverable Zinc	mg/kg dry wt	-	-	-	-	138

SUMMARY OF METHODS

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

Sample Type: Soil			
Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-5
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	5
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-5
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-4

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

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

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

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



This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised. The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

Appendix B – Remediation Location Plan



LEGEND

- ⊙ SS3 Soil sample location XRF and lab tested
- ⊙ SS3 Soil sample location XRF tested
- ⊙ **SS3** Soil sample location that exceeds Residential SGV for arsenic
- Proposed remediation area

Notes:

1. This plan has been prepared for soil contamination risk assessment purposes only. No liability is accepted if the plan is used for any other purposes.
2. Any measurements taken from this plan which are not dimensioned on the electronic copy are at the risk of the user.
3. Soil sample locations are approximate only.



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Remediation Location Plan 150 Dunbars Rd, Halswell, Christchurch

Scale: NTS

Date: 3 February, 2016

Drawing No: 01056/3