STS GeoEnvironmental Pty Ltd
Geotechnical and Environmental Solutions

REMEDIAL ACTION PLAN

FOR

NSW LAND AND HOUSING CORPORATION

Land at 188-190 Moore Street, Liverpool, New South Wales

Report No: 16/0735

Project No: 10530/2746B (STS No. 6795C)

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EXECUTIVE SUMMARY

This Remedial Action Plan (RAP) has been prepared for the property at 188-190 Moore Street, Liverpool, New South Wales (the 'site'). The purpose of this RAP is to provide a plan of remediation which will be implemented to make the site suitable for the proposed high density residential land use. This RAP has been prepared in accordance with Environment Protection Authority (EPA) guidelines for the assessment and management of site contamination.

The results of a previous environmental assessment undertaken by STS GeoEnvironmental in April 2016 show that the concentrations of chemical contaminants measured in soil samples retrieved from the site are generally low. However, the presence of asbestos was identified in soil at two locations in the northern part of 188 Moore Street (location BH2) and in the centre of the backyard at 190 Moore Street (location BH6), posing a potential risk to human health in the proposed redevelopment. The presence of asbestos in soils at these two locations and is above criteria that are designed to be protective of human-health for a high density residential land use setting. Therefore, remediation of soils on the site is necessary to make the site suitable for the proposed high density residential use.

The remedial strategy provided in this RAP has been developed with respect to the preferred order of remedial options outlined in the ANZECC Guidelines, which are endorsed by the NSW EPA. The preferred remedial option, being excavation and offsite disposal of the contaminated soil, is considered to be the most appropriate and cost-effective remediation method in view of the type of contamination on the site and with respect to the site's proposed bulk excavation for the construction of a basement car parking facility, which would require the removal of all contaminated soil in any case. Other more preferred remedial options are either not available, not cost effective, or are not applicable within the timeframe of the remedial program.

The results of the soil sampling performed to date show that the soil on the site is predominantly classed as General Solid Waste (GSW) for the purposes of offsite disposal to a landfill facility, and it is likely that the natural soils beneath the surficial topsoil and fill layer may be able to be classified as virgin excavated natural material (VENM). However, the presence of asbestos in the surficial soils at two locations require the soil from these locations to be classed as Special Waste (Asbestos). Therefore, in order to contain landfill disposal costs, it is recommended that the two asbestos 'hotspots' be excavated and removed separately, thus enabling the bulk of the fill to be disposed of as GSW. Procedures for the remediation of the two asbestos contamination hotspot areas are outlined in this RAP.

This RAP also outlines a methodology to validate the site to confirm that all unacceptable soil contamination has been appropriately remediated. In addition, this RAP outlines a number of operational management strategies to ensure that the remedial works will not cause adverse impacts to human health or the environment, or result in a disruption or loss of amenity, particularly for neighbouring properties. Contingency plans for the remedial works are also provided. Completion of the remediation and validation program in accordance with this RAP

will ensure that the site is made suitable for a high density residential land use without restrictions.

1. INTRODUCTION

STS GeoEnvironmental Pty Ltd (STS) has prepared a Remedial Action Plan (RAP) for the remediation and validation program which is to be performed at the property 188-190 Moore Street, Liverpool, NSW (the 'site'). This RAP must be adhered to by all personnel and contractors involved in the remediation and redevelopment of the site.

The site is proposed to be redeveloped for a high density residential use. We understand that this will involve the demolition of the existing building on the site located at 190 Moore Street, and the construction of a new four-storey residential unit complex comprising fourteen one bedroom units and nine two bedroom units with twenty-one basement car parking spaces. Bulk excavation of the entire site will be necessary for the construction of the basement area. The proposed development plans have not been finalized at this stage.

The objectives of the RAP are to:

- Summarise the condition of the site and its land use history;
- Outline the extent of contamination that has been identified at the site;
- Provide a cost effective remedial strategy to make the site suitable for the proposed residential redevelopment; and
- Outline the details of a validation sampling strategy which would be implemented to determine the effectiveness of the remedial works, and to confirm the suitability of the site for a high density residential land use.

2. SITE IDENTIFICATION

The site has an area of 1,375.6 m^2 and is defined as Lots 10 and 11 in Deposited Plan (DP) 35980, Parish of St Luke, County of Cumberland. The location of the site is shown on Drawing No. 16/2746B/1.

The site is located within the Liverpool City Council local government area and is zoned 'R4 – High Density Residential'.

3. PREVIOUS ENVIRONMENTAL REPORTS

A Preliminary Site Investigation (PSI) report was previously prepared for the site by SMEC Testing Services in October 2015:

- *SMEC Testing Services Pty Ltd (2015), Preliminary Site Investigation, 188-190 Moore Street, Liverpool, NSW, for NSW Land and Housing Corporation, Report No. 15/2746, October 2015.*

Potential contamination sources that were identified during the PSI included the presence of asbestos fibres in soils on the site due to the breakdown of the fibre cement sheeting on the existing house and the previous house located at the vacant block of land at 188 Moore Street.

The use of lead-based paints was also identified as a potential source of contamination during the PSI. However, the potential for the soils on the site to be chemically contaminated at levels that would be significant for a high density residential land use setting was considered to be generally low. It was noted that the proposed residential redevelopment of the site provides for the construction of a basement car parking facility that will require the bulk excavation of the entire site to a depth of approximately 3 m. This would remove all fill material from the site and also a considerable amount of the underlying natural soil and rock. Therefore, the proposed site redevelopment would effectively remediate the site.

Based on the results of the PSI, the site was considered to be suitable for the proposed high density residential redevelopment, provided that the land is developed in accordance with the current development plans. However, a soil sampling program was recommended to verify this and to classify the soils on the site for offsite disposal prior to the commencement of any bulk excavation works.

The subsequent Preliminary Soil Sampling and Analysis Program was completed in April 2016 and reported in:

- *STS GeoEnvironmental (2016), Preliminary Soil Sampling and Analysis Program, 188-190 Moore Street, Liverpool, NSW, for NSW Land and Housing Corporation, Report No. 16/0639, April 2016.*

The Preliminary Soil Sampling and Analysis Program undertook sampling at seven (7) locations across the site and selected samples were analysed for a broad range of contaminants of potential concern (COPCs). The concentrations of COPCs measured in the soils across the site were low, and at levels that would not present an unacceptable risk to human-health or the environment for a high density residential land use. Further, the site was not expected to be a source of groundwater impacts.

Based on the analytical data obtained from the soil sampling and analysis program, the majority of soils on the site were classed as General Solid Waste (GSW). However, asbestos fibres were identified in soils at two locations in the northern part of 188 Moore Street (location BH2) and in the centre of the backyard at 190 Moore Street (location BH6), posing a risk to human health in the proposed site development. Soils from these two locations would

be classed as Special Waste (Asbestos), although a delineation and validation of the waste classification would be required to distinguish soils to be classed as GSW and soils at locations BH2 and BH6 that would be classed as Special Waste (Asbestos).

The preparation of a Remedial Action Plan (RAP) for the site was recommended to enable a delineation, excavation, waste classification for offsite disposal of asbestos impacted soils from the site.

3.1 Site History Review

An appraisal of the land use history at the site was performed for the PSI, and involved a review of historical aerial photographs dating back to 1930, historical land titles and a Council Section 149(2) planning certificate. In addition, NSW EPA databases in relation to contaminated land management and chemical storage/waste generation licensing were also reviewed.

Based on the above information sources, it was confirmed that the site has historically been used for residential purposes since 1951, which has continued to the present day, although a house which existed in the allotment forming the eastern portion of the site (188 Moore Street) had been demolished between 2009 and 2012, and the land has since remained vacant. In addition, the house located at 190 Moore Street is not occupied at present. Prior to 1951 the site was vacant and its use unknown.

3.2 Geology and Hydrogeology

A review of geology and hydrogeology of the site was performed for both the PSI and the Preliminary Soil Sampling and Analysis Program, with specific information on the nature of soils at the site being obtained during the soil sampling program.

The review showed that the site is underlain by Triassic Age geological formation being Bringelly Shale of the Wianamatta Group. The Bringelly Shale formation typically comprise shale, claystone and laminites. The natural soils encountered during the PSI and the Preliminary Soil Sampling and Analysis Program comprised orange brown silty clays, which are consistent with residual soils weathered from the regional geological formation. A layer of topsoil or fill between approximately 0.1 m and 0.5 m in thickness was also identified during the PSI and the Preliminary Soil Sampling and Analysis Program, with the composition of the topsoil/fill material comprising silty clay and sandy gravel.

No regional groundwater was encountered in any of the boreholes drilled on the site, however, based on the geological review it is expected that groundwater may be encountered at depths between 8 m and 10 m below the ground surface, with the groundwater flow direction expected to follow the natural land slope contour at the site, this being to the east. Further, groundwater flowing beneath the site would be expected to ultimately discharge to

Brickmakers Creek, located approximately 300 m to the east of the site. Brickmakers Creek is a tributary stream to the Georges River.

3.3 Extent of Land Contamination

Soil sampling was undertaken at seven (7) boreholes drilled at evenly spaced locations across the site as part of the previous Preliminary Soil Sampling and Analysis Program. The soil samples were analysed for a broad screen of chemical contaminants, including heavy metals, total petroleum hydrocarbons (TPHs), monocyclic aromatic hydrocarbons (MAHs), polycyclic aromatic hydrocarbons (PAHs), phenolic compounds, organochlorine pesticides (OCPs), organophosphorus pesticides (OPPs), polychlorinated biphenyls (PCBs), and asbestos. A site plan showing the soil sampling locations from the Preliminary Soil Sampling and Analysis Program is provided in Drawing No. 16/2746B/2, and the soil sampling results are summarised in Table A (provided in Appendix A).

The results of the sampling program showed that whilst the contaminant concentrations in the soils across the site are generally low, and below criteria that are protective of human-health for a high density residential land use setting, asbestos fibres were detected at two locations in near surface soils retrieved from boreholes BH2 (Sample S3) in the northern area of the vacant lot at 188 Moore Street and from borehole BH6 (Sample S11) located in the central backyard area of 190 Moore Street. At sample location BH2 soil contained 0.005% friable asbestos, including chrysotile (white asbestos), amosite (brown asbestos) and crocidolite (blue asbestos). At sample location BH6 soil contained 0.0005% friable asbestos (i.e. crocidolite - blue asbestos). However, no free fibres were identified in any of the soil samples analysed for asbestos. In view of this, remediation of the asbestos-impacted soil would be necessary to make the site suitable for the proposed high density residential redevelopment.

3.4 Outcomes of Previous Assessments

As the entire site is proposed to be bulk excavated during redevelopment, all chemically impacted fill and also substantial volumes of underlying natural soil and rock material will need to be removed from the site. That is, the site would be effectively remediated simply by redeveloping the land in accordance with the proposed development. However, specific requirements will need to be implemented during redevelopment to ensure that the asbestos-impacted soil is appropriately handled and disposed of during the proposed excavation works for the basement area. In view of this, it was recommended that a RAP be prepared, which would outline procedures to address the chemically impacted soil during redevelopment.

4. WASTE CLASSIFICATION OF SOILS

In order to determine disposal options for the surplus soils which are to be derived from the bulk excavation of the site, the analytical results from the chemical analyses of the soil samples were compared against the criteria of the *Waste Classification Guidelines, Part 1: Classifying Waste* (NSW EPA, 2014). The results of the waste classification are provided in Table A (see Appendix A). The analytical laboratory reports for the primary soil data used in the waste classification were provided in Appendix C of the Preliminary Soil Sampling and Analysis Program report (STS GeoEnvironmental, April 2016).

The results show that the concentrations of chemical contaminants in the soil samples do not exceed the Waste Guidelines' CT1 values for General Solid Waste (GSW), with the exception of lead in three soil samples:

- S7 (126 mg/kg) from location BH4; and
- S9 (215 mg/kg) and S10 (123 mg/kg) from location BH5.

The concentrations of lead in these three samples marginally exceeded the CT1 criterion for GSW (100 mg/kg). Subsequent analysis of the potential leachability of lead from these soils (TCLP testing) confirmed that the concentrations of leachable lead in soil samples S7, S9 and S10 were below the combined SCC1 and TCLP1 criteria for GSW (1,500 mg/kg and 5 mg/L, respectively).

Therefore, the soils on the site meet the criteria for GSW, with the exception of soils that are impacted by asbestos at locations BH2 and BH6. Soils at these locations would be classed as Special Waste (Asbestos). Further, delineation of the vertical and lateral extent of the asbestos contamination hotspots is required, followed by excavation and removal of the asbestos-impacted soils from the site. In addition, validation of the asbestos hotspot excavation areas at BH2 and BH6 is required to enable a classification of the remaining soil to be excavated from the site as GSW.

It is also noted that the results of the Preliminary Soil Sampling Program (refer to Table A) show that the concentrations of contaminants measured in the samples of soil retrieved from the site are low and within natural background levels. Therefore, it is expected that the natural soil beneath the fill layer and the topsoils at the site may be classed as virgin excavated natural material (VENM), and therefore be deemed suitable for beneficial reuse as clean fill on other development sites. However, following the removal of the fill and topsoil layer on the site, further inspection and soil sampling and analysis across the top of the natural soil profile would be necessary to confirm a VENM classification for the underlying natural clays.

5. REMEDIAL STRATEGY

The goals of the remedial program are to remediate the site such that the site does not present a risk to human-health for a residential land use setting with limited accessible soil.

5.1 Remedial Options and Preferred Remedial Strategy

The *Guidelines for the NSW Site Auditor Scheme (2nd Edition)* (DEC, 2006) outlines EPA's preferred remedial strategies. These adopt the ANZECC/NHMRC site remediation policy provided in the *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites 1992* (ANZECC Guidelines). The preferred order of options for site remediation and management outlined in the ANZECC Guidelines is:

- On site treatment of the soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level; or
- Off-site treatment of excavated soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level, after which the soil is returned to the site.

The Guidelines also note that if these options cannot be implemented then other options that should be considered include:

- Removal of contaminated soil to an approved site or landfill facility, followed, where necessary, by replacement with clean fill; and
- Consolidation and isolation of the soil on the site by containing with a properly designed barrier.

However, there are currently no technologies for the removal of asbestos fibres from the soil mass. Further, given that the entire site is proposed to be bulk excavated during redevelopment, any treated soil could not be reused on the site in any case.

The next preferred option for site remediation in accordance with the ANZECC (1992) hierarchical approach to site remediation involves the removal of contaminated soil to an approved landfill facility. In view of the proposed bulk excavation of the site, offsite disposal is the preferred and most cost-effective remedial strategy for the site.

5.2 Timeline for Remedial Program

The key components of the remediation and validation program and a proposed timeline for their implementation are summarized below. The individual components are addressed in further detail in the following sections of this RAP.

- ***Step 1: Excavation of the soils from the two asbestos 'hotspots' at BH2 and BH6, followed by validation sampling from the walls and base of the two excavated remediation areas at BH2 and BH6 to confirm that all soil classed as Special Waste (Asbestos) has been removed;***
- ***Step 2: Offsite disposal of Special Waste (Asbestos) to a landfill facility;***
- ***Step 3: Completion of the bulk excavation across the site and off-site disposal of the soils up to a depth of up to 3 m as GSW.***

Note that If the underlying natural soil profile is to be classed as VENM, the topsoil/fill material present on the site would need to be excavated and removed separately as GSW, followed by validation sampling across the top of the natural soil profile prior to the implementation of the bulk excavation and removal of the natural clay soils. In addition, the RAP would need to be amended accordingly, to reflect the additional validation sampling and analysis and VENM classification of the natural soils on the site.

5.3 Excavation of Contamination Hotspots

Based on the results of the soil sampling performed to date, it is recommended that the asbestos hotspots identified at sample locations BH2 and BH6 be removed in the first instance, as this will enable the remainder (bulk) of the fill material and underlying natural soils to be classed simply as GSW, thus minimising landfill disposal costs.

Initially, soil will be excavated across a 16 m^2 (4 m by 4 m) area centred over each of the two asbestos hotspot locations BH2 and BH6. The two excavations will extend to 0.5 m depth or to the base of the fill layer at each location, whichever is greater. The locations and extent of the two remediation areas is shown on Drawing No. 16/2746/2.

The soil which is excavated from the hotspot locations will be either temporarily stockpiled on plastic sheeting prior to removal from the site, or loaded directly into trucks for landfill disposal. It is expected that a minimum of approximately 8 m^3 of waste soil will be generated from each of the two contamination hotspot remediation areas at BH2 and BH6, i.e. a total of about 16 m^3.

After the excavation works have been completed, validation sampling will be performed to confirm the absence of asbestos in the soils in the two asbestos hotspot remediation areas. The procedures for validation sampling in excavated areas are outlined in Section 6 of this RAP. Further excavation may be necessary should the results of the initial validation sampling show a presence of asbestos in soils in any of the walls and/or the base of the two remediation area excavation pits. The procedure to remove any residual contaminated soil will be to extend by

0.5 m any wall or base where a validation sample has 'failed', followed by resampling in accordance with the validation procedures outlined in Section 6 of this RAP.

After all necessary validation sampling has been performed for the two asbestos contamination hotspot areas at BH2 and BH6, bulk excavation of the remnant soils on the site to a depth of 3 metres below ground level may commence.

5.4 Classification and Disposal of Waste Soil

The soil sampling and analysis which has been performed to date is considered to be sufficient to classify the soils across the majority of the site for landfill disposal purposes. However, it is recommended that an additional stand-alone waste classification and remediation validation report be prepared for the remainder of the fill and topsoil layer, following the removal of the asbestos-impacted soils. This report will include details of the validation sampling and analysis of soils for asbestos at the two contamination hotspot excavation remediation areas. The procedures for the validation sampling are outlined in Section 6.

If a separate VENM classification of the underlying natural clays is required, the validation sampling and analysis of the underlying soils would be undertaken, following the excavation and offsite removal of the topsoil/fill layer material. The results of the VENM validation sampling would be reported in the same waste classification and remediation validation report.

Prior to any soil being removed from the site the relevant waste classification and contamination hotspot excavation remediation validation report will need to be submitted to the selected landfill facility in order to obtain their approval for the disposal of the soil. The soil would then be transported to a landfill facility by an appropriately licensed contractor once the necessary disposal approval has been granted. The landfill will be requested to provide receipts confirming the appropriate disposal of the contaminated soil at that facility. EPA-approved waste transport certificates will be completed to accompany each load of soil delivered to the landfill, where applicable.

5.5 Handling of Other Wastes

Groundwater is not expected to be encountered during the removal of the contamination hotspots or during the bulk excavation of the site. However, should any groundwater or surface runoff accumulate in the base of the excavations, this will be removed by a suction truck and disposed of to a licensed waste treatment facility, in accordance with EPA regulations and statutory requirements. Alternatively, the water could potentially be discharged to sewer provided that it the appropriate approvals are obtained from the relevant consent authorities (Sydney Water).

5.6 Contingency Plan

As the remedial program will involve the excavation and offsite disposal of soil to landfill, there is little chance for this remedial strategy to fail. Contingency measures would need to be implemented should the results of the remediation area validation sampling to be performed at the two asbestos-hotspot remediation areas as part of the contamination hotspot validation program identify persistent asbestos contamination on the site. These contingency measures are discussed below.

5.6.1 Procedures to Address Additional Asbestos Contamination

Should persisting asbestos contamination be identified based on the results of the remediation area validation sampling program, the same procedures for soil removal and disposal, as outlined in Sections 5.3 and 5.4 above, will be implemented. Samples retrieved from the walls and bases of the remediation area hotspot excavations would be analysed for the contaminant of concern which triggered the remedial works (i.e. asbestos).

6. VALIDATION PROGRAM

In order to minimise landfill disposal costs for the soil material to be removed from the site and to confirm if the site is suitable for the proposed high density residential redevelopment, a validation program will be implemented. This will involve soil sampling from the walls and base of the excavated areas where the two hotspots of asbestos-impacted soil are removed. A final inspection of the site, following the completion of the bulk excavation, is also required to confirm that no residual fill material remains on the site. The approach to each of these components to the validation program is outlined below.

6.1 Validation of Hotspot Excavations

Following the removal of the contaminated fill from the two contamination hotspot areas (centred over BH2 and BH6), a validation soil sampling program will be necessary to confirm the effectiveness of the remedial works. As a minimum, this will involve the collection of soil samples from the base of each excavated area at a rate of one sample per 25 m^2 (or a minimum of one sample). Validation samples would also be retrieved from each excavation wall at a rate of one sample per 5 linear metres of wall length (or a minimum of one sample per wall).

The samples will be collected from between 0-100 mm depth into the excavation walls and base using hand tools, and placed directly into laboratory-supplied zip lock plastic bags. All sampling equipment will be decontaminated prior to use and between sampling locations by washing with a mixture of water and DECON 90, followed by a rinse with potable water.

Each validation sample retrieved will be analysed for the contaminant of concern, this being asbestos.

6.2 Site Inspection

At the completion of the bulk excavation, the site must be inspected by the overseeing environmental consultant to confirm that all fill material has been removed from the site. The pouring of basement slabs, etc. must not commence until the consultant has completed the inspection and provided written confirmation that the site has been appropriately remediated.

6.3 Backfilling of Excavated Areas

Given that the entire site is proposed to be bulk excavated, it is unlikely that any soil material will need to be imported during the redevelopment. However, should the importation of soil be required to backfill remediation areas or for general site filling, only uncontaminated natural soils may be used. Any soil or rock that is proposed to be imported for backfilling purposes must first be appropriately validated to confirm its suitability for use on a residential site.

As a minimum, imported soil should be sampled at a rate of one sample per 100 m^3 and analysed for a comprehensive suite of chemical contaminants, including heavy metals, PAHs, TPHs, BTEX, OCPs, PCBs, phenolic compounds, and asbestos. However, the sampling frequency may need to be increased depending on the volumes of soil to be sourced from a particular site and the soil's expected land use history. Therefore, the frequency of validation sampling will be evaluated on case-by-case basis.

Any backfill material proposed to be imported onto the site must meet the following criteria:

- For natural *in situ* soils, contaminant concentrations must be demonstrated to be below the NSW EPA SILs (Column 1) criteria for a residential land use with accessible soil and the PILS contained in the *Guidelines for the NSW Site Auditor Scheme (2nd Edition)* (EPA, 2006), and the threshold concentrations for a sensitive land use outlined in the *Guidelines for Assessing Service Station Sites* (NSW EPA, 1994) or;
- For recycled soil (i.e. Excavated Natural material (ENM)), contaminant concentrations must be below the thresholds for ENM outlined in Table 2 of the *Protection of the Environment Operations (Waste) Regulation – General Exemption Under Part 6, Clause 51 and 51A, 'The Excavated Natural Material Exemption, 2012'* in addition to being below the SIL (Column 1) and EPA threshold concentrations criteria listed above;
- The soil must not be a potential or actual acid sulfate soil;
- If the soil is to be sourced from a potential acid sulfate soil formation, then it must be assessed in accordance with the *Acid Sulfate Soils Assessment Guidelines* (1998)

published by the Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW; and

- The soil must not contain any industrial waste, building material or demolition waste, putrescible waste or asbestos containing materials, and it must not be chemically stained or odorous.

6.4 Quality Assurance

A quality assurance/quality control (QA/QC) program in accordance with EPA requirements will also be implemented during the validation sampling program. This will include the collection of soil samples in zip lock plastic bags provided by the selected NATA-approved primary analytical laboratory. Further, Chain of Custody (COC) documentation will be used to record and track the samples and a field-based quality assurance program comprising the collection and analysis of intra-laboratory duplicate samples, in accordance with EPA requirements, will also be implemented.

6.5 Clean Up Criteria

Following the completion of the bulk excavation, all fill material and also a considerable depth of the underlying natural soil will have been removed from the site, thus removing any contamination-related risks. In view of this no final validation sampling is considered necessary. However, the clean-up criteria for the validation program are that the entire site must have been bulk excavated, with the excavation extending to the property boundaries and at least 1 m into the natural soil profile.

With regards to the hotspot excavation areas, for the asbestos-impacted soil to be deemed successfully remediated, the validation samples must be free of asbestos fibres and also must contain no visible bonded asbestos.

6.6 Validation Reporting

Upon completion of the bulk excavation, a final validation report is to be prepared by the overseeing environmental consultant. Based on the results of the validation sampling program and final site inspection, the report must make recommendations as to the suitability of the site for the proposed high density residential use. Further, a copy of the report must be provided to Liverpool City Council.

7. INTERIM SITE MANAGEMENT PLAN

As discussed in Section 3.3, the soils on the site are impacted with a presence of asbestos in near surface soils at two locations (BH2 and BH6) that could present a potential risk to human-health where exposure pathways exist. That is, the asbestos-impacted soil is potentially accessible to site users. However, the site is currently unoccupied and the site at 188 Moore Street and the backyard area of 190 Moore Street are fenced off, thus limiting public access to the land. Further, the areas where the asbestos-impacted soils have been identified are covered in a thick and continuous cover of grasses, which protect the soils from being mobilised by surface runoff or wind action. In view of this, an interim site management plan is not considered necessary, although interim remedial measures and a management plan would be recommended if the site was to be reoccupied prior to this RAP being implemented in the short term.

8. LONG TERM SITE MANAGEMENT

It is not expected that there will be any impediments to the excavation and removal of the contaminated soil from the site. However, should any contaminated soil not be able to be removed, for example if in close proximity to below ground services such as power, water or communications, a strategy of onsite containment may need to be implemented.

Should any on-site containment of contaminated soil be contemplated, the appropriateness of such a strategy must be discussed with Liverpool City Council. In addition, a revised RAP would need to be prepared documenting the proposed changes in the remedial approach. Further, under a containment strategy, a Site Management Plan (SMP) would also need to be prepared, which outlines strategies to ensure that residual contaminated soil is appropriately managed so that human-health and environmental exposures due to the impacted soil do not occur in the long term.

9. CONTAMINATION RELATED RISKS DURING REMEDIATION

The key chemical contaminant that may be encountered at the site during the remediation and redevelopment program is asbestos in the near surface soils. The presence of asbestos does not present a significant risk to site workers during earthworks at the site provided that the potential exposure pathways are eliminated. The key potential exposure pathways for asbestos at the site are summarized in Table 9.1 below.

TABLE 9.1 – SUMMARY OF CONTAMINANT EXPOSURE PATHWAYS

Contaminant	Medium	Relevant Exposure Pathway		
		Inhalation	Ingestion	Dermal Contact
Asbestos	Soil	**Yes (of free fibres, if present)**	NA	NA
	Soil Gas	NA	NA	NA
	Groundwater	NA	NA	NA

NA = Exposure pathway is not applicable at the site

Procedures to ensure that the exposure pathways listed above are not realized during the remediation and redevelopment of the site are outlined in Sections 10 and 11 of this RAP. The implementation of these procedures will ensure that human-health and the environment are adequately protected.

10. OPERATIONAL PHASE SITE MANAGEMENT

A number of management practices will be implemented during the remedial works to ensure that they do not pose a risk to human-health and the environment. These are detailed below.

10.1 Site Access

In order to ensure that there is no public access to the site, secure fencing will enclose the site for at least the duration of the remedial works. Gates will be locked when the site is unattended.

10.2 Soil and Sediment Control

Prior to the remedial works occurring, the excavation/earthworks contractor must prepare a site specific soil and water management plan which should be reviewed and approved by the overseeing environmental consultant. A copy of the approved plan must be kept on-site at all times during the remedial works.

The offsite migration of soil-derived particulate materials via surface runoff will be minimized by ensuring that any stockpiles of contaminated soil are contained by hay bales or silt fencing. Stockpiles of soil should also be covered if they are likely to remain onsite for more than 24 hours following excavation. In addition, the excavated areas should also be contoured such that all surface runoff is contained within the excavations.

Vehicle access to the site shall also be controlled to prevent the tracking of particulate soil material onto adjacent roadways. In times of wet weather, spraying vehicle wheels with high pressure water should also be undertaken as necessary, to ensure that soil migration from the site is minimized. A rumble grid should also be installed at all vehicle entry and exit points. In addition, all truckloads of soil which are removed from the site should be covered securely to prevent any soil being spilt in transit to the landfill facility.

10.3 Dust Control

The potential for dust generation and off-site migration will be minimized by implementing the following procedures:

- Wetting down of exposed unsealed surfaces and the covering of stockpiled soil, as required;
- Erecting dust screens around the perimeter of the remediation area and also on the perimeter boundary fencing; and
- Securely covering all loads.

10.4 Specific Controls for Asbestos-Impacted Soils

In addition to the general controls outlined in Sections 10.2 and 10.3 above, specific soil management procedures for earthworks will need to be implemented at the site due to the presence of asbestos-impacted soils. These are outlined below.

10.4.1 Air Monitoring

An asbestos air monitoring program must also be implemented from the time earthworks commence, and until the two asbestos hotspot areas have been deemed successfully remediated. The program must be implemented by an industrial hygienist, and will involve the installation of monitoring stations at a number of locations around the boundary of the site. No works which disturb the soil should commence until the monitoring stations have been installed and the hygienist provides written confirmation to that effect.

The hygienist will analyse samples collected from the monitoring stations at regular intervals and must provide the Principal Contractor with a written status report after each monitoring event. Further, a final compilation report on the overall monitoring program must be prepared by the hygienist at the completion of earthworks.

10.4.2 Soil and Sediment Controls for Asbestos-Impacted Soils

The following procedures are to be implemented during earthworks in the two asbestos contamination hotspot areas:

- To prevent the generation of dust, the soil which is exposed in the walls and base of the excavations should be kept moist via water sprays, as necessary;
- The works area should be enclosed by separate fencing, with signage to be placed on the fencing notifying that asbestos removal works are in progress;
- Further, dust screens (shade cloth or a similar fabric) should be placed around the fencing to minimize wind action and to limit the potential off-site migration of dust from the excavation; and
- If temporary stockpiling of the asbestos-impacted soil is necessary, it should be placed on high density polyethylene or black plastic sheeting (or similar) and the stockpiles must remain covered with the same material until being removed from the site.

10.4.3 SafeWork NSW Requirements

All works that involve the excavation and transport of soils impacted with asbestos must be undertaken by an asbestos-licensed contractor in accordance with SafeWork NSW requirements. The contractor must hold the necessary licenses to undertake works involving the disturbance of fibrous asbestos.

10.5 Management of Ponded Water

Any water that accumulates in the excavated areas should be removed by a licensed liquid waste contractor. Alternatively, it could potentially be discharged to sewer under a temporary Trade Waste Agreement issued by Sydney Water.

10.6 Noise, Vibration and Air Emission Control

Noise or air emissions (including odour) from plant and equipment will be controlled by the appropriate operating of the equipment. Remedial activities will be staged, so as to occur during business hours.

As elevated concentrations of volatile organic compounds have not been detected in the soils on the site, emission of odours from the soil are not likely to occur. However, should any odorous soil be encountered it would be controlled by covering the soil and/or by the use of proprietary odour suppressant products (for example, Biosolve).

To ensure that vibrations will be limited during concrete removal works, or during the excavation of natural rock, a procedure of sawing and ripping will be preferentially used. The use of rock beakers will be avoided, where possible.

10.7 Timing and Hours of Operation

It is expected that the remedial program may take up to two months to complete, once redevelopment works commence, however, this will be confirmed with the development contractor prior to commencing work.

All remediation activities shall be carried out only between standard permissible hours for construction works, these being between 7.00 am and 6.00 pm on Mondays to Fridays, and between 8.00 am and 1.00 pm on Saturdays. No work shall be carried out on Sundays and on Public Holidays.

11. HEALTH AND SAFETY

To ensure that site workers are adequately protected during the remediation and redevelopment of the site, a number of health and safety procedures should be implemented. Two levels of occupational health and safety (OH&S) will apply at the site, including those for the general site, and those for the two asbestos hotspot remediation areas. The OH&S requirements for the project are outlined below.

11.1 General OH&S Requirements

The general OH&S requirements are as follows:

- A site-specific OH&S plan should be developed by the principal earthworks contractor prior to any excavation works commencing, with the plan to be reviewed by the overseeing environmental consultant. The plan shall include, but not be limited to, the following:
  - Outlining roles and responsibilities of site staff;
  - Site access requirements, restrictions and site security;
  - Personal protective equipment (PPE) requirements for workers handling chemically-impacted or asbestos-impacted soils;
  - A Safe Work Method Statement (SWMS);
  - Drug and alcohol policies; and
  - Emergency and evacuation procedures.

- All subcontractors undertaking works in association with the remediation and redevelopment of the site must provide the principal earthworks contractor with a Safe Work Method Statement (SWMS) specific to their activities, and have it approved by the principal contractor prior to commencing works;
- All subcontractors must undergo a site induction from the superintendent (principal development/earthworks contractor) before commencing works. It is the superintendent's responsibility to make subcontractors aware of any hazards at the site and to confirm that they have read and understood this RAP;
- It is the responsibility of the superintendent to ensure that the health and safety procedures outlined in this RAP are adhered to by all site staff. Any contractors found to be in breach of the procedures must be made to cease works until appropriate rectification measures have been implemented;
- To prevent unauthorized persons entering the site, all works areas on the site are to be secured by a fence/gate that must be locked whilst unattended. Further, site access during active works should be via a single entry/exit point, and all personnel must be made to sign-in with the principal contractor before entering the site;
- All persons undertaking works that may involve dermal or physical contact with the soil on the site should wear personal protective equipment (PPE), including long pants and a long sleeved shirt. Hard hats and high visibility safety vests must also be worn by all site staff. Gloves should also be worn, if manual handling of soils is required; and
- No persons should enter open excavations deeper than 1.5 m in depth, unless the walls are battered to at least 45 degrees or engineered wall support measures have been implemented.

11.2 OH&S Requirements for Asbestos Remediation Areas

It is noted that works within the two asbestos remediation areas at BH2 and BH6 may not require site workers to wear a particulate-rated respirator, as the asbestos detected at the two locations did not include free fibres (i.e. potentially inhalable fibres). However, it is recommended for all workers who enter the specific asbestos remediation areas (to be enclosed by separate fencing) to wear any other equipment that may be recommended by the industrial hygienist.

12. PERSONNEL

The contactors involved in the remediation works are not confirmed at this stage. However, a sign displaying contact numbers of the relevant parties shall be displayed on the site adjacent to the site access. The sign shall be displayed throughout the duration of the remediation works.

13. OPERATIONAL PHASE CONTINGENCY PLANS

Site incidents that may potentially occur during the remedial works include spillages of diesel during refuelling of plant and equipment used on the site, and off-site spillages of asbestos-contaminated soil during loading or transport. An unexpected finds protocol is also required as a precautionary measure to manage soil impacted with chemical compounds other than those which have already been identified as the key contaminant of concern at the site (i.e. asbestos), should any be discovered at the site during the remedial works or as a result of validation sampling. Strategies to mitigate the effects of these potential incidents on the surrounding environment, site workers and the community include the following:

13.1 Off-Site Spillages of Contaminated Soil

Although due care will be taken to ensure that off-site spillages of contaminated soil do not occur, the potential remains for contaminated soil to be spilt during the loading of trucks and during transport of waste soil to the waste facility. Containment and removal of any such spillages will be the responsibility of the earthworks contractor. Any spillage of contaminated soil that occurs off-site is to be immediately reloaded onto trucks using either plant or manual labour. The remaining soil residue will need to be removed by shovelling or wet vac, as required. To prevent dust generation, any spilt soil should not be dry-swept and the soil should also be wetted down during reloading.

13.2 Spillages During On-Site Refuelling

There is potential for spillages of diesel fuels to occur onsite should refuelling of plant and equipment be required during the remedial program. All such, spills are the responsibility of the plant and equipment contractor. The contractor will be required to maintain a spill kit onsite for the duration of the remedial works. Should any fuel spillages occur all storm water drains at the site (if present) are to be sealed immediately and the spill contained using an appropriate spill kit. The contents of the spill and any resulting contaminated soil would then be required to be removed from the site and disposed of in accordance with NSW EPA requirements. NSW EPA will also be notified should any off-site migration of spilt fuels occur.

13.3 Unexpected Finds of Contaminated Soils

Based on the previous site assessment, it is unlikely that soil which is impacted with contaminants other than asbestos would be identified at the site. However, in the event that hazardous and/or intractable wastes, chemically stained or odorous soil (identified from the site inspection) or actual contaminated soil (identified from validation sampling program) is encountered during the remediation works, it should be reported to the overseeing environmental consultant immediately and all works should cease. The consultant will then determine the most appropriate means of addressing the issue and will organize all necessary testing and approvals to ensure chemically impacted soil/hazardous materials is appropriately assessed and remediated and/or disposed of to a licensed landfill facility, in accordance with NSW EPA requirements.

14. REGULATORY COMPLIANCE REQUIREMENTS

The regulatory requirements that must be addressed for the remedial program include the following:

14.1 State Environmental Protection Policy (SEPP) 55 Regulations

The *Planning Guidelines SEPP 55 – Remediation of Land* defines the regulations for Category 1 and Category 2 remediation works. The remedial works to be undertaken at the site (i.e. hotspot removal) are minor and would constitute Category 2 works. For Category 2 remedial works development consent is not required, however, Liverpool City Council must be notified 30 days prior to the commencement of remedial works. In addition, Liverpool City Council must be notified within 30 days of the completion of the remedial works.

14.2 Waste Disposal Approvals

Prior to transporting the soil off site, approval must first be sought from an EPA-licensed waste disposal facility that they will accept the soil. All weighbridge documentation relating to the disposal of soil to landfill must be retained by the earthworks contractor and provided to the environmental consultant for review and incorporation into their validation report.

14.3 Council Regulations

Site works will occur only in designated hours in accordance with Liverpool City Council policies. Wastes will be managed in accordance with this RAP to ensure compliance with Council requirements and that the environment is protected.

14.4 Community Consultation

Occupants of premises adjoining and across the road form the site shall be notified at least two (2) days prior to the commencement of the remediation works. The notification will take the form of either a short letter or notice.

15. CONCLUSIONS

The results of a previous environmental assessment undertaken by STS GeoEnvironmental show that the concentrations of chemical contaminants measured in soil samples retrieved from the site are generally low. However, asbestos was identified in soil at two locations on the site, which is above criteria designed to be protective of human-health for a high density residential land use setting. Therefore, remediation of asbestos-impacted soils is necessary to make the site suitable for the proposed land use.

The remedial strategy provided in the RAP has been developed with respect to the preferred order of remedial options outlined in the ANZECC Guidelines, which are endorsed by the NSW EPA. The preferred remedial option, being excavation and offsite disposal of the contaminated soil, is considered to be the most appropriate and cost-effective remediation method in view of the type of contamination on the site and that the site is proposed to be bulk excavated for the construction of a basement car parking facility, which would require the removal of all contaminated soil in any case. Other more preferred remedial options are either not available, not cost-effective or not applicable within the timeframe of the remedial program.

The results of the soil sampling performed at the site to date show that the layer of fill on the site is predominantly classed as General Solid Waste (GSW) for the purpose of landfill disposal. It is expected that the natural soils beneath the fill may be able to be classed as VENM, although this classification would require an additional sampling and analysis programme following the excavation and removal of the topsoil/fill material on the site.

The presence of asbestos in soil at two locations requires the soil at these locations to be classed as Special Waste (Asbestos). Therefore, it is recommended that the asbestos 'hotspots' are excavated and removed separately, thus enabling the bulk of the soil to be excavated from the site to be disposed of as General Solid Waste (GSW). Procedures for the remediation of the hotspot areas are outlined in this RAP.

A comprehensive validation sampling program will be implemented, which will involve soil sampling from the walls and bases of the two excavated remediation areas from which asbestos-impacted soil has been removed. Final validation of the site will be also performed by

way of a visual inspection to confirm that no residual fill material remains on the site, and following the completion of the bulk excavation of the site.

This RAP also provides a number of operational management strategies to ensure the remedial works will not cause adverse human health or environmental effects, or result in disruption or loss of amenity, particularly for neighbouring sites. This RAP also includes an unexpected finds protocol to address additional contaminated material in the unlikely event that any is identified during redevelopment of the site.

Following the completion of the remediation and validation program in accordance with this RAP, the site will be suitable for a high density residential land use without restrictions.

16. LIMITATIONS

STS GeoEnvironmental Pty Ltd has prepared this RAP for the purpose of providing a plan of remediation for the property at 188-190 Moore Street, Liverpool, NSW. It is not intended that this RAP be used for any other purpose.

This RAP outlines a remedial strategy, which when implemented, will make the site suitable for a high density residential land use. If the nature of the proposed development changes, the remedial strategies outlined in this RAP may need to be revised. Opinions and judgments expressed herein, which are based on our understanding and interpretation of current regulatory standards, should not be construed as legal opinions.

This document and the information herein have been prepared solely for the use of the NSW Land and Housing Corporation for the purposes nominated in this report. No person or organization other than the Land and Housing Corporation is entitled to rely on any part of the report without the prior written consent of STS GeoEnvironmental Pty Ltd. Any third party relying on this report shall have no legal recourse against STS GeoEnvironmental Pty Ltd or its parent organizations or subsidiaries and shall indemnify and defend them from all and against all claims arising out of, or in conjunction with such use or reliance.

Report Written By:	Report Reviewed By:
	
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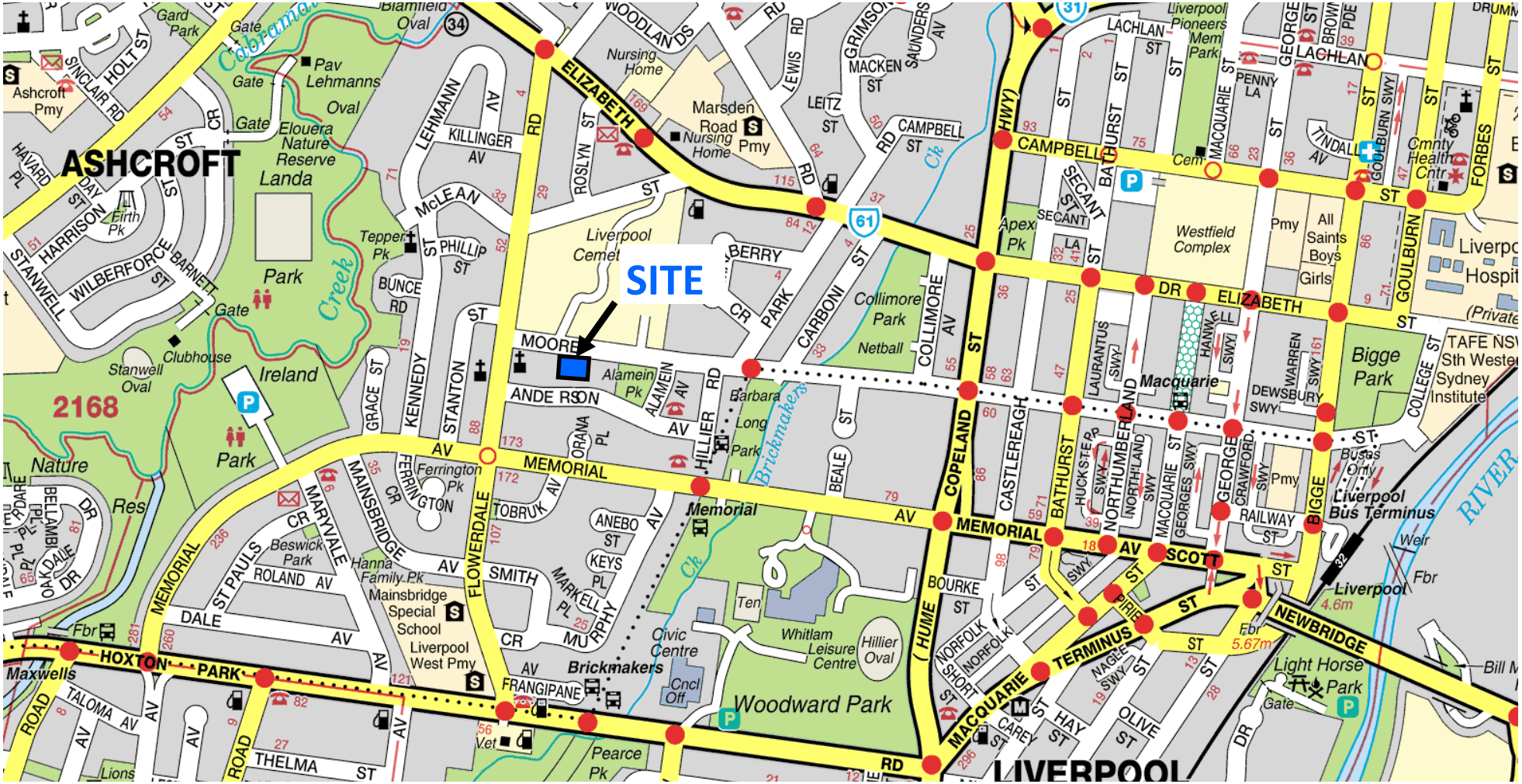
Environmental Engineer	Principal Geotechnical Engineer

FIGURES



STS GEOENVIRONMENTAL PTY	Scale: Unknown	Date: April 2016
Client: NSW LAND & HOUSING CORPORATION		
REMEDIAL ACTION PLAN **188-190 MOORE STREET, LIVERPOOL** **SITE LOCATION**	Project No. 10530/2746B	
	Drawing No: 16/2746B-1	

N

Site Boundary

BH1 Borehole Number & Location (March 2016)

Proposed Remediation Area Validation Sampling Point

Proposed Hotspot Excavation/Remediation Area

STS GEOENVIRONMENTAL PTY LTD	Scale: Unknown	Date: April 2016
Client: NSW LAND & HOUSING CORPORATION		
REMEDIAL ACTION PLAN - 188-190 MOORE ST, LIVERPOOL SITE FEATURES, SAMPLING LOCATIONS AND REMEDIATION AREAS	Project No. 10530/2746B	
	Drawing No: 16/2746B-2	

APPENDIX A – TABLE OF RESULTS FROM PREVIOUS SOIL CLASSIFICATION

Table A Analytical Results for Soil Samples

Analytes	Sample No.	S1	S2	S3	S5	S7	S8	S9	S10	S11	S13	Average Concentration (S1-S15)	NEPM Background Ranges[a]	NEPM HILs/HSLs B (High Density Residential)	NEPM EILs/ESLs (Urban Residential)	CRC Care HSL-B	Waste Classification Criteria for General Solid Waste (CT1)	Waste Classification Combined SCC1 and TCLP1 Criteria for General Solid Waste	Waste Classification Criteria for Special Waste
	Borehole No.	BH1	BH1	BH2	BH3	BH4	BH4	BH5	BH5	BH6	BH7								
Metals																			
	Arsenic	8	10	6	9	5	14	11	8	7	9	9	1-50	500	100[f]		100		
	Cadmium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	140	3[g]		20		
	Chromium (total)	21	25	14	22	15	22	27	20	20	19	21	5-1000	500[c]	400[g,h]		100		
	Copper	15	12	25	30	20	10	51	28	35	16	24	2-100	30000	100[g]				
	Lead	52	26	56	57	126	40	215	123	47	50	79	2-200	1200	1100[f]		100	1500	
	Leachable Lead (mg/L)					<0.1		<0.1	<0.1									5	
	Manganese	259	90	209	181	190	187	264	255	557	254	245	850	8000					
	Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.001-0.1	600[d]	1[d,g]		4		
	Nickel	8	7	8	7	8	8	12	9	10	6	8	5-500	900	60[g]		40		
	Zinc	110	34	126	175	144	27	127	100	169	105	112	10-300	60000	200[g]				
Monocyclic Aromatic Hydrocarbons (MAHs)																			
	Benzene	<0.2									<0.2	NA		0.7[e]	10[i]	140	10		
	Ethylbenzene	<0.5									<0.5	NA			65[i]	5900	600		
	Toluene	<0.5									<0.5	NA		480[e]	40[i]	21000	288		
	Xylenes	<0.5									<0.5	NA		110[e]	1.6[i]	17000	1000		
	Napthalene	<1									<1	NA		5[e]	170[i]	2200			
	Total MAHs above detection limits	ND									ND	NA							
Total Petroleum Hydrocarbons (TPHs)																			
	Total C_6-C_9[j]	<10									<10	NA					650		
	F1 C_6-C_{10}[k]	<10									<10	NA		50	180[i]	5600			
	F2 C_{10}-C_{16}	<50									<50	NA		280	120[i]	4200			
	F3 >C_{16}-C_{34}	<100									<100	NA			1300[i]	5800			
	F4 >C_{34}-C_{40}	<100									<100	NA			5600[i]	8100			
	Total C_{10}-C_{36}	<50									<50	NA					10000		
Polycyclic Aromatic Hydrocarbons (PAHs)																			
	Carcinogenic PAHs	<0.5									<0.5	NA		4			0.8		
	Total PAHs above detection limits	ND									ND	NA		400					
	Aldrin + Dieldrin	ND									ND	NA		10			200		
	Chlordane	ND									ND	NA		90					
	DDT+DDD+DDE	ND									ND	NA		600					
	Heptachlor	ND									ND	NA		10					
Phenolic Compunds																			
	Phenolic Compounds above detection	ND									ND	NA							
Organochlorine Pesticides (OCPs)																			
	Total OCPs above detection limits	ND		ND						ND	ND	NA							
Organophosphorus Pesticides (OPPs)																			
	Total OPPs above detection limits	ND		ND						ND	ND	NA							
Polychlorinated Biphenyls (PCBs)																			
	Total PCBs above detection limits	ND									ND	NA		1			50		
Asbestos																			
Asbestos Detected		No		Yes	No	No		No		Yes	No	NA		No visible asbestos					Presence of asbestos
Asbestos Type				Ch+Am+Cr						Cr		NA							
Free fibres		No		No	No	No		No		No	No	NA							
Friable asbestos (%)		<0.001		0.005	<0.001	<0.001		<0.001		0.0005	<0.001	NA							

Notes : Results expressed as mg/kg unless otherwise indicated

ND = No individual species detected above laboratory detection limits.

NA = Not available.

Results shaded red exceed the health-based investigation level for low density residential housing (HIL-A) (NEPM, 2013)

Results shaded blue exceed the ecological investigation level for low urban residential land use (NEPM, 2013)

Results shaded yellow exceed the CRC Care (2012) investigation level high density residential land use

Results shaded orange exceed the NSW Waste Guidelines Criterion for General Solid Waste

Results shaded light green exceed the NSW Waste Guidelines Criterion for Special Waste (Asbestos)

Ch Chrysotile (white asbestos)

Am Amosite (brown asbestos)

Cr Crocidolite (blue asbestos)

(a) ANZECC background ranges

(b) NSW EPA Excavated Material Order (2014)

(c) Criterion for hexavalent chromium

(d) Criterion for inorganic mercury

(e) 2013 NEPM HSL for clay soils within 1 m of land surface

(f) 2013 NEPM generic EIL

(g) 1999 NEPM EIL criterion

(h) Criterion for Chromium III

(i) 2013 NEPM ESL criterion for fine texture grade soils

(j) F1 TPH = TPH (C6-C10) minus BTEX fraction

(k) F2 TPH = TPH (C10-C16) minus naphthalene fraction

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