Remedial Action Plan Addendum – Residential house

771 Cudgen Road, Cudgen, NSW

January 2019, Ref. 18084 R02 V3

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Report Details

Report:

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Cudgen, NSW

Ref: 18084 R02 V3

for

Woollam Constructions Pty Ltd

Distribution:

Deliverables	Status	Date	Recipient
1	Original R02	20/12/2018	Tony Jackman Woollam Constructions
1	V2	08/01/2019	
	V3	24/01/2019	
1	Copy	24/01/2019	Cavvanba project file
1	Copy	24/01/2019	Cavvanba library

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1.0 Introduction

Cavvanba Consulting (Cavvanba) was engaged by Woollam Constructions Pty Ltd to prepare a remedial action plan (RAP) for lead contamination in soil at a site located at 771 Cudgen Road, Cudgen NSW 2487.

This RAP should be read in full, including Section 1.4, *General limitations to environmental information.*

1.1 Background

The site consists of a farm shed, residential house and garage with farmland extending out into the western portion. Refer to Appendix A for a Photographic log and Figure 1 for an overview of the investigation boundary and features. It is understood that the previous owner had occupied the site for approximately 30 years and used it for agriculture.

As part of the new Tweed Valley Hospital development the residential house and garage are proposed to be demolished in order for preliminary works to continue at the site. OCTIEF conducted a preliminary and detailed investigation at the site in September 2018:

- OCTIEF (2018), *Preliminary and Detailed Site Investigation – 771 Cudgen Road, Cudgen, NSW 2487* (Ref. J8961).

The scope comprised of a soil and groundwater investigation which extended broadly over 771 Cudgen Road (Lot Lot 11, Deposited Plan 1246853). A total of 44 boreholes were advanced over the site, however it is noted that no soil sampling was conducted by OCTIEF within the current investigation area. A Figure from this report is included in Appendix B.

OCTIEF (2018) prepared a remediation action plan for asbestos contaminated soil associated with the farm shed, adjacent to the house:

- OCTIEF (2018) *Remediation action plan – Tweed Valley Hospital Site, 771 Cudgen Road, Cudgen NSW*. (Ref: J8961)

It should however be noted that the remedial area was outside the subject investigation area of this report.

Cavvanba conducted a contamination investigation at the site during November and December 2018, focussing on contaminants of lead and organochlorine pesticides (OCPs) associated with the residential house and garage:

- Cavvanba Consulting (2018), *Residential house – soil investigation report, 771 Cudgen Road, Cudgen, NSW* (Ref.: 18084 R01).

The investigation included the advancement of 22 test pits to maximum explored depths of 0.6 m. Following the investigation, lead contamination has successfully been delineated both vertically and laterally. The results are further discussed in Section 2.5.

Lead in soils is a common contaminated land issue with old buildings, and the EPA (2003) *Managing Lead Contamination in Home Maintenance, Renovation and Demolition Practices. A Guide for Councils* states that:

- there are over a million homes in NSW that were built before 1970 and are potentially contaminated with lead paint, dust and soil; and
- New Zealand research found soil lead levels of 16–28 ppm in homes built less than 10 years ago but 455– 16,858 ppm in homes built over 90 years ago.

1.2 Objectives

The objectives of the RAP are to:

- summarise background information and current conditions at the site;
- summarise the nature and extent of contamination at the site;

- summarise the results with respect to the proposed land use;
- describe the regulatory issues associated with the proposed remediation;
- describe the overall remedial strategy necessary to remove unacceptable risks to human health and the environment associated with the identified contaminants, as well as potential contingencies; and
- describe the remedial works to be conducted, including environmental management, occupational health and safety (OH&S), and site validation.

1.3 RAP Requirements

Office of Environment and Heritage (OEH) (2011) *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*, describes that RAPs should:

- Set remediation goals that ensure the remediated site will be suitable for the proposed use and will pose no unacceptable risk to human health or to the environment.
- Document in detail all procedures and plans to be implemented to reduce risks to acceptable levels for the proposed site use.
- Establish the environmental safeguards required to complete the remediation in an environmentally acceptable manner.
- Identify and include proof of the necessary approvals and licenses required by regulatory authorities.

The information required by OEH (2011) in regard to RAPs, and where this information is addressed in this RAP, is shown in Table 1.1. Section 2 of the RAP summarises the site condition and previous investigation findings, and is based on the previous Cavvanba investigation.

Table 1.1: RAP requirements

Report requirement	Section
Discussion of the extent of remediation required.	4.0
Identification of regulatory compliance requirements such as licences and approvals.	5.0
Remediation goal.	6.1
Discussion of possible remedial options and how risk can be reduced.	6.2
Rationale for the selection of recommended remedial option.	6.3.1
Contingency plan if the selected remediation strategy fails.	6.4
Proposed testing to validate the site after remediation.	7.1
Interim site management plan (before remediation), including e.g. fencing, erection of warning signs, stormwater diversion.	8.2

Report requirement	Section
Site management plan (operation phase): - site stormwater management plan; - soil management plan; - noise control plan; - dust control plan, including wheel wash (where applicable); - odour control plan; and - occupational health and safety plan.	8.0
Remediation schedule.	8.4
Hours of operation.	8.5
Contingency plans to respond to site incidents, to obviate potential effects on surrounding environment and community.	8.7
Names and phone numbers of appropriate personnel to contact during remediation.	8.8
Community relations plans, where applicable.	n/a
Staged progress reporting, where appropriate.	n/a
Long-term site management plan.	8.9

1.4 Limitations

The findings of this report are based on the objectives and scope of work outlined above. Cavvanba performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental assessment profession. No warranties or guarantees, express or implied, are made. Subject to the scope of work, Cavvanba's assessment is limited strictly to identifying typical environmental conditions associated with the subject property, and does not include evaluation of any other issues. This report does not comment on any regulatory obligations based on the findings, for which a legal opinion should be sought. This report relates only to the objectives and scope of work stated, and does not relate to any other works undertaken for the Client.

The report and conclusions are based on the information obtained at the time of the assessment. Changes to the subsurface conditions may occur subsequent to the investigation described herein, through natural processes or through the intentional or accidental addition of contaminants, and these conditions may change with space and time.

The site history, and associated uses, areas of use, and potential contaminants, were determined based on the activities described in the scope of work. Additional site history information held by the Client, regulatory authorities, or in the public domain, which was not provided to Cavvanba or was not sourced by Cavvanba under the scope of work, may identify additional uses, areas of use and/or potential contaminants. The information sources referenced have been used to determine site history and desktop information regarding local subsurface conditions. While Cavvanba has used reasonable care to avoid reliance on data and information that is inaccurate or unsuitable, Cavvanba is not able to verify the accuracy or completeness of all information and data made available.

Further chemicals or categories of chemicals may exist at the site, which were not identified in the site history, and which may not be expected at the site. The absence of any identified hazardous or toxic materials on the subject property, should not be interpreted as a warranty or guarantee that such materials do not exist on the site. If additional certainty is required, additional site history or desktop studies, or environmental sampling and analysis, should be commissioned.

The results of this assessment are based upon site inspection and fieldwork conducted by Cavvanba personnel and information provided by the Client. All conclusions regarding the property area are the professional opinions of the Cavvanba personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, Cavvanba assumes no responsibility or liability for errors in any data obtained from regulatory agencies, information from sources outside of Cavvanba, or developments resulting from situations outside the scope of this project.

2.0 Site Setting

2.1 Site identification

The site location and investigation boundary are shown on Figure 1.

Owner:	Health Infrastructure NSW.
Street address:	771 Cudgen Road, Cudgen NSW 2487.
Property description:	Lot 11, Deposited Plan 1246853.
Investigation area (part of Lot 11 DP1246853):	Approximately 900 m^2 (consisting of the area surrounding the residential house and garage).
Co-ordinates:	Latitude: -28.265228 Longitude: 153.566395
Local government area:	Tweed Shire Council.
Elevation:	Approximately 27 m above AHD.
Landuse – existing:	Rural Residential/Agricultural.
Landuse – proposed:	Hospital.
Zoning – existing:	RU1 Primary Production.
Zoning – proposed:	SP2 Infrastructure (Hospital).

2.2 Surrounding Land Uses

The site is located in an area of mainly rural and recreational landuse, with the surrounding landuses identified as:

North:	Agricultural land use, followed by bushland.
East:	Cudgen Road followed by TAFE NSW Kingscliff.
West:	Agricultural land use.
South:	Cudgen Road followed by agricultural land use.

2.3 Topography

The site is relatively flat with a slight slope falling toward the south-west.

2.4 Geology and soils

2.4.1 Geology

Based on NSW Environment & Heritage Soil and Land Information (eSPADE, accessed 13 December 2018), the site lies on Lamington Volcanics—Tertiary basalt, consisting of rhyolite, trachyte, tuff, agglomerate, conglomerate.

The landscape consists of very low to low undulating hills and rises on the Cudgen Plateau and nearby basalt caps. Elevation is 30–40 m on the Cudgen Plateau.

The vegetation in the area is cleared closed-forest (rainforest). Most of this landscape is cultivated, but the original vegetation would have been be similar to that of the Limpinwood (li) or Green Pigeon (gp) soil landscapes.

2.4.2 Soils

Based on NSW Environment & Heritage Soil and Land Information (eSPADE, accessed 13 December 2018) the soil profile in the area consists of deep (>100 cm), well-drained red silty clay (Krasnozems). This soil profile is consistent with the observations made during the investigation of the house and garage.

2.5 Previous environmental investigation

Cavvanba conducted a soil investigation at the site during November and December 2018:
- Cavvanba Consulting (2018), *Residential house – soil investigation report, 771 Cudgen Road, Cudgen, NSW* (Ref.: 18084 R01).

The potential drip zone from the outer walls, underneath the house and garage slab were targeted for potential contamination of lead and/or OCPs.

2.5.1 Scope

The scope of work included:

- Review of previous environmental investigations OCTIEF (2018) report.
- Completion of a comprehensive site walkover and visual inspection for key features to identify potential areas of environmental concern on- and off-site.
- Advancement of 22 soil test pits using a hand auger in a staged investigation.
- Collect and analyse samples for potential contaminants of concern, which will assist in the classification of any material required for offsite disposal.
- Inclusion of the results and findings into a report.

The analytical results were compared to residential land use with minimal opportunities for soil access land use for human health screening (HIL A) and for urban residential and public open space environmental screening (EIL) and have been provided in Section 2.5.3.

2.5.2 Sampling conducted

Cavvanba's expectation of contamination based on similar sites is lead contamination from paint is generally limited to within 2 – 3 m of drip the zone, and within 0.5 m of the ground surface. At this site, the original house appeared to have been extended, therefore it was possible that lead would also be present beneath the building.

The sampling strategy included collection of samples at the following locations:
- within 1 m of existing perimeter on each side of the residential house and garage;
- step out locations at 2 m from the house and garage perimeter;
- samples beneath the house;
- samples beneath the garage slab; and
- samples at multiple depths at each location i.e. (0.1, 0.3 and 0.6 m below the ground surface).

Of those samples collected, the first stage of sample analysis selection was limited to:
- all samples beneath the house and garage slab;
- all samples within 1 m of the building perimeter i.e. on each side of the house and garage; and
- only samples at shallow depth (0.1 m).

Additional analysis was undertaken at step-out locations at greater depths that 0.1 m to delineate any criteria exceedances on an as needs basis. The sampling strategy completed was considered to meet the definition of a systematic approach, and meets the minimum sampling requirements in accordance with *Sampling Design Guidelines* (NSW EPA, 1995). Additionally, consideration was given to the Tweed Shire Council for Pre-Demolition Testing of organochlorine pesticides beneath structures and dwellings.

Table 2 below describes the rationale for the chosen sampling design and additional delineation sampling/analysis.

Table 2: Overall sampling design and rationale

Location/sample ID	Rationale
First stage of analysis	
TP01_0.1 to TP04_0.1	Targeting any potential sources of lead paint located underneath the residential house at the surface.
TP05_0.1 to TP10_0.1 & TP17_0.1 to TP19_0.1	Targeting the potential drip zone from the walls of the residential house and garage at the surface.
TP28_0.1, TP29_0.1, TP30_0.1	Targeting sub slab of garage.
TP11_0.1 to TP16_0.1	Samples taken to delineate any potential lead impact from the residential house.
Delineation sampling/analysis	
TP01_0.3, TP01_0.6, TP02_0.3, TP02_0.6, TP03_0.3, TP03_0.6, TP04_0.3	Further sampling/analysis conducted at 0.3 and 0.6 m below the ground surface; aiming to delineate the vertical extent of lead impact.

2.5.3 Analytical results

The results are summarised on the following page by contaminant. The analytical results have been compared to the screening criteria adopted for the site. The NEPM health investigation and screening levels for residential land use (HIL A) have been used along with the ecological investigation levels (EILs) for urban residential and public open space to ascertain the magnitude of impacts.

Table 2.1: Soil analytical summary

Analyte	Health criteria	Ecological criteria	Site data			
	HIL / HSL (mg/kg)	EIL/ESL (mg/kg)	No. samples analysed	Number of detects	Max' (mg/kg)	Meets screening criteria?
Metals						
Lead	**300**	1,100	27	27	**1,600**	**No**
Organochlorine pesticides						
DDT+DDE+DDD	240	180[1]	24	10	9.07	Yes
Aldrin and dieldrin	6	-[2]		7	1.18	Yes
Chlordane	50	-		4	4.10	Yes
Endosulfan	270	-		0	<0.05	Yes
Endrin	10	-		0	<0.05	Yes
Heptachlor	6	-		0	<0.05	Yes
HCB	10	-		0	<0.05	Yes
Methoxychlor	300	-		0	<0.2	Yes

Table notes:
1 – Criteria for DDT only.
2 – = No criteria available
3 – **BOLD** indicates exceedance of HILs criteria.
4 – Underscore indicates exceedances of EILs criteria.

The results are also summarised as eight samples exceeded HILs (Residential A) for lead collected from four locations (TP01, TP02, TP03 and TP06).

The maximum reported lead concentration of 1,600 mg/kg was reported at TP03_0.3 (located underneath the south-western corner of the residential house). This sample also exceeded the EILs (urban residential and open public space) criteria for lead.

All samples (excluding TP06_0.1) which exceeded the HILs were located underneath the residential house. OCPs were detected at 10 sample locations, concentrations were almost all an order of magnitude below the adopted criteria.

2.5.4 Discussion and recommendations

Discussion

Lead concentrations exceeding site criteria were present:
- underneath the former residential house in all four samples locations to 0.3 m depth;
- approximately 1 m from the eastern wall of the residential house, in the southern portion associated with TP06 to 0.1 m depth; and
- extending to 0.6 m depth at TP02 which still had reported concentrations of 324 mg/kg which marginally exceeds site criteria.

Based on the trends of decreasing lead concentrations with depth at TP02, it is anticipated that exceedances of residential criteria will not extend below 0.7 m below ground surface:
- TP02_0.1 = 1,070 mg/kg;
- TP02_0.3 = 838 mg/kg; and
- TP02_0.6 = 324 mg/kg.

Validation samples will be collected to confirm that lead contamination does not exceed these depths following remediation and has been further discussed in Section 7.1 of this report.

Recommendations

Based on the concentrations detected underneath the former residential house and ~1 m from the eastern wall, remediation and/or management is required.

A remedial action plan should be prepared for the former residential house which should consider:
- off-site disposal; and/or
- on-site management/capping including long term management.

2.6 Overarching RAP

OCTIEF was engaged by TSA management on behalf of NSW Health Infrastructure to compile a remediation action plan for Lot 11 DP 1246853 (the site) located at 771 Cudgen Road, Cudgen NSW:

– OCTIEF (2018) *Remediation action plan – Tweed Valley Hospital Site, 771 Cudgen Road, Cudgen NSW*. (Ref: J8961)

The OCTIEF RAP outlined remediation works which are considered category 2. The scope included excavation and disposal of asbestos contaminated soil to the south of the farm shed which is located nearby the house. Given the remediation strategy is similar for both the shed and house, this RAP supports the OCTIEF RAP.

3.0 Remediation criteria

The remediation area is to be made suitable for residential soil land use.

3.1 Soil

It should be noted that the proposed use of the site is a public hospital. For conservative purposes for lead in soil, the appropriate criterion is 300 mg/kg. This is sourced from Column 1 (residential with garden/accessible soil) health-based investigation levels from NEPM (2013).

ASC NEPM 2013 states that the NEPM HILs are not protective of construction workers, and site specific risk should be taken into consideration: (Schedule B7: Guideline on health-based investigation levels – Section 3.1) *The HILs are therefore considered to be protective of exposures to other receptor populations; however, the HILs do not specifically address short-duration exposures that may occur during construction and maintenance of a site (including intrusive works). These exposures should be addressed on a site-specific basis.*

Considering the above description and the following points, residential criteria is an appropriately conservative criteria for handing the site over for construction purposes without the need for further site specific risk assessment:

- the use of residential criteria is also consistent with the OCTIEF investigation documents;
- the potential area of lead impacted soil typically presents a small volume which can be feasibly removed from the site;
- the high level of public interest, and desire for conservative criteria to be implemented;
- the development was to be staged separately between demolition and construction, and the contaminated land investigation and potential remediation was expected to be undertaken prior to construction; and
- there are proposed construction works and the HILs for commercial/industrial landuse were not developed to be specifically protective of the risks to construction workers.

Developments in management of lead contaminated soils

In December 2013, the U.S. Environmental Protection Agency released a technical and policy guidance document by the Technical Review Workgroup for Lead (TRW) entitled *Technical Review Workgroup Recommendations Regarding Gardening and Reducing Exposure to Lead-Contaminated Soils* (OSWER 9200.2-142). The primary exposure risks identified four pathways of lead exposure, being:

- direct ingestion of produce (i.e. within vegetables);
- ingestion of lead in soil on produce (i.e. soil on vegetables);
- incidental ingestion of soil while gardening; and
- incidental ingestion of soil tracked into residence.

The following table outlines the best management practices reported by the TRW.

Table 1. TRW Lead Committee Recommended Best Management Practices for Gardening in Lead Contaminated Areas

Soil-Lead Concentration (ppm)	Category	Recommendation: Gardening Practices	Recommendation: Choosing Plants[a]
<100	Low risk	• No specific remedial action needed. • Wash hands, produce, clothes (good gardening and housekeeping practices).	• No restrictions of crop types.
>100–400[b] ⋯→ 400–1200	Potential risk	• Increasing use of good gardening and housekeeping practices as described in Table 3. • Relocate garden to lower risk garden areas. • Increasing use of soil amendments (*e.g.*, compost, clean fill), barriers (*e.g.*, mulch), and other remedial measures (see Table 3) up to and including raised beds and containers. • Ensure gardeners wear gloves and use tools to reduce soil contact and ingestion.	• Decrease planting of root vegetables or relocate root crop planting to lower risk areas. • Increase use of soil amendments and barriers to reduce soil deposition onto leafy vegetables. • Increase planting of fruiting vegetables, vegetables that grow on vines, and fruit trees.
>1200	High risk	• All of the above good gardening and housekeeping practices. • Raised beds, soil containers, soil replacement (*i.e.*, excavate contaminated soil and replace with soil containing low lead concentrations) are strongly recommended.[c] • Consider finding other locations for garden. • Restrict child access to only established safe areas. • Restrict all gardening by or for children in contaminated soils.	• Select plants with shallow roots for raised beds or areas with replacement soil to ensure that roots do not reach contaminated soil that is left in place, if any, otherwise, no restrictions.

The guidance provided is consistent with the NEPM. Based on the advice in the TRW best practice document, the concentrations present on-site are high risk and require management.

3.2 Waste

Material to be transported to another site is subject to the waste requirements of the POEO Act, i.e. the waste guidelines are relevant.

NSW EPA (2014) *Waste Classification Guidelines Part 1: Classifying waste,* states that "waste contaminated with lead (including lead paint waste) from residential premises or educational or child care institutions" are pre-classified as 'general solid waste (non-putrescible). Therefore, if soil material requires off-site disposal it will be classified as general solid waste.

The concentrations of other contaminants, namely OCPs do not change the classification.

3.3 Imported fill

Any soil imported to the site must be obtained from reputable suppliers and must comprise virgin excavated natural material (VENM).

Any material to be transported to another site is subject to the waste requirements of the POEO Act, i.e. the waste guidelines are relevant.

4.0 Extent of remediation required

4.1 Media

This remedial action plan is limited to soil only.

4.2 Potential contaminants of concern

Potential contaminants of concern associated with the site are limited to lead only.

4.3 Lateral and vertical extent

Based on presence of lead paint inside the residential house, it is assumed that this is the source of elevated lead concentrations in soil.

Lead exceeding 300 mg/kg has been detected. Based on the results of the previous investigation conducted by Cavvanba, contamination is estimated to be approximately 132 m^3 of soil, surrounding the house as shown on Figure 2 and Figure 3, which is within:

- the edge of the former residential house to the north, south, west;
- approximately 2 m the east of the former residential house – in the southern portion; and
- 0.7 m depth in all directions.

5.0 Regulatory requirements

Regulatory aspects relating to the remediation of this site are summarised below.

5.1 SEPP 55

The planning approach to the remediation of contaminated land is legislated in *State Environmental Planning Policy No 55—Remediation of Land* which requires certain considerations of when consent is required to undertake remediation works. The SEPP classifies remediation as either:

- Category 1 – remediation work for which development consent is required; or
- Category 2 – remediation work not requiring development consent.

Whilst Category 2 remediation may not require consent, all relevant conditions described in the SEPP must be considered, and notice must be given to the consent authority and local council 30 days prior to the commencement of the work. It is understood that Tweed Shire Council was notified of remedial works on 5 December 2018.

The development application pathway for the Project consists of a staged Significant Development Application under section 4.22 of the Environmental Planning and Assessment Act 1979 (EP&A) Act. This report is provided to meet the requirements of SEPP 55 and Department of Planning and Urban Affairs (1998) *Planning Guidelines SEPP 55 – Remediation of Land*.

5.2 Environmentally Hazardous Chemicals act 1985

The Environmentally Hazardous Chemicals Act (1985) has been taken into consideration and is relevant to the remedial phase of the project. Section 4.14 in the order describes scheduled chemical wastes:

> *scheduled chemical wastes means any liquid or solid waste that contains one or more of the chemicals listed in Schedule A to this chemical control order where the total concentration of those chemicals is more than two milligrams per kilogram.*

The impacted soil is considered to be a scheduled chemical waste as reported concentrations of OCPs were more than two milligrams per kilogram. However, no requirements are applicable for transportation of the material as OCP concentrations were reported below 50 milligrams per kilogram. Section 22 of the order (Conveying scheduled chemical waste) describes the following:

> *A person must not convey scheduled chemical wastes in or on a vehicle, where the total concentration of the chemicals listed in Schedule A is 50 milligrams per kilogram or more, unless accompanying the vehicle there is personnel:*
> - *trained in methods of containing spilled scheduled chemical wastes; and*
> - *provided with appropriate personal protective equipment, clean-up material and equipment to deal with any spill.*

5.3 POEO Act 1997

The requirements of the *Protection of the Environment Operations (POEO) Act* 1997, and associated schedules and regulations, are relevant to the remedial phase of the project. The objectives of the Act include to protect, restore and enhance the quality of the environment in New South Wales, having regard to the need to maintain ecologically sustainable development.

The Act includes requirements not to pollute waters, to prevent or minimise air pollution, to maintain and operate plant in a proper and efficient condition/manner and to deal with materials in a proper and efficient manner to minimise noise impacts, and to minimise and manage wastes. The Act also requires notification to the EPA when a pollution incident occurs that causes or threatens material harm to the environment.

The POEO Act is relevant for disposal of wastes, importation of backfill materials, and excavation validation and reporting.

5.4 CLM Act

The Contaminated Land Management (CLM) Act 1997 enables the EPA to respond to contamination that is significant enough to warrant regulation to protect humans or the environment. The *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (June 2009) outline a decision-making process for reporting contamination to the EPA.

5.5 Environmental Planning & Assessment (EP&A) Act 1979

The Environmental Planning & Assessment (EP&A) Act enables the consent authority to consider the suitability of the site for the development, which includes whether the site is contaminated.

The site is mapped as having no known occurrence of acid sulphate soils (ASS). Based on this, a preliminary acid sulphate investigation is not required.

6.0 Remedial actions

6.1 Remediation goal

The remediation goal for the site is to:
- render the site suitable for the intended land use (for conservative purposes, residential with garden/accessible soils;
- remove any unacceptable risk to human health and environment associated with contaminated material; and
- ensure protection of the remediation team, surrounding community and the environment throughout the remediation works.

6.2 Remedial options

NEPM, 2013 outlines a remediation hierarchy in the Assessment of Site Contamination Policy Framework (Attachment A, page 8 and 9).

> *(16) Attainment of environmental outcome*
>
> *In general, to achieve the desired environmental outcome, the process of the assessment of site contamination should be placed within the context of the broader site assessment and management process. In particular, in assessing the contamination, the site assessor and others should take into account the preferred hierarchy of options for site clean-up and/or management which is outlined as follows:*
>
> - *on-site treatment of the contamination so that it is destroyed, or the associated risk is reduced to an acceptable level; and*
> - *off-site treatment of excavated soil, so that the contamination is destroyed or the associated risk is reduced to an acceptable level, after which soil is returned to the site; or*
>
> *If the above are not practicable,*
> - *consolidation and isolation of the soil on site by containment with a properly designed barrier; and*
> - *removal of contaminated material to an approved site or facility, followed, where necessary, by replacement with appropriate material;*
>
> *or,*
> - *Where the assessment indicates remediation would have no net environmental benefit or would have a net adverse environmental effect, implementation of an appropriate management strategy.*

In assessing the remedial options available for the site, the following have been considered:
- the types and form of the contaminants present;
- the land use proposed for the remediation area;
- available proven remediation methods/technologies; and
- regulatory requirements.

Based on this, a range of remedial options has been considered, comprising:
1. no action;
2. treatment of the impacted material;
3. removal and offsite disposal of the impacted material.

A brief review of the remedial options is summarised below.

6.2.1 No action

Contamination has been detected at the site which requires remediation and/or management and as the site is to be redeveloped, the 'no action' option is not considered to be appropriate.

6.2.2 Stabilisation/treatment

Stabilisation generally requires the excavation and either on-site or off-site treatment and/or disposal, and is essentially a remediation technology that reduces the mobility of contaminants, either by chemically altering or binding it (USEPA 1994). It is most applicable to inorganic (metal) contamination.

Immobilisation requires additional investigation, testing and verification, and at this stage is not considered appropriate.

6.2.3 Removal

Removal of contaminants involves physically digging up the contaminated material and off-site disposal of these materials. Contaminants can be effectively 'chased-out' based on the investigation results and current understanding. It is relatively time efficient and low-tech, however the removal requires some form of reinstatement and disruption, and can be costly for large volumes requiring off-site disposal.

The previous investigation delineated the impact vertically and laterally as described in Section 2.5.4 and determined that approximately 132 m^3 of soil required disposal off-site, depending on the level of certainty required. Considering the concentrations of lead and the volume of waste present, removal is considered appropriate. Two remedial options for removal have provided as Figure 1 and Figure 2:

- The Figure 1 strategy is to excavate and remove 0.7 m of soil across the entire remediation area; and
- The Figure 2 strategy is to remove 0.4 m of soil in the shallower contaminated areas (TP01, TP03, TP04, TP06) and to remove 0.7 m of soil in the vicinity of TP02 where contamination extended beyond 0.4 m depth.

6.2.4 Capping and containment

Capping

This primarily involves isolating the contaminated area with barriers and covering it so that it cannot be disturbed during normal site activities associated with the proposed landuse. The contamination therefore cannot generate dust, or come into contact with site occupiers. This option is generally applicable where the contamination is buried at depth, or will be buried at depth, where a layer of clean fill covers the impacted area. Capping also minimises disturbance, and infiltration of surface waters, therefore minimising the potential for migration of contaminants.

This option requires the placement of a geo-textile marker layer or similar to avoid disturbance, and requires ongoing management and notification on the Section 149 certificate.

Due to contamination being present at the ground surface, and the requirement for ongoing management this is considered to be an inappropriate strategy for the site.

In-situ

Containment technologies include both surface capping to impede direct contact (USEPA 1994), and construction of purpose built cells. ANZECC (1999) outlines design

requirements for onsite containment of contaminated soils, and includes contingencies for accumulation of vapours, potential for groundwater contamination, infiltration etc. The option of designing and constructing a cell onsite is not considered a feasible option, and would require ongoing management and notification on the Council 149 certificate.

Ex-situ

Ex-situ containment involves excavation and re-placement of the soil in a suitable place, which may include a specially designed cell offsite. This option, when compared to disposal to landfill is not economical.

6.3 Remedial strategy

The remedial strategy of off-site disposal is considered to meet the remedial requirements and be acceptable for the proposed development. The lead remediation area is outlined on Figure 2 and Figure 3.

Table 6.1: Summary remedial and management strategy

Aspect	Specific remedial or management strategy
Lead in soil	A lead in soil management area (which exceeds the site criteria) has been outlined on Figure 2 and Figure 3, and is to be excavated and disposed of off-site.
Off-site disposal	Off-site disposal of soil is proposed. Pre-classified as general solid waste as lead contamination is associated with lead paint from a residential premises.
Validation	Validation sampling for lead will be required, following the removal of impacted soil. This needs to be completed by a suitably qualified contaminated land environmental consultant. Further information is provided in Section 7.0.
Imported fill	If back filling is required, imported VENM may be required to bring the site back to grade, which will need to be evaluated in line with the guidance provided in Section 3.3.
Interim measures	Refer to Section 8.2, below.
Long term management	No long term management will be required, following the excavation and off-site disposal works.

6.3.1 Appropriateness of remedial strategy

For this site and scenario, the remedial strategy to excavate and remove ~ 132 m^3 of lead contaminated soil is the most appropriate based on the following:

- the duration of remedial works;
- the level of reported lead concentrations (> 500% of site criteria);
- minimal disturbance of the property; and
- long-term management or notification is considered unnecessary.

6.4 Remediation contingency

Remediation contingencies are limited to further excavation and disposal being required if the initial validation results exceed the site criteria.

7.0 Remediation validation and monitoring

7.1 Validation works

A validation report must be prepared following the works which is in accordance with:
- EPA (1995) *Contaminated Sites - Sampling Design Guidelines*; and
- NSW OEH (2011) *Guidelines for consultants reporting on contaminated sites*.

Based on an excavation area of approximately 220 m^2, a minimum of five locations will be required in accordance with NSW EPA Sampling Design Guidelines (five locations for less than 0.05 hectares).

The report will provide a clear conclusion stating whether or not the RAP has been satisfied and a conclusion regarding the site suitability for its existing or proposed future use.

7.2 Imported fill

VENM is described in the NSW EPA 2014 waste guidelines as natural material (e.g. clay, gravel, sand, soil or rock fines):
- that has been excavated or quarried from areas that are not contaminated with manufactured chemicals or process residues, as a result of industrial, commercial, mining or agricultural activities; and
- that does not contain sulphidic ores or soils, and includes excavated natural material that meets such criteria for virgin excavated natural material as may be approved for the time by a notice published in the NSW Government Gazette.

To validate imported fill, one sample per 100m^3 will be collected and analysed for potential contaminants of concern (PCOCs) as per NSW EPA *Technical Note: Investigation of Service Station Sites* (2014), namely metals (arsenic, cadmium, chromium, copper, lead, mercury and zinc), TRH, BTEXN, organochloride pesticides (OCPs) and polychlorinated biphenyls (PCBs). Visual observation for asbestos must also be conducted.

8.0 Site Management Plan

Specific controls and strategies for environmental protection during remediation forms part of the requirements of the RAP.

8.1 Hazard identification and exposure pathways

8.1.1 Hazards

Based on the site assessment, the hazards which require management are:
- soil potentially contaminated with lead; and
- standard construction site hazards.

8.1.2 Exposure

Exposure is likely only when the soil is exposed. This may occur if:
- the grass is removed or killed; or
- following earth works, bare soil is exposed.

Based on the proposed remedial strategy, potential environmental impacts are considered to relate to movement of soils through erosion or disturbance, and movement of dust.

Potential human health exposure relates to:
- dermal (skin) contact with soil or dust; and/or
- inhalation of soil or dust; and/or
- ingestion of soil or dust.

Controlling the above exposure pathways will effectively minimise the risks to workers or occupants in relation to the contaminated soil.

8.2 Interim (before remediation)

The residential house has recently been demolished and the resultant footprint is currently uncontrolled, with the exception of being fenced for security purposes. It is expected that the remediation works will be undertaken imminently, however in the circumstance that remediation is delayed, the following interim measures are required in order to maintain the current minimal exposure scenario:

- Implement erosion and sediment controls which are adequate to ensure no soil leaves the remediation area via runoff or air. It is recommended that these measures are designed and implemented by an appropriately qualified specialist in erosion and sediment control. These measures may include covering with a geofabric, or other free draining, rot proof cover with high tensile strength, and redirection of any surface water which may accumulate or traverse the remediation area.

- The interim measures are considered appropriate for a period of up to 12 months if the site is undisturbed and maintained.

8.3 Site management (remediation phase)

The remedial program should be undertaken with due regard to legislative requirements and any relevant environment planning instruments that apply to the site described in the above sections.

In particular, in addition to any statutory compliance required by the above-mentioned Acts and planning instruments, the contractor shall carry out the site works with all due care, to ensure that the following conditions are complied with, as far as practicable:
- wind-borne dust is minimised;

- no water containing any suspended matter or contaminants is to be allowed to leave the confines of the site in such a manner that it could pollute any nearby waterway;
- material from exposed, surfaces is not to be tracked onto other areas of the site by personnel or equipment; and
- noise levels at the site boundary are to comply with the Council requirements.

The contractor will ensure that each employee or sub-contractor employed by the contractor is familiarised with the requirements of the RAP by the site manager/supervisor. Specific environmental requirements relating to the remediation works include:

1. Maintain erosion and sediment controls to prevent offsite migration of impacted soils.

2. Use appropriate methods to control the generation of dust, e.g. limit extent of works at any one time, use water sprays to keep soils moist (but not enough to generate surfacewater), cover work areas if required, or stop work if wind sufficient to generate dust.

3. During excavation works, use methods which minimise manual handling of soils.

4. Minimise the movement of soil via personnel and machinery tracking soil out of the lead in soil remediation area.

5. Ensure all personnel whom are coming into contact with potentially contaminated soils are wearing appropriate personal protective equipment (PPE), such as gloves, long sleeves shirt, long pants and the like.

6. Given ingestion is a primary exposure pathway, all workers must wash their hands and faces before eating.

8.4 Remediation schedule

The remediation schedule is yet to be defined.

8.5 Hours of operation

Remediation works must comply with the development application, including:
- Monday to Saturday from 7.00 am to 5.00 pm;
- no work to be carried out on Sundays or Public Holidays; and
- the proponent is responsible to instruction and control subcontractors regarding hours of work.

8.6 Unexpected finds

As for all sites, a potential exists that wastes or contaminated soils exist through undetected hotspots or uncontrolled dumping. During the site works, all materials should be assessed for potential contamination. Indications of contamination include, but are not limited to, soils, fills or wastes which exhibit:
- staining or discolouration; and/or
- odours; and/or
- waste materials such as ash or slag; and/or
- construction or demolition wastes (brick, concrete, tile, timber, steel, carpet, etc.); and/or
- asbestos cement sheeting or pipe pieces or fragments; and/or
- bottles, chemical containers, broken glass, plastic, etc.; and/or
- white goods, garbage, etc.

An unexpected finding protocol (UFP) for the site works includes, the following:
- immediately stop work in the area of concern;

- contact the site manager or their designated authority;
- erect temporary barricading to prevent access, and warning signs as required;
- provide cover or suitable suppressant if odorous;
- provide erosion and sediment control measures as required; and
- contact appropriate organisations to provide specialist advice/support, this should include the involvement of an appropriately qualified environmental consultant, specialising in contaminated land.

The UFP should be integrated with the site-specific emergency response plan. If the unexpected findings present an immediate hazard, then the emergency response plan should take precedence over the UFP

8.7 Contingency plans

The purpose of the contingency plan is to identify unexpected situations that could occur during the remediation works, and specify procedures that can be implemented to manage such situations and prevent adverse impacts to the environment and human health, and manage unexpected situations. Contingency plans for the remedial works include:

- If initial validation works do not remove all sufficient contamination, further excavation and off-site disposal may be required to meet site criteria.

- Dust emissions are to be confined within the site boundary. The following dust control procedures may be employed to comply with this requirement:
  - minimisation of work areas;
  - erection of dust screens around the perimeter of the site or dust generating activities;
  - use of water sprays across the site to suppress dust (but not to generate runoff);
  - covering of all stockpiles of soil or other materials likely to generate dust or odours; and
  - changing or modifying work practices based on climatic conditions.

8.8 Contact details

The following contact details are to be provided:

Contact	Name	Details
The Tweed Hospital, Powell St & Florence Street, Tweed Heads NSW 2485	Nearest Medical Assistance	(07) 5536 1133
Emergency	-	000
Client	Tony Jackman Woollam Constructions Pty Ltd	0408 464 648
EPA	Pollution Hotline	(02) 9995 5000
Cavvanba Consulting Pty Ltd 1/66 Centennial Circuit, Byron Bay NSW 2481 ABN: 37 929 679 095	Ben Wackett Ross Nicolson Rob McLelland	0428 606 064 0488 225 692 02 6685 7811
Cavvanba Field Scientist	Glen Chisnall	0499 401 092

8.9 Long term management plan

A long-term management plan is not considered likely to be required following remediation works.

9.0 References

Consultant reports

Cavvanba Consulting (2018) *Soil investigation report – Residential house, 771 Cudgen Road, Cudgen, NSW* (Ref. 18084 R01).

OCTIEF (2018), *Preliminary and Detailed Site Investigation – 771 Cudgen Road, Cudgen, NSW 2487* (Ref. J8961).

OCTIEF (2018) *Remediation action plan – Tweed Valley Hospital Site, 771 Cudgen Road, Cudgen NSW* (Ref: J8961)

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EPA (1985) *Environmentally Hazardous Chemicals act 1985, Chemical control order in relation to scheduled chemical wastes. (Published in Government Gazette No 77 of 30.4.2004, p 2283)*.

DEC (2007) *Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination*. NSW EPA, Sydney.

Department of Environment, Climate Change and Water (DECCW) (2009) *Guidelines for Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008*. NSW DECCW, Sydney;

EPA (2016) *Contaminated Land Management: Draft Guidelines for the NSW Site Auditor Scheme (3rd edition)*. EPA, Sydney.

EPA (1995a) *Contaminated Sites: Guidelines for the Vertical Mixing of Soil on Former Broad-acre Agricultural Land*. NSW EPA, Sydney.

EPA (1995b) *Contaminated Sites: Sampling Design Guidelines*. NSW EPA, Sydney.

EPA (1997) *Contaminated Sites: Guidelines for Assessing Banana Plantation Sites*. NSW EPA, Sydney.

EPA (2005) *Contaminated Sites: Guidelines for Assessing Former Orchards and Market Gardens*. NSW EPA, Sydney.

EPA (1999) *Contaminated Sites: Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report*. NSW EPA, Sydney.

EPA (2000) *Environmental Guidelines: Use and Disposal of biosolids products*. NSW EPA, Sydney.

EPA (2012) *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases*.NSW EPA, Sydney.

EPA (2015) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*. NSW DECC, Sydney.

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ANZECC/NHMRC (1992) *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*. Australian and New Zealand Environment and Conservation Council and the National Health and Medical Research Council, Canberra.

Australian Government Department of Health (2017) *Health Based Guidance Values for PFAS for use in site investigations in Australia*.

Department of Health and Ageing and EnHealth Council (2002) *Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards*. Commonwealth of Australia, Canberra.
Lock, W. H., (1996) "Composite Sampling", *National Environmental Health Forum Monographs, Soil Series No. 3*. SA Health Commission, Adelaide.

NEPC (1999) *National Environment Protection (Assessment of Site Contamination) Measure, Schedule A and Schedules B(1)-B(10), amended April 2013*. National Environment Protection Council, Adelaide.

NHMRC/ NRMMC (2011) *Australian Drinking Water Guidelines*. National Health and Medical Research Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, and Natural Resource Management Ministerial Council (NRMMC), Australian Government, Canberra.

NSW Agricultural/CMPS&F (1996) *Guidelines for the Assessment and Clean Up of Cattle Tick Dip Sites for Residential Purposes*. NSW Agricultural and CMPS&F Environmental, Canberra.

Figures

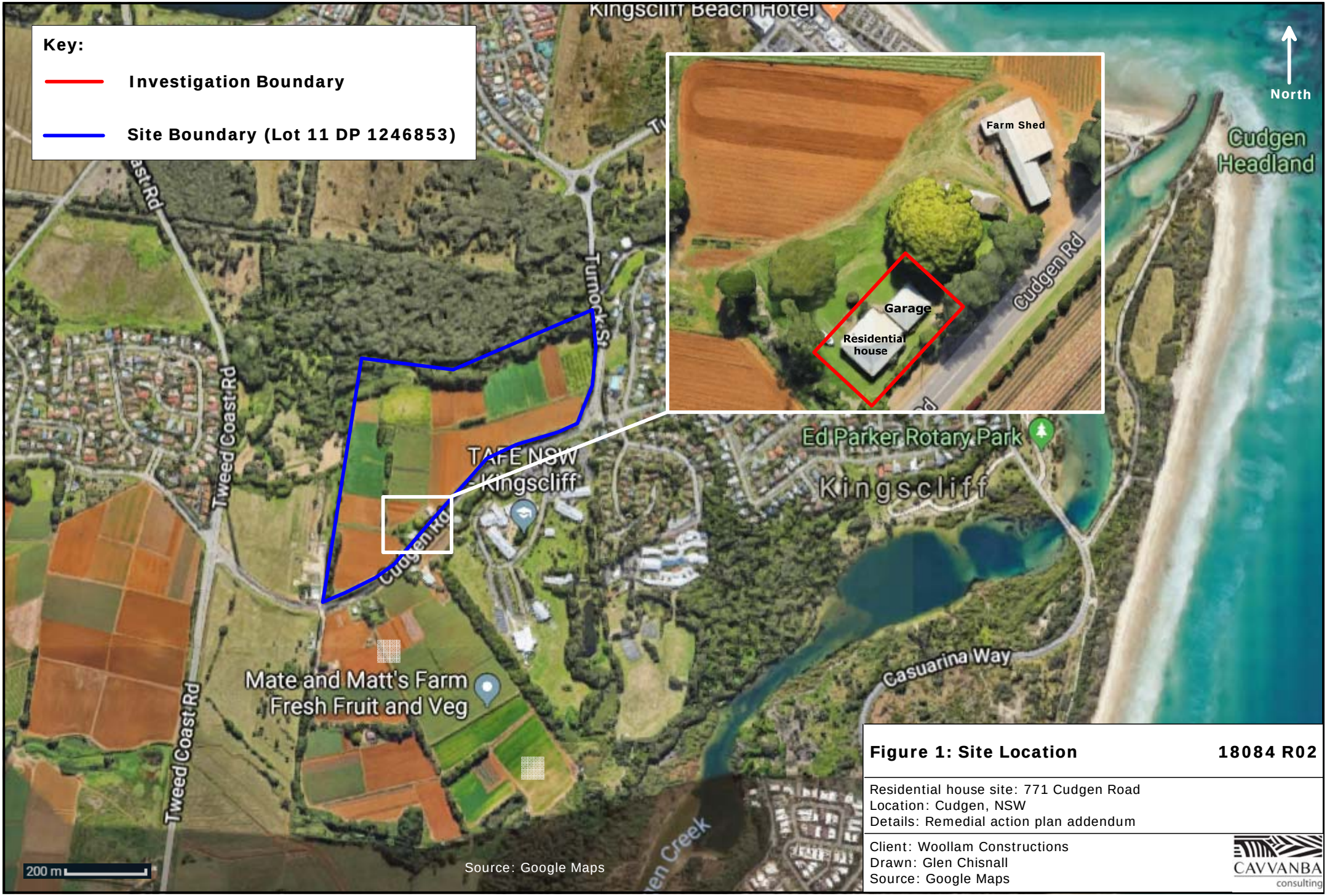

Figure 1: Site Location **18084 R02**

Residential house site: 771 Cudgen Road
Location: Cudgen, NSW
Details: Remedial action plan addendum

Client: Woollam Constructions
Drawn: Glen Chisnall
Source: Google Maps

CAVVANBA consulting

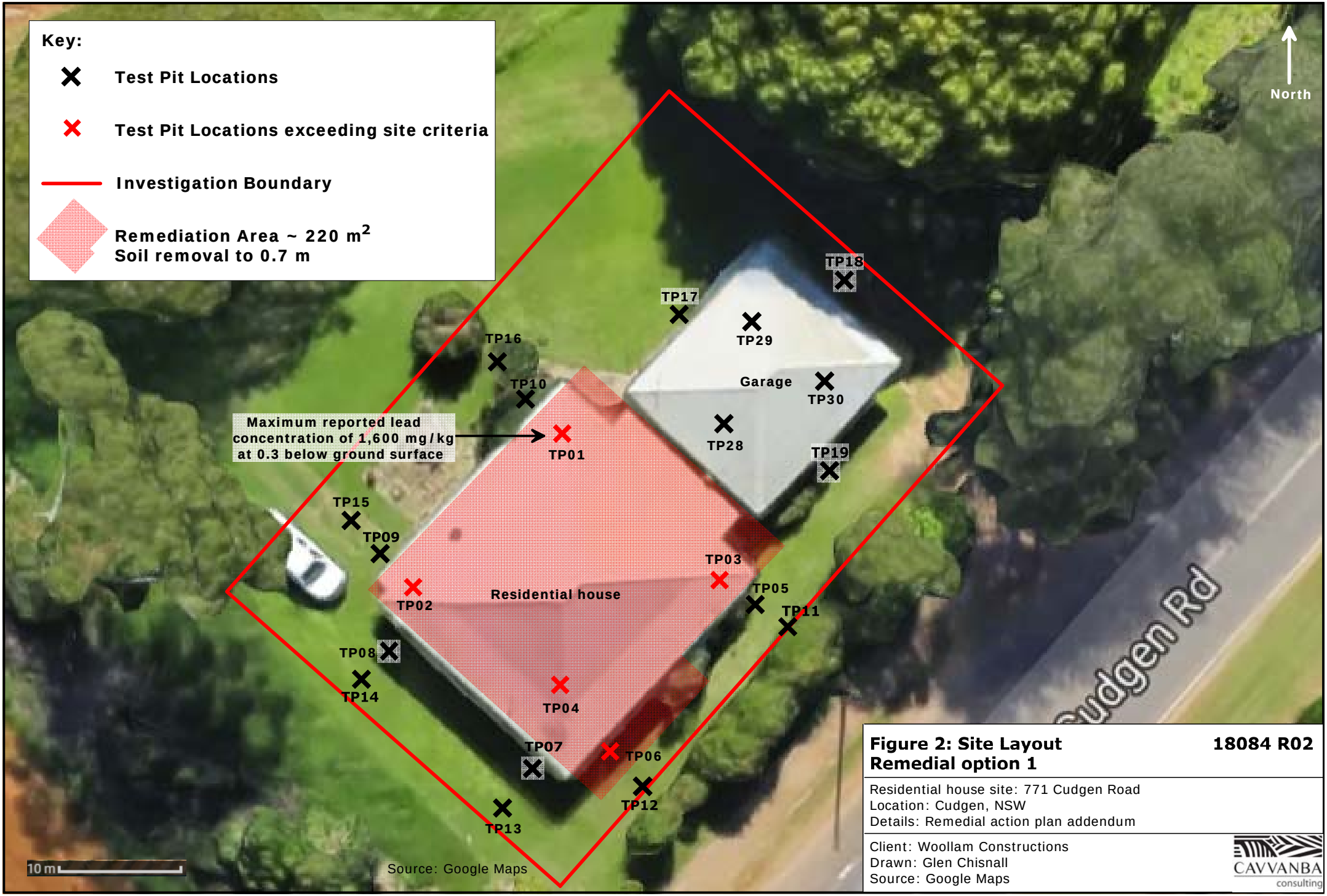

Figure 2: Site Layout **18084 R02**
Remedial option 1

Residential house site: 771 Cudgen Road
Location: Cudgen, NSW
Details: Remedial action plan addendum

Client: Woollam Constructions
Drawn: Glen Chisnall
Source: Google Maps

CAVVANBA consulting

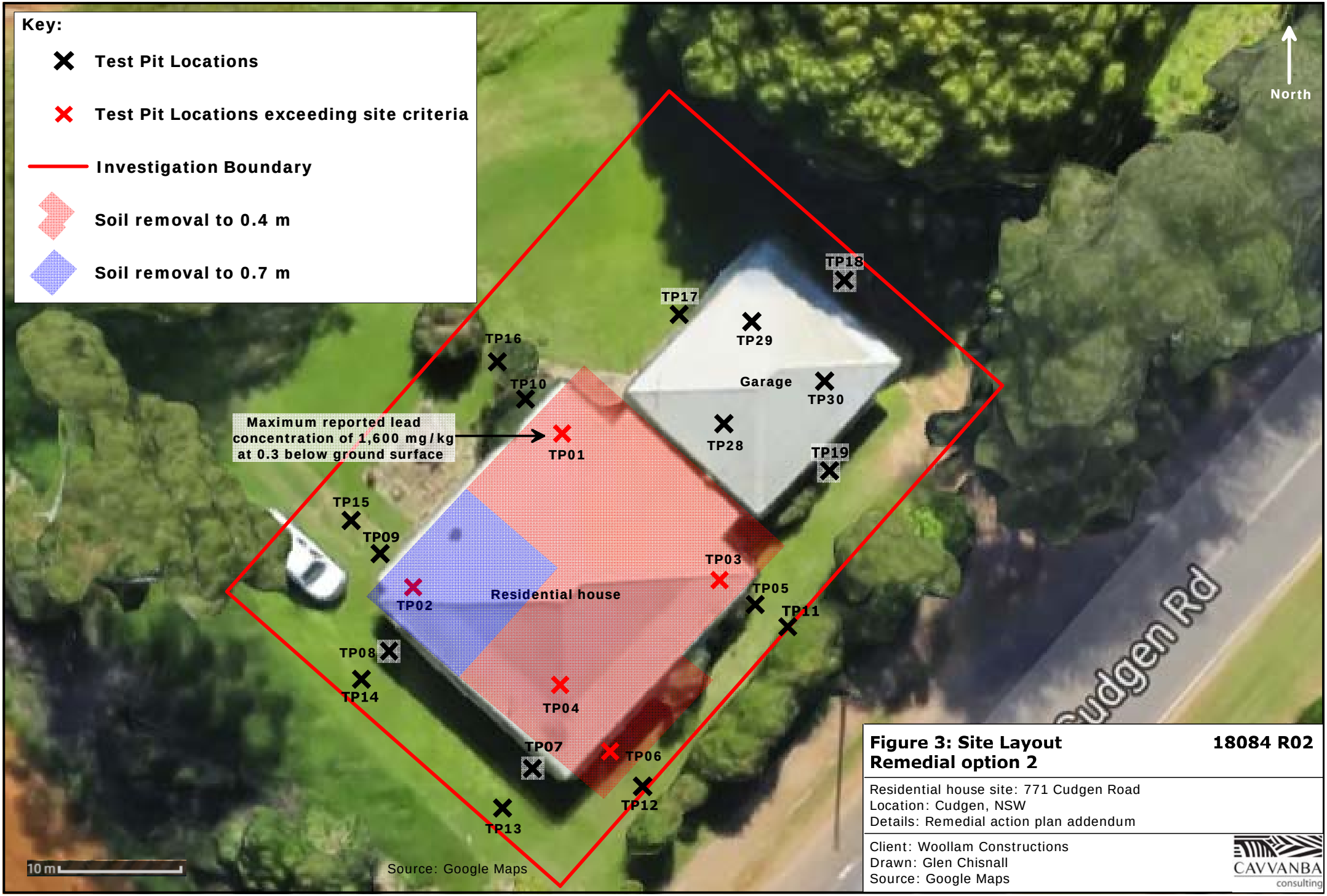

Figure 3: Site Layout **18084 R02**
Remedial option 2

Residential house site: 771 Cudgen Road
Location: Cudgen, NSW
Details: Remedial action plan addendum

Client: Woollam Constructions
Drawn: Glen Chisnall
Source: Google Maps

CAVVANBA consulting

Tables

Table 1: Sample Description and Analytical Summary

Sample	Depth (m)	Date sampled	Description	Lead	OCPs
Soil - Test Pits					
Residential house					
TP01	0.1	30/11/18	Reworked natural: Dark brown to red silty clay. Slightly moist with low plasticity. Anthropogenic inclusions of glass and tiles.	•	•
TP01	0.3	30/11/18	Reworked natural: Dark brown to red silty clay. Slightly moist with low plasticity. Anthropogenic inclusions of glass and tiles.	•	•
TP01	0.6	12/12/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	
TP02	0.1	30/11/18	Reworked natural: Dark brown to red silty clay. Slightly moist with low plasticity. Anthropogenic inclusions of glass and tiles.	•	•
TP02	0.3	30/11/18	Reworked natural: Dark brown to red silty clay. Slightly moist with low plasticity. Anthropogenic inclusions of glass and tiles.	•	
TP02	0.6	12/12/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	
TP03	0.1	30/11/18	Reworked natural: Dark brown to red silty clay. Slightly moist with low plasticity. Anthropogenic inclusions of glass and tiles.	•	•
TP03	0.3	30/11/18	Reworked natural: Dark brown to red silty clay. Slightly moist with low plasticity. Anthropogenic inclusions of glass and tiles.	•	•
TP03	0.6	12/12/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	
TP04	0.1	30/11/18	Reworked natural: Dark brown to red silty clay. Slightly moist with low plasticity. Anthropogenic inclusions of glass and tiles.	•	•
TP04	0.3	30/11/18	Reworked natural: Dark brown to red silty clay. Slightly moist with low plasticity. Anthropogenic inclusions of glass and tiles.	•	
TP05	0.1	30/11/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	•
TP06	0.1	30/11/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	•

Table 1: Sample Description and Analytical Summary

Sample	Depth (m)	Date sampled	Description	Lead	OCPs
TP06	0.3	12/12/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	
TP07	0.1	30/11/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	•
TP08	0.1	30/11/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	•
TP09	0.1	30/11/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	•
TP10	0.1	30/11/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	•
TP11	0.1	30/11/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	•
TP12	0.1	30/11/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	•
TP13	0.1	30/11/18	Reworked natural: Dark brown to red silty clay. Slightly moist with low plasticity. Anthropogenic inclusions of glass and tiles.	•	•
TP14	0.1	30/11/18	Reworked natural: Dark brown to red silty clay. Slightly moist with low plasticity. Anthropogenic inclusions of glass and tiles.	•	•
TP15	0.1	30/11/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	•
TP16	0.1	30/11/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	•
TP17	0.1	30/11/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	•
TP18	0.1	30/11/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	•
TP19	0.1	30/11/18	Dark brown to red silty clay. Slightly moist with low plasticity.	•	•
Underneath garage slab					
TP28	0.1	11/12/18	Dark brown to red silty clay. Slightly moist with low plasticity.		•
TP29	0.1	11/12/18	Dark brown to red silty clay. Slightly moist with low plasticity.		•
TP30	0.1	11/12/18	Dark brown to red silty clay. Slightly moist with low plasticity.		•

Table 2: Soil Analytical Summary, OCPs and Lead

Sample	Depth (m)	Heptachlor	Total Chlordane (sum)	Endrin	Endosulfan (sum)	Methoxychlor	Sum of Aldrin + Dieldrin	Sum of DDD + DDE + DDT	Hexachlorobenzene (HCB)	Sum of OCPs	Lead
LORs		*0.05*	*0.05*	*0.05*	*0.05*	*0.2*	*0.05*	*0.05*	*0.05*	-	*0.1*
Analytical - Test pits											
Residential House											
TP01	0.1	nd	4.1	nd	nd	nd	0.77	3.58	nd	8.45	**1,090**
TP01	0.3	nd	2.06	nd	nd	nd	1.18	9.07	nd	12.31	**1,600**
TP01	0.6	-	-	-	-	-	-	-	-	-	144
TP02	0.1	nd	0.16	nd	nd	nd	0.14	0.06	nd	0.36	**1,070**
TP02	0.3	-	-	-	-	-	-	-	-	-	**838**
TP02	0.6	-	-	-	-	-	-	-	-	-	**324**
TP03	0.1	nd	nd	nd	nd	nd	0.88	1.09	nd	1.97	**502**
TP03	0.3	nd	nd	nd	nd	nd	0.34	0.25	nd	0.59	**416**
TP03	0.6	-	-	-	-	-	-	-	-	-	15
TP04	0.1	nd	0.14	nd	nd	nd	0.29	0.08	nd	0.51	**324**
TP04	0.3	-	-	-	-	-	-	-	-	-	252
TP05	0.1	nd	nd	nd	nd	nd	nd	0.83	nd	0.83	155
TP06	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	**317**
TP06	0.3	-	-	-	-	-	-	-	-	-	162
TP07	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	64.6
TP08	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	60.9
TP09	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	161
TP10	0.1	nd	nd	nd	nd	nd	0.23	0.07	nd	0.3	119
TP11	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	32.2
TP12	0.1	nd	nd	nd	nd	nd	nd	0.1	nd	0.1	195
TP13	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	34
TP14	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	54.8
TP15	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	72.4
TP16	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	134
TP17	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	76.5
TP18	0.1	nd	nd	nd	nd	nd	nd	0.07	nd	0.07	27
TP19	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	31.6

Table 2: Soil Analytical Summary, OCPs and Lead

Sample	Depth (m)	Heptachlor	Total Chlordane (sum)	Endrin	Endosulfan (sum)	Methoxychlor	Sum of Aldrin + Dieldrin	Sum of DDD + DDE + DDT	Hexachlorobenzene (HCB)	Sum of OCPs	Lead
LORs		*0.05*	*0.05*	*0.05*	*0.05*	*0.2*	*0.05*	*0.05*	*0.05*	-	*0.1*
Underneath garage slab											
TP28	0.1	nd	nd	nd	nd	nd	5.18	nd	nd	5.18	-
TP29	0.1	nd	nd	nd	nd	nd	5.19	0.1	nd	5.29	-
TP30	0.1	nd	nd	nd	nd	nd	10.6	nd	nd	10.6	-
Statistics											
Samples analysed		21	21	21	21	21	21	21	21	21	27
Detects		0	4	0	0	0	7	10	0	10	27
% detect		0%	19%	0%	0%	0%	33%	48%	0%	48%	100%
Maximum		<0.05	4.10	<0.05	<0.05	<0.05	1.18	9.07	<0.05	12	**1,600**
Mean		<0.05	0.31	<0.05	<0.05	<0.05	0.18	0.72	<0.05	1.21	306
Median		<0.05	1.11	<0.05	<0.05	<0.05	0.34	0.18	<0.05	0.55	155
Minimum		<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	15
Criteria											
HILs- Residential A		6	50	10	270	300	6	240	10	-	**300**
EILs - Urban residential and public open space		-	-	-	-	-	-	180 (DDT only)	-	-	1,100

Table 3: Soil Analytical Summary, Quality Control (mg/kg)

Analyte	LOR mg/kg	TP09_0.1	QS01	**RPD**	TP09_0.1	QS02	**RPD**
Type	-	*Primary*	*Duplicate*	*%*	*Primary*	*Inter-laboratory Duplicate*	*%*
Date	-	30/11/18	30/11/18	-	30/11/18	30/11/18	-
Media	*Soil*	*Soil*	*Soil*	-	*Soil*	*Soil*	-
Heavy metals							
Lead	5	161	167	4	161	140	14
Organochlorine Pesticides (OCPs)							
Heptachlor	0.05	nd	nd	-	nd	nd	-
Total Chlordane (sum)	0.05	nd	nd	-	nd	nd	-
Endrin	0.05	nd	nd	-	nd	nd	-
Endosulfan (sum)	0.05	nd	nd	-	nd	nd	-
Methoxychlor	0.2	nd	nd	-	nd	nd	-
Sum of Aldrin + Dieldrin	0.05	nd	0.88	-	nd	nd	-
Sum of DDD + DDE + DDT	0.05	nd	0.11	-	nd	nd	-
Hexachlorobenzene (HCB)	0.05	nd	nd	-	nd	nd	-
Sum of OCPs	-	nd	0.99	-	nd	nd	-
Data Quality Indicator		-	-	*<50%*	-	-	*<50%*

See tables notes at end of section

Table 3: Soil Analytical Summary, Quality Control (mg/kg)

Analyte	LOR mg/kg	TP07_0.1	QS03	**RPD**	TP07_0.1	QS04	**RPD**
Type	-	*Primary*	*Duplicate*	*%*	*Primary*	*Inter-laboratory Duplicate*	*%*
Date	-	30/11/18	30/11/18	-	30/11/18	30/11/18	-
Media	*Soil*	*Soil*	*Soil*	-	*Soil*	*Soil*	-
Heavy metals							
Lead	5	64.6	61.9	4	64.6	57	13
Organochlorine Pesticides (OCPs)							
Heptachlor	0.05	nd	nd	-	nd	nd	-
Total Chlordane (sum)	0.05	nd	nd	-	nd	nd	-
Endrin	0.05	nd	nd	-	nd	nd	-
Endosulfan (sum)	0.05	nd	nd	-	nd	nd	-
Methoxychlor	0.2	nd	nd	-	nd	nd	-
Sum of Aldrin + Dieldrin	0.05	nd	nd	-	nd	nd	-
Sum of DDD + DDE + DDT	0.05	nd	nd	-	nd	nd	-
Hexachlorobenzene (HCB)	0.05	nd	nd	-	nd	nd	-
Sum of OCPs	-	nd	nd	-	nd	nd	
Data Quality Indicator		-	-	*<50%*	-	-	*<50%*

See tables notes at end of section

Table 3: Soil Analytical Summary, Quality Control (mg/kg)

Analyte	LOR mg/kg	TP03_0.6	QS03	**RPD**	TP03_0.6	QS06	**RPD**
Type	-	*Primary*	*Duplicate*	*%*	*Primary*	*Inter-laboratory Duplicate*	*%*
Date	-	12/12/18	12/12/18	-	12/12/18	12/12/18	-
Media	*Soil*	*Soil*	*Soil*	-	*Soil*	*Soil*	-
Heavy metals							
Lead	5	15	26	**54**	15	6	**86**
Organochlorine Pesticides (OCPs)							
Heptachlor	0.05	-	-	-	-	-	**-**
Total Chlordane (sum)	0.05	-	-	-	-	-	**-**
Endrin	0.05	-	-	-	-	-	**-**
Endosulfan (sum)	0.05	-	-	-	-	-	**-**
Methoxychlor	0.2	-	-	-	-	-	**-**
Sum of Aldrin + Dieldrin	0.05	-	-	-	-	-	**-**
Sum of DDD + DDE + DDT	0.05	-	-	-	-	-	**-**
Hexachlorobenzene (HCB)	0.05	-	-	-	-	-	-
Sum of OCPs	-	-	-	-	-	-	
Data Quality Indicator		-	-	***<50%***	-	-	***<50%***

See tables notes at end of section

Soil Analytical Summary Table Notes

LOR denotes limit of reporting (standard LOR unless otherwise shown)

PBILs denotes phytotoxicity based investigation levels

nd denotes not detected above the LOR

NL denotes non-limiting

- denotes not analysed/not available

Bold - Exceeds landuse criteria

^ denotes raised LOR

TRH C6-C10 F1 = TRH C6-C10 minus BTEX compounds

*analyte list shown on laboratory report

1. Methyl mercury / inorganic mercury
2. Netherlands protection of terrestrial organisms/ Netherlands human health based and human health and ecologically based protection level.
3. Criteria for phenol

Appendix A

Photographic log

Photograph 1.
View east of investigation area, garage to the left and the residential house on the right. All photographs taken on 30 November; 11 and 12 December 2018.

Photograph 2.
View of TP02; located underneath the south-western section of the former residential house. Anthropogenic materials consisting of plastic and glass scattered around the test pit location.

Photograph 3.
View of test pit location TP04; located underneath southeast portion of the house, in the southeast portion.

Photograph 4.
Test pit location TP06, located ~ 1 m from the eastern wall of the former residential house.

Photograph 5.
View of test pit location TP14, sampled ~ 5 m to the south of the residential house. Anthropogenic inclusions of glass and tiles were identified within this location.

Photograph 6.
View over garage slab. Test pit locations TP28 and TP30 visible in foreground followed by demolition waste from the former residential house.

Appendix B

OCTIEF (2018) *Preliminary and detailed site investigation – 771 Cudgen Road, Cudgen, NSW 2487* Figure 3 DSI sampling locations

REV	DESCRIPTION	DATE	INT	APP
1		04/4/2016	MO	RJ

OCTIEF

CLIENT:	Health Infrastructure NSW	DESIGNED:	DRAWN:
PROJECT TITLE:	Tweed Hospital PSI/DSI	CHECKED:	No. SHEETS:
		SCALE:	DATE STARTED:
SITE ADDRESS:	771 Cudgen Road, Cudgen	JOB No:	J8961
DRAWING TITLE:	DSI Sampling Locations	DRAWING No:	3