Remedial Action Plan – Development Area

Wood and Grieve Engineers Pty Ltd

St Aloysius College,
Kirribilli NSW 2061

April 2019

Ref. 17066 R03 V2

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Report Details

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Remedial Action Plan – Development Area

St Aloysius College, Kirribilli, New South Wales 2061

Ref: 17066 R03

for

Wood & Grieve Engineers Pty Ltd

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1.0 Introduction

Cavvanba Consulting Pty Ltd (Cavvanba) was engaged by Wood & Grieve Engineers Pty Ltd (WGE) to prepare a Remedial Action Plan (RAP) for the proposed site development. Previous investigations identified contaminated fill material on-site which is proposed to be excavated as part of the proposed site development. The RAP was prepared to address the requirements of the *State Environmental Planning Policy No. 55 – Remediation of Land (SEPP 55).*

The RAP has been prepared in accordance with Cavvanba's proposal of 19 November 2018, and the client's acceptance of 21 November 2018. This RAP should be read in conjunction with Cavvanba's *General limitations to environmental information*, shown in Section 1.4.

St Aloysius' College is an independent Jesuit day school for boys in Kirribilli, a suburb on the Lower North Shore of Sydney, NSW. The college (the site) consists of three discrete campuses, located in close proximity off Humphrey Place, Kirribilli NSW as detailed below from north to south (and shown on Figure 1):

- Junior School;
- Senior School; and
- Main Campus.

The Junior School is the northernmost campus and is located approximately 80 m north of the Senior School, being separated by Bligh and Fitzroy Street (one street block). The site area is completed sealed, being covered by buildings, concreted areas and/or artificial turf and raised garden beds.

The Senior School is positioned between the Junior School and the Main Campus, being separated from the Main Campus by Upper Pitt Street. The Senior School is predominantly covered by buildings with external paved and an open grassed area in the western portion of the School.

The Main Campus is the southernmost campus and is covered predominantly by buildings surrounding a central concreted open space area with raised garden beds.

It should be noted that this RAP has been specifically designed to meet the requirements of the development application (DA) and as such, does not constitute site wide requirements. Additionally, the excavation and off-site disposal of excess material generated by the works outlined in the DA is likely to be limited to the spoil excavated aspart of the construction.

1.1 Proposed development

The proposed development consists of the following:

- Junior School: construction of an underground sports hall;
- Senior School: construction of a new single-story classroom structure; and
- Main Campus: construction of a new building and repurposing of adjoining structures.

Further information is provided in Section 4 regarding the proposed development.

1.2 Remediation 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;
- describe the regulatory issues associated with the proposed remediation;
- describe the overall remedial strategy to remove unacceptable risks to human health and the environment associated with the identified contaminants; and

– describe the remedial works to be conducted, including environmental management and occupational health and safety (OH&S).

1.3 RAP requirements

The Environmental Protection Authority (EPA) (2011) *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*, describes that a RAP is to include the following:

- 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 EPA (2011) in regard to a RAP, and where this information is addressed in this RAP, is provided in Table 1.1. Sections 1 – 4 of the RAP summarises the site condition and previous investigation findings.

Table 1.1: RAP requirements

Report requirement	Section
Discussion of the extent of remediation required.	5.0
Identification of regulatory compliance requirements such as licences and approvals.	6.0
Remediation goal.	7.1
Discussion of possible remedial options and how risk can be reduced.	7.2
Rationale for the selection of recommended remedial option.	7.3
Contingency plan if the selected remediation strategy fails.	10.6 and 10.7
Proposed testing to validate the site after remediation.	8.0
Interim site management plan (before remediation), including e.g. fencing, erection of warning signs, stormwater diversion.	10.2
Site management plan (operational 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.	10.3
Remediation schedule.	10.4
Hours of operation.	10.5
Contingency plans to respond to site incidents, to obviate potential effects on surrounding environment and community.	10.6 and 10.7

Report requirement	Section
Names and phone numbers of appropriate personnel to contact during remediation.	10.8
Community relations plan, where applicable.	n/a
Staged progress reporting, where appropriate.	n/a
Long-term management plan	9

1.4 General limitations to environmental information

The findings of this reporting are based on the objectives and scope of the services provided. Cavvanba Consulting 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, expressed or implied, are made.

Cavvanba's review/assessment is strictly limited to identifying the environmental conditions associated with the subject property in regard to site contamination, and does not seek to provide an opinion regarding other aspects of the environment not related to site contamination, or to the suitability of the site in regard to: landuse planning and legal use of the land; and/or regulatory responsibilities or obligations (for which a legal opinion should be sought); and/or the occupational health and safety legislation; and/or the suitability of any engineering design. Reviews of such information are only in relation to the contaminated land aspects of any project or site. If specialist technical review of such documents is required, these should be obtained by an appropriate specialist.

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

Field monitoring, sampling and chemical analysis of environmental media and structures are based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate, based on regulatory requirements, site history, and the proposed landuse, not on sampling and analysis of all media, at all locations, for all potential contaminants.

Limited field monitoring, and environmental sampling and laboratory analyses, were undertaken as part of the investigations reviewed or conducted by Cavvanba, as described. Ground conditions, contaminants, and material types/composition can vary between sampling locations, and this should be considered when extrapolating between sampling locations. Except at each sampling location, the nature, extent and concentration of contamination is inferred only.

Furthermore, the test methods used to characterise the contamination at each sampling location are subject to limitations and provide only an approximation of the contaminant concentrations. Monitoring and chemical analytes are based on the information detailed in the site history. 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 at the site should not be interpreted as a warranty or guarantee that such materials do not exist at the site. Therefore, future work at the site which involves subsurface excavation or removal of structures or parts thereof, should be conducted based on appropriate management plans. These should include, *inter alia*, environmental management plans, including unexpected

findings protocols, hazardous building materials management plans, and occupational health and safety plans.

If additional certainty is required, then additional site history information should be obtained, or additional exploration and sampling and analysis should be conducted. This decision should be made by the user of this information based on an appropriate risk management process, and the user should commission additional services if required.

2.0 Site identification and environmental setting

2.1 Site identification

St Aloysius’ College is an independent Jesuit day school for boys in Kirribilli, a suburb on the Lower North Shore of Sydney, NSW.

The college consists of three discrete campuses, located in close proximity off Humphrey Place as detailed below from north to south:
- Junior School;
- Senior School; and
- Main Campus.

The Junior School is the northernmost campus and is located approximately 80 m north of the Senior School, being separated by Bligh and Fitzroy Street (one street block). The site area is completed sealed, being covered by buildings, concreted areas and/or artificial turf and raised garden beds.

The Senior School is positioned between the Junior School and the Main Campus, being separated from the Main Campus by Upper Pitt Street. The Senior School is predominantly covered by buildings with external paved and an open grassed area in the western portion of the School.

The Main Campus is the southernmost campus and is covered predominantly by buildings surrounding a central concreted open space area with raised garden beds.

Specific site details are presented in Sections 2.1.1 – 2.1.3, below. A site locality map is provided as Figure 1.

2.1.1 Junior School identification and topography

The Junior School site location is shown on Figure 1. The site identification and landuse details are:

Owner:	The Trustees of The Jesuit Fathers.
Site Address:	29 Burton Street, Milsons Point, 2061, NSW
Legal Property Description:	Lot 1 in DP830667
Property area:	Approximately 4,300m^2.
Co-ordinates:	Latitude: -33.846545536 Longitude: 151.213584165
Local Government Authority:	North Sydney Council.
Elevation:	Approximately 30 metres (m) above mean sea level.
Landuse – Existing:	Junior School.
Landuse – Proposed:	Junior School.
Zoning – Existing:	SP2 – Educational Establishment.
Zoning – Proposed:	SP2 – Educational Establishment.

The Junior School is situated at approximately 29 metres above mean sea level forming the topmost portion of the ridge to the Kirrbilli Peninsula. The site slopes from the Bligh Street entrance at its highest point with a gradual fall of approximately 4 metres toward the Burton Street entrance to the north. It is anticipated that surface water would be directed over land to the north of the site towards the municipal stormwater drainage system, eventually discharging to Sydney Harbour.

2.1.2 Senior School identification and topography

The Senior School site location is shown on Figure 1. The site identification and landuse details are:

Registered Proprietor:	The Trustees of the Jesuit Fathers.
Site Address:	1-5 Jeffreys Street, Milsons Point, 2061, NSW
Legal Property Description:	Lot 101 of DP1108496
Property area:	3,400 m^2
Co-ordinates:	Latitude: -33.847878851 Longitude: 151.214116498
Local Government Authority:	North Sydney Council.
Elevation:	Approximately 30 metres (m) above mean sea level.
Landuse – Existing:	Senior School
Landuse – Proposed:	Senior School
Zoning – Existing:	SP2 – Educational Establishment.
Zoning – Proposed:	SP2 – Educational Establishment.

The Senior School is situated at approximately 28 metres above mean sea level, which also forms part of the ridge to the Kirribilli Peninsula. The site is predominantly occupied by buildings, however the open, south-western portion of the site is relatively flat with a gradual fall to the southwest towards Sydney Harbour. It is anticipated that surface water would be directed within the on-site stormwater drainage system to the southwest, eventually discharging to Sydney Harbour.

2.1.3 Main Campus identification

The main campus site location is shown on Figure 1. The site identification and landuse details are:

Owner:	The Trustees of the Jesuit Fathers.
Site Address:	47 Upper Pitt Street, Milsons Point, 2061, NSW
Legal Property Description:	Lot 10 of DP880841.
Property area:	Approximately 3,800 m^2.
Co-ordinates:	Latitude: -28.550873

	Longitude: 153.503748
Local Government Authority:	North Sydney Council.
Elevation:	Approximately 20 - 30 metres (m) above mean sea level.
Landuse – Existing:	College
Landuse – Proposed:	College
Zoning – Existing:	SP2 – Educational Establishment.
Zoning – Proposed:	SP2 – Educational Establishment.

The Main Campus is situated at approximately 24 metres above mean sea level, forming part of the Kirribilli Peninsula ridge line. The site is occupied completely by buildings with the exception of a level, concrete open space area in the central – eastern portion of the site. The general area within the immediate vicinity of the Main Campus slopes from the Upper Pitt Street entrance at its highest point with a fall of approximately 6 metres towards Kirribilli Avenue to the south. Similar to the Senior School site, it is anticipated that surface water would be directed within the on-site stormwater drainage system to the southwest, eventually discharging to Sydney Harbour. Sydney Harbour is located approximately 100 m to the south of the Main Campus.

2.2 Surrounding landuse

The three properties are located in a mixed residential and commercial/industrial area. The boundaries of all properties are roads, excluding the northern portion of the Senior School. Land use features surrounding the three sites are summarised below.

2.2.1 Junior School

Land use features surrounding the Junior School are summarised below.

North:	Burton Street is situated immediately to the north of the site; beyond this, industrial and residential properties extend over a number of streets.
East:	Residential properties are located to the east of the site beyond Crescent Place.
South:	Bligh Street is situated directly to the South, residential and commercial buildings occupy the block beyond this point including a dry cleaners.
West:	Residential properties are located to the east beyond Humphrey Place.

2.2.2 Senior School

Land use features surrounding the Senior School are summarised below.

North:	Fitzroy Street is located to the North; residential dwellings occupy the area immediately beyond this.
East:	Residential and apartment block buildings occupy the east.

South:	Upper Pitt Street runs adjacent to the southern boundary of the site; beyond this is St Aloysius's Main Campus site.
West:	Jeffery Street is situated to the west; apartment buildings appear to occupy the block beyond.

2.2.3 Main Campus

Land use features surrounding the Main Campus are summarised below.

North:	Upper Pitt Street runs along the northern boundary of the site. The St Aloysius Senior School is situated approximately 30 m to the north.
East:	Apartment buildings occupy the neighbouring land to the east.
South:	The site is bordered by Kirribilli Avenue to the south, followed by residential buildings.
West:	The site is bordered with Jefferys Street to the west, followed by residential buildings.

2.3 Geology

Based on the Sydney Area Coastal Quaternary Geology Map (Geological Survey of New South Wales, 2008), the site lies on Hawkesbury Sandstone, consisting of cross-bedded to massive quartz sandstone with mudstone lenses.

During the previous investigations conducted by Cavvanba on-site, heterogeneous fill material was encountered, followed by sandstone depths from depths of 0.4 m – 1.9 m below ground surface. More information is provided in Sections 2.3.1 – 2.3.3.

2.3.1 Junior School

The profile consisted of the fill material consisting of brown sandy gravel / sand to the maximum explored depths of 0.5 m. At this depth, refusal was encountered with the hand tools used.

The fill material observed beneath the basketball court and artificial turf was consistent with material observed during the previous PSI at the Junior School, suggesting a similar origin.

2.3.2 Senior School

The profile consisted of the following:
- fill consisting of brown/black sand to clayey sand, to maximum depths of 1.3 m;
- in BH04, a different fill material was encountered from 0.6 m to 1.3 m depth which included anthropogenic materials including ash, brick, tiles, bone fragments, glass and slate; this was followed by
- weathered sandstone.

Fill material observed at the Senior School was variable with ash fill being observed at BH04 location from approximately 0.6 m to 1.3 m. The same fill layer was not present at the adjacent BH05 and BH06 locations.

2.3.3 Main Campus

BH03 was advanced during the PSI in the western portion of the courtyard area approximately 20 m south-west of the DSI locations. A greater depth of fill material was observed to 1.3 m. Particularly of note was a black and brown clayey sandy layer which exhibited hydrocarbon odours from 0.15 – 0.8 m and following analysis was confirmed to contain high concentrations of PAHs.

This fill material is therefore limited to the western extent of the courtyard only. The remainder of the locations consisted of:

- fill consisting of brown / yellow sand to maximum depths of 0.2 m;
- sandstone was observed from approximately 0.2 m below the concrete pavement in BH07, BH08 and BH09;

Soil boring locations, BH10 and BH11 were unable to be sampled due to the presence of the sandstone bedrock directly beneath the concrete pavement at 0.1 m. Both of these locations are in the eastern portion of the courtyard.

2.4 Hydrogeology

Groundwater was encountered during previous investigations at depths within 10 m of the ground surface. Regional groundwater is anticipated to flow to the south towards Sydney Harbour.

A search of NSW Department of Primary Industries Office of Water licensed bores within a 500 m radius of the senior school site identified one registered bore, which is located 450 m east of the site. This bore is considered to be across-gradient assuming the groundwater is flowing towards Sydney Harbour to the south.

The results of the groundwater bore search are provided in full in Appendix A and summarised in Table 2.1 below.

Table 2.1: Licensed bore summary

Bore ID	Registered use	Distance from site	Geology	Depth (m)	Water bearing zone (m)
GW114492	Monitoring bore	~ 450 m east	0 – 0.3 m fill dark brown, silty sandy clay. 0.3 – 1.3 m fill dark brown, silty sandy clay, sandstones. 1.3 – 1.7 m Sandstone, low strength, yellow brown. 1.7 – 10.0 m Sandstone, medium strength, grey.	10.0	1.2 m

3.0 Contamination assessment

3.1 Previous assessments

Cavvanba has conducted previous investigations at the site:

- Cavvanba Consulting (2018) *Preliminary Site Investigation, St Aloysius College, Kirribilli, New South Wales 2061* (Ref. 17066 R01);
- Cavvanba Consulting (2018) *Preliminary Waste Classification, New sports court development, 29 Burton Street, Kirribilli NSW 2061* (Ref. 17066 L01); and
- Cavvanba Consulting (2018) *Detailed Site Investigation, St Aloysius College, Kirribilli, New South Wales 2061* (Ref. 17066 R02).

3.2 Cavvanba, PSI (2018)

Cavvanba was commissioned by Wood & Grieve Pty Ltd (WGE) to undertake a Preliminary Site Investigation (PSI) at three parcels of land located in Kirribilli, New South Wales 2061.

The objective of the PSI was to identify all past and present potentially contaminating activities, identify potential contaminant types, discuss the site conditions, provide a preliminary assessment of site contamination; and assess the need for further investigations.

To meet the project objectives, the scope of work completed included a desktop review of background information and undertaking a limited intrusive investigation which included the advancement of six soil bores across the three properties, installation of three monitoring wells and sampling of soil and groundwater focussed on the areas of the site proposed to be disturbed by the works outlined in the DA.

The sources of potential on-site contamination were identified to include fill material, underground fuel storage, demolition waste and asbestos in buildings as well as off-site sources including a dry-cleaners.

Soil analytical results exceeded adopted health-based residential screening criteria in samples collected and analysed from fill material from all three properties. As the sites are largely sealed, complete exposure pathways to the impacted fill material were found to be limited.

Groundwater analytical results from the installed monitoring wells exceeded site criteria for metals and benzo(a)pyrene, as well as detections for TRH and BTEXN.

Based on the findings of the preliminary site investigation undertaken, it was found that the risk of exposure to the contaminated fill material requires management during the proposed works as complete exposure pathways exist during excavation. More detailed environmental investigation works were proposed to characterise contamination at the site, evaluate if there are unacceptable risks to human health or the environment and to determine site suitability.

3.3 Cavvanba, Preliminary Waste Classification (2018)

Cavvanba was engaged to undertake a preliminary waste classification of 2,200m^3 of material proposed to be excavated resulting from the new sports court development at 29 Burton Street, Kirribilli NSW 2061 known as St Aloysius College Junior School. It should be noted that this letter was limited to the Junior School at the time of completion, and did not include the other two properties.

Two boreholes were advanced into the material beneath the proposed development; with a gravelly sandy fill material recorded to explored depths of 1.9 m. All samples were collected on 7 and 8 December 2017. Seven (7) samples (BH01_0.5, BH02_0.2, BH02_0.4.

BH02_0.55, BH02_1, BH02_1.5, BH02_1.9) were analysed in order to provide a classification of the material with samples analysed for the following analytes:

- heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc);
- PAHs;
- benzo(a)pyrene;
- TPHs and BTEXN; and
- asbestos.

Based on the results of the preliminary waste classification, it was concluded that the material assessed at the Junior School was likely to be classified as **restricted solid waste** (non-putrescible) in accordance with the NSW EPA (November 2014) *Waste Classification Guidelines, Part 1: Classifying Waste.* The primary reason for the restricted solid waste classification was exceedances recorded above the general solid waste criteria for lead (without TCLP analysis) and benzo(a)pyrene (with TCLP analysis).

The preliminary waste classification letter recommended that additional sampling be undertaken at the site in order to meet waste classification sampling rates and the possibility to conduct a statistical analysis on the samples collected and possibly reduce the classification from restricted waste to general solid waste.

3.4 Cavvanba, DSI (2018)

Cavvanba Consulting Pty Ltd was commissioned by Wood & Grieve Engineers Pty Ltd (WGE) to undertake a Detailed Site Investigation (DSI) at three parcels of land located in Kirribilli, New South Wales 2061 (herein known as the site).

The detailed site investigation objectives were to provide additional information to supplement the PSI. The intrusive investigation focussed on the areas of the site proposed to be disturbed by the works outlined in the DA.

To meet the project objectives, the scope of work completed included a desktop review of background information and advancement of fifteen soil bores across the three properties with soil samples collected from thirteen of the boreholes completed.

The soil profile identified across the site was observed to consist of fill material to varying depths, followed by the natural sandstone profile. Field indicators, including hydrocarbon odours were absent in the fill material encountered. Potential asbestos containing material fragments were not observed on surface soils or within the soil profile on-site.

Soil analytical results exceeded adopted health-based residential screening criteria in samples collected and analysed from fill material from all three properties. As the sites are largely sealed, complete exposure pathways to the impacted fill material are limited in its current condition.

The risk of exposure to the contaminated fill material will need to be managed during the proposed works as complete exposure pathways exist during construction excavation as well as to future site occupants in the open space area of the Senior School.

A remedial action plan will be required to manage the contaminated fill during the proposed site development process. In addition, a long-term management plan will be required to minimise access to future site users as the contaminated fill is unlikely to be limited to the development areas of the site only.

Based on the implementation of the RAP and EMP, the site is considered to be able to be made suitable for the proposed land use.

3.5 Summary

A summary of the findings of the PSI and DSI reports are detailed below in Table 3.1.

Table 3.1: Primary issues from the investigation

Issue	DSI outcome	Recommendation	Applicable to DA process
Fill material on-site	Fill material was identified on all three sites to depths of 1.7 m which exceeded site criteria for lead, total recoverable hydrocarbons, benzo(a)pyrene, and polycyclic aromatic hydrocarbons (PAHs). It is understood that as part of the proposed development, excavation of fill is likely to occur. These works will disturb this material and it's understood that it will be surplus to requirements and require off-site disposal. In addition, fill material at the Senior School is at shallow depths and there is a risk of a complete exposure pathway.	Prepare a remedial action plan. The fill material will require management during the proposed development works to prevent exposure to construction workers, depending on the extent of disturbance. In addition, a long-term management plan will be required for the site.	Yes. The proposed development will disturb and potentially expose construction workers and users to the fill material.
Asbestos – poor historical demolition practices	Asbestos has not been identified on-site to date. The potential for unexpected finds remains during large-scale excavation.	Take this into consideration during the proposed excavation works.	Yes. Fill is likely to be directly disturbed during the proposed works.
Underground petroleum storage system (UPSS)	UPSS was identified on the Main Campus site, which is likely to be a diesel tank associated with heating oil.	Decommission USTs in accordance with NSW EPA UPSS Regulation.	UPSS is located approximately 20 m from the area of disturbance on the Main Campus. The UPSS is not anticipated to be impacted by the development. The development will not impede further investigation of the UPSS.
Groundwater – metals, TRHs and benzo(a)pyrene	Elevated metals, TRHs and benzo(a)pyrene were identified in site monitoring wells.	Further assessment of groundwater is required to determine if this is a site-specific issue associated with fill/fuel storage or a broader regional issue. Based on the exceedances of drinking water, consideration should	Further assessment of groundwater is not likely to be required for the DA process. Groundwater is understood to be disturbed by the proposed development, and will need to be taken into consideration and managed.

Issue	DSI outcome	Recommendation	Applicable to DA process
		be given to the duty to notify the NSW EPA.	The extent of disturbance is likely to be minor and limited to the construction phase only. Dewatering poses a potential pathway for exposure and discharge to the environment. Dewatering may mobilise or exacerbate unknown sources of contamination. The development will not impede further investigation of groundwater.

4.0 Proposed site development

The site is proposed to be developed and an environmental site assessment is required to be submitted with the development application (DA). The development proposed for the site is detailed below:

- Junior School: construction of an underground sports hall;
- Senior School: construction of a new single-story classroom structure; and
- Main Campus: construction of a new building and repurposing of adjoining structures.

4.1 Soil disturbance

Disturbance of fill material is understood to consist of the following:

- Junior School: excavation and off-site disposal of ~ 2,200 m^3 of fill material beneath the existing basketball court;
- Senior School: excavation and off-site disposal activities associated with installation of drainage and piles (estimated to be ~ 25 m^3); and
- Main Campus: excavation and off-site disposal of fill material from beneath the courtyard (estimated to be ~ 800 m^3).

It is likely that as part of these works, subsurface disturbance with occur including excavation of soil and potential off-site disposal.

A site locality and site features plan are provided as Figure 1 and Figures 2, 4 and 6, respectively. These Figures show the areas proposed to be disturbed by the works.

4.2 Groundwater disturbance

A table summarising the anticipated groundwater disturbance is provided as Table 4.1.

Table 4.1: Summary of anticipated groundwater disturbance

	Junior School	Senior School	Main Campus
Groundwater encountered (Mac Geo, 2018)	3.9 m	Groundwater not investigated on Senior School property. Shallow footings will be founded on rock.	No free ground water observed
Stabilised groundwater depth (January 2018)	5.2 m		1.9 m (groundwater considered to be under confined conditions in Sandstone Fracture / Bed)
Proposed excavation and depth and activity	6 m – 7 m for basement.		1.5 m footings
Proposed building type	Underground enclosed building	Enclosed building	Enclosed building
Groundwater disturbance likely?	Potential, but likely to be limited to during construction.	-	Unlikely, due to shallow footings and groundwater likely confined.
Heavy metals in groundwater	Dewatering poses a potential pathway for exposure and requires discharge to the environment.	-	Low risk. Unlikely to be in direct contact.
Volatile hydrocarbons in groundwater		-	Low risk. Unlikely to be in direct contact.

	Junior School	Senior School	Main Campus
	Treatment prior to discharge may be necessary. Dewatering may also mobilise or exacerbate unknown sources of contamination.		

5.0 Extent of remediation required

5.1 Media

This remediation action plan is limited to soil and management of any groundwater disturbance.

5.2 Potential contaminants of concern

Potential contaminants of concern are detailed in Table 5.1 below for soil and groundwater and are generally associated with the presence of fill material.

Table 5.1: PCOCs and summary of areas of concern

PCOCs	Description and common relationship
Heavy Metals	arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni) and zinc (Zn). Fuels/oils, fill, metal working, buildings, fences, urban runoff, electrical components, pest control, fertilisers, etc.
TRHs	Total recoverable hydrocarbons including volatile fractions (C_6 – C_9 TRHs) and semi-volatile fractions (C_{10} – C_{36} TRHs). Fuels, oils and grease, fill material, solvents.
BTEXN	Benzene, toluene, ethyl benzene, xylenes and naphthalene. Volatile hydrocarbons. Fuel constituents, fill materials, solvents.
PAHs	Polycyclic aromatic hydrocarbons. Semi-volatile hydrocarbons. Constituents in bitumen, tar, asphalt, fuel constituents, oil, grease, ash.
Asbestos (soil only)	Asbestos in the form of free fibres and asbestos containing materials (ACMs). Commonly used in pipework, buildings (fibro), etc.

5.3 Lateral and vertical extent

Fill material exceeding site criteria was identified on all three properties in the samples analysed. These exceedances were with respect to:
- lead;
- TRH F2 ($>C_{10}$-C_{16});
- TRH F3 ($>C_{16}$-C_{34});
- benzo(a)pyrene TEQ;
- benzo(a)pyrene; and/or
- total PAHs.

Analytical results are provided in full in Tables 1 – 6, attached. Exceedances of site criteria are detailed on Figures 3, 5 and 7 for the respective Campuses.

The potential exists for exposure to these contaminants to construction workers during the proposed site development as well as during future site use.

5.4 Waste summary

A summary of the current waste classification information is provided in Appendix A in the following letter:
- Cavvanba (2018) *Waste Classification Summary, Proposed Site Development Works, St Aloysius College, Kirribilli NSW 2061* (Ref. 17066 L02).

A summary of the waste classification results is provided below in Table 5.2 below.

Table 5.2: Waste Classification summary

	Junior School	Senior School	Main Campus	
Media	Fill material	Fill material	Fill material – sand / reworked natural	Black clayey sand fill (BH03, western portion)
Estimated volume to be excavated	~2,200 m^3	~ 25 m^3	< 800 m^3	Unknown, likely to be < 25 m^3
Exceedances of criteria	Total PAHs and Benzo(a)pyrene	Nickel, lead, Total PAHs and Benzo(a)pyrene	N/A	Total PAHs and Benzo(a)pyrene
Current Waste Classification	**Restricted solid waste**	**Restricted solid waste**	General solid waste	**Hazardous solid waste**
More data required?	No	No	Yes	Yes

Collection of additional samples for the fill material proposed to be removed from the Junior School and Senior School are unlikely to lower the waste classification at this stage.

Additional samples are recommended at the Main Campus during excavation to appropriately characterise the two waste streams. In addition, oversight from a suitably qualified environmental scientist and segregation of material types will be vital to minimising the hazardous waste stream and costs.

6.0 Regulatory requirements

Regulatory aspects relating to the remediation of this site are summarised in Table 6.1, including a summary of the acts, regulations, policies and the like which are considered potentially germane to the management of contaminated land.

Table 6.1: Regulatory review summary

Act, regulation, policy, etc.	Relevant requirements	Project specific application
Environmental Planning & Assessment (EP&A) Act 1979 All development proposals in NSW must be assessed to ensure they comply with relevant planning controls and, according to nature and scale, that they are environmentally and socially sustainable. State, regional and local plans and policies indicate what level of assessment is required, and who is responsible for assessment. Planning and development is carried out under the EP&A Act and the *Environmental Planning and Assessment (EP&A) Regulation* 2000. Under S. 79C of the EP&A Act, the consent authority has to consider the suitability of the site for the continued landuse which includes whether the site is contaminated.		
Development application approval Development applications are made under the EP&A Act for developments that are legal under the planning scheme. In determining an application, the consent authority must consider statutory requirements (acts and regulations, state environmental planning policies, and regional and local environmental plans) and non-statutory requirements (development control plans (DCPs) and council and state policies and guidelines).	Notices of determinations are issued, which may be subject to conditions. These will generally include requirements for appropriate environmental management as part of the development works. For sites where contamination has been identified, submittal of appropriate assessment and management documents are generally required. A statutory site audit may be required if conditioned by the consent authority.	The consent authority is the Department of Planning and Environment, and development consent is required prior to the works being conducted. Where long term management is required, any relevant environmental management plan should be noted in the Council Section 10.7 planning certificate and should be legally enforceable. There are not statutory audit requirements on this site. It is understood that this RAP is required for the consent authority to make a determination on the proposed development approval process. Therefore, the application of this RAP and any associated requirements for management of contamination of soil or groundwater will form part of the conditions of approval.

Act, regulation, policy, etc.	Relevant requirements	Project specific application
Designated development Designated development includes development that has a high potential to have adverse impacts because of their scale or nature or because of their location near sensitive environmental areas, such as wetlands. Designated developments are listed in Schedule 3 of the EP&A Regulation, or in planning instruments such as *SEPP 14.*	Including contaminated soil treatment works that treat soil exclusively from the site and: – incinerate more than 1,000 m3 a year of contaminated soil; or – treat otherwise than by incineration and store more than 30,000 m3 of contaminated soil; or – disturb more than an aggregate area of 3 ha of contaminated soil.	No incineration or storing of contaminated soil are proposed. In addition, the works will not disturb more than 3 ha of contaminated soil.
State Environmental Planning Policy No. 55 Provides for a State-wide planning approach to the remediation of contaminated land and aims to promote the remediation of contaminated land for the purpose of reducing the risk of harm to human health or any other aspect of the environment.	Specifies Category 1 and or 2 remediation, i.e. where consent is required for the remedial works, and includes prior notice for Category 2, requirements for compliance with guidelines, notices of completion for Category 1 works, and various planning considerations.	The consent authority is understood to be the Department of Planning and Environment. The works will likely meet the definition of Category 2 work.
Contaminated lands policy or development control plans (DCPs) Under SEPP 55, councils can make a contaminated land policy. DCPs provide specific, more comprehensive guidelines for certain types of development. The detailed guidelines contained within a DCP are in addition to the provisions of the legal planning instrument.	Varies based on local government area. Policies and/or DCPs provide specific guidance as to what the consent authority requires for remediation, including site management requirements. Under SEPP 55, remedial work which does not comply with a relevant planning policy is classified as Category 1.	No additional management requirements.
Contaminated Land Management (CLM) Act 1997 The CLM Act establishes a legal framework that gives EPA powers to require the assessment and remediation of site where contamination is significant enough to warrant regulation. Under the ACT, EPA can agree to voluntary investigation and management of sites, or impose orders for investigation or management.		
Duty to report There is a duty for landowners and persons who have responsibility for contamination to notify EPA under Section 60 of the CLM Act.	Reporting to EPA if required based on the considerations and criteria described in EPA (2014) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*.	Notification is not required.

Act, regulation, policy, etc.	Relevant requirements	Project specific application
Orders or voluntary agreements EPA can declare land to be an investigation or remediation area, or to be significantly contaminated. Management of investigation and remedial works can be by an order or a voluntary management proposal.	Determine if any orders under Part 3 of the CLM Act or approved voluntary management proposals under the CLM Act exist or are in preparation.	None identified.
Protection of the Environment Operations (POEO) Act 1997 The objectives of the Act include to protect, restore and enhance the quality of the environment in NSW, having regard to the need to maintain ecologically sustainable development. The requirements of the POEO Act and associated schedules and regulations, are relevant to the assessment and management of contaminated land.		
Air, noise, water General provisions in regard to 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.	Development of appropriate management plans, e.g. environmental management plan (EMP), having regard to specific approvals and relevant guidance. The Act also requires notification when a pollution incident occurs that causes or threatens material harm to the environment.	No additional provisions are required beyond the typical construction controls for earthworks, and those described in this RAP. A long-term environmental management plan will be required following completion of the works. This is discussed further in Section 9.
Environment protection licences For scheduled development work and scheduled activities, and non-scheduled activities for water pollution (e.g. S. 43, 47, 48, 55, and 122).	Schedule 1 of the POEO Act defines contaminated soil treatment as a scheduled activity as for designated developments, and contaminated groundwater treatment with the capacity to treat more than 100 megalitres per year.	Not applicable.

Act, regulation, policy, etc.	Relevant requirements	Project specific application
The Act defines 'waste' for regulatory purposes and establishes management and licensing requirements.	Includes waste classification, resource recovery exemptions (e.g. VENM/ENM), general immobilisation approvals, requirements for immobilisation, and licensing requirements. The POEO Act is relevant to the disposal of soil to a licensed landfill and importation of fill material.	Contaminated soil will be disposed of off-site during the works, and this will be assessed and classified in accordance with relevant EPA waste guidelines. Underlying natural sandstone which is surplus to requirements is proposed to be classified under a resource recovery exemption as VENM. Any material for off-site disposal should consider the requirements of the POEO Act. Any imported fill should be assessed and classified as VENM (or ENM) in compliance with the POEO Act.
Underground Petroleum Storage Systems (UPSS) Regulation 2008 Best practice in the design, installation and ongoing operation of a UPSS, which applies to all UPSSs in NSW.	Specific requirements include: – loss monitoring and detection; – incident management (response); – groundwater monitoring wells; – site validation following decommissioning/ – removal/replacement; and – environmental protection plan (EPP).	Not applicable to this RAP.
Environmentally Hazardous Chemicals (EHC) Act 1985 The main provisions of the EHC Act relate to a statutory chemical assessment function, and the regulation and control of chemicals via Chemical Control Orders (CCOs), licences and regulations. The EHC Act regulations set general requirements for fees, provision of information, exemptions and penalties while the CCOs set controls for specific chemicals both through generic requirements and by requiring that certain processes be subject to particular licence conditions.		

Act, regulation, policy, etc.	Relevant requirements	Project specific application
Chemical Control Orders Chemical control orders in force in NSW: – aluminium smelter wastes; – dioxin-contaminated wastes; – scheduled chemical wastes (SCW); – organotin waste materials; and – polychlorinated biphenyls (PCBs) and wastes.	A CCO provides set requirements for a broad range of activities, including the manufacture, processing, distribution, use, sale, transportation, storage and disposal of chemicals and chemical wastes. In regard to the assessment and management of contaminated land, CCOs can be applicable to onsite use or to offsite disposal. In regard to OCPs, any concentrations, or combined concentration that is greater than 2 mg/kg is considered to be SCW.	Not applicable.
Water Management Act (WMA) 2000 The object of the WMA and the *Water Management (General) Regulation* 2004 is the sustainable and integrated management of the State's water for the benefit of both present and future generations. It includes the establishment of water sharing plans, and various approvals and licences to protect and maintain surface and ground waters.		
Controlled activity approval A controlled activity approval (CAA) under Part 3, Chapter 3 of the WMA is required for controlled activities carried out in, on or under waterfront land.	Waterfront land includes the bed and banks of a river, lake or estuary, including land to within 40 metres of the highest bank or the mean high water mark (also check NSW Fisheries).	Not applicable.
Licensing of groundwater wells	A licence is required to establish a groundwater bore for any purpose, including groundwater monitoring.	Not applicable Monitoring wells < 40 m depth no longer require licensing. If the volume of dewatering is more than 3 megalitres per year, a licence under Part 5 of the Water Act 1912 prior to commencing the activity or approval from the Office of Water will be required.

Act, regulation, policy, etc.	Relevant requirements	Project specific application
Heritage Act 1977		
A relic is any deposit, object or material evidence which relates to the settlement of NSW, not being Aboriginal settlement, and which is 50 or more years old.	If any relics or suspected relics are discovered, they should not be remove or disturb, as an archaeological investigation may be required and a permit under the Act may be required.	Not applicable for these remedial works.
National Parks and Wildlife Act 1974		
Aboriginal object means any deposit, object or material evidence relating to the Aboriginal habitation of NSW, being habitation before and/or concurrent with the occupation of non-Aboriginal persons, and includes Aboriginal remains.	If any Aboriginal or suspected Aboriginal objects are detected, they should not be remove or disturb as an archaeological investigation may be required and a permit under the Act may be required.	Not applicable for these remedial works.
Work, Health and Safety Act 2012		
Primary work, health and safety legislation, specifying health and safety requirements for employers and workers, governed by WorkCover NSW.	Persons undertaking work on the site within the lead management area must comply with the WHS requirements	A health and safety plan was developed by Cavvanba for the site works to ensure compliance with the WHS Act and Regulation.

7.0 Remedial actions

7.1 Remediation goal

The goal of the remedial works is to ensure that impacted fill material which will be disturbed as part of the project and is surplus to requirements is appropriately removed from site and taken to a facility that can lawfully accept the contaminated materials. Contaminated material which is to be excavated as part of the project will be managed in such a way that eliminates or reduces the risk the material can pose to human health or the environment.

The excavation works will also be undertaken in a manner that reduces potential for exacerbation of impacts during the works.

The goal of the remedial works is not to address all contamination present at the Site, which is largely widespread associated with fill material. By removing a portion of the contamination from the site through the excavation and off-site disposal of contaminated material, a net benefit to risk profile of the site will be achieved.

7.2 Remediation 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.

7.2.1 No action

The ‘no action’ approach would involve stockpiling contaminated excavated material on-site following the completion of the project. This option would present an ongoing risk to potential receptors of the site (public access and intrusive maintenance workers).

Based on the proposed development and excavation and off-site disposal being required for the development, the 'no action' option is not considered to be appropriate.

7.2.2 Treatment of material

On-site and off-site treatment of material is not applicable for the impacted fill material which is surplus to site requirements. Due to space and time constraints associated with the project, onsite management or treatment would be impractical.

7.2.3 Off-site disposal

Off-site disposal is the only option available for soil which is excess to development requirements and does not meet the requirements of the resource recovery order and resource recovery exemption framework.

Based on the concentrations of lead and PAHs identified, the soil does not meet the resource recovery order and exemption framework.

Material should be classified in accordance with NSW EPA, *Waste Classification Guidelines* 2014, and transferred to a landfill licensed to accept such wastes.

Preliminary classification of material to be disposed off-site has already been conducted.

7.3 Rationale for selected remedial option

Due to the following reasoning, on-site management or treatment would be impractical:
- the site is an operational school;
- there is limited space available on-site for use of suitable material and/or treatment and/or stockpiling of soil;
- minimal time is available for works due to works being limited to school holidays.

Therefore, based on an assessment of the remedial options in light of the project objectives, it is considered that excavation and off-site disposal is the most practical and reasonable remedial strategy for managing contaminated excavated material at the Site.

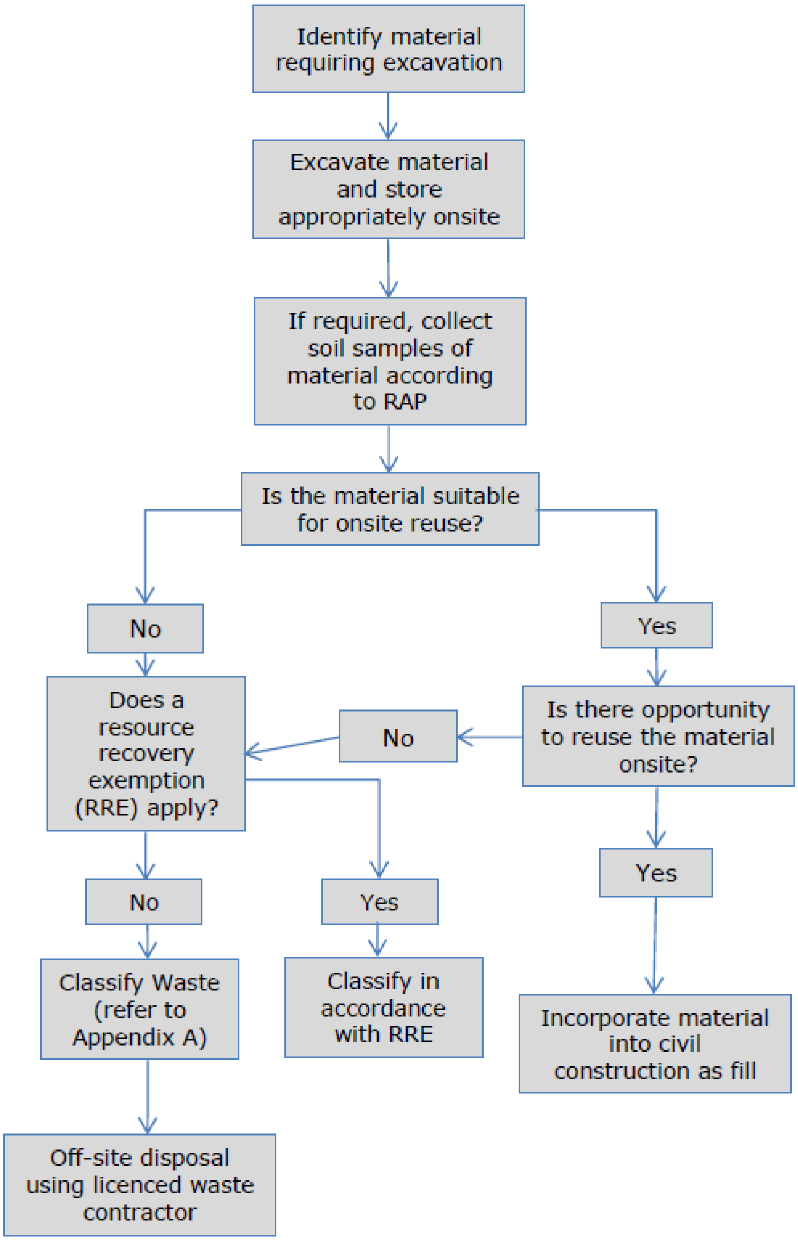
7.4 Remedial strategy

The remediation works described in this RAP will be primarily undertaken in accordance with the Site Contractors Environmental Management Plan (CEMP), as well as the applicable management plans described in Section 9.0.

The remedial works will consist of the following scope:
- excavate soils during earthworks (refer to Section 4.0 for anticipated excavation volumes). The excavation works are to extend only to the pre-determined limits prescribed by the development design;

- segregate material which is expected to be contaminated from other materials based on both field observations and the waste classification summary provided as Appendix A;
- material may be either stockpiled in designated areas, stored within containers such as drums or skip bins, or loaded directly into the waste transport;
- collect additional soil samples from the excavated material for screening against waste classification purposes and/or assessment of suitability for on-site beneficial use and preparation of waste classification letters as required. Statistical analysis (95% UCL) can be used to assess the data set. The material which is not suitable for on-site reuse will be classified in accordance with the NSW EPA (2014) *Waste Classification Guidelines*; and
- material which is considered to require off-site disposal, will be removed from Site and disposed to an appropriately licenced facility by an appropriately licenced waste contractor.

The above scope can be summarised by the following flow chart, which describes the decision-making process associated with the excavation and management of contaminated soils at the Site.



7.5 Stockpiling

Generation of excavated material which will require further management is expected associated with the Main Campus. The various excavations planned as part of the project design will be undertaken across the majority of the Site and will intercept variable levels of contamination.

7.5.1 Separation of stockpiles

Given the variable nature of contamination at the Main Campus, effort will be made to separate material based on suspected contamination. The determination of expected magnitude of contamination of material will be made by the operator or consultant according based on both field observations (presence of odours, staining, sheen, PID readings) and previous understanding of on-site contamination. The outcome of the determination will be used to determine whether certain materials require separation. It is noted that all stockpiled excavated material will be subject to classification as detailed in Section 7.6.

7.5.2 Stockpile management

At a minimum, all stockpiled material will be placed on concrete hardstand or polyethylene sheeting and bunded by silt mesh and sand bags for the control of silt and surface water runoff. Stockpiles will not be placed adjacent drainage lines, gutters or stormwater pit.

If stockpiled material is suspected to be contaminated, then the stockpile will be covered by plastic sheeting until the classification process is complete and a determination can be made on the contamination of the material. This measure will further reduce the risk of mobilisation of contaminated materials during high winds and rain fall. Contaminated stockpiles will be removed from Site as soon as practicable following sampling and classification.

If inclement weather conditions are encountered (i.e. rainfall which causes flowing run off or wind causing uncontrolled dust), excavation works will cease. Any stockpiled material will be stored in a location that would reduce risk of increased impact to surrounding properties, while not reducing the safety of workers at the site. This will be undertaken within a secure area until laboratory results concerning the material are received. No soil or water is to be removed from the site without appropriate waste classification. A preference to pre-classify soil within the excavation over stockpiling would be implemented throughout construction works.

Site plans detailing excavation areas, classification sampling and soil movements will be recorded during the civil works. All stockpiles will be labelled to ensure that they are properly classified according to contaminant concentrations and to ensure that cross contamination of classified soil does not occur.

7.6 Excavated material classification

7.6.1 Soil sampling methodology

Soil samples will be collected for waste classification purposes where required. As a large number of in-situ sampling has already been conducted, samples will likely be collected from soil stockpiles. All soil samples will be collected and logged in accordance with best practise described in the ASC NEPM (2013). In summary the following general work procedures will be followed:

- The soil will be logged by an appropriately trained and experienced scientist/engineer to record the following information: soil/rock type, colour, grain size, sorting, angularity, inclusions, moisture condition, structure, defects, staining and odour in general accordance with AS 1726-1993.

- A duplicate of each soil sample collected for field screening will be placed in sealed zip lock bags and screened using a PID, calibrated at the beginning of each working day. Where the presence of VOCs or other impact is suspected, additional laboratory analysis may be undertaken.

- Representative soil samples will be collected (to the extent practicable) in accordance with techniques described in Australian Standard AS4482 (Part 2) to maintain the representativeness and integrity of the samples. The samples will be placed in a pre-treated laboratory supplied sample container. The containers will be filled, where practical, to minimise headspace, before being sealed and appropriately labelled.

- Field quality control/quality assurance (QA/QC) samples will be collected.

- Sample jars will be sealed and placed in an insulated cooler on ice immediately and stored to reduce the potential for loss or degradation of contaminants.

- All non-disposable sampling equipment will be decontaminated.

7.6.2 Laboratory analysis

Primary samples will be shipped under chain of custody documentation to a National Association of Testing Authorities (NATA) accredited analytical laboratory. Secondary field duplicate samples will be shipped under chain of custody documentation to a secondary NATA accredited analytical laboratory.

At a minimum, samples collected will be analysed for the following in accordance with the primary contaminants of concern for the Site:
- TRH;
- BTEX;
- PAH; and
- heavy metals.

7.6.3 Waste classification reporting

Prior to the off-site disposal of soil material (primarily contaminated media), a waste classification letter will be written in accordance with the *Waste Classification Guidelines* (NSW EPA 2014). The document has already been partially completed in Appendix A. The waste classification letter will be produced by a suitably qualified independent professional. The waste classification letter will provide advice on the waste stream which the material should be managed under (i.e. liquid, non-putrescible general solid, restricted or hazardous). To be classified under a certain waste stream, material must satisfy a number of physical and chemical parameters as described by NSW EPA (2014).

The following information is to be included within the waste classification letter (in line with NSW EPA recommendations):
- the full name, address, Australian Company Number (ACN) or Australian Business Number (ABN) of the organisation and person(s) providing the waste classification;
- location of the site where the waste was generated, including the site address;
- the processes and activities that have taken place to produce the waste;
- If any, potential contaminating activities that may have occurred at the site where the waste was generated;
- description of the waste, including photographs, visible signs of contamination, such as discolouration, staining, odours;
- quantity of the waste;
- number of samples collected and analysed;

- sampling method including pattern, depth, locations, sampling devices, procedures, and photos of the sample locations and samples;
- contaminants tested;
- laboratory documentation – chain-of-custody, sample receipt, laboratory report;
- all results regardless of whether they are not used in the classification process;
- results of sample mean, sample standard deviation and if required the 95% upper confidence limit (UCL);
- brief summary of findings including discussion of results, exceedances of the relevant contaminant threshold (CT) or specific contaminant concentration (SCC) if toxicity characteristics leaching procedure (TCLP) threshold values are available; and
- a clear statement of the classification of the waste as at the time of the report.

7.6.4 Waste stream management

Following the waste classification process, waste material generated at the Site is expected to fall into the following waste streams as defined by the NSW EPA (2014) *Waste Classification Guidelines*:
- liquid waste;
- hazardous waste;
- restricted solid waste; and/or
- general solid waste (non-putrescible).

It is noted that only material which is required to be removed from site is defined as waste. All waste removed from site must be transported by an appropriately licenced waste contractor under a waste tracking certificate. The waste tracking certificate is provided by the waste contractor and is administered by the NSW EPA. The waste tracking certificate provides all relevant information regarding the transport and disposal of the material and can be used as suitable evidence of the management of the material.

7.6.5 Virgin excavated natural material certification

It is anticipated that the underlying natural weathered rock which requires excavation during the works is likely to meet the classification of virgin excavated natural material (VENM).

A suitably qualified environmental consultant should assess the material in-situ to determine that the sandstone meets the definition and if appropriate provide a VENM certificate.

7.6.6 Imported fill

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

VENM is described in the 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.*

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.

Alternatively, excavated natural material (ENM) can be used on-site if the specific use is in accordance with the ENM exemption and order.

7.7 Water management

It is understood that groundwater will potentially be disturbed as part of the proposed development. The extent of disturbance is likely to be minor and limited to the construction phase only.

As contamination was identified in groundwater on-site consisting of heavy metals, TRH and benzo(a)pyrene, water that collects within the excavation will be removed from the excavation using a tanker and disposed of at a licensed waste disposal facility, licensed to accept liquid waste.

7.8 Dewatering

A dewatering management plan (DMP) is recommended to be prepared for the site prior to construction. A DMP is a useful tool to ensure that any dewatering activities are carried out with appropriate planning in place. A DMP should be prepared by a suitably qualified hydrogeologist for the proponent responsible for the dewatering activity. The DMP must take into consideration surrounding landuses and potential sources of groundwater contamination and can form part of the Construction Environmental Management Plan (CEMP).

The DMP should take into consideration information obtained through the risk and geotechnical assessments. Relevant hydrogeological information should be used to decide upfront the expected duration of the dewatering project (short or long term) and, for a long-term project, whether dewatering can be completed in a specified time or will be ongoing. The DMP should clearly follow the principles of the waste management hierarchy. Failure to anticipate dewatering requirements and subsequent intersection of groundwater during excavation can lead to costly construction delays, while approvals for dewatering are sought. This highlights the need for dewatering to be considered during the design stage.

The volume to be disposed of is assumed to be less than 3 megalitres per year (3 ML/yr). It is the applicant of the DA's responsibility to assess and monitor water take and impacts, and to advise the NSW Office of Water if they exceed thee conditions.

If the volume to be extracted is more than 3 megalitres per year, a licence under Part 5 of the Water Act 1912 prior to commencing the activity or approval from the Office of Water will be required.

Council should be notified that dewatering is proposed. Under the Protection of the Environment Operations Act 1997 (POEO), allowing sediment or sediment laden water to enter any waterway including street gutters, stormwater drains, swales or creek lines (flowing or not) is considered to be water pollution.

Records should be kept of the following during dewatering:

- a dewatering work method statement should be prepared;
- date, time and estimated volume of water released for each discharge location;
- water quality test results for each discharge;
- records of approvals; and
- evidence of discharge monitoring or risk assessment.

8.0 Remediation validation and monitoring

8.1 Validation works

The remediation objective is limited to removing contaminated fill at pre-determined extents in accordance with the proposed development.

It has been established that potentially contaminated material exists both within the development area and throughout the three properties. Based on the likelihood of potentially contaminated fill material outside of the development area, validation of excavations is not considered to be necessary.

It is anticipated that the waste classification samples already collected/proposed to be collected as part of the project could also be used as an indication of the presence and distribution of residual contamination. Since the classification samples will be collected a various depths and locations within these excavations, samples will generally be collected proximal to the material which will remain in-situ following excavation. Therefore, it can be assumed that the analytical data collected from these samples would generally be representative of the material in the immediate vicinity of the excavation and valuable with respect to further characterisation and to the future management of residual conditions at the Site.

8.2 Validation reporting

A validation report will be prepared on the completion of the bulk earthworks, summarising the works undertaken. The report will provide a clear conclusion stating whether or not the remediation strategy has been satisfied and a conclusion regarding the site suitability for its proposed future use.

The report will be written in accordance with the relevant sections of the NSW OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*. The report will also provide a statement as to the suitability of the site for the proposed land use.

9.0 Long term environmental management plan

Fill material consistent with that identified within the DA area is likely to be present across the broader site area and will require management.

In addition, management will be required in the grassed area of the Senior School to prevent direct contact where soil is accessible.

As the majority of the site has inaccessible soil, an environmental management plan (EMP) detailing a strategy consisting of capping will need to be developed to manage this risk.

The EMP document will be developed following the completion of development works, and compilation of the validation report.

10.0 Site management plan

Specific controls and strategies for environmental protection during remediation forms part of the requirements of the RAP. This information should be integrated into the CEMP for the site.

10.1 Hazard identification and exposure pathways

10.1.1 Hazard identification

Based on the site assessments, the hazards which require management are related to fill material which exceeds site criteria for lead and PAHs and is surplus to site development requirements.

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.

Based on the proposed remedial strategy, potential human health exposure relates to:
- dermal (skin) contact with soil or dust; and/or
- inhalation of fibres, vapours, soil or dust; and/or
- ingestion of soil or dust.

Controlling the above exposure pathways will effectively minimise the risks to workers in relation to the contaminated soil and prevent off-site impacts.

10.2 Interim measures (before remediation)

The interim measures relate to the site as-is. It is possible that the redevelopment works may be undertaken in stages, therefore until the remediation works commence the grass cover must be maintained, and/or low dust conditions kept to a minimum.

Access to the Senior School open space area should be restricted. Consideration should be given to fencing off this area of the site to prevent uncontrolled exposure to the impacted fill material.

PAHs and lead can have adverse effects on human health through inhalation, dermal contact and ingestion. It is recommended that no vegetables are planted within the vicinity of the Senior School open space area as they may accumulate lead and PAH residues by absorbing them from soil (e.g. carrots, potatoes) or by soil remaining on the skin.

Given ingestion is a primary exposure pathway, all workers must wash their hands and faces before eating. Additionally, it should be ensured that 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.

It should be noted that these measures are considered to be temporary and may be impractical. Cavvanba recommends conducting a human health risk assessment (HHRA) to determine the risk associated with:
- dermal (skin) contact with soil or dust; and/or
- inhalation of fibres, vapours, soil or dust; and/or
- ingestion of soil or dust.

10.3 Site management (remediation phase)

These site management requirements should be taken into account by the persons conducting the remediation works, and where relevant, be built into safe work method statements and the-like.

The remedial program should be undertaken with due regard to legislative requirements and any relevant environment planning instruments that apply to the site, including the following:

- *Protection of the Environment Operations* Act 1997;
- *Contaminated Land Management Act* 1997;
- *NSW State Environmental Planning Policy 55*;
- WHS Act 2012; and
- enHealth 2003.

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 the grass cover where possible.

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

3. 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.

4. If soil disturbance is required, use methods which minimise manual handling of soils.

5. Minimise the movement of soil via personnel and machinery tracking soil out of the soil management area.

6. 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.

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

10.3.1 Asbestos exposure

Asbestos has not been identified on-site but the potential exists for it be present, and disturbed with large-scale excavation.

If potential asbestos is observed on-site, the unexpected findings protocol described in Section 10.4 should be put into place.

If present, the potential exposure to ACM fragments is during excavation works; if the bonded ACM become disturbed it poses a hazard to workers on-site and neighbouring properties.

Based on the proposed remedial strategy, potential environmental impacts are considered to relate to movement of soils and ACM through disturbance, and movement of dust. Potential human health exposure relates to:
- dermal (skin) contact with soil or dust; and/or
- inhalation of soil, dust, asbestos; and/or
- ingestion of soil, dust and asbestos.

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

10.4 Remediation schedule

The remediation schedule will be determined by the overall project schedule, but is anticipated to be completed within 12 months.

Interim measures can be applied immediately, as described in Section 10.2.

10.5 Hours of operation

To be advised (TBA) but will be in line with North Sydney Council requirements.

10.6 Unexpected findings protocol

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, coal, tar; 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.

The areas containing potential contamination have been discussed in this RAP. If the above mentioned finds occur outside of those areas, it should be considered an unexpected find, and this UFP for the site works should be followed, which 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.

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.

10.7 Contingency plan

Contingency plans are to respond to site incidents, to obviate potential effects on surrounding environment and community.

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:

- 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); and
  - changing or modifying work practices based on climatic conditions.

- If environmental or safety controls fail, the reason for the failure will require exploring, the impacted areas will require remediation and the environmental and safety plans will require updating.

10.8 Contact details

Contact details are provided below in Table 10.1.

Table 10.1: Contact details

Contact	Name	Details
Royal North Shore Hospital Reserve Road, St Leonards NSW 2065	Nearest Medical Assistance	02 9926 7111
Emergency	-	000
Client	Jon Durnell Wood & Grieve Engineers	0414 127 445
EPA	Pollution hotline	131 555
Cavvanba Consulting Pty Ltd 1/66 Centennial Cct, Byron Bay NSW 2481 ABN: 37 929 679 095 Cavvanba Field Scientist	Ross Nicolson Ben Wackett Rob McLelland Michael Wright	0428 606 064 0488 225 692 02 6685 7811 0434 376 146

11.0 Conclusion

This RAP has been developed in general accordance with the NSW EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites, as well as SEPP 55 – Remediation of Land*. The RAP describes management procedures which will assist in the identification, handling and disposal of contaminated material which may be encountered during excavation activities associated with the project. The RAP focuses on the management of excavated material which is expected and requires off-site disposal, as well as providing protocols to follow in the event of the identification of further contamination.

Successful implementation of this RAP is intended to facilitate the completion of civil works related to the site development works, whilst managing the known and potential contamination issues at the properties in such a way that satisfies relevant regulatory responsibilities.

12.0 Glossary and references

12.1 Glossary

AST	Aboveground storage tank
BTEXN	Benzene, toluene, ethyl benzene, xylenes and naphthalene
CSM	Conceptual site model
EIL	Environmental Investigation Level
ESL	Environmental Screening Level
EMP	Environmental Management Plan
ESA	Environmental site assessment
GME	Groundwater monitoring event
HHRA	Human health risk assessment
HIL	Health Investigation Level
HSL	Health Screening Level
LOR	Limit of reporting
Metals	Arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), and zinc (Zn)
NATA	National Association of Testing Authorities
NEPM/C	National Environmental Protection Measure/Council
OCPs	Organochlorine pesticides
OH&S	Occupational health and safety
OPPs	Organophosphorus pesticides
PAHs	Polycyclic aromatic hydrocarbons, including the USEPA 16 priority pollutants: naphthalene; acenaphthylene; acenaphthene; fluorine; phenanthrene; anthracene; fluoranthene; pyrene; benzo(a) anthracene; chrysene; benzo(b)fluoranthene; benzo(k) fluoranthene; benzo(a)pyrene; indeno(1.2.3.cd)pyrene; dibenz (a.h)anthracene; and benzo(g.h.i)perylene
PCBs	Polychlorinated biphenyls
PID	Photo-ionisation detector
PSH	Phase separated hydrocarbons
QA/QC	Quality assurance/quality control
RAP	Remediation action plan

RPD	Relative Percentage Difference
SWL	Standing water level
TRHs	Total recoverable hydrocarbons, including volatile C6 – C10 fraction and semi- and non-volatile >C10 – C36 fractions
UCL	Upper confidence limit
UST	Underground storage tank
VRP	Voluntary remediation proposal
VOCs	Volatile organic compounds

12.2 References

Consultant reports

Cavvanba Consulting (2018a) *Preliminary Site Investigation, St Aloysius College, Kirribilli, New South Wales 2061* (Ref. 17066 R01).

Cavvanba Consulting (2018b) *Preliminary Waste Classification, New sports court development, 29 Burton Street, Kirribilli NSW 2061* (Ref. 17066 L01).

Cavvanba Consulting (2018c) *Detailed Site Investigation – Development Areas, St Aloysius College, Kirribilli, New South Wales 2061* (Ref. 17066 R02).

Cavvanba (2018d) *Waste Classification Summary, Proposed Site Development Works, St Aloysius College, Kirribilli NSW 2061* (Ref. 17066 L02).

Other References

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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.

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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.

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EPA (November 2014) *Waste Classification Guidelines – Part 1: Classifying Waste*. NSW EPA, Sydney, NSW.

Office of Environment & Heritage (2011) *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*. NSW OE&H, Sydney.

OEH Science (2017) *PFAS Screening Criteria – Draft (May 2017)*. NSW OEH Science, Sydney.

Guidelines approved by the EPA

ANZECC/ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Paper No 4, Canberra.

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 Locality Plan

Remedial Action Plan
St Aloysius College,
Kirribilli NSW
Reference: 17066 R03

Client: WGE
Drawn: MW 18/12/18
Source: NSW Gov SIX

CAVVANBA consulting

Figure 2. Junior School Site Layout

Remedial Action Plan
St Aloysius College,
Kirribilli NSW
Reference: 17066 R03

Client: WGE
Drawn: MW 18/12/18
Source: NSW Gov SIX

CAVVANBA consulting

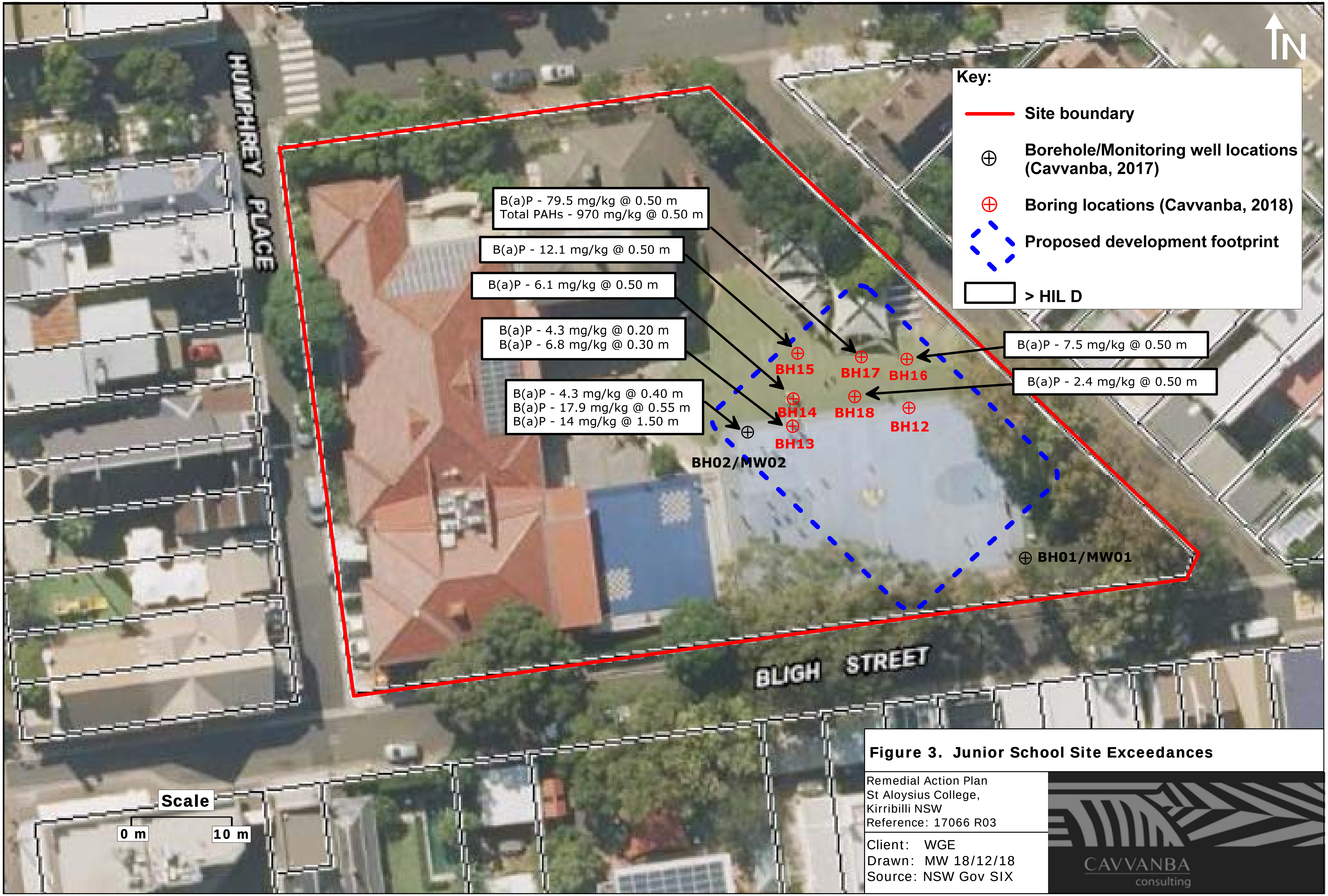

Figure 3. Junior School Site Exceedances

Remedial Action Plan
St Aloysius College,
Kirribilli NSW
Reference: 17066 R03

Client: WGE
Drawn: MW 18/12/18
Source: NSW Gov SIX

CAVVANBA consulting

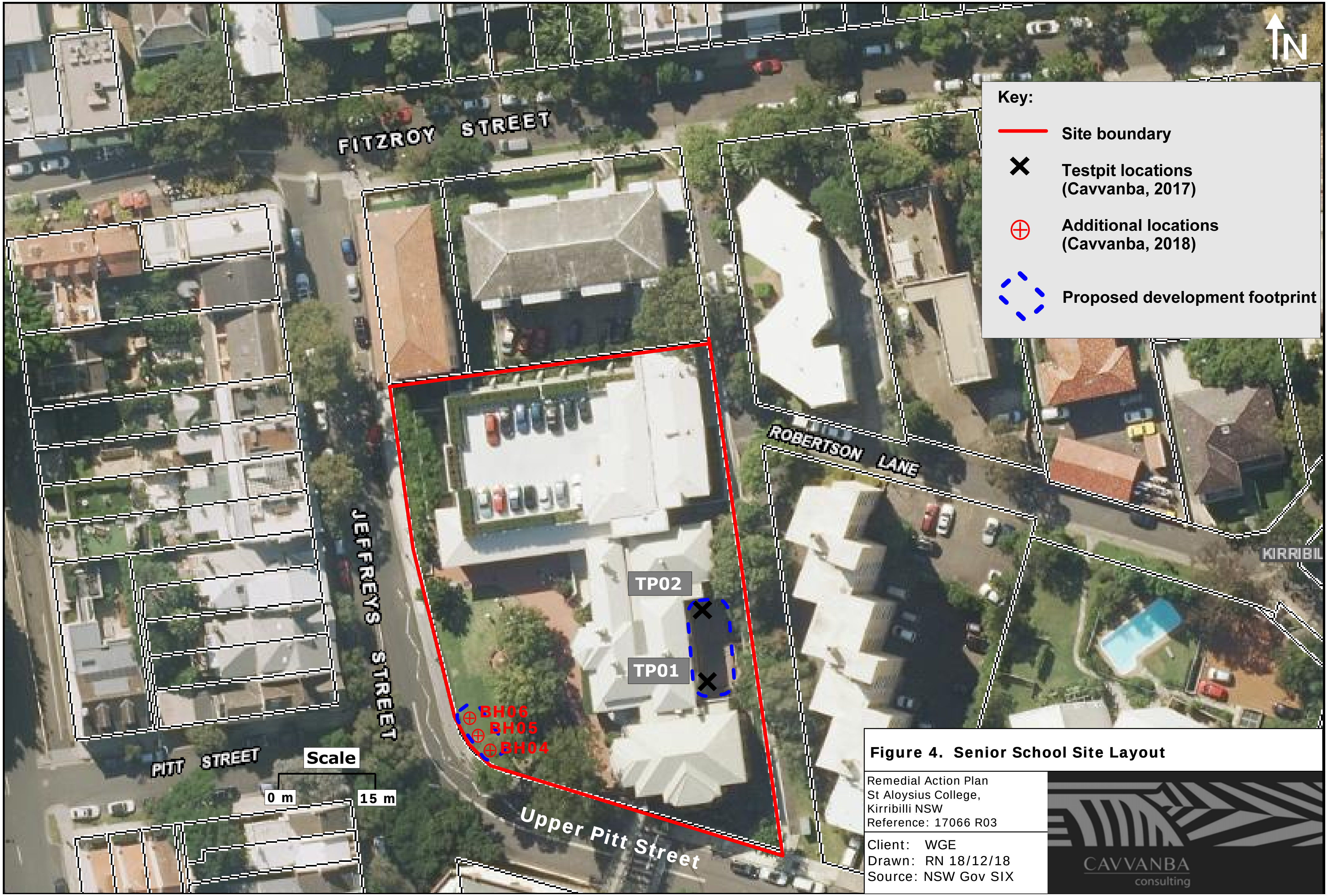

Figure 4. Senior School Site Layout

Remedial Action Plan
St Aloysius College,
Kirribilli NSW
Reference: 17066 R03

Client: WGE
Drawn: RN 18/12/18
Source: NSW Gov SIX

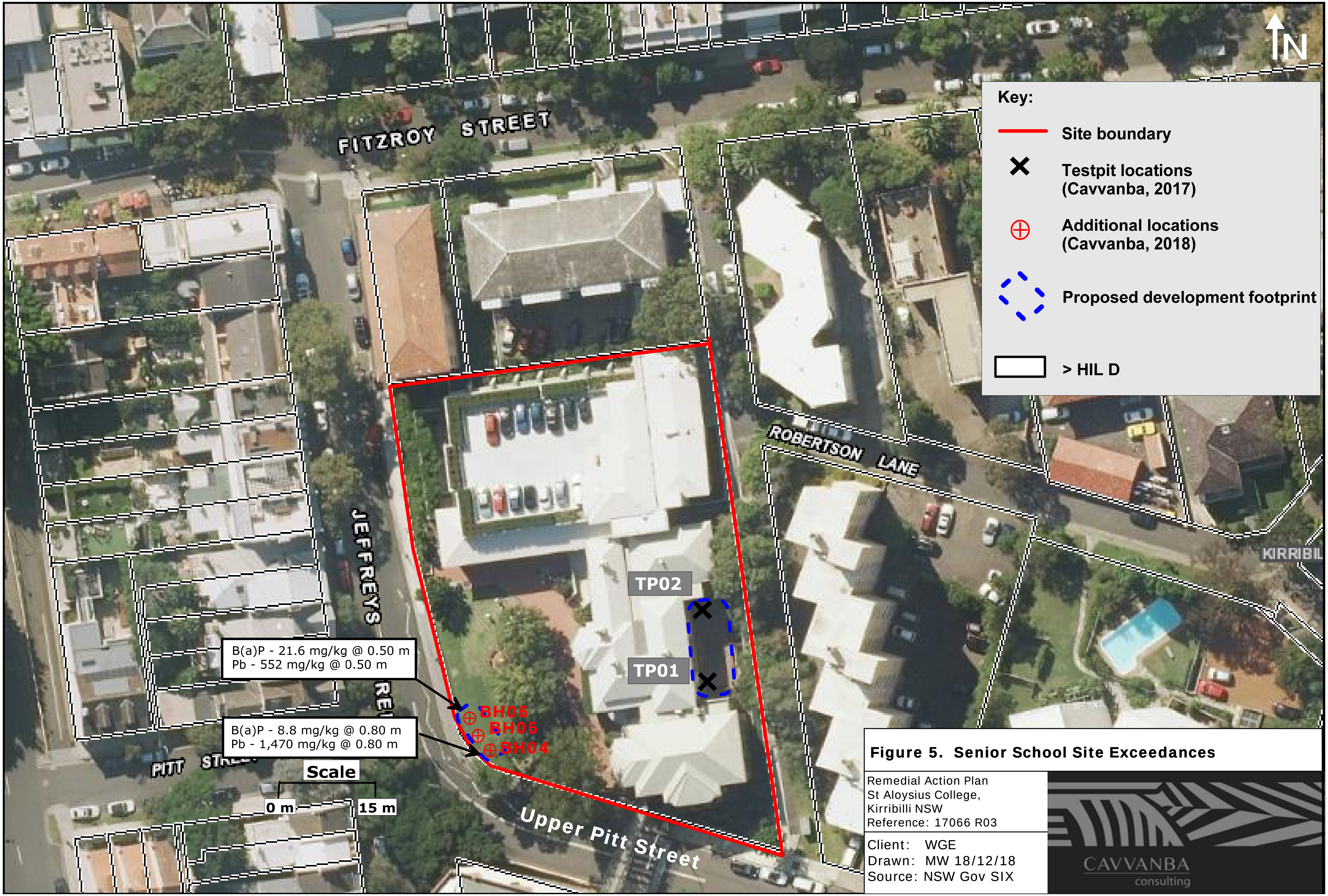

Figure 5. Senior School Site Exceedances

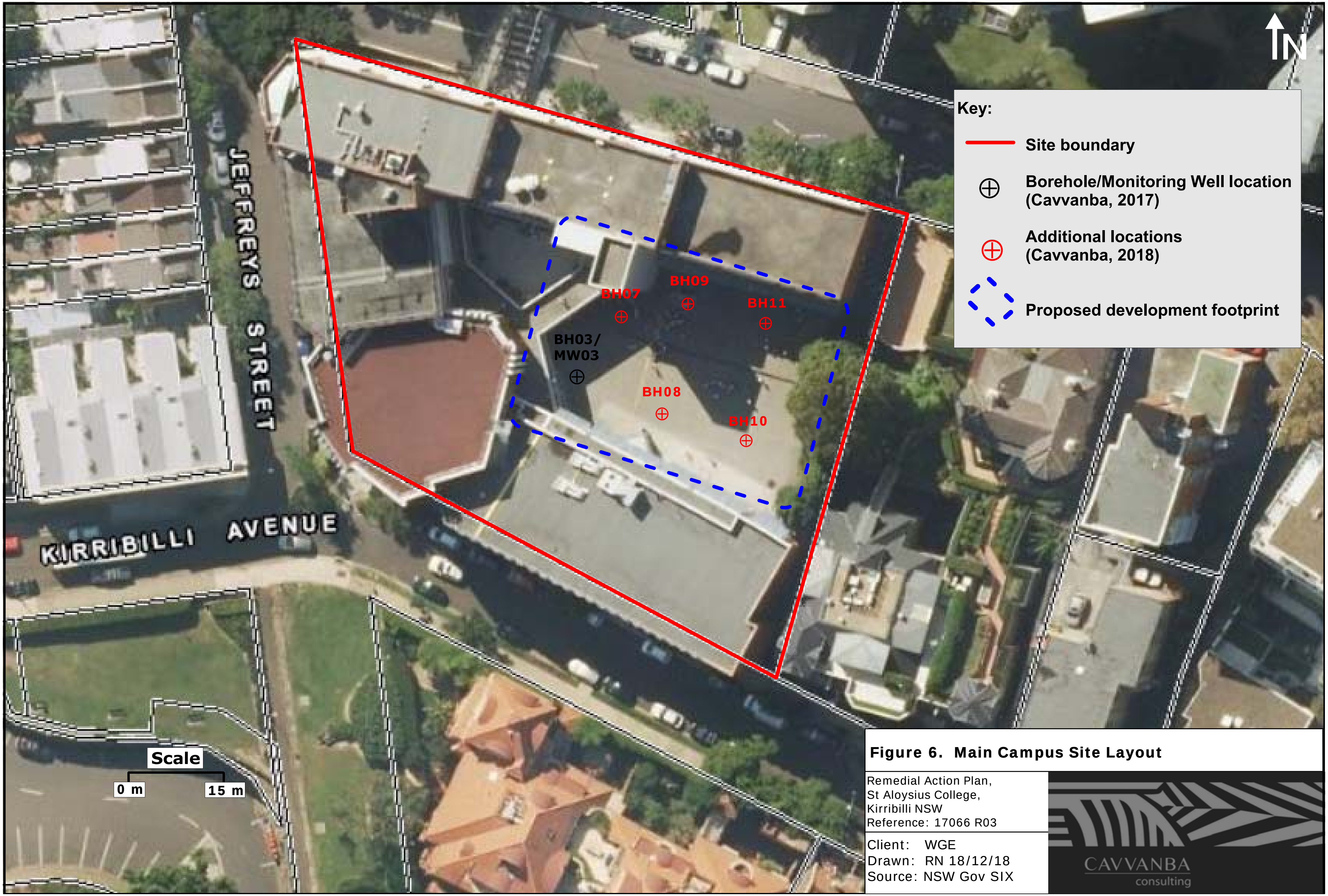

Figure 6. Main Campus Site Layout

Remedial Action Plan,
St Aloysius College,
Kirribilli NSW
Reference: 17066 R03

Client: WGE
Drawn: RN 18/12/18
Source: NSW Gov SIX

Figure 7. Main Campus Site Layout Exceedances

Remedial Action Plan,
St Aloysius College,
Kirribilli NSW
Reference: 17066 R03

Client: WGE
Drawn: MW 18/12/18
Source: NSW Gov SIX

Figure 8: Conceptual Site Model Flow Chart

Primary Contaminant Source	Secondary Contaminant Source	Release Mechanism	Exposure Pathway	Exposure Route	Receptors: Human: On-site school	Human: Off-site residential/commercial	Human: Construction maintenance workers	Human: Off-site recreational water users	Ecological: Terrestrial biota	Ecological: Aquatic biota	Comments
Imported Fill / Underground fuel storage	Soil contamination	Wind (dust/particulates)	Outdoor air	Inhalation	■	□	■	□	□	□	Impacted fill material present with site criteria exceedances.
		Direct contact	Soil	Ingestion	■	□	■	□	□	□	Majority of site sealed so minimal direct contact exposure unless disturbed. Potential exposure during development works if not managed adequately.
				Inhalation	■	□	■	□	□	□	
				Dermal contact	■	□	■	□	□	□	
				Uptake by organisms	□	□	□	□	■	□	
		Surface run off	Sediment	~~Ingestion~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	Direct contact present at Senior School Open Space Area which requires management.
				~~Dermal contact~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	
				~~Uptake by organisms~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	
			Surface water	~~Ingestion~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	
				~~Dermal contact~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	
				~~Uptake by organisms~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	
		Volatilisation	Outdoor air (vapour)	~~Inhalation~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	
			Indoor air (vapour)	~~Inhalation~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	
		Leaching → Groundwater contaminaion									
	Groundwater contaminaion	Volatilisation	Outdoor air	~~Inhalation~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	
			Indoor air	~~Inhalation~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	~~□~~	
		Disolved phase	Groundwater	Ingestion	□	□	□	□	□	□	Ecological receptor pathway is unlikely to be affected due to distance. No groundwater bores in close proximity to the site.
				Dermal contact	□	□	□	□	□	□	
				Uptake by organisms	□	□	□	□	□	■	
			Surface water discharge	Ingestion	□	□	□	□	□	□	High dissolved metals and benzo(a)pyrene concentrations in groundwater. Not applicable to DA works.
				Dermal contact	□	□	□	□	□	□	
				Uptake by organisms	□	□	□	□	■	■	

□	Pathway incomplete
■	Pathway potentially complete
~~□~~	~~No pathway~~

Tables

Table 1: Sample Description and Analytical Summary

Sample	Depth (m)	PID (ppm)	Date sampled	Description	Analysis							
					TRHs	BTEXN	PAHs	8 metals	OCPs	VOCs	TCLP Lead / PAHs	Asbestos
Analytical												
Junior School												
BH01	0.50	2.9	07/12/17	FILL: Gravelly sand: Fine to course grained sand, orange brown, fine to medium, sub-angular gravel, trace low plasticity clay.	•	•	•	•	•			
BH02	0.20	5.8	08/12/17	FILL: Sandy gravel: Fine to course gravel, sub angular, brown and grey, fine to course sand.	•	•	•	•	•			
BH02	0.40	7.1	08/12/17	FILL: Sandy gravel: Fine to course gravel, sub angular, brown and grey, fine to course sand.	•	•	•	•	•			•
BH02	0.55	1.7	08/12/17	FILL: Sandy gravel: Fine to course gravel, sub angular, brown and grey, fine to course sand.	•	•	•	•	•			•
BH02	1.00	5.8	08/12/17	FILL: Sandy gravel: Fine to course gravel, sub angular, brown and grey, fine to course sand.	•	•	•	•	•			•
BH02	1.50	11.5	08/12/17	FILL: Gravelly clay: low plasticity, red and brown, fine to medium, sub angular gravel.	•	•	•	•	•	•		•
BH02	1.90	-	08/12/17	FILL: Gravelly clay: low plasticity, red and brown, fine to medium, sub angular gravel.	•	•	•	•	•			•
BH12	0.40	0.1	24/11/18	FILL: Sand: Fine to course sand, yellow, loose, dry	•	•	•	•	•		•	
BH13	0.20	1.1	24/11/18	FILL: Sandy Gravel: Fine to course sand, brown, fine to coarse gravel, loose, dry, sandstone blocks from surface 0.2	•	•	•	•	•		•	
BH13	0.30	1.0	24/11/18	FILL: Clayey Sandy Gravel: Fine to course gravel, brown and grey, fine to coarse grained sand, loose, dry, low plasticity clay, sandstone blocks present	•	•	•	•	•		•	
BH14	0.50	0.1	25/11/18	FILL: Clayey Sandy Gravel: Fine to course gravel, brown, fine to coarse grained sand, loose, dry, low plasticity clay, sandstone blocks present	•	•	•	•	•		•	
BH15	0.50	0.00	25/11/18	FILL: Clayey Sandy Gravel: Fine to course gravel, brown, fine to coarse grained sand, loose, slightly moist, low plasticity clay, sandstone blocks present	•	•	•	•	•		•	
BH16	0.50	0.4	25/11/18	FILL: Sandy Gravel: Fine to course sand, brown, fine to coarse gravel, loose, slightly moist	•	•	•	•	•		•	
BH17	0.50	0.5	25/11/18	FILL: Clayey Sandy Gravel: Fine to course gravel, brown, fine to coarse grained sand, loose, slightly moist, low plasticity clay, sandstone blocks present	•	•	•	•	•		•	
BH18	0.50	0.8	25/11/18	FILL: Sandy Gravel: Fine to course sand, brown, fine to coarse gravel, loose, slightly moist	•	•	•	•	•			

Table 1: Sample Description and Analytical Summary

Sample	Depth (m)	PID (ppm)	Date sampled	Description	Analysis							
					TRHs	BTEXN	PAHs	8 metals	OCPs	VOCs	TCLP Lead / PAHs	Asbestos
Analytical												
Senior School												
TP01	0.10	46.7	07/12/17	FILL: Sand: Fine to course grained sand, dark grey with low plasticity clay, trace roots <2mm	•	•	•	•	•			
TP01	0.50	1.7	07/12/17	FILL: Gravelly clayey sand: Fine to course sand, plae brown and pale grey brown, low plasticity clay, fine to course, sub-angular gravel, with cobbles, trace sub-angular boulders	•	•	•	•	•			
TP02	0.15	8.5	07/12/17	FILL: Gravelly sand: Fine to course grained sand, dark grey, fine to course, sub-rounded gravel with low plasticity clay.	•	•	•	•	•			
TP02	0.30	11.9	07/12/17	FILL: Clayey sand: Fine to course grained sand, brown and grey, brown mottled pale grey, low plasticity clay with fine to course sub-angular gravel with angular cobbles. Trace clay pockets <50mm, gravel 0.25-0.40mm: 3 nos of sub-angular boulders. Locally gravels tredning to sand gravel.	•	•	•	•	•			
BH04	0.80	0.4	24/11/18	FILL: Sand: Fine to course sand, black and grey, loose, slightly moist, sub-angular gravel, glass, bone, terra cotta tile, ceramic observed from 0.6 m to 1.3 m	•	•	•	•	•		•	
BH05	0.05	0.4	24/11/18	FILL: Sand: Fine to course sand, brown, loose, slightly moist	•	•	•	•	•		•	
BH06	0.50	0.0	24/11/18	FILL: Sand: Fine to course sand, brown, loose, slightly moist	•	•	•	•	•		•	
Main Campus												
BH03	0.25	-	09/01/18	FILL: Clayey sand: Fine to course grained sand, grey brown and orange, low plasticity clay (slight hydrocarbon odour)	•	•	•	•	•			
BH07	0.10	0.1	24/11/18	Sand: Fine to course sand, yellow, loose, dry	•	•	•	•	•		•	
BH07	0.20	0.0	24/11/18	Sand: Fine to course sand, yellow, loose, dry	•	•	•	•	•		•	
BH08	0.10	0.0	24/11/18	FILL: Sand: Fine to course sand, brown, loose, dry	•	•	•	•	•		•	
BH08	0.20	0.0	24/11/18	Sand: Fine to course sand, yellow, loose, dry	•	•	•	•	•		•	
BH09	0.10	0.0	24/11/18	Sand: Fine to course sand, yellow, loose, dry	•	•	•	•	•		•	
BH09	0.20	0.0	24/11/18	Sand: Fine to course sand, yellow, loose, dry	•	•	•	•	•		•	

Table 2: Soil Analytical Summary, Metals

Sample	Depth (m)	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
LORs		*5*	*1*	*2*	*5*	*5*	*2*	*5*	*0.1*
Analytical									
Junior School									
BH01	0.50	nd	nd	14	36	9	25	24	nd
BH02	0.20	nd	nd	11	36	27	25	82	nd
BH02	0.40	nd	nd	9	35	21	21	39	nd
BH02	0.55	nd	nd	12	9	36	3	39	nd
BH02	1.00	8	nd	13	7	50	nd	42	nd
BH02	1.50	5	nd	12	16	116	3	89	nd
BH02	1.90	6	nd	16	9	20	5	43	nd
BH12	0.40	nd	nd	59	18	18	51	31	nd
BH13	0.20	nd	nd	18	60	44	32	66	nd
BH13	0.30	nd	nd	20	66	34	30	67	nd
BH14	0.50	nd	nd	9	19	96	15	72	nd
BH15	0.50	nd	nd	8	31	84	38	66	nd
BH16	0.50	nd	nd	13	20	95	18	74	nd
BH17	0.50	nd	nd	20	22	195	15	134	0.1
BH18	0.50	nd	nd	9	20	46	22	54	nd
Senior School									
TP01	0.10	nd	nd	9	55	48	122	41	nd
TP01	0.50	nd	nd	11	5	58	7	37	nd
TP02	0.15	nd	nd	9	48	34	120	51	nd
TP02	0.30	nd	nd	11	7	173	4	57	nd
BH04	0.80	6	nd	10	31	**<u>1,470</u>**	6	485	0.3
BH05	0.05	nd	nd	5	7	49	3	40	nd
BH06	0.50	18	nd	10	38	**552**	6	431	0.6
Main Campus									
BH03	0.25	nd	nd	6	nd	91	nd	49	nd
BH07	0.10	nd	nd	6	nd	8	nd	24	nd
BH07	0.20	nd	nd	4	9	nd	nd	13	nd
BH08	0.10	nd	nd	8	6	5	4	10	nd
BH08	0.20	nd	nd	5	5	nd	2	8	nd
BH09	0.10	nd	nd	8	nd	6	2	9	nd
BH09	0.20	nd	nd	14	nd	6	4	11	nd
Statistics									
Samples analysed		29	29	29	29	29	29	29	29
Detects		5	0	29	25	27	25	29	3
% detect		17%	0%	100%	86%	93%	86%	100%	10%
Maximum		18	0	59	66	**<u>1,470</u>**	122	485	0.6
Mean		9	-	12	25	126	23	75	0.3
Median		6	-	10	20	46	15	43	0.3
Minimum		5	-	4	5	5	2	8	0.1
Criteria									
HILs - Residential A		100	20	100	6,000	**300**	400	7,400	40
EILs - Urban residential and public open space (aged)		100	-	410	230	<u>1,100</u>	270	770	-

See table notes at end of section

Table 3: Soil Analytical Summary, BTEXN and TRHs (mg/kg)

Sample	Depth (m)	Benzene	Toluene	Ethyl benzene	meta- & para-Xylenes	ortho-Xylene	Naphthalene	F1 TRHs C6 - C10	F2 TRHs >C10 - C16	F3 TRHs >C16 - C34	F4 TRHs >C34 - C40
LORs		*0.2*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*10*	*50*	*100*	*100*
Analytical											
Junior School											
BH01	0.50	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH02	0.20	nd	nd	nd	nd	nd	nd	nd	nd	140	nd
BH02	0.40	nd	nd	nd	nd	nd	nd	nd	nd	190	nd
BH02	0.55	nd	nd	nd	nd	nd	nd	nd	nd	820	180
BH02	1.00	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH02	1.50	nd	nd	nd	nd	nd	nd	nd	nd	460	140
BH02	1.90	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH12	0.40	nd	nd	nd	nd	nd	nd	nd	nd	130	nd
BH13	0.20	nd	nd	nd	nd	nd	nd	nd	nd	200	nd
BH13	0.30	nd	nd	nd	nd	nd	nd	nd	nd	310	nd
BH14	0.50	nd	nd	nd	nd	nd	nd	nd	nd	230	nd
BH15	0.50	nd	nd	nd	nd	nd	nd	nd	nd	410	110
BH16	0.50	nd	nd	nd	nd	nd	nd	nd	nd	260	nd
BH17	0.50	nd	nd	nd	nd	nd	nd	nd	280	4,340	960
BH18	0.50	nd	nd	nd	nd	nd	nd	nd	nd	110	nd
Senior School											
TP01	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TP01	0.50	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TP02	0.15	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TP02	0.30	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH04	0.80	nd	nd	nd	nd	nd	nd	nd	nd	260	nd
BH05	0.05	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH06	0.50	nd	nd	nd	nd	nd	nd	nd	nd	780	190
Main Campus											
BH03	0.25	nd	nd	nd	nd	nd	nd	nd	**410**	3,810	560
BH07	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH07	0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH08	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH08	0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH09	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH09	0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Statistics											
Samples analysed		29	29	29	29	29	29	29	29	29	29
Detects		0	0	0	0	0	0	0	2	15	6
% detect		0%	0%	0%	0%	0%	0%	0%	7%	52%	21%
Maximum		-	-	-	-	-	-	-	**410**	4,340	960
Mean		-	-	-	-	-	-	-	280	633	348
Median		-	-	-	-	-	-	-	280	245	160
Minimum		-	-	-	-	-	-	-	nd	nd	nd
Criteria Low - high density residential (HSLs), urban residential and public open space (ESLs)											
Health screening levels 0m to <1m		0.5	160	55	40		3	45	**110**	no limit	no limit
Health screening levels 1m to <2m		0.5	220	no limit	60		no limit	70	240	no limit	no limit
Health screening levels 2m to <4m		0.5	310	no limit	95		no limit	110	440	no limit	no limit
Health screening levels 4m+		0.5	540	no limit	170		no limit	200	no limit	no limit	no limit
Health investigation levels		-	-	-	-	-	-	-	-	-	-
Ecological screening levels (fine texture)		10	65	40	1.6		-	180	120	1,300	5,600
Ecological investigation levels		-	-	-	-	-	170	-	-	-	-

See table notes at end of section

Table 4: Soil Analytical Summary, PAHs and VOCs (mg/kg)

Sample	Depth (m)	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benz(a)anthracene	Chrysene	Benzo(b+j)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1.2.3.cd)pyrene	Dibenz(a.h)anthracene	Benzo(g.h.i)perylene	Total PAHs	B(a)P TEQ (zero LOR)	Total VOCs
LORs		*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	-	-	-
Analytical																			
Junior School																			
BH01	0.50	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH02	0.20	nd	nd	nd	1.6	0.6	4.3	4.2	1.8	1.6	1.8	0.8	1.8	0.6	nd	0.7	19.8	2.3	-
BH02	0.40	nd	nd	nd	3.2	1.2	8	7.8	3.1	3.1	3.7	1.2	3.3	1.6	nd	1.9	38.1	**4.3**	-
BH02	0.55	3.3	0.7	1.6	30.8	7.7	35	30.8	14.7	12.4	15.3	5.6	12.1	4.8	1.6	5.3	183	**17.9**	-
BH02	1.00	nd	nd	nd	1.7	0.6	3.1	2.9	1.4	1.3	1.8	0.6	1.5	0.7	nd	0.8	16.4	2	-
BH02	1.50	2.2	0.9	2.8	19.6	5.2	25.8	23.1	10.3	9.1	11.1	4	9.6	4.1	1.3	4.5	134	**14**	nd
BH02	1.90	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH12	0.40	nd	nd	nd	1.6	0.5	3.6	3.3	1.6	1.8	2.2	0.9	2.1	0.9	nd	1	19.5	2.7	-
BH13	0.20	0.6	nd	0.7	4.9	1.6	7.7	7.2	3.4	2.9	3.8	1.5	3.3	1.3	nd	1.5	40.4	**4.3**	-
BH13	0.30	0.7	nd	0.9	7.8	2.2	11.4	10.4	4.5	4.4	5.3	2.2	4.8	1.8	0.6	1.8	59	**6.8**	-
BH14	0.50	0.6	nd	nd	4.4	1.3	9.1	7.4	3.6	3.7	5.1	1.9	4.3	1.6	0.5	1.7	45	**6.1**	-
BH15	0.50	1.7	nd	0.7	10.9	3.2	16.5	15.2	7.5	7.2	8.8	3.7	8.6	3.2	1.1	3.2	92	**12.1**	-
BH16	0.50	1	nd	nd	5.8	1.7	10.1	9.6	4.5	4.4	5.7	2.1	5.4	2	0.6	2.2	55	**7.5**	-
BH17	0.50	32.8	8.3	20.3	205	43	186	158	66.1	65.2	66.3	20.5	57.1	14.6	4.9	13.7	**970**	**79.5**	-
BH18	0.50	nd	nd	nd	2.4	0.6	3	2.9	1.6	1.5	1.7	0.6	1.9	0.5	nd	nd	17	2.4	-

Table 4: Soil Analytical Summary, PAHs and VOCs (mg/kg)

Sample	Depth (m)	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benz(a)anthracene	Chrysene	Benzo(b+j)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1.2.3.cd)pyrene	Dibenz(a.h)anthracene	Benzo(g.h.i)perylene	Total PAHs	B(a)P TEQ (zero LOR)	Total VOCs
LORs		*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	-	-	-
Analytical																			
Senior School																			
TP01	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
TP01	0.50	nd	nd	nd	0.6	nd	1.2	1.2	0.6	0.5	0.5	nd	0.5	nd	nd	nd	5.1	0.6	-
TP02	0.15	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
TP02	0.30	nd	nd	nd	0.9	nd	2	2	1	0.9	0.9	nd	0.8	nd	nd	nd	8.5	1	-
BH04	0.80	1	nd	nd	5.9	1.4	11.9	11.4	5.5	5.4	6.9	2.4	6.4	2.6	0.6	3.2	64.6	**8.8**	-
BH05	0.05	nd	nd	nd	1	nd	2.4	2.4	1.1	1.1	1.2	nd	1.2	nd	nd	0.5	10.9	1.4	-
BH06	0.50	4	nd	1.2	38.2	7.5	40.7	33.9	16.5	16.3	18.9	8.3	14.2	6.6	2.1	7.2	217	**21.6**	-
Main Campus																			
BH03	0.25	33.6	4.8	36.3	294	54.5	204	194	66.4	59.3	58.8	19.8	54.6	21.9	6.8	25.8	**1,150**	**78.9**	-
BH07	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH07	0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH08	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH08	0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH09	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH09	0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-

Table 4: Soil Analytical Summary, PAHs and VOCs (mg/kg)

Sample	Depth (m)	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benz(a)anthracene	Chrysene	Benzo(b+j)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1.2.3.cd)pyrene	Dibenz(a.h)anthracene	Benzo(g.h.i)perylene	Total PAHs	B(a)P TEQ (zero LOR)	Total VOCs
LORs		*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	-	-	-
Analytical																			
Statistics																			
Samples analysed		29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	1
Detects		11	4	8	19	16	19	19	19	19	19	16	19	16	10	16	19	19	0
% detect		38%	14%	28%	66%	55%	66%	66%	66%	66%	66%	55%	66%	55%	34%	55%	66%	66%	0%
Maximum		32.8	8.3	20.3	205.0	43.0	186	158.0	66.1	65.2	66.3	20.5	<u>57.1</u>	14.6	4.9	13.7	**970**	**79.5**	-
Mean		5.4	3.3	4.5	20.1	5.3	21.8	19.1	8.4	8.0	9	3.5	<u>7.8</u>	2.9	1.5	3.2	113.5	11	-
Median		1.4	0.9	1.3	4.4	1.6	8.0	7.4	3.4	3.1	3.8	1.9	3.3	1.6	1.1	1.9	40.4	4.3	-
Minimum		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Criteria																			
HILs - Residential A		NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	**300**	**3**	-
ESLs - Urban residential and public open space		NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	<u>0.7</u>	NL	NL	NL	NL	NL	-

See table notes at end of section

Table 5: Soil Analytical Summary - OCPs, OPPs & PCBs (mg/kg)

Sample	Depth (m)	Heptachlor	Total Chlordane (sum)	Endrin	Endosulfan (sum)	Methoxychlor	Sum of Aldrin + Dieldrin	Sum of DDD + DDE + DDT	Total Polychlorinated Biphenyls
LOR		*0.2*	*0.1*	*0.05*	*0.05*	*0.2*	*0.05*	*0.05*	*0.1*
Analytical - Soil									
Junior School									
BH12	0.40	nd	nd	nd	nd	nd	nd	nd	nd
BH13	0.20	nd	nd	nd	nd	nd	nd	nd	nd
BH13	0.30	nd	nd	nd	nd	nd	nd	nd	nd
BH14	0.50	nd	nd	nd	nd	nd	nd	nd	nd
BH15	0.50	nd	nd	nd	nd	nd	nd	nd	nd
BH16	0.50	nd	nd	nd	nd	nd	nd	nd	nd
BH17	0.50	nd	nd	nd	nd	nd	nd	nd	nd
BH18	0.50	nd	nd	nd	nd	nd	nd	nd	nd
Senior School									
BH04	0.80	nd	nd	nd	nd	nd	nd	nd	nd
BH05	0.05	nd	nd	nd	nd	nd	nd	nd	nd
BH06	0.50	nd	nd	nd	nd	nd	nd	nd	nd
Main Campus									
BH07	0.10	nd	nd	nd	nd	nd	nd	nd	nd
BH07	0.20	nd	nd	nd	nd	nd	nd	nd	nd
BH08	0.10	nd	nd	nd	nd	nd	nd	nd	nd
BH08	0.20	nd	nd	nd	nd	nd	nd	nd	nd
BH09	0.10	nd	nd	nd	nd	nd	nd	nd	nd
BH09	0.20	nd	nd	nd	nd	nd	nd	nd	nd
Statistics									
Samples analysed		17	17	17	17	17	17	17	17
Detects		0	0	0	0	0	0	0	0
% detect		0%	0%	0%	0%	0%	0%	0%	0%
Maximum		0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Mean		-	-	-	-	-	-	-	-
Median		-	-	-	-	-	-	-	-
Minimum		-	-	-	-	-	-	-	-
Criteria									
HILs - Residential A		6	50	10	270	300	6	240	1
ESLs - Urban residential and public open space		NL	NL	NL	NL	NL	NL	180	NL

See table notes at end of section

Table 6: Soil Analytical Summary, Asbestos

Sample	Depth (m)	Date	Asbestos
LORs			-
Analytical			
Soil			
BH02	0.40	08/12/17	No
BH02	0.55	08/12/17	No
BH02	1.00	08/12/17	No
BH02	1.50	08/12/17	No
BH02	1.90	08/12/17	No
Criteria			
HILs A - Residential			No

See table notes at end of section

Table 7: Waste Classification Analytical Summary, Metals

Sample	Depth (m)	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
LORs		*5*	*1*	*2*	*5*	*5*	*2*	*5*	*0.1*
Analytical									
Junior School									
BH01	0.50	nd	nd	14	36	9	25	24	nd
BH02	0.20	nd	nd	11	36	27	25	82	nd
BH02	0.40	nd	nd	9	35	21	21	39	nd
BH02	0.55	nd	nd	12	9	36	3	39	nd
BH02	1.00	8	nd	13	7	50	nd	42	nd
BH02	1.50	5	nd	12	16	**116**	3	89	nd
BH02	1.90	6	nd	16	9	20	5	43	nd
BH12	0.40	nd	nd	59	18	18	**51**	31	nd
BH13	0.20	nd	nd	18	60	44	32	66	nd
BH13	0.30	nd	nd	20	66	34	30	67	nd
BH14	0.50	nd	nd	9	19	96	15	72	nd
BH15	0.50	nd	nd	8	31	84	38	66	nd
BH16	0.50	nd	nd	13	20	95	18	74	nd
BH17	0.50	nd	nd	20	22	**195**	15	134	0.1
BH18	0.50	nd	nd	9	20	46	22	54	nd
Senior School									
TP01	0.10	nd	nd	9	55	48	**122**	41	nd
TP01	0.50	nd	nd	11	5	58	7	37	nd
TP02	0.15	nd	nd	9	48	34	**120**	51	nd
TP02	0.30	nd	nd	11	7	**173**	4	57	nd
BH04	0.80	6	nd	10	31	**1,470**	6	485	0.3
BH05	0.05	nd	nd	5	7	49	3	40	nd
BH06	0.50	18	nd	10	38	**552**	6	431	0.6
Main Campus									
BH03	0.25	nd	nd	6	nd	91	nd	49	nd
BH07	0.10	nd	nd	6	nd	8	nd	24	nd
BH07	0.20	nd	nd	4	9	nd	nd	13	nd
BH08	0.10	nd	nd	8	6	5	4	10	nd
BH08	0.20	nd	nd	5	5	nd	2	8	nd
BH09	0.10	nd	nd	8	nd	6	2	9	nd
BH09	0.20	nd	nd	14	nd	6	4	11	nd
Statistics									
Samples analysed		29	29	29	29	29	29	29	29
Detects		5	0	29	25	27	25	29	3
% detect		17%	0%	100%	86%	93%	86%	100%	10%
Maximum		18	0	59	66	**1,470**	**122**	485	0.6
Mean		9	-	12	25	126	23	75	0.3
Median		6	-	10	20	46	15	43	0.3
Minimum		5	-	4	5	5	2	8	0.1
Criteria - Contamination threshold values (CT1 & CT2) [4]									
General solid waste		100	20	-	-	**100**	**40**	-	4
Restricted solid waste		400	80	-	-	**400**	160	-	16

See table notes at end of section

Table 8: Waste Classification Analytical Summary, BTEXN and TRHs (mg/kg)

Sample	Depth (m)	Benzene	Toluene	Ethyl benzene	meta- & para-Xylenes	ortho-Xylene	Naphthalene	F1 TRHs C6 - C10	F2 TRHs >C10 - C16	F3 TRHs >C16 - C34	F4 TRHs >C34 - C40
LORs		*0.2*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*10*	*50*	*100*	*100*
Analytical											
Junior School											
BH01	0.50	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH02	0.20	nd	nd	nd	nd	nd	nd	nd	nd	140	nd
BH02	0.40	nd	nd	nd	nd	nd	nd	nd	nd	190	nd
BH02	0.55	nd	nd	nd	nd	nd	nd	nd	nd	820	180
BH02	1.00	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH02	1.50	nd	nd	nd	nd	nd	nd	nd	nd	460	140
BH02	1.90	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH12	0.40	nd	nd	nd	nd	nd	nd	nd	nd	130	nd
BH13	0.20	nd	nd	nd	nd	nd	nd	nd	nd	200	nd
BH13	0.30	nd	nd	nd	nd	nd	nd	nd	nd	310	nd
BH14	0.50	nd	nd	nd	nd	nd	nd	nd	nd	230	nd
BH15	0.50	nd	nd	nd	nd	nd	nd	nd	nd	410	110
BH16	0.50	nd	nd	nd	nd	nd	nd	nd	nd	260	nd
BH17	0.50	nd	nd	nd	nd	nd	nd	nd	280	4,340	960
BH18	0.50	nd	nd	nd	nd	nd	nd	nd	nd	110	nd
Senior School											
TP01	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TP01	0.50	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TP02	0.15	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TP02	0.30	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH04	0.80	nd	nd	nd	nd	nd	nd	nd	nd	260	nd
BH05	0.05	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH06	0.50	nd	nd	nd	nd	nd	nd	nd	nd	780	190
Main Campus											
BH03	0.25	nd	nd	nd	nd	nd	nd	nd	410	3,810	560
BH07	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH07	0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH08	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH08	0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH09	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH09	0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Statistics											
Samples analysed		29	29	29	29	29	29	29	29	29	29
Detects		0	0	0	0	0	0	0	2	15	6
% detect		0%	0%	0%	0%	0%	0%	0%	7%	52%	21%
Maximum		-	-	-	-	-	-	-	410	4,340	960
Mean		-	-	-	-	-	-	-	280	633	348
Median		-	-	-	-	-	-	-	280	245	160
Minimum		-	-	-	-	-	-	-	nd	nd	nd
Criteria - Contamination threshold values (CT1 & CT2) [4]											
General solid waste		10	288		1,000		-	650		10,000	
Restricted solid waste		40	1,152		4,000		-	2,600		40,000	

See table notes at end of section

Table 9: Waste Classification Analytical Summary, PAHs and VOCs (mg/kg)

Sample	Depth (m)	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benz(a)anthracene	Chrysene	Benzo(b+j)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1.2.3.cd)pyrene	Dibenz(a.h)anthracene	Benzo(g.h.i)perylene	Total PAHs	B(a)P TEQ (zero LOR)	Total VOCs
LORs		*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	-	-	-
Analytical																			
Junior School																			
BH01	0.50	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH02	0.20	nd	nd	nd	1.6	0.6	4.3	4.2	1.8	1.6	1.8	0.8	**1.8**	0.6	nd	0.7	19.8	2.3	-
BH02	0.40	nd	nd	nd	3.2	1.2	8	7.8	3.1	3.1	3.7	1.2	**3.3**	1.6	nd	1.9	38.1	**4.3**	-
BH02	0.55	3.3	0.7	1.6	30.8	7.7	35	30.8	14.7	12.4	15.3	5.6	**12.1**	4.8	1.6	5.3	183	**17.9**	-
BH02	1.00	nd	nd	nd	1.7	0.6	3.1	2.9	1.4	1.3	1.8	0.6	**1.5**	0.7	nd	0.8	16.4	2	-
BH02	1.50	2.2	0.9	2.8	19.6	5.2	25.8	23.1	10.3	9.1	11.1	4	**9.6**	4.1	1.3	4.5	134	**14**	nd
BH02	1.90	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH12	0.40	nd	nd	nd	1.6	0.5	3.6	3.3	1.6	1.8	2.2	0.9	**2.1**	0.9	nd	1	19.5	2.7	-
BH13	0.20	0.6	nd	0.7	4.9	1.6	7.7	7.2	3.4	2.9	3.8	1.5	**3.3**	1.3	nd	1.5	40.4	**4.3**	-
BH13	0.30	0.7	nd	0.9	7.8	2.2	11.4	10.4	4.5	4.4	5.3	2.2	**4.8**	1.8	0.6	1.8	59	**6.8**	-
BH14	0.50	0.6	nd	nd	4.4	1.3	9.1	7.4	3.6	3.7	5.1	1.9	**4.3**	1.6	0.5	1.7	45	**6.1**	-
BH15	0.50	1.7	nd	0.7	10.9	3.2	16.5	15.2	7.5	7.2	8.8	3.7	**8.6**	3.2	1.1	3.2	92	**12.1**	-
BH16	0.50	1	nd	nd	5.8	1.7	10.1	9.6	4.5	4.4	5.7	2.1	**5.4**	2	0.6	2.2	55	**7.5**	-
BH17	0.50	32.8	8.3	20.3	205	43	186	158	66.1	65.2	66.3	20.5	**57.1**	14.6	4.9	13.7	**970**	**79.5**	-
BH18	0.50	nd	nd	nd	2.4	0.6	3	2.9	1.6	1.5	1.7	0.6	**1.9**	0.5	nd	nd	17	2.4	-

Table 9: Waste Classification Analytical Summary, PAHs and VOCs (mg/kg)

Sample	Depth (m)	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benz(a)anthracene	Chrysene	Benzo(b+j)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1.2.3.cd)pyrene	Dibenz(a.h)anthracene	Benzo(g.h.i)perylene	Total PAHs	B(a)P TEQ (zero LOR)	Total VOCs
LORs		*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	-	-	-
Analytical																			
Senior School																			
TP01	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
TP01	0.50	nd	nd	nd	0.6	nd	1.2	1.2	0.6	0.5	0.5	nd	0.5	nd	nd	nd	5.1	0.6	-
TP02	0.15	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
TP02	0.30	nd	nd	nd	0.9	nd	2	2	1	0.9	0.9	nd	**0.8**	nd	nd	nd	8.5	1	-
BH04	0.80	1	nd	nd	5.9	1.4	11.9	11.4	5.5	5.4	6.9	2.4	**6.4**	2.6	0.6	3.2	64.6	**8.8**	-
BH05	0.05	nd	nd	nd	1	nd	2.4	2.4	1.1	1.1	1.2	nd	**1.2**	nd	nd	0.5	10.9	1.4	-
BH06	0.50	4	nd	1.2	38.2	7.5	40.7	33.9	16.5	16.3	18.9	8.3	**14.2**	6.6	2.1	7.2	**217**	**21.6**	-
Main Campus																			
BH03	0.25	33.6	4.8	36.3	294	54.5	204	194	66.4	59.3	58.8	19.8	**54.6**	21.9	6.8	25.8	**1,150**	**78.9**	-
BH07	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH07	0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH08	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH08	0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH09	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH09	0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-

Table 9: Waste Classification Analytical Summary, PAHs and VOCs (mg/kg)

Sample	Depth (m)	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benz(a)anthracene	Chrysene	Benzo(b+j)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1.2.3.cd)pyrene	Dibenz(a.h)anthracene	Benzo(g.h.i)perylene	Total PAHs	B(a)P TEQ (zero LOR)	Total VOCs
LORs		*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	-	-	-
Analytical																			
Statistics																			
Samples analysed		29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	1
Detects		11	4	8	19	16	19	19	19	19	19	16	19	16	10	16	19	19	0
% detect		38%	14%	28%	66%	55%	66%	66%	66%	66%	66%	55%	66%	55%	34%	55%	66%	66%	0%
Maximum		32.8	8.3	20.3	205.0	43.0	186	158.0	66.1	65.2	66.3	20.5	**57.1**	14.6	4.9	13.7	**970**	**79.5**	-
Mean		5.4	3.3	4.5	20.1	5.3	21.8	19.1	8.4	8.0	9	3.5	**7.8**	2.9	1.5	3.2	113.5	11	-
Median		1.4	0.9	1.3	4.4	1.6	8.0	7.4	3.4	3.1	3.8	1.9	3.3	1.6	1.1	1.9	40.4	4.3	-
Minimum		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Criteria - Contamination threshold values (CT1 & CT2)4																			
General solid waste		-	-	-	-	-	-	-	-	-	-	-	**0.8**	-	-	-	**200**	-	-
Restricted solid waste		-	-	-	-	-	-	-	-	-	-	-	**3.2**	-	-	-	**800**	-	-

See table notes at end of section

Table 10: Waste Classification Summary, TCLP Lead and PAHs

Sample	Depth	Units	Lead	Benzo(a)pyrene	Total PAHs
LOR Soil		mg/kg	*0.005*	*0.5*	-
LOR TCLP		µg/L	*0.1*	*0.5*	*0.5*
Analytical					
Junior School					
BH02	0.4	mg/kg	-	3.3	-
		mg/L	-	nd	-
BH02	1.5	mg/kg	-	9.6	-
		mg/L	-	nd	-
BH12	0.4	mg/kg	18	2.1	19.5
		mg/L	nd	nd	nd
BH13	0.2	mg/kg	44	3.3	40.4
		mg/L	nd	nd	27.6
BH13	0.3	mg/kg	34	4.8	59
		mg/L	0.1	nd	15.5
BH14	0.5	mg/kg	96	4.3	45
		mg/L	nd	nd	10.1
BH15	0.5	mg/kg	84	8.6	92
		mg/L	nd	nd	1.6
BH16	0.5	mg/kg	95	5.4	55
		mg/L	nd	nd	3.1
BH17	0.5	mg/kg	195	**57.1**	**970**
		mg/L	0.2	nd	11.1
BH18	0.5	mg/kg	46	1.9	17
		mg/L	nd	nd	nd
Senior School					
BH04	0.8	mg/kg	1,470	6.4	64.6
		mg/L	**6.4**	nd	nd
BH05	0.05	mg/kg	49	1.2	10.9
		mg/L	nd	nd	nd
BH06	0.5	mg/kg	552	**14.2**	**217**
		mg/L	0.5	nd	nd
Main Campus					
BH07	0.1	mg/kg	8	nd	nd
		mg/L	nd	nd	nd
BH07	0.2	mg/kg	nd	nd	nd
		mg/L	nd	nd	nd
BH08	0.1	mg/kg	5	nd	nd
		mg/L	nd	nd	nd
BH08	0.2	mg/kg	nd	nd	nd
		mg/L	nd	nd	nd
BH09	0.1	mg/kg	6	nd	nd
		mg/L	nd	nd	nd
BH09	0.2	mg/kg	6	nd	nd
		mg/L	nd	nd	nd
Waste classification [6]					
General solid waste	Total	mg/kg	1,500	**10**	**200**
	TCLP	mg/L	**5**	0.04	N/A
Restricted solid waste	Total	mg/kg	6,000	**23**	**800**
	TCLP	mg/L	20	0.16	N/A

Table 11: Soil Analytical Summary, Quality Control (mg/kg)

Analyte	LOR mg/kg	TP01	QS01	**RPD**	BH02	QS02	**RPD**	Trip Blank	Trip Spike	TSC	**Trip Spike**
Type	-	*Primary*	*Duplicate*	*%*	*Primary*	*Duplicate*	*%*	-	-	-	*Recovery*
Date	-	07/12/17	07/12/17	-	08/12/17	08/12/17	-	5/12/17	30/11/17	30/11/17	-
Media	*Soil*	*Soil*	*Soil*	-	*Soil*	*Soil*	-	-	-	-	-
Heavy metals											
Arsenic	*5*	nd	5	-	5	nd	-	-	-	-	-
Cadmium	*1*	nd	nd	-	nd	nd	-	-	-	-	-
Chromium	*2*	11	11	0	12	12	0	-	-	-	-
Copper	*5*	5	7	33	16	19	17	-	-	-	-
Lead	*5*	58	92	45	116	72	47	-	-	-	-
Nickel	*2*	7	7	0	3	3	0	-	-	-	-
Zinc	*5*	37	82	**76**	89	71	23	-	-	-	-
Mercury	*0.1*	nd	nd	-	nd	nd	-	-	-	-	-
PAHS											
Naphthalene	*0.5*	nd	nd	-	nd	0.5	-	-	-	-	-
Acenaphthylene	*0.5*	nd	1.4	-	2.2	1.9	15	-	-	-	-
Acenaphthene	*0.5*	nd	nd	-	0.9	0.9	0	-	-	-	-
Fluorene	*0.5*	nd	nd	-	2.8	2.4	15	-	-	-	-
Phenanthrene	*0.5*	0.6	5.3	**159**	19.6	20.3	4	-	-	-	-
Anthracene	*0.5*	nd	1.3	-	5.2	5.3	2	-	-	-	-
Fluoranthene	*0.5*	1.2	12.6	**165**	25.8	29.8	14	-	-	-	-
Pyrene	*0.5*	1.2	11.5	**162**	23.1	26.8	15	-	-	-	-
Benz(a)anthracene	*0.5*	0.6	5.4	**160**	10.3	13.2	25	-	-	-	-
Chrysene	*0.5*	0.5	4.5	**160**	9.1	11.4	22	-	-	-	-
Benzo(b+j)fluoranthene	*0.5*	0.5	5.2	**165**	11.1	13.6	20	-	-	-	-
Benzo(k)fluoranthene	*0.5*	nd	2.1	-	4	4.6	14	-	-	-	-
Benzo(a)pyrene	*0.5*	0.5	4.9	**163**	9.6	11.7	20	-	-	-	-
Indeno(1.2.3.cd)pyrene	*0.5*	nd	1.5	-	4.1	4.1	0	-	-	-	-
Dibenz(a.h)anthracene	*0.5*	nd	nd	-	1.3	1	26	-	-	-	-
Benzo(g.h.i)perylene	*0.5*	nd	1.6	-	4.5	4.5	0	-	-	-	-
Sum of PAHs	*0.5*	5.1	57.3	**167**	134	152	13	-	-	-	-
Benzo(a)pyrene TEQ (zero)	*0.5*	0.6	6.4	**166**	14	16.4	16	-	-	-	-
Organics											
Benzene	*0.2*	nd	nd	-	nd	nd	-	nd	nd	nd	-
Toluene	*0.5*	nd	nd	-	nd	nd	-	nd	7.9	8.2	96
Ethyl benzene	*0.5*	nd	nd	-	nd	nd	-	nd	1.1	1.3	85
meta- & para-Xylene	*0.5*	nd	nd	-	nd	nd	-	nd	5.7	6.8	84
ortho-Xylene	*0.5*	nd	nd	-	nd	nd	-	nd	2.4	3.1	77
TRHs C6 – C10	*10*	nd	nd	-	nd	nd	-	nd	11	14	79
TRHs >C10 - C16	*50*	nd	nd	-	nd	nd	-	-	-	-	-
TRHs >C16 - C34	*100*	nd	nd	-	460	600	26	-	-	-	-
TRHs >C34 - C40	*100*	nd	nd	-	140	130	7	-	-	-	-
Data Quality Indicator		-	-	***<50%***	-	-	*<50%*	-	-	-	*70-130%*

See tables notes at end of section

Table 11: Soil Analytical Summary, Quality Control (mg/kg)

Analyte	LOR mg/kg	BH18 0.5	QCS04	**RPD**	BH18 0.5	QCS05	**RPD**	Trip Blank	Trip Spike	TSC	**Trip Spike**
Type	-	*Primary*	*Duplicate*	*%*	*Primary*	*Duplicate*	*%*	-	-	-	*Recovery*
Date	-	25/11/18	25/11/18	-	25/11/18	25/11/18	-	22/11/18	22/11/18	22/11/18	-
Media	*Soil*	*Soil*	*Soil*	-	*Soil*	*Soil*	-	-	-	-	-
Heavy metals											
Arsenic	*5*	nd	nd	-	nd	2.2	-	-	-	-	-
Cadmium	*1*	nd	nd	-	nd	nd	-	-	-	-	-
Chromium	*2*	9	13	36	9	15	50	-	-	-	-
Copper	*5*	20	20	0	20	23	14	-	-	-	-
Lead	*5*	46	36	24	46	30	42	-	-	-	-
Nickel	*2*	22	25	13	22	25	13	-	-	-	-
Zinc	*5*	54	51	6	54	47	14	-	-	-	-
Mercury	*0.1*	nd	nd	-	nd	nd	-	-	-	-	-
PAHS											
Naphthalene	*0.5*	nd	nd	-	nd	nd	-	-	-	-	-
Acenaphthylene	*0.5*	nd	nd	-	nd	nd	-	-	-	-	-
Acenaphthene	*0.5*	nd	nd	-	nd	nd	-	-	-	-	-
Fluorene	*0.5*	nd	nd	-	nd	nd	-	-	-	-	-
Phenanthrene	*0.5*	2.4	1.1	**74**	2.4	1.0	**82**	-	-	-	-
Anthracene	*0.5*	0.6	nd	-	0.6	nd	-	-	-	-	-
Fluoranthene	*0.5*	3	2.6	14	3	2.3	26	-	-	-	-
Pyrene	*0.5*	2.9	2.6	11	2.9	2.3	23	-	-	-	-
Benz(a)anthracene	*0.5*	1.6	1.3	21	1.6	1.1	37	-	-	-	-
Chrysene	*0.5*	1.5	1.3	14	1.5	1.1	31	-	-	-	-
Benzo(b+j)fluoranthene	*0.5*	1.7	1.2	34	1.7	1.5	13	-	-	-	-
Benzo(k)fluoranthene	*0.5*	0.6	nd	-	0.6	0.6	0	-	-	-	-
Benzo(a)pyrene	*0.5*	1.9	1.6	17	1.9	1.5	24	-	-	-	-
Indeno(1.2.3.cd)pyrene	*0.5*	0.5	nd	-	0.5	1.1	**75**	-	-	-	-
Dibenz(a.h)anthracene	*0.5*	nd	nd	-	nd	nd	0	-	-	-	-
Benzo(g.h.i)perylene	*0.5*	nd	0.5	-	nd	1.2	-	-	-	-	-
Sum of PAHs	*0.5*	17	12.2	31	17	13.7	20	-	-	-	-
Benzo(a)pyrene TEQ (zero)	*0.5*	2.4	1.9	23	2.4	2.0	18	-	-	-	-
Organics											
Benzene	*0.2*	nd	nd	-	nd	nd	-	nd	0	0.3	133
Toluene	*0.5*	nd	nd	-	nd	nd	-	nd	16	16.5	95
Ethyl benzene	*0.5*	nd	nd	-	nd	nd	-	nd	2	2	95
meta- & para-Xylene	*0.5*	nd	nd	-	nd	nd	-	nd	10	11.3	87
ortho-Xylene	*0.5*	nd	nd	-	nd	nd	-	nd	4	4.6	85
TRHs C6 – C10	*10*	nd	nd	-	nd	nd	-	nd	61	68	90
TRHs >C10 - C16	*50*	nd	nd	-	nd	nd	-	-	-	-	-
TRHs >C16 - C34	*100*	110	130	17	110	110	0	-	-	-	-
TRHs >C34 - C40	*100*	nd	nd	-	nd	nd	-	-	-	-	-
Data Quality Indicator		-	-	***<50%***	-	-	*<50%*	-	-	-	*70-130%*

See tables notes at end of section

Appendix A

Cavvanba (2018), Waste Classification Summary (Ref: 17066 L02)

1 / 66 Centennial Circuit
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Byron Bay NSW 2481
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Jonathon Durnell
Wood & Grieve Engineers

Via email: Jonathon.durnell@wge.com.au

Ref: 17066 L02 19 December 2018

Dear Jonathon,

Waste Classification Summary
Proposed Site Development Works
St Aloysius College, Kirribilli NSW 2061

1.0 Introduction

Cavvanba Consulting have been engaged to undertake a waste classification summary of excavated material resulting from the proposed site development. The waste was assessed in accordance with NSW EPA (November 2014) *Waste Classification Guidelines, Part 1: Classifying Waste* and it is expected that the reader has a working understanding of the waste classification process.

This letter should be read in full, including Cavvanba's attached *General limitations to environmental information* and the following attachments.

2.0 Background

The site is proposed to be developed and an environmental site assessment is required to be submitted with the development application (DA). The development proposed for the site is detailed below:

- Junior School: excavation and off-site disposal of ~ 2,200 m^3 of fill material beneath the existing basketball court;
- Senior School: excavation and off-site disposal activities associated with installation of drainage and piles (estimated to be ~ 25 m^3); and
- Main Campus: excavation and off-site disposal of fill material from beneath the courtyard (estimated to be ~ 800 m^3).

Disturbance of fill material is understood to consist of the following:

- Junior School: excavation and off-site disposal of ~ 2,200 m^3 of fill material beneath the existing basketball court;
- Senior School: excavation and off-site disposal activities associated with installation of drainage and piles (estimated to be ~ 25 m^3); and
- Main Campus: excavation and off-site disposal of fill material from beneath the courtyard (estimated to be ~ 800 m^3).

3.0 Assessment of soil

3.1 Sampling

Details of the sampling was provided in the previous reports and is not repeated here.

For further information, please refer to:
- Cavvanba Consulting (2018) *Preliminary Site Investigation, St Aloysius College, Kirribilli, New South Wales 2061* (Ref. 17066 R01);
- Cavvanba Consulting (2018) *Preliminary Waste Classification, New sports court development, 29 Burton Street, Kirribilli NSW 2061* (Ref. 17066 L01); and
- Cavvanba Consulting (2018) *Detailed Site Investigation, St Aloysius College, Kirribilli, New South Wales 2061* (Ref. 17066 R02).

3.2 Analytical results

Junior School

A total of fifteen samples have been collected from the fill material at the Junior School.

The results of the sampling have been summarised in Table 3.1, and where no relevant criteria is available, this is shown as 'n/a'. Where TCLPs have been undertaken, the CT1 criteria have been struck out. ProUCL statistical analysis of the data set is included in Appendix A.

Table 3.1: Junior School waste assessment summary

Analyte	Criteria	Criteria		Site Data			Meets general solid waste?
	CT1 (mg/kg)	SCC1 (mg/kg)	TCLP 1 (mg/L)	Number of detects	Maximum	Maximum TCLP	
Metals							
Arsenic	100	500	5	3	8	-	Yes
Cadmium	20	100	1	0	-	-	Yes
Chromium (VI)	100	1,900	5	15	59	-	Yes
Copper	n/a	n/a	n/a	15	66	-	Yes
Lead	**~~100~~**	1,500	5	15	195	0.2	Yes
Mercury	4	50	0.2	1	0.1	-	Yes
Nickel	**40**	1,050	2	14	**51**	-	**No**
Zinc	n/a	n/a	n/a	15	134	-	Yes
PAHs							
Total (PAHs)	n/a	**200**	n/a	13	**970**	-	**No**
Benzo(a) pyrene	**~~0.8~~**	**10**	**0.04**	13	**57.1**	nd	**No**
TPHs, BTEXN							
TPHs C6 - C9	n/a	650	n/a	0	-	-	Yes
TPHs C10 - C36	n/a	10,000	n/a	12	5,580	-	Yes
Benzene	10	18	0.5	0	-	-	Yes
Toluene	288	518	14.4	0	-	-	Yes
Ethylbenzene	600	1,080	30	0	-	-	Yes

Analyte	Criteria	Criteria		Site Data			Meets general solid waste?
	CT1 (mg/kg)	SCC1 (mg/kg)	TCLP 1 (mg/L)	Number of detects	Maximum	Maximum TCLP	
Xylenes	1,000	1,800	50	0	-	-	Yes
OCPs/OPPs/PCBs							
Scheduled Chemicals	<50	<50	N/A	0	-	-	Yes
Polychlorinated Biphenyls	<50	<50	N/A	0	-	-	Yes

Statistical analysis was conducted on select analytes which exceeded criteria. These are summarised below in Table 3.2:

Table 3.2: Junior School waste assessment summary

Analyte	Maximum concentration	95% UCL	General Solid Waste Criteria (mg/kg)	Restricted Solid Waste Criteria (mg/kg)
Nickel	51	26.72	40 (CT1)	160 (CT2)
Total PAHs	**970**	**277.1**	**200** (SCC1)	800 (SCC2)
Benzo(a)pyrene	**57.1**	**15.64**	**10** (SCC1)	23 (SCC2)

Note: **BOLD** = exceeds criteria

The majority of the analytes were below the CT1 criteria for general solid waste, excluding the following:

- nickel – 95% UCL analysis is less than CT1, so therefore meets general solid waste classification for nickel;
- lead – exceeds CT1 criteria however with TCLP data concentrations are below SCC1 and TCLP1, therefore meets general solid waste classification for lead.
- total PAHs – maximum concentrations exceeds SCC1. 95% UCL also exceeds SCC1, therefore restricted solid waste for total PAHs.
- benzo(a)pyrene – maximum concentrations exceeds SCC1. 95% UCL exceeds SCC1, therefore restricted solid waste for benzo(a)pyrene.

Therefore, fill material from the Junior School (~ 2,200 m^3) is classified as **restricted solid waste.**

Senior School

A total of seven samples have been collected from the fill material at the Senior School.

The results of the sampling have been summarised in Table 3.3, and where no relevant criteria is available, this is shown as 'n/a'. Where TCLPs have been undertaken, the CT1 criteria have been struck out.

Table 3.3: Senior School waste assessment summary

Analyte	Criteria	Criteria		Site Data			Meets general solid waste?
	CT1 (mg/kg)	SCC1 (mg/kg)	TCLP 1 (mg/L)	Number of detects	Maximum	Maximum TCLP	
Arsenic	100	500	5	2	18	-	Yes
Cadmium	20	100	1	0	-	-	Yes
Chromium (VI)	100	1,900	5	7	11	-	Yes

Analyte	Criteria	Criteria		Site Data			Meets general solid waste?
	CT1 (mg/kg)	SCC1 (mg/kg)	TCLP 1 (mg/L)	Number of detects	Maximum	Maximum TCLP	
Copper	n/a	n/a	n/a	7	55	-	Yes
Lead	~~**100**~~	1,500	**5**	7	**1,470**	**6.4**	**No**
Mercury	4	50	0.2	2	0.6	-	Yes
Nickel	**40**	1,050	2	7	**122**	-	**No**
Zinc	n/a	n/a	n/a	7	485	-	Yes
PAHs							
Total (PAHs)	n/a	**200**	n/a	5	**217**	-	**No**
Benzo(a) pyrene	~~**0.8**~~	**10**	**0.04**	5	**14.2**	nd	**No**
TPHs, BTEXN							
TPHs C6 - C9	n/a	650	n/a	0	-	-	Yes
TPHs C10 - C36	n/a	10,000	n/a	2	970	-	Yes
Benzene	10	18	0.5	0	-	-	Yes
Toluene	288	518	14.4	0	-	-	Yes
Ethylbenzene	600	1,080	30	0	-	-	Yes
Xylenes	1,000	1,800	50	0	-	-	Yes
OCPs/OPPs/PCBs							
Scheduled Chemicals	<50	<50	N/A	0	-	-	Yes
Polychlorinated Biphenyls	<50	<50	N/A	0	-	-	Yes

Statistical analysis was conducted on select analytes which exceeded criteria. It should be noted that based on These are summarised below in Table 3.4:

Table 3.4: Senior School waste assessment summary

Analyte	Maximum concentration	95% UCL	General Solid Waste Criteria (mg/kg)	Restricted Solid Waste Criteria (mg/kg)
Lead	1,470	**1,797***	**1,500** (CT1)	6,000 (CT2)
Total PAHs	**217**	**382***	**200** (SCC1)	800 (SCC2)
Benzo(a)pyrene	**14.2**	**12.02**	**10** (SCC1)	23 (SCC2)

Note: **BOLD** = exceeds criteria
95% UCL concentrations exceed maximum values possibly due to small data set.

The majority of the analytes were below the CT1 criteria for general solid waste, excluding the following:

- nickel – maximum concentration exceeds CT1, so therefore meets restricted solid waste classification for nickel;
- lead – exceeds CT1 criteria and with TCLP data concentrations are below SCC1 but above the TCLP1, therefore meets restricted solid waste classification for lead.
- total PAHs – maximum concentrations exceeds SCC1. 95% UCL also exceeds SCC1, therefore restricted solid waste for total PAHs.
- benzo(a)pyrene – maximum concentrations exceeds SCC1. 95% UCL exceeds SCC1, therefore restricted solid waste for benzo(a)pyrene.

Therefore, fill material from the Senior School (estimated to be ~ 25 m^3) is classified as **restricted solid waste.**

Main Campus

A total of seven samples have been collected from the fill material at the Main Campus.

The results of the sampling have been summarised in Table 3.5, and where no relevant criteria is available, this is shown as 'n/a'. Where TCLPs have been undertaken, the CT1 criteria have been struck out.

Table 3.5: Soil waste assessment summary

Analyte	Criteria	Criteria		Site Data			Meets general solid waste?
	CT1 (mg/kg)	SCC1 (mg/kg)	TCLP 1 (mg/L)	Number of detects	Maximum	Maximum TCLP	
Metals							
Arsenic	100	500	5	0	-	-	Yes
Cadmium	20	100	1	0	-	-	Yes
Chromium (VI)	100	1,900	5	7	14	-	Yes
Copper	n/a	n/a	n/a	3	9	-	Yes
Lead	100	1,500	5	5	91	-	Yes
Mercury	4	50	0.2	0	-	-	Yes
Nickel	40	1,050	2	4	4	-	Yes
Zinc	n/a	n/a	n/a	7	49	-	Yes
PAHs							
Total (PAHs)	n/a	**200**	n/a	1	**1,150**	-	**No**
Benzo(a) pyrene	**~~0.8~~**	**10**	**0.04**	1	**54.6**	-	**No**
TPH/BTEXN							
TPHs C6 - C9	n/a	650	n/a	1	410	-	Yes
TPHs C10 - C36	n/a	10,000	n/a	1	4,370	-	Yes
Benzene	10	18	0.5	0	-	-	Yes
Toluene	288	518	14.4	0	-	-	Yes
Ethylbenzene	600	1,080	30	0	-	-	Yes
Xylenes	1,000	1,800	50	0	-	-	Yes
OCPs/OPPs/PCBs							
Scheduled Chemicals	<50	<50	N/A	0	-	-	Yes
Polychlorinated Biphenyls	<50	<50	N/A	0	-	-	Yes

The majority of the analytes were below the CT1 criteria for general solid waste, excluding the following:

- total PAHs – maximum concentrations exceeds SCC1 and SCC2 criteria, therefore classified as hazardous solid waste for total PAHs.
- benzo(a)pyrene – maximum concentrations exceeds SCC1 and SCC2, therefore classified as hazardous solid waste for benzo(a)pyrene.

Therefore, fill material from the Main Campus is classified as **hazardous solid waste.**

It is noted that all of the exceedances are associated with the clayey sand fill material encountered in location BH03 only. This material should be carefully segregated from the remaining material to minimise volumes.

The remainder of samples met general solid waste criteria. Due to segregation of these materials, additional samples may be necessary to meet the minimum sample density requirements.

4.0 Assessment of waste classification

The NSW EPA (2014) guideline explains the six basic steps for classifying waste. These steps are briefly outlined below, along with the results of the assessment.

Table 4.1: Waste classification

Step (EPA 2014)	Description (EPA 2014)	Assessment
1.	Establish if the waste should be classified as special waste. If the waste is special waste due to its contamination with asbestos (i.e. classified as asbestos waste), continue to classify the waste in accordance with the steps below.	Not special waste (No asbestos detected)
2.	If not special waste (other than asbestos waste), establish whether the waste should be classified as liquid waste.	- The material is soil. - The waste is capable of being picked up by a spade or shovel and does not become free-flowing at or below 60 degrees Celsius or when it is transported. - Not classified as liquid waste.
3.	If not special waste (other than asbestos waste) or liquid waste, establish whether the waste is of a type that has been 'pre-classified'. To simplify the classification process, the Environment Protection Authority (EPA) has pre-classified a number of commonly generated wastes as either hazardous, restricted solid or general solid waste (putrescible) or general solid waste (non-putrescible).	Not pre-classified.
4.	If the waste is not special waste (other than asbestos waste), liquid waste or pre-classified, establish if it has certain hazardous characteristics and can therefore be classified as hazardous waste.	No hazardous characteristics.
5.	If the waste does not possess hazardous characteristics, it needs to be chemically assessed to determine whether it is hazardous, restricted solid or general solid waste (putrescible and non-putrescible). If the waste is not chemically assessed, you must manage the waste as if it were hazardous waste.	The frequency of samples meets requirements for the Junior and Senior School but does not meet the requirements for the Main Campus due to segregation of material types. For the purposes of this preliminary waste classification letter is it

Step (EPA 2014)	Description (EPA 2014)	Assessment
		considered acceptable at this stage. Where concentrations of specific analytes have exceeded CT1 criteria, TCLP analysis was undertaken.
6.	If the waste is chemically assessed as general solid waste, a further assessment is available to determine whether the waste is putrescible or non-putrescible. The assessment determines whether the waste is capable of significant biological transformation. If you do not wish to undertake this assessment, you must manage the waste as if it were general solid waste (putrescible).	Given the nature of the material the material is considered to be non-putrescible.

A summary of the waste classification results is provided below in Table 4.2.

Table 4.2: Waste Classification summary

	Junior School	Senior School	Main Campus	
Media	Fill material	Fill material	Fill material – sand	Black clayey sand fill (BH03, western portion)
Estimated volume to be excavated	~2,200 m^3	~ 25 m^3	< 800 m^3	Unknown, likely to be < 25 m^3
Exceedances of criteria	Total PAHs and Benzo(a)pyrene	Nickel, lead, Total PAHs and Benzo(a)pyrene	N/A	Total PAHs and Benzo(a)pyrene
Current Waste Classification	**Restricted solid waste**	**Restricted solid waste**	General solid waste	<u>**Hazardous solid waste**</u>
More data required?	No	No	Yes	Yes

Sufficient data has been collected to date for the Junior School and Senior School fill material. Collection of additional samples from this material is unlikely to lower the waste classification.

Additional samples are recommended at the Main Campus during excavation to appropriately characterise the two waste streams. In addition, oversight from a suitably qualified environmental scientist and segregation of material types will be vital to minimising the hazardous waste stream and costs.

This material should be disposed of at a New South Wales Environment Protection Authority (EPA) landfill licensed to accept the applicable waste classification.

✧ ✧ ✧ ✧

Thank you for your time in regard to this matter. Please do not hesitate to contact the undersigned on (02) 6685 7811 if you require additional information or clarification.

Yours sincerely
Cavvanba Consulting Pty Ltd

Ross Nicolson
Senior Environmental Scientist

Glen Chisnall
Environmental Scientist

Attachment A

ProUCL Outputs

	A–E	F	G–K	L
1	UCL Statistics for Uncensored Full Data Sets			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.119/12/2018 11:35:02 AM		
5	From File	Junior School Stats.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
11	Junior School Nickel			
12				
13	**General Statistics**			
14	Total Number of Observations	15	Number of Distinct Observations	12
15			Number of Missing Observations	0
16	Minimum	2	Mean	20.33
17	Maximum	51	Median	21
18	SD	14.05	Std. Error of Mean	3.627
19	Coefficient of Variation	0.691	Skewness	0.492
20				
21	**Normal GOF Test**			
22	Shapiro Wilk Test Statistic	0.947	**Shapiro Wilk GOF Test**	
23	5% Shapiro Wilk Critical Value	0.881	Data appear Normal at 5% Significance Level	
24	Lilliefors Test Statistic	0.129	**Lilliefors GOF Test**	
25	5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level	
26	**Data appear Normal at 5% Significance Level**			
27				
28	**Assuming Normal Distribution**			
29	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
30	95% Student's-t UCL	26.72	95% Adjusted-CLT UCL (Chen-1995)	26.79
31			95% Modified-t UCL (Johnson-1978)	26.8
32				
33	**Gamma GOF Test**			
34	A-D Test Statistic	0.62	**Anderson-Darling Gamma GOF Test**	
35	5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level	
36	K-S Test Statistic	0.2	**Kolmogorov-Smirnov Gamma GOF Test**	
37	5% K-S Critical Value	0.225	Detected data appear Gamma Distributed at 5% Significance Level	
38	**Detected data appear Gamma Distributed at 5% Significance Level**			
39				
40	**Gamma Statistics**			
41	k hat (MLE)	1.543	k star (bias corrected MLE)	1.279
42	Theta hat (MLE)	13.18	Theta star (bias corrected MLE)	15.9
43	nu hat (MLE)	46.28	nu star (bias corrected)	38.36
44	MLE Mean (bias corrected)	20.33	MLE Sd (bias corrected)	17.98
45			Approximate Chi Square Value (0.05)	25.17
46	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	23.86
47				
48	**Assuming Gamma Distribution**			
49	95% Approximate Gamma UCL (use when n>=50))	30.98	95% Adjusted Gamma UCL (use when n<50)	32.68
50				
51	**Lognormal GOF Test**			
52	Shapiro Wilk Test Statistic	0.865	**Shapiro Wilk Lognormal GOF Test**	

	A	B	C	D	E	F	G	H	I	J	K	L
53					5% Shapiro Wilk Critical Value	0.881	Data Not Lognormal at 5% Significance Level					
54					Lilliefors Test Statistic	0.254	**Lilliefors Lognormal GOF Test**					
55					5% Lilliefors Critical Value	0.22	Data Not Lognormal at 5% Significance Level					
56	**Data Not Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	0.693					Mean of logged Data	2.654
60					Maximum of Logged Data	3.932					SD of logged Data	1.022
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	51.25					90% Chebyshev (MVUE) UCL	42.65
64					95% Chebyshev (MVUE) UCL	51.62					97.5% Chebyshev (MVUE) UCL	64.08
65					99% Chebyshev (MVUE) UCL	88.54						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	26.3					95% Jackknife UCL	26.72
72					95% Standard Bootstrap UCL	26.19					95% Bootstrap-t UCL	27.41
73					95% Hall's Bootstrap UCL	27.49					95% Percentile Bootstrap UCL	26.33
74					95% BCA Bootstrap UCL	26.8						
75					90% Chebyshev(Mean, Sd) UCL	31.22					95% Chebyshev(Mean, Sd) UCL	36.15
76					97.5% Chebyshev(Mean, Sd) UCL	42.99					99% Chebyshev(Mean, Sd) UCL	56.43
77												
78	**Suggested UCL to Use**											
79					95% Student's-t UCL	26.72						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.119/12/2018 11:21:01 AM
From File	Junior School Stats.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Junior School Total PAHs

General Statistics

Total Number of Observations	15	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	0.5	Mean	112.7
Maximum	970	Median	40.4
SD	242.5	Std. Error of Mean	62.61
Coefficient of Variation	2.152	Skewness	3.599

Normal GOF Test

Shapiro Wilk Test Statistic	0.455	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.334	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	223	95% Adjusted-CLT UCL (Chen-1995)	277.8
		95% Modified-t UCL (Johnson-1978)	232.7

Gamma GOF Test

A-D Test Statistic	0.74	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.797	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.196	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.234	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.481	k star (bias corrected MLE)	0.429
Theta hat (MLE)	234.3	Theta star (bias corrected MLE)	262.5
nu hat (MLE)	14.43	nu star (bias corrected)	12.88
MLE Mean (bias corrected)	112.7	MLE Sd (bias corrected)	172
		Approximate Chi Square Value (0.05)	5.809
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	5.235

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	249.7	95% Adjusted Gamma UCL (use when n<50)	277.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.882	**Shapiro Wilk Lognormal GOF Test**

	A	B	C	D	E	F	G	H	I	J	K	L
53	5% Shapiro Wilk Critical Value					0.881	Data appear Lognormal at 5% Significance Level					
54	Lilliefors Test Statistic					0.248	**Lilliefors Lognormal GOF Test**					
55	5% Lilliefors Critical Value					0.22	Data Not Lognormal at 5% Significance Level					
56	**Data appear Approximate Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59	Minimum of Logged Data					-0.693	Mean of logged Data					3.396
60	Maximum of Logged Data					6.877	SD of logged Data					1.974
61												
62	**Assuming Lognormal Distribution**											
63	95% H-UCL					2265	90% Chebyshev (MVUE) UCL					430.2
64	95% Chebyshev (MVUE) UCL					554.5	97.5% Chebyshev (MVUE) UCL					726.9
65	99% Chebyshev (MVUE) UCL					1066						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
69												
70	**Nonparametric Distribution Free UCLs**											
71	95% CLT UCL					215.7	95% Jackknife UCL					223
72	95% Standard Bootstrap UCL					209.4	95% Bootstrap-t UCL					623.1
73	95% Hall's Bootstrap UCL					585.2	95% Percentile Bootstrap UCL					229.9
74	95% BCA Bootstrap UCL					308.4						
75	90% Chebyshev(Mean, Sd) UCL					300.5	95% Chebyshev(Mean, Sd) UCL					385.6
76	97.5% Chebyshev(Mean, Sd) UCL					503.7	99% Chebyshev(Mean, Sd) UCL					735.7
77												
78	**Suggested UCL to Use**											
79	95% Adjusted Gamma UCL					277.1						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

1	UCL Statistics for Uncensored Full Data Sets											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.119/12/2018 11:25:45 AM								
5	From File			Junior School Stats.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
11	Junior School BaP											
12												
13	General Statistics											
14	Total Number of Observations					15	Number of Distinct Observations					13
15							Number of Missing Observations					0
16	Minimum					0.5	Mean					7.787
17	Maximum					57.1	Median					3.3
18	SD					14.07	Std. Error of Mean					3.632
19	Coefficient of Variation					1.806	Skewness					3.498
20												
21	Normal GOF Test											
22	Shapiro Wilk Test Statistic					0.495	Shapiro Wilk GOF Test					
23	5% Shapiro Wilk Critical Value					0.881	Data Not Normal at 5% Significance Level					
24	Lilliefors Test Statistic					0.315	Lilliefors GOF Test					
25	5% Lilliefors Critical Value					0.22	Data Not Normal at 5% Significance Level					
26	Data Not Normal at 5% Significance Level											
27												
28	Assuming Normal Distribution											
29	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
30	95% Student's-t UCL					14.18	95% Adjusted-CLT UCL (Chen-1995)					17.27
31							95% Modified-t UCL (Johnson-1978)					14.73
32												
33	Gamma GOF Test											
34	A-D Test Statistic					0.782	Anderson-Darling Gamma GOF Test					
35	5% A-D Critical Value					0.774	Data Not Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic					0.196	Kolmogorov-Smirnov Gamma GOF Test					
37	5% K-S Critical Value					0.23	Detected data appear Gamma Distributed at 5% Significance Level					
38	Detected data follow Appr. Gamma Distribution at 5% Significance Level											
39												
40	Gamma Statistics											
41	k hat (MLE)					0.763	k star (bias corrected MLE)					0.655
42	Theta hat (MLE)					10.21	Theta star (bias corrected MLE)					11.89
43	nu hat (MLE)					22.89	nu star (bias corrected)					19.64
44	MLE Mean (bias corrected)					7.787	MLE Sd (bias corrected)					9.623
45							Approximate Chi Square Value (0.05)					10.59
46	Adjusted Level of Significance					0.0324	Adjusted Chi Square Value					9.778
47												
48	Assuming Gamma Distribution											
49	95% Approximate Gamma UCL (use when n>=50)					14.45	95% Adjusted Gamma UCL (use when n<50)					15.64
50												
51	Lognormal GOF Test											
52	Shapiro Wilk Test Statistic					0.96	Shapiro Wilk Lognormal GOF Test					

	A	B	C	D	E	F	G	H	I	J	K	L
53					5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level					
54					Lilliefors Test Statistic	0.106	**Lilliefors Lognormal GOF Test**					
55					5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level					
56	**Data appear Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	-0.693					Mean of logged Data	1.27
60					Maximum of Logged Data	4.045					SD of logged Data	1.221
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	20.69					90% Chebyshev (MVUE) UCL	14.28
64					95% Chebyshev (MVUE) UCL	17.6					97.5% Chebyshev (MVUE) UCL	22.22
65					99% Chebyshev (MVUE) UCL	31.28						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	13.76					95% Jackknife UCL	14.18
72					95% Standard Bootstrap UCL	13.61					95% Bootstrap-t UCL	31.17
73					95% Hall's Bootstrap UCL	35.28					95% Percentile Bootstrap UCL	14.48
74					95% BCA Bootstrap UCL	18.52						
75					90% Chebyshev(Mean, Sd) UCL	18.68					95% Chebyshev(Mean, Sd) UCL	23.62
76					97.5% Chebyshev(Mean, Sd) UCL	30.47					99% Chebyshev(Mean, Sd) UCL	43.92
77												
78	**Suggested UCL to Use**											
79					95% Adjusted Gamma UCL	15.64						
80												
81	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
82	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
83												
84	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
85	Recommendations are based upon data size, data distribution, and skewness.											
86	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
87	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
88												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.119/12/2018 11:36:13 AM
From File	Senior School Stats.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Senior School Lead

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	34	Mean	340.6
Maximum	1470	Median	58
SD	531.2	Std. Error of Mean	200.8
Coefficient of Variation	1.56	Skewness	2.093

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.67	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.338	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	730.7	95% Adjusted-CLT UCL (Chen-1995)	840.5
		95% Modified-t UCL (Johnson-1978)	757.2

Gamma GOF Test

A-D Test Statistic	0.71	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.313	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.325	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.639	k star (bias corrected MLE)	0.46
Theta hat (MLE)	532.8	Theta star (bias corrected MLE)	739.6
nu hat (MLE)	8.948	nu star (bias corrected)	6.447
MLE Mean (bias corrected)	340.6	MLE Sd (bias corrected)	501.9
		Approximate Chi Square Value (0.05)	1.872
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	1.222

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50)	1173	95% Adjusted Gamma UCL (use when n<50)	1797
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.856	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.285	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.304	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	3.526	Mean of logged Data	4.873
Maximum of Logged Data	7.293	SD of logged Data	1.44
Assuming Lognormal Distribution			
95% H-UCL	6983	90% Chebyshev (MVUE) UCL	763.6
95% Chebyshev (MVUE) UCL	976.5	97.5% Chebyshev (MVUE) UCL	1272
99% Chebyshev (MVUE) UCL	1853		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	670.8	95% Jackknife UCL	730.7
95% Standard Bootstrap UCL	642.3	95% Bootstrap-t UCL	2602
95% Hall's Bootstrap UCL	3684	95% Percentile Bootstrap UCL	694.6
95% BCA Bootstrap UCL	860.1		
90% Chebyshev(Mean, Sd) UCL	942.9	95% Chebyshev(Mean, Sd) UCL	1216
97.5% Chebyshev(Mean, Sd) UCL	1594	99% Chebyshev(Mean, Sd) UCL	2338
Suggested UCL to Use			
95% Adjusted Gamma UCL	1797		
Recommended UCL exceeds the maximum observation			
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
Recommendations are based upon data size, data distribution, and skewness.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.119/12/2018 11:37:07 AM
From File	Senior School Stats.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Senior School Nickel

General Statistics

Total Number of Observations	7	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	3	Mean	38.29
Maximum	122	Median	6
SD	56.52	Std. Error of Mean	21.36
Coefficient of Variation	1.476	Skewness	1.228

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.625	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.424	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	79.8	95% Adjusted-CLT UCL (Chen-1995)	84.02
		95% Modified-t UCL (Johnson-1978)	81.45

Gamma GOF Test

A-D Test Statistic	1.147	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.748	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.409	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.326	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.553	k star (bias corrected MLE)	0.411
Theta hat (MLE)	69.18	Theta star (bias corrected MLE)	93.04
nu hat (MLE)	7.748	nu star (bias corrected)	5.761
MLE Mean (bias corrected)	38.29	MLE Sd (bias corrected)	59.68
		Approximate Chi Square Value (0.05)	1.519
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	0.956

	A–E	F	G–K	L
53	**Assuming Gamma Distribution**			
54	95% Approximate Gamma UCL (use when n>=50))	145.2	95% Adjusted Gamma UCL (use when n<50)	230.6
55				
56	**Lognormal GOF Test**			
57	Shapiro Wilk Test Statistic	0.751	**Shapiro Wilk Lognormal GOF Test**	
58	5% Shapiro Wilk Critical Value	0.803	Data Not Lognormal at 5% Significance Level	
59	Lilliefors Test Statistic	0.355	**Lilliefors Lognormal GOF Test**	
60	5% Lilliefors Critical Value	0.304	Data Not Lognormal at 5% Significance Level	
61	**Data Not Lognormal at 5% Significance Level**			
62				
63	**Lognormal Statistics**			
64	Minimum of Logged Data	1.099	Mean of logged Data	2.515
65	Maximum of Logged Data	4.804	SD of logged Data	1.584
66				
67	**Assuming Lognormal Distribution**			
68	95% H-UCL	1464	90% Chebyshev (MVUE) UCL	88.64
69	95% Chebyshev (MVUE) UCL	114.1	97.5% Chebyshev (MVUE) UCL	149.5
70	99% Chebyshev (MVUE) UCL	219		
71				
72	**Nonparametric Distribution Free UCL Statistics**			
73	**Data do not follow a Discernible Distribution (0.05)**			
74				
75	**Nonparametric Distribution Free UCLs**			
76	95% CLT UCL	73.43	95% Jackknife UCL	79.8
77	95% Standard Bootstrap UCL	69.89	95% Bootstrap-t UCL	1304
78	95% Hall's Bootstrap UCL	1217	95% Percentile Bootstrap UCL	71.43
79	95% BCA Bootstrap UCL	71.86		
80	90% Chebyshev(Mean, Sd) UCL	102.4	95% Chebyshev(Mean, Sd) UCL	131.4
81	97.5% Chebyshev(Mean, Sd) UCL	171.7	99% Chebyshev(Mean, Sd) UCL	250.9
82				
83	**Suggested UCL to Use**			
84	95% Hall's Bootstrap UCL	1217		
85				
86	**Recommended UCL exceeds the maximum observation**			
87				
88	**In Case Bootstrap t and/or Hall's Bootstrap yields an unreasonably large UCL value, use 97.5% or 99% Chebyshev (Mean, Sd) UCL**			
89				
90	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
91	Recommendations are based upon data size, data distribution, and skewness.			
92	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
93	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
94				

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.119/12/2018 11:39:44 AM
From File	Senior School Stats.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Senior School Total PAHs

General Statistics

Total Number of Observations	7	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	0.5	Mean	43.87
Maximum	217	Median	8.5
SD	79.59	Std. Error of Mean	30.08
Coefficient of Variation	1.814	Skewness	2.266

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.634	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.375	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	102.3	95% Adjusted-CLT UCL (Chen-1995)	120.9
		95% Modified-t UCL (Johnson-1978)	106.6

Gamma GOF Test

A-D Test Statistic	0.41	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.771	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.268	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.382	k star (bias corrected MLE)	0.314
Theta hat (MLE)	114.9	Theta star (bias corrected MLE)	139.9
nu hat (MLE)	5.348	nu star (bias corrected)	4.389
MLE Mean (bias corrected)	43.87	MLE Sd (bias corrected)	78.35
		Approximate Chi Square Value (0.05)	0.881
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	0.504

	A	B	C	D	E	F	G	H	I	J	K	L
53	**Assuming Gamma Distribution**											
54	95% Approximate Gamma UCL (use when n>=50)					218.5	95% Adjusted Gamma UCL (use when n<50)					382
55												
56	**Lognormal GOF Test**											
57	Shapiro Wilk Test Statistic					0.931	**Shapiro Wilk Lognormal GOF Test**					
58	5% Shapiro Wilk Critical Value					0.803	Data appear Lognormal at 5% Significance Level					
59	Lilliefors Test Statistic					0.172	**Lilliefors Lognormal GOF Test**					
60	5% Lilliefors Critical Value					0.304	Data appear Lognormal at 5% Significance Level					
61	**Data appear Lognormal at 5% Significance Level**											
62												
63	**Lognormal Statistics**											
64	Minimum of Logged Data					-0.693	Mean of logged Data					2.046
65	Maximum of Logged Data					5.38	SD of logged Data					2.27
66												
67	**Assuming Lognormal Distribution**											
68	95% H-UCL					117109	90% Chebyshev (MVUE) UCL					155
69	95% Chebyshev (MVUE) UCL					203.7	97.5% Chebyshev (MVUE) UCL					271.4
70	99% Chebyshev (MVUE) UCL					404.3						
71												
72	**Nonparametric Distribution Free UCL Statistics**											
73	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
74												
75	**Nonparametric Distribution Free UCLs**											
76	95% CLT UCL					93.35	95% Jackknife UCL					102.3
77	95% Standard Bootstrap UCL					89.82	95% Bootstrap-t UCL					766.4
78	95% Hall's Bootstrap UCL					472.8	95% Percentile Bootstrap UCL					95.57
79	95% BCA Bootstrap UCL					113.7						
80	90% Chebyshev(Mean, Sd) UCL					134.1	95% Chebyshev(Mean, Sd) UCL					175
81	97.5% Chebyshev(Mean, Sd) UCL					231.7	99% Chebyshev(Mean, Sd) UCL					343.2
82												
83	**Suggested UCL to Use**											
84	95% Adjusted Gamma UCL					382						
85												
86	**Recommended UCL exceeds the maximum observation**											
87												
88	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
89	Recommendations are based upon data size, data distribution, and skewness.											
90	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
91	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
92												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.119/12/2018 11:38:16 AM
From File	Senior School Stats.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Senior School BaP

General Statistics

Total Number of Observations	7	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.5	Mean	3.443
Maximum	14.2	Median	0.8
SD	5.203	Std. Error of Mean	1.967
Coefficient of Variation	1.511	Skewness	1.928

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.669	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.381	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	7.265	95% Adjusted-CLT UCL (Chen-1995)	8.21
		95% Modified-t UCL (Johnson-1978)	7.503

Gamma GOF Test

A-D Test Statistic	0.884	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.741	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.336	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.324	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.678	k star (bias corrected MLE)	0.483
Theta hat (MLE)	5.076	Theta star (bias corrected MLE)	7.131
nu hat (MLE)	9.496	nu star (bias corrected)	6.759
MLE Mean (bias corrected)	3.443	MLE Sd (bias corrected)	4.955
		Approximate Chi Square Value (0.05)	2.039
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	1.35

	A	B	C	D	E	F	G	H	I	J	K	L
53	**Assuming Gamma Distribution**											
54					95% Approximate Gamma UCL (use when n>=50))	11.41					95% Adjusted Gamma UCL (use when n<50)	17.24
55												
56	**Lognormal GOF Test**											
57					Shapiro Wilk Test Statistic	0.794	**Shapiro Wilk Lognormal GOF Test**					
58					5% Shapiro Wilk Critical Value	0.803	Data Not Lognormal at 5% Significance Level					
59					Lilliefors Test Statistic	0.261	**Lilliefors Lognormal GOF Test**					
60					5% Lilliefors Critical Value	0.304	Data appear Lognormal at 5% Significance Level					
61	**Data appear Approximate Lognormal at 5% Significance Level**											
62												
63	**Lognormal Statistics**											
64					Minimum of Logged Data	-0.693					Mean of logged Data	0.341
65					Maximum of Logged Data	2.653					SD of logged Data	1.366
66												
67	**Assuming Lognormal Distribution**											
68					95% H-UCL	51.22					90% Chebyshev (MVUE) UCL	7.404
69					95% Chebyshev (MVUE) UCL	9.431					97.5% Chebyshev (MVUE) UCL	12.25
70					99% Chebyshev (MVUE) UCL	17.77						
71												
72	**Nonparametric Distribution Free UCL Statistics**											
73	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
74												
75	**Nonparametric Distribution Free UCLs**											
76					95% CLT UCL	6.678					95% Jackknife UCL	7.265
77					95% Standard Bootstrap UCL	6.4					95% Bootstrap-t UCL	57.12
78					95% Hall's Bootstrap UCL	35.66					95% Percentile Bootstrap UCL	6.943
79					95% BCA Bootstrap UCL	7.514						
80					90% Chebyshev(Mean, Sd) UCL	9.343					95% Chebyshev(Mean, Sd) UCL	12.02
81					97.5% Chebyshev(Mean, Sd) UCL	15.73					99% Chebyshev(Mean, Sd) UCL	23.01
82												
83	**Suggested UCL to Use**											
84					95% Chebyshev (Mean, Sd) UCL	12.02						
85												
86	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
87	Recommendations are based upon data size, data distribution, and skewness.											
88	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
89	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
90												