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Soil Pollution Evaluation at University of New South Wales

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Abstract: *This report focuses on a petrol spill incident at the University of New South Wales. After a maintenance worker knocked over a petrol can, soil contamination assessment was carried out. It details the site history, landscape, geology, sampling techniques, QA/QC data, and analysis results. The results showed that some metal and pollutant concentrations exceeded safety thresholds. Recommendations include physical, chemical, and biological remediation methods. Appropriate measures should be chosen based on geological and pollution conditions to mitigate pollution.*

Keywords: *soil contamination, petrol spill, remediation methods*

1. Introduction

A maintenance worker is clumsy. He knocked down a large can of petrol that was packed in a large container on a lawn at the University of New South Wales (UNSW). On the surface of the soil, the petrol begins to diffuse in a circular shape and gradually infiltrates into the depth of the soil, with a diameter of about 2 meters. One concern is that a plume will start moving down gradient from the spill to the subsoil layers. This situation has been reported to the local council and the NSW Environment and Heritage Office (OEH) by maintenance workers. Soil contamination assessment is requested to proceed immediately. This report will assess the soil contamination assessment at the UNSW spill site.

2. Scope of investigation and report

The purpose of this report is to analyze the causes of soil contamination at different points. First of all, the report describes the history of the site. Secondly, the landscape and geological conditions of the site were further investigated to provide more valuable land information for subsequent research. Thirdly, the experimental group selects sampling points and conducts experiments. In addition, QA and QC data are evaluated and interpreted, and compared to safety threshold levels. Finally, the experimental group discusses the results and make feasible recommendations with the aim of obtaining effective remediation and protection measures.

3. The history and description of spill site

The UNSW was founded in 1949 and is campus located on the eastern suburb at Kensington. Fifty years ago, the area was a manufacturing engineering laboratory. It was built as a lawn after being removed in 1985 *Figure 1*.

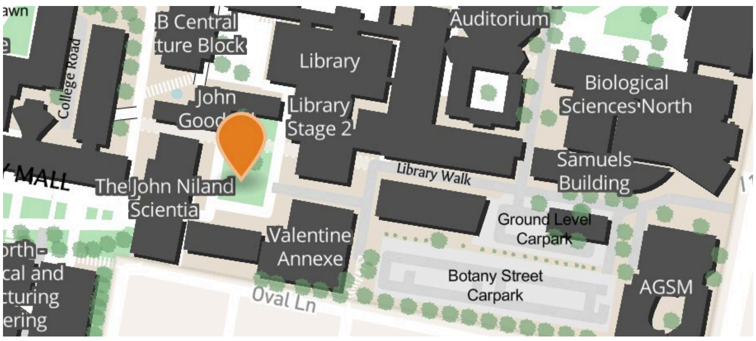

Figure 1. Map of spill site (UNSW StudentVIP,2019)

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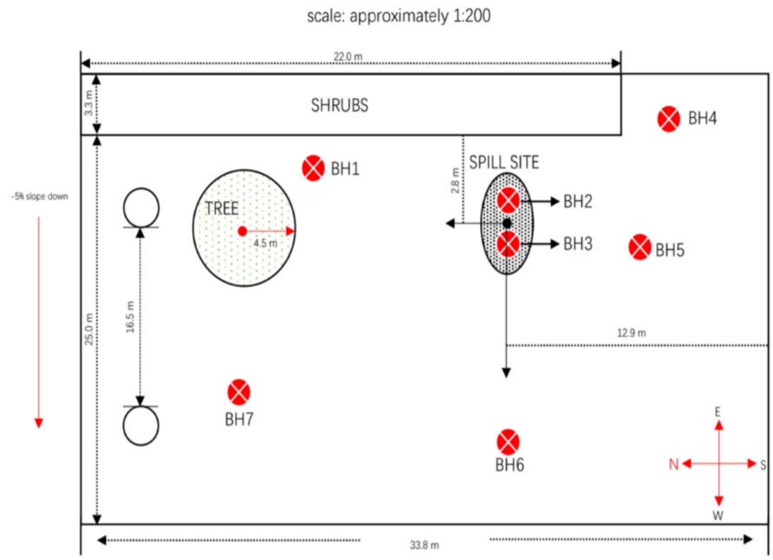

Figure 2. Spill site plan

The area contaminated by petrol is a lawn that is surrounded by 4 building, respectively the UNSW school of civil and environmental engineering, UNSW Scientia building, UNSW IT center, John Goodsell Building. According to the measurement, the lawn is about 33.8 meters long and about 25.0 meters wide. The total area of the lawn is 845 square meters. First, there is a shrub area in the northeast corner of the lawn. The shrub area is about 22.0 meters long and about 3.3 meters wide. In addition, there is a tree in the lawn on the west side of the shrub area, and the tree area is a circular area with a radius of 4.5 meters. Moreover, there are two wells on the north side of the tree area and on the west side of the shrub area. They are 16.5 meters apart *Figure 2*.

According to site observations, the petrol spill point is located on the surface of the soil and it shows a circular shape with a diameter of approximately 2.0 meters. It is 2.8 meters from the east side of the lawn and 12.9 meters from the south side of the lawn.

4. The soil landscape and geology description

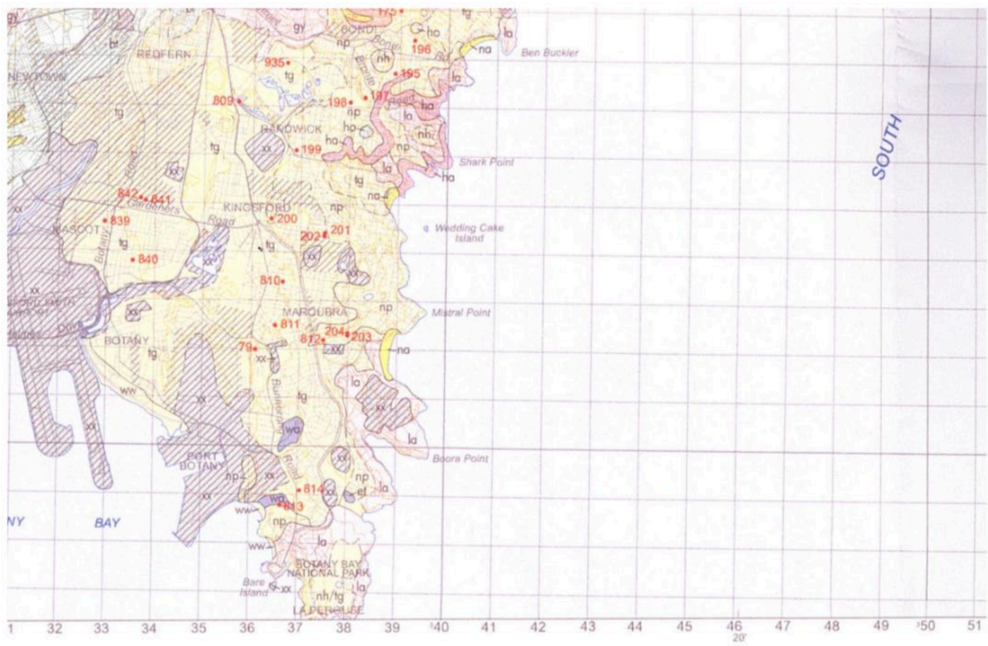

Figure 3. The Sydney soil landscape (Chapman & Murphy, 1989)[1]

Research conducted by Chapman CA ,et.al (1989) shows that the 1:100,000-page soil landscape map of Sydney shows spill site in the NEWPORT and TUGGERAH areas *Figure 3*. Although the TUGGERAH area also forms part of the soil landscape, most of this is made up of NEWPORT. The Newport area is made up of plains. Local terrain has undulations, but the undulation height is less than 10 meters and the slope are less than 10%. In shallow soils less than 50 cm, it is mostly siliceous sand and is well sorted. Overlying moderately deep less than 150 cm is buried sand, and then deeper is deep yellow sandy soil. Furthermore, shale lenses are also present in some soils, and Hawkesbury sandstone is the main geology (Chapman and Murphy, 1989)[1].

According to the landscape map, there is a high risk of wind erosion at the spill point. In addition, as Chapman and Murphy (1989) point out that this point presents a steep slope and a low soil fertility. In particular, the surface soil lacks viscosity[1]. Therefore, the leakage of petrol at this point will not only cause pollution of the UNSW lawn but may even cause pollution in the surrounding area.

5. Site plan and borehole locations

According to the site plan (figure2) with a ratio of 1:200, the total lawn area is approximately 845 square meters. In order to assess soil contamination, it is recommended to select 20 sampling points for analysis. Soil samples were collected by drilling. The seven boreholes in the picture are BH1-BH7. First, the boreholes BH2 and BH3 are located in areas that are directly contaminated. The direct effects of petrol contaminated soil can be analyzed by samples 4, 5, 6 and samples 7, 8, 9. Second, the borehole BH1 is located next to the tree to study whether soil contamination affects the normal growth of the tree. Third, the boreholes BH4, BH5, and BH6 are distributed around the spill site. Through the analysis of each sample point in different directions and at different levels, the purpose is to study the penetration speed, penetration direction and penetration degree after petrol leakage.

6. Sampling technique in Sample processing

In this assessment report, not only two boreholes with direct spill points were selected, but also five other boreholes in different directions were selected. The sampling depth is about 1.0 meters. The boreholes points BH1-BH5 have 3 depth ranges at each position between the surface and 1.0 meters. In addition, since the borehole points BH6 and BH7 are located on the east side of the spill point, and the entire lawn is inclined from the east to the west by about 5 degrees, only two depth ranges are selected for the two borehole points for analysis. Moreover, sample 20 was used as a replicate of sample 19 and was used to assess whether the soil and contaminated samples met the requirements.

7. Sample handing integrity

The content of this soil contamination assessment includes not only total xylene, ethylbenzene, toluene, benzene, hydrocarbons and petroleum, but also Cu, VI, Cr, Ni, Zn, Hg-inorganic, Pb, Cd, As. Due to the processing and integrity of the sample directly affect the accuracy of the evaluation results, so sample processing and integrity are an important and necessary part of soil pollution assessment. On the one hand, secondary contamination of the sample should be avoided during the sampling process. A study by NEPM Schedule B(1) (1999) indicates that sampling personnel should perform sampling in strict accordance with the testing standards, and the sampling records should be clear and complete, including the sampling location, date and time[2]. Sampling personnel should perform sampling in strict accordance with the testing standards, and the sampling records should be clear and complete, including the sampling location, date and time[3].

8. The QA/QC data evaluation and explanation

Laboratory Report QA/QC (Metals) *Table1*

Samples received 9:20am,18/6/19 cool on ice packs from Student Name, of EX Consultancy.

Sample matrix: soil

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Table1. QA/QC of Laboratory Report

Analyte	Method	PQL	(reagent) Blank	Lab duplicate 1	Lab duplicate 2	RPD	Recoveries		
		(Mg/kg)	(Mg/kg)	(Mg/kg)	(Mg/kg)	%	Blank spike (%)	Matrix spike (%)	Reference material (%)
As	NT2.49	0.5	<0.5	8.9	9.6	7	106	100	105
Cd	NT2.49	0.5	<0.5	0.63	0.69	9	106	99	103
Cr	NT2.49	0.5	<0.5	17	18	5	102	97	106
Cu	NT2.49	0.5	<0.5	34	34	0	106	105	110
Pb	NT2.49	0.5	<0.5	61	57	6	101	97	110
Hg	NT2.49	0.2	<0.2	<0.2	<0.2	0	99	101	93
Ni	NT2.49	0.5	<0.5	22	22	0	102	97	105
Zn	NT2.49	0.5	<0.5	130	130	0	107	116	121

QA/QC Legend:
PQL = practical quantitative limit.
Reagent blank should be below the PQL.
Acceptable relative percentage difference (RPD) on lab duplicates should be <44%.
Acceptable recoveries on blank, matrix and reference material spikes are in the range 75- 120%.
Refer to the QA/QC section of the NEPM B(2) schedule for further information.

Quality Assurance (QA) is a review of data that is systematically reviewed by non-participating data monitoring and reporting personnel. Quality Control (QC) involves routine systematic inspection activities that evaluate and maintain data to enhance the reported data quality. According to the laboratory report QA/QC metals, the reagent blank data results for the eight metals analytes were less than practical quantitative limit (PQL) criteria. Therefore, there is no secondary contamination during the sample being tested, which indicates that the experiment is highly reliable. In addition, the acceptable relative percentage difference (RPD) for laboratory replicates was less than 44%. This means that the test method has a certain degree of accuracy. Moreover, the acceptable recovery of blank, matrix and reference material peaks range are 75-120%. By analyzing all metal objects, the copper Zn reference material peaked at 121%, which was only 1% above the standard range. Thus, considering it may have some experimental error.

9. The analyze result in comparison with safe threshold levels

Table2. Analyte results

Your analyte results (in mk/kg):PQL=practical quantitative limit

Borehole number	PQL	BH1	BH1	BH1	BH2	BH2	BH2	BH3	BH3	BH3	BH4
Sample number	-	1	2	3	4	5	6	7	8	9	10
Depthe	-	0.3m	0.6m	0.9m	0.3m	0.6m	0.9m	0.3m	0.6m	0.9m	0.3m
Date		17/6/19									
Metals											
As	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cd	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cr	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cu	0.5	0.68	1.2	3.5	6	2.1	<0.5	<0.5	15	44	98
Pb	0.5	11	8	2.3	1.5	5	8	<0.5	45	7	<0.5
Hg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	32	<0.2	<0.2
Ni	0.5	<0.5	622	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zn	0.5	56	22	10	18	2.2	9	<0.5	1.8	9	105
BTEX											
Benzene	0.5	<0.5	<0.5	<0.5	2.1	1.2	<0.5	2.5	0.6	<0.5	<0.5
Toluene	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethyl Be	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TPH											
C6-9	10	<10	<10	<10	200	120	62	210	110	60	<10
C10-40	250	<250	<250	<250	2430	1850	260	2600	1950	270	<250

Analyte results continued：

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Borehole number	PQL	BH4	BH4	BH5	BH5	BH5	BH6	BH6	BH7	BH7	BH7
Sample number	-	11	12	13	14	15	16	17	18	19	20
Depthe	-	0.6m	0.9m	0.3m	0.6m	0.9m	0.3m	0.6m	0.3m	0.6m	0.6m
Date		17/6/19									
Metals											
As	0.5	<0.5	212	<0.5	<0.5	<0.5	<0.5	199	82	<0.5	<0.5
Cd	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cr	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cu	0.5	85	12	15	550	122	2168	320	65	206	58
Pb	0.5	<0.5	1.2	965	921	681	50	24	1.5	1.5	68
Hg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	35	<0.2	<0.2
Ni	0.5	645	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zn	0.5	122	549	189	56	12	<0.5	520	245	173	168
BTEX											
Benzene	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.5	<0.5	<0.5
Toluene	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethyl Be	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TPH											
C6-9	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C10-40	250	<250	<250	<250	<250	<250	<250	<250	<250	<250	<250

Based on the soil survey level (SIL) standard, and the leak point is planned as an open space. Therefore, the E column data should be used as the standard value for comparison *Table 2*. On the one hand, the copper (Cu) test results at a depth of 0.3m at a BH6 point of 2168 mg/kg, which exceeds the HILs standard of 168 mg/kg. At a depth of 0.6 m at the BH4 point, the detection of nickel (Ni) was 645 mg/kg, which was higher than the HIL standard of 45 mg/kg. At a depth of 0.6 m at the BH3 point, the detection of mercury (Hg) was 32 mg/kg, which was higher than the HIL standard of 2 mg/kg. At a depth of 0.9 m at the BH4 point, the detection result of arsenic (As) was 212 mg/kg, which was higher than the HIL standard of 12 mg/kg. On the other hand, in the BH5 point test, the lead (Pb) sample test results (965 mg/kg, 921 mg/kg and 681 mg/kg) in the depth range of 0.3 to 0.9 m far exceeded the HIL standard of 600 mg/kg.

10. Recommendation

The soil was contaminated by clumsy workers who knocked over the containers of petrol. Not only does it pose a hazard to the existing environment, but there are also some potential pollution problems. Therefore, some appropriate recommendations and remedial strategies have been proposed to alleviate these problems. According to Thomas and Tellam (2007), after the petrol spill, heavy metals in the petrol cause air pollution, soil pollution, and groundwater pollution[4]. What's more, it threatens human health, causes a series of diseases and even leads to death.

First, the soil is repaired using physical methods such as thermal desorption repair techniques. In reference to this, Bonnard et al. (2010) state that it heats the soil contaminated with organic matter above the boiling point of organic matter[5]. Separation occurs when the organic matter in the soil is volatilized into a gaseous state. Although this method is more efficient, it is costly. Second, the soil is repaired using chemical methods such as chemical leaching. Mulligan et al. (2001) believe that it uses a chemical solvent that promotes the dissolution or migration of contaminants, injects the eluent into the contaminated soil layer under gravity, and then extracts the solution containing the contaminants from the soil for separation and treatment[6]. This method has the advantages of long-lasting and easy operation, but its treatment depth is limited, and it is easy to bring secondary pollution. Third, the soil is repaired using biological methods such as phytoremediation. Mulligan et al. (2001) claim that it uses agricultural technology to restore and degrade pollutants directly or indirectly through the cultivation of preferred plants to restore the natural ecological environment and vegetation landscape[6]. This method is low in cost, does not change the nature of the soil, and has no secondary pollution, but it has the disadvantage of being time consuming.

In conclusion, appropriate restoration measures should be selected according to different geological characteristics and pollution conditions, with the aim of reducing the degree of pollution.

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11. Conclusions

Through the investigation of the background, history, landscape and geology, and the comparison of test results with safety threshold levels, we obtain the following three conclusions. First, as in sample 12, Pb in sample 13, Hg in sample 8, and Ni in sample 2 are slightly higher than the HILs standard value. Therefore, two reasons are considered. On the one hand, a small amount of petrol spreads to the surrounding sampling points. On the other hand, the site was likely to have heavy metal residues for manufacturing engineering laboratories 50 years ago. Second, the concentrations of benzene in samples 4, 5, 7 and 14 were detected at direct spill points (BH2 and BH3) higher than the standard values. Samples 4, 5 and 7 are located at the direct spill point (BH2 and BH3) and sample 14 is located on the west side of the direct spill point (BH5). Since the lawn is tilted about 5 degrees from east to west, it is considered that the pollutants gradually spread downward along with the slope. Third, for TPH contamination, the C6-10 and C10-40 concentration in the test samples 4, 5, 7, 8 at the spill points (BH2 and BH3) exceeded the HILs standard of 65 mg/kg and 1000 mg/kg. There was contamination at the spill site, but it did not penetrate into other locations. Although no significant contaminants were detected at the BH1, BH4, BH5, BH6 and BH7 points, the turf soil was less sticky and more permeable. Therefore, it is not excluded to produce infiltration pollution in the future. Some appropriate methods should be considered to mitigate spillage and prevent contamination in related areas.

References

[1] Chapman, G.A., and Murphy, C.L. (1989) Soil Landscapes of the Sydney 1:100,000 Sheet. Soil Conservation Service of NSW, Sydney.
[2] National Environment Protection Council (1999) Schedule B(1) Guideline on the Investigation Levels for Soil and Groundwater.
[3] National Environment Protection Council (1999) Schedule B(2) Guideline on Data Collection, Sample Design and Reporting.
[4] Thomas, A., & Tellam, J. (2007, January). Development of a GIS model for assessing groundwater pollution from small scale petrol spills. In Urban Groundwater, Meeting the Challenge: IAH Selected Papers on Hydrogeology 8 (p. 107). CRC Press.
[5] Bonnard, M., Devin, S., Leyval, C., Morel, J. L., & Vasseur, P. (2010). The influence of thermal desorption on genotoxicity of multipolluted soil. Ecotoxicology and environmental safety, 73(5), 955-960.
[6] Mulligan, C. N., Yong, R. N., & Gibbs, B. F. (2001). Remediation technologies for metal-contaminated soils and groundwater: an evaluation. Engineering geology, 60(1-4), 193-207.