Remediation Options Appraisal

At: Antrim Grove Allotments, Antrim Grove Belsize Park, London, NW3 4XR

For: London Borough of Camden

Report Reference: LP2248/ROA/Draft

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SCOPE OF WORKS

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EXECUTIVE SUMMARY

This report presents the procedures and findings of a remediation options appraisal, for an allotment site which is being considered by London Borough Camden. The subject site is Antrim Grove Allotments, Antrim Grove Belsize Park, London, NW3 4XR.

The site has a history of use as a nursery prior to becoming allotment gardens between c. 1920 and 1950. The decision was taken to investigate the site following work at another allotment site with the London Borough of Camden which identified elevated concentrations of lead and the presence of asbestos. A historical borough-wide background survey also indicated that elevated concentrations of heavy metals may be present at the site.

Following an intrusive site investigation and data analysis, it has been concluded that some plots within the allotment site may require some form of remediation as a result of risks posed by elevated concentrations of arsenic, lead and benzo[a]pyrene. Following careful assessment, the decision has been taken ***not*** to designate the site as contaminated land under Part 2A of the Environmental Protection Act of 1990 and a voluntary remediation approach is recommended.

The purpose of this Remediation Options Appraisal is to consider the viable options for remediation of selected plots and establish which (either separately or in combination) provides the best overall approach to remediation to ensure that the pollutant linkages which will likely form the basis of the determinations are no longer significant pollutant linkages. Budget costings for the remediation have also been presented, for the primary remediation options in order to assess the reasonableness of the decision to remediate. It should be noted that the report does not constitute a detailed design nor implementation strategy, nor have the remediation options been prepared to a detailed specification under a formal tender process (which will likely be required in due course), and as such the costs should be taken as estimated costs for the purposes of relative comparison and **not** final costings.

It should be noted that the areas included in this options appraisal include only the plot areas themselves since it has been concluded that these represent the most sensitive land use at the site. Testing across other parts of the site has not been undertaken.

In summary, the options appraisal has identified that feasible options are considered to be fairly limited, and three final strategies have been considered in detail, all of which would address the identified risks from arsenic, lead and benzo[a]pyrene, and which are:

- Option 1 – Excavation and offsite disposal of soils to a depth of at least 500mm across designated plots and reinstatement with clean subsoil and topsoil;
- Option 2A – Excavation and selective replacement of top 300mm of existing soils followed by partial level raise with imported certified clean cover soils to reduce residual concentrations in the top 300mm of the in-situ soils across designated plots;

- Option 2B – Construction of modular raised beds 500mm in depth in conjunction with the installation of a barrier below the internal paths at surface level across designated plots to prevent cultivation of crops outside of the raised beds.

Indicative costs estimates for the three options (including allowances for general set up costs – such as design and verification) are as follows:

- Option 1 - £460,000 exc VAT
- Option 2A - £106,000 exc VAT
- Option 2B - £145,000 exc VAT

Although Option 1 offers a solution with negligible future liability, it would have a significant detrimental impact on the local community (by way of increased soil movements and hence increased lorry movements) and would not prove to be a sustainable solution on account of the amount of soil needing to be disposed of into landfill. Furthermore, this is by far the most costly option. For these reasons, Option 1 is not recommended.

Option 2A has the benefit of no significant soil disposal (thus reducing vehicle movements by greater than 50% over Option 1 and by a slightly lower amount over Option 2B) but does require the excavation and direct handling of impacted soils. Perhaps the least desirable aspect is that plot holders would still be directly gardening impacted soils (albeit at reduced concentrations).

Option 2B has the benefit of no significant soil disposal (thus significantly reducing vehicle movements by greater than 50% over Option 1) and does not require the handling of impacted soils (as raised beds would simply be constructed over the impacted soils). The drawbacks to Option 2B are a reducing planting area (due to the requirement for paths between the raised beds) and that some future monitoring of the site would be required to ensure that future residents adhere to the growing restrictions.

Options 2A and 2B are considered to be fairly similar from a cost standpoint.

Option 2B is concluded to be the preferred solution. Consideration could be given to a combination of Options 2A and 2B subject to the nature and constraints on specific plots and the preferred solution of the plot holders.

A INTRODUCTION

Leap Environmental Ltd (hereafter referred to as LEAP) has been appointed by London Borough of Camden (hereafter referred to as LBC) to undertake a Remediation Options Appraisal (ROA) for a site referred to as Antrim Grove Allotments.

1 Background

Ongoing work at one of the council's other allotment sites has identified some elevated concentrations of lead and benzo[a]pyrene along with the presence of asbestos. This, coupled with evidence of elevated concentrations of heavy metals at the subject site (gleaned from a borough-wide survey undertaken by the council themselves in the early 2000s) led the council to decide to investigate two of their other allotment sites, one being Antrim Grove.

Previous Report

- Phase I Desk Study, Site Reconnaissance & Phase II Site Investigation Report: Antrim Grove Allotments, Antrim Grove Belsize Park, London, NW3 4XR. LEAP Environmental Ltd. Report Reference: LP2248, dated 28th July 2020.

2 Approach

The site has not been designated as contaminated land as defined by Part 2A of the Environmental Protection Act (1990). The proposed remediation is on a 'voluntary basis by the landowner (LB Camden). Nevertheless, given the nature of the site and that public funds will be utilised to execute the remediation, the decision has been taken to produce the ROA in broad accordance with Part 2A statutory guidance.

According to relevant statutory and technical guidance, a rigorous process of options appraisal must inform the selection of the preferred remedial option at a Part 2A site. This is because there is normally more than one available method for dealing with each "significant pollutant linkage" (SPL) and the options appraisal approach ensures that a balance is met between the following:

- Reasonableness in relation to costs and the seriousness of the risk; and
- Practicability, durability, effectiveness and environmental impact.

The overall approach may be regarded as a "sustainability appraisal" in that the right balance is struck between environmental, social and economic impacts. Implicit in the approach adopted in this report is that all of the remedial options reviewed in this manner are capable of rendering the SPLs no longer significant.

This Options Appraisal has been conducted having regard to the statutory guidance for Part 2A[1] and with reference to other current guidance on the assessment and remediation of land contamination, including that from the Environment Agency[2] ("Model Procedures"). The Model Procedures advise that assessors should specify a series of objectives at the outset of the options appraisal, objectives which will aim to ensure that the final remediation strategy achieves favour with most if not all of the people involved. Typical objectives under the model procedures include the: "degree of risk reduction; time; practicability, etc". It is noted that, at the time of writing, the model procedures are being revised and the conclusions reached herein may need to be revisited once the revised guidance is published. Where options for the remediation of contaminated land under Part 2A are being appraised, the health effects (including stress) experienced by owners / occupiers should be considered.

3 Objectives

The scope of this Options Appraisal study is based on the current guidance described above.

3.1 Information Sources

The following information sources have been used in completing this study:

- Information supplied by LBC;
- Data review, analysis and site investigation undertaken by LEAP Environmental Ltd;
- Published information on remedial technologies;
- Relevant national guidance;
- Budget costings based on data from Cognition Land and Water Ltd;
- Other information, as appropriate.

3.2 Report Structure and Limitations

The remainder of this report is structured as follows:

- Section B – presents a summary of the site characteristics and constraints;
- Section C – presents the remediation objectives;
- Section D–summarises the remediation criteria;

[1] Environmental Protection Act 1990, Contaminated Land Statutory Guidance, HM Government, April 2012.
[2] Model Procedures for the Management of Land Contamination. Environment Agency R&D Report CLR 11, 2004. (http://www.environment-agency.gov.uk/static/documents/model_procedures_881483.pdf).

- Section E – identifies and evaluates the feasible remediation options;
- Section F – considers costs and reasonableness;
- Section G – provides conclusions.

The reader's attention is drawn to the report's limitations, which are provided at the start of this document.

3.3 Site Description and History

The allotment site is located on Antrim Grove, Belsize Park, London, NW3 4XR as shown in Figure 1, Appendix B. The site comprises of c. 2,700m2 of allotment gardens.

The site comprised 20 No. regular, rectangular plots, 2 of which were full-sized and 18 of which were subdivided into half-sized plots. The site takes the appearance of a traditional walled garden and is largely flat apart from a c. 0.6m high retaining wall at the rear of the site where plots 1-6 are located. There was a communal seating area and tool shed in the central region of the site.

The site is bounded by housing to the east, southwest and northwest, by a playground to the southeast, by flats to the northeast and (according to online mapping) by a car rental company building to the north.

The site has a history of use as a nursery prior to becoming allotment gardens between c. 1920 and 1950. The allotments are located in a residential area and form 1 of 4 allotment sites in the LB of Camden which are run by allotment associations with the support of the council's parks team. The published bedrock geology comprises silty clays of the London Clay Formation. No superficial deposits are mapped. The site is not located within a groundwater source protection zone (SPZ). There are no surface water features on, or in close vicinity to the site.

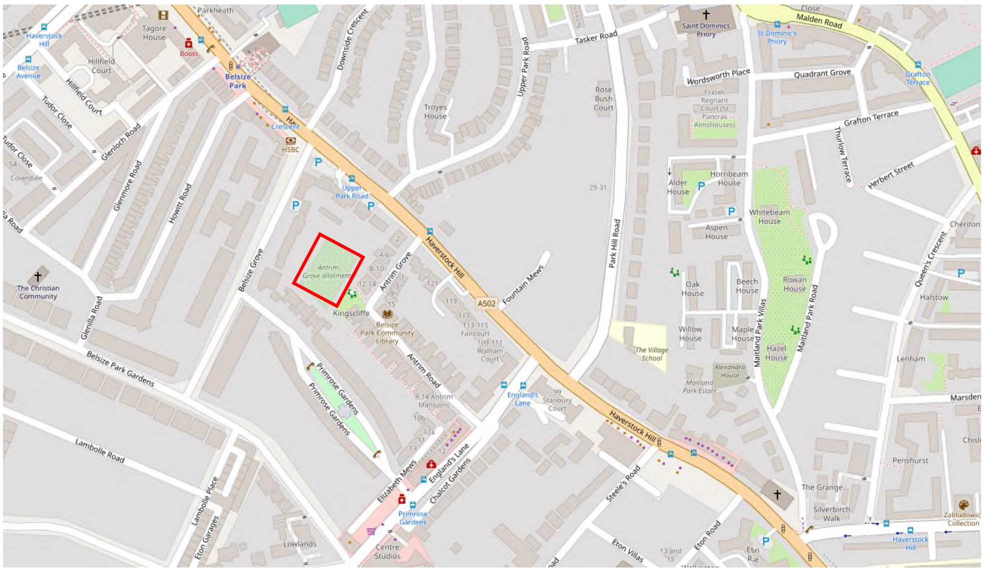


Plate 1 – Approximate extent of site considered by options appraisal

It should be noted that the areas included in this options appraisal includes the plot (gardened) areas of the site. No assessment has been undertaken across other areas of the site (i.e. below communal areas and/or footpaths).

B SITE CHARACTERISTICS AND CONSTRAINTS

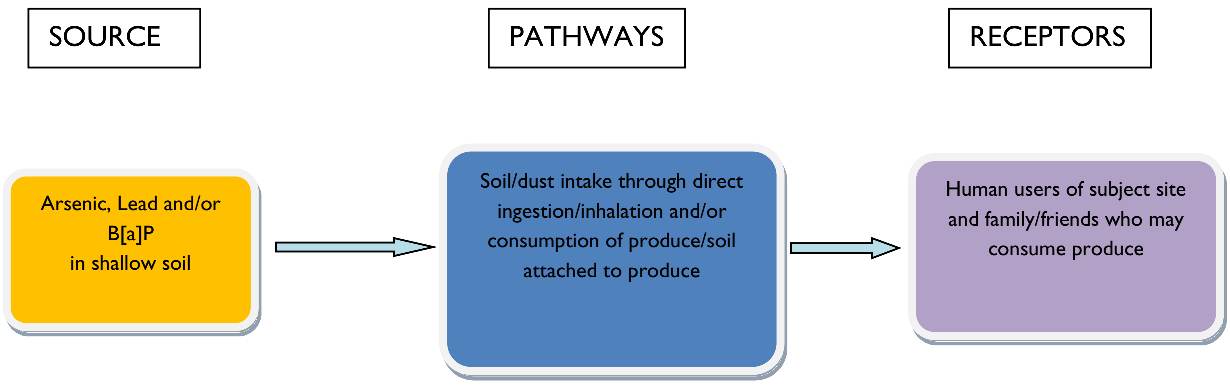
This section summarises the findings of the risk assessment undertaken, as well as the physical characteristics of the site in so far as they affect remediation activities.

4 Conclusions of Risk Assessment

A risk assessment has been carried out by LEAP in 2020. This report is referenced in Section 1.

The testing and statistical assessment indicated that the topsoil contained lead at an average concentration of nearly sixteen times above the GAC (80 mg/kg). GAC exceedances were also recorded for other metals and PAH compounds but these were subsequently discounted by statistical assessment on a ***site-wide*** basis. However, concentrations of arsenic, zinc and B[a]P in addition to lead were found to fail the statistical assessments on a ***plot-by-plot*** basis. Zinc was not identified as a driver for remediation as elevated concentrations tend to be associated more with phytotoxicity (impacts to plants) rather than to human health. During the SI, the engineers did not observe any evidence of phytotoxicity to plants during the site works. It is likely that only a small portion of the detected metal concentrations are bioavailable i.e. in a chemical form such that they can be absorbed into plant tissues. Asbestos was detected in just two of 160 samples and quantified at low levels. Asbestos is not therefore considered to be a contaminant of concern at the site.

The findings of the CSM can be summarised as follows:



The reader is referred to the individual risk assessments for further information in this respect.

As the site has not been designated as contaminated land as defined by Part 2A of the EPA 1990. This is primarily on the basis of the background concentrations for lead in the surrounding area. No final remedial criteria / site-specific assessment criteria (SSAC) have been defined for the site. Based on the findings at the Branch Hill site it has been concluded that a detailed quantitative risk assessment (DQRA) would be unlikely to significantly alter the assessment criteria and hence the conclusions of the risk assessment. For lead; an equivalent and directly relevant work has been carried out in the recent Newcastle allotment academic study of 2019, this work has been utilised rather than commissioning a separate study.

Thus, the ultimate decision on what constitutes an acceptable risk and hence the degree of voluntary remediation will be at the discretion of the council.

To aid in this decision, LEAP has scrutinised the data and produced the following summary (much of which is presented and discussed in the Phase II Site Investigation Report dated July 2020).

NOTE:

Due to sample size, statistical assessment was not possible for half-sized plots (where the sample size was four). At least six samples are required for statistical assessment. Half plots were therefore combined with the neighbouring plot i.e. plot 1A and 1B, 2A and 2B etc… to create a sample size of eight thus enabling analysis on a full-sized plot basis.

4.1 Lead

All 160 samples taken at the site exceeded the generic assessment criteria for lead (the Category 4 Screening Level) of 80 mg/kg.

Table 1: Analysis of lead concentrations vs. depth

	No. Samples	Mean [mg/kg]	Max [mg/kg]	U95 Norm* [mg/kg]
All samples	160	1,277	7,420	1,386
0.0-0.3m	95	1,192	3,550	1,300
0.31m +	65	1,401	7,420	1,621

*assuming a normal distribution

The table indicates that lead concentrations below 0.3m are, on average, higher than those in the top 0.3m. This could suggest a made ground / former subbase / foundation material source rather than simply lead deposition from the air.

Table 2 : Borough-wide background lead data

Survey	No. Samples	Mean [mg/kg]	Max [mg/kg]	U95 Norm* [mg/kg]
Open Space	55	436	1,500	504
Allotments w/o Antrim Grove Data	33	412	1,451	483

*assuming a normal distribution

These data suggest that lead concentrations at Antrim Grove allotments (mean 1,277 mg/kg and U95 confidence interval 1,386 mg/kg) are c. three times higher than the average allotment concentration across the borough and 2.8-2.9 times higher than the average public open space concentration. Targeting plots with an U95 confidence interval above the borough-wide open space or allotment average would result in 19/20 plots requiring remediation (all except Plot 7).

Table 3 : Plot by plot lead concentrations vs. borough wide allotment data*

No. times over borough-wide average*	No. Plots	Plot No.(s)
<1	1	7
1-2	3	10, 15, 18
2-3	6	4, 8, 11, 13, 14, 19
3-4	4	2, 16,17, 20
4-5	4	1, 3, 5, 12
5+	2	6, 9

*data excluding Antrim Grove (refer to Table 2)

Alternatively, the decision could be made by assessing the lead concentrations on individual plots against the SSAC range as defined in the Newcastle allotment study of 2019. The study concluded a range of between 722-1,634 mg/kg. A conservative assessment taking the lower end of the range indicates that eighteen of the twenty plots exceed the lower end of the Newcastle allotment study-derived SSAC (722 mg/kg – all except Plot #s 7 and 15). Adopting the lower end of the range is deemed prudent as the specified range was calculated for adults only (planned work to incorporate child receptors into the assessment would likely result in a reduction to the SSAC). However, the council may want to consider a less conservative approach i.e. consider the suitability of adopting the mid-point of the specified SSAC range (1,178 mg/kg). If this were to be done then the U95% CI of thirteen of the twenty plots would exceed the mid-point of the derived SSAC range (Plots #s 1-6, 8, 9, 12, 13, 16, 17 and 20).

4.2 Arsenic

Forty-six of 160 samples taken at the site exceeded the generic assessment criteria (the Category 4 Screening Level) of 49 mg/kg. Twenty-four of these were in the top 0.3m whilst Twenty-two were from samples taken from below 0.3m. The site-wide data indicated that arsenic concentrations were slightly higher in the lower 0.3m than the top 0.3m (48 mg/kg (53) vs. 41 mg/kg (44) – U95% CIs in brackets). The BGS estimated urban soil chemistry data for arsenic was not elevated above the GAC at 19 mg/kg. The average borough-wide allotment arsenic concentration (excluding samples from Antrim Grove) was also not elevated above the GAC (mean: 22.45 mg/kg, U95% CI: 26 mg/kg, n=33). Eight plots failed the statistical assessment (#s 3, 5, 6, 9, 11,12, 14 and 17).

4.3 Benzo[a]pyrene

Twenty-seven of 160 samples taken at the site exceeded the generic assessment criteria (the Category 4 Screening Level) of 5.7 mg/kg. Eleven of these were in the top 0.3m whilst sixteen were from samples taken from below 0.3m. Conversely, the site-wide data indicated that B[a]P concentrations were slightly higher in the top 0.3m (4.7 mg/kg (6.5) vs. 4.3 mg/kg (5.2) – U95% CIs in brackets). There is no borough-wide allotment data or BGS background data for B[a]P. Six plots failed the statistical assessment (#s 9, 12, 14, 17, 19 and 20).

4.4 Other exceedances (plot-by-plot assessment)

Eight plots failed the statistical assessment for zinc (#s 2, 5, 6, 8, 9, 12, 17 and 20). Plot 17 failed the assessment for copper and Plot 9 for phenanthrene but these two occurrences were influenced by one high result. The zinc failures are not considered a driver for remediation for the reason stated previously. It is noteworthy however, that the remedial solutions presented in this report would be just as effective for copper, zinc and phenanthrene as for the contaminants identified as the main drivers for remediation.

4.5 Summary

Table 4: Summary of CoC concentrations to assist in the remediation decision making process

Plot	Lead						B[a]P	Arsenic
	U95% C.I. Exceeds that of borough-wide dataset	U95% C.I. Exceeds that of borough-wide dataset by at least 2-3 times	U95% C.I. Exceeds that of borough-wide dataset by at least 3-4 times	U95% C.I. Exceeds that of borough-wide dataset by 5+ times	U95% C.I. Exceeds lower end of the Newcastle study-derived SSAC range	U95% C.I. Exceeds mid-point of Newcastle study-derived SSAC range	U95% C.I. Exceeds GAC	U95% C.I. Exceeds GAC
1	✓	✓	✓		✓	✓		
2	✓	✓	✓		✓	✓		
3	✓	✓	✓		✓	✓		✓
4	✓	✓			✓	✓		
5	✓	✓	✓		✓	✓		✓
6	✓	✓	✓	✓	✓	✓		✓
7								
8	✓	✓			✓	✓		
9	✓	✓	✓	✓	✓	✓	✓	✓
10	✓				✓			
11	✓	✓			✓			✓
12	✓	✓	✓		✓	✓	✓	✓
13	✓	✓			✓	✓		
14	✓	✓			✓		✓	✓
15	✓							
16	✓	✓	✓		✓	✓		
17	✓	✓	✓		✓	✓	✓	✓

Plot	Lead						B[a]P	Arsenic
	U95% C.I. Exceeds that of borough-wide dataset	U95% C.I. Exceeds that of borough-wide dataset by at least 2-3 times	U95% C.I. Exceeds that of borough-wide dataset by at least 3-4 times	U95% C.I. Exceeds that of borough-wide dataset by 5+ times	U95% C.I. Exceeds lower end of the Newcastle study-derived SSAC range	U95% C.I. Exceeds mid-point of Newcastle study-derived SSAC range	U95% C.I. Exceeds GAC	U95% C.I. Exceeds GAC
18	✓				✓			
19	✓	✓			✓		✓	
20	✓	✓	✓		✓	✓	✓	
Total	19	16	10	2	18	13	6	8

The summary does indicate that some plots appear to be more affected than others namely #s 6, 9, 12, 17 and 20. With the exception of Plot 6, these plots are on the eastern side of the site which the historical mapping indicates is where the majority of the former nursery buildings were once sited.

5 Site Constraints

The most notable site constraints relating to remediation are:

- Limited access for plant that is available at the subject site;
- Restrictions on vehicle movements in the vicinity of the site;
- Proximity to houses and the children's playground; and
- The number of different stakeholders involved.

The site is accessed via a relatively narrow footpath to the northeast of the playground on Antrim Grove. There are gates at both the road and allotment ends of the path. The path is not sufficiently wide to drive a vehicle but very small plant (such as a 1.5T rubber tracked excavator) may be able to access the site. However, all paths across the site itself are generally grassed, fairly narrow and there is only stepped access to Plots 1-6 beyond the c. 0.6m high retaining wall at the rear of the site.

Antrim Grove and Antrim Road are residential streets with resident only, permitted parking on both sides of the roads. Parking of any vehicles, welfare facilities or skips would require careful consideration so as not to cause visual impairment and traffic congestion along the streets.

The playground will likely require closure for the safety of children during the works. Noise may prove to be a consideration (should mechanical plant be utilised) given the proximity of houses and this may restrict / dictate working hours.

Allotments are a major part of the site users' lives and a programme of remediation is likely to cause site users considerable distress (many plot holders having waited for or gardened their plots for decades). The process could be met with considerable opposition (primarily as site users will fear losing their plot and the work/time put into them over the years). Any remedial solution is likely to need to be tailored to each individual plot with considerable liaison with the respective plot holders. The council may decide to consult their legal team in advance to gauge an approach should any plot holders refuse to comply. It is noteworthy however, that plot holders at Antrim Grove have been found by LEAP to be generally supportive of the soil sampling works.

C REMEDIATION OBJECTIVES

6 Risk Mitigation

The aim of remediation is to ensure that the land no longer presents an unacceptable risk to the site users. For this site, this means ensuring that the risks from lead, benzo-a-pyrene and/or asbestos are reduced to a level that the pollutant linkages are no longer "unacceptable".

Contaminated land remediation generally falls into one or more of the following categories:

- **Source Treatment**
  - i.e. decrease contaminant mass, concentration, mobility and/or toxicity
- **Pathway Interception**
  - i.e. remove or modify the pathway between contaminant and receptor
- **Receptor Modification**
  - i.e. remove or modify the behaviour of the receptor

The "ideal" scenario would be to treat or remove the contamination and reinstate the allotments to such a degree that residents are able to undertake the full range of normal activities that might be expected at an allotment garden without impunity.

However, the contaminated land regime requires the identification of the best practicable option, which includes an evaluation of the extent that remediation is "reasonable"[3], and this in turn requires a formal assessment of the costs and benefits. This is especially applicable when utilising public funds to pay for the remediation.

Furthermore, The Model Procedures (CLR 11) state that:

> *".....cost benefit assessment is an inherent part of sustainable environmental management and a requirement of .... regulatory regimes"*

7 Technical Constraints

Some of the major constraints have been briefly introduced in Section 5. It is a possibility that at least some of the remedial works will need to be undertaken without the assistance of mechanical plant.

[3] Environmental Protection Act 1990, Contaminated Land Statutory Guidance, HM Government, April 2012 – Section 6(d).

There will be limited scope to increase the levels of the plots without installing long-lasting edging (timber below ground level will not be suitable) and stepped access. Decisions will need to be taken regarding how soil around trees, perennial plants (such as soft fruit canes and bushes), below more permanent paths and below any buildings* is dealt with.

* the vast majority of plots do not contain buildings (Plot 20 being an exception).

With regard to remediation technologies it is noted that although one of the contaminants of concern (B[a]P) is an organic compound, the widely available methods for destructively dealing with organic contamination, for example bioremediation, tend to be less effective with more complex hydrocarbon compounds (such as benzo-a-pyrene), particularly when it is highly sorbed to soil and at generally low concentrations (<1%).

On the contrary to the constraints; the works will be undertaken in an outdoor location with low numbers of people present. Hence, in some ways, the process may prove to be more straight forward than a comparable task of remediating private rear gardens. Environmental monitoring should not be required and dust can easily be suppressed by scheduling the works for the wetter months and/or dampening down soils and covering waste awaiting removal.

Subject to the council's consideration (and discussion with adjacent homeowners), the open space within the playground area could potentially be used for storage and/or welfare facilities during the remedial works. This would require the temporary closure of the playground (estimated duration 6-12 weeks) and potentially, the temporary removal of some of the railings. Welfare could potentially be lifted into the playground (over the retaining wall and railings) from the road using a lorry-mounted HiAB crane.

The consideration of feasible schemes is discussed further in Section E.

8 Sustainability

Paragraphs 6.33 to 6.36 of the statutory guidance relate to the adverse environmental impacts that a remedial scheme may create, and which are taken into account as part of the practicability assessment of a remedial scheme.

Sustainable remediation is defined by the UK Sustainable Remediation Forum (SuRF UK)[4] as:

> *"The practice of demonstrating in terms of environmental, social, and economic indicators, that an acceptable balance exists between the effects of undertaking remediation activities and the benefits that those activities will deliver."*

The key principles of sustainable remediation are quoted by SuRF UK as:

[4] A Framework for Assessing the Sustainability of Soil and Groundwater Remediation – FINAL March 2010. SuRF UK, and CL:AIRE

- Protection of human health and the environment;
- Safe Working practices;
- Consistent clear evidence-based decision making;
- Record keeping and transparent reporting;
- Good governance and stakeholder involvement;
- Sound science.

The sustainability indicators for remediation are divided into three main categories; Environmental, Social, and Economic. Qualitative or quantitative approaches may be used in sustainability assessments, although the SuRF UK framework notes that:

> *"..quantitative approaches are limited to particular aspects of sustainability.."*

9 Appraisal Methodology

The remedial options are appraised in Section E of this report. In line with the statutory guidance, a quantitative appraisal has been made of the viable options on a site wide basis, with the two "best" approaches from that appraisal taken forward for an assessment of costs and benefits.

Ultimately, detailed consideration of the most appropriate scheme, together with the respective costs and benefits should be made on a plot specific basis in order to ensure that the most appropriate scheme is adopted in each case.

D REMEDIATION CRITERIA

10 Assessment Criteria

The following contaminants in soil are understood to be of potential concern, and are expected to form the basis of the determinations:

- Arsenic;
- Lead;
- Benzo[a]pyrene;

At the time of writing no final decision has been made with regard to the remediation criteria and hence specifically which plots may be remediated. As such, considerations and cost comparisons have been made on a site wide basis at this stage.

10.1 Verification and Monitoring

It will be necessary to verify the satisfactory completion of any remediation and produce a suitable completion report to demonstrate this.

It is envisaged that in the case of a source treatment remedial scheme (for example removal of contaminated soil) sufficient verification testing would be undertaken to demonstrate with a stated degree of confidence that the residual contamination does not exceed the remediation criteria.

In the case of a pathway interception scheme (for example placement of clean cover soils), verification may simply be a case of demonstrating the required thickness or specification of clean cover has been imported, and, as above, demonstrating that the imported soils are suitable for use. In the case of a pathway interception scheme that could be able to be modified relatively easily (for example a geotextile liner below internal paths for example), there is an inherent need for ongoing monitoring and maintenance to confirm that the remediation remains viable.

In either case, it would also be necessary to verify any soils imported to site to ensure that they are of an appropriate standard. The assessment criteria for these soils would be expected to be different to those for the soils remaining at depth (based on assessment criteria indicative of minimal risk – such as soil guideline values), and would for example need to include performance criteria (such as topsoil quality testing in accordance with BS 3882 for instance). Given the allotment setting, these soils may also need to be augmented to improve soil structure and nutritional value (e.g. addition of manure). Furthermore, the need to 'top up' levels following settling of materials may merit consideration.

A detailed specification for verification testing and reporting is outside of the brief for this report but will need to be produced as part of the detailed specification for remedial works. It is noted, however, that budget costs for this element of the project have been included in the costs assessments outlined in Section F.

E REMEDIATION OPTIONS

11 Introduction

This section details the various remediation options that are considered to be feasible for the site. In each case, a quantitative assessment of the Practicability, Effectiveness, Durability and Environmental Impact of the feasible options has been included in the evaluation.

Only source treatment and pathway interception options have been considered in this report as it is not anticipated that modifying receptor behavior* is appropriate as a long term solution (although this will be applicable in the interim, whist the site awaits remediation).

*for example; advising residents via a formal communication to thoroughly wash and peel root vegetables prior to consumption.

12 Source Treatment Methods

The primary **soil** source treatment methods that are widely available in the UK are as follows:

- Contaminant Destruction – for example:
  - Bioremediation (e.g. using natural or implanted bacteria to degrade organic contaminants);
  - Chemical Oxidation (e.g. using chemicals such as Fenton's reagent[5] to oxidise organic contaminants);
  - Thermal Desorption (heating of soils - to very high temperatures - to remove organic contaminants);
- Containment / Stabilisation – for example:
  - Soil mixing (e.g. using e-clays, or pozzolanic materials to bind contaminants and reduce leachability and bio-accessibility);
- Engineering/physical methods – for example:
  - Excavation and off-site disposal at a suitably licensed facility;
  - Soil Washing (e.g. chemical and mechanical segregation to separate contaminated and uncontaminated soil particles).

[5] A solution of hydrogen peroxide and an iron catalyst

12.1 Initial Considerations

In the case of the subject site, the identified significant pollutant linkages relate to contamination by arsenic, lead and benzo[a]pyrene. In this respect, arsenic and lead cannot be chemically destroyed and as discussed previously, no reliable contaminant destruction methods currently exist for the generally low levels of benzo[a]pyrene encountered in the shallow soils.

Although certain soil mixing techniques can affect contaminant bio-accessibility, there has not been any large-scale uptake of this technique to deal with human health protection (it being more commonplace in groundwater protection schemes). Furthermore, changing the structure and workability of the soil would be completely unsuitable for soils in an allotment setting.

Soil Washing has been demonstrated on various large-scale schemes (most notably the Olympics regeneration project) to be an effective technique for contamination remediation. Soil washing essentially involves segregating the fines particles (where the majority of the contamination typically resides) from larger particles and re-using the cleaner, larger particles on site, thus reducing the volume of material requiring off-site disposal. However, soil washing equipment is typically very large, disruptive, and costly to establish, and therefore would not be suitable for the subject site. It may still be possible to be used as an off-site technique to separate excavated soils into different waste streams (allowing the most cost effective disposal routes to be adopted) and as such, this process effectively becomes just a sideline consideration to an excavation and off-site disposal option.

12.2 Option 1 – Full Excavation and Disposal

Despite the increasing consideration of sustainability issues and the rising costs of land-filling, this remains a common remediation technique employed in the UK. It is a well understood technique and *can* be implemented by a wide range of contractors (both specialist and non-specialist).

It is not necessarily a "low-tech" solution, and the method of its implementation at the subject site would be critical to its success or failure.

It is evident from the results of the previous risk assessment that the B[a]P concentrations are slightly higher in the top 300mm than at greater depth whereas the reverse is indicated for arsenic and lead. However, the remediation will be driven to a greater extent by the practical requirements of gardening an allotment i.e. a certain minimum depth of soil is required in order to grow root vegetables such as potatoes effectively.

The decision on the required depth will be critical as even a small reduction in the necessary remediation depth will offer substantial cost savings. However, this cannot compromise the suitability of the site for its intended use.

Based on the considerable experience gleaned by LEAP during the recent investigation of three of LBC's allotment sites, it is concluded that most plot holders will garden their soil down to a depth of one spade depth (c. 300mm) with this increasing to c. 400mm for the best kept plots (greater depths were encountered in rare instances). Clearly 300mm would be insufficient to allow root vegetables such as potatoes to develop properly. Hence, a minimum depth of 450-500mm is suggested as being necessary. This could be achieved in one of two ways: removal and disposal of soils down to 0.45-0.5m below existing levels and re-instate with imported soils to match previous levels. Alternatively, removal of a portion of the soils (reducing offsite disposal with associated cost and sustainability advantages) and re-instatement to above previous levels i.e. reduce to 0.2m if a final level of 0.3m above previous levels could be accommodated.

As the identity of the plots to be remediated is currently unknown, further assessment has been made assuming that all plots require remediation.

The vast majority of the soil would be anticipated to be classified as hazardous waste. [An average concentration of lead in the region of 1,000 mg/kg would be required to be indicative of a hazardous classification]. The extensive dataset has indicated a mean concentration of 1,277 mg/kg and an U95 confidence interval of 1,386 mg/kg. No other determinants are indicated to be present at concentrations which would result in a hazardous waste classification. This will have significant cost implications for offsite disposal.

12.2.1 Waste Regulations

One important consideration with off-site disposal is the 2007 requirement to pre-treat all wastes prior to land-filling. Pre-treatment is defined by using the following 'three-point test'. All three criteria must be satisfied for all of the waste to have been treated:

1. It must be a physical, thermal, chemical or biological process including sorting.
2. It must change the characteristics of the waste.
3. It must do so in order to:
    - (a) reduce its volume; or
    - (b) reduce its hazardous nature; or
    - (c) facilitate its handling; or
    - (d) enhance recovery.

Criteria (c) and (d) of the above list tend to apply to process wastes rather than contaminated soils as such. Ultimately, the reduction of material going to landfill is the objective of these requirements. With regard to a typical excavation and disposal project, it is therefore necessary to demonstrate that at least some of the excavated material has been retained on site. In practice this may prove very difficult in this instance (although there will inevitably be green waste to segregate and dispose of). It should be noted in this respect that there are no specific volume targets for the amount of reduction to comply with the regulations. In other words, re-using one cubic metre of soil out of several thousand destined for landfill would comply with the regulations (although not in the spirit that was intended).

In addition, to the above considerations, it should be noted that soils disposed of as part of remediation by excavation and disposal are subject to landfill tax. At the time of writing, the effective tax rates are £94.15 per tonne for active wastes (such as hazardous and non-hazardous soils), and £3.00 per tonne for inactive (or inert) wastes. Topsoil cannot be classified as inert on account of its elevated organic content and hence almost all* material sent offsite for disposal to landfill would attract the higher rate of landfill tax.

*inert materials such as any brick, concrete etc… may be able to be separated out and disposed of as inert waste at the lower rate of landfill tax.

Soils classified as either inert or hazardous waste are required to be tested for Waste Acceptance Criteria (WAC) prior to disposal in order to confirm their waste classification and an appropriate destination landfill.

12.2.2 Practical and Technical Considerations for Excavation and Disposal

The bulk removal of soils from the allotment plots under consideration will require access across the site via the network of paths. Some plots may be accessible with a small mechanical excavator but others (especially Plots 1-6) will likely need to be remediated by hand (hand tools and wheelbarrows). A dump truck irrespective of how small is not considered appropriate as numerous journeys along the soft, narrow paths will result in damage.

Soils would need to be transported to a skip positioned on the road or within the open space within the playground area (the former would require a council permit). A low sided 'Roll On, Roll Off' (RORO) skip is considered the best option on the roadside as the larger capacity and ease of internal access would ease loading and minimise vehicle movements along with associated H&S and Environmental concerns. Alternatively, removal via grab lorry may be the best option should the playground area be utilised. This process would then need to be largely undertaken again but in reverse for the application of imported, certified clean subsoil and topsoil.

As with the clean cover systems (discussed in the next section) decisions would have to be made regarding what (if anything) would be allowed to remain, how plot holders will be compensated for plants lost and how much soil augmentation and replanting the council foresees itself carrying out. There is also the question of how/where removable items destined to be returned to the plot would be stored during the remediation. Again, there may be the option of utilising the playground area.

12.2.3 Sustainability Considerations for Excavation and Disposal (Adverse Environmental Impacts)

Excavation and disposal remediation does not typically score well in sustainability considerations. The generation of wastes and disposal at landfill has obvious detrimental environmental implications. In addition, there is the environmental impact of the bulk transport of soils requiring export and importation to site. This activity has significant negative social and economic impacts as well. The physical activity of removing large volumes of soil from an allotment site with limited access in a residential area on streets with extensive resident parking will have a negative impact on the community as a whole and if not carried out correctly, could present detrimental health and safety risks. In the worst case, these may exceed the detrimental health effects of using the allotment in its current state.

On the positive side, a large-scale excavation scheme would entirely remove unacceptable risks and as such has social and economic benefits for the affected plots and their respective plot holders. This technique would also provide certainty of safe future use of the site as the 'source' has been permanently removed and no long-term monitoring would be required.

13 Pathway Interception Methods

The primary **soil** pathway interception treatment methods that are widely available in the UK are as follows:

- Containment– for example:
  - Passive or active barrier systems (e.g. passive - using bentonite slurry walls to contain contaminants);
- Provision of Clean Cover – for example:
  - Importation of sufficient thickness of uncontaminated soils to limit exposure to contaminated soils at depth;
- Encapsulation – for example:
  - Encapsulating contaminated soils in concrete.

13.1 Initial Considerations

In the case of the subject site, the identified pollutant linkages relate to arsenic, lead and benzo[a]pyrene. In this respect, a containment system as described above would not be appropriate (these being more typically employed for groundwater remediation projects). The allotment plots would offer limited potential for raising levels significantly (some raising of levels by installing perimeter edging and stepped access may be feasible). In order to provide an effective barrier to the elevated levels of contamination present at the site whilst still maintaining functionality, it is envisaged that a minimum cover system of 450-500mm thickness would be required with an additional deter-to-dig geotextile membrane at the base. An encapsulation system is considered unsuitable for the subject site as the soils need to remain accessible and useable for the purposes of growing edible plants. Furthermore, the encapsulation of the underlying soils (for example with a layer of concrete) would adversely affect drainage of the overlying soils.

13.2 Clean Cover Systems

13.2.1 Option 2A – Partial Level Raise

This option would comprise excavating and selectively replacing the top 300mm of existing soils and raising levels with imported certified clean cover soils by 300mm on top of the replaced existing soils thusly reducing the average concentrations of lead, B[a]P and asbestos that plot holders are exposed to in the soil, but acknowledging that mixing will occur with the underlying contaminated soils over time. This option could be undertaken in conjunction with the installation of a deter-to-dig geotextile membrane beneath the base of the excavated soils, perimeter edging and stepped access to accommodate the land raise as / where required.

13.2.2 Option 2B – Construction of Full Raised Beds

This option would comprise applying a deter-to-dig geotextile membrane over the surface the entire plot and the erection of 500mm deep, modular raised beds with associated c. 0.5m wide access paths (the geotextile being covered with chipped bark, pea shingle or an equivalent). Many allotment plots already adopt such a layout. Raised beds have the advantage of easy accessibility and good drainage but the disadvantage that the overall 'plantable area' across the plot is inevitably smaller. The higher materials costs (to construct the raised beds) would be counteracted with a smaller plan area of imported certified clean cover soil being required to fill the raised beds compared to Options 1 and 2A. This option could potentially be delivered by a landscaping contractor (with QA/QC and validation undertaken by an environmental consultant) without the need for a specialist remediation contractor. However, the anticipated presence of heavy metal and PAH contamination at the formation level may mean that a specialist remains the more suitable option.

13.2.3 Practical and Technical Considerations for a Clean Cover System

The access requirements for a clean cover system would be similar to that for an excavation and disposal system but with the notable advantage that soils will not require removal and offsite disposal (some green waste will require offsite disposal). Similarly, access to the local area would also be required for haulage vehicles but only to import soils thus, the overall soil volumes and hence lorry movements, would be expected to be much reduced compared to the complete excavation option.

13.2.4 Sustainability Considerations for a Clean Cover System

The clean cover system approaches would be favourable to a scheme based on complete excavation from a sustainability point of view. With regard to environmental considerations, the reduced generation of wastes and disposal at landfill has significant positive environmental implications, as does the reduced transport of soils requiring export and importation to site (all green waste could be recycled). This means it is beneficial socially and economically over a full excavation solution. As detailed in the previous section, the physical activity of removing soil from allotments with limited access will have a negative impact on the community as a whole and could present detrimental health and safety risks if not carried out properly. A fully clean cover system potentially offers distinct advantages compared to a complete or partial excavation system in this regard.

Although a clean cover scheme could be designed so as to provide certainty of safe future use of the site, it would not remove the source of contamination, and as such does not have the same long term social and economic benefits as an excavation system. In particular, it would be susceptible to future residents changing the use of their allotments - particularly in the case of the raised beds – Option 2B and would therefore require careful control measures (likely to take the form of routine monitoring) and documentation to mitigate against future risks. In this regard, wider stakeholder involvement is critical to the success of such a scheme (the allotment association could police this). Alternatively, the internal access paths in Option 2B could be laid out to concrete providing a physical barrier to planting in these areas where contaminated underlying soils would remain (although this may have negative implications with respect to drainage).

14 Quantitative Options Appraisal

As previously discussed, and in accordance with the statutory guidance, a quantitative assessment of the Practicability, Effectiveness, Durability and Environmental Impacts of the feasible options has been carried out and is summarised below. The marks overall are out of 100, with an even share between the three main categories to consider as above. The relevant paragraph of the statutory guidance is also referenced where applicable. It should be noted that any such assessment is inherently subjective and LBC may wish to make its own assessments of the options considered herein.

In this instance, the appraisal has been used to shortlist the two preferred options, which have then been assessed for reasonableness and cost.

		OPTION 1 Complete Excavation	OPTION 2A Partial Cover System	OPTION 2B Raised Beds	Notes
PRACTICABILITY					
Technical Constraints (7pts)	i) Available ii) Conflict	4 3	4 3	4 3	Reference Para 6.24 (i) *Considers whether remediation option is widely available in marketplace and appropriate to proposed use (for example is there any potential conflict between the contaminants to be treated)*
Site Constraints (6pts)	i) Location / Access ii) Pollutant Types	1 3	2 3	3 3	Reference Para 6.24 (ii) *Considers access to the individual allotments and the area generally, and to the contaminated soils themselves.*
Time (6pts)	i) Permits ii) Consent iii) Procurement	1 1 1	1 1 2	2 2 2	Reference Para 6.24 (iii) *Considers the* ***time*** *required to obtain the necessary permits to carry out the work, and to obtain agreement from residents, and to procure the services of an appropriate contractor.*
Regulatory (6pts)	i) Safety & Permits	2	4	6	Reference Para 6.24 (iv) *Considers the* ***complexity*** *of obtaining the necessary permits (e.g. waste permitting), and approvals and being able generally to carry the work out safely.*

	OPTION 1 Complete Excavation	OPTION 2A Blending of Soils	OPTION 2B Raised Beds	Notes
EFFECTIVENESS				
Objectives (25pts)	25	20	25	Reference Para 6.27 *Considers whether remediation option is able to achieve the objectives of the remediation, and the time required to achieve those objectives.*
DURABILITY				
Overall Timeframe (8pts)	8	7	6	Reference Para 6.25-6.26 *Considers the **longevity** of the remediation option, and the allowance for future monitoring and maintenance.*
Maintenance & Repair (8pts)	8	6	4	
Monitoring Requirement (7pts)	7	5	3	
HEALTH & ENVIRONMENTAL IMPACTS				
Potential Health Impacts of Remediation (15pts)	5	10	15	Reference Para 6.34 *Considers the direct and indirect (e.g. stress) health effects to local residents*
Potential Environmental Impacts of Remediation (10pts)	5	10	10	Reference Para 6.35 *Considers the potential damage to local environment (e.g. soil, water, air and animals), and nuisance risks.*
TOTAL	**76**	**78**	**88**	**MARKS OUT OF 100**

F REASONABLENESS AND COST

15 Budget Costs for Complete Excavation and Disposal (Option 1)

For the purposes of this options appraisal, a specialist contractor has been asked to provide budget rates for the two favoured remediation options (the modified clean cover systems – Options 2a and 2B). LEAP has utilised the rates provided by the contractor to provide an approximate rate for a complete excavation and disposal scheme (Option 1) for comparison. This has been calculated on the basis of the above concepts and considerations. It should be noted that the costs, are indicative only since they have not been based on a detailed design and specification and have not been obtained as part of a formal tender process. In particular the volumes used in the calculations are provisional and would be subject to detailed re-measurement in the final account.

The cost for excavation and disposal would therefore be approximately as follows:

- £400,000-450,000 exc VAT

The range stated is fairly wide due to uncertainties relating to the classification of the large volumes of soil requiring offsite disposal and the programme duration.

LEAP estimates that the project duration would be c. 10-12 weeks in total. This cost is based on remediation of **all** plots across the site and hence costs would be reduced if only a portion of plots are selected for remediation. However, it is important to note that many line items (such as project set-up costs) would be required irrespective of the number of plots scheduled for remediation.

All areas outside of the plots including the communal paths are excluded from the scope. Some form of partial repair and/or reinstatement may prove necessary if small plant were to be utilised to assist with the works. Augmenting imported soils with compost/manure has not been allowed for. Neither has reinstatement of any structures nor replanting any plants which may have been removed prior to the remedial works.

Additionally, there would be some Environmental Consultancy costs associated with the verification and reporting process. Budget sums for these services are usually considered in the 8-10% of remedial costs range.

The total project price for this option (including consultancy fees at 8%) is therefore estimated at approximately £460,000 exc VAT.

16 Budget Costs for Clean Cover Systems (Options 2A and 2B)

For the purposes of this options appraisal, a specialist contractor has been asked to provide budget rates for the two variations of clean cover systems.

For both options, the contractor has calculated a remediation area of c. 2,185m^2 for the 20 plots. **The client should be aware that the quoted volumes (and hence total costs) may rise once the true area of the plots is known** (a topographical survey will be required to determine this which will need to be included in the tender information for the formal tender process). In addition to the budget estimates set out below, the contractor has also priced Options 2A and 2B assuming that plant cannot access the site (i.e. that all excavation, importation and placement is carried out by hand). In both cases this results in a 50-60% uplift on the estimates set out below. These uplifted costs have not been used in the costs comparisons below. It will be essential to confirm access for plant as part of any detailed specification and costing exercise as the implications are significant.

16.1 Option 2A – Partial Clean Cover

As for the complete excavation option, it should be noted that the costs are indicative only, since they have not been based on a detailed design and specification and have not been obtained as part of a formal tender process. In particular the volumes used in the calculations are provisional and would be subject to detailed re-measurement in the final account. The contractor's budget estimated cost for Option 2A is approximately as follows:

- **£98,000 exc VAT**

The contractor estimates that the project duration would be 9 weeks in total. This cost is based on remediation of **all** plots across the site and hence costs will be reduced if only a portion of plots are selected for remediation. However, it is important to note that many line items (such as project set-up costs) would be required irrespective of the number of plots scheduled for remediation.

All areas outside of the plots including the communal paths are excluded from the scope. Some form of partial repair and/or reinstatement may prove necessary if small plant were to be utilised to assist with the works. Augmenting imported soils with compost/manure has not been allowed for. Neither has reinstatement of any structures nor replanting any plants which may have been removed prior to the remedial works.

Additionally, there would be some Environmental Consultancy costs associated with the verification and reporting process. Budget sums for these services are usually considered in the 8-10% of remedial costs range.

The total project price for this option (including consultancy fees at 8%) is therefore estimated at approximately £106,000 exc VAT.

16.2 Option 2B – Construction of raised beds

As for the complete excavation option, it should be noted that the costs are indicative only, since they have not been based on a detailed design and specification and have not been obtained as part of a formal tender process. In particular the volumes used in the calculations are provisional and would be subject to detailed re-measurement in the final account.

The contractor's budget estimated cost for Option 2B is approximately as follows:

- **£134,250 exc VAT**

The contractor estimates that the project duration would be 9 weeks in total. This cost is based on remediation of **all** plots across the site and hence costs will be reduced if only a portion of plots are selected for remediation. However, it is important to note that many line items (such as project set-up costs) would be required irrespective of the number of plots scheduled for remediation.

All areas outside of the plots including the communal paths are excluded from the scope. Some form of partial repair and/or reinstatement may prove necessary if small plant were to be utilised to assist with the works. Augmenting imported soils with compost/manure has not been allowed for. Neither has reinstatement of any structures nor replanting any plants which may have been removed prior to the remedial works.

Additionally, there would be some Environmental Consultancy costs associated with the verification and reporting process. Budget sums for these services are usually considered in the 8-10% of remedial costs range.

The total project price for this option (including consultancy fees at 8%) is therefore estimated at approximately £145,000 exc VAT.

17 Reasonableness

In order to comply with the statutory guidance, the remediation costs must be deemed to be reasonable. The guidance states that:

> *The enforcing authority should regard a remediation action as being reasonable …… if an assessment of the costs likely to be involved and of the resulting benefits shows that those benefits justify incurring those costs. Such an assessment should include the preparation of an estimate of the costs likely to be involved and of a statement of the benefits likely to result. This latter statement need not necessarily attempt to ascribe a financial value to these benefits.*

The statutory guidance further goes on to say that for these purposes;

> *.. the enforcing authority should regard the benefits … as being the contribution that the action makes … to reducing the seriousness of any harm …*

LEAP has not made any specific assessment of the reasonableness of the remediation in this report since it is a voluntary remediation. However, the council may wish to give some formal consideration to this for its own record purposes.

17.1 Seriousness of Harm

As indicated above, the planned remediation scheme will focus on pollutant linkages associated with unacceptable risks to human health – namely holders (current and future) of the plots concerned. The removal of such unacceptable risks is the objective of the remediation.

G CONCLUSIONS

18 Conclusions and Recommendations

The quantitative appraisal of practicability, effectiveness and durability resulted in relatively close scores between Options 1 and 2A with Option 2B scoring an additional c. 10%. Costs for all three options have been considered, with budget estimates provided by a specialist contractor for the two preferred options; 2A and 2B.

- Option 1 – Substantial excavation of allotment plots to a depth of 500mm bgl and reinstatement with clean subsoil and topsoil. Total Estimated Cost £460,000 exc VAT;

- Option 2A – Blending of the top 300mm of native soils on a 1:1 basis with imported, certified clean topsoil with an associated raise in plot levels. Estimated Total Cost £106,000 exc VAT;

- Option 2B – Construction of 500mm deep raised beds across the plots, filling with imported, certified clean topsoil and the application of a deter to dig geotextile below the internal paths. Total Estimated Cost £145,000 exc VAT.

The volumes quoted may prove to be an underestimate but the rates do apply to all 20 plots. The approach taken to assess the volumes is the same for each of the three options so respective total costs are directly comparable as the volumes would rise by the same margin for each option meaning the overall price trends would remain the same. Options 2A and 2B have also been costed by the contractor assuming that plant access is not available. These costs estimates have not been used for the comparisons herein but do result in a significant (50-60%) uplift over the budget estimates used and as such confirmation of both areas and access will be essential for final specification and pricing.

Although Option 1 offers a solution with negligible future liability, it would have a significant detrimental impact on the local community (by way of increased soil movements and hence increased lorry movements and potentially health effects) and would not prove to be a sustainable solution on account of the amount of soil needing to be disposed of into landfill. Furthermore, this is by far the most costly option. For these reasons, Option 1 is not recommended.

Option 2A has the benefit of no significant soil disposal (thus reducing vehicle movements by greater than 50% over Option 1) but does require the excavation and direct handling of impacted soils. Perhaps the least desirable aspect is that plot holders would still be directly gardening impacted soils (albeit at reduced concentrations overall).

Option 2B has the benefit of no significant soil disposal (thus significantly reducing vehicle movements by greater than 50% over Option 1) and does not require the any significant handling of impacted soils (as raised beds would simply be constructed over the impacted soils). This Option also has the benefit of adopting a system of growing edibles already popular with gardeners and one that is particularly suitable from an accessibility standpoint for older or less physically able persons. The drawbacks to Option 2B are a reduced planting area (due to the paths required between the beds) and that some future monitoring of the site would be required to ensure that future residents do not grow plants within the ground level internal pathways, remove the raised beds or the deter-to-dig geotextile membranes. The raised beds themselves appear to be the reason why Option 2B is more expensive than Option 2A. The costs of this element of the remediation may be able to be reduced if the council were to enlist the services of a specialist landscaper already on their approved contractors list.

Options 2A and 2B are fairly similar from a cost standpoint. Planting of edibles within ground level internal pathways is not considered to represent a significant concern as exposure to any impacted underlying soils would be fairly negligible given the percentage of the plot area which they would represent. Furthermore, the site already has a residents association in place to 'police' the use of the site.

For the reasons outlined above, Option 2B is considered to be the preferred solution. Alternatively, consideration could be given to a combination of Options 2A and 2B subject to the nature and constraints on specific plots and the preferred solution of the plot holders.

18.1 Further Considerations

The budget costs estimates presented herein are for comparative purposes only and should not be used for financial assessment. They are subject to limitations and assumptions as highlighted in the text. LEAP are not quantity surveyors nor costs consultants and final designs will need to be prepared and fully costed and then subjected to a formal tendering exercise.

It should be noted that the areas included in this options appraisal include only the plots themselves and not communal pathways and the surrounding naturalised border regions of the site (these border regions are sloped and heavily vegetated with mature trees and underlying vegetation). Asbestos has been observed in the sloped area to the rear of plots 6-9 and some consideration into remediating this area may merit attention. A simpler 300mm clearance, geotextile installation and replacement with certified clean overlying soils may suffice in this area but this would naturally increase overall costs.

The safe execution of the works is of paramount importance and has been a key consideration in the outline proposals presented herein. The remediation works may be notifiable under the Construction Design and Management (CDM) Regulations 2015. It will therefore be necessary for LB Camden to appoint an external advisor to provide independent health and safety advice in respect of the design and implementation of the works.