Environment Agency (North West Region)
Advisory Notes for Well Abandonment Specifications (1)
for
Water Wells and Boreholes up to 1 metre diameter.

Abandonment specifications for wells of up to 1m diameter, should have regard to the following advice.
See separate document (2) for larger diameter wells, shafts and boreholes. Updated Feb 2005

Temporary Abandonment (ie Preserved for possible future re-use):

A bolted blank flange (typically NP16) with gasket seal, to be seam welded or threaded to the borehole casing. Well head then to be protected from vandalism and traffic damage etc. as appropriate to location.
To prevent corrosion it is usually prudent to ensure that the exposed casing and flange is kept well painted, and that bolt threads are greased before assembly. If the bolted flange is to be buried, it is prudent to employ corrosion resistant nuts and bolts (eg stainless steel) and to wrap the joint in moisture repellent protective tape.
N.B. Avoid 'building over' unless the wellhead is fully sealed, or else vented in accordance with Health & Safety Executive guidance for methane risk. (HSE Local Authority Circular No: 27/14). -Available on www.hse.gov.uk website.

Permanent Abandonment:

EITHER:

Remove pumping plant and rising main etc.
During decommissioning, great care must be taken to prevent any contaminants, (eg fuel or oil) or any other debris (eg demolition rubble or metalwork etc) from falling down the open well.

Cut the casing down to a height that will enable a cap* to be installed so that the cap will be at least 1 metre below formation level of proposed site redevelopment. Never build structures directly onto well caps or linings.
Fill the part of the well in aquifer with inert pea gravel, from the base upwards, by tremmie pipe, followed by cement bentonite grout plug of not less than 5 metres length to be placed through the superficial deposits/upper part of the well. This must also be placed by tremmie pipe, from the base upwards.
When filling a well it may be necessary to make appropriate arrangements to pump out and/or dispose of displaced water.
The cement-bentonite plug needs to be anchored into the casing to prevent slippage, or should be suspended from the well cap, unless it can be seated upon a point of diameter reduction within the borehole.
*The cap should be either an impermeable, thick steel plate, seam welded to the casing top and treated to resist corrosion, or a cast-in-situ reinforced concrete cap, designed to support any likely loads that would be imposed during or after redevelopment. The cap should always be at least twice the diameter of the well.

In structurally competent and highly permeable strata, the structural integrity of the rock may be such that backfill at depth is not necessary to provide structural support to the well sides. However, in such circumstances it is essential that the upper part of the well or borehole is fully sealed with a competent cement-bentonite or in-situ cast, dense mass concrete plug extending from at least three metres below the base of the superficial deposits to the underside of the cap. It will be necessary to install a packer or structural plug upon which to cast this extended plug, so as to prevent loss of materials into the void below. The plug may be spragged into the casing; founded on a diameter reduction, or suspended from the shaft/borehole cap. (EG using steel reinforcing bars).

OR:

If the borehole is in an area where the Environment Agency wishes to obtain long term groundwater level data:
It may be possible that the Environment Agency would be willing to adopt, lease or acquire the redundant borehole as an addition to the Agency's national water level monitoring network.
As the well would remain 'in use' for non-abstraction purposes, this course of action might obviate the need for backfill or capping. This approach saves cost and may leave options open for future re-use.

INFORMING OTHERS:

Always notify the Environment Agency (Groundwater Section) of the abandoned well location and structure.
It is also very good practice to mark or deeply inscribe well caps with the word "WELL".
Even if done crudely it can avoid considerable risk, delay or uncertainty in the event of the structure being encountered during excavation by others in the future who may not otherwise know what the feature is.
Clearly recording and marking the location is essential where any part of the well has not been filled.

PLEASE READ THE FOLLOWING EXPLANATORY NOTES:
Water Well and Borehole Abandonment Advice (Continued):
EXPLANATORY NOTES:

The purpose of the hydraulic seal provided by the cap and cast in-situ plug is to prevent potential discharge of geological origin gasses (eg methane and carbon dioxide) or possible future artesian groundwater discharge via a preferential pathway through the well.
This seal also prevents any risk of present or future fluid contaminants perched in surface soils, or the well-head chamber, from finding a preferential pathway down into the aquifer, where it would cause pollution of groundwater.

The reasons for using a tremmie pipe to deliver fill into the well are:
1. To prevent blockage or bridging during the filling process, and
2. To ensure that graded materials such as cement, grout or concrete do not separate out or become diluted by passage through water and
3. To prevent the displaced water from becoming polluted by suspended solids. The latter is particularly important where filling a well may displace a significant volume of polluted water into a fissure flow aquifer or to the ground surface.

The purpose of filling the well is to provide structural support to the sides in the long term, particularly as steel casing or mortar in brickwork is likely to eventually corrode away, and weak rocks may crumble.
Inert granular fill is cheaper and more permeable, so can be used in parts of the well in the permeable strata (aquifers).
Low permeability parts of the sequence (Mud-rock, shale, clay etc) or the superficial deposits (regardless of permeability) should be plugged with a non-permeable support (eg: cement-bentonite grout or dense mass concrete)

The purpose of the cap is to secure the hydraulic seal and provide a structural protection of the casing top. In the event of future slippage of the fill or well casing, the larger diameter of the cap provides support from the surrounding ground. Sometimes it may be appropriate to just cap the well without in-fill if there is a possible future need for access or re-use.

The purpose of suspending or anchoring the cement-bentonite plug is to ensure that it cannot move as the granular fill below settles with time. This is especially likely during changes in local groundwater level.

The purpose of finishing the well cap at least 1 metre below formation level of subsequent developments is to ensure that rigid structures are not broken or 'hogged' over the effective pile formed by the well casing. It also to avoids the transfer of point loads direct to and damaging the casing, which was not designed as a load bearing pile.

The reason for informing others:
There are often circumstances arising where developers or the owners of sites lose or do not have records of the exact location or structure of below ground voids – especially where they have been redundant for a long time. For this reason it is good practice to also register the exact location and structure with an appropriate third party maintaining a publicly accessible archive.
Shafts and boreholes sometimes connect with much larger underground voids.
The presence of below ground voids can have implications for the quantities of material used to fill or plug the well, health and safety issues, pollution pathways and for the structural integrity of the development.
As long as the exact location and structure of a well is known, it is usually a simple matter to locate and deal with it as necessary, or to design around it.
If the location, condition or status of former voids is not properly recorded, projects can incur significant delay, uncertainty or expense as a result – especially if the feature is only discovered as the result of a structural failure.

Details of known mine workings and mine openings such as shafts and adits are recorded by the Coal Authority (coal) or the Health and Safety Executive Mines Records (Non-coal).
Records of many water wells and borings are held by the Environment Agency, and geological details are also recorded by the British Geological Survey at Wallingford.

Always notify the Environment Agency (Groundwater Section) of the 'as constructed' details of the abandoned well structure, accompanied with an accurate location plan of the filled or capped well. The plan should be adequate to locate the well to within a metre or so on the ground relative to features shown on large scale published maps of the Ordnance Survey.
It is especially important to do this when capping open (unfilled) wells, boreholes or shafts.

APPENDIX H

ENCIA GENERAL SPECIFICATION FOR ENGINEERED FILL

ENCIA GENERAL SPECIFICATION FOR ENGINEERED FILLS

1 Introduction

1.1 This model specification is intended to be used in connection with the construction of low-rise buildings on engineered fill. The specification is believed to be suitable for most purposes but there may be special conditions existing at some sites which are not treated in this document and which should be taken into account in arriving at a properly engineered fill. It is emphasised that clay fills can be at least as susceptible to settlement or heave due to climatic, vegetation or other effects, as naturally occurring cohesive soils.

1.2 This specification is for contracts which are designed and supervised by Encia Regeneration Limited.

1.3 It is assumed that a site investigation will have been performed prior to the works and that the geotechnical properties of relevance to enforcing the specification will have been measured.

1.4 Note should be taken of the requirements of the Construction (Design and Management) Regulations to the extent that they may be relevant to the works.

1.5 This specification has been prepared by Encia Regeneration Ltd based on the suitably modified "Model Specification for Engineered fills to Support Low Rise Structures", written by N A Trenter and J A Charles, Paper 10819, Proceedings of the Institution of Civil Engineers, Geotechnical Engineering, October 1996.

2 Engineered Fill

2.1 Engineered fill is defined as fill which is selected, placed and compacted to an appropriate specification so that it will exhibit the required engineering behaviour.

2.2 Grading limits for the most common types of general fill are presented in the Appendix to this specification. The remaining fill types are specified in the DoT Specification.

2.3 Fill shall be classified as follows:-

- Unsuitable fill
- General fill
- Restricted fill
- Special fill

3 Unsuitable Fill:-

3.1 Unsuitable fill shall comprise any material so designated by the Engineer and shall include:-

- Cohesive soils having a liquid limit in excess of 90% or Plasticity Index in excess of 65%
- Chalk having a fine fraction (<400μm) in excess of 10% at the borrow pit.
- Any material containing topsoil, wood, peat or lignite.
- Any material containing biodegradables.
- Any material containing scrap metal.
- Frozen or waterlogged substances.
- Material defined as unsuitable by the Engineer because of its type or level of contamination.
- Material which, by virtue of its particle size or shape, cannot be properly and effectively compacted (eg oversize material, gravels which are tabular and some slate wastes).
- Expansive steel slag.

3.2 Unsuitable fill shall not be used at any structurally load bearing location or part of the site but may be used under landscaped areas with the agreement of the Engineer.

4 General Fill

4.1 General fill shall comprise all fill except unsuitable fill, restricted fill and special fill.

5 Restricted Fill

5.1 Restricted fill shall comprise material which would otherwise be classified as general fill but which contains minerals hostile to the built environment and shall include:-

- Pyritic shales
- Gypsiferous clays
- Burnt colliery discard
- Pulverised fuel ash
- Spent oil shale
- Incinerator waste
- Demolition and construction industry waste, at the discretion of the Engineer.

5.2 Such fill shall be precluded from use in designated zones, including locations where groundwater may rise to the level of the underside of the deepest foundation and where its use will be condemned by the appropriate authorities on pollution grounds. Such fill shall not be placed to a depth less than one metre from the underside of the deepest foundation.

6 Special Fill

6.1 Special fill shall comprise material which would otherwise be classed as general fill but which contains durable well graded natural sand and natural gravel or crushed rock, other than argillaceous rock, or durable clean crushed demolition rubble of similar particle size and free from any contaminants. Such fill may be employed as capping layers beneath structure foundations, beneath roads or as backfill to retaining walls.

7 Type of Compaction Specification

7.1 The fill shall be compacted to either an end product specification or a method specification.

7.2 If the grading of the fill is such as to permit laboratory compaction tests to be conducted on it then an end product specification may be used.

7.3 If laboratory compaction tests cannot be carried out on the fill (because of the large size of particles that it contains) then a method specification shall be employed and site compaction trials shall be carried out to confirm the proposed method.

7.4 Notwithstanding that laboratory compaction tests may be possible on the fill, the Engineer may instruct at his discretion that a method specification shall be employed and that site compaction trials shall be carried out to confirm the proposed method.

8 Selection of End Product Requirements

8.1 If an end product specification is to be used then on the basis of the results of a site investigation which he/she shall have carried out, the Engineer shall provide the Contractor with the following:-

8.2 The results of the tests shown below for each type of fill on site:-

- Natural moisture content (BS1377: Part2:1990:Section 3)
- Liquid and plastic limits for cohesive soils (BS1377:Part 2:1990:Sections 4 and 5).
- Compaction tests to determine maximum dry density and optimum moisture content at the appropriate compactive effort (2.5 and 4.5kg rammer) (BS1377:Part 4:1990:Section 3).
- Particle density (specific gravity) to assist in evaluating the compaction test (BS1377:Part 2:1990:Section 8).
- Particle size distribution by wet sieving method to give the distribution of particle sizes down to fine sand and the percentage of fines (BS1377:Part 2:1990:Section 9.2).

8.3 A graph such as that illustrated in Figure 1.

8.4 The graph will show the dry density plotted against moisture content for the 2.5kg rammer method compaction tests, the corresponding optimum moisture contents and maximum dry densities and the 0%, 5% and 10% air voids lines. The 4.5kg rammer method compaction test should only be carried out and quoted in addition to the 2.5kg rammer method compaction test for developments having the following buildings:

- buildings with large windows or large open areas.
- mixed single and 2 storey buildings.
- long load bearing walls without regular construction joints.
- buildings with heavily loaded floor areas.
- buildings with heavily loaded column bases because of wide spans.

8.5 By reference to the shaded area illustrated on Figure 1, the required level of compaction will be indicated by selecting appropriate moisture content and dry density values. This level of compaction shall form the basis of the end product compaction specification.

9 Method Specification

9.1 If a method specification is to be used for the compaction of the fill then site trials shall be carried out to confirm the method.

9.2 On the basis of the results of a site investigation which has been carried out, the Engineer shall provide the Contractor with the results of the following tests for each type of fill on site.

- Natural moisture content (BS1377:Part 2:1990:Section 3).
- Liquid and plastic limits for cohesive soils (BS1377:Part 2:1990:Section 4 and 5).
- Particle density (specific gravity) to assist in evaluating compaction results.
- Particle size distribution by wet sieving method to give the distribution of particle sizes down to fine sand and the percentage of fines (BS1377:Part 2:1990:Section 9.2).

9.3 A separate compaction trial shall be carried out for each type of fill to be used on the site.

9.4 Crushed product derived from the screening and crushing of relict foundations, concrete slabs and oversize materials should yield good quality granular Type 6F2 material (125mm to dust) which at the discretion of the Engineer does not require a site trial to confirm the method specification for its compaction and the method given in Table 1 shall be adopted.

10 Compaction Site Trials

10.1 Sufficient of each type of material shall be excavated and screened of deleterious material to lay a 10m x 4m x approximately 0.25m thick trial pad on a previously rolled horizontal area of the site. Any soft spots in the subgrade below the trial pad should be removed and replaced with compacted granular material. A guide to the thickness of layer that may be suitable may be obtained from Table 1 in this specification (Table 1 is an extract from Tables 6/1-4 DoT Specification for Highway Works Series 600 Earthworks).

10.2 The trial shall be conducted using the same compaction plant as is proposed for the main compaction works. A guide to the size and type of plant that may be suitable may be obtained from Table 1 in this specification.

10.3 The bulk density and moisture content of the fill in the trial pad shall be determined by sand replacement test and oven-drying in two locations immediately after placement and spreading by the dozer but before any rolling.

10.4 Bulk density and moisture content determinations shall be carried out at different locations after subsequent passes by the roller to give density and moisture content determinations after 0, 1, 2, 4, 6, 8 and 10 passes of the roller.

Note: This will give a total of 14 no tests for each material.

10.5 Two laboratory determinations of particle density, grading and Atterberg Limits (if applicable), shall be carried out for each type of material.

10.6 The graph of dry density against number of passes shall be drawn and the number of passes required to achieve more than 95% of the maximum dry density in the field trial and less than 5% air voids at the in-situ moisture content shall be determined (see Figure 2).

10.7 As a guide, the number of passes derived in 6.6 above should be equal to or greater than the number derived from Table 1 in this specification. The number of passes derived from the site trial shall form the method specification for site compaction of that type of material at the in-situ moisture content.

10.8 If it is shown that 5% or less air voids cannot be achieved during the site trial, then the site trial shall be repeated with different conditions, ie heavier or different type of roller and/or increased/decreased moisture content and/or thinner layer.

10.9 If it is required to calibrate a Nuclear Density Meter (NDM) then measurements of bulk density and moisture content shall be made using the NDM at locations adjacent to those carried out by sand replacement tests in Section 6.4. The calibration shall then be carried out in accordance with the Encia standard method as detailed in the Encia Staff Handbook, Section 6.

10.10 If the source for the fill material alters, and a new material is therefore proposed for use, then a site trial shall be performed on this material to demonstrate that it can be compacted satisfactorily before this material is used in the works.

11 Preparation of Site

11.1 Drainage grips or trenches shall be excavated, as necessary, uphill of the area to be filled to prevent the area becoming flooded. Drainage shall be effected without causing siltation or erosion and water shall be disposed of in a manner to be agreed by the Engineer.

11.2 The area to be filled, whether an existing excavation or otherwise undisturbed ground, shall be graded to falls, and sump pumping or other suitable dewatering facilities shall be provided as necessary by the Contractor to keep the base of the excavation dry at all times.

11.3 Where the area to be filled comprises an existing excavation, the excavation shall be inspected and subsequently monitored by the Contractor, to ensure that there is no danger of its collapse during the works with consequences for safety, for existing buildings or for other construction adjoining.

11.4 All topsoil shall be stripped and, where required for further use, stockpiled in an area provided by the Contractor and agreed by the Engineer.

11.5 All soft and compressible soils or existing fill shall be removed and run to spoil in dumps provided by the Contractor and agreed by the Engineer. The works shall be accomplished in such a way that there is no undercutting of the sides of existing excavations.

11.6 Existing foundations or ledges of hard rock, roots of trees or former pipelines or services at the base of the area to be filled shall be excavated and replaced with compacted general fill which shall be compacted to the same specification as adopted for subsequent compaction works.

Note: *No tree roots greater than 5mm diameter, no root balls and no masses of fibrous roots shall remain at the base of the excavation.*

11.7 The base of the area to be filled shall be proof rolled with a dead weight roller and all soft materials removed and replaced with compacted fill. Where unsuitable material has been excavated, the underlying natural ground shall be compacted to the same specification as adopted for subsequent compaction works.

12 Disposition of Fill

12.1 Where construction is required upon fill placed over sloping natural ground, and where fill thickness is less than 5m, the natural ground shall be benched, with the maximum vertical height of each bench not exceeding 500mm and providing that the fill depth below any building does not vary by more than 15% (see Figure 3).

12.2 Where, because of the method of working, previously engineered fill placed during the current works has to be benched as in Section 8.1 to allow new fill to be placed adjacent to it, then the benches only require to be 0.5m high by 1.0m wide, even where these occur beneath plots providing that the fill is the same material throughout the plot.

12.3 Where a development contains landscaped areas on which no structures are proposed, the underlying fill shall be selected, placed and compacted in the same way as the engineered fill, unless otherwise directed by the Engineer. Where some relaxation of the specification for fill compaction underlying landscaped areas is permitted, there shall be a transition zone between the fill underlying the landscaped area and the fill underlying the structure (see Figure 4). The dimensions of the transition zone will depend on the degree to which fill compaction was relaxed for the fill in the landscaped area. The location and extent of fill placed to a reduced standard of compaction shall be recorded.

13 Placing and Compacting Fill

13.1 Fill shall be placed and compacted in near-horizontal layers of the thicknesses required to achieve the specified end product or in accordance with the approved method specification, and shall, as far as practicable, be brought up at a uniform rate so that all parts of the site or particular sections of the site reach finished (formation) level at the same time.

13.2 The compaction plant selected, the number of passes made and the fill layer thickness and moisture content used shall have regard either to the specified end product and the means and manner of control testing or the specified method and the means and manner of control testing.

13.3 Where several different types of fill material (all meeting the requirements of Section 2 of this specification) are to be employed, they shall be deposited in such a way that all parts or particular sections of the site receive roughly equal amounts of a given material, in roughly the same sequence, thus ensuring a uniform distribution of fill types over the whole fill thickness.

13.4 The Contractor shall take all necessary steps to ensure that the fill is placed at the moisture content necessary to achieve the specified level of compaction and shall, where necessary, add water to or dry the fill, in order to obtain this value. Where it is necessary to add water, this shall be done as a fine spray and in such a way that there is time for the water to be absorbed into the fill before being rolled by the plant.

13.5 Cobbles, boulders, rock or waste fragments, the largest dimension of which is greater than two-thirds of the compacted layer thickness, shall not be incorporated into the fill.

13.6 No fill shall be placed and left uncompacted at the end of the working day. Compacted fill shall be graded to falls to ensure free run-off of rainwater without ponding.

13.7 Compaction plant and compaction method shall be selected having regard to the proximity of existing trenches, excavations, retaining walls or other structures and all work shall be performed in such a way as to ensure that their existing stability is not impaired.

13.8 If weather conditions are such that the specified moisture content and density values cannot be achieved, the Contractor shall cease work until such time as the fill can be placed and compacted to meet specification requirements.

13.9 If the results of control tests (Section 10) indicate that the fill is being placed and compacted in such a way that the desired level of compaction is not being achieved, the Contractor shall further compact or, if necessary, shall excavate the affected work and replace with new fill, compacted to meet the specification requirements.

13.10 If the results of control tests (Section 10) indicate that antecedent weather conditions (such as frost or heavy rain) have caused deterioration of finished work such that the work no longer meets with the specification, the Contractor shall, at his or her own cost, take such steps as are necessary to bring the fill to specification requirements.

14 Control Testing

14.1 The end product requirements shall be controlled by in-situ and laboratory testing as follows:-

- In-situ-dry density (BS1377:Part 9:1990, Section 2)
- moisture content determinations (BS1377:Part2:1990, Section 3) shall be performed as soon as is practical after placement so as to prevent changes in moisture content that can be caused by the weather being reported as compaction moisture contents.
- Control tests shall be performed by the Engineer throughout the fill at such frequency and at such locations as shall be deemed necessary by the Engineer at no cost to the Contractor.
- The minimum frequency of testing shall be 1 test per 500m^3 of fill placed with a maximum frequency of 1 test per 200m^3 of fill placed. Extra testing will be required in visually doubtful areas or previously failed areas.

14.2 The method specification requirements shall be controlled by in-situ and laboratory testing as follows:-

- moisture content determinations (BS1377:Part2:1990, Section 3).
- The minimum frequency of testing shall be 1 test per 500m^3 of fill placed with a maximum frequency of 1 test per 200m^3 of fill placed. Extra testing will be

required in visually doubtful areas or previously failed areas.

- It is expected that a minimum of 3no moisture content determinations shall be performed each working day as soon as is practical after placement so as to prevent changes in moisture content that can be caused by the weather being reported as compaction moisture contents.
- In-situ dry density (BS1377:Part 9:1990, Section 2).
- These tests shall be performed at a rate of approximately 1 per 2000m^2 every fourth or fifth compacted layer. The tests are required as a confirmation that the methods of compaction being used are producing the desired results.
- Control tests shall be performed by the Engineer throughout the fill at such frequency and at such locations as shall be deemed necessary by the Engineer at no cost to the Contractor.

14.3 The Engineer shall make available a plot of in-situ dry densities against in situ moisture content results on a graph such as illustrated in Figure 1, showing that the results lie within or above the shaded area. Should any results lie outside the shaded area, the Contractor shall agree with the Engineer proposals for rectifying the existing situation and for improving future performance.

14.4 The compacted layer thickness shall be checked by the Engineer using profile boards installed by the Contractor at his own cost or by laser level supplied by the Contractor at his own cost.

14.5 The numbering system to be adopted for Quality Control testing shall be decided by the Engineer at the start of the works. The system adopted shall enable the location of each test to be identified in the works ie plan location and level beneath final formation level. The date of test shall also be included.

14.6 eg Plot24/1.2/25May would indicate a test under Plot 24 at a depth of 1.2m below final formation level carried out on 25th May. The testing laboratory shall be informed of the number of each test they perform and shall report that number on the results sheet.

15 Monitoring of Fill Performance

15.1 If instructed by the Engineer, the Contractor shall make arrangements for the performance of the fill, once placed, to be monitored. Monitoring may take one or more of the following forms:-

- Optical levelling of surface monuments
- Standpipes or piezometers
- Load tests
- Other methods as directed by the Engineer

Note: *Monitoring of fill performance shall only be carried out if specifically required by the Client and then only after consultation with the Geotechnical Manager. Properly compacted fill using this specification should not require to meet criteria at the end of the fill operations. The only useful purpose for carrying out such monitoring is to obtain allowable bearing pressures and settlement parameters.*

15.2 The Contractor shall, within twenty one working days of receiving notification of the Engineer's intention to monitor fill performance, arrange for the procurement and supply of the equipment to the Engineer's written specification and shall inform the

Engineer of the date on which the equipment installation shall commence. The specification shall include:-

- A full description of the nature and type of instrument and the purpose it fulfils
- The number required and the locations and/or depths at which it is to be installed
- The frequency, accuracy and duration for which any readings are to be taken

APPENDIX I

HIGHWAYS AGENCY SPECIFICATION FOR HIGHWAY WORKS SERIES 600 TABLE 6/4

TABLE 6/4: Method Compaction for Earthworks Materials: Plant and Methods (Method 1 to Method 6)
(This Table is to be read in conjunction with sub-Clause 612.10)

Type of Compaction Plant	Ref No.	Category	Method 1		Method 2		Method 3		Method 4		Method 5		Method 6		
			D	N#	D	N#	D	N#	D	N	D	N	N for D = 110 mm	N for D = 150 mm	N for D = 250 mm
Smoothed wheeled roller (or vibratory roller operating without vibration)		Mass per metre width of roll:													
	1	over 2100 kg up to 2700 kg	125	8	125	10	125	10*	175	4	unsuitable		unsuitable	unsuitable	unsuitable
	2	over 2700 kg up to 5400 kg	125	6	125	8	125	8*	200	4	unsuitable		16	unsuitable	unsuitable
	3	over 5400 kg	150	4	150	8	unsuitable		300	4	unsuitable		8	16	unsuitable
Grid roller		Mass per metre width of roll:													
	1	over 2700 kg up to 5400 kg	150	10	unsuitable		150	10	250	4	unsuitable		unsuitable	unsuitable	unsuitable
	2	over 5400 kg up to 8000 kg	150	8	125	12	unsuitable		325	4	unsuitable		20	unsuitable	unsuitable
	3	over 8000 kg	150	4	150	12	unsuitable		400	4	unsuitable		12	20	unsuitable
Deadweight tamping roller		Mass per metre width of roll:													
	1	over 4000 kg up to 6000 kg	225	4	150	12	250	4	350	4	unsuitable		12	20	unsuitable
	2	over 6000 kg	300	5	200	12	300	3	400	4	unsuitable		8	12	20
Pneumatic-tyred roller		Mass per wheel:													
	1	over 1000 kg up to 1500 kg	125	6	unsuitable		150	10*	240	4	unsuitable		unsuitable	unsuitable	unsuitable
	2	over 1500 kg up to 2000 kg	150	5	unsuitable		unsuitable		300	4	unsuitable		unsuitable	unsuitable	unsuitable
	3	over 2000 kg up to 2500 kg	175	4	125	12	unsuitable		350	4	unsuitable		unsuitable	unsuitable	unsuitable
	4	over 2500 kg up to 4000 kg	225	4	125	10	unsuitable		400	4	unsuitable		unsuitable	unsuitable	unsuitable
	5	over 4000 kg up to 6000 kg	300	4	125	10	unsuitable		unsuitable		unsuitable		12	unsuitable	unsuitable
	6	over 6000 kg up to 8000 kg	350	4	150	8	unsuitable		unsuitable		unsuitable		12	unsuitable	unsuitable
	7	over 8000 kg up to 12000 kg	400	4	150	8	unsuitable		unsuitable		unsuitable		10	16	unsuitable
	8	over 12000 kg	450	4	175	6	unsuitable		unsuitable		unsuitable		8	12	unsuitable
Vibratory tamping roller		Mass per metre width of a vibrating roll:													
	1	over 700 kg up to 1300 kg	100	12	100	12	150	12	100	10	unsuitable		unsuitable	unsuitable	unsuitable
	2	over 1300 kg up to 1800 kg	125	12	125	12	175	12*	175	8	unsuitable		12	unsuitable	unsuitable
	3	over 1800 kg up to 2300 kg	150	12	150	12	200	12*	unsuitable		unsuitable		8	12	unsuitable
	4	over 2300 kg up to 2900 kg	150	9	150	9	250	12*	unsuitable		400	5	6	10	unsuitable
	5	over 2900 kg up to 3600 kg	200	9	200	9	275	12*	unsuitable		500	6	6	10	unsuitable
	6	over 3600 kg up to 4300 kg	225	9	225	9	300	12*	unsuitable		600	6	4	8	unsuitable
	7	over 4300 kg up to 5000 kg	250	9	250	9	300	9*	unsuitable		700	6	3	7	12
	8	over 5000 kg	275	9	275	9	300	7*	unsuitable		800	6	3	6	10

TABLE 6/4: Method Compaction for Earthworks Materials: plant and Methods (Method 1 to Method 6)
(This Table is to be read in conjunction with sub-Clause 612.10)

Type of Compaction Plant	Ref No.	Category	Method 1		Method 2		Method 3		Method 4		Method 5		Method 6		
			D	N#	D	N#	D	N#	D	N	D	N	N for D = 110 mm	N for D = 150 mm	N for D = 250 mm
Vibratory roller		Mass per metre width of a vibratory roll:													
	1	over 270 kg up to 450 kg	unsuitable		75	16	150	16	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
	2	over 450 kg up to 700 kg	unsuitable		75	12	150	12	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
	3	over 700 kg up to 1300 kg	100	12	125	10	150	6	125	10	unsuitable		16	unsuitable	unsuitable
	4	over 1300 kg up to 1800 kg	125	8	150	8	200	10*	175	4	unsuitable		6	16	unsuitable
	5	over 1800 kg up to 2300 kg	150	4	150	4	225	12*	unsuitable		unsuitable		4	6	12
	6	over 2300 kg up to 2900 kg	175	4	175	4	250	10*	unsuitable		400	5	3	5	11
	7	over 2900 kg up to 3600 kg	200	4	200	4	275	8*	unsuitable		500	5	3	5	10
	8	over 3600 kg up to 4300 kg	225	4	225	4	300	8*	unsuitable		600	5	2	4	8
	9	over 4300 kg up to 5000 kg	250	4	250	4	300	6*	unsuitable		700	5	2	4	7
	10	over 5000 kg	275	4	275	4	300	4*	unsuitable		800	5	2	3	6
Vibrating plate compactor		Mass per m² of base plate:													
	1	over 880 kg up to 1100 kg	unsuitable		unsuitable		75	6	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
	2	over 1100 kg up to 1200 kg	unsuitable		75	10	100	6	75	10	unsuitable		unsuitable	unsuitable	unsuitable
	3	over 1200 kg up to 1400 kg	unsuitable		75	6	150	6	150	8	unsuitable		unsuitable	unsuitable	unsuitable
	4	over 1400 kg up to 1800 kg	100	6	125	6	150	4	unsuitable		unsuitable		8	unsuitable	unsuitable
	5	over 1800 kg up to 2100 kg	150	6	150	5	200	4	unsuitable		unsuitable		5	8	unsuitable
	6	over 2100 kg	200	6	200	5	250	4	unsuitable		unsuitable		3	6	12
Vibro-tamper		Mass:													
	1	over 50 kg up to 65 kg	100	3	100	3	150	3	125	3	unsuitable		4	8	unsuitable
	2	over 65 kg up to 75 kg	125	3	125	3	200	3	150	3	unsuitable		3	6	12
	3	over 75 kg up to 100 kg	150	3	150	3	225	3	175	3	unsuitable		2	4	10
	4	over 100 kg	225	3	200	3	225	3	250	3	unsuitable		2	4	10
Power rammer		Mass:													
	1	100 kg up to 500 kg	150	4	150	6	unsuitable		200	4	unsuitable		5	8	unsuitable
	2	over 500 kg	275	8	275	12	unsuitable		400	4	unsuitable		5	8	14
Dropping-weight compactor		Mass of rammer over 500 kg weight drop:													
	1	over 1 m up to 2 m	600	4	600	8	450	8	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
	2	over 2 m	600	2	600	8	unsuitable		unsuitable		unsuitable		unsuitable	unsuitable	unsuitable

TABLE 6/4: Method Compaction for Earthworks Materials: Plant and Methods (Method 7)
(This Table is to be read in conjunction with sub-Clause 612.10)

Type of Compaction Plant	Ref No.	Category	Method 7	
			N for D = 150 mm	N for D = 250 mm
Smooth wheeled roller (or vibratory roller operating without vibration)		Mass per metre width of roll		
	1	over 2100 kg up to 2700 kg	unsuitable	unsuitable
	2	over 2700 kg up to 5400 kg	unsuitable	unsuitable
	3	over 5400 kg	12	unsuitable
Grid roller		Mass per metre width of roll:		
	1	over 2700 kg up to 5400 kg	unsuitable	unsuitable
	2	over 5400 kg up to 8000 kg	16	unsuitable
	3	over 8000 kg	8	unsuitable
Deadweight tamping roller		Mass per metre width of roll:		
	1	over 4000 kg up to 6000 kg	4	8
	2	over 6000 kg	3	6
Pneumatic-tyred roller		Mass per wheel:		
	1	over 1000 kg up to 1500 kg	unsuitable	unsuitable
	2	over 1500 kg up to 2000 kg	12	unsuitable
	3	over 2000 kg up to 2500 kg	6	unsuitable
	4	over 2500 kg up to 4000 kg	5	unsuitable
	5	over 4000 kg up to 6000 kg	4	16
	6	over 6000 kg up to 8000 kg	unsuitable	8
	7	over 8000 kg up to 12000 kg	unsuitable	4
	8	over 12000 kg	unsuitable	4
Vibratory tamping roller		Mass per metre width of vibrating roll:		
	1	over 700 kg up to 1300 kg	unsuitable	unsuitable
	2	over 1300 kg up to 1800 kg	unsuitable	unsuitable
	3	over 1800 kg up to 2300 kg	16	unsuitable
	4	over 2300 kg up to 2900 kg	12	unsuitable
	5	over 2900 kg up to 3600 kg	10	unsuitable
	6	over 3600 kg up to 4300 kg	8	16
	7	over 4300 kg up to 5000 kg	7	14
	8	over 5000 kg	6	12
Vibratory roller		Mass per metre width of vibrating roll:		
	1	over 270 kg up to 450 kg	unsuitable	unsuitable
	2	over 450 kg up to 700 kg	unsuitable	unsuitable
	3	over 700 kg up to 1300 kg	unsuitable	unsuitable
	4	over 1300 kg up to 1800 kg	unsuitable	unsuitable
	5	over 1800 kg up to 2300 kg	12	unsuitable
	6	over 2300 kg up to 2900 kg	10	unsuitable
	7	over 2900 kg up to 3600 kg	10	unsuitable
	8	over 3600 kg up to 4300 kg	8	unsuitable
	9	over 4300 kg up to 5000 kg	8	unsuitable
	10	over 5000 kg	6	12
Vibratory plate compactor		Mass per m² of base plate:		
	1	over 880 kg up to 1100 kg	unsuitable	unsuitable
	2	over 1100 kg up to 1200 kg	unsuitable	unsuitable
	3	over 1200 kg up to 1400 kg	unsuitable	unsuitable
	4	over 1400 kg up to 1800 kg	10	unsuitable
	5	over 1800 kg up to 2100 kg	8	unsuitable
	6	over 2100 kg	6	unsuitable
Vibro-tamper		Mass:		
	1	over 50 kg up to 65 kg	unsuitable	unsuitable
	2	over 65 kg up to 75 kg	unsuitable	unsuitable
	3	over 75 kg up to 100 kg	unsuitable	unsuitable
	4	over 100 kg	8	unsuitable
Power rammer		Mass:		
	1	100 kg up to 500 kg	8	unsuitable
	2	over 500 kg	6	10
Dropping weight compactor		Mass of rammer over 500 kg height drop:		
	1	over 1 m up to 2 m	unsuitable	unsuitable
	2	over 2 m	unsuitable	unsuitable

APPENDIX J

ENCIA PROTOCOL FOR IMPORTATION & USE OF SOIL COVER

Protocol for Importation & Use of Soil Cover (Capping)

Introduction

Isolation of made ground in garden and landscaped areas beneath a cover of "clean" subsoil, and topsoil is often recommended on residential developments where made ground is left in-situ; most notably when it contains some inorganic contaminants at concentrations above guidance threshold values. A cover solution is not generally appropriate for organic contamination (fuels, solvents etc); removal or treatment will probably be required.

The "clean" soil cover blocks potential linkages between the contaminated fill and future residents. Such a cover is only required in proposed garden and landscaped areas underlain by made ground (i.e. not beneath drives, garages or houses).

The thickness of cover is dependant on the nature and degree of contamination (and often the Local Authority whose area the site lies within), but typically between 600mm and 1,000mm is required. However, if the made ground is essentially "clean", but contains materials generally considered undesirable as a near-surface material in garden areas (colliery spoil, construction\demolition rubble etc) then a 300mm thick cover, in accordance with NHBC Standards, Chapter 9.2, should be adequate. If the made ground is essentially "clean" and comprises reworked natural soil, the only cover likely to be required is topsoil.

The **CML initiative**, which came into force on 1st April 2003, requires house builders to submit to NHBC (or other warranty providers) a validation report confirming the thickness and quality (i.e. contaminant-free) of the soil cover. Validation reports are normally prepared by independent geoenvironmental consultants such as Encia Regeneration Ltd (Encia).

Soil **quality** is best determined by sampling of the **source** at least 7 working days before importation to the development site. If this is achieved, further, on-site (post-placement) quality testing should not usually be necessary providing cover material is stockpiled on site away from site horizons and not placed before the first fix to avoid unnecessary tracking over, compaction and movement of contamination.

Soil **thickness** can only be checked after placement, but should be done before turfing, fencing etc. Thickness could be checked via the excavation of an appropriate number of inspection pits or by survey carried out prior to and immediately after the placement of cover material.

Soil cover is usually placed many weeks after completion of the preparatory\remedial works, and issue of the associated Verification Report. Consequently, site visits, to generate supplementary letter reports, are typically required after soil cover has been placed in the gardens of each plot, or set of plots.

Failure to submit cover validation reports (a **RED** item) promptly will delay NHBC finalling plots – this will delay the release of mortgage funds and hence legal completion – i.e. the financial implications are very significant.

Given the potential for cross-contamination of soil cover (by excavation arisings, builders rubble etc), it should be validated at a relatively late stage in the construction programme (ideally after scaffolding has been dismantled). However, it is essential that Encia is instructed at least 2 weeks prior to the anticipated finalling date.

Cover material can sometimes be sourced on-site from foundation\drainage excavations in natural in-situ strata, but import is often necessary. The following protocol (testing at source) is recommended.

Protocol (Testing at Source)

The materials should be inspected by Encia **at source**.

Soil material should:

- be clean and free of foreign debris, building waste materials or contaminants;
- not have a stone content of greater than 20% by dry weight and
- have a maximum stone size of 150mm in any one direction.
- not have been sourced from an area within 7m laterally, or 3m vertically, of Japanese Knotweed plants, and not contain any Japanese Knotweed fragments (rhizomes, leaves, stems etc).

Encia should take representative samples of the cover material from the proposed source. The number of samples taken will be dependant on the nature of the source and the quantity of material to be imported. However, as a guide, a **minimum** of 6 samples of each soil type should be tested, with a further sample for each 250m^3 of subsoil, where the quantity exceeds 1,500m^3; and a further sample for each 50m^3 topsoil, where the quantity exceeds 300m^3.

A less frequent sampling rate may be appropriate for soils from a greenfield source or where large volumes (say > 5,000m^3) of soil are imported from a single, relatively homogenous source.

Each sample taken should be forwarded to an analytical laboratory for testing in accordance with the following schedule:

Table 1 – Test schedule

Source	Definition	Test Schedule	Other requirements\Remarks
Greenfield	No 'source' of contamination present i.e. undeveloped; absence of made ground.	*pH, total metals (Cu, Ni, Zn, Cr, As, Hg, Se, Cd & Pb), water soluble boron.*	Photographs of site and stockpile for import. If review of an SI report confirms source site has always been greenfield (and redevelopment is yet to commence), there should be no need for speciated PAH testing.
Brownfield	Potential source anticipated i.e. current or historical industrial or commercial use; evidence of bonfires; presence of made ground. Soil transfer stations.	*pH, total metals (Cu, Ni, Zn, Cr, As, Hg, Se, Cd & Pb), water soluble boron.* *Speciated PAH and banded TPH.*	Photographs of site and stockpile for import.

NB The schedules detailed above have been prepared in accordance with the Secondary Model Procedures. This document state that analysis should be relevant to potential sources and not merely a set list of parameters applied to each site.

Additional determinands could be scheduled, although if considered necessary, would probably suggest the material is unlikely to be suitable for use as clean cover in gardens.

The analytical testing should be undertaken on a 3 or 5-day turnaround and the Client\Contractor should be notified of the soil's suitability (or otherwise) immediately after receipt of the results. Chemical assessment (Tier 1) criteria for imported soils are tabulated on page v.

On receipt of written confirmation from Encia, the Client should instruct his Contractor to commence importation. It will probably be necessary to stockpile the cover prior to placement in garden\landscaped areas. Encia should inspect the stockpiled material prior to placement, to confirm that it is the same material as previously tested, or the Contractor should provide the Client with appropriate haulage notes.

Validation letter reports should be issued by Encia as each plot, or set of plots, is completed.

Imported **topsoil** should be subject to the above protocol, wherever it is *not* being sourced from an approved supplier. In addition, some analysis in accordance with BS3882 may be appropriate.

Protocol (Testing after Placement)

Clearly, if soil cover is imported and placed before confirmation of its suitability, we cannot guarantee that our validation work will yield the desired results. In which case, it may be necessary to excavate and export the placed soil cover and\or import further "clean" soil.

The materials should be inspected by Encia via inspection pits excavated through the entire thickness of placed cover material.

Encia should take representative samples of soil from each pit. It will typically be necessary to retrieve 1 sample per 250m^3 (Subsoil), and 1 sample per 50m^3 (Topsoil). For a development with "standard" gardens comprising a total area of 100m^2 (front and rear), and a soil cover thickness of 300mm or 600mm, incorporating a minimum 150mm topsoil, this will typically require a minimum of one pit per 3 plots.

Soil material should:

- be clean and free of foreign debris, building waste materials or contaminants;
- not have a stone content of greater than 20% by dry weight and
- have a maximum stone size of 150mm in any one direction.
- not have been sourced from an area within 7m laterally, or 3m vertically, of Japanese Knotweed plants, and not contain any Japanese Knotweed fragments (rhizomes, leaves, stems etc).

Each sample taken should be forwarded to an analytical laboratory for testing in accordance with Table 1 above.

The analytical testing should be undertaken on a 3 or 5-day turnaround and the Client/Contractor should be notified of the soil's suitability (or otherwise) immediately after receipt of the results. Chemical assessment (Tier 1) criteria for imported soils are tabulated on page v.

Validation letter reports should be issued by Encia as each plot, or set of plots, is completed.

Placed **topsoil** should be subject to the above protocol, wherever it is *not* being sourced from a reputable supplier able to provide analytical certificates, in accordance with BS3882.

Chemical assessment criteria for imported soils to the site to create the soil cover system

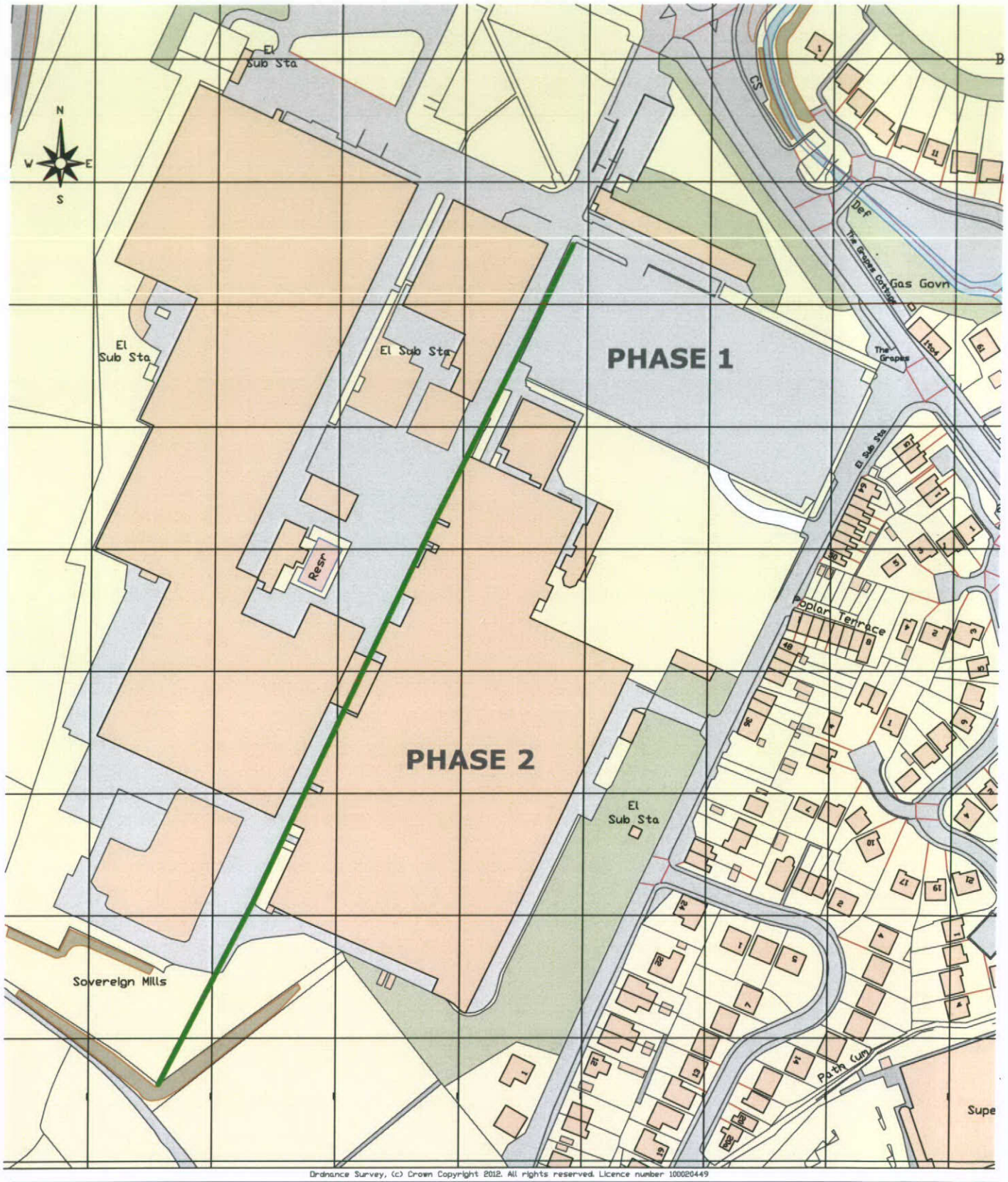
Contaminant	Source	Tier 1 Assessment Criteria (mg/kg) Resi with gdns	Comments/Notes
pH	CLEA		
As	CLEA	32	Science Report SC050021 / Arsenic SGV
Cd	CLEA	10	Science Report SC050021 / Cadmium SGV
Cr	CLEA	3,000	Assumes Cr is CrIII if demonstrated Cr is CrVI screen would be 4mg/kg
Pb	CLEA	450	Based on former SGV
Hg	CLEA	170	Assumes mercury present as an inorganic compound (cf elemental metal or within organic compound). See Science Report SC050021/Mercury SGV
Ni	CLEA	130	Assessment of human health risk only Science Report SC050021 / Nickel SGV
Se	CLEA	350	Science Report SC050021 / Selenium SGV
B	CLEA	5	Based on phytotoxic risks as plants are the more sensitive receptor (Cu and Zn are pH dependent)
Cu	CLEA	80-200	
Zn	CLEA	200-450	
Naphthalene	CLEA	16	Calculated Assessment Criteria calculated by CLEA v1.06 model to be **142mg/kg** driven by consumption of homegrown produce. However concentrations of this magnitude are likely to present a DRO issue and would not be considered appropriate as soil cover. Value for 'Generic/Basic' assessment of CLEA model adopted as a precautionary approach.
Benzo(a)pyrene (as surrogate marker)	CLEA	1.6	Where source is **not** a coal tar and historic use of site does not suggest possible presence of coal tar
GRO	CLEA	330	Based on oral exposure for Aromatic fraction C5-C7
DRO	CLEA	690	Based on combined exposure value for aromatic C8-C10 range.
LRO	CLEA	2,230	Based on an outdoor inhalation and direct contact value Aromatic C21-C35

It should be noted that many of the compounds detected by laboratory analysis for TPH and PAH are naturally occurring in coal, humic acid, bark, leaf litter etc; these are clearly not 'sources' within the legal definition. Encia can undertake further risk assessment where PAH screening values are exceeded, *but* inspection of the soils has not identified any petroleum or combustion derived material.

However it should be noted that Encia will **only** analyse for TPH and PAH where a possible source is identified or where cover material is obtained from a Brownfield site or transfer station, Encia will **not** undertake this sampling as a matter of routine on proven Greenfield sites.

APPENDIX K

NOISE ATTENUATION BARRIER DETAILS



SCALE 0m 50m 100m 150m 200m

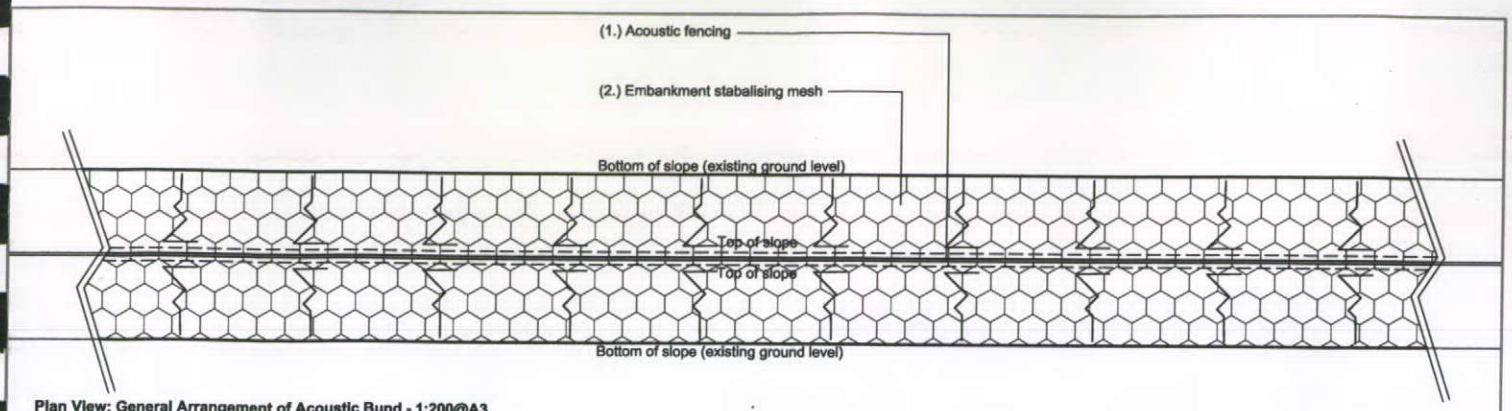
KEY

Alignment of Proposed Noise Attenuation Barrier (subject to final noise assessment survey)

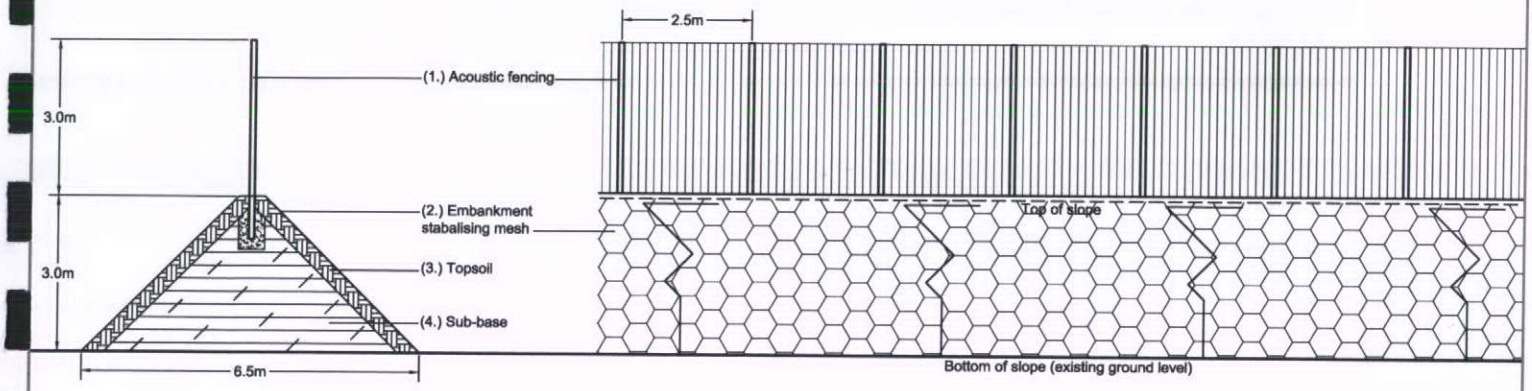
REV	DESCRIPTION	BY	DATE

ENCIA
2 Regent Street Knutsford Cheshire WA16 6GR
T 01565 652394 F 0845 519 0766 LoCall 0845 519 0755
E info@encia.co.uk W encia.co.uk
Company No 6270147

CLIENT	HEYROSE PROPERTY LIMITED
JOB TITLE	FERODO, CHAPEL-EN-LE-FRITH
DRAWING TITLE	ALIGNMENT OF PROPOSED NOISE ATTENUATION BARRIER
STATUS	FINAL
DRAWN BY	AJA
SIGNATURE	
DATE	22-03-12
APPROVED	KL
SIGNATURE	
DATE	22-03-12
SCALE	AS_SHOWN
DRG No.	APPENDIX_K



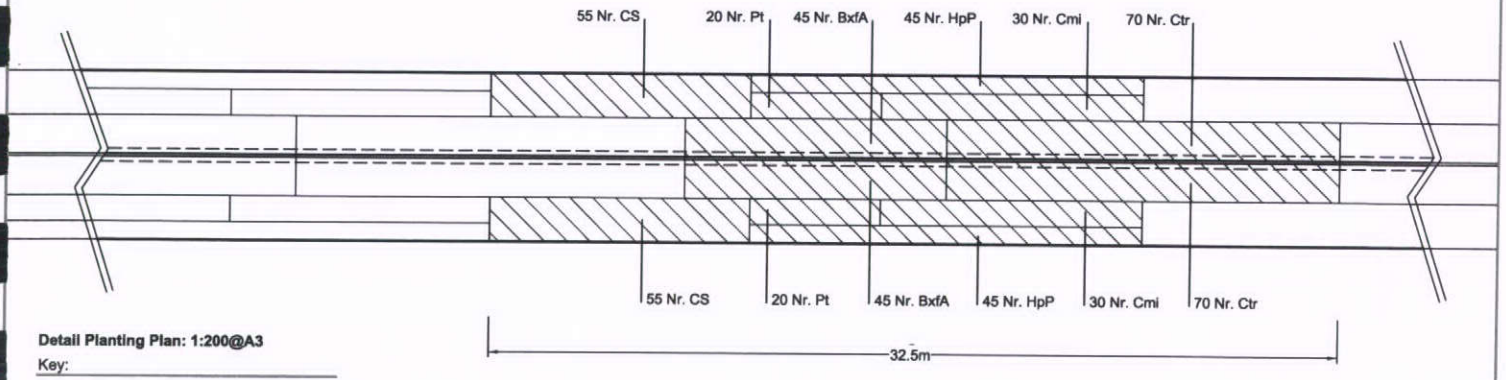
Plan View: General Arrangement of Acoustic Bund - 1:200@A3



Section: Construction Formation of Acoustic Bund - 1:100@A3

Elevation: General Arrangement of Acoustic Bund - 1:100@A3

Notes.
(1.) Reflective acoustic close board timber fencing. 2.5m wide x 3.0m high panels.
(2.) Embankment stabalising mesh to be TechWeb 3/200 supplied by: Technix Rubber & Plastics Ltd (Tel: 01489 789 944) or similar as approved by CA
(3.) Minimum 300m depth Premium Grade as dug topsoil (BS 3882) to form final graded formation layer of acoustic bund.
(4.) Acoustic bund sub-base to be formed from compacted layers (300mm-500mm deep) of hardcore spoil retained from site excavation and clearence works.



Detail Planting Plan: 1:200@A3

Key:

Plant groups included in specification below. To be repeated at every 32.5m length intervals.

Abbrev	Name	Girth/ Dia. cm	Height cm	Root zone	Specification	No. /m²	Qty
SHRUBS							
B xf 'A'	Berberis x frikartii 'Amstelveen'		25-30	3L	Bushy: 4 brks	3	90
C t r	Ceanothus thyrsiflorus repens	30-40D		3L	Bushy: 5 brks	3	140
C mi	Cotoneaster microphyllus		30-40	3L	Bushy: 3 brks	3	60
C 'S'	Cotoneaster 'Skogholm'	40-60D		3L	Bushy: 4 brks	3	110
H p 'P'	Hebe pinguifolia 'Pagei'	20-30D	5-10	2L	Bushy: 3 brks	4	90
P t	Pachysandra terminalis	15-20D		2L	Sev. shoots: 7 brks	4	40
					TOTALS		**530**

Notes:-
No dimensions are to be scaled from this drawing. The contractor shall verify all dimensions on the site. Drawn on CAD, alter at terminal only.

Rev:

Project
FEDERAL MOGUL TECHNICAL CENTRE

Title
Acoustic Bund Details

Drawn	Checked	Date	Scale	Number
AB	/	FEB/11	As indicated @ A3	FM_08

Recro
46 Nelstrop Road
Heaton Chapel
Stockport SK4 5LX