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CAR PARK SURFACING & DRAINAGE OPTIONS REPORT

East Heath Car Park, Hampstead Heath

for

City of London

June 2017

Car Park Surfacing and Drainage Options Report

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P3266	**Car Park Surfacing and Drainage Options Report, East Heath Car Park, Hampstead Heath**

Revision	Date of issue	Comments	Prepared By	Checked By
1.0	25/05/2017	First Issue	EB	JB
2.0	16/06/2017	Costs revised, further details on construction method and maintenance programme	JB	AC
3.0	21/06/2017	Final comments by Client	JB	DB

Should you have any queries relating to this document please contact:

David Brooke / James Bailey
Stilwell Limited
Satelliet House
2 Nexus Park
Lysons Avenue
Ash Vale
GU12 5QE

T: +44 (0) 1276 700 400
E: jamesb@stilwell-ltd.co.uk

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Appendices

1.0 Introduction

1.1 The Stilwell Partnership has been instructed by the City of London to investigate suitable drainage solutions and three options for a new surface at East Heath Car Park, Hampstead Heath.

1.2 As part of this study, we have been asked to set out the advantages and disadvantages of each option, determine maintenance requirements, costs and approximate lifespan. This report first of all sets out the current issues and constraints associated with the car park, and those set out by the Client, and then goes on to outline each surfacing option in more detail and the most suitable drainage solution, before making a recommendation as to which option should be taken forward.

1.3 The general limitations of this assessment are that:

- A number of data sources have been used in compiling this report. Whilst The Stilwell Partnership (TSP) believe them to be trustworthy; it is unable to guarantee the accuracy of the information that has been provided by others.
- This report is based on information available at the time of preparation. There is potential for further information to become available, which may create a need to modify conclusions drawn in this report.

2.0 Current Issues and Constraints

2.1 The existing car park is the busiest car park serving Hampstead Heath and as such, a suitable surface is required in order to withstand frequent turning movements. The current surface is a self-binding Coxwell Gravel, which was laid a few years ago – see the site layout in **Appendix A**. This surface has not performed well to the daily operations of the car park – see photo in **Appendix B**. The surface has been dug up in places, leaving numerous potholes, resulting in some of the material being washed away to the south-eastern corner of the car park when it rains, and further onto East Heath Road during prolonged heavy periods of rain.

2.2 The City of London has tried to fill the potholes, but the infill material is soon washed away again when heavy rain returns. As a result, the Client requires a new surface to be installed which will deliver suitable natural drainage and provide a surface which will be able to withstand the daily rigours of the car park operations. In addition, the Client would like to keep the colour and texture of the existing car park surface, in order for it to remain in keeping with the surrounding conservation area.

2.3 There are sections of tarmacadam surfacing within the car park; from the entrance heading north to the grassed area to the north of the car park (which provides access for Fairground vehicles) and at the south-eastern corner of the car park for the disabled spaces. Both of these tarmacadam areas are to remain and repaired where necessary.

2.4 The Client has also specified that the new surface adopted must be able to have individual bays discreetly marked out.

3.0 Description of the Surfacing Options

3.1 Within the brief, the Client set out two options which should be given consideration and stated that one other should be considered. The two which were set out within the brief were 'Groundtrax Cellpav' or similar, with gravel in fill and Asphalt with spray and chip finish. The third option we have considered is a resin bound finish on a macadam surface. A description of each surface, construction programme and cost, the advantages and disadvantages and maintenance issues are outlined below for each option.

3.2 It should be noted that we have assumed that the existing tarmacadam sections (linking the site access to the field to the north-east and for the disabled bays at the southern corner of the site) will remain in order to provide a strong construction to support fairground vehicles and provide a level and solid standing for disabled users. We have allowed for the replacement of the surface and binder courses where sections of this macadam surface has broken up and this is included within our cost estimate of each option. It should also be noted that the drainage elements of each option, whilst outlined in the following section (**Section 4.0**), are included within the cost estimates provided in this section.

3.3 The Client has requested how long the car park would have to be closed for and, whilst the period of construction may vary from option to option, the answer remains the same. Essentially whether the car park is closed completely, for the duration of the works, will depend upon the Clients' required programme and budget costs. If the car park is closed completely, then each layer can be laid in one go, where as if the Client would like to keep part of the car park open during construction, then the layers will be laid in sections and this will increase costs and extend the programme. For each option below a range of construction periods have been given, with and upper and lower period.

Option 1 – Groundtrax CellPave 40

3.4 Groundtrax CellPave is an interlocking cellular paving grid system, which can be used for car parks, but is also safe for pedestrians to walk over.

Construction programme

3.5 The CellPave tiles would be laid down onto a geotextile fabric, above a prepared sub-base (usually 250mm deep, but soil investigations would need to be undertaken to determine the exact thickness) and a gravel in-fill used within the grid system. A typical cross section from an extract from Groundtrax CellPave 40 installation guide can be seen in **Figure 1** below and **Appendix C**.

3.6 We anticipate that this option could take between 3 to 4 weeks to install, depending upon weather and whether the car park is closed completely or not.

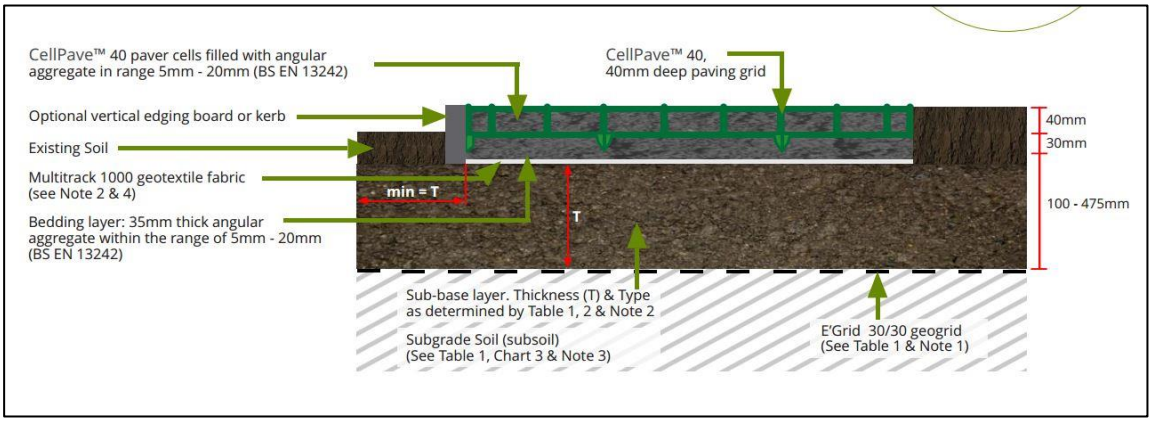

Figure 1: CellPave 40 Cross Section (Source: Groundtrax)

Cost of construction

3.7 This system would cost in the region of £360,000 to install. A breakdown of the various items (Bill of Quantities) used to estimate this cost of installing this option is included within **Appendix D**. It should be noted that the rates used are based on rates quoted to us on recent projects. However, they may vary significantly when the work is tendered, so the final price should only be used as a guide.

Advantages and disadvantages

3.8 The advantages and disadvantages of this system are as follows:

Advantages:

- Tiles allow water to pass through, therefore maintaining natural drainage;
- Durable construction;
- Good running surface for vehicles;
- Low cost compared to other options;
- Green - made from recycled PE/PP;
- Would prevent material being washed away into the carriageway, unlike the current scenario with Coxwell gravel.

Disadvantages:

- Not compatible with all bases;
- Gravel could be displaced by the movement of vehicles;
- The finished surface is not aesthetically pleasing as the cells can be seen at the surface;
- Difficult to mark-up car parking bays and road markings;
- Tends to be used as a temporary car park solution rather than a permanent car park solution.
- Not suitable for heavy vehicles

Maintenance issues, costs and programme

3.9 In terms of maintenance, the main issue would be the dislodging and required topping up of the gravel infill. The anticipated lifespan of this system would be in the region of 10 years, according to the supplier. At which point, some, if not all, of the CellPave tiles would need to be replaced. If vehicles larger than cars or small vans enter the car park, then damage may occur.

3.10 Regular inspection of the surface will need to be undertaken by the parks contractor / groundskeeper to assess whether the gravel infill needs sweeping or re-spreading. However, it may require re-spreading every 3 to 6 months. Maintenance of the drainage elements of this option are outlined in the next section of this report (**Section 4.0**).

Option 2 – Asphalt with spray and chip finish

3.11 This method essentially consists of a macadam construction and surface course, with a layer of liquid bitumen laid down before stone chippings are scattered onto the surface. The coloured stone chipping used would match the existing car park surface colour and provide a rustic texture.

Figure 2: Surface Dressing (Source: Foster Contracting)

Construction programme

3.12 The car park construction would include the following layers:

- A spray and chip surface dressing is applied to the surface course;
- 30mm dense bitumen macadam surface course;
- 60mm dense bitumen macadam binder course;
- 100mm dense bitumen macadam road base;
- 250mm type 1 sub base (subject to on site CBR tests).

3.13 Typical details are included within **Appendix E**, which show what a typical section through the spray and chip construction may look like.

3.14 In terms of the time periods required for laying each surface and the drainage, we anticipate that construction could take between 4 and 5 weeks. The spray and chip finish surface dressing should be laid during the summer months and will take approximately 3 days to lay. It should be noted that the surface course of the macadam construction should be left for at least 1 week, but ideally 2 weeks, before laying the chip finish surface dressing.

Cost of construction

3.15 The cost of this method would be in the region of £365,000 to install. A breakdown of the various items (Bill of Quantities) used to estimate this cost of installing this option is included within **Appendix D**. It should be noted that the rates used are based on rates quoted to us on recent projects. However, they may vary significantly when we go out to tender, so the final price should only be used as a guide.

Advantages and disadvantages

3.16 The advantages and disadvantages of this method are as follows:

Advantages

- Good running surface for vehicles;
- Good surface for pedestrians;
- Easy to apply clear road markings afterwards;
- The chipping surface gives a more pleasing look to the overall car park.

Disadvantages

- Possible Maintenance and schedule to re-spray and chip surface could be required after 3 to 5 years;
- In areas of tight manoeuvres there is a tendency for the chippings to be removed which can leave bare patches within the car park;
- The cost of the car park is increased as the spray and chip surface is a straight addition to the basic construction of the car park.
- A full positive drainage system is required with full height kerbs on the low side of the site.

Maintenance issues, costs and programme

3.17 In terms of maintenance, the main issue would be the spreading of loose chips. Brushing with a soft brush should be undertaken regularly. If they are not cleared regularly, there is a danger that they could get thrown up into the air and washed away into the south-eastern corner of the car park, potentially blocking up the drainage system. After a number of times of spreading the chips, they will become more embedded and fewer sweeps will be required.

3.18 The spray and chip finish should be reapplied after 5 to 6 years, after which the dressing should last for a further 10 years. However, it is important that the chips are swept and spread about the car park regularly. With the exception of the redressing, the regular (say every few months or so) monitoring and spreading / sweeping of the loose chips can be done by the parks regular maintenance contractor / groundkeeper. Maintenance of the drainage elements of this option are outlined in the next section of this report (**Section 4.0**).

Option 3 – Resin Bound finish

3.19 With this system, a resin bound aggregate is mixed with a clear resin on site so that each particle is completely coated with the resin. See **Figure 3** below and **Appendix F**. Once the resin and aggregates are fully mixed they are applied to the tarmac base and laid to give a permeable, smooth and durable finish. The finished depth of the bound system usually varies between 12mm and 24mm. The aggregate used would be of a similar colour to the existing car park surface.

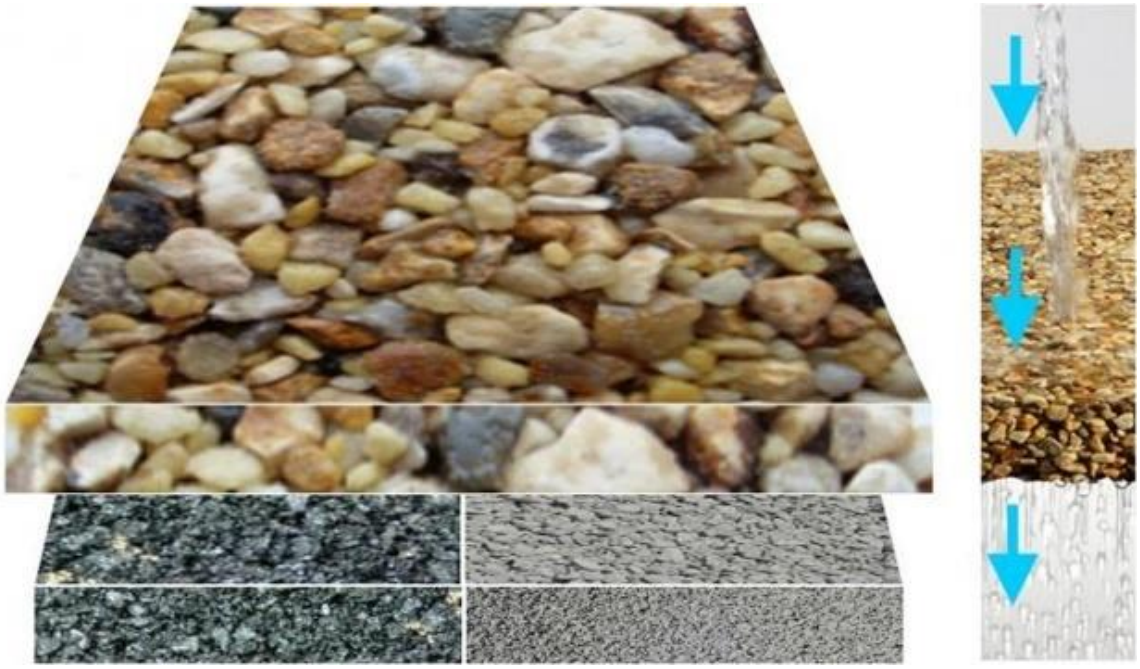

Figure 3: Resin Bound Aggregate (Source: Sureset)

Construction programme

3.20 The resin bound layer would be laid on top of a new porous tarmacadam surface, which would include; a geotextile membrane below a 300mm clean stone, below a 100mm base course and 60mm asphalt concrete binder course. Typical details are included within **Appendix E**, which show what a typical section through the resin bound permeable construction may look like.

3.21 The resin bound layer could take around 10 days to lay and it can only be applied during summer months. Sureset state that they can normally lay around 300sqm per day during the summer. The total resin bound surface construction, including the tarmacadam construction, drainage and resin bound layer, could take between 4 to 6 weeks to complete. The first two or three weeks would be spent laying the geotextile, sub-base and drainage, followed by the road base and binder course. The following two or three weeks would be spent laying the resin bound layer.

Cost of construction

3.22 This option could cost in the region of £459,000 to install. A breakdown of the various items (Bill of Quantities) used to estimate this cost of installing this option is included within **Appendix D**. It should be noted that the rates used are based on rates quoted to us on recent projects. However, they may vary significantly when we go out to tender, so the final price should only be used as a guide.

Advantages and disadvantages

3.23 The advantages and disadvantages of this method are as follows:

Advantages:

- Comes in wide range of colours so can be coloured to suit existing surface;
- Fast setting, allowing car park to be reopened within hours;
- Versatile – The resin can be applied to awkward areas such as steps and in corners;
- Lightweight – The finished surface can be as little as 12mm thick;
- Is porous, so contributes towards a Sustainable Urban Drainage system;
- UV stable, slip resistant, easy to maintain;
- Good surface for pedestrians;
- Easy to apply clear road markings afterwards;
- Does not loose stones, which end up on the adjacent carriageway;
- The resin bound surface would give a more pleasing look to the overall car park.

Disadvantages:

- This surface is fairly new to the market and, therefore, long term durability is not proven;
- More expensive than the other options;
- Bitumous blacktop/tarmac surfaces are prone to movement with changes in temperature. This may result in cracking of the bound screed;
- Possible maintenance to resin bound surface required after 5 to 8 years
- More expensive than other options.

Maintenance issues, costs and programme

3.24 In terms of maintenance, the main issues are going to be keeping the permeable pores free of debris and clearing any loose aggregate. Regular brushing with a soft brush should be undertaken and the surface should be inspected for damage, moss and weeds. Moss or weed killer can be applied to affected areas, if required, ensuring that no solvent or petrochemical products are used. One manufacturer, Sureset, recommend that the surface is pressure washed every 6 months, to ensure that the pores are kept clear and permeability is maintained in the resin.

3.25 In adverse weather conditions the surface may be prone to frost and/or ice, i.e. if minor cracks appear, these could fill with water, turn to ice and expand, just as with ordinary macadam surface course. The surface will not be affected by the application of granular sodium chloride or grit, but it is recommended that the surface is brushed to eliminate any spoil, grime or build. The lifespan of the resin bound layer is over 10 years, with one of the larger manufacturers, SureSet, guaranteeing their product for 18 years.

3.26 In terms of maintenance costs, it would cost the client a couple of local contractors a few days each year to pressure wash the car park. Costs will vary from contractor to contractor, but each pressure wash programme will require the car park to be closed in sections, along with appropriate traffic management. Maintenance of the drainage elements of this option are outlined in the next section of this report (**Section 4.0**).

4.0 Compatible Drainage Options

4.1 It should be noted that the underlying strata is likely to be clay. Therefore, a positive connection to the existing surface water sewer is required. As the car park is more than 20 spaces, there is a requirement for oil interception and treatment in accordance with the Pollution Prevention Guidelines (PPG). A petrol interceptor will be required for all options which do not have a natural treatment train, i.e. permeable paving options will have a natural treatment train and, therefore, a petrol interceptor will not be required. A positive connection to the existing inspection chamber (IC @73.720m AOD) will be utilized. All surface water drainage options will ultimately discharge into Hampstead No. 1 pond, east of the car park. There should be no interaction with the groundwater table in any drainage solution.

4.2 Considering the above constraints and the proposed surfacing options outlined in the previous section, we have considered the most suitable drainage solutions for each surfacing option and these are set out below, along with their advantages and disadvantages.

Option 1 – Groundtrax CellPave

4.3 This surface system is permeable and so a drainage system would be utilised to collect surface water from underneath the surface. The drainage system would consist of a geotextile layer below the CellPave grid and gravel in-fill material. 250mm of clean open-graded stone would be laid below a permeable geotextile. A partial infiltration pipe wrapped in a geotextile would be laid across the site, to convey the surface water to the outfall. The pipe would be 150mm diameter and set in a 450mm wide trench of clean open graded stone, wrapped in geomembrane. Treatment to comply with current legislation, will be provided in the clean stone layer and textiles.

4.4 The advantages and disadvantages of this system related to drainage are as follows:

Advantages

- Low cost;
- Good treatment train – i.e. there will naturally be at least two stages of treatment of surface water before it meets the outfall.

Disadvantages

- Poor durability;
- Maintenance of the gravel in-fill.

Drainage maintenance regime

4.5 The drainage system for this option will be permeable and most of the cleaning of the surface water will be through the permeable layers. However, it is recommended that the partial infiltration pipe and connection to the existing inspection chamber are checked every 6 months and cleared out as and when required, in line with the existing drainage maintenance regime.

Option 2 – Asphalt with spray and chip finish

4.6 This surface system is impermeable and so surface water will need to be positively collected by gulleys at the surface level and directed to the gulleys located along the edges. Trapped gullies will be placed to accommodate a maximum of 150 square metres of car park area each. 150mm diameter plastic standard piped drainage system would be used to convey surface water to the outfall. Treatment would be via the trapped gullies. Due to the size of the car park and the lack of filtration material, a bypass petrol interceptor will be required at the outfall.

4.7 The advantages and disadvantages of this system related to drainage are as follows:

Advantages

- Good durability;
- Low cost.

Disadvantages

- Poor treatment train – i.e. the system may struggle to provide sufficient treatment without the inclusion of an oil interceptor. This would have cost implications and may introduce level constraints and complexities during installation.

Drainage maintenance regime

4.8 The drainage system for this option will be impermeable and the cleaning of the surface water will be via a petrol interceptor. The lifespan of petrol interceptors vary from manufacturer to manufacturer, but some state 20 years. The petrol interceptor will need to be inspected every 6 months to check the depth of the accumulated oil and service the equipment. It is recommended that the interceptor is emptied every 5 years, but this will be dependant on usage.

4.9 In addition to the maintenance of the petrol interceptor, the gulleys and drainage pipes will also need to be regularly inspected and cleaned out once or twice a year. A visual inspection of the gulleys can be undertaken by the parks maintenance contractor / groundskeeper every month or so and after a heavy storm, to ensure the drainage system is operating efficiently.

Option 3 – Resin Bound finish above porous asphalt surfacing

4.10 This surface system is permeable and so a drainage system would be utilised to collect surface water from underneath the surface. The drainage system would consist of a geotextile layer below the Resin topping and gravel in-fill material. 300mm of clean open-graded stone would be laid below a permeable geotextile. A partial infiltration pipe wrapped in a geotextile would be laid across the site, to convey the surface water to the outfall. The pipe would be 150mm diameter and set in a 450mm wide trench of clean open graded stone, wrapped in geomembrane. Treatment to comply with current legislation, will be provided in the clean stone layer and textiles.

4.11 The advantages and disadvantages of this system related to drainage are as follows:

Advantages

- Good treatment train – i.e. there will naturally be at least two stages of treatment of surface water before it meets the outfall.
- Aesthetics.

Disadvantages

- Poor durability
- High cost.

Drainage maintenance regime

4.12 The drainage system for this option will be permeable and most of the cleaning of the surface water will be through the permeable layers. However, it is recommended that the partial infiltration pipe and connection to the existing inspection chamber are checked every 6 months and cleared out as and when required, in line with the existing drainage maintenance regime.

4.13 As stated in the previous section, it is also important that the permeable pores are kept clear and the surface is cleaned regularly. The car park surface will also need to be jet washed every year to ensure the pores are kept clear.

5.0 Recommendations and Conclusions

5.1 In considering which of the surfacing options and their associated drainage solutions outlined in **Sections 3.0** and **4.0**, there are a number of factors which need to be considered. With all of the options we have considered the following factors:

- Aesthetics;
- Usability;
- Potential maintenance issues;
- Lifespan; and
- Cost.

5.2 In terms of aesthetics, the resin bound finish would look more in keeping with the location, although the spray and chip finish surface could also match the existing surface colour and texture in a similar manner. The CellPave option, however, is unlikely to be in keeping and is likely to result in the build-up of gravel at the edges of the car park. This is also a potential issue with the spray and chip finish, if not sufficiently maintained.

5.3 Manufacturers of all options state that they are safe for pedestrians to walk across. However, with the CellPave and, to a lesser extent, the spray and chip finish, there is a potential for loose stone and gravel to build up in channels and areas where frequent turning occurs. This could be an issue for drainage maintenance, as well as a safety issue for pedestrians.

5.4 Maintenance has been touched on already and it is clear that the loose aggregate is the main issue from the surfacing perspective. The spray and chip finish surface will need reapplying after 5 years or so, whereas the resin bound would not (although it is not clear whether 'patching' may be required over time). From a drainage perspective, any porous surfacing option would need to be regularly cleaned of grit, moss, or any other detritus which may find its way into the pores. However, the spray and chip finish option would require gulleys and a petrol interceptor, so maintenance costs are likely to be higher.

5.5 In terms of the lifespan, the resin bound surface finish would appear to be the best option. However, it is a relatively new type of surface and it is not fully clear if the surface would be able to last for the full period claimed by the manufactures. Clearly it would come down to the level of use of the car park and clearly the site in question is extremely well used. Therefore, a thick surface and sufficiently strong resin would have to be used. Further discussions with the manufacturer would have to be had in order to ensure that the correct specification is applied. The spray and chip finish surface could last up to 15 years, but would need to be re-dressed after 5 years and would have to be sufficiently maintained, by regular spreading of the loose chips.

5.7 In terms of cost, the spray and chip finish and Cellpave options are the cheapest (approx.. £360k), whilst the resin bound would be approximately £90k - £100k more expensive (approx.£460k). Whilst the resin bound surface finish is the most expensive, the maintenance issues would be relatively minimal. Another factor is that the permeability of the resin bound surface would allow a more natural (sustainable) drainage option to be installed, which would provide a good treatment train, when compared to the traditional drainage system required for the spray and chip finish surface, where gulleys and a petrol interceptor would be required. However, maintenance of the spray and chip finish is unlikely to cost anywhere near £90k more than the resin bound.

5.8 In summary, it would be a balance between the spray and chip finish and the resin bound finish, in terms of construction cost and maintenance. Both options would provide the aesthetic requirements of the park and be suitable to meet the needs of the users of the car park. The spray and chip finish is the lower priced option, but is likely to require more maintenance and could have a slightly shorter lifespan – although it is unclear if the lifespan of the resin bound is proven. The resin bound option would be a more expensive option, but should require less maintenance.

5.9 Our recommendation would be to use the spray and chip finish option. This option has already been used elsewhere on the footways within Hampstead Heath. In addition, we have specified this option at a number National Trust site car parks, where maintaining the historical feel of the site is important and they have lasted well.

Appendix A

Site Location Plan

. 8m

527000

527000

186000

186000

100

100

200

200

900

900

Trough

BM 82. 56m

79. 7m

East Heath Car Park

Car Park

Hampstead Heath

East Heath

BM 75. 77m

Sluice

75. 5m

Path (um)

72. 1m

72. 0m

74. 9m

LB

71. 0m

BM
74. 89m

N

W

E

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THIS IS A CONTROLLED DOCUMENT
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Rev	Description	Drw	Ckd	Date
A	FIRST ISSUE	EB	DB	25.05.17

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Stilwell PARTNERSHIP
STILWELL LIMITED CONSULTING ENGINEERS
SATELLIET HOUSE
2 NEXUS PARK
ASH VALE
SURREY
GU12 5QE
Tel: 01276 700400
Fax: 01252 544934
E-Mail: info@stilwell-ltd.co.uk
Web: www.stilwell-ltd.co.uk

Client:

CITY OF LONDON

Project:

EAST HEATH
CAR PARK

Title:

Site Location Plan

Date:	Drawn:	Checked:
MAY 2017	EB	DB

Scale:	Status:
NTS @ A3	Preliminary

Drawing No: TSP/COL/P3266/01

Rev: A

Appendix B

Pothole Photograph


AX03 AWN
LP15 WYZ

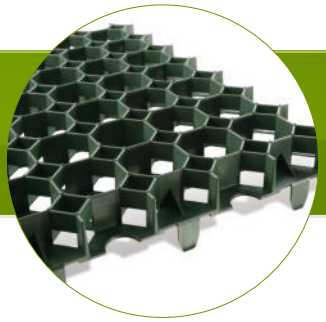
Appendix C

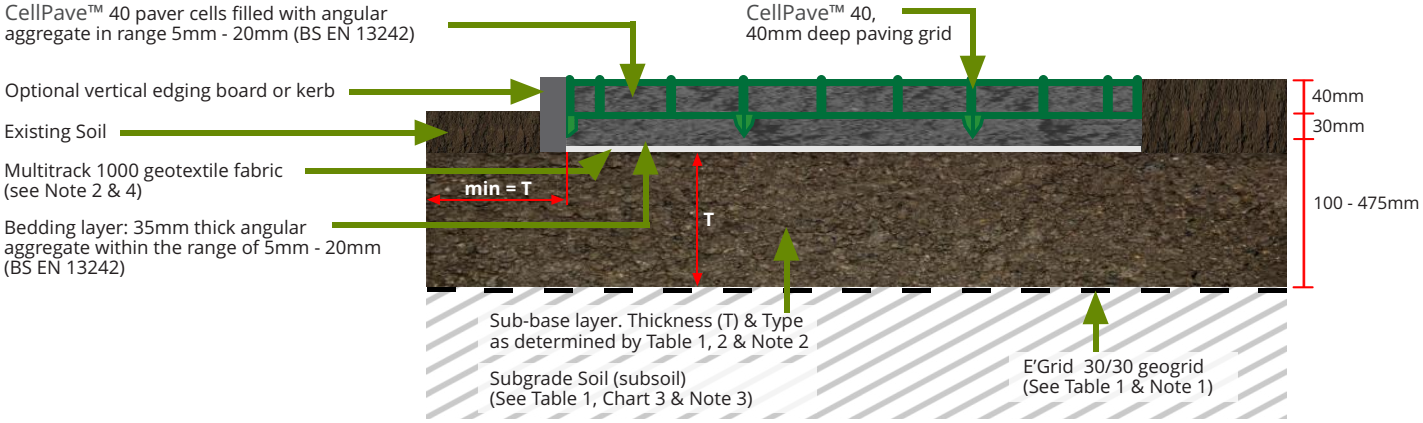
Ground Trax CellPave 40

CELLPAVE™ 40

CELLPAVE™ 40 - Interlocking Cellular Paving Grid System

INSTALLATION GUIDE - GRAVEL SURFACES





Installation Method

1. Place paver units with spikes downward onto the prepared well consolidated bedding layer. Edging boards or kerbs can be used where required, according to existing soil conditions.

2. Connect the pavers using the ground spikes and loops, progressing over the area in rows. Use protective gloves to avoid abrasions.

3. Pavers can be cut using a hand or power saw to fit around obstructions and curves. Cut pieces which are less than half the original size should be avoided where possible.

4. Fill the pavers to the top of the cells with the specified angular decorative aggregate. If required, use a light vibrating plate to consolidate the aggregate into the cells. Top up cells with aggregate as necessary. Fully rounded 'pea gravel' is not recommended.

5. If the area is to be used as horse paddock, it is preferable to cover the area with a 50-100mm thick layer of fine sand/mulch.

6. The surface may be trafficked immediately.

Note 1: If the geogrid layer is omitted, then the total sub-base layer thickness (T) must be increased by 50%.

Note 2: A 'DoT Type 1' sub-base may be used, provided that an adequate drainage system is installed (refer to note 4).
Alternatively a porous/open-graded (reduced fines) sub-base layer may be specified, e.g as part of a Sustainable Urban Drainage System (SUDS) application. If a 'reduced fines' sub-base layer is specified, this must be covered with either a geotextile filter membrane and/or a suitable clean gravel blinding layer, to avoid fine particles entering the sub-base layer. Do not use sand for the paver bedding layer.

Note 3: Specific advice on ground conditions, CBR% and construction over ground with a CBR less than 1% is available from Groundtrax Systems Ltd. CBR% = California Bearing Ratio, a measurement of subgrade soil strength.

Note 4: Typical drainage details; 100mm diameter perforated pipe drain laid at minimum gradient 1:100, bedded on gravel in trench backfilled with 'DoT Type A' drainage aggregate, covered or wrapped with Multitrack 1000 geotextile fabric and leading to a suitable outfall or soakaway. Drains placed down centre or one edge of access routes up to 5m wide. Wider areas may require additional drains at 5m - 10m centres. Drainage design to be determined by the specifier based on specific conditions on site. Specific advice on Drainage and Sustainable Urban Drainage Systems (SUDS) is available from Groundtrax Systems Ltd.

Note 5: Maximum advised gradient for traffic applications is 12% (1:8) 7°. Pegging may be required. Specific advice for the use of CellPave™ 40 on slopes can be obtained from Groundtrax Systems Ltd.

Note 7: CellPave™ 40 complies with BS8300:2001 - "Design of buildings and their approaches to meet the needs of disabled people" - Code of Practice. (ISBN 0580384381)

CELLPAVE™ 40 - Interlocking Cellular Paving Grid System
INSTALLATION GUIDE - GRAVEL SURFACES

Table 1: Typical Sub-base Thickness (T) Requirements - refer to construction profile

Application / Load	CBR (%) strength of subgrade soil *(see Chart 1)*	(T) DoT sub-base thickness (mm) *(see Note 2)*	Geogrid *(see Note 1)*
Fire engine and occasional HGV access	≥ 6	100	E'Grid 30/30
	= 4 < 6	120	E'Grid 30/30
	= 2 < 4	190	E'Grid 30/30
	= 1 < 2	380	E'Grid 30/30
Light vehicle access and overflow car parking	≥ 6	100	E'Grid 30/30
	= 4 < 6	100	E'Grid 30/30
	= 2 < 4	135	E'Grid 30/30
	= 1 < 2	260	E'Grid 30/30

Table 2: Paving Grid Specification

Product	CellPave™ 40
Material	Rigid 100% recycled polyethylene
Colour	Black
Paver Dimensions	500mm x 500mm x 40mm
Paver Size	500mm x 500mm (4 grids per m2)
Nominal Cell Size	60mm Octagonal
Cell Wall Thickness	2.7mm - 3.2mm
Weight	1.2kg/paver - (4.80kg/m2)
Load Bearing Capacity	150 tonnes/m2 (Crush resistance)
Central Base Support	25mm long pegs on underside (4 per paver)
Open Cell %	Top 95% / Base 75%
Connection Type	Spike and loop edge connection
Chemical Resistance	Excellent
UV Resistance	High
Toxicity	Non Toxic
Bedding Layer	30mm thick of 5-20mm angular aggregate (BS EN 13242)
Paver fill	To top of pavers using 5-20mm crushed aggregate (BS EN 13242)
Sub-Base Type	DoT Type 3 or a modified porous sub-base *(Table 1 & Note 2).* DoT Type 1 with drains
Base Reinforcement	E'Grid 30/30 geogrid *(Table 1 & Note 1)* - Specifications available on request.

NOTE:
This field guide is provided as an aid to assessing the mechanical stabilisation requirements in commonly encountered site conditions. Groundtrax Systems Ltd accepts no responsibility for any loss or damgae resulting from the use of this guide.

Chart 1: Field guidance for estimating sub-grade strengths

Consistancy	Indicator			Strength	
	Tactile (feel)	Visual (observation)	Mechanical (test) SPT	CBR %	CU kN/m²
Very Soft	Hand sample squeezes through fingers	Man standing will sink >75mm	<2	<1	<25
Soft	Easily moulded by finger pressure	Man walking sinks 50-70mm	2-4	Around 1	Around 25
Medium	Moulded by moderate finger pressure	Man walking sinks 25mm	4-8	1-2	25-40
Firm	Moulded by strong finger pressure	Unloaded construction vehicle ruts 10-25mm	8-15	2-4	40-75
Stiff	Cannot be moulded but can be indented with thumb	Loaded construction vehicle ruts by 25mm	15-30	4-6	75-150

For more information, contact us today or visit our website:
www.cellpave.com

GROUNDTRAX
Ground Protection and Reinforcement
Telephone: 08456 800008 | Fax: 08456 800208
E-Mail: info@groundtrax.com | Website: www.groundtrax.com

Appendix D

Bill of Quantities

East Heath - Car Park Resurfacing
(Hampstead Heath) - P3266 - Bill of Quantities
Option 1 - Groundtrax CellPave 40

DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
1.0	**PRELIMINARIES**				
1.1	**Site Set up & Establishment**				
1.1.1	Site welfare inc. maintenance of all facilities allow for a meeting room an engineers area with desk.	4	week	400.00	1,600.00
1.1.2	Establishment, maintenance and dis-establishment of secure site compound	4	week	100.00	400.00
1.1.3	Setting out of all works	1	item	100.00	100.00
1.1.4	Scan area for services locations and mark on surface as required	1	item	200.00	200.00
1.2	**Temporary Traffic Management**				
1.2.1	Taking measures for the construction, maintenance and removal of temporary traffic and pedestrian management but not measured individually.	4	Week	300.00	1,200.00
1.3	**As Built Drawings / Health and Safety File**				
1.3.1	As built drawings	1	Item	0.00	0.00
1.3.2	Health and safety file on completion of works	1	item	350.00	350.00
1.3.3	Precautions taken for working in the vicinity of live services	1	Item	300.00	300.00
1.3.4	Trial holes to determine the location of services	2	Item	300.00	600.00
1.4	**Site Clearance**				
1.4.1	General Site Clearance.	1	Item	200.00	200.00
1.4.2	Clean out manholes, gulleys / channels and jet lateral runs	1	Item	1,500.00	1,500.00
			TOTAL		**6,450.00**

DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
2.0	**EARTHWORKS**				
2.1	**Excavation of Material**				
2.1.1	Excavation of existing gravel / surface verge to construct new resurface (500mm deep)	1300	Cu.m	25.00	32,500.00
2.1.2	Excavate existing tarmac surface and base course	100	Cu.m	25.00	2,500.00
2.2	**Disposal of Materials**				
2.2.1	Disposal of unacceptable materials Class U1.	1400	Cu.m	30.00	42,000.00
2.3	**Soft Spots and other Voids**				
2.3.1	Excavation of soft spots and other voids (PROVISIONAL)	10	Cu.m	40.00	400.00
			TOTAL		**77,400.00**

DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
3.0	**PAVEMENTS**				
3.1	**Sub-Base**				
3.1.1	Granular Type 1 sub-base (assumed 250mm)	650	Cu.m	65.00	42,250.00
3.2	**Pavement**				
3.2.1	CellPave 40 - Interlocking Cellular Paving Grid System including CellPave 40 paver cells filled with angular aggregate in range 5mm - 20mm (BS EN 13242), Optional vertical edging board or kerb, Multitrack 1000 geotextile fabric, Bedding layer: 35mm thick angular aggregate within range of 5mm - 20mm. Sub-base layer, 135mm thick DoT Type 1 Sub-base, E'Grid 30/30 geogrid.	2600	Sq.m	55.00	143,000.00
3.2.2	Relay 40mm thick Dense Macadam surface course (B.S.4987, part2 2001) (CL.7.4) 10mm N.S aggregate. 100PEN binder	670	Sq.m	13.00	8,710.00
3.2.3	Relay 100mm Dense Macadam Base course (B.S.4987:Part 1 2001 Cl.5.2) 32mm N.S aggregate 125 PEN binder.	670	Sq.m	25.00	16,750.00
3.2.4	Terram (or Similar) 900/1000 Geomembrane	2600	Sq.m	10.00	26,000.00
		TOTAL			**236,710.00**

DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
4.0	**ROAD MARKINGS & STREET FURNITURE**				
4.1.1	Daily rate for all Road Markings	1	Day	1,000.00	1,000.00
		TOTAL			**1,000.00**
5.0	**DRAINAGE**				
5.1.1	Provide and lay 150mm dia partial infiltration pipes to connect into existing manhole / outfall.	65	lin.m	100.00	6,500.00
		TOTAL			**6,500.00**

Item No.	Description	Qty	Units	Rate	Amount £ p
	GENERAL SUMMARY				
1.0	**PRELIMINARIES**				6,450.00
2.0	**EARTHWORKS**				77,400.00
3.0	**PAVEMENTS**				236,710.00
4.0	**ROAD MARKINGS**				1,000.00
5.0	**DRAINAGE**				6,500.00
6.0	**10% CONTINGENCY**				32,806.00
		TOTAL			**360,866.00**

East Heath - Car Park Resurfacing
(Hampstead Heath) - P3266 - Bill of Quantities
Option 2 - Asphalt and Chip Finish

DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
1.0	**PRELIMINARIES**				
1.1	**Site Set up & Establishment**				
1.1.1	Site welfare inc. maintenance of all facilities allow for a meeting room and engineers area with desk.	4	week	400.00	1,600.00
1.1.2	Establishment, maintenance and dis-establishment of secure site compound	4	week	100.00	400.00
1.1.3	Setting out of all works	1	item	100.00	100.00
1.1.4	Scan area for services locations and mark on surface as required	1	item	200.00	200.00
1.2	**Temporary Traffic Management**				
1.2.1	Taking measures for the construction,	4	Item	300.00	1,200.00
1.3	**As Built Drawings / Health and Safety File**				
1.3.1	As built drawings	1	Item	0.00	0.00
1.3.2	Health and safety file on completion of works	1	item	0.00	0.00
1.3.3	Precautions taken for working in the vicinity of	1	Item	300.00	300.00
1.3.4	Trial holes to determine the location of services	2	Item	300.00	600.00
1.4	**Site Clearance**				
1.4.1	General Site Clearance.	1	Item	200.00	200.00
1.4.2	Clean out manholes, gulleys / channels and jet lateral runs	1	Item	1,500.00	1,500.00
			TOTAL		**6,100.00**

DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
2.0	**EARTHWORKS**				
2.1	**Excavation of Material**				
2.1.1	Excavation of existing gravel / surface to construct new resurface (410mm deep)	1066	Cu.m	25.00	26,650.00
2.1.2	Excavate existing tarmac surface and base course	100	Cu.m	25.00	2,500.00
2.2	**Disposal of Materials**				
2.2.1	Disposal of unacceptable materials Class U1.	1166	Cu.m	35.00	40,810.00
2.3	**Soft Spots and other Voids**				
2.3.1	Excavation of soft spots and other voids (PROVISIONAL)	10	Cu.m	40.00	400.00
			TOTAL		**70,360.00**

DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
3.0	**PAVEMENTS**				
3.1	**Sub-Base**				
3.1.1	Granular Type 1 sub-base (assumed 250mm)	650	Cu.m	65.00	42,250.00
3.2	**Pavement**				
3.2.1	30mm thick Dense Macadam surface course (B.S.4987, part2 2001) (CL.7.4) 10mm N.S aggregate. 100PEN binder	2600	Sq.m	13.00	33,800.00
3.2.2	Relay 40mm thick Dense Macadam surface course (B.S.4987, part2 2001) (CL.7.4) 10mm N.S aggregate. 100PEN binder	670	Sq.m	13.00	8,710.00
3.2.3	60mm Dense Macadam binder course (B.S.4987:Part 1 2001 Cl.6.5) 20mm N.S aggregate 125 PEN binder.	2600	Sq.m	18.00	46,800.00
3.2.4	100mm Dense Macadam Base course (B.S4987:Part 1 2001 Cl.6.5) 20mm N.S aggregate 125 PEN Binder	2600	Sq.m	25.00	65,000.00
3.2.5	Relay 100mm Dense Macadam Base course (B.S.4987:Part 1 2001 Cl.5.2) 32mm N.S aggregate 125 PEN binder.	670	Sq.m	25.00	16,750.00
3.2.6	Spray and chip Finish	2600	Sq.m	7.00	18,200.00
		TOTAL			**231,510.00**

DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
4.0	**KERBS, FOOTWAY AND PAVED AREAS**				
4.1	**Kerbing, Channels, Edgings etc.**				
4.1.1	Precast concrete kerbs to BS7263 Type HB2 255x125mm, laid straight or curved	120	Lin.m	32.00	3,840.00
		TOTAL			**3,840.00**

DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
5.0	**ROAD MARKINGS & STREET FURNITURE**				
5.1.1	Daily rate for all Road Markings	1	Day	1,000.00	1,000.00
		TOTAL			**1,000.00**
6.0	**DRAINAGE**				
6.1.1	Provide and install new 450mm dia, precast concrete gully pots with ductile iron grating and frame to BS EN 124, class D400. Gully pots to have 150mm ST2 concrete bed and surround. To include all excavation and disposal.	8	No.	450.00	3,600.00
6.1.2	Provide and lay 150mm dia clay pipes from new gulleys to connect into existing manhole. To include all concrete bedding and surround and road construction in trenches.	100	lin.m	100.00	10,000.00
6.1.3	Drainage connections to manhole/inspection chambers and gulleys.	1	No.	90.00	90.00
6.1.4	Petrol / Oil Interceptor - Supplied and laid	1	No.	5,500.00	5,500.00
		TOTAL			**19,190.00**

DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
	GENERAL SUMMARY				
1.0	PRELIMINARIES				6,100.00
2.0	EARTHWORKS				70,360.00
3.0	PAVEMENTS				231,510.00
4.0	KERBS				3,840.00
5.0	ROAD MARKINGS				1,000.00
6.0	DRAINAGE				19,190.00
7.0	10% CONTINGENCY				33,200.00
		TOTAL			365,200.00

East Heath - Car Park Car Park Resurfacing
(Hampstead Heath) - P3266 - Bill of Quantities
Option 3 - Resin Bound Finish

DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
1.0	**PRELIMINARIES**				
1.1	**Site Set up & Establishment**				
1.1.1	Site welfare inc. maintenance of all facilities allow for a meeting room an engineers area with desk.	4	week	400.00	1,600.00
1.1.2	Establishment, maintenance and dis-establishment of secure site compound	4	week	100.00	400.00
1.1.3	Setting out of all works	1	item	100.00	100.00
1.1.4	Scan area for services locations and mark on surface as required	1	item	200.00	200.00
1.2	**Temporary Traffic Management**				
1.2.1	Taking measures for the construction, maintenance and removal of temporary traffic and pedestrian management but not measured individually.	4	Week	300.00	1,200.00
1.3	**As Built Drawings / Health and Safety File**				
1.3.1	As built drawings	1	Item	0.00	0.00
1.3.2	Health and safety file on completion of works	1	item	0.00	0.00
1.3.3	Precautions taken for working in the vicinity of live services	1	Item	300.00	300.00
1.3.4	Trial holes to determine the location of services	2	Item	300.00	600.00
1.4	**Site Clearance**				
1.4.1	General Site Clearance.	1	Item	200.00	200.00
1.4.2	Clean out manholes, gulleys / channels and jet lateral runs	1	Item	1,500.00	1,500.00
			TOTAL		**6,100.00**

DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
2.0	**EARTHWORKS**				
2.1	**Excavation of Material**				
2.1.1	Excavation of existing gravel / surface to construct new resurface (490mm deep)	1274	Cu.m	25.00	31,850.00
2.1.2	Excavate existing tarmac surface	100	Cu.m	25.00	2,500.00
2.2	**Disposal of Materials**				
2.2.1	Disposal of unacceptable materials Class U1.	1374	Cu.m	30.00	41,220.00
2.3	**Soft Spots and other Voids**				
2.3.1	Excavation of soft spots and other voids (PROVISIONAL)	10	Cu.m	40.00	400.00
			TOTAL		**75,970.00**

DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
3.0	**PAVEMENTS**				
3.1	**Sub-Base**				
3.1.1	Granular Type 3 sub-base (assumed 300mm), locally sourced clean stone	780	Cu.m	75.00	58,500.00
3.2	**Pavement**				
3.2.1	(30mm thick) Resin Bound Layer with separate layers as needed .	2600	Sq.m	40.00	104,000.00
3.2.2	60mm AC10 open surface asphalt concrete binder course max 100-150 PEN to BSEN 13108-1:2006	2600	Sq.m	18.00	46,800.00
3.2.3	100mm AC20 open BIN asphalt concrete Road Base Max 100/150 PEN to BSEN 13108:2006.	2600	Sq.m	25.00	65,000.00
3.2.4	Relay 40mm thick Dense Macadam surface course (B.S.4987, part2 2001) (CL.7.4) 10mm N.S aggregate. 100PEN binder	670	Sq.m	13.00	8,710.00
3.2.5	Relay 100mm Dense Macadam Base course (B.S.4987:Part 1 2001 Cl.5.2) 32mm N.S aggregate 125 PEN binder.	670	Sq.m	25.00	16,750.00
3.2.6	Terram (or similar) 900/1000 Geomembrane	2600	Sq.m	10.00	26,000.00
			TOTAL		**325,760.00**

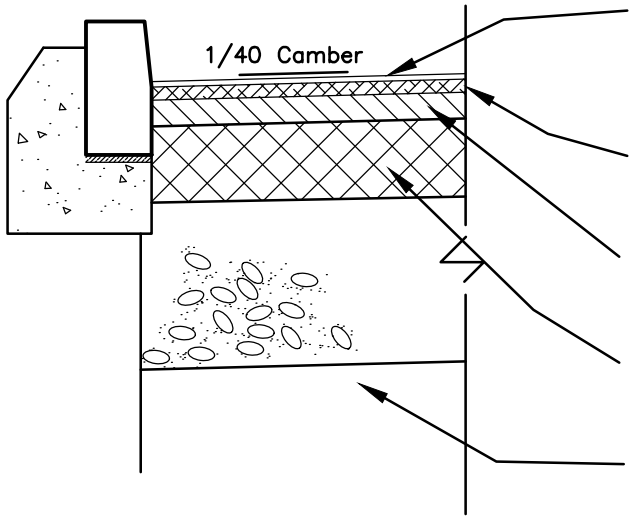
DRAFT

Item No.	Description	Qty	Units	Rate	Amount £ p
4.0	**ROAD MARKINGS & STREET FURNITURE**				
4.1.1	Daily rate for all Road Markings	1	Day	1,000.00	1,000.00
			TOTAL		**1,000.00**
5.0	**DRAINAGE**				
5.1.1	Provide and lay 150mm dia partial infiltration pipes to connect into existing manhole / outfall.	65	lin.m	100.00	6,500.00
5.1.2	Provide and install new 450mm dia, precast concrete gully pots with ductile iron grating and frame to BS EN 124, class D400. Gully pots to have 150mm ST2 concrete bed and surround. To include all excavation and disposal.	4	No.	450.00	1,800.00
			TOTAL		**8,300.00**

Item No.	Description	Qty	Units	Rate	Amount £ p
	GENERAL SUMMARY				
1.0	**PRELIMINARIES**				6,100.00
2.0	**EARTHWORKS**				75,970.00
3.0	**PAVEMENTS**				325,760.00
4.0	**ROAD MARKINGS**				1,000.00
5.0	**DRAINAGE**				8,300.00
6.0	**10% CONTINGENCY**				41,713.00
			TOTAL		**458,843.00**

Appendix E

Typical details (spray & chip and resin bound options)



12mm OF ASPHALT AND CHIP FINISH; ONE LAYER OF 1.6l/m² OF HOT BITUMEN EMULSION FOLLOWED BY 6mm GOLDEN GRAVEL CHIPPINGS AND THEN 1.4l/m² OF HOT BITUMEN EMULSION FOLLOWED BY ANOTH 6mm GOLDEN GRAVEL CHIPPINGS

30mm CLOSE GRADED ASPHALT CONCRETE SURFACE COURSE (BSEN 13108–01) (Cl.912 DTp.Spec.)
10mm N.S aggregate. 100/150 binder.

60mm DENSE MACADAM BINDER COURSE (BSEN 13108–01) (Cl.906 DTp.Spec.)
20mm N.S aggregate. 40/60 binder.

100mm DENSE MACADAM ROADBASE (BSEN 13108–01) (Cl.906 DTp.Spec.)
28mm N.S aggregate. 40/60 binder.

250mm min GRANULAR SUB–BASE MATERIAL Type 1 crushed rock (Cl.803 DfT.Spec.)

ASPHALT AND CHIP FINISH CONSTRUCTION

30mm RESIN BOUND PERMEABLE PAVING SURFACE, 10mm AGGREGATE. AS SUPPLIED BY SURESET OR SIMILAR

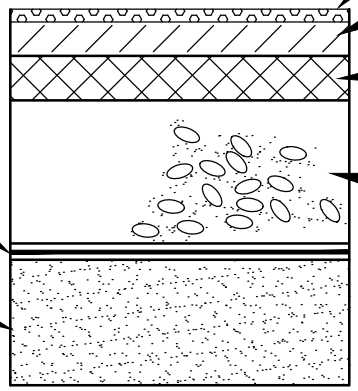
60mm AC10 OPEN SURFACE ASPHALT CONCRETE BINDER COURSE MAX 100–150 PEN TO BS EN 13108–1:2006.

100mm AC20 OPEN BIN ASPHALT CONCRETE ROAD BASE MAX 100/150 PEN TO BS EN 13108:2006. LAID TO MINIMUM FALL OF 1.5% (1 IN 66).

300mm WELL COMPACTED TYPE 3 GRANULAR SUB BASE TO SHW CLAUSE 805 OR 4/40mm GRADED CRUSHED AGGREGATE TO EN12620 OR LOCALLY AVAILABLE SECONDARY OR RECYCLED AGGREGATES WHICH COMPLY WITH THE ABOVE SPECIFICATION BLINDED WITH 2/6.3mm GRADED CRUSHED CONCRETE AGGREGATE TO EN12620

TERRAM 900/1000/ADVANTAGE GEOTEXTILE MEMBRANE TO PREVENT UPWARD MIGRATION OF LINE SOIL PARTICLES

150mm CAPPING LAYER Type 2 SUB–BASE IF SUBGRADE HAS A CBR VALUE LESS THAN 15%



RESIN BOUND PERMEABLE CONSTRUCTION

A	FIRST ISSUE	JB	DB	16/06/17

Part of the Parsons Group
Stilwell PARTNERSHIP
STILWELL LIMITED CONSULTING ENGINEERS
SATELLIET HOUSE
2 NEXUS PARK
ASH VALE
SURREY
GU12 5QE
Tel: 01276 700400
Fax: 01252 544934
E-Mail: info@stilwell-ltd.co.uk
Web: www.stilwell-ltd.co.uk

Client: CITY OF LONDON

Project: EAST HEATH CAR PARK, HAMPSTEAD HEATH

Date: JUNE 2017 | Drawn: JB | Checked: DB

Scale: NTS @ A4 | Status: PRELIMINARY

Title: CAR PARK CONSTRUCTION TYPICAL DETAILS

Drawing No: TSP/COL/P3266/02 | Rev: A

Appendix F

Sureset – Resin Bound

PERFECT PAVING

We take pride in the fact we offer great customer service along with great products.

From start to finish we can offer technical advice, full supply and installation and a 18 year guarantee to complete the service.

Our resin bound paving solutions offer natural and recycled materials, unlimited colours, and a design flexibility no other type of paving can match.

Unlike many traditional paving systems SureSet is permeable; this means that any proposal including SureSet demonstrates a sustainable approach to water management.

As a market leader in permeable resin bound paving, we have the reputation, experience and innovative approach to make any design outstanding throughout the world.

- Durable
- Permeable
- Quick and easy to install
- Unlimited colours
- Flexible design capability
- Low maintenance
- Smooth, hardwearing finish
- Colour stable
- 18 year guarantee

Visit our website to watch our videos or subscribe to our YouTube channel

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