REPORT

Birchall Garden Suburb

Outline Remediation Strategy

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1 Introduction

1.1 Background

Tarmac is promoting Birchall Garden Suburb as an extension to Welwyn Garden City in the form of a new Garden Suburb. The extent of the land being promoted for development includes Cole Green former mineral workings, land to the south and west of Cole Green former mineral workings and land to the north and south of Birchall Lane. The landfilled former mineral workings will be utilised as public open space. No housing will be developed on the landfill but development will take place in terms of access roads, footpaths, cycle paths, and green infrastructure etc.

Royal HaskoningDHV were commissioned by Tarmac to advise on potential land quality constraints at the site in the context of the proposed development. As such several studies have been undertaken and are summarised in **Section 3**.

Some of the studies confirmed potential contaminants of concern were present at the site at concentrations that potentially represent an unacceptable risk to human health, and that the landfill was having an ongoing impact on shallow groundwater and surface waters in the vicinity of the site. This outline remedial strategy has therefore been developed to mitigate against unacceptable risks to human health and to improve the overall environmental baseline.

This report should be read in conjunction with the technical studies referred to above and referenced throughout this document.

1.2 Report Objectives

The key objective of this report is to present an outline strategy to mitigate the identified unacceptable risks, to improve the overall environmental baseline conditions such that the site will be suitable for the proposed end use, and to obtain regulatory sign off under the planning regime.

1.3 Report Format

The remainder of this report comprises the following principal sections:

- Section 2 – Proposed Development
- Section 3 – Summary of Previous Investigations
- Section 4 – Pollutant Linkages
- Section 5 – Remediation Strategy
- Section 6 – Validation
- Section 7 – Materials Management
- Section 8 – Unforeseen Contamination
- Section 9 – Implementation Plan
- Section10 - Verification

2 Proposed Development

The Proposed Development is shown on the Parameter Plan presented in **Appendix 1**, and comprises the following:

- 2,550 new homes
- Sites for two primary schools and one secondary school, including associated sports facilities
- Two mixed use local centres, which could include land uses within the following Use Classes: A1-A5 (local retail and related uses); B1 (business uses); C1 (hotel); C2 (residential institutions, including care accommodation); C3 (housing); D1 (non-residential institutions, including health services and community facilities); and D2 (assembly and leisure uses, including local indoor sports facilities)
- A gypsy/traveller site, accommodating 15 pitches
- A network of green infrastructure complementing that in the site's environs and including extensive informal open space, as well as allotments / community orchards and play areas
- Vehicular access via the A414, B195 and Cole Green Lane, including the re-alignment of the B195
- Internal roads, footpaths, cycleways and bridleways
- Sustainable drainage and utilities infrastructure, including drainage basins, foul water pumping stations and electricity sub-stations within the informal open space
- Prior extraction of circa 162,000 tonnes of sands and gravels from that part of the site to the north of public footpath Hertingfordbury 023 and to the west of Birchall Wood
- Management and control of the historic landfill in the central part of the site, including measures to ensure the safety of site users

3 Summary of Previous Investigations

3.1 Cole Green Site[1]

This report presents the findings of an intrusive investigation undertaken across the southwestern part of the proposed development site. The area of the investigation incorporates an 'L' shaped site bordered to the north by residential housing south of Cole Green Lane, to the east by the former Cole Green mineral workings, to the south by the A414, and the west by residential housing off Howlands and The Commons Local Nature Reserve, and is accessed off Holwell Hyde Lane. The site has no history of mineral extraction or land filling. The site is currently used to grow crops by tenant farmers. Future development will include a mixed use development including housing and associated infrastructure.

The intrusive investigation was undertaken in 2013/14 and comprised boreholes, trial pits, installation of groundwater and gas monitoring wells and the collection of soil and groundwater samples for laboratory analysis. Three rounds of ground gas monitoring were also undertaken on completion of the investigation.

The investigation identified Made Ground in a number of exploratory holes predominantly in the vicinity of farm tracks and two isolated locations in the south of the site. The Made Ground consisted of mainly sand, gravel and clay with some brick, ceramic tile and glass in the south. Away from these areas the exploratory holes recorded topsoil over natural deposits. The natural superficial deposits comprised of alternating horizons of clay and sand of varying thicknesses across the site. A stiff grey clay was also encountered in the east and northeast as expected. A brown and orange gravel, which was overlain by lower permeability deposits was identified along the western boundary of the site and a section of the southern boundary along the A414 (Hertford Road). The Chalk was encountered close to the southern boundary of the site beneath the gravels. There was no visual/olfactory evidence of gross contamination at any of the exploratory holes including any evidence of waste materials. Groundwater was encountered across the site associated with the sands and gravels. Review of the groundwater levels recorded during monitoring indicates a tentative local groundwater flow to the south and west.

On completion of the intrusive investigation and receipt of the laboratory data a Generic Quantitative Risk Assessment was undertaken to determine if the ground conditions represent a potential unacceptance risks to human health or controlled waters.

The data assessment confirmed that concentrations of the majority of the potential contaminants of concern did not exceed the laboratory limits of detection/the Generic Assessment Criteria. Made Ground, predominantly associated with two tracks across the site (the public thoroughfare from Holwell Hyde Lane and the farm track running from the fishing lake to the north side of Burnside) include traces of materials such as asbestos and benzo(a)pyrene that may represent an unacceptable risk to human health. This is not untypical of agricultural tracks that are often constructed from surplus materials obtained from off-site sources.

Ground gasses were not generally detected. However, an increased flow rate and slightly increased concentration of carbon dioxide was recorded at one monitoring well during one of the monitoring rounds but was not replicated in the other two rounds. Gas Characteristic Situation 2 was calculated based on the increased flow and carbon dioxide, and indicates a low risk, although some mitigation measures are recommended.

[1] *Royal HaskoningDHV.2014. Cole Green Site Characterisation and Generic Quantitative Risk Assessment. 9Y0074*

On-site surface water samples show some impact from the former mineral workings, however the report concluded that the potential contaminants of concern would be unlikely to represent an unacceptable risk to human health.

The shallow groundwater has been known for many years to show some impact from the landfill and the recent investigation and subsequent assessment confirmed this. The report recommended *inter alia* a programme of further monitoring to corroborate the findings to date.

Appendix 2 contains a site plan showing the exploratory holes and potential contaminants of concern.

3.2 Cole Green Former Mineral Workings Site[2]

This report presents the findings of an intrusive investigation undertaken across the former Cole Green mineral workings which is centrally located within the proposed development site. The site is currently utilised as informal open space and for the grazing of horses. The former mineral workings will be utilised as public open space. No housing will be developed on the landfill but development will take place in terms of access roads, footpaths, cycle paths, and green infrastructure.

The investigation was undertaken in 2014 using a hand auger to a target depth of approximately 1.0 metre below ground level (mbgl) to provide an indication of the nature and distribution of the shallow soils and to facilitate the collection of disturbed soil samples for laboratory analysis.

The investigation confirmed a thin layer of topsoil was present at the majority of the exploratory holes and was underlain by Made Ground predominantly comprising a clay matrix. In most cases the top soil was vegetated with grass (other vegetation to a limited extent), although in some locations vegetation was absent.

Following completion of the soil survey and receipt of laboratory data a Generic Quantitative Risk Assessment was undertaken to determine if the ground conditions represent an unacceptable risk to human health. A review of historical gas monitoring data provided by Tarmac was also undertaken. The data assessment confirmed that concentrations of the majority of the potential contaminants of concern did not exceed the laboratory limits of detection/the Generic Assessment Criteria and do not represent an unacceptable risk to human health assuming a public open space end use.

Four samples contained asbestos fibres and asbestos containing material, and three samples exhibited elevated concentrations of polychlorinated biphenyls, although the results were not indicative of widespread contamination. The report concluded that the presence of these potential contaminants of concern may represent an unacceptable risk to human health.

Methane and carbon dioxide concentrations recorded at the site are generally low. However, significantly higher concentrations are associated with some of passive gas vents in the northwest of the site adjacent to Holwell Hyde Lane.

The report recommended *inter alia* review of Tarmac's ongoing gas monitoring data, and further sampling in the vicinity of the asbestos and polychlorinated biphenyl hotspots.

Appendix 3 contains a site plan showing the exploratory holes and potential contaminants of concern.

[2] *Royal HaskoningDHV. 2014. Cole Green Former Mineral Workings Soil Survey and Generic Quantitative Risk Assessment*

3.3 Birchall Farm Site[3]

This report presents the findings of an intrusive investigation undertaken across the northeastern part of the proposed development site. The area of the investigation incorporates land adjacent to and to the north of Birchall Lane and to the southwest of the A414/Birchall Lane roundabout. The land to the north of Birchall Lane is bordered by residential properties and open countryside. The land to the southwest of the roundabout is bordered by the former Cole Green mineral workings to the west. The site is currently used to grow crops by tenant farmers and has no history of mineral extraction or land filling. Future development will include localised mineral extraction, restoration and subsequently a mixed use development including residential dwellings and associated infrastructure.

The intrusive investigation was undertaken in 2014 and comprised boreholes, machine excavated trial pits, hand dug trial pits, installation of combined groundwater and gas monitoring wells and the collection of soil and groundwater samples for laboratory analysis. Ground gas monitoring was also undertaken.

The ground investigation indicated that the soils at the site comprised limited areas of topsoil/Made Ground overlying alternating horizons of clay and sand of varying thicknesses at all exploratory holes. The clay deposits were generally described as firm. Although Made Ground was encountered the only observable anthropogenic material identified was brick, clinker, asphalt and ceramics associated with a former moat located adjacent to the farm complex; and brick in the vicinity of a former 'Chalk pit'. However, there was no visual/olfactory evidence of gross contamination at any of the exploratory hole locations. Groundwater was encountered in the more permeable horizons in some of the exploratory holes during the intrusive investigation. Review of the groundwater levels tentatively indicates a local groundwater flow to the south.

On completion of the intrusive investigation and receipt of the laboratory data a Generic Quantitative Risk Assessment was undertaken to determine the presence of unacceptance risks to human health and controlled waters. The assessment indicated that the majority of the potential contaminants of concern are not likely to represent an unacceptable risk to site users assuming a mixed use development.

Soil samples from an infilled historical moat adjacent to the farm complex recorded a range of potential contaminants of concern (total petroleum hydrocarbons, polycyclicaromatic hydrocarbons, carbazole, dibenzofuran and 2-methylnaphthalene) at concentrations that could represent an unacceptable risk to human health.

Ground gases were generally not detected. A preliminary assessment of the gas results indicated a Gas Characteristic Situation of 1. This indicates a very low risk and does not require any special precautions to be adopted in residential buildings.

There is evidence that seven high explosive bombs fell on the site during World War II. Four of these fell in the area next to the southeast corner of Birchall Wood. This area is considered to have a moderate unexploded ordnance (UXO) hazard level to account for the possibility of an unexploded bomb being present. No other significant sources of UXO have been identified for the site. Zetica[4] consider that the UXO hazard level on the site can be zoned from low to moderate. Risk mitigation measures will be required during any intrusive works by site contractors but there will be no subsequent risk to residential occupants after construction.

Appendix 4 contains a site plan showing the exploratory holes and potential contaminants of concern.

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[3] *Royal HaskoningDHV. 2014. Birchall Farm Site Characterisation and Generic Quantitative Risk Assessment*
[4] *Zetica. 2014. Sitesafe UXO Desk Study. Birchall Farm, Cole Green, Hertfordshire. P4719-14-R1-A*

3.4 Cole Green Inert Landfill Site[5]

This report presents the findings of an intrusive investigation within the northern extent of the former Cole Green mineral workings which is centrally located within the proposed development site. This part of the former mineral workings was subject to more detailed intrusive investigations as the master planning process explored potential options for built development in this area. However, as noted previously the former mineral workings will be utilised as open space only.

The intrusive investigation was undertaken in 2015 and comprised boreholes and trial pits, installation of groundwater and gas monitoring wells and the collection of soil and groundwater samples for laboratory analysis. Ground gas monitoring was also undertaken.

The investigation identified Made Ground in all the exploratory holes. Anthropogenic (human derived) material such as brick is present in the shallower deposits, however with depth the amount of anthropogenic material increases and comprises fragments of brick, concrete, wood, plastic, paper, glass, fabric, rubber, carpet, electrical cabling and ceramics. The anthropogenic materials referred to above are described as domestic waste/ landfill material on a number of the exploratory hole logs. The Made Ground was underlain by firm to very stiff clay overlying dense gravel overlying Chalk.

On completion of the intrusive investigation and receipt of the laboratory data a Generic Quantitative Risk Assessment was undertaken to determine the presence of unacceptable risks to human health and controlled waters. The majority of the potential contaminants of concern did not exceed the laboratory limit of detection/assessment criteria. A limited number of potential contaminants of concern recorded concentrations above the assessment criteria, however these samples were recovered from the waste deposits at depth and are not considered to represent a risk to human health assuming site levels remain the same. However, asbestos and polychlorinated biphenyls were detected in a limited number of shallow soil samples and could represent an unacceptable risk to human health.

Elevated ground gas concentrations were recorded at the site, although a sustained flow was not detected. Assessment of the gas results in line with current guidance indicates gas protection measures would be required in some structures to mitigate potential risks to structures and human health.

With respect to controlled waters the majority of the potential contaminants of concern did not exceed the laboratory limit of detection/assessment criteria. Metals and hydrocarbons were indicated to be potentially mobile at concentrations exceeding the assessment criteria and perched groundwater samples recovered from the waste materials also recorded metals and hydrocarbons at concentrations in excess of the assessment criteria.

Appendix 5 contains a site plan showing the exploratory holes and potential contaminants of concern.

3.5 Cole Green Former Mineral Workings Supplementary Investigation[6]

Previous investigations undertaken across the landfill indicated that asbestos and polychlorinated biphenyls (PCB) were present in a limited number of soil samples within the top metre of the soil profile and may represent a risk to human health. To provide a greater degree of certainty with respect to the

[5] *Royal HaskoningDHV. 2016. Cole Green Inert Landfill Preliminary Site Characterisation.*
[6] *Royal HaskoningDHV. 2017. Birchall Garden Suburb – Cole Green Former Mineral Workings Assessment of Material in Soils for Future Development Suitability. 9Y0074*

presence of asbestos and PCB at the site a further phase of intrusive investigation and assessment was undertaken in 2017.

The intrusive investigation comprised the recovery of three further samples by hand auger at each of the previously identified asbestos and PCB 'hotspots'. The hand augers were located around the perimeter of each existing hotspot at an approximate distance of five metres from the centre, and soil samples were recovered from the same depth at which the original soil sample had been taken.

On receipt of the laboratory results a Generic Quantitative Risk Assessment was undertaken to assess the potential risk to human health. The conclusions of the assessment are presented below:

Asbestos

During the ground investigations across the former landfill ACM (Asbestos Containing Materials) were not observed, and ACM was not identified in the soil recovered for laboratory analysis. Subsequent laboratory analysis has shown that where asbestos was indicated to be present in the soil sample the quantification analysis confirmed all but one sample recorded results below the laboratory limit of detection. Guidance[7] suggests that there are many other factors that affect the potential for asbestos to become airborne, and following consideration of these factors we consider that the asbestos is unlikely to represent a significant risk to site users.

PCB

Based on the investigations undertaken to date we consider that the PCB concentrations recorded at the site would not represent a significant risk to site users.

Appendix 6 contains site plans showing the exploratory holes.

3.6 Mineral Investigations

In addition to the studies summarised above, the site has been the subject of many intrusive ground investigations undertaken by Tarmac's predecessor companies in connection with their operations. Information from these investigations has been used in conjunction with data from the contemporary studies to develop the geological model and inform this outline remediation strategy.

Appendix 7 contains an exploratory hole plan showing the historical investigations.

[7] *CIRIA. 2007. C665 Assessing Risks Posed by Hazardous Ground Gases to Buildings*

4 Pollutant Linkages

Based on the site assessments undertaken to date **Table 1** presents the pollutant linkages where remedial measures are required:

Table 1 Pollutant Linkages

Pollutant Linkage(PL)	Source	Contaminant	Receptor	Pathway
PL1	Cole Green Landfill	Ground gas	Human health	Migration into confined spaces and inhalation
PL2	Shallow Made Ground in access tracks – Cole Green	Asbestos	Human health	Inhalation
PL3	Shallow Made Ground in access tracks – Cole Green	Benzo(a)pyrene	Human health	Ingestion, inhalation of dust, dermal contact
PL4	Cole Green Landfill	Contaminants in groundwater and surface water as a result of diffuse pollution	Controlled waters	Migration of dissolved phase contaminants
PL5	Cole Green Landfill	Contaminants in surface water (Copse) as result of leachate breakouts	Drainage systems and surface water	Direct discharge
PL6	Cole Green Landfill	Contaminants in surface water (Great Captains Wood) as a result of leachate breakouts	Surface water	Direct discharge
PL7	Shallow Made Ground in Moat – Birchall Farm	Benzo(a)pyrene	Human health	Ingestion, inhalation of dust, dermal contact

5 Remediation strategy

5.1 Remediation Philosophy

The remediation strategy has been designed to address potential risks associated with the ground conditions across the proposed development, as well to facilitate an overall improvement in baseline environmental conditions, and is based on the following assumptions:

- At the end of the development works the area comprising Birchall Garden Suburb will be utilised as a mixed use development in line with the description in **Section 2** and the Parameter Plan contained within **Appendix 1**
- An earthworks balance has not yet been developed, however to achieve maximum sustainability during the development works, it is envisaged that soils generated as a result of earthworks will be utilised within the development, assuming they are suitable for use on the grounds of chemical quality and geotechnical properties (geotechnical requirements are outside the scope of this report but will be addressed in due course within an Earthworks Specification)
- Soils that are deemed unsuitable for use on the grounds of chemical quality will be disposed/ recovered off-site in line with current legislation and guidance

5.2 Health, Safety and Environmental Protection

The remediation works shall be undertaken in line with current legislation and best practice. It should be noted that Birchall Farm is a listed building and protected species have been identified at the site, therefore coordination with archaeology and ecology specialists will be undertaken prior to commencing the remedial works to ensure the works do not have detrimental impacts on the site.

5.3 Remediation Works

To mitigate the risks associated with the pollutant linkages summarised in **Table 1** the following strategy will be adopted. However, it should be noted that studies are on-going at the site (e.g. gas monitoring, design of interceptor drain), the results of which will be used to refine the strategy presented herein, and will be agreed with the Regulators in advance of commencing works on site.

5.3.1 Pollutant linkage 1

Landfill gas monitoring undertaken during the site characterisation studies has generally confirmed low gas concentrations and a worst case Gas Characteristic Situation 2 (driven by an increased flow rate and slightly increased concentration of carbon dioxide at CGBH11 on one occasion). Periodically high methane concentrations have also been recorded at a limited number of locations, particularly within the northern extent of the former mineral workings, although preliminary data indicates the high values are generally not sustained and are not supported by a positive flow.

To corroborate the existing data and to ensure appropriate mitigation measures are adopted in the development further gas monitoring will be undertaken, including the adoption of continuous gas monitoring instruments.

A precautionary approach will be adopted and it is envisaged that structures built to the west and south of the former mineral workings will incorporate gas mitigation measures in line with CIRIA[8] guidance. Based on a Gas Characteristic Situation 2 the mitigation measures will include one of the following:

- Reinforced concrete slab cast *in situ* floor slab (suspended, non-suspended or raft) with at least 1200g damp proof membrane and underfloor venting; all joints and penetrations sealed
- Beam and block or pre-cast concrete and 2000g DPM/ reinforced gas membrane and underfloor venting; all joints and penetrations sealed membrane and underfloor venting

Appendix 8 contains a plan showing the area of the proposed development where gas mitigation measures are likely to be installed within buildings.

Landfill gas vents were installed as a precautionary measure on the northwestern part of the former mineral workings adjacent to Hollwell Hyde Lane over twenty-five years ago. These vents will be reduced in height to make them less obtrusive and refurbished. Additional works may also be progressed subject to review of the on-going gas monitoring, and will be agreed with the Regulator in advance of commencing the works.

It should also be noted that the proposed groundwater interceptor drain which will be installed along the western boundary of the former mineral works (**Section 5.3.3**) may also be designed to act as a passive gas vent, subject to the results of further assessment.

5.3.2 Pollutant linkage 2, 3 and 7

Asbestos and benzo(a)pyrene have been recorded at isolated locations within the material forming the thoroughfare from Holwell Hyde Lane and the agricultural track running towards Burnside within the Cole Green site. It is likely that this material derives from fly tipping and the historically common practice of repairing farm tracks using demolition material. Benzo(a)pyrene has also been identified in isolated locations in the south adjacent to Burnside and the A414. Elevated concentrations of benzo(a)pyrene were also recorded within an historical moat within the Birchall Farm site and appears to be associated with localised disposal. **Appendix 2** and **4** contains an exploratory hole plan showing the locations of asbestos and benzo(a)pyrene.

Given the sensitivity of the proposed development and the likely variability of the material forming the tracks, a precautionary approach will be adopted which will see the tracks excavated and the arisings stockpiled on site prior to reuse in screening bunds (part of the network of green infrastructure to be constructed as part of the development) at a depth greater than 1.0mbgl, assuming the material is suitable for use on the grounds of chemical quality and geotechnical properties. A geotextile separation layer will also be placed above this material prior to completion of the screening bunds. Prior to excavation additional samples shall be recovered from the tracks at 50m intervals and submitted for laboratory analysis to corroborate the previous data and to facilitate an assessment of the potential for re-use within the scheme.

The two areas in the south of Cole Green and the material within the Birchall Farm moat will be excavated and stockpiled on site prior to reuse in screening bunds, assuming the material is suitable for use on the grounds of chemical quality and geotechnical properties. The excavation zone will extend around the hotspot for a distance of 5.0m and for a depth of 1.0m. Upon completion of the excavation samples shall be recovered for validation purposes.

[8] *CIRIA. 2007. C665. Assessing Risks Posed by Hazardous Ground Gases to Buildings*

5.3.3 Pollutant linkage 4

Leachate generated by the former mineral workings is currently intercepted by a northsouth trending drain located to the east of the fishing lake in the north and to the east of the Eastern arm of the Hatfield Hyde Brook further south. The drain collects a combination of leachate and groundwater from the superficial deposits. The interception drain was installed in 1984 to minimise the impact on the wider groundwater and on the eastern arm of the Hatfield Hyde Brook. Whilst this system has worked successfully over the years, some impact does occur on both the shallow groundwater and the brook.

A new interceptor drain will therefore be installed to improve baseline conditions and provide a long term sustainable solution. The existing system will remain in place and has already undergone a series of upgrades including:

- Installation of automatic monitoring and telemetry to control and measure the pumping
- Maintaining a service and emergency call out contract with the pump supplier

The interceptor drain will be installed along the western and south western boundary of the former mineral workings. The drain will extend from the fishing lake in the north and wrap around the south western boundary of the former mineral workings, terminating to the east of a small Copse. The new interceptor drain will be approximately 200mm in diameter and will be located at a depth of around 6.5m below ground level within the superficial deposits. The drain will tie into the existing on-site pumping station which pumps effluent to the public sewer in Thistle Grove under a consent to discharge. Inspection chambers will be installed along the length of the drain[9]. The system will be managed and maintained as part of the developments aftercare strategy.

Studies are ongoing and will be utilised to finalise the detailed design of the new interceptor drain, and will be agreed with the Regulator prior to construction.

Appendix 9 contains a plan showing the proposed route of the interceptor drain.

5.3.4 Pollutant linkage 5

Contaminated groundwater in the vicinity of the Copse has historically been managed via a drainage ditch bounding the southern edge of the Copse. The site characterisation studies recovered samples from the drain around the Copse for laboratory analysis. Subsequently an assessment of the laboratory data confirmed the presence of elevated metals and hydrocarbon contaminants. An ocherous seepage is also present within the Copse . **Appendix 10** contains a plan showing the location of the Copse .

The installation of the new groundwater interceptor drain discussed in **Section 5.3.3** will be routed adjacent and to the north of the Copse to intercept contaminated groundwater in this area and will therefore sever the pathway. The existing ditches and ponds will be scraped to remove any residual contaminated sediments, validation samples recovered and the area reinstated.

Studies are ongoing and will be utilised to finalise the detailed design of the new interceptor drain, and will be agreed with the Regulator prior to construction.

[9] *Based on studies undertaken by THDA*

5.4 Pollutant Linkage 6

A low flow seepage of discoloured water is known to exist within Great Captains Wood to the east of the Cole Green cycleway. The seepage feeds a shallow pond. An ochre precipitate can be observed at the change in slope immediately above the water level within the ponds. The ochre is in an area of soft marsh ground at the edge of the pond.

TerraConsult were commissioned by Tarmac to undertake a high level appraisal of potential sustainable leachate management solutions at the former mineral workings[10]. Based on the high level assessment the preferred solution is an interceptor drain and a reed bed treatment system.

An interceptor drain will be constructed at the toe of the slope to preferentially channel the seepage away from the surface and into a reed bed treatment zone. The reed bed treatment system could be either formal via a purpose built reed bed or informal by adapting the current ponds subject to discussions with the Environment Agency.

A reed bed in the order of 20m x 20m is likely to be capable of treating an intercepted groundwater flow. However, the reed bed could be extended by converting the initial section of the receiving stream at the culvert into a reed bed system, by introducing some permeable materials to ensure that the culvert volume flows through a treatment zone. Phragmites could be planted within any newly created reed bed or it may be possible to translocate bull rushes within and adjacent to the existing ponds into the reed beds.

Appendix 10 shows the location of Great Captains Wood.

[10] *TerraConsult. 2017. Cole Green Landfill Site Leachate Management Options Appraisal*

6 Validation

Validation of the remedial works will be undertaken to demonstrate the objectives of the strategy have been achieved.

6.1 Pollutant Linkage 1

Construction Quality Assurance (CQA) will be undertaken by an independent environmental consultant for all aspects of the gas protection measures that are to be implemented at the site, including:

- Building gas protection measures
- Gas vents

6.2 Pollutant Linkage 2, 3 and 7

6.2.1 Cole Green Tracks

It is anticipated the tracks constructed from anthropogenic material will be removed from across the site, to reveal the natural soils beneath. Therefore validation will be based on visible inspection only, and shall be recorded via digital photos and provision of a description of the ground conditions. However, prior to excavation samples shall be recovered to facilitate an assessment of the potential for re-use of the material within screening bunds.

Soil samples shall be recovered at 50m intervals along the tracks and at a depth of 0.5m below ground level and shall be analysed by a UKAS and MCERTS accredited laboratory for the following potential contaminants of concern:

- Asbestos presence/absence
- Asbestos quantification (if asbestos identified)

If asbestos is confirmed to be present an assessment will be undertaken in line with current guidance. If following assessment it is concluded the material is suitable for use the results shall be agreed with the Regulator prior to use.

6.2.2 Cole Green Hotspots and Birchall Farm

Following excavation of the 'hotspot' areas validation samples will be taken from the sides and base of the excavation to confirm that the existing soils do not represent an unacceptable risk to sensitive receptors. The number of samples taken will be dependent on the size of the excavation but will be generally based on the following rates:

- One sample from each side and base of the excavation where excavation is 5.0m(L) x 5.0m(W) x 2.0m(D)
- Where larger excavations are undertaken the sampling rate will be increased pro-rata

The soil samples shall be analysed by a UKAS and MCERTS accredited laboratory for the following potential contaminants of concern:

- PAH16

In order to confirm the hotspot has been removed the laboratory results will be compared with human health Generic Assessment Criteria (GAC) for a residential end use. The GAC will be authoritative and scientifically based in line with current guidance and agreed with the Regulator.

6.3 Pollutant Linkage 4, 5 and 6

Validation of the new interceptor drain and reed bed system will comprise on-site audits and digital photographs by the site supervisor to confirm the construction complies with the approved detailed design and on-going monitoring of surface water and groundwater as part of the developments aftercare strategy. The frequency will be in line with Tarmac's current monitoring programme.

Following excavation of the sediments associated with the ponds within the Copse samples will be taken from the sides and base of the excavation to confirm that the existing soils do not represent an unacceptable risk to sensitive receptors. The number of samples taken will be dependent on the size of the excavation but will be generally based on the following rates:

- One sample from each side and base of the excavation where excavation is 5.0m(L) x 5.0m(W) x 2.0m(D)
- Where larger excavations are undertaken the sampling rate will be increased pro-rata

The soil samples shall be analysed by a UKAS and MCERTS accredited laboratory for the following potential contaminants of concern:

- Metals
- TPHCWG
- PAH16

In order to confirm any contaminated materials have been removed the laboratory results will be compared with human health Generic Assessment Criteria (GAC) for a residential end use and Environmental Quality Standards (EQS) for controlled waters. The GAC and EQS will be authoritative and scientifically based in line with current guidance and agreed with the Regulator.

7 Materials Management

7.1 Re-Use of Soil

As well as meeting the remedial objectives it is important that all regulatory requirements are addressed and complied with such as mobile treatment plant licenses and waste management regulations. The regulatory issues associated with remediation are particularly complex as the works encompass two regulatory regimes, planning and waste management. The works will be undertaken under a Planning Permission, and in accordance with the CL:AIRE document "The Definition of Waste: Development Industry Code of Practice" utilising appropriate Materials Management Plans.

The Code of Practice enables excavated soils and subsoil materials to be re-used on a development site without the need for an appropriate regulatory framework (Environmental Permit issued under the Environmental Permitting Regulations 2010 or an Exemption from these Regulations) by de-classifying them as 'waste'. A Materials Management Plan shall be prepared to demonstrate that the proposed re-use operations accord with the principles of the CL:AIRE protocol, namely that:

- Re-use of the materials will not pose an unacceptable risk of pollution of the environment or harm to human health
- The materials are suitable for use (that is, they require no treatment to make their chemical and geotechnical properties suitable for the intended use)
- There is certainty of use (i.e. their re-use should be a certainty rather than a probability)
- Only the quantity of materials required will be used (use of any additional materials would constitute disposal of waste materials)

This Material Management Plan along with relevant supporting documents will be submitted to a Qualified Person for review, signing of the declaration and submission to the Environment Agency.

Material from the landfill will not be used within other areas of the site.

7.2 Stockpiles

Material excavated from across the scheme will be stored on-site in a number of stockpiles depending on the origin of the soil, and the chemical and geotechnical parameters. The stockpiles will not be permitted to come into contact with each other and will be maintained and managed such that the soil does not escape via windblown dust or contaminated leachate, nor cause cross contamination, nor contaminate the surrounding area.

A detailed survey of the stockpiles will be undertaken and maintained throughout the works to provide an audit trail of the volumes of material entering and leaving the site/ stockpiles. Each stockpile will also be labelled with a unique identifier such that its origin and content will be known throughout the works.

7.3 Groundwater Management

As noted previously the site characterisation studies have indicated that the shallow groundwater exhibits elevated concentrations of a range of potential contaminants of concern. Where earthworks are likely to intercept the shallow groundwater and dewatering is required to facilitate the works, provision shall be

made for appropriate management including storage, testing and disposal. Disposal may include on-site disposal to sewer via the existing interceptor drain or off-site subject to further assessment/ approvals. Full details of all waste characterisation and test results will be made available for inspection by all parties and Regulators. All testing will be undertaken by an UKAS and MCERTS accredited laboratory.

7.4 Disposal

Soils that are considered unsuitable will be disposed/recovered off-site in accordance with current regulations. Full details of all waste characterisation and test results will be made available for inspection by all parties and Regulators. All testing will be undertaken by an UKAS and MCERTS accredited laboratory.

7.5 Imported Material

Imported materials such as top soil, sub soil, secondary aggregate and virgin aggregate shall be validated to ensure they are suitable for use in the scheme. Suitability for use shall be demonstrated by evidence of compliance with the relevant industry standards or via a programme of sampling, analysis and assessment.

Where validation sampling is undertaken samples shall be recovered at the following frequency:

- 1 sample/ 50m^3 where material is to be used within residential gardens
- 1 sample/ 250m^3 where material is to be used within landscaping/ public open space areas

Where validation sampling is undertaken samples shall be scheduled for a range of determinands including:

- Metals
- TPHCWG
- PAH
- SVOC
- VOC

Samples shall also be scheduled for leachability analysis.

All testing will be undertaken by an UKAS and MCERTS accredited laboratory.

In order to confirm suitability the laboratory results will be compared with human health Generic Assessment Criteria (GAC) for either a residential end use or public open space end use depending on the point of use of the materials, and Environmental Quality Standards (EQS) for controlled waters. The GAC and EQS will be authoritative and scientifically based in line with current guidance and agreed with the Regulator.

8 Unforeseen Ground Conditions/Contamination

Historical preliminary ground investigations have been undertaken to develop a preliminary understanding of the ground conditions at the site, based on the conceptual site model developed from documentary research. Whilst further investigation would provide additional confidence with respect to the ground conditions it is not practicable to investigate all areas of the development site.

Therefore a 'watching brief' should be maintained during the development of the site, and especially during any earthworks. The watching brief will be conducted by a competent person by visual and olfactory inspection. Where Made Ground/suspected contamination is identified, no further excavation of the material shall be carried out until further investigation and risk assessment by an appropriately qualified and experienced consultant has been undertaken. If significant unforeseen contamination is encountered, the Regulator shall be notified immediately.

Where remediation is required, an addendum remediation statement shall be provided and acted upon accordingly and shall include appropriate verification and control measures. Should it not be practicable to delay the earthworks, a temporary quarantine area shall be prepared on site. Where the contamination is potentially mobile, e.g. hydrocarbons, oils etc., the area will be suitably surfaced to prevent run-off and shall be covered with sheeting to prevent rainfall ingress. This material shall then be subject to assessment by a contaminated land specialist. Where found to be contaminated this material will be disposed of off site in accordance with current regulations.

Any initial emergency actions shall be implemented and reported, e.g. fuel spillage from on site tank, absorbent material deployed and impacted materials removed from site, and a contaminated land specialist asked to verify the clean-up action as soon as practicable. Full records of any unforeseen contamination including location, volume, description, photographs, soil analysis, waste transfer notes, assessments and any other pertinent details shall be collated for inclusion within the final verification report for the site.

9 Implementation plan

An Implementation Plan (remediation method statements) will be developed by the Principal Contractor to demonstrate how the remediation works will be implemented to achieve the stated objectives. The document will be drafted in advance of the works and will be submitted to the Regulator and Clients Representative for approval.

Method Statements will be drafted for each activity being carried out and are required to be written in accordance with environmental best practice, and detail the procedures to be adopted to mitigate potential impacts to human health and controlled waters during the implementation of the works.

The method statements should include the following details as a minimum:

- Security details
- Health and safety issues – risk assessments, PPE
- Environmental issues – managing risks to surface waters, groundwater
    - How cross contamination will be managed
    - How runoff and dust will be managed
- Sequencing of the works
- Parties involved in the works
- Equipment used to progress the works
- Responsibilities
- Supervision
- Methodology for dealing with unforeseen contamination
- Methodology for assessing laboratory data
- Auditing protocols
- Location of activities including stockpiling of materials
- Source of materials for backfilling
- Programme

10 Verification

Verification is an essential element of any remedial strategy. The verification process aims to provide assurance that the original risk management objectives have been satisfactorily achieved and so provide confidence to all stakeholders. This requires that the process itself is transparent, robust and provides a data set demonstrating adequate performance of the remediation measures.

Following completion of the site works a Verification Report will be prepared by the Clients Representative and submitted to the Regulator to provide evidence of the satisfactory completion of the works in accordance with this Strategy and the submitted Materials Management Plan.

As noted previously some of the validation requirements will be incorporated within the long term aftercare strategy for the development, for example the new interceptor drain and reed bed system. The results of this monitoring will therefore be provided to the Regulator as complementary volumes to the initial verification report prepared at the conclusion of the remedial works.

The report will summarise the remedial works carried out on site and include, as a minimum (as appropriate):

- Description of the works undertaken
- As built drawings for all construction works
- Audit records
- Photographic records
- Details on any unforeseen ground conditions encountered, and how these were managed
- Laboratory results associated with any validation/ additional assessments undertaken
- Data assessments
- Description of how the use of materials links with the Remediation Strategy
- Ground investigation data
- Reference to the tracking system
- Waste transfer documentation, including return loads (if applicable)
- Signed delivery tickets (if applicable)
- Records of contingency arrangement(s) that had to be implemented
- Materials management records – volumes excavated, disposed of and reused, source of origin

10.1 Verification Records

Submission of the verification report is reliant on the Principal Contractor providing the above information in appropriate detail and in a timely fashion. To avoid delays associated with missing data or addressing clarifications, the auditing protocols (e.g. frequency of site audits, data requirements and how the information will be recorded) and programme for submission to the Clients Representative shall be agreed with the Principal Contractor prior to commencing the remedial works. These requirements will be a specific requirement of the contract.

Appendix 1

Birchall Garden Suburb Parameter Plan

TARMAC
A CRH COMPANY

Royal HaskoningDHV

Legend

- Planning Application Boundary
- Adjacent Land Under Applicant's Control
- District Boundary
- Primary Route
- Proposed Point of Access
- Proposed Strategic Footpath/ Cycle Route
- Proposed Footpath/Cycle and Potential Equestrian Link
- Existing Right of Way to be Upgraded to Bridleway
- Existing National Cycle Route to be Retained
- Existing Right of Way to be Retained
- Byway Open to All Traffic to be Retained
- BOAT downgraded to Footpath/Cycle Route
- Residential
- Local Centre (Indicative location)
- Primary School Site
- Secondary & Primary School Sites
- Gypsy/Travellers Site
- Existing Civic Amenity Site
- Informal Open Space
- Allotment/Community Orchard
- Existing Woodland to be Retained and Managed
- Proposed Woodland Planting
- Existing Waterbody to be retained
- Existing Holwell Hyde Lake Car Park to be retained
- Wildlife Habitat Link
- Play Area (Indicative location)
- Drainage Basin (Indicative location)

East Hertfordshire District

Welwyn Hatfield District (B)

TARMAC
A CRH COMPANY

Birchall Garden Suburb
Parameter Plan

David Lock Associates
Town Planning and Urban Design

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Drawn:	Designed:	Approved:	Date:		Dwg: LAF019-153
DKS	RDC	AW	04/04/2017	N	Rev: B
			Scale: 1:5,000 @ A2		Do not scale from this drawing

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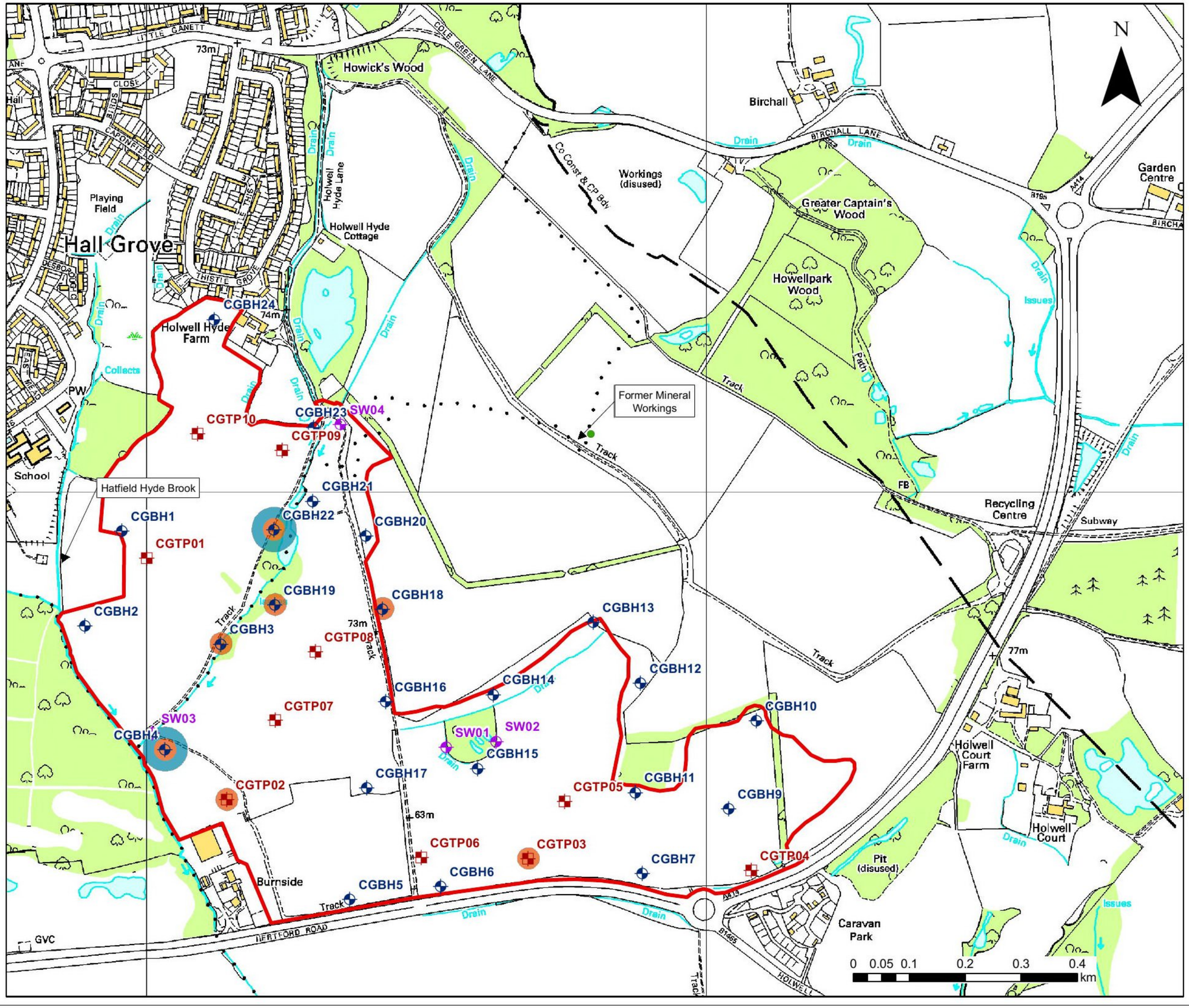
Appendix 2

Cole Green Exploratory Hole Location Plan and Potential Contaminants of Concern

TARMAC
A CRH COMPANY

Royal HaskoningDHV



Key:

- Site Boundary
- Surface Water ID
- Borehole ID
- Trial Pit ID

Potential contaminants

- Asbestos
- Polycyclic aromatic Hydrocarbons

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Title:
Exploratory Hole Location Plan
and Potential Contaminants of Concern

Project:
Birchall Garden Suburb
Remediation Strategy

Client:
Tarmac

Date:	Scale @ A3:
Sept 2017	1:6,500

Appendix 2

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A CRH COMPANY

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Appendix 3

Cole Green Former Mineral Workings Exploratory Hole Location Plan and Potential Contaminants of Concern

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Key:

- Site Boundary
- HA Locations
- HA Location not carried out

Potential contaminants

- Asbestos
- Polycyclic aromatic Hydrocarbons

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Title:

Exploratory Hole Location Plan and Potential Contaminants of Concern

Project:

Birchall Garden Suburb Remediation Strategy

Project:

Tarmac

Date:	Scale @ A3:
Sept 2017	1:6,500

Appendix 3

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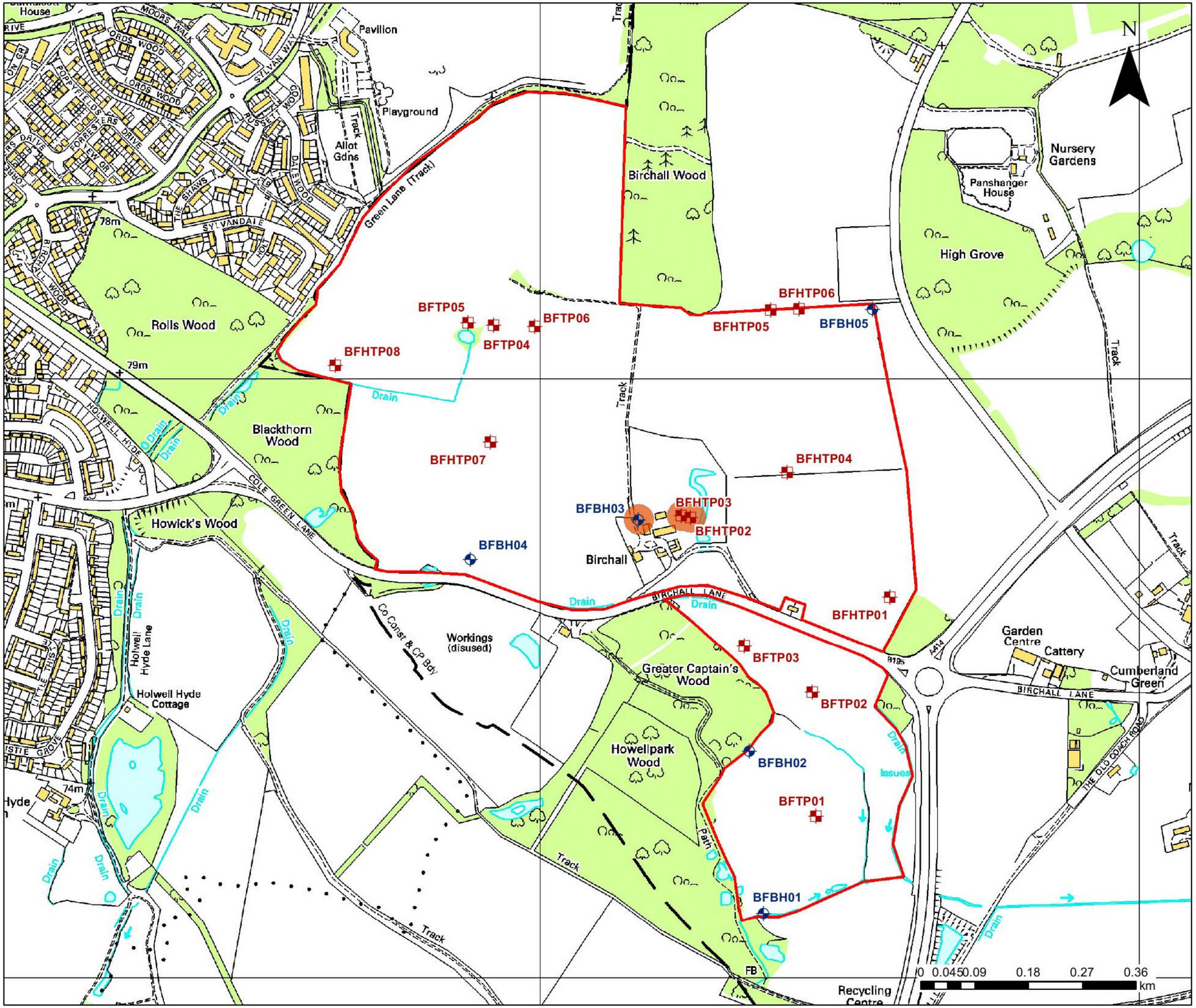
Appendix 4

Birchall Farm Exploratory Hole Location Plan and Potential Contaminants of Concern

TARMAC
A CRH COMPANY

Royal HaskoningDHV



Key:

- Site boundaries
- Borehole ID
- Trial Pit ID

Potential contaminants

- Polycyclic aromatic Hydrocarbons and organics

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Title:

Exploratory Hole Location Plan and Potential Contaminants of Concern

Project:

Birchall Garden Suburb Remediation Strategy

Project:

Tarmac

Date: Sept 2017

Scale @ A3: 1:6,000

Appendix 4

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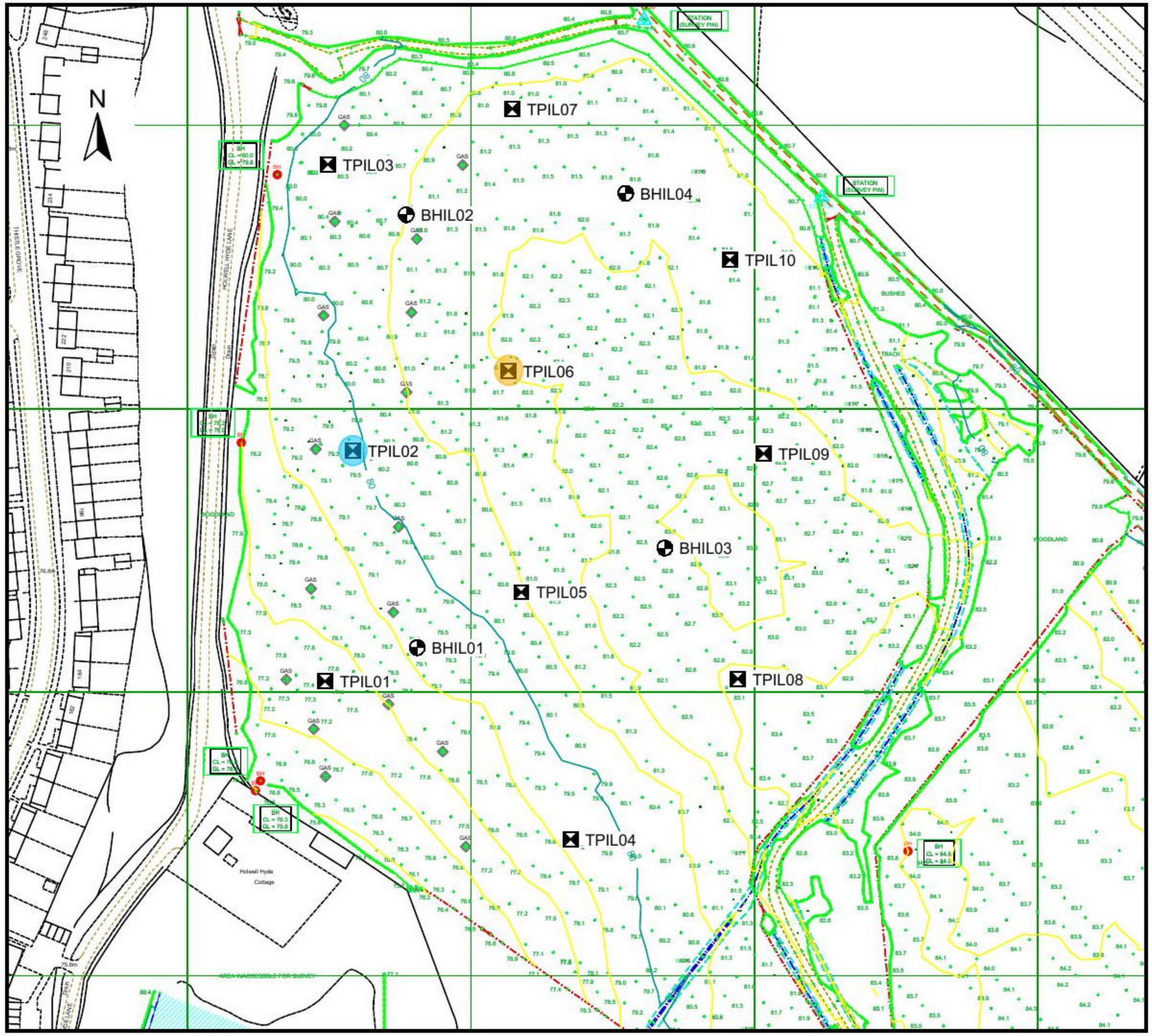
Appendix 5

Cole Green Inert Landfill Exploratory Hole Location Plan and Potential Contaminants of Concern

TARMAC
A CRH COMPANY

Royal HaskoningDHV



LEGEND

- Trial Pit Location
- Borehole Location
- Polychlorinated Biphenyls
- Asbestos

REV	DATE	DESCRIPTION	BY	CHD	APR
00	27.01.2016	-	JH	JW	-

DIMENSION	SCALE	ORIGIN SIZE
m	1:2000	A4

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CLIENT

Tarmac

PROJECT

Cole Green Inert Landfill

TITLE

EXPLORATORY HOLE LOCATION PLAN

JOB NO	FIGURE
562072	2
DRAWING STATUS	REV
-	00

SCALE BAR

0 20 40 60 80 100m