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Hinckley Academy, Leicestershire

Flood Risk Assessment and Drainage Strategy

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1 Introduction

1.1. Project Background

Design ID have been appointed to complete a Flood Risk Assessment and Drainage Strategy in support of a planning submission for the construction of a new school development. The following report shall review site constraints and ground conditions, flood risk, appropriate SuDS systems for use as part of the development and outline the proposed surface and foul water drainage strategy for the site.

The project will consist of the demolishing of existing campus Blocks B, C & D and the construction of a new 3 storey modular block and hardstanding play area, serving a total of 1450 students between the ages of 11 – 18 (300 places for 6th form students). There will also be a 2 storey temporary building to the south of the site to house students during the construction of the permanent building.

The entire site is approximately 18ha. The proposed main building is approximately 0.6ha and the Temporary building is approximately 0.23ha. The site consists of existing school buildings, open ground, concrete and tarmac surfacing and soft landscaping.

The proposed development will comprise the construction of a new, two storey, modular school building towards the northeast of the site. There will be associated hardstanding and soft landscaping around the proposed building and elevated part of the site to the west which will also have a hardstanding play area. Existing stepped access connects the upper level to the lower level. There will be a new 2 storey temporary building and carpark located to the southwest of the site to house students while the new block is under construction.

1.2. Project Team

The Project Team involved are as follows:

- Client: Department for Education
- Main Contractor: Reds10
- Architect: Sense of Space
- Landscape Architect: MAC Consulting
- M&E Engineer: Jones King
- Structural and Civil Engineer: Design ID

1.3. Site Location

The proposed site is within the existing Hinkley School campus and is accessed off Butt Lane in Hinkley, Leicestershire. The site is bounded to the north by the housing off Bradgate Road and Bradgate Gardens. To the east of the site is Hinkley Golf Course. Housing off Woodland Road bounds the south of the site, adjacent to the school playing fields. A site location plan can be found in Figure 1 below.



Figure 1 – Proposed Site Location (See Appendix A)

1.4. Planning Policy Context

The potential consequences of inappropriate development in a flood risk area for occupiers, either of the development or elsewhere, pose significant risks in terms of personal safety and damage to property.

1.5. National Policy

The National Planning Policy Framework (NPPF) includes Government policy on development and flood risk stating that:

“When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

- a) Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location.
- b) The development is appropriately flood resistant and resilient.
- c) It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate.
- d) Any residual risk can be safely managed, and

e) Safe access and escape routes are included where appropriate, as part of an agreed emergency plan.”

The Planning Practice Guidance to the NPPF requires that at the planning stage, the developer should prepare and submit an appropriate FRA to demonstrate how flood risk from all sources of flooding to the development itself and flood risk to others will be managed now and when taking climate change into account.

To comply with the NPPF, a FRA must be submitted for planning applications with developments within Flood Zones 2 and 3 (medium or high risk fluvial or tidal flooding) and for all developments located in Flood Zone 1 (low risk) which are 1 hectare or greater; or which has been identified by the Environment Agency as having critical drainage problems; identified in a Strategic Flood Risk Assessment as being at increased flood risk in the future; or that it may be subject to other sources of flooding, where its development would introduce a more vulnerable use.

An assessment of surface water and drainage is also required as part of the FRA in order to demonstrate how flood risks to others will be managed following development and taking climate change into account.

The Planning Practice Guidance requires that Sustainable Drainage Systems (SuDS) should be considered and included where practicable, in line with DEFRA Technical Standards (Non-Statutory Technical Standards for Sustainable Drainage Systems, March 2015). The Technical Standards are therefore a key reference document and should be used in the formulation of the surface water drainage strategy for a scheme of this nature. The standards include the following requirements:

Flood Risk Outside the Development:

S1- Where the drainage system discharges to a surface water body that can accommodate uncontrolled surface water discharges without any impact on flood risk from that surface water body (e.g., the sea or large estuary), the peak control standards (S2 and S3 below) and volume control technical standards (S4 and S6 below) need not apply.

Peak Flow Control:

S2- For greenfield developments, the peak runoff rate from the development to any highway drain, sewer, or surface water body for the 1 in 1-year rainfall event and the 1 in 100-year rainfall event should never exceed the peak greenfield runoff rate for the same event.

S3- For developments which were previously developed, the peak runoff rate for the development to any drain, sewer, or surface water body for the 1 in 1-year rainfall events must be as close as reasonably practicable to the greenfield runoff rate for the development for the same rainfall event but should never exceed the rate of discharge from the development prior to redevelopment for that event.

Volume Control:

S4- Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer, or surface water body in the 1 in 100-year, 6-hour rainfall event should never exceed the greenfield runoff volume for the same event.

S5- Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer, or surface water body in the 1 in 100-year, 6-hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event but should never exceed the runoff volume from the development site prior to redevelopment for that event.

S6- Where it is reasonably practicable to constrain the volume of runoff to any drain, sewer, or surface water body in accordance with S4 and S5 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

Flood Risk Within the Development:

S7- The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 30-year rainfall event.

S8- The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100-year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g., pumping station or electricity substation) within the development.

S9- The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100-year rainfall event are managed in exceedances routes that minimise the risks to people and property.

Structural Integrity:

S10- Components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirements for reasonable levels of maintenance.

S11- The materials, including products, components, fittings or naturally occurring materials, which are specified by the designer must be of a suitable nature and quality for their intended use.

Designing for Maintenance Considerations:

S12- Pumping should only be used to facilitate drainage for those parts of the site where it is not reasonably practicable to drain water by gravity.

Construction:

S13- The mode of construction of any communication with an existing sewer or drainage system must be such that the making of the communication would not be prejudicial to the structural integrity and functionality of the sewerage or drainage system.

S14- Damage done to the drainage system resulting from associated construction activities must be minimised and must be rectified before the drainage system is considered to be completed.”

1.6. Local Policy and Guidance

As the development is located in Hinckley, both the County Council and the Lead Local Flood Authority (LLFA) in this case are Leicestershire County Council (LCC). This Flood Risk Assessment then acknowledges the following local documents and guidance:

- The Leicestershire City Level 1 Strategic Flood Risk Assessment (SFRA), Leicestershire City Council, October 2017
- Leicestershire County Council Preliminary Flood Risk Assessment, Leicestershire County Council, June 2011
- Leicestershire Local Flood Risk Management Strategy, Leicestershire County Council, August 2015
- Humber River Basin District Flood Risk Management Plan 2021 – 2027, December 2022

1.7. Climate Change

Climate change has important implications for the assessment and management of flood risk. The NPPF requires that climate change is considered when assessing the flood risk posed to future development and the impacts to surface water management.

Climate change has the potential to affect all identified sources of flooding. The likely impacts of climate change include increased severity of rainfall events as well as wetter winters leading to higher groundwater levels and increased frequency and severity of surface water flooding.

The influence of climate change on rainfall intensity has been taken into account by the surface water drainage strategy outlined in Chapter 6 and an inclusion of 40% for climate change has been allowed for in the 1 in 100-year event, in accordance with NPPF requirements and Environment Agency requirements (Environment Agency (2016) Flood Risk Assessments: Climate Change Allowances).

2 Site Constraints

2.1. Topography/Site Analysis

A topographical survey was carried out at the proposed site on 24.08.21 by Tetra Tech (drawing reference: 784-B026224, see Appendix A). This survey provided an outline of topographical information at the site.

The existing site falls approximately 13m north to south and approximately 11m west to east. The site ranges in topographical elevations from 125.66m AOD in the north to 120.00m AOD at the centre of the southern border. The existing Block D building sits at 123.56m AOD and Block B sits at approximately 127.37m AOD. They are steps and a retaining wall to make up the level differences between the blocks with the lower ground to the east of the wall.

Levels across the site vary significantly, with the upper area to the east of the proposed site being approximately 5m above the FFL of the building (123.6mAOD). This area consists of soft landscape and a permeable hardstanding play area.

2.2. Services

Topographical and GPR utility surveys (see Appendix A) were carried out by Tetra Tech in June 2021 to survey the existing site and determine the location of any existing utility and drainage infrastructure. Survey information shows an existing series of 150-300mm diameter surface water pipes and 150mm diameter foul water pipes around the existing Block D building. The survey confirms the surface water discharges into a ditch along the site boundary to the east within Hinckley Golf Club. The foul water from Block D runs from MH44 (CL: 123.58, IL: 122.63) to MH53 (CL: 123.58, IL: 122.56) via a 225mm diameter pipe. MH53 is located at the north entrance of Block G. From here it flows through the site via a series of 150-225mm diameter to the south of the schools boundary and is assumed to connect into a 300mm diameter combined sewer on Woodland Road (See Sever Trent Utility Map Ref:617667-3). It is anticipated there will be existing underground utility and drainage services below existing concrete slabs that may not have been picked up by GPR survey across the remainder of the site. Low and high voltage electricity lines along with gas and water utilities are mapped throughout the site.

2.3. Existing Watercourse

Sketchley Brook is located to the south of the railway track which is southwest of the site (approx. 2.1km). It flows in a south westerly direction away from the site as an Ordinary Watercourse before becoming a Main River 2km downstream.

2.4. Drainage

There are ditches and drains within Hinckley Golf Course, to the east of the site. The Utilities Survey performed by Tetra Tech (Ref:784-B026224) confirms that Block D discharges to a ditch within Hinckley

Golf Club via a 300mm diameter pipe. The rest of the surface water drainage flows to the south of the site and then east via a series of 100-375mm diameter pipes and discharges into a ditch within Hinckley Golf Club.

2.5. UXO

An online risk assessment was carried out on Zetica.com to assess the risk of unexploded ordnance on the proposed site. As can be seen below in Figure 2, there is a very low risk of encountering any unexploded bombs on the site with the map indicating the possibility of 15 bombs or less per 1000 acres. If any suspect items are found during construction the following mitigation measures are advised:

- Creation of UXO Risk Management Plans.
- Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.
- Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works.
- Intrusive Magnetometer Survey of all borehole and pile locations down to a maximum bomb penetration depth.

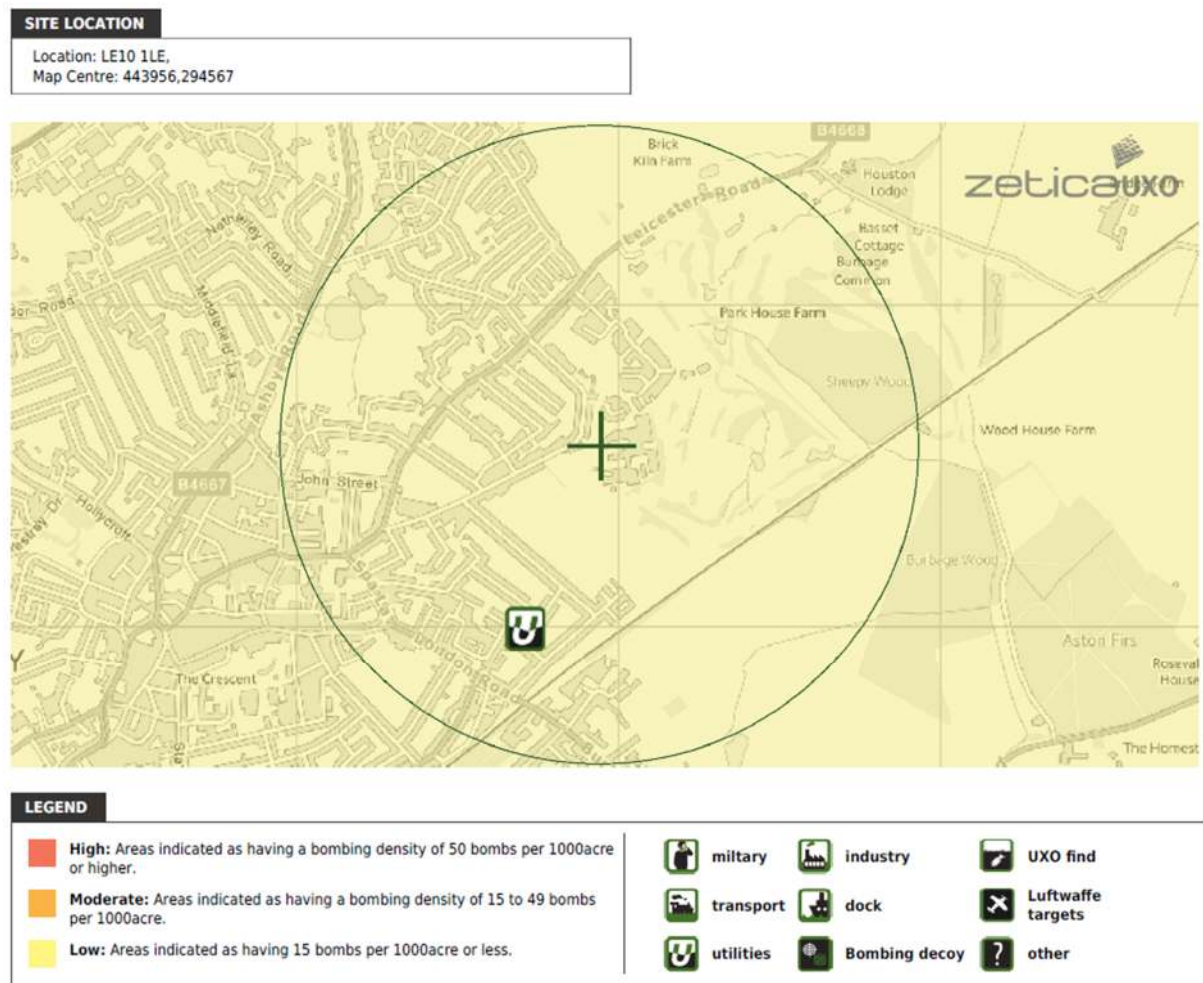


Figure 2: Unexploded Ordnance Risk Map (zeticauxo.com)

3 Flood Risk Assessment

3.1. Scope of Work

The scope of this FRA will be to assess the following:

- Flood risk to the development from all sources
- The potential for the design, construction, and operation of the development to increase the risk of flooding to neighbouring properties
- Any necessary mitigation measures required to address identified potential flood risks
- Impact of climate change on the flood risk
- Any residual flood risks remaining

The approach shall be consistent with the NPPF and its associated Technical Guidance along with the requirement of the local planning policy.

3.2. Flood Risk Vulnerability

The purpose of this flood risk assessment is to steer development into the lowest-risk area possible. The site is currently situated entirely in Flood Zone 1; therefore, the sequential test is automatically passed, and developments of all vulnerabilities are acceptable (see below table).

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception test required	✓	✓
Zone 3a	Exception test required	✓	x	Exception test required	✓
Zone 3b	Exception test required	✓	x	x	x

3.3. Flood Risk from Fluvial and Tidal Sources

The entirety of the development site is located within the Environment Agency's (EA) Flood Zone 1, as shown in Figure 3, and Appendix B. NPPF Technical Guidance described Flood Zone 1 as having a less than 1 in 1000 annual probability of river or sea flooding (<0.1%). As aforementioned, all uses of land are appropriate in this zone.

The development site is not located within a Critical Drainage Area, which implies that there is a low flood risk from fluvial, tidal, surface or groundwater sources generally. Regardless, this Flood Risk Assessment will provide a detailed analysis of the flood risk both to and as a result of the development.



Figure 3: Fluvial and tidal flood map extent, taken from Flood Maps for Planning (gov.uk), accessed 29/11/2022

3.4. Flood Risk from Surface Water

The site is largely at very low risk of surface water flooding, with the majority of the site classified as having a very low (0.1%) flood risk. There are, however, areas within the school campus at low to high risk of surface water flooding. (Please see Figures 4 below). Surface water flooding can occur when rainwater does not drain away through the in-place drainage or soak into the existing ground.

The southern half of the site falls within the Humber River basin district which is classed as a Flood Risk Area (FRA). Incidents of fluvial flooding, sewer flooding and overtopping have been recorded in this area. The main school does not fall within this area, but the temporary building does. Whilst the temporary building lies within this boundary, analysis of surface water flood maps shows that there very low risk of surface water flooding at the temporary building location therefore this report considers the surface water flood risk to be low across the site. (Please see Figures 4 below).

The HBBC Level 1 Strategic Flood Risk Assessment (SFRA) has no historical records of surface water flooding near to the site.

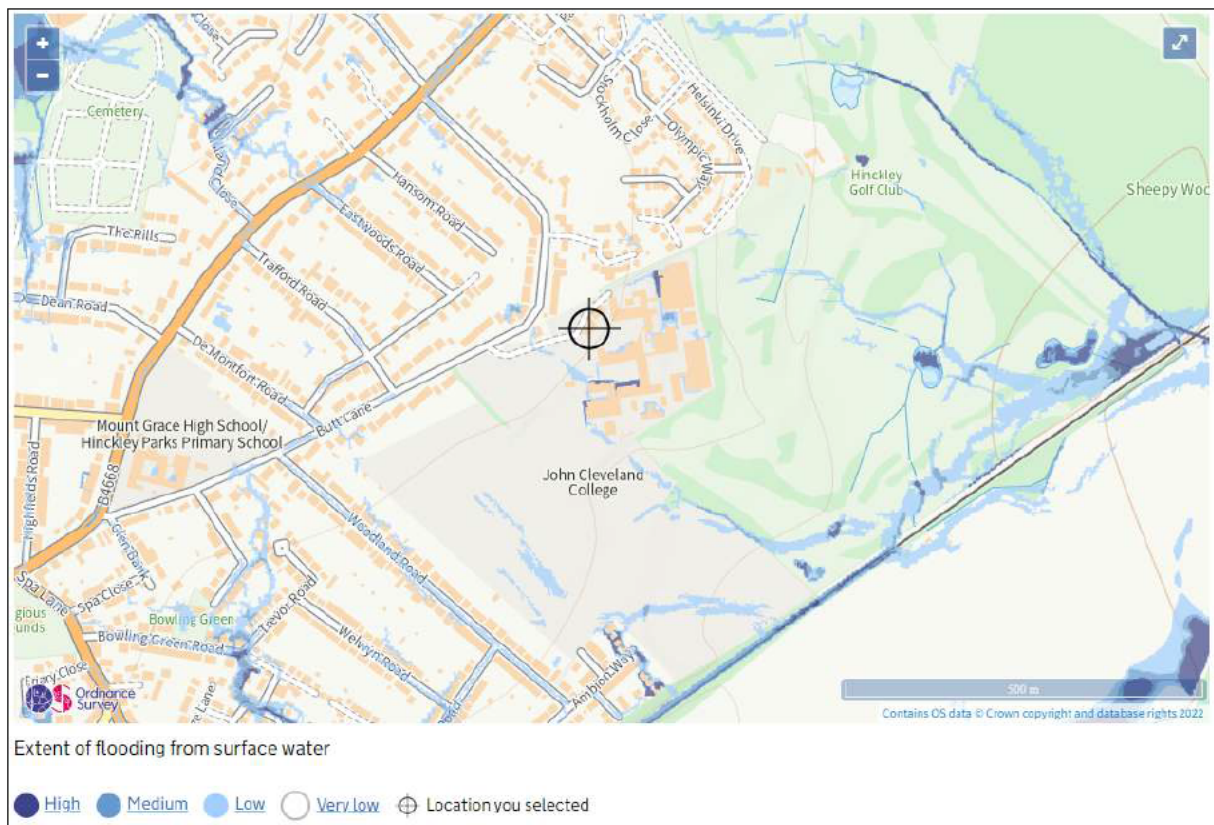


Figure 4: Surface water flood map (accessed from gov.uk, on 29/11/2022)

To ensure appropriate mitigation of surface water flood risk to this or any other developments in the future, the following measures have also been proposed:

- The surface water drainage strategy has been developed to manage flows from the site from storm events up to a 1 in 100-year event + 40% climate change. Flows will be stored on site in appropriate attenuation features.

- External areas have been profiled to ensure that flows are directed away from the school building.
- Appropriate maintenance of the surface water drainage network and SuDS, as recommended later in this report will minimise the risk of blockages and ensure the system's efficiency.

3.5. Flood Risk from Groundwater

Groundwater flooding occurs when groundwater emerges at the surface under conditions where the 'normal' range of groundwater levels and groundwater flows is exceeded. There is limited data available on groundwater flood risk in the Hinckley area. The available flood maps show that, in general the majority of the Hinckley area is within the <25% susceptible classification (See Figure 5 below), therefore it is at a lower risk of groundwater flooding. Only areas along the River Sence channel fall within the higher susceptibility classifications and are therefore at higher risk from groundwater flooding. The proposed site does not fall into this category.

Borehole logs for the proposed site show a groundwater depth of 13.20m rising to 10.71m (113mAOD), therefore there is a low risk of groundwater flooding.

A review of the British Geological Survey (BGS) online geological mapping and Tetra Tech ground investigation report reference: B030162 V1, (See Appendix C). indicates that the site is predominately underlain by the Oadby Member (Diamicton) with the south of the site underlain by Wolston Sand & Gravel. The underlying rock across the entire site is the Mercia Mudstone Group. There are seven publicly available BGS borehole logs located within the site (within the area of the school buildings). These layers will not be significant as the deposits are designated as secondary (undifferentiated) aquifers. Therefore, the risk of groundwater flooding is considered to be low.

This Flood Risk Assessment considers the groundwater flood risk for the development to be low. As infiltration is not proposed for the site, the development is also not likely to be contributing to a groundwater flood risk to itself or any other development.

Regardless of the low groundwater flood risk, the following mitigation measures shall be incorporated into the proposed drainage strategy to ensure a low flood risk for this and any other future developments:

- Appropriate waterproofing shall be incorporated into the substructure design, and any below ground structures.
- Dewatering shall be carried out as necessary throughout the construction phase of development.

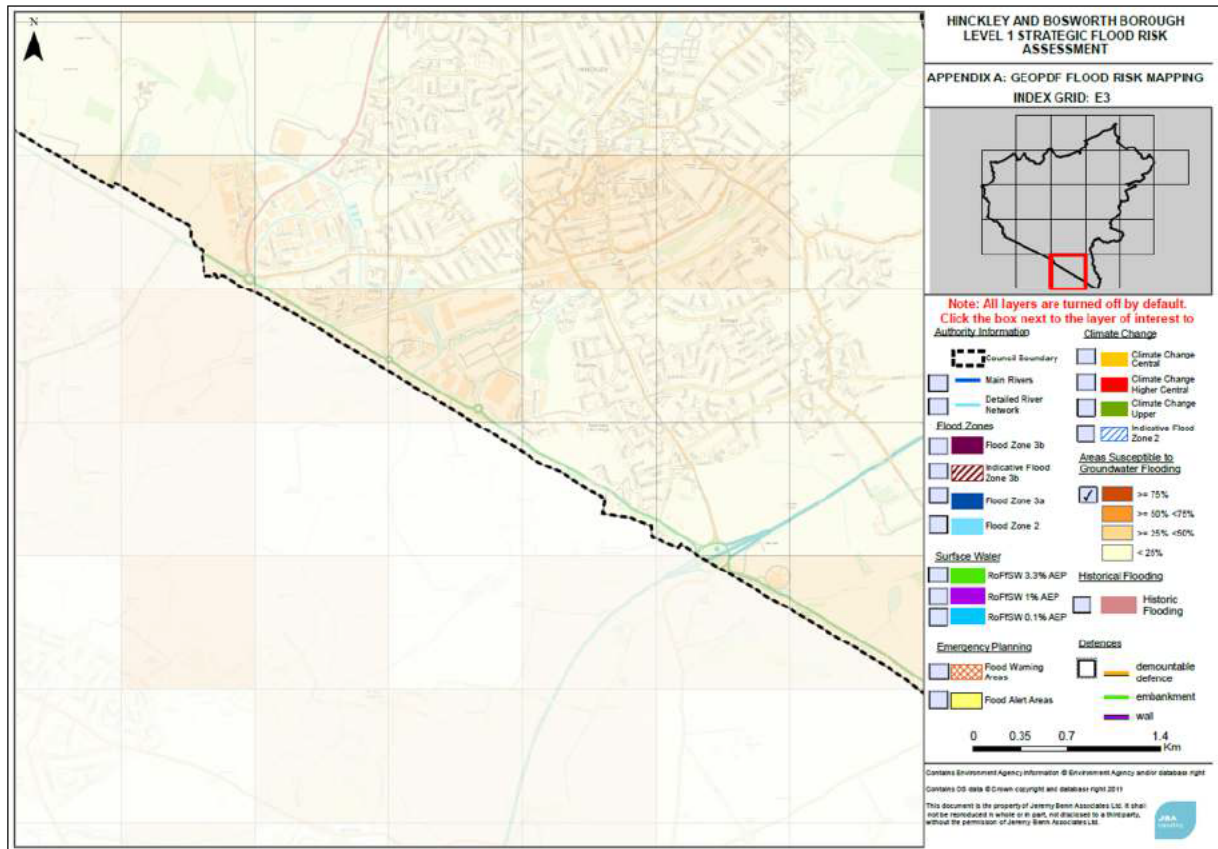


Figure 5: Areas Susceptible to Groundwater Flooding, Hinckley & Bosworth Borough Council Local Flood Risk Management Strategy report, Appendix C

3.6. Flood Risk from Artificial Water Bodies

The entirety of the development is located outside any extent of flooding from reservoirs (see Figure 6). The site will therefore have a 0% flood risk from artificial water bodies and is acceptable for all forms of development.

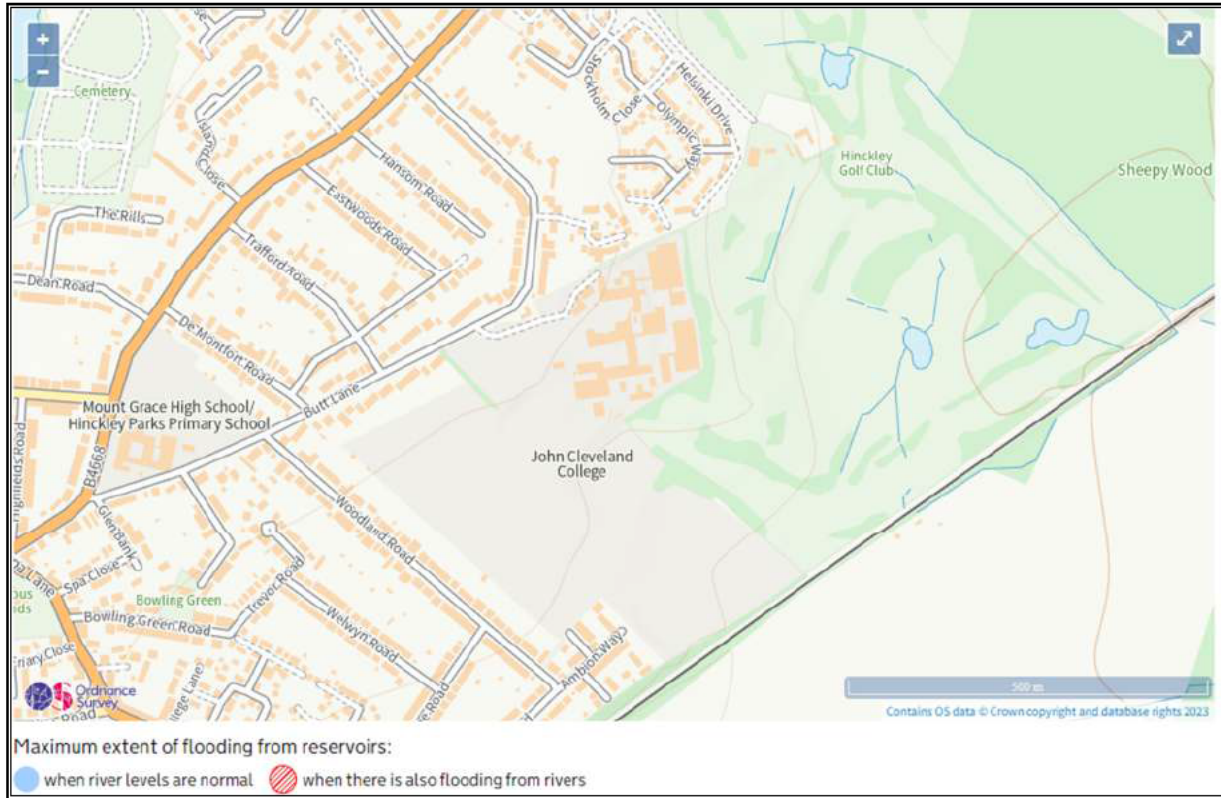


Figure 6: Artificial Water Bodies Flooding Map (EA, gov.uk website, accessed 16/01/2023)

3.7. Flood Risk from Canals

There is one canal in the Hinckley borough, the Ashby canal. It has the potential to interact with other watercourses and become flow paths during flood events or breach scenarios. There have been 8 recorded incidents of canal breach from 1981 – 1996 but only in rural locations and only three recorded incidents of canal overtopping which occurred in the Stoke Golding & Hinckley area. Therefore, the risk of flooding from canals is considered low. Figure 7 below shows the location of canal breach and overtopping incidents in the Hinckley area.

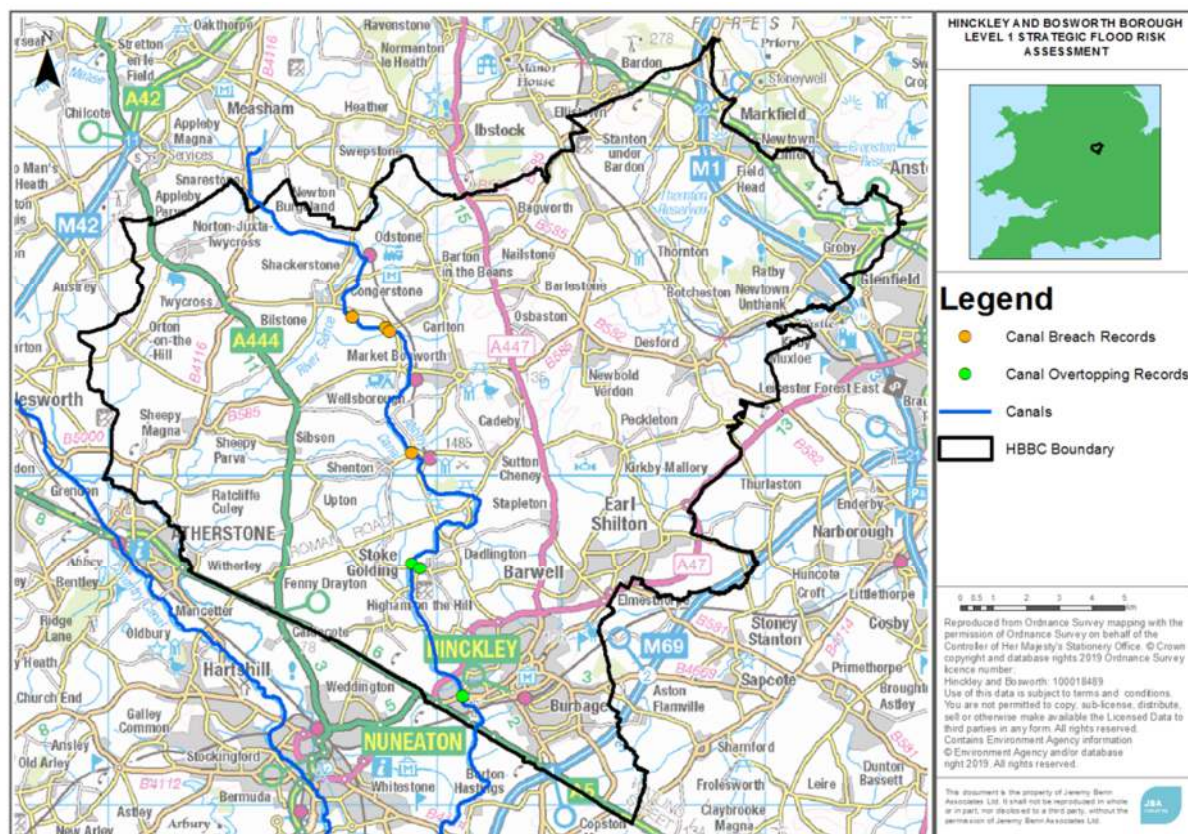


Figure 7: Map Showing the Location of all recorded incidents of canal breaches and overtopping in the study area (dated 2019)

3.8. Flood Risk from Water Mains

Flood risk from this source is considered to be a residual risk with the main threat being from internal pipework during any building works. As flooding from water mains poses a residual risk to the proposed development, this will be mitigated through the routine inspection of potable water networks within the Site by the development owner and the water mains asset owner.

A Utilities survey was carried out and there are no water mains on the proposed site. There are however 2 existing water mains that run along Butt Lane to the East of the proposed development site. This can be observed in the Severn Trent Asset Map included in Appendix E of this report (Ref: C_SPL0001-TTL-XX-XX-G-O-0002-UtilitiesSurvey-A2-C01). Both are a significant enough distance from the development and are likely to be well maintained by Severn Trent, therefore the flood risk from water mains is considered to be low for the site.

3.9. Flood Risk from Sewers

Flooding from sewers is a potential risk to any development site. A review of GPR survey information (see Appendix F) shows that there is an existing sewer network on the proposed site for the existing buildings. JMS group carried out a survey of the existing network. The existing surface water network was modelled to determine the extent of possible flooding within the system. From this they determined that the existing pipes were undersized to accommodate the contributing impermeable areas into the system. They proposed re-laying pipework to larger diameter pipes to accommodate the contributing flows and added attenuation to alleviate flooding. These upgrades can be seen in JMS drawing C021/036/02 201 – 206 along with their Drainage Design Statement dated 21.07.21.

Part of their proposal for upgrading the system included works to be carried out during the construction of the proposed works. Therefore, this project is bettering the current flood risk associated with the site which further reduces the risk of flooding.

As the problems with the existing network have been identified and will be completed with the construction of the proposed development, we can therefore assume that the risk of flooding from sewers is low.

3.10. Historical Flooding

A review of the historical flooding data indicates that there have been no recorded flood events within the boundary of the proposed development site or the associated access road as can be seen in Figure 8 below.

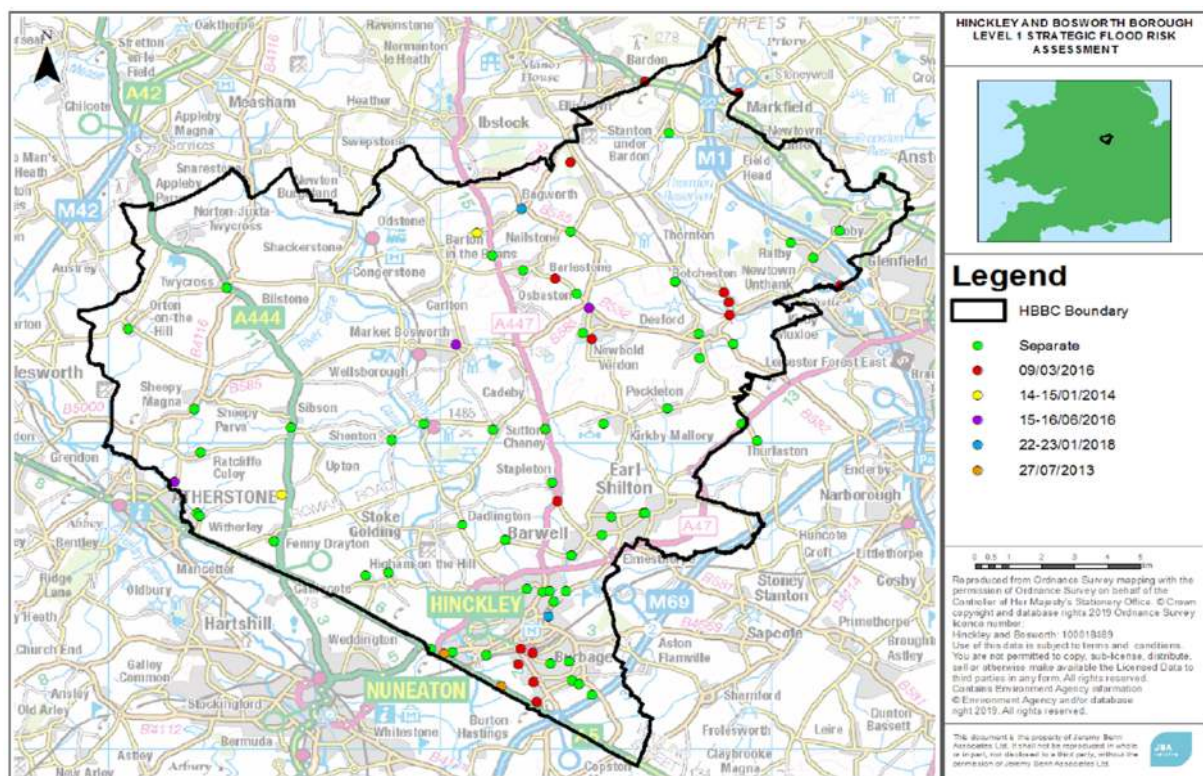


Figure 8: Historical Flooding Extent Map, Data extracted from 2019 Strategic Flood Risk Assessment for Hinckley & Bosworth Borough Council.

4 Ground Conditions

4.1. Geology

A Geotechnical Ground Investigation Report has been produced by Tetra Tech (February 2022), report reference: B030162 V1, (See Appendix D). This ground investigation was comprised of one cable percussive borehole and five trial pits, which identified the geology on site to be as follows:

- Made Ground – 0.10 - 0.30m – Base fill
- Made Ground – 0.30 - 1.30m – Firm brown slightly sandy gravelly CLAY
- Made Ground – 1.30 - 4.60m – Stiff reddish brown slightly gravelly sandy CLAY (Oadby Member) (Diamicton).
- Woolston Sand and Gravel – 4.6 – 8.7m – Medium dense reddish brown slightly silty fine to course SAND.
- Woolston Sand and Gravel – 8.7 – 15m – to the full depth of the investigation.

The geology in this area is predominately mudstone which are part of the Mercia Mudstone Group. Soils are predominantly clay that have a naturally high groundwater table and impede drainage. Therefore, we can assume that there will be no significant infiltration. Additionally, borehole and window sample information can be found in Tetra Techs ground investigation report. The logs generally recorded stiff/silty clay to a depth of 15m.

4.2. Contamination and Ground Gas

No significant contamination was recorded within the soils and groundwater (See Ground Investigation report reference: B030162 V1, Appendix...). The groundwater table is deep (10.40m BGL) significantly reducing the risk of any contaminant linkages to the underlying Secondary A aquifer. Further to this, ground gas was not recorded in concentrations that are likely to present a significant risk at this site.

4.3. Groundwater

The Ground Investigation Report completed by Tetra Tech (ref: B030162 V1, See Appendix D) outlines the results from three rounds of groundwater monitoring (see Figure 9 below). The monitoring results show that the groundwater level at BH01 (located at the southern end of Block D) sits at 13.20m rising to 10.71m (113mAOD). This groundwater level is significantly lower than the proposed school building FFL of 123.600 mAOD, which further emphasis the low groundwater flood risk as set out in Chapter 3.5.

Table 5 Summary of Groundwater Monitoring

Location	R1: 2.12.21 (m bgl)		R2: 8.12.21 (m bgl)		R3: 8.2.22 (m bgl)	
	Water	Base	Water	Base	Water	Base
BH01	10.44	13.39	10.39	13.38	10.22	13.36
WS01	Dry	4.35	Dry	4.34	Dry	4.34
WS02	Dry	3.20	Dry	3.20	Dry	3.21
WS03	Dry	3.71	Dry	3.69	Dry	3.68

Figure 8: Groundwater monitoring results from Tetra Tech Ground Investigation Report: B030162 V1 (February 2022)

4.4. Discharge to Ground

As described in Section 2.5, the underlying bedrock is mudstone and the local BGS borehole logs indicate the area to be predominantly underlain by clay. Clay and mudstone are typically poor for infiltration due to their impermeable nature and therefore it is unlikely that discharge to ground is feasible.

4.1. Discharge to Watercourse

There are no watercourses within a reasonable distance from the site (the closest being Sketchley Brook approx. 2.1km away from the site), therefore discharge to watercourse is not considered to be a feasible option. The railway to the south of the site presents a significant constraint to any connectivity to Sketchley Brook.

4.1. Discharge to Sewer

Given that discharge to ground and watercourse are unfeasible, discharge of foul water for the main and temporary building to an existing foul sewer and discharge of surface water from the temporary building to an existing surface water sewer is likely to be the preferred method of discharge, subject to agreement with Severn Trent Water.

5 Review of SuDS Options

5.1. Drainage Hierarchy

National Planning Policy and Leicestershire County Council guidance documents recommend the design of surface water systems to be based upon the following design hierarchy, as much as possible, in order to maximise benefits.

Hierarchy	Sustainable Drainage System
1	Use surface water runoff as a resource (e.g., rainwater harvesting, use for irrigation)
2	Manage rainwater close to where it falls, at source
3	Manage runoff on the surface, above ground (e.g., permeable pavements)
4	Allow rainwater to soak into the ground (infiltration)
5	Promote evapotranspiration (soft landscaping, rain garden)
6	Slow and store runoff to mimic natural runoff rates and volumes (below ground attenuation structure)
7	Reduce contamination of runoff through pollution prevention and by controlling the runoff at the source
8	Treat runoff to reduce the risk of urban contaminants causing environmental pollution

Due to the presence of a silty clay soil, infiltration is not possible as a means of discharging surface water. (See Tetra Tech Ground Investigation Report B030162 V1, Appendix D).

5.2. Comparison of Suitable SuDS

In addition to being a regulatory requirement, it is the Client's aspiration to incorporate Sustainable Drainage Systems (SuDS) within the proposed development where feasible, to attain improvements to water quality, biodiversity, and amenity, whilst reducing the site's runoff by storing water in on-site attenuation.

A management system of sustainable drainage techniques shall be employed as part of the surface water drainage strategy. An assessment of various SuDS measures can be found in the table below, alongside recommendations for those that are appropriate for a school environment.

Sustainable Drainage System (SuDS) Technique		Proposed Development Suitability
Porous Pavements	Description	Pavements constructed with porous paving can provide storage and water treatment via the sub-base.
	Suitability	Suitable for car parking bays, MUGA pitch and hardstanding informal and social areas of the proposed development. As infiltration is not possible at the site, porous pavements will be lined with an impermeable geomembrane, and used as water treatment and storage, before discharging from the site.
Soakaways	Description	Designed structures that store and infiltrate runoff.
	Suitability	Due to the presence of a silty clay soil, infiltration is not possible. Soakaways are therefore not suitable.
Filter Drains	Description	Granular filled linear drains/soakaways usually with a perforated pipe installed at the base.
	Suitability	Due to the presence of a silty clay soil, infiltration is not possible. Filter drains are therefore not suitable.
Swales/Bioretention Structure	Description	Shallow naturally landscaped channels that convey and/or infiltrate the runoff.
	Suitability	Swales are unlikely to be suitable for development due to safety risks associated with depressions and above ground water storage. Bioretention structure in the form of rain garden can be suitable in small areas if away from areas of footfall and planted so as to reduce the risk. These will provide treatment benefits alongside biodiversity and amenity benefits to the school development.
Retention Ponds	Description	Partially filled waterbodies that can provide significant storage during critical storms.
	Suitability	Unlikely to be suitable for development due to school setting and safety risks associated with depressions and above ground water storage. Alternative SuDS components proposed to achieve water quality improvements.
Detention Basin	Description	Naturally, vegetated depressions designed to store runoff temporarily.
	Suitability	As infiltration is not possible and development constraints (proximity of building foundations, existing trees, and development extent) a detention basin will therefore not be suitable.
Green/Blue Roof	Description	Vegetated roof areas that reduce/store runoff and increase times of concentration and restrict flow.

	Suitability	Unsuitable as the roof of the school building will incorporate a PV panel array and plant storage. Access to the roof will be required for maintenance.
Underground storage	Description	Attenuation structures installed below ground to provide runoff storage.
	Suitability	Geocellular attenuation will be required upstream of a flow control measure in order to restrict surface water discharge from the site to an acceptable rate and store surface water on site.

5.3. Summary of Suitable SuDS

SuDS components to be proposed as part of the surface water drainage design are as follows:

- Permeable pavements
- Rain Garden (Bioretention structure)
- Underground Storage (geocellular attenuation)
- Bioretention structure (Pond) for attenuation at the temporary building

As infiltration on site is not feasible, all relevant SuDS features will be surrounded by an impermeable geomembrane. Surface water will route through a variety of SuDS features to maximise benefits such as source control and water treatment.

6 Surface Water Network

6.1. Standards and Guidance

The proposed surface water drainage system and any SuDS features shall be designed in accordance with the following standards and guidance:

- The SuDS Manual, C753, CIRIA, 2015
- Sewers Sector Guidance V2-2, Appendix G, 2022
- BS EN 752, Drain and Sewer Systems Outside Buildings, 2017
- The Building Regulations 2010, Drainage and Waste Disposal Part H, 2015
- Local Flood Risk Management Strategy, Leicestershire County Council, August 2015

The surface water drainage network shall also be designed in accordance with the table below:

Return Period	Condition	Source
1 in 30 year	No surface flooding	Sewers for Adoption 7 th Edition

6.2. Existing Surface Water Drainage

Topographical and GPR utility surveys (see Appendices I and C respectively) were carried out by Tetra Tech in August 2021 to survey the existing site and determine the location of any existing utility and drainage infrastructure.

The existing surface water network discharges from a 300mm diameter pipe from MH46 to the west of Block D with a cover level of approx. 123.600mAOD and an invert level of 119.400m AOD. The existing network is a gravity network and is made up of 150-300mm diameter pipework, approximately 2m deep. There is an existing attenuation tank to the south of Block D.

The temporary building will be located on a soft landscaped area of the site. The utilities survey carried out by Tetra Tech (See Appendix F) show no existing drainage in this area.

6.3. Proposed Surface Water Drainage

Rainwater from the proposed building shall be collected in an underground gravity surface water drainage network. Runoff from the hardstanding play area will be collected in a rain garden and enter the surface water network via a perforated pipe. Suitable areas of external hardstanding surrounding the proposed building shall discharge through porous pavements and filter drains and routed to the below ground attenuation storage and therefore will not put any pressure on proposed drainage networks.

Surface water falling on impermeable hardstanding areas will route to linear drains and / or gullies, which will then discharge in the below ground gravity drainage network. Overland flow from outside of the development boundary is not anticipated to route towards the proposed school or associated drainage infrastructure.

The surface water system will route in all cases to an adequately sized geocellular attenuation structure (Polystorm R Modular Cells, datasheet in Appendix H) which shall be wrapped in an impermeable geomembrane. The attenuation structure is upstream of a hydrobrake valve which will restrict the flow leaving the site to 4.35 l/s, which in turn allows the attenuation structure to store all surface water flows generated by impermeable surfaces. Flows downstream of the hydrobrake chamber route to an existing manhole via proposed 300mm diameter pipework and shall discharge into the drainage ditch that bounds the site to the east, alongside the existing flows. The rain garden will provide additional storage for surface water runoff from the hardstanding play area further reducing the pressure on the proposed surface water network.

In accordance with the SuDS Manual (Ciria C753, 2015), the surface water discharge rate shall be limited to the Greenfield runoff rate (see table in Chapter 6.5). The project team has followed design guidance and been in discussions with Hydrobrake International, who have advised that the hydrobrake valve sized to allow a discharge rate of 4.35 l/s is suitable for use on the site and will not be prone to blockage.

Rainwater from the proposed temporary building shall be collected in an underground gravity surface water drainage network. Runoff from the temporary car park will enter the surface water network via a perforated pipe. All surface water will be routed to a bioretention pond. The pond is upstream of a hydrobrake chamber which will restrict the flow leaving the site to 2.00 l/s, which in turn allows the attenuation structure to store all surface water flows generated by impermeable surfaces. Flows downstream of the hydrobrake chamber route existing manhole 133 via proposed 300mm diameter pipework.

The proposed surface water drainage network for the development can be found in Appendix L of this report. The total and effective volumes of each of the SuDS features can be observed from this drainage layout, resulting in a total effective attenuation volume for this site of 357m³.

6.4. Calculations

Surface water and storage calculations have been produced as part of the proposed drainage design for both the permanent and temporary buildings. These can be found in Appendix I of this report. The network shall incorporate a 40% climate change allowance in line with current Environmental Agency (EA) guidance, which can be observed in the calculations.

Hydrobrake calculations have been completed on both MicroDrainage and using the Hydrobrake International tool to ensure an optimum design which is appropriate for the site in restricting discharge to Greenfield rates, that also is not prone to blockage (See Appendix J).

6.5. Comparison of Run Off – Pre and Post Development

As the nature of many areas of the site will change with development, the associated run off will also change. The below table shows run off rates for the site pre and post development, as well as a comparison with Greenfield run off rates, to prove that discharge is being limited as much as possible to reduce the flood risk.

	Assumed Unrestricted Existing Runoff Rates (l/s)	Proposed Runoff Rates (inclusive of 40% CC) (l/s)
1 in 1 year	20.94	4.35
QBAR (approx. 1 in 2.3 year)	48.70	4.35
1 in 30 year	92.44	4.35
1 in 100 year	167.93	4.35

Local policy and guidance do not explicitly state that a betterment needs to be achieved in regard to this development. Regardless, based on the maximum allowable runoff rate of 16l/s (Based on JMS Group Drainage Remedial Works dwg Ref:C021/036/02 202), the proposed drainage system will provide a betterment of 72.8% for rainfall events, whilst including a 40% climate change allowance for the 1 in 100 year.

6.6. Comparison of Impermeable Areas – Pre and Post Development

The area of impermeable surfaces will also be altered during development. The pre-development and post-development impermeable areas are 4875m² and 2750m² respectively, giving a betterment of 43%. Hardstanding external areas to the building where possible are to be constructed as porous paving. An impermeable hardstanding play area has been proposed to the east of the site where Blocks B & C are currently located and will fall to a proposed rain garden. The temporary car park will be constructed using gravel and filter drains will be introduced to discharge runoff into the surface water

network serving the temporary building. Numerous soft landscaped areas proposed throughout the site will reduce the amount of impermeable surfacing on site as much as possible.

6.7. Water Quality Management

The surface water drainage network has been designed to meet recommendations and guidance within The SuDS Manual, CIRIA, C753.

The Simple Index Approach has been used to determine whether the proposed water quality measures are sufficient for the site. Indices are used to approximate the level of pollution from different land uses, with 0 indicating no pollution hazard and 1 indicating a high pollution hazard. Hazards can be managed and reduced using mitigation indices for each SuDS component which are summarised in The SuDS Manual.

Car Parking Areas:

Parking areas will be trafficked by cars and the occasional lorry/van/refuse vehicle. These areas shall be drained through porous paving, geotextile, and granular filter below. Treatment of the runoff from these areas is as per the table below.

Treatment Stage	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Pre-Treatment Levels	0.5	0.4	0.4
Treatment Mitigation Indices	0.7	0.6	0.7
Post-Treatment Levels	0	0	0

External Pedestrian Areas:

In the event external pedestrian paths are occasionally used by maintenance vehicles, treatment from these areas shall be as per the table below. Runoff shall be drained through porous paving, geotextile, and granular filter below.

Treatment Stage	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Pre-Treatment Levels	0.5	0.4	0.4
Treatment Mitigation Indices	0.7	0.6	0.7

Post-Treatment Levels	0	0	0
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School Roof (discharging directly to geocellular attenuation):

Treatment Stage	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Pre-Treatment Levels	0.3	0.2	0.05
Treatment Mitigation Indices	0.7	0.6	0.7
Post-Treatment Levels	0	0	0

7 Foul Water Network

7.1. Standards and Guidance

- Sewers Sector Guidance V2-2, Appendix G, 2022
- BS EN 752, Drain and Sewer Systems Outside Buildings, 2017
- The Building Regulations 2010, Drainage and Waste Disposal Part H, 2015

7.2. Existing Foul Drainage

Topographical and GPR utility surveys (see Appendices I and C respectively) were carried out by Tetra Tech in August 2021 to survey the existing site and determine the location of any existing utility and drainage infrastructure.

The existing gravity foul sewer network is made up of a series of between 100mm – 300mm diameter pipes. The network routes from north to south to MH52 and then falls southwest along the boundary of the site towards the sports pitches and then out to MH001 at a depth of 2.16m. The cover level is unknown but levels close to the manhole suggest it is approximately 124.00mAOD.

7.3. Proposed Foul Drainage

Foul water from the proposed school building shall be collected in a separate system from surface water and gravitate into an external foul water drainage network, which in turn shall discharge into an underground packaged foul water pumping station. The foul water pump station is proposed to be private, and a location has been selected within the canopy area at Block D.

The foul water pump station shall be sized to accommodate 24-hour emergency storage for the school building in accordance with Building Regulations.

A rising main from the below ground pumping station shall be installed and routed to existing gravity MH63 at the southern end of Block D.

Foul water from the proposed school building shall be collected in a separate system from surface water and gravitate to existing manhole 121 in the south of the site via proposed 150mm diameter pipework.

A pre-planning application has been submitted by Design ID to Severn Trent on 28th Nov 2022 for permission to discharge foul water flows from the proposed school into the existing Severn Trent foul sewer within the proposed site (See Appendix K for response). The proposed foul water drainage network for the development is shown on Proposed Drainage Layout, included in this report as Appendix L.

Regular maintenance of the foul water drainage network and pumping station is critical to the long-term performance of the foul water drainage network. It is proposed that maintenance of the foul water

network and pump station will be undertaken by the school on a regular basis through the appointment of an experienced Contractor.

8 Maintenance of Sustainable Drainage Systems

Regular maintenance of sustainable drainage systems is essential to maintain its performance and ensure the continued benefits are achieved. It is proposed that maintenance of the surface water network and sustainable drainage components will be instructed by the Client and undertaken by an experienced Contractor, in accordance with the maintenance strategy outlined in The SuDS Manual, C753, CIRIA. This has been summarised below, the list of actions is not exhaustive, and some actions may not always be required.

An agreed maintenance programme should be prepared and supervised by either the School facilities manager or an appointed property management company. This will be included within the Building Manual for the development on completion. A local council representative may wish to inspect the systems from time to time to monitor performance.

The Trust / School will be responsible for maintaining the on-site drainage and this will form part of the ongoing site management and maintenance programme. This has been budgeted into the annual allowance to cover site maintenance works. A written confirmation of this can be found in Appendix M at the end of this report.

8.1. Porous Paving

Many of the specific maintenance activities for pervious pavements can be undertaken as part of a general site cleaning contract.

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface).	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturers recommendations.
Occasional Maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Removal of weeds or management using glyphosate applied directly into the weeds.	As required – once per year on less frequently used pavements.
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving.	As required.
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing materials.	As required.
	Rehabilitation of surface and upper substructure by remedial sweeping.	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging).
Monitoring	Initial Inspection.	Monthly for three months after installation.
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action.	Three-monthly, 48 hours after large storms in first six months.
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually.

8.2. Geocellular Attenuation Structure

Regular inspection and maintenance are required to ensure the effective long-term operation of below ground storage systems. Maintenance plans and schedules are specific to the type of tank utilised.

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then annually.
	Remove debris from the catchment surface (where it may cause risks to performance).	Monthly.
	Remove sediment from pre-treatment structures and/or internal forebays.	Annually, or as required.
Remedial Actions	Repair/rehabilitate inlets, outlets, overflows, and vents.	As required.
Monitoring	Inspect/check all inlets, outlets, vents, and overflows to ensure that they are in good condition and operating as designed.	Annually
	Survey inside of tank for sediment build-up and remove if necessary.	Every 5 years or as required.

8.3. Filter Drains

Filter drains will require regular maintenance to ensure continuing operation to design performance standards. Litter and debris removal should be undertaken as part of general landscape maintenance for the site.

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter (including leaf litter) and debris from filter drain surface and access chambers.	Monthly (or as required).
	Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage.	Monthly.
	Inspect inlets and perforated pipework for silt accumulation and establish appropriate silt removal frequencies.	Six monthly.
	Remove sediment from pre-treatment devices.	Six monthly or as required.
Occasional maintenance	Remove or control tree roots where they are encroaching the sides of the filter drain, using recommended methods (NJUG, 2007 or BS 3998:2010).	As required.
	At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium .	Five yearly, or as required.
	Clear perforated pipework of blockages.	As required.

8.4. Bioretention Structure/ Rain Garden

Maintenance Schedule	Required Action	Typical Frequency
Regular inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) to determine if maintenance is necessary.	Quarterly
	Check operation of underdrains by inspection of flows after rain.	Annually
	Assess plants for disease infection, poor growth, invasive species etc and replace as necessary.	Quarterly
	Inspect inlets and outlets for blockage	Quarterly
Regular Maintenance	Remove litter and surface debris and weeds.	Quarterly (or more frequently for tidiness or aesthetic reasons)
	Replace any plants, to maintain planting density.	As required
	Remove sediment, litter, and debris build-up from around inlets or from forebays.	Quarterly to biannually
Occasional Maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required.	As required
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch.	As required
Remedial Actions	Remove and replace filter medium and vegetation above	As required but likely to be > 20 years.

8.5. Inlets, Outlets, Flow Controls, and Inspection Chambers

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect surface structures removing obstructions and silt, as necessary. Check there is no physical damage.	Monthly
	Strim vegetation 1m min. surround to structures and keep hard aprons free from silt and debris	Monthly

	Remove cover and inspect ensuring water is flowing freely and that the exit route for water is unobstructed. Remove debris and silt.	Annually
	Undertake inspection after leaf fall in autumn.	Annually
Occasional Maintenance	Check topsoil levels are 20mm above edges of baskets and chambers to avoid mower damage	As required
Remedial Work	Repair physical damage if necessary.	

8.6. Construction Phase Drainage Strategy

The SuDS Manual (2015), Section 31.1 outlines that “For SuDS, although the form of the drainage will be constructed during the earthworks phase, the final construction should not take place until the end of the development” and “Certain SuDS components should not be used to manage construction runoff, for example pervious surfaces. No traffic should be allowed to run on the pervious surface components if it is likely to introduce sediment on to the pavement surface from dusty or muddy areas or result in over compaction.” It is the recommendation of this report that the porous paving is to be constructed last in order to ensure the long term efficacy of the SuDS feature.

The risks prevalent during the construction phase are identified as:

- Polluted water entering the sewerage system and out falling into a watercourse.
- The risk that the drainage system will be severed or become blocked by the construction activities causing surface water flooding; and
- Polluted water entering the groundwater.

(Referenced from Control of Pollution from Construction Sites (C532) and PPG 6 Construction and Demolition Sites: Prevention of Pollution)

The most likely sources of pollution for this development and proposed mitigation measures are outlined below:

- Storage of materials, in particular sands and gravels that can be washed into the sewers. All stockpiles should be kept well away from any drains or openings in the drainage system and kept covered and located on an impermeable surface.

- Washing of plant and equipment involved with concreting excavations shall be carried out in a designated area where a sump pit is provided to capture the runoff and the solids are allowed to settle before removal off site.

Measures to minimise the risk of polluting agents reaching the groundwater of surface water sewers and prevent localised flooding include:

- Create an impermeable area as hardstanding for use during the construction period to store materials and vehicle parking.
- Place a cut off barrier at site entrance and exit points to direct any surface water into a sump where silts, muds, etc can settle before removal from site; and
- Any drains/gullies should be sealed or bunded off to prevent silts from entering the drainage network.

Subject to the above actions, the risk of pollution and flooding during the construction phase is considered to be low.

9 Summary

This Flood Risk Assessment has provided evidence that the proposed school development does not constitute a flood risk to either this or any other development. Risks and hazards as a result of all sources of flooding have been considered and have been considered at an acceptable level of flood risk, subject to the proposed strategies being implemented. There is a widely accepted low flood risk from fluvial and tidal sources, and artificial water bodies. The surface water flood risk in its existing state is considered to be low and groundwater flooding can also be considered to be negligible due to the impermeable geology on site and the significantly higher elevations of the development in comparison with tested groundwater levels. Whilst there will always be a residual risk of flooding from water mains and sewers, this will be mitigated as much as possible through best practise design and maintenance of the networks involved.

All constraints present on the site have been examined and have influenced the drainage design for the development. The proposed drainage strategy follows the drainage hierarchy. As infiltration was not possible, surface water is being managed close to the source in a series of attenuation features before ultimately discharging into a drainage ditch to the east of Block D. Many SuDS features have been incorporated into the design, including porous paving, filter drains and rain gardens. Evapotranspiration has been promoted where possible in the soft landscaping, habitat areas and rain gardens throughout the development. It should also be noted that these features promote biodiversity and add amenity value to the development.

Comparisons of surface water calculations with the assumed existing runoff rate of 16l/s (Based on JMS Group Drainage Remedial Works dwg Ref:C021/036/02 202) for the site show that surface water runoff for the proposed site has a betterment of 72.8%. As a result, the amount of surface water runoff for a 1 in 2.3-year event will be identical, proving that the development is not worsening the flood risk to itself or other developments. In addition to this, the drainage strategy proposed will provide a betterment to the assumed restricted runoff values of 72.8% for the 1 in 30-year and 1 in 100-year events, whilst including a 40% climate change allowance for the 1 in 100 year, proving that this development will in fact improve the flood risk locally, and will be a beneficial development to its immediate surroundings.

Appendix A – Site Location Plan & GA



Legend

- Site Boundary
- Ownership Boundary

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Project
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Drawn By
JS

Design ID Project No.
22229

Drawing Title
Site Location Plan

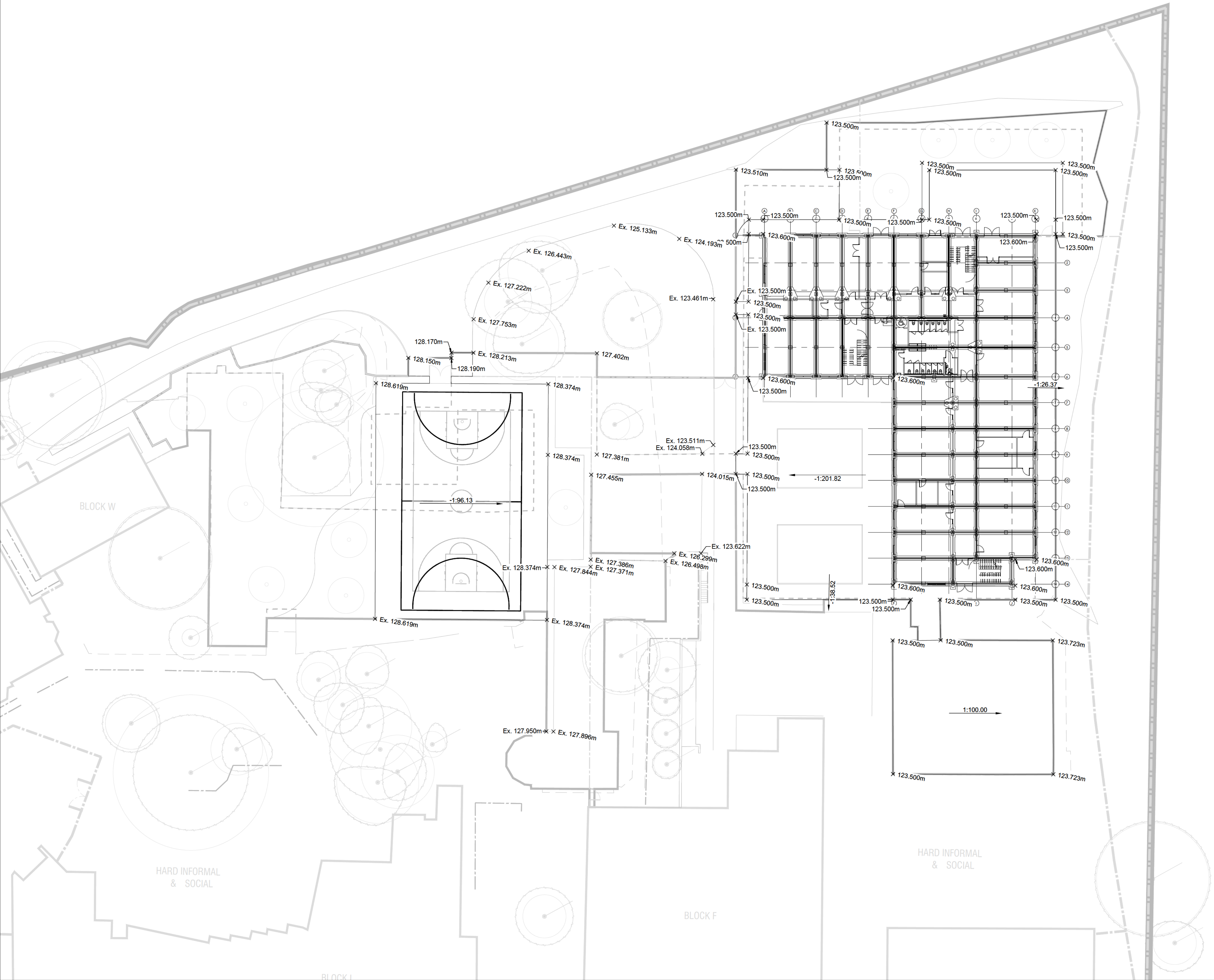
Date Drawn
Nov'22

Scale(s) @ A4
1:2500

Full Document Reference
22229-DID-XX-XX-DR-C-0001

Suitability & Description
S3 - For Review and Comment

Project	Originator	Volume	Level	Type	Role	Number	Revision
22229	- DID -	XX -	XX -	DR -	C -	0001	P01



General Notes

2. For setting out refer to Architect's drawings.
3. This drawing to be read in conjunction with all other Architectural and Engineering drawings and all other related drawings and specifications.
4. Do not scale from this drawing. Use figured dimensions only.
5. Hard copies and pdf will form a controlled issue of the drawing. All other formats (dwg, dxf, rvt, etc) are not to be used. All drawings and specifications on these files are the property of the design risk. Design ID will not accept any responsibility for any errors arising from the use of these files, either by human error by the recipient, use of un-dimensioned measurements, software errors or any other errors arising when these files are used by the recipient for drawing production or setting out on site.
6. Contractor shall check and verify all dimensions and levels on site before commencing work and report any errors to the Design ID.
7. This drawing/document must be read in conjunction with the Design ID project specification. If not received the Contractor must request this from this office before commencing.
8. The Design ID (Design and Management) Regulations (N) 2016 (CDM - Client's Duties and Management) Regulations (N) 2016 (CDM - Client's Duties
9. CDM Regulations aim to improve health and safety in the industry by helping to:
- Sensibly plan the work so the risks involved are managed from start to finish
 - Have the right people for the job at the right time
 - Cooperate and coordinate work between clients, designers and contractors
 - Have the right information about the risks and how they are being managed
 - Communicate this information effectively to the right people
 - Consult and engage with workers about the risks and how they are being managed
10. To comply with the CDM Regulations the Client must be aware of and undertake all their duties and responsibilities under the Regulations and ensure that the necessary arrangements for welfare facilities, appointing a Principal Designer and appointing a Principal Contractor. A free copy of the HSE's Guidance on the Regulations can be downloaded from the HSE website www.hse.gov.uk/cdm/cdmadvice.htm
11. The Regulations can be downloaded from the UK Legislation website (www.legislation.gov.uk)

Specific Notes

2. This drawing is to be read in conjunction with all other engineering and architectural information. The layout is based on the following information:
 - Architectural Ground Floor Plan, Model Ref. SPL0001-SOS-ZZ-00-A-D-001 dated 02-11-2002
 - Landscape Site Plan, Drawing Ref. SPL0001-MAC-XX-XX-D-0004 dated 23-11-2002
 - Topographical survey, Drawing Ref. SPL0001-TTL-XX-XX-G-0001 dated 28-09-2002
3. The Contractor is responsible for the checking and recording of all existing level information prior to setting out the works.
4. Refer to Architect / Structural Engineer information for setting out of structures.
5. The Contractor shall ensure that footways have a crossfall of at least 1:40, falling away from buildings.

Legend

X123.500m	Proposed Levels
X ex 123.500m	Existing Levels
1:40	Proposed Fall

02	29.11.22	MM	DF	DRAFT CP ISSUE	
07	11.12.22	CB	DF	FOR APPROVAL	
ev	Date	Drawn By	Appr. By	Description	
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Drawing Title
GENERAL ARRANGEMENT

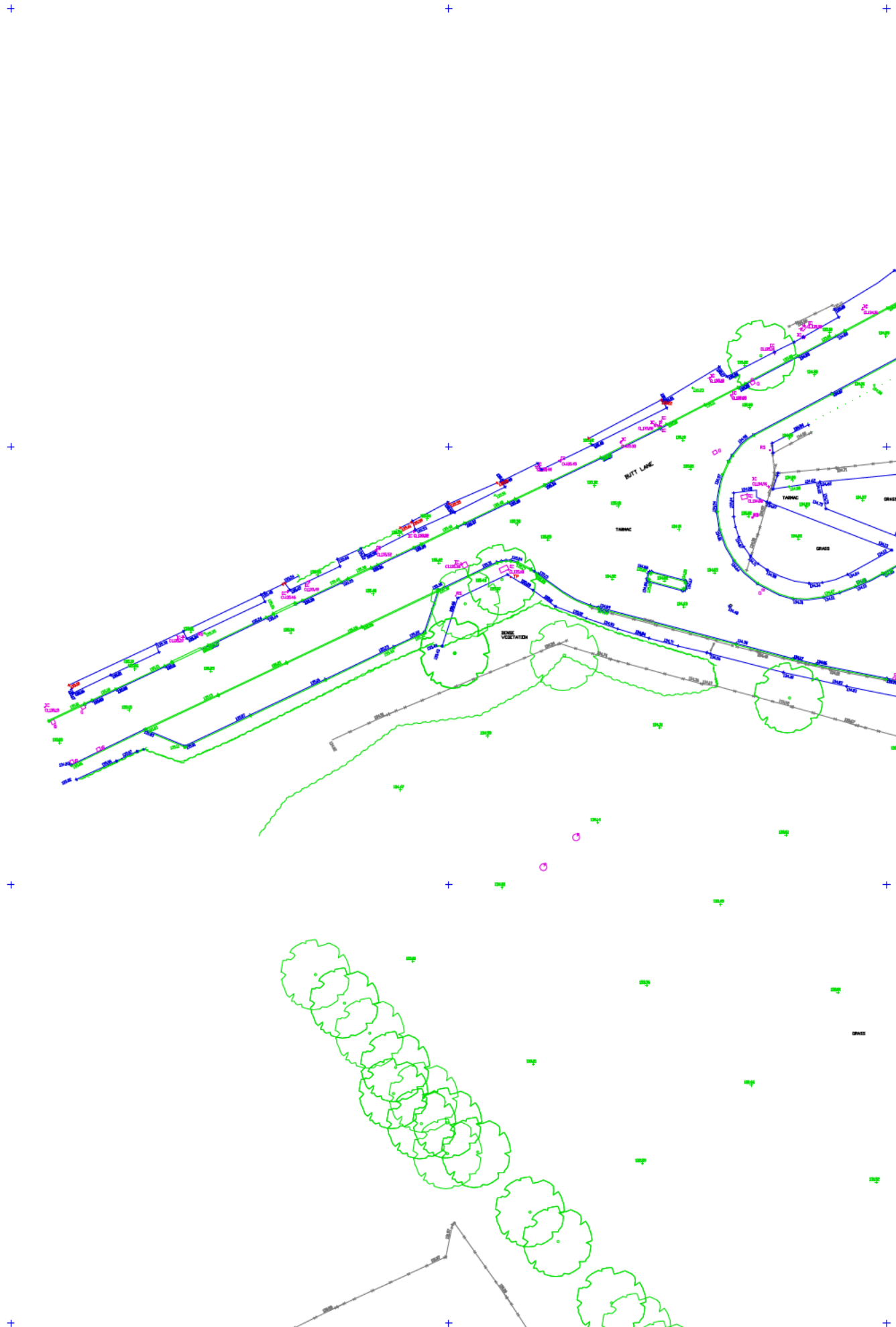
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S4 - FOR APPROVAL

Project	Originator	Volume	Level	Type	Role	Number	Revision
22229	- DID -	XX -	XX -	D -	C -	5001	P02

Appendix B – Topographical Survey

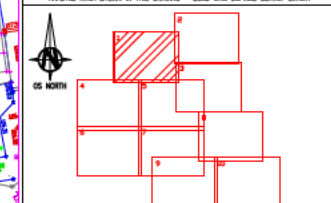


1. UNLESS NOTED OTHERWISE, ALL DIMENSIONS ON THIS DRAWING ARE IN METRES.
2. ALL LEVELS ARE IN METRES AND RELATED TO MEAN LOW OF TIDE, FROM CHDS POSTERING, CONVERTED USING THE NATIONAL GRID GRID MODEL. OSBMIS
3. LOCAL PLANE METRIC GRID RELATED TO ORDNANCE SURVEY GRID

[illegible]

LOCATION PLAN

HATCHED AREA SHOWN IN THIS DRAWING - BOLD LINE DEFINES SURVEY EXTENT



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A	FIRST APPROVED ISSUE	04/06/21	IS	OH	GP
File	Worksheet	Name	DPT / DYS / AGE		

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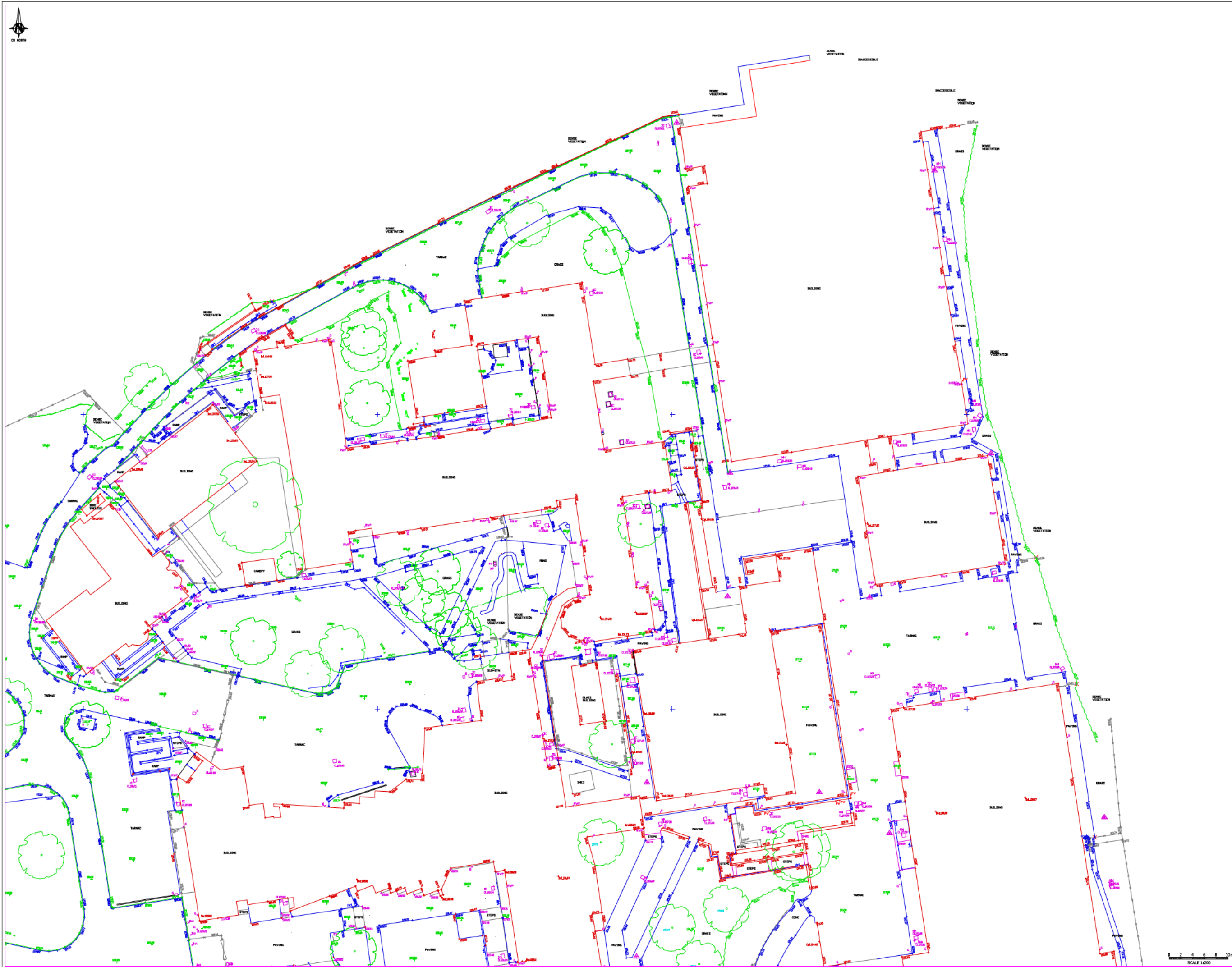
 GLEEDS
Product Name Gleeds Schools - Hinckley Academy

Sheet 10a

HINCKLEY ACADEMY
3D TOPOGRAPHICAL SURVEY
SHEET 1 OF 10

TTE Project Number	Owner Rly	Stop	Checked Rly	Stop	Approved Rly	Stop	Stop # 30	Notes
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Client Project Number	City/State	Industry/Market	Level/Class	Type/Code	Job Number	Number
-	-	TTE	00	01	PL - G	00001



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3. LOCAL PLANE METRIC GRID RELATED TO ORDNANCE SURVEY GRID

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LOCATION PLAN

HATCHED AREA SHOWN IN THIS DRAWING - BOLD LINE DEFINES SURVEY EXTENT



GLEEDS

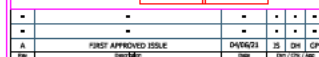
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Client/Project Number	Object Number	Volume Number	Level/Location	Type/Code	Role	Number	Revision	
-	- TTE	- 00	- 01	- PL - G	-	00001	A	

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LOCATION PLAN

HATCHED AREA SHOWN IN THIS DRAWING - BOLD LINE DEFINES SURVEY EXTENT



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GLEEDS

Product Name
Gleeds Schools - Hinckley Academy

Sheet 10b

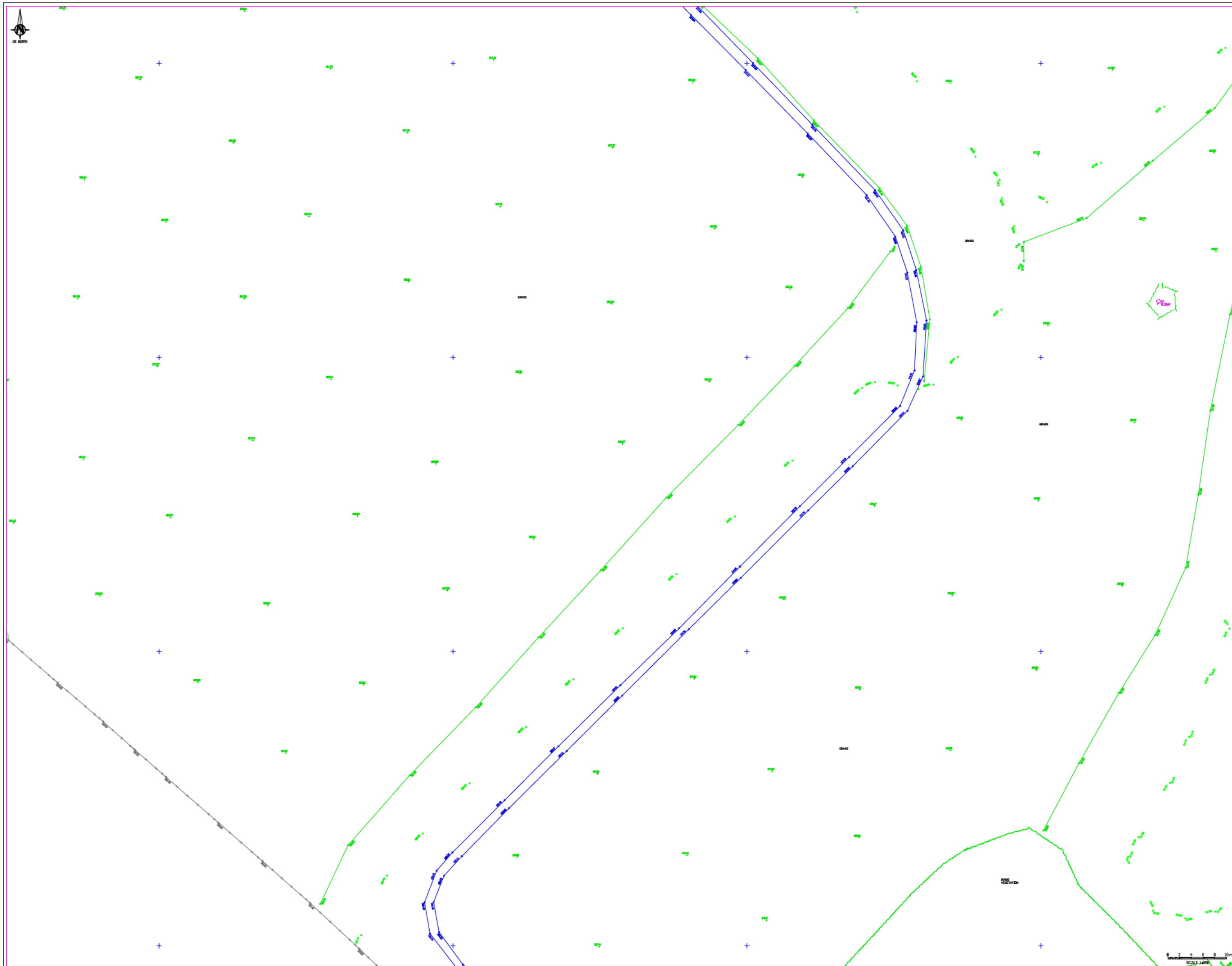
HINCKLEY ACADEMY
3D TOPOGRAPHICAL SURVEY
SHEET 4 OF 10

TTE Project Number	Drawn By	Dep	Checked By	Dep	Approved By	Dep	Std. # 30	Std. # 50
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Class Project Number	Class Number	Volume Number	Leaf Number	Type Code	Sub	Number	Number	
-	- TTE	- 00	- 01	- PL	- G	- 000001		A

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TOPO LEGEND

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FINAL ISSUE

LOCATION PLAN

HATCHED AREA SHOWN IN THIS DRAWING - BOLD LINE DEFINES SURVEY EXTENT



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A	FIRST APPROVED ISSUE	04/06/21	JS	DM	GP
File	0000162	ISSUE	DET	12/1	1/02

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Project Name
Gleeds Schools - Hinkley Academy

Sheet 10b

HINCKLEY ACADEMY
3D TOPOGRAPHICAL SURVEY
SHEET 7 OF 10

TTEProj#	Order By	Ship	Checked By	Ship	Agreed By	Ship	Ship #	Ship #
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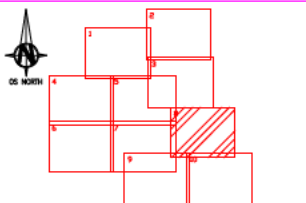
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FINAL ISSUE

LOCATION PLAN

HATCHED AREA SHOWN IN THIS DRAWING - BOLD LINE DEFINES SURVEY EXTENT



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A	FIRST APPROVED ISSUE	D4TG71	25	08	CP
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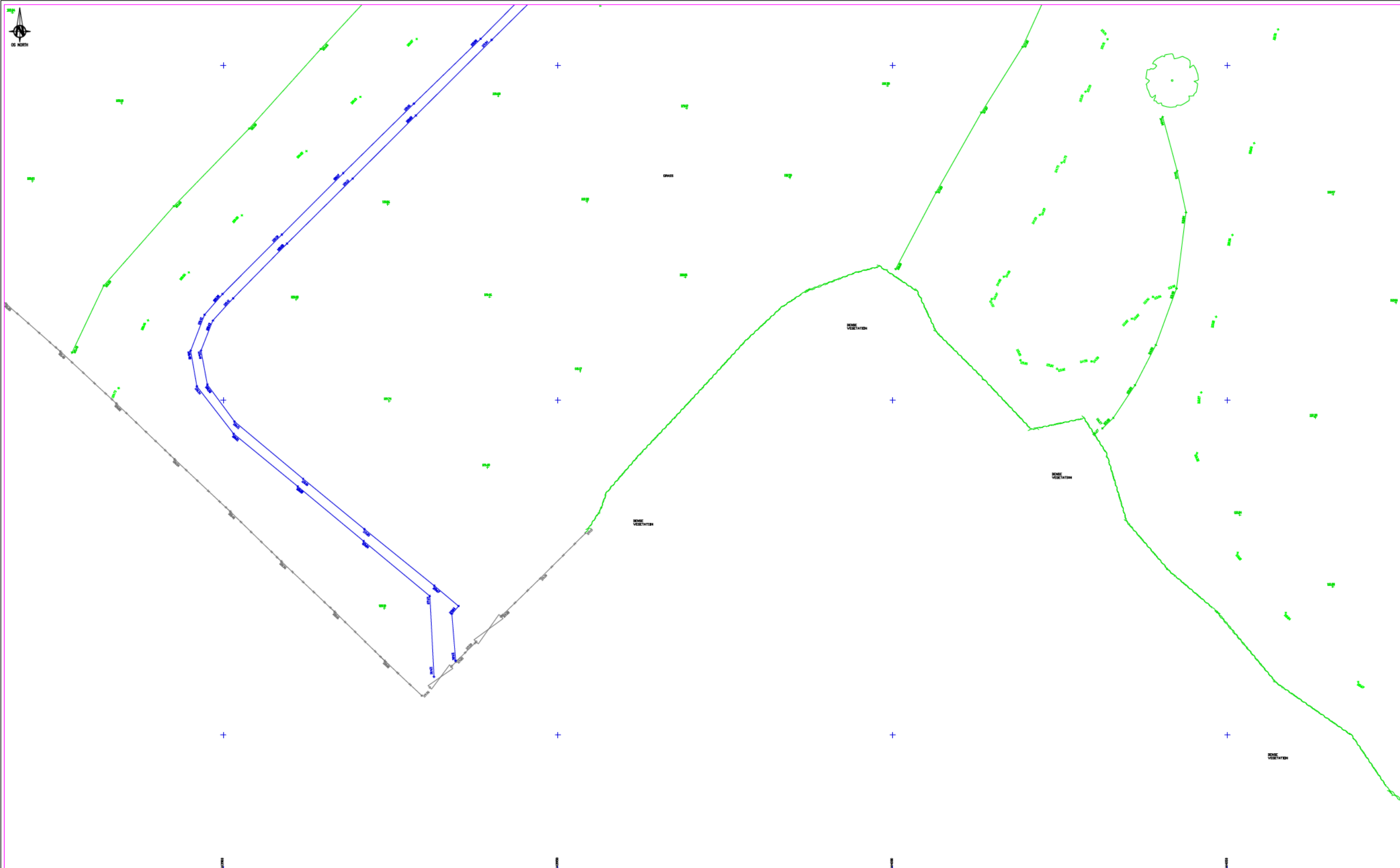
Gl Leeds Schools - Hinkley Academy

HINCKLEY ACADEMY
3D TOPOGRAPHICAL SURVEY
SHEET 8 OF 10

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TTE Project Number	Cd	User	Module Number	Level Code	Type Code	Sub	Number	Name	
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DOI 10.1002/pola.22301



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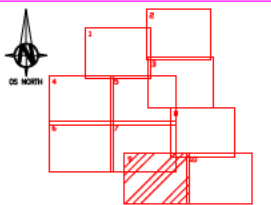
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FINAL ISSUE

LOCATION PLAN

HATCHED AREA SHOWN IN THIS DRAWING - BOLD LINE DEFINES SURVEY EXTENT



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A	FIRST APPROVED ISSUE	04/06/21	25	06	CP
FILE	issuance	ISS	07/12/21	AS	

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BLEEDS

Project Name
Gleeds Schools - Hinckley Academy

1. [Introduction](#)

HTNCKLEY ACADEMY

3D TOPOGRAPHICAL SURVEY
SHEET 9 OF 10

TRF Pro Number	Drawn By	Qty	Checked By	Qty	Approved By	Qty	Issued At	Units
786-8060162	CD	24/08/21	GP	04/06/21	GP	27/08/21	1:000	53

Client/Project/Number	Originator	Industry/System	Level/Location	Type/Code	Role	Number	Revision
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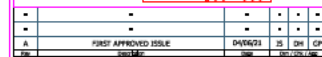
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FINAL ISSUE

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HATCHED AREA SHOWN IN THIS DRAWING - BOLD LINE DEFINES SURVEY EXTENT



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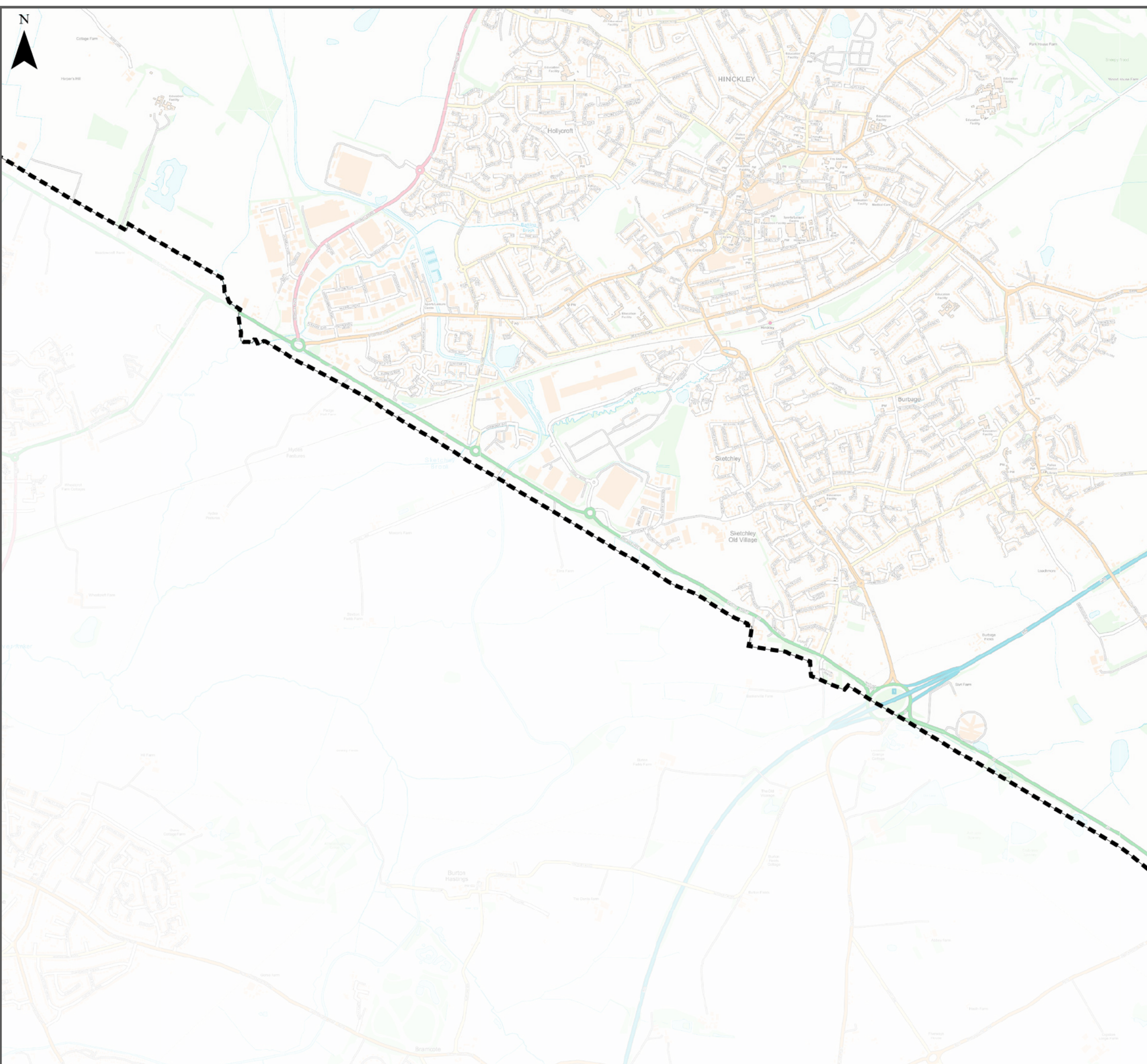


Project Name
Gleeds Schools - Hinckley Academy

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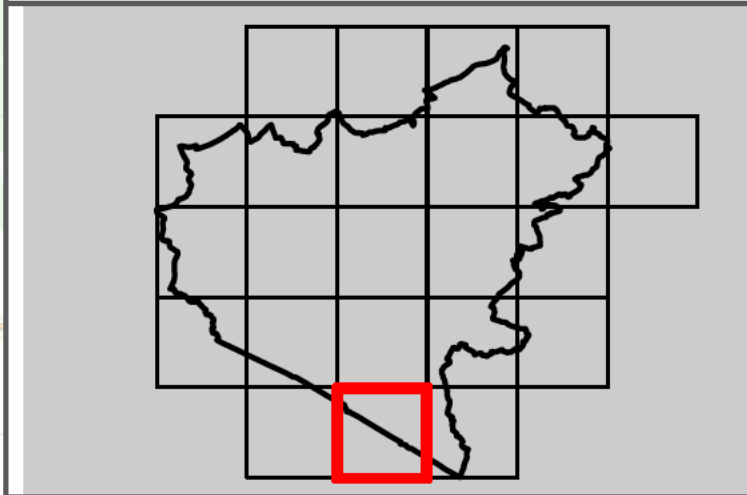
Appendix C – Flood Maps for Planning



HINCKLEY AND BOSWORTH BOROUGH LEVEL 1 STRATEGIC FLOOD RISK ASSESSMENT

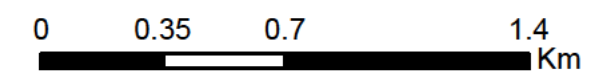
APPENDIX A: GEOPDF FLOOD RISK MAPPING

INDEX GRID: E3



**Note: All layers are turned off by default.
Click the box next to the layer of interest to**

- | Authority Information | | Climate Change | |
|--------------------------|--------------------------|---|-------------------------------|
| ☐ | Council Boundary | ☐ | Climate Change Central |
| ☐ | Main Rivers | ☐ | Climate Change Higher Central |
| ☐ | Detailed River Network | ☐ | Climate Change Upper |
| ☐ | | ☐ | Indicative Flood Zone 2 |
| Flood Zones | | Areas Susceptible to Groundwater Flooding | |
| ☐ | Flood Zone 3b | ☒ | >= 75% |
| ☐ | Indicative Flood Zone 3b | ☐ | >= 50% <75% |
| ☐ | Flood Zone 3a | ☐ | >= 25% <50% |
| ☐ | Flood Zone 2 | ☐ | < 25% |
| Surface Water | | Historical Flooding | |
| ☐ | RoFfSW 3.3% AEP | ☐ | Historic Flooding |
| ☐ | RoFfSW 1% AEP | | |
| ☐ | RoFfSW 0.1% AEP | | |
| Emergency Planning | | Defences | |
| ☐ | Flood Warning Areas | ☐ | demountable defence |
| ☐ | Flood Alert Areas | ☐ | embankment |
| | | ☐ | wall |

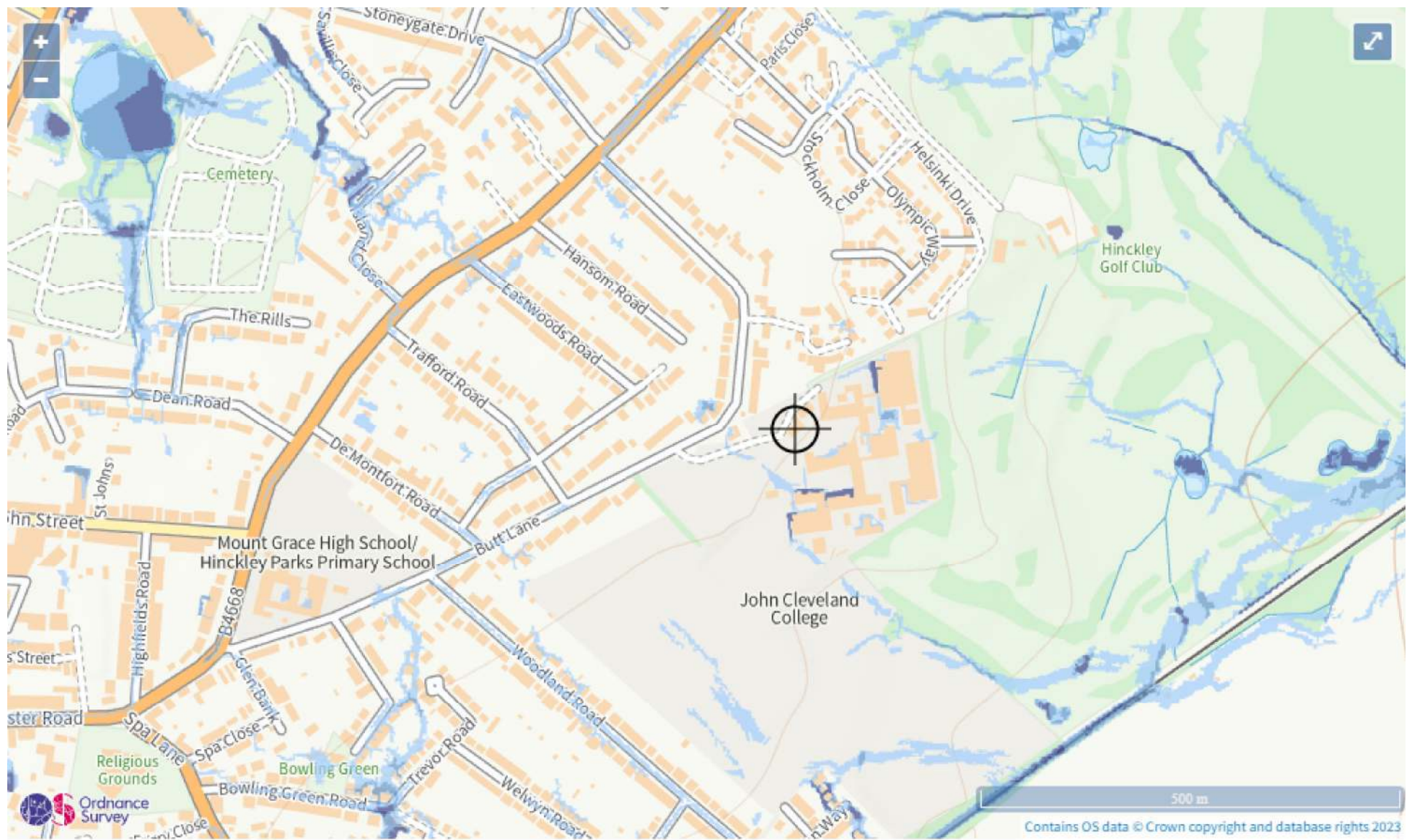


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Extent of flooding from surface water

Appendix D – Tetra Tech Ground Investigation Report - B030162 V1

Hinckley Academy

Ground Investigation Report

B030162 V1

February 2022

Prepared on Behalf of Tetra Tech Limited. Registered in England number:
01959704

Document control

Document:	Ground Investigation Report
Project:	Hinckley Academy
Client:	Department for Education
Job Number:	B030162
File Origin:	\\Londondc02\100sjs\Projects\B0 Series\B030162 Hinckley\9. Reports and Specifications\GIR\B030162 Hinckley GIR 23.2.22 V1.docx

Revision:	V0	Status:	Draft
Date:	20 th December 2021		
Prepared by:	Checked By:	Approved By:	
Heshawa Abayatilaka		Cathy Cooke	
Description of revision:			
First issue			

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EXECUTIVE SUMMARY

Site Location and Description	The site is centred on National Grid Reference: 443929, 294487 and covers an area of approximately 11 Hectares on the eastern outskirts of Hinckley, south Leicestershire. At the time of the investigation the site comprised school buildings and landscaped areas constructed on levelled platforms.
Geology	Ground investigation confirmed the following geological sequence: Made Ground (predominantly fine soils which are likely derived from Oadby Member): 0.26-4.60 thick. Oadby Member (fine soils): up to 3.30m thick where present depth fully established. Woolston Sand and Gravel (coarse soils): to the full depth of the investigation (15.00m bgl).
Hydrogeology	The superficial deposits have been classified as an Undifferentiated Secondary A Aquifer .
Hydrology	A lined pond is located on site. Thurston Brook and Soar rivers are within 250m of the site.
UXO	Risk maps show the site to be at Low risk of UXO .
Ground Investigation	The ground investigation completed by Tetra Tech during November 2021 comprised the following: • 1No. cable percussive boreholes to a depth of 15m including recovery of undisturbed (UT100) samples and Standard Penetration Tests (SPTs) • 3No. window sample boreholes to a maximum depth of 5m bgl • 5No. hand excavated inspection pits • 4No. Dynamic cone penetrometer tests • 4No. Groundwater and gas monitoring wells • Soil geo-chemical and geotechnical testing, of samples recovered from site • 3No. return groundwater and ground gas monitoring visits
Geo-Environmental Risk Assessment	Based on the review of desk study information, subsequent ground investigation and a conceptual model of source, pathway and receptor linkages, the following risk levels established have been identified: • Groundworkers – Low/Moderate • Future School Site Users – Low/Moderate • Surface Water Features – Very Low • Secondary A Superficial Aquifer – Very Low No significant contamination has been recorded within the soils and groundwater on site (albeit limited testing completed). However, fragments of anthropogenic materials (concrete, brick, ceramic etc) in Made Ground may present a hazard if present in soft cover playing fields.
Ground Gas	The site has been assessed to be CS1 (Very Low Risk).
Geotechnical	Conventional shallow foundations (pad or strip) can be considered for relatively light structural loads associated with the temporary modular units. Piled foundations will be required to support permanent development in the vicinity of Block D.

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1.0 INTRODUCTION

1.1 INSTRUCTION

Tetra Tech (Tt) were commissioned by Gleeds, on behalf of the Department for Education (D for E), to undertake a ground investigation at Hinckley Academy and John Cleveland Sixth Form Centre in Hinckley, Leicestershire.

1.2 OBJECTIVE

Following the Phase 1 Desktop Assessment^{ref 1}, the investigation was scoped by Tt to provide a more detailed understanding of risks associated with ground contamination and provide geotechnical recommendations for future development. This information will be provided to contractors to inform design and construction.

This report details the investigations undertaken and provides a factual record of the conditions encountered.

1.3 PROPOSED DEVELOPMENT

The development proposal being considered at the time of compilation of this report was confirmed in an email from Gleeds (12.11.21) and included the removal and landscaping of Blocks B and C in the north area of the site. Block D (the Technology Block) in the northeast will also be demolished and a new development is proposed in this area, the details of which were not confirmed / available at the time of writing. Temporary modular classrooms will be required during the construction phase and an area to the southwest of the main carpark has been identified to site these units.

Blocks F, G, I, L and M are scheduled for refurbishment. Blocks A, Q, R and W will remain untouched throughout the scheme. Block X is leased to another provider and will not form part of this scope of work.

The proposed development plans are provided in **Appendix 2**.

1.4 REPORT CONDITIONS

This report has been prepared for the client, Department for Education, in accordance with the terms and conditions of the contract. The report is prepared in line with the Invitation to Tender and the Tetra Tech tender submission and the agreed scope for the ground investigation for this specific site (dated 25th October 2021) and is subject to the report conditions included as **Appendix 1**.

The recommendations and opinions expressed within this report are based on the information provided and other sources of readily available information. Where reference has been made to

¹ B030162_Hinckley_DTS_V1_1, TetraTech (August 2021)

other reports or information provided by the client, or from other Third-party sources, such data has been reviewed in good faith and it has been assumed that their contents are correct. Tetra Tech is unable to guarantee any Third-Party Information. The ground conditions presented herein are representative of the conditions recorded at the time and in the positions of the investigation. Ground conditions may vary over time and in between investigation locations.

2.0 SITE INFORMATION

2.1 SITE LOCATION AND DESCRIPTION

The site is centered on National Grid Reference: 443929, 294487 and covers an area of approximately 11 Hectares on the eastern outskirts of Hinckley, south Leicestershire.

The school buildings occupy the northeast portion of the site and are arranged around hardstand access roads, walkways and landscaped areas which include broad-leaved mature trees, grass and hedgerows.

The buildings comprise the original single and two-story brick structures with pitched tiled roofs dating from c.1900 to 1960 (blocks A, B, I and K) and later (c.1990 to 2000) flat roof buildings, including the technology block D, which is of block construction.

The site lies across a southeast facing hillside, with levels stepped into the slope to accommodate the buildings. At its highest level, in the northwest extremity of the site, the playing fields reside at c. 135mAOD. Blocks B and C (scheduled for demolition / landscaping) are constructed into the slope falling from c.132 in the west to 127mAOD in the east, and this area is bounded by a steep bank down to the Block D level (Technology Block) at c.123.4mADO. A covered walkway connects an upper level on Block D with the ground floor of Block B. The lowest point in the southwest extremity of the site as at c.110mAOD.

Asphalt and AstroTurf sports pitches are situated to the southwest of the school buildings, beyond which, to the southwest and northwest are playing fields. The area identified to accommodate temporary units during the construction phase is in the northwest playing field immediately southwest of the main school carpark.

Structural defects, including water ingress and damp, noted in the project brief are attributed to flash flooding of the site.

2.2 GEOLOGY AND HYDROGEOLOGY

Information regarding the underlying geology anticipated from published British Geological Survey (BGS) maps and provided in the Phase 1 Assessment ^{ref 1} is summarised in Table 1.

Table 1 Summary of Anticipated Ground Conditions

Stratum	Thickness (m)	Aquifer Classification
Made Ground	0 to 3.00	Undifferentiated / Non-aquifer
Oadby Member	Up to 20m	Secondary Undifferentiated Aquifer
Wolston Sand and Gravel	Up to 20m	Secondary A Aquifer
Mercia Mudstone Group	more than 100m	Secondary B Aquifer

2.2.1 Made Ground

Various phases of development reside on generally level ground, and although not indicated on BGS mapping, it is anticipated that fill (likely comprising site won soils) would have been used to construct these platforms into the general southeast sloping topography. Therefore, based on the recorded site levels, the thickness of imported fill could potentially increase from <1m to c.5m from northwest to southeast across each platform.

2.2.2 Oadby Member

The BGS Lexicon of Named Rock Units ^{ref2} describes the Oadby Member, which is indicated across to the north and west of the site, as a grey, weathered brown, Diamicton comprising Cretaceous and Jurassic rock fragments with subordinate lenses of sand and gravel, clay and silt, and typically occurring as a brown to grey, and silty clay, with chalk and flint fragments.

2.2.3 Wolston Sand and Gravels

The south and eastern edges of the site is indicated to be underlain by the Wolston Sand and Gravels, which are also of glacial origin and are described as sand and gravel, locally with lenses of silt, clay or peat.

2.2.4 Mercia Mudstone Group

The bedrock geology is indicated to be of the Mercia Mudstone Group, described as red, commonly green-grey, mudstones and siltstones with thick halite-bearing units.

It is noted that based on BS5930 definitions, in terms of composition, the Mercia Mudstone Group can be highly variable and can be present as both soil or rock units of variable thickness depending on its detailed lithology and state of weathering. In some cases, localised weaker material (e. clay) can occur below stronger material (e.g sandstone), with associated geotechnical risks for substructures. Furthermore, the Mercia Mudstone Group contains evaporite minerals, mainly halite (sodium chloride) and gypsum (hydrous calcium sulfate). These lithologies can cause significant problems for construction due to dissolution (both naturally occurring and anthropogenically induced through brining). The Mercia Mudstone may contain aqueous solutions of sulfate and sulfuric acid in sufficient quantity for potential chemical attack on concrete.

2.2.5 Historic Boreholes

The BGS database holds records of borehole dating from 1957 which describe soils as 'Topsoil over firm to stiff reddish brown slightly sandy clay with little gravel, becoming stiff with depth' to depths of approximately 2m bgl (6ft). This description is comparable to the BGS lexicon description of the Oadby Member.

² <https://www.bgs.ac.uk/technologies/the-bgs-lexicon-of-named-rock-units/>

The nearest BH records extending beyond these shallow depths are SP49SW364 ^{ref 3} and SP49SW46 ^{ref 4} located approximately 320m west southwest of the site on ground currently residing at c.121m AOD. These records describe 18.5m of 'soft' and 'sandy marl' from ground level, above 4.3m of 'Very fine running sand' with alternating 'sandy clay' and 'marl' until 'rock marl' indicated at a depth of c.50m, which is possibly suggestive a locally deep Mercia Mudstone weathering profile

2.3 SERVICES

Services integral to the site including water, drainage, gas, electricity, and telecoms run below surface and are connecting to the mains statutory routes along Butts Lane to the north. The service routes within the site boundary were traced during a non-intrusive survey undertaken by others as indicated on the site layout plan (Figure ref: B030162-TTE-00-XX-DR-U-0001 (Ground Investigation Layout Plan) included in Appendix 2.

During the intrusive investigations, prior to breaking ground, exploratory hole locations were scanned using CAT and genny operating in both passive and active mode. Inspection pits were then excavated to a depth of 1.20m bgl. No uncharted services were encountered in these excavations.

³ http://scans.bgs.ac.uk/sobi_scans/boreholes/334578/images/14820719.html

⁴ http://scans.bgs.ac.uk/sobi_scans/boreholes/334260/images/10633607.html

3.0 GROUND INVESTIGATION

3.1 SUMMARY OF SCOPE

The scope of work originally proposed (Tt document ref: Hinckley - Proposed GI Scope 25.10.21 and Hinckley - Fee adjustment notice 11.11.21) was reduced due to the requirement for weekend working to limit disruption to school activities. The weekend work was further subject to statutory constraints on working hours relating to construction noise generation on sites at weekends. Furthermore, late notice revisions to the proposed developments resulted in revisions to the proposed layout of the proposed exploratory boreholes which could not be achieved due to practical constraints, including operational access tracks that could not be obstructed, and steep slopes impacting the safe mobilisation of cable percussive drilling.

The Tt intrusive investigations undertaken on 20th and 21st of November and 2nd December 2021 were therefore reduced from the originally planned scope of work, and in summary comprised the following.

- 5No. Hand excavated inspection pits (IP01 to IP05 inclusive) to 1m bgl
- 1No. Cable percussive boreholes with standard penetration testing (SPTs) (BH01) to a depth of 15m bgl
- 3No. Dynamic sample boreholes to depths ranging between 3 and 5m bgl
- 4No. TRRL Dynamic Cone Penetrometer tests to depths of c.1.40m bgl
- 4No. Dual purpose groundwater and gas monitoring installations
- Laboratory geo-environmental and geotechnical testing soil samples
- 3No. return monitoring visits to recover water samples and measure ground gas concentrations

Site investigation activities were undertaken in general accordance with BS5930:2015 'Code of Practice for Site Investigations' which incorporates BS-EN 1997-2:2007 and BS10175:2011 A1:2013.

Exploratory hole locations are indicated on the plan included in **Appendix 2**.

3.2 SUMMARY OF GROUND CONDITIONS ENCOUNTERED

The ground conditions encountered during the investigation compared well to the conditions anticipated from published information (Section 2.2) and in summary comprised the following deepening succession.

- Made Ground
- Oadby Member (locally present)
- Woolston Sand and Gravels

A summary of strata depths and thicknesses is provided in Tables 2 and 3. Detailed soil descriptions are provided on the Engineering Logs included in **Appendices 3 & 4**.

Table 2 Proposed Demolition / Development Area (around Block B and D) Summary of Strata Depths and Thicknesses

Location	Made Ground		Oadby Member		Woolston Sand and Gravel	
	From (mbgl)	Thickness (m)	From (mbgl)	Thickness (m)	From (mbgl)	Thickness (m)
BH01	GL	1.30	1.30	3.30	4.60	>11.40
WS01	GL	4.60	NP	NP	4.60	>0.40
WS02	GL	>3.80	NE	NE	NE	NE
WS03	GL	>3.90	NE	NE	NE	NE
IP01	GL	>1.00	NE	NE	NE	NE
IP02	GL	>1.00	NE	NE	NE	NE

'>' Denotes the maximum thickness confirmed (base depth of the material not proved), NE – Not Encountered, NP – Not Present

Table 3 Proposed Temporary Classrooms Summary of Strata Depths and Thicknesses

Location	Made Ground		Oadby Member		Woolston Sand and Gravel	
	From (mbgl)	Thickness (m)	From (mbgl)	Thickness (m)	From (mbgl)	Thickness (m)
IP03	GL	>1.00	NE	NE	NE	NE
IP04	GL	>1.00	NE	NE	NE	NE
IP05	GL	0.26	0.26	>0.74	NE	NE

'>' Denotes the maximum thickness confirmed (base depth of the material not proved), NE – Not Encountered

3.3 MADE GROUND

3.3.1 Proposed Demolition / Development area

IP01, IP02, WS01 and WS03 were located in soft landscaped areas and encountered a c.200mm thick layer of Topsoil at surface comprising grass / turf (where present) over dark brown slightly gravelly sandy silt. Gravel generally comprised flint with rare brick and concrete fragments and rootlets were also noted.

WS02 was commenced on hard standing and confirmed a 100mm thick layer of bitumen bound macadam (asphalt), whilst BH01 was drilled within a parking bay surfaced with mortared herringbone brick.

The full thickness of the Made Ground was not established in WS02, WS03, IP01, IP02 and IP03 where it persisted to the base of the exploratory holes at depths ranging between 1.00 and 3.90m bgl and confirmed the anticipated thicker layer of disturbed soils associated with historic earthworks (see Sections 2.1 and 2.2.1).

Where the full thickness was confirmed in BH01 and WS01, it extended to depths of between 0.20 to 4.60m bgl.

WS03 refused at a depth of 3.90m bgl.

Although slightly variable in composition, the Made Ground generally comprised fine soil (silt and clay) with lesser subordinate sand and gravel, and inclusions of ceramic tile, concrete, asphalt fragments near the surface, and rare fragments of brick noted throughout.

3.3.2 Area of Proposed Temporary Classrooms

Below the surface Topsoil within the area of the proposed temporary classrooms, soils showed obvious signs of disturbance between a depth of 0.18 and 0.26m bgl in IP05. Below this depth, natural soils are tentatively assumed, however this assumption is based only on the absence of anthropogenic materials.

The Made Ground was variable in composition and comprised dark grey to black slightly ashy slightly sandy gravel of quartzite, sandstone and coal with rare metal.

3.4 OADBY MEMBER

3.4.1 Proposed Demolition / Development area

The Oadby Member was encountered below the Made Ground in BH01 at a depth of 1.30m bgl where the full thickness of the unit was established (3.30m). This unit was locally absent at WS01 where the underlying Wolston Sand and Gravels were encountered below the Made Ground at 4.60. The Made Ground unit above the Woolston Sands and Gravels (between 2.20 and 4.60m bgl) at WS01 is noted to be of similar composition to the Oadby Member (reddish brown slightly gravelly silty CLAY), albeit with rare fragments of asphalt indicating disturbance.

The unit was relatively uniform in composition and described as soft to firm orangish to reddish brown slightly gravelly sandy clay.

3.4.2 Area of Proposed Temporary Classrooms

The Oadby Member was encountered in HP05 at 0.26m bgl and although similar soils were encountered in HP04 and HP05 at similar depths, rare brick fragments have also been identified indicating possible disturbance within the depths investigated at these positions.

The unit was relatively uniform in composition and soils encountered were similar to those encountered in the proposed development areas (and consisted of soft to firm orangish to reddish brown slightly gravelly sandy clay). The gravel component comprised subangular to subrounded fine to medium flint and quartzite (with rare brick fragments noted in IP04 and IP03).

3.5 WOLSTON SAND AND GRAVEL

The Wolston Sand and Gravel was encountered directly below the Made Ground (possibly disturbed Oadby Member) in WS01 and below the Oadby Member in BH01 at a depth of 4.60m bgl.

The full thickness of the unit was not established, and the unit persisted to the full depth of the investigation (15.00m bgl) in BH01.

The deposit was variable in composition and comprised a c.12.5m thick horizon of medium dense reddish brown silty fine to coarse sand, becoming gravelly between 8.70 and 10.40m bgl, and loose at 10.40m (possibly associated with the groundwater) overlying dense greyish brown sand with 40 to 120mm bands of stiff grey-brown clay which persisted to the base of BH01 (at 15.00m bgl).

3.6 GROUNDWATER STRIKES

During drilling, a groundwater strike occurred at 13.20 which then rose to a depth of 10.71m bgl after 20minutes in BH01.

3.7 MONITORING INSTALLATIONS

50mm internal diameter dual purpose land gas and groundwater monitoring standpipes were installed within BH01, WS01, WS02 and WS03. Installation details are provided on the engineering logs in Appendix 3 & 4 and response zone depths are summarised in Table 4.

Table 4 Summary of Borehole Installations

Location	Response Zone (m bgl)		Unit
	Top	Base	
BH01	1.00	14.50	Made Ground / Woolston Sand and Gravel
WS01	1.00	4.60	Made Ground
WS02	1.00	3.80	Made Ground
WS03	1.00	3.90	Oadby Member / Woolston Sand and Gravel

3.8 INSITU TESTING

3.8.1 Standard Penetration Tests (SPTs)

Standard Penetration Tests (SPTs) were undertaken at 1.00 to 1.50m intervals in BH01, WS01, WS02 and WS03. SPT N values are indicated on the engineering logs (Appendix 3 & 4).

3.8.2 Dynamic Cone Penetrator (DCP) Testing

Dynamic cone penetrator (DCP) testing was undertaken from ground level at 3No. locations adjacent to hand pits within the area of the proposed temporary classrooms as indicated on Figure B030162-TTE-00-XX-DR-U-0001 (Ground Investigation Layout Plan) ('DCP' ref locations). The tests were undertaken using a standard Transport and Roads Research Laboratory (TRRL) specification DCP probe to drive a 20mm diameter 60° cone using an 8kg weight dropped from a height of 575mm. The California Bearing Ratio (CBR) derived from these tests is presented in the tables

included in Appendix 5. CBR has been calculated for layers displaying discernible uniform rates of penetration (blows /10mm) using the TRRL standard relationship:

- $\text{Log}_{10}(\text{CBR}) = 2.48 - 1.057 \cdot \text{Log}_{10}(\text{mm/blow})$ ^{ref 5}

3.9 MONITORING AND SAMPLING

3No return gas and groundwater monitoring visits have been carried out to date on 2.12.21 (Round 1), 8.12.21 (Round 2) and 8.2.22 (Round 3) to monitor and record the following parameters using a Photo Ionisation Detector (PID) and GA5000 Gas Analyser.

- Volatile Organic Hydrocarbons (VOCs)
- Methane CH₄ (% Volume)
- Carbon Dioxide CO₂ (% volume)
- Carbon Monoxide CO (% volume)
- Oxygen O₂ (% volume), CO (ppm)
- Hydrogen Sulfide H₂S (ppm)
- Atmospheric pressure (mB)
- Gas flow rates (liters/hr)

Groundwater levels recorded during monitoring are summarised in Table 5 and ground gas monitoring results are included as Appendix 6 and summarised in Table 6.

Table 5 Summary of Groundwater Monitoring

Location	R1: 2.12.21 (m bgl)		R2: 8.12.21 (m bgl)		R3: 8.2.22 (m bgl)	
	Water	Base	Water	Base	Water	Base
BH01	10.44	13.39	10.39	13.38	10.22	13.36
WS01	Dry	4.35	Dry	4.34	Dry	4.34
WS02	Dry	3.20	Dry	3.20	Dry	3.21
WS03	Dry	3.71	Dry	3.69	Dry	3.68

⁵ ORN8 A users manual for a program to analyse dynamic cone penetrometer data (TRL, 1990)

Table 6 Summary of Land Gas Monitoring

Round	Peak Readings (*denotes minimum)							
	VOC (ppm)	CH ₄ (%)	CO ₂ (%)	CO (%)	O ₂ (%)*	H ₂ S (ppm)	ATM Trend	Flow (ltrs/hr)
1	1.10	ND	3.50	ND	15.50	ND	Static	-0.026
2	0.40	0.10	3.10	1	16.40	ND	Rising	0.000
3	0.20	0.10	2.90	ND	15.6	ND	Static	-0.020

3.10 GEOTECHNICAL LABORATORY ANALYSIS

A programme of geotechnical testing was carried out on samples recovered from the exploratory holes. The testing was scheduled by Tetra Tech and undertaken by GEO Site & Testing Services Ltd who are UKAS accredited for a wide range of geotechnical tests. All testing was carried out in accordance with BS 1377:1990 ‘Methods of Tests for Soils for Civil Engineering Purposes’. Table 7 presents a summary of geotechnical testing undertaken. Laboratory certificates are detailed in **Appendix 7**.

Table 7 Summary of Laboratory Geotechnical Testing

Test	Standard	No. Tests
Moisture Content	BS 1377: Part 2 : Clause 3.2 : 1990	8
Atterberg Limits	BS EN ISO 17892-12:2018	7
Particle Size Distribution	BS EN ISO 17892-4:2016, cl. 5.2	10
PSD (Pipette Method)	BS EN ISO 17892-4:2016, cl. 5.4	8
Quick Undrained Single Stage 106mm dia	BS EN ISO 17892-7:2018	1
Geotechnical Chemistry - BRE SD1 Suite A	BRE SD1 2005, BS1377: Part 3: 1990	2
pH and SO ₄ of soil	BRE SD1 2005, BS1377: Part 3: 1990	2

3.11 ENVIRONMENTAL LABORATORY ANALYSIS

The assessment of the environmental chemistry of selected soil and water samples was scheduled by Tetra Tech and carried out by Element Laboratories (Element) as summarised in Table 8. Element are an approved supplier in accordance with the requirements of Tt quality system and are themselves UKAS and MCERTS accredited for a range of chemical analyses. Laboratory testing was carried out in accordance with BS 10175: 2011+A1:2013^{ref 6}.

⁶ BS 10175: 2011+A1:2013 Investigation of Potentially Contaminated Sites – Code of Practice

Laboratory test certificates with results are provided in **Appendix 8**.

Table 8 Summary of Laboratory Environmental Testing

Test	Determinants	No. Tests
Tt Soil Suite B	Asbestos Screen, FOC (Fraction of Organic Carbon), cyanide, heavy metals, PAH, TPH, BTEX	8
Tt Leachate Suite B	pH, SO ₄ , NH ₄ alkalinity as CaCO ₃ , heavy metals, total phenol, PAH, TPH.	2
Tt Water Suite B	pH, cyanide, heavy metals, PAH, TPH, BTEX	1

4.0 GROUND MODEL AND GEOTECHNICAL PARAMETERS

4.1 SUMMARY GROUND MODEL

4.1.1 Soil Units

The ground model presented in Table 9 has used information from the investigation to summarise the depth and thickness of the units encountered.

Table 9 Ground Model

Unit	Unit Ref	Characteristic Surface		Characteristic Thickness (m)
		mbgl	mAOD	
Made Ground	MG	GL	123	1 to 5*
Oadby Member	ODT	1 to 5	122	<3
Woolston Sand and Gravel	WOL	2 to 4.5	119	>12

*Made Ground thickness increasing from west to east across cut / fill platforms.

4.1.2 Groundwater

Groundwater levels within the limited investigation remained relatively stable at around 10.40m bgl (113m AOD) during the investigation and monitoring. Shallow wells (<5m deep) remained dry.

4.2 SOIL PROPERTIES

The ranges of the various soil properties measured via in situ and laboratory testing are summarised in the following sections. Where characteristic values are provided, these are reasonably conservative estimates of a measured or assessed property, usually based on the lower quartile or average value that may be used to represent the overall behaviour of the material.

Due to inherent variability of MG, which comprised of slightly gravelly silty clay with occasional fragments of brick and concrete, these soils are not considered readily characterisable and conservative parameters should be used. Allowances should also be made for the presence of hydraulically bound materials (e.g. asphalt and concrete) where present.

4.2.1 Classification

4.2.1.1 Made Ground (MG)

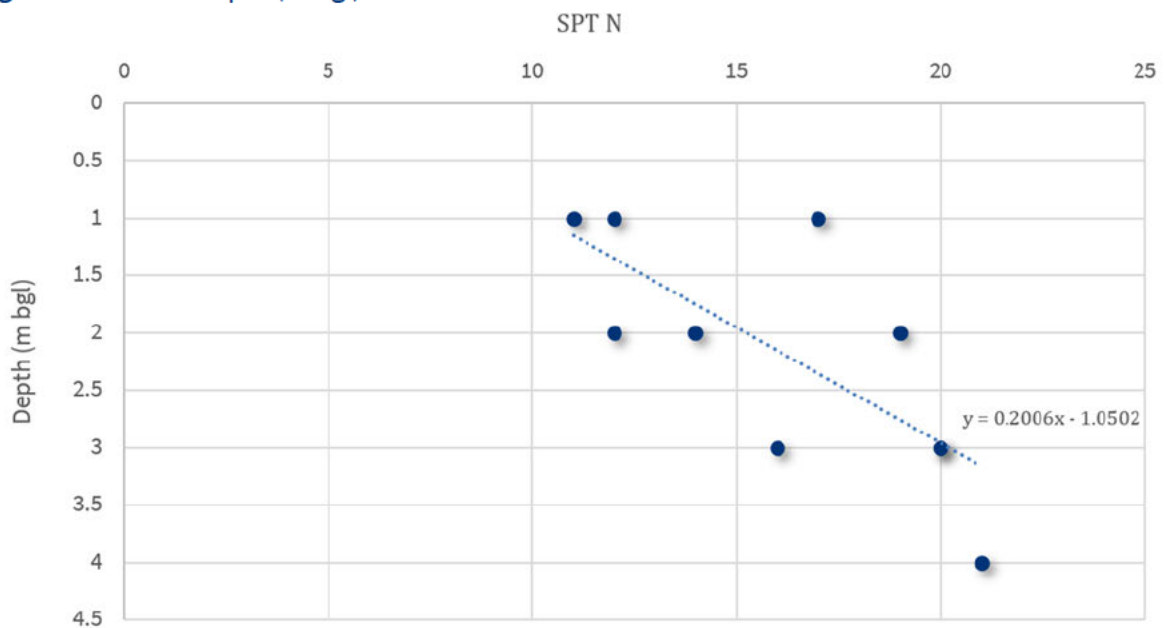
Particle Size Distribution (PSD) assessment undertaken on 3No. samples of MG confirmed predominantly fine soils with a similar size distribution to the likely parent materials (underlying Oadby Member) and compared well with the engineer's description of slightly sandy, slightly gravelly silty clay and clayey silt.

Atterberg limits derived from laboratory assessment of MG have confirmed moisture content in the range of 13 and 19%, a liquid limit in the range of 24 and 52%, a plastic limit in the range of 10 and 16%, and a plasticity index ranging between 14 and 42%.

Between 72 and 82% of the sample passed the 425µm sieve indicating a modified plasticity index (**I_p**) ranging between **11** and **34**, indicative of **low plasticity** fine soil of low to medium volume change potential ^{ref 7}.

SPT N within MG generally ranged between 11 and 21 (a single outlier N of >50 recorded in WS03 at 4.00m bgl is possibly indicative of refusal in the underlying soils) and showed a gradual increase with depth (see Figure 1).

Figure 1 SPT N vs Depth (m bgl): Made Ground



Using the relationship proposed by Stroud and Butler ^{ref 8}, where for SPT N <~25, the undrained shear strength (C_u) = SPT N x 4.5, the C_u ranges between **49 and 94 kPa** (where N = <50).

N shows an increase in depth equivalent to the gradient: Depth (m bgl) = 0.2N-1.05. Although SPT N demonstrates relative consistency, due to the evidence of disturbance and limited data available, unless further assessment is undertaken, it is recommended that these indicative strength parameters are used with caution, and a worse case (**N=11**) is considered characteristic throughout this unit.

TRRL DCP probes within the area of the proposed temporary classrooms confirmed variable CBR (%) ranging between 3 and 10% through the upper meter of MG. Owing to the inherent variability of the Made Ground a lower bound CBR of **3%** is considered conservative.

⁷ NHBC Standards 2011 Chapter 4, 4.2 Building near trees

⁸ Stroud and Butler, The Standard Penetration Test and the Engineering Properties of Glacial Materials, 1975 Conf. of the Midlands Geotechnical Society

Assessment of the geotechnical chemistry of 3No. samples of MG is summarised in Table 10.

Table 10 Summary of Chemical Analysis – Made Ground

Range (min – max)				
Acid Soluble Sulfate SO ₄ (% w/w)	Total Sulfur (% w/w)	pH	Water Soluble Sulfate SO ₄ as 2:1 extract (mg/l)	Corresponding DS & ACEC Class
0.04	0.02	8.5-8.6	41-72	DS1 AC-1

DS – Design Sulfate Class, ACEC – Aggressive Chemical Environment for Concrete

4.2.1.2 Oadby Member (ODT)

Due to limited presence (the ODT was only encountered in BH01 between depths of 1.30 and 3.30m bgl, and in IP05 from 0.27 to >1.00m bgl), limited assessment of the ODT has been undertaken. From the engineer's soil descriptions, it is tentatively concluded that the ODT is the parent material for much of the Made Ground on site, and therefore occurs as localised replacement fill which extends across the cut platform area covering the proposed development area (below blocks B and D), hence its subsequent classification as MG with which it is likely to share the general properties described in Section 4.2.1.1.

A PSD on a single sample of ODT confirmed the engineer's description of slightly gravelly very sandy, silty clay.

Atterberg limits derived from laboratory assessment of a single sample of ODT have confirmed moisture content of 14%, a liquid limit of 41%, a plastic limit of 12%, and a plasticity index of 29%. 95% of the sample passed the 425µm sieve indicating **I_p** of **27.55**, indicative of low plasticity fine soil of **low volume change** potential which is within the range determined for the MG.

SPT N of 19 and 25 at depth of 1.50 and 3.5m bgl suggest an increase in consistency with depth which plots above the MG trend line (see Figure 1) and are possibly indicative of higher consistencies owing to the soils undisturbed state. Laboratory quick undrained triaxial assessment of a single UT100 samples obtained from the ODT determined a **Cu (kPa)** of **123** which compares well with SPT N derived consistency of 112.5kPa^{ref 8} at 3.50m bgl.

A bulk and dry density of 198 and 1.71Mg/m³ was determined on a single sample of ODT from a depth of 2.50m bgl.

TRL DCP blow counts at deeper levels within TRL04 recorded an average stabilised CBR of c.5% through the ODT.

Assessment of the geotechnical chemistry of a single sample of ODT is summarised in Table 11 and again indicates similar properties to the MG.

Table 11 Summary of Chemical Analysis – Oadby Member

Acid Soluble Sulfate SO ₄ (% w/w)	Total Sulfur (% w/w)	pH	Water Soluble Sulfate SO ₄ as 2:1 extract (mg/l)	Corresponding DS & ACEC Class
-	-	8.6	41	DS1 AC-1

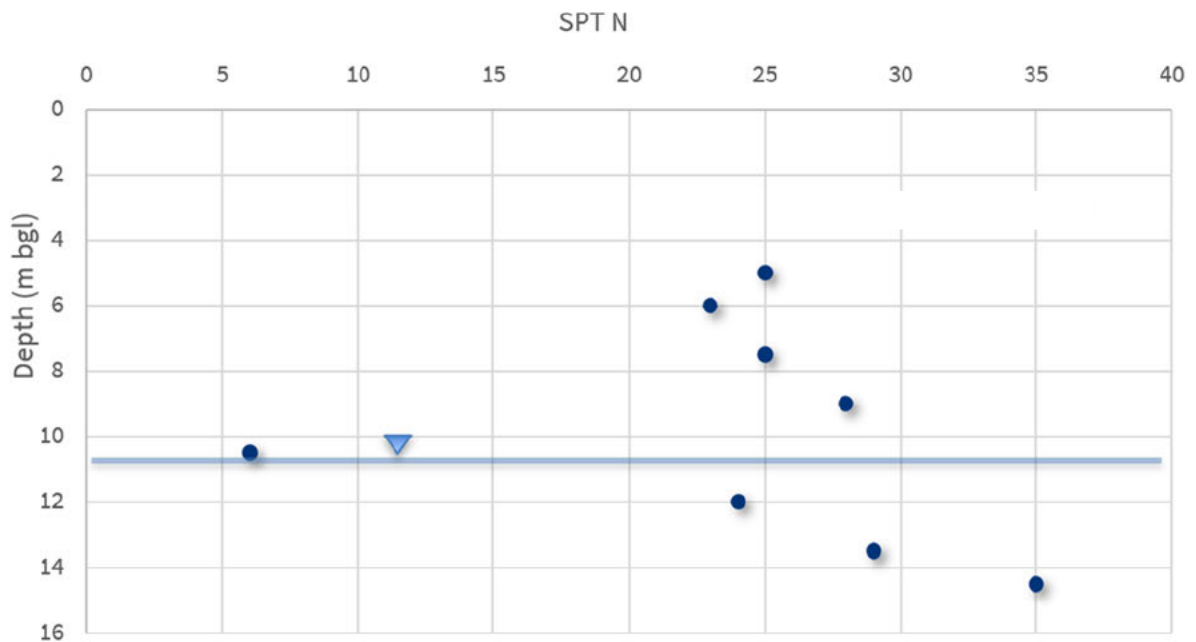
DS – Design Sulfate Class, ACEC – Aggressive Chemical Environment for Concrete

4.2.1.3 Wolston Sand and Gravel (WOL)

PSD assessments of samples obtained from the WOL at 4.60m bgl (WS01) and 6.00 and 9.00m bgl (BH01) indicate predominantly coarse soils and confirm the engineer's description of a silty fine to coarse sand horizon between 8.70 and 10.40m bgl. The engineers' observations of a horizon with greater fine soil component at deeper levels is also confirmed by PSD assessment on a sample at 14.50m bgl which determined 50% silt / clay and 50% sand components.

SPT N within WOL generally ranged between 23 and 35. Although a generalised increase in N with depth was discernible within the limited data available, a single outlier from this range of 6 was recorded at a depth of 10.50m bgl. This test coincided with a groundwater strike and is likely to be indicative of loosening of the soils associated with vadose conditions (see Figure 2).

Figure 2 SPT N vs Depth (m bgl): Wolston Sand and Gravel



5.0 GEOTECHNICAL CONSIDERATIONS

5.1 INTRODUCTION

The current development proposals (as of December 2021) are summarised in Section 1.3.

A new development is proposed in the current Block D (Technology Block) area, the details of which were not confirmed / available at the time of writing. This area is characterised by an area of Made Ground from surface which is likely to deepen from west to east overlying the predominantly fine soils of the Oadby Member, which in turn overlie the Woolston Sand and Gravel comprising predominantly coarse soils, with potentially loose coarse soils at the water table and clay / silt bands at deeper levels.

Geotechnical risks are presented by the assumed associated relatively high structural loads of the proposed block bearing upon the variable composition and thickness of the Made Ground, and Woolston Sand and Gravel at deeper levels.

Temporary modular classrooms will be required during the construction phase and an area to the southwest of the main carpark has been identified to site these units. Soils in this area were relatively uniform and the risks associated with the assumed temporary and relatively light loads of proposed structure are considered less significant, but residual risk remains.

The following sections present preliminary recommendations which are based on the limited data available from the constrained investigations. With consideration to the established geotechnical risks, once development proposals are finalised, it is recommended that further investigations are undertaken to inform efficient design, and further reduce these risks.

5.2 FOUNDATIONS

Due to the relatively variable near surface geotechnical conditions within the footprint of the proposed development, which potentially includes Made Ground to depths of up to 5m bgl, the use of conventional shallow foundations, e.g pads or strip, are unlikely to be a viable foundation solution for the new block due to the risk of unacceptable total or differential settlements, which could occur both in the short and long term, and therefore, it is therefore likely that piled foundations will need to be considered.

There is a lower risk of deeper Made Ground in the footprint of the proposed temporary classrooms. In this area and the soils show a relatively consistent composition. The proposed temporary modular units are also likely to be less sensitive to variable / differential settlements in the short term, much of which can be accommodated by design, e.g. via the use of large footprint or adjustable pad foundations, and therefore conventional shallow could be considered for relatively light structural loads of temporary modular units.

Shallow soils are noted to be of low to medium volume change potential and are susceptible to shrink and swell movements associated with seasonal moisture changes. Although these movements may not pose a significant risk to temporary buildings, in line with NHBC guidance ^{ref 7},

it is recommended that permanent structures would need to be constructed on foundations bearing at depths below the zones of influence of nearby trees.

Furthermore, both pile caps and the upper sections of piled foundations would need to be protected with compressible voids and sleeves to remove risks associated with volume change and the possible introduction of negative skin friction to pile shafts.

5.2.1 Conventional Shallow Foundations

The adoption of conventional spread foundations (e.g pad or strip foundations) is likely to be viable for light or broadly distributed loads such as the temporary classrooms.

Due to potential variability in composition and consistency of the near surface soils it is anticipated that these soils, if loaded, may give rise to unpredictable and unacceptable total and differential settlements. It is therefore recommended that foundations pass through the Made Ground and bear onto the underlying Oadby Member.

In consideration of allowable bearing pressures alone, calculations based on the Brinch Hansen method have estimated a net allowable bearing capacity (NBC) of the order of 70kPa. Loads of this order would limit settlement to less than 25mm and could be achieved for a 1x1m wide pads bearing at a depth of 1.0m bgl within the Oadby Member where it occurs at shallow levels, e.g within the area of the proposed temporary classrooms.

It is recommended that the local conditions are confirmed by a geotechnical engineer, and foundations extended to avoid low strength / variable soils where required.

5.2.2 Piled Foundations

Piled foundations will be required to support the permanent structures planned in the area of the existing technology block (Block D). A choice of pile type of various lengths and diameters can be designed to bear into the strata encountered beneath the site. However general site conditions, environs and proximity to adjacent extant structures and foundations are all influential in choice of piling system.

In consideration of the prevailing conditions and the anticipated scale of the scheme, where piles are required, Continuous Flight Auger (CFA) piles are likely to provide a practical and cost-effective solution due to limited generation of arisings and relatively quick installation. CFA piles also limit the risks to sensitive nearby substructures associated with vibration and percussion.

It is noted that certain practical constraints apply, for example when considering the incorporation of pile reinforcement or geothermal exchange systems, and pile emplacement in ground with potential obstructions. For these reasons it is recommended that a competent and experienced specialist piling contractor undertakes all piling works, adopting appropriate controls and that their advice should be sought at the earliest opportunity.

To provide an indicative assessment of pile capacities for the purposes of this illustrative exercise, variations in strata thickness have been averaged in a simplified model of ground conditions and characteristics as indicated in Table 9 whilst adopting worse case conditions (Made Ground of c. 5m thick). It is noted that the parameters applied are potentially conservative and have been

developed from the limited data available. The indicative capacities in Table 12 account for potentially weak soils at or near to the water table and include a widened buffer of 3m of potentially loose coarse soils around the vadose zone. Further efficiency / capacity may be achievable through a more detailed characterisation based on additional lateral coverage and deeper ground investigations to provide parameters for deeper piles.

Service capacities for a range of possible founding depths and pile dimensions have been calculated for CFA piles as outlined in Table 12.

Table 12 Summary CFA Preliminary Pile Capacity Assessment

Pile Embedment Length (m)	Pile Diameter (m)		
	0.30	0.60	1.20
	Approximate Service Capacity (kN)		
8	140	380	1170
10	190	510	1540
12	420	1300	4600

Parameters: α 0.30, β 0.30-0.56, N_c 8, N_q 2xSPT N, Groundwater 2.40m bgl. FOS: **1.5** shaft, **3.50** base.

5.2.3 Floor Slabs

Due to the presence of a variable thickness of Made Ground, which will be subject to variable longer-term settlement under relatively light loads, it is recommended that floor slabs are suspended.

5.2.4 Temporary Works

Shallow excavations remained stable during the investigation, however, owing to the variability of the shallow soils, there is potential for excavations to be unstable. It is therefore likely that temporary excavations will require battering back during excavation, and in line with good working practices, man entry into excavations greater than 1.2m deep, or working adjacent to unsupported soils, should only be carried out where temporary works and shoring are in place.

Shallow groundwater was not encountered during the investigation; however, there is some potential for minor perched water ingress, particularly after heavy precipitation and therefore allowances for the dewatering of excavations will need to be considered. It is recommended that dewatering is undertaken in accordance with the guidelines of CIRIA C515 Groundwater control – Design and Practice.

5.2.5 Concrete

It is recommended that concrete used for substructures complies with the design sulfate class of DS1 and ACEC class of AC-1 which assumes a mobile groundwater condition.

6.0 CONCEPTUAL SITE MODEL AND QUALITATIVE RISK ASSESSMENT

6.1 INTRODUCTION

Under the current UK environmental legislation (Environment Act 1995, Water Resources Act 1994, Environmental Protection Act 1990 (as amended), Health and Safety at Work Act 1994, Town and Country Planning Act 1990 and Building Regulations 1985), land is defined as contaminated if there is a significant ‘pollutant linkage’. This requires evidence of the presence of a contaminant “source”, a “pathway” through which contaminants could travel, and a “receptor” that could be harmed by the contaminant. In addition, the type of receptor and any harm must meet the descriptions of significant harm given in the statutory guidance. A site where a contaminant is causing, or is likely to cause, significant pollution of controlled waters also constitutes contaminated land.

This section of the report refines the Conceptual Site Model (CSM) developed during the Desk Based Assessment ^{ref 1}, which includes a qualitative assessment of environmental risks associated with each of the pollutant linkages identified.

The qualitative risk assessment is achieved by classifying the likely significance or severity of the risk and the probability of the risk actually occurring, to determine an overall risk for that particular pollutant linkage. The assessment has been undertaken with cognisance of:

- The nature, volume and extent of any identified contamination source;
- The potential pathways;
- Identified primary receptors; and
- Due regard to the current site status and potential future site redevelopment as a school.

6.2 GROUND CONTAMINATION TIER 1 SCREENING ASSESSMENT

The objective of the Tier 1 Screening Assessment presented herein is to identify the chemical constituents analysed which might potentially pose unacceptable levels of risk to sensitive on-site and off-site receptors. Measured concentrations in soil have been compared with various sets of Tier 1 Screening Values (TSVs). Where measured concentrations exceed these levels, this does not necessarily indicate a requirement for remediation; it can, however, be the trigger for the undertaking of a more detailed quantitative assessment in accordance with the current UK tiered risk assessment framework.

6.2.1 Human Health

6.2.1.1 Soils

In March 2014, DEFRA published the ‘C4SLs’ within the ‘Policy Companion Document: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination’

(SP1010). The purpose of the C4SLs is to identify a concentration in soil indicative of Category 4 status as defined by Part 2a Statutory Guidance on the definition of contaminated land. In September 2014, further clarification was published in a letter from Lord DeMauley to Local Authorities instructing them to use C4SLs in planning. Where available C4SLs have been used as the preferred choice of screening criteria.

For those constituents where no C4SL has been published, Tt have screened soil against Suitable for Use Levels (S4ULs).

For the purposes of this risk assessment, human health criteria for soils applicable to a school end use have been used in order to screen the site data. The TSVs applied are based on a 'residential without plant uptake' scenario and whilst this is conservative for the end use, it is considered protective of school pupils.

A number of TSVs are dependent on the Soil Organic Matter (SOM) content, and as such TSVs are typically calculated for a SOM of 1%, 2.5%, and 6%. An average SOM of 0.21% was calculated for samples taken. For this reason, GACs corresponding to a SOM of 1% have been used for the screening of the samples.

6.2.1.2 Tier 1 – Soil Screening

8No. soil samples obtained from the near surface materials on site were submitted for chemical laboratory analysis.

A single exceedance of the TSVs was recorded when using the screening criteria defined in S.6.2.1. Beryllium was recorded at a concentration of 3.1mg/kg with position IP05 at a depth of 0.20mbgl, compared to the TSV of 1.7mg/kg. All other analysed contaminants were recorded at concentrations below the corresponding TSVs within all soil samples.

It is considered that the exceedance of beryllium is relatively marginal and with the associated sample taken from Made Ground soils at a depth of 0.2mbgl, it is unlikely school end users would come into direct contact with these soils. It should also be noted that the analysed soils from that same position at a depth of 0.1mbgl did not show any exceedances above the TSV.

Full copies of laboratory certificates for all soil analyses are as well as the screened results are included as **Appendix 8**.

6.2.1.3 Asbestos Screening

8No. samples were analysed for the presence of asbestos comprising samples from a range of shallow depths. No Asbestos was identified in any of the samples.

6.2.2 Groundwater

The superficial geology is classified by the Environment Agency (EA) as a Secondary Undifferentiated Aquifer (Oadby Member) overlying a Secondary A Aquifer (Wolston Sand and