

SAXON PIT

Hydrogeological Assessment

Prepared for: East Midlands Waste Management Ltd

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1.0 Introduction

SLR Consulting Ltd (SLR) has been retained by East Midlands Waste Management Limited (EMWM) to prepare a Hydrogeological Assessment of Saxon Pit, a former clay pit which is in the process of restoration under a recovery permit (EPR/BB3038AY).

The site is located off Peterborough Road (A605), Nr Whittlesey, Cambridgeshire, PE7 1NP. Centred at National Grid Reference (NGR) 525754 297057.

This report provides an initial Hydrogeological Risk Assessment of the site based on a desktop survey and prior site investigations. This report aims to initially assess the risk of the current site on local and regional groundwater receptors and outline additional work required to fully assess the site and/or outlines potential mitigation.

2.0 Conceptual Site Model

The site's Conceptual Site Model (CSM) has been developed based on available desktop data from the British Geological Survey (BGS), Environment Agency (EA), Ordnance Survey (OS), Natural England (NE) and from previous site investigations.

The CSM is presented in a source-pathway-receptor approach to aid understanding

2.1 Source

Saxon Pit was developed as a clay pit; providing material for the adjacent brickworks with excavation taking place to depths of between 18m and 27m below natural ground level. Following excavation the site has historically suffered from several minor failures of the quarry face along its eastern and southern boundaries. Following site investigations in 1997 and 1998 it was recommended that Hanson (the site owner at the time) undertook a stabilisation scheme based on buttressing of the slopes using imported inert waste material.

Inert waste material is imported to the site under recovery permit EPR/BB3038Y (previously held by Glazewing). The permit allows for the import of a specific list of permitted wastes comprising of low risk inert materials. It is however acknowledged that additional waste materials which do not meet the specific criteria outlined within the permit have previously been accepted and input into the site. It is understood that the material comprises residue from end-of-life vehicle metal shredder plant following metal extraction.

It is understood that the material unlikely to have much leachable content and there is no evidence of leachate being generated within in-waste boreholes. However given that these wastes can not be classified as inert it is assumed as worst case that there is the potential for them to generate leachate at concentrations greater than that associated with inert material.

These wastes therefore have the potential to pose a risk to any groundwater or surface water receptors present, however the risk is considered relatively low.

2.2 Pathways

2.2.1 Site Setting & Hydrology

Saxon pit is an 18m to 27m deep excavation into Oxford Clay strata located to the South of Peterborough Road (A605); immediately West of Whittlesey and c. 6km East of Peterborough, Cambridgeshire. The site is bound to the north by scrub woodland, residential properties in Whittlesey to the east, railway line and King's Dike to the south, and operational buildings for the Saxon brickworks to the west.

The wider topography beyond the quarry is flat and low lying with large areas of fenland, located at an elevation of c.2mAOD, where the landscape is dominated by drainage channels managed by Internal Drainage Boards (IDB's).

The site is located within the Whittlesey and District Internal Drainage Board (IDB) who manage water levels within the surrounding drains and dikes; the closest of which is the King's Dike located immediately to the south of the site. The Dike is constructed on an embankment and is therefore above the elevation of the site and does not directly receive any surface water run-off from the site.

Surface water run-off from the quarry area currently drains to a settlement pond within the base of the quarry. The attenuation pond is constructed within low permeability Oxford Clay bedrock strata and therefore infiltration rates are likely to be negligible. Water from the attenuation pond is pumped as and when required to the King's Dyke, to the South of the site via a consented discharge point.

2.2.2 Geology

BGS mapping¹ indicates that the site is located on Oxford Clay bedrock which is described as "*silicate-mudstone, grey, generally smooth to slightly silty, with sporadic beds of argillaceous limestone nodules*". The Oxford Clay overlies Kellaways Formation comprising of Sands overlying Clays.

The underlying Kellaways Formation comprises '*Mudstone, grey, commonly silici-silty or silici-sandy, with (predominantly in the upper part) beds of generally calcareous siltstone and sandstone*' and is typically subdivided between the Kellaways Sand ('*Silicate sandstone and silicate siltstone, pale grey, calcareous cemented, with interbeds of sandy and silty mudstone*') overlying Kellaways clays ('*Silicate mudstone, grey, commonly smooth in basal part (see Previous Names), but more generally silici-silty or silici-sandy, locally with thin beds of siltstone and sandstone, and nodules of argillaceous limestone*').

Sands are thin; typically 2m – 3m in thickness and outcrop as a thin band. C.9km to the west of the site. These deposits subsequently dip in an easterly direction beneath the Oxford Clay. BGS borehole logs to the west and south-east of the site indicate that the base of the Oxford Clay dips from c.15m below ground level to the west and 30m below ground level to the east..

It is understood that Saxon Pit was dug to depths of between 18m and 27m; suggesting that the site will have largely excavated towards the base of the clays, although has not extended beneath the base of the Oxford Clay / top of the Kellaways Sand. It is estimated that there is several metres of clay present beneath the base of the site.

A site investigation undertaken in October 2017² included the drilling of four boreholes along the southern boundary of the site. All four boreholes were drilled to a depth of 20m, equal to the base of the quarry. The boreholes logs confirm that the geology comprises of "*very stiff to hard slightly fissured bluish grey silty CLAY with occasional partings of silt and rare shells and shell fragments*". Clay is recorded to the base of all four boreholes.

There are no superficial deposits overlying the bedrock in the immediate vicinity of the site; although superficial deposits of March Gravels are present to the north and east, and Peat to the south. These deposits are not located immediately adjacent to the quarry walls and are therefore unaffected by the development.

2.2.3 Hydrogeology

The Oxford Clay bedrock is classified by the Environment Agency as "Unproductive Strata", described as :

¹ <http://mapapps2.bgs.ac.uk/geoindex/home.html>

² SLR Consulting Ltd (Dec 2017) *Saxon Pit: Factual Ground Investigation Report*, Ref: 403-07764-00001

'rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow'.

The underlying Kellaways Sands are classified as a 'Secondary A Aquifer' which are described as:

'Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers'

The superficial March gravels are also classified as a 'Secondary A aquifer', although given that these deposits are not present across the site there is considered to be no potential pathway for any contaminants generated by the site.

The site investigation confirmed minor groundwater seepages from the Oxford Clay in one of the four boreholes however no permanent waterbody was encountered as would be anticipated by the geology. Oxford clay is characterised as having a very low permeability; regularly recorded at less than 1×10^{-9} m/s.

Although classified as a Secondary A aquifer, and exhibiting relatively high porosity available laboratory testing of the Kellaways Sands indicates relatively low permeabilities, with an interquartile range of between 3.1×10^{-6} to 6.8×10^{-3} m/day (3.6×10^{-11} to 7.9×10^{-8} m/s). Consequently the formation yields small supplies of groundwater³.

The site is not located within a source protection zone.

2.3 Receptors

The potential receptors relating to potential groundwater and surface water pathways are outlined below.

2.3.1 Groundwater Receptors

Saxon Pit is located within Oxford Clay deposits which, as discussed above, are classified as Unproductive Strata. Given the nature of the strata there is considered to be little potential for private abstractions. There are therefore considered to be no receptors within the Oxford Clay strata.

The Oxford Clay is underlain by the Kellaways Formation which while comprising predominantly of low permeability mudstones includes a thin sandstone horizon located between the Oxford Clay and Kellaway Clay units which has the potential for groundwater flow. It is however noted that given the low permeability and limited thickness of the formation along with the highly saline nature of any water encountered any groundwater present is unlikely to provide a significant or potable resource. A prior assessment of the Kellaways Sands has been undertaken by Mather et.al (1998)⁴ which had the following conclusion:

'Many formations treated as Minor Aquifers for the purpose of resource protection do not meet accepted definitions of aquifers. The Kellaways Sand is a typical example, and modern waste-disposal licenses require the installation of an engineered containment system to protect groundwater within it. However the formation is clay-rich and only 4-5m in thickness, and has a transmissivity of around $0.13 \text{m}^2/\text{day}$. Contained water quality is poor with salinities well above maximum admissible concentrations for drinking water. As the Kellaways Sand does not yield water to pumping wells, the only rational reason for protection is that the formation might contribute to baseflow in the River Ouse to the north-east. However hydraulic gradients are such that seepage rates to the River will not exceed more than a few cubic meters per year over the length of outcrop adjacent to the river. It is concluded that the installation of engineered mineral liners at the base of brick-pits in the Lower

³ BGS / EA (2000) *The physical properties of minor aquifers in England and Wales*

⁴ Mather, J.D., Halliday, D. & Joseph, J.B (1998) *Is all groundwater worth protecting? The example of the Kellaways Sand, in: Groundwater Pollution, Aquifer Recharge and Vulnerability*, Geological Society, London, Special Publications, 130, 211-217

Oxford Clay do nothing to reduce the risks associated with waste disposal. Resources spent on protecting the Kellaways Sand could be better used in other areas of environmental protection’.

Given the above and available permeability data it is considered highly unlikely that there will be any groundwater abstractions from the Kellaways Sands within the vicinity of the site (an information request to the EA and Fenland Council has been submitted to confirm this).

2.3.2 Surface Water Receptors

The main surface water receptor from the site is the King’s Dike, which receives pumped water from the site’s settlement pond.

The King’s Dike is a raised channel and forms part of the Whittlesey and District Internal Drainage Board (IDB) area which comprises a series of Dikes and interconnected drains which ultimately discharge to the River Nene via Twenty Foot River, approximately 19km to the east.

Flows across the IDB area are controlled by a series of sluices and pumps. Although not classified as Main Rivers the EA Water Framework Directive (WFD) classification⁵ for the ‘Middle Level’ which includes the King’s Dike and all surrounding drains are classified as having a “moderate” overall status, comprising of a “moderate” ecological status and “good” chemical status.

⁵ <https://environment.data.gov.uk/catchment-planning/WaterBody/GB205033000050>

3.0 Hydrogeological Impact Assessment

Following the review of the Conceptual Site Model it is considered that there are two potential receptors from any contaminants generated from the waste previously accepted at the site. These are:

- Groundwater within the Kellaways Sand Formation beneath the site; and
- Surface water quality within the discharge from the sites attenuation pond

3.1 Groundwater Risk

In the event of contaminated leachate being generated from the site the conceptual site model has confirmed that the risk to groundwater is low. There is no pathway or receptor associated with the Oxford Clay within which the waste material has been input and there is no potential pathway to any groundwater within the superficial deposits to the north-east of the site.

It is acknowledged that the underlying Kellaways Sand formation is classified as a Secondary A aquifer, however an existing natural geological barrier exists between the base of the quarry and the aquifer; it is understood that the base of the quarry retained several metres of in-situ Oxford Clay. Literature values for the clay suggests that the in-situ permeability is likely to exceed the requirements of the Landfill directive (maximum of 1×10^{-7} m/s) for inert landfills and be comparable to the requirements for a non-hazardous site (1×10^{-9} m/s). This suggests that the natural containment and attenuation provided by the geological setting is likely to mitigate any potential impact in the event of contaminated leachate being generated.

It is also noted that although the Kellaways Sand formation are classified as a Secondary A aquifer past investigations suggest that permeabilities and potential yields are very low. Consequently the Kellaways Sands are not considered a significant receptor, particularly given the relatively low risk posed by the site.

3.2 Surface Water Risk

There is a potential for contaminated water generated from the site to impact on water quality within the attenuation pond, and consequently the water quality in the King's Dike, however it is considered that this risk is relatively low. There are two potential sources:

- Direct Run-off from the Surface of the waste material;
- Leakage through the base of the waste into the underdrainage

Due to the generally low permeability of the waste material and surrounding geology it is anticipated that infiltration rates will be low and run-off rates high. Given the relatively short period of time that any run-off will be in contact with the material and low solubility of the material the likelihood of significant contamination occurring is low.

Any water seeping through the waste material and into the underdrainage has a higher propensity for contamination, however given the low permeability of the material and the lack of any groundwater inputs it is considered that leakage rates within the underdrainage will be minor and undergo significant dilution with run-off from the wider site and within the King's Dike.

It should also be noted that discharge to the King's Dike is controlled by pumping and an existing discharge consent, monitoring of the discharge has confirmed that there have been no exceedances of the discharge limits.

The overall risk to surface water is considered to be low, however it is considered that additional measures could be taken to further reduce the risk to surface water receptors, as discussed in section 3.3.

3.3 Additional Work / Mitigation

To further refine the above assessment additional data will be required to confirm some of the assumptions and uncertainties outlined above, to include:

- Completion of leaching tests on the material to quantify the likelihood and potential strength of any contaminated water being generated from the material.
- A Review of all historic borehole data to confirm the thickness of the in-situ Oxford Clay beneath the base of the site. If not available it is recommended that additional Site Investigation is undertaken to confirm;
- Completion of water interest survey to confirm that there are no groundwater receptors associated with the Kellaways Sand formation within the vicinity of the site;
- Completion of surface water monitoring up-stream and down-stream of the King's Dike discharge to ensure that there is no impact on water quality.

To further reduce the risk of the in-situ material impacting surface water quality the following measures would be recommended:

- Overtipping the material using suitable inert material low permeability material (ideally clays) to ensure that any run-off from the site will not come into direct contact with the material and infiltration into the waste is minimised;
- Regular monitoring of the settlement pond so that in the unlikely event of any adverse impact from the material it is identified and mitigated prior to discharge to the King's Dike.

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