Report of the Cemetery Working Group on the suitability of Freeland cemetery for burials

(1) **Groundwater and drainage**

On 8 March 1995, planning permission was obtained by the Parish Council for change of use of land "adjacent to Wroslyn Road" to form a burial ground. Attached to this permission was the condition that ***"No burial excavations shall be constructed such that they penetrate the water table. REASON: to prevent pollution of groundwater".*** Reinforcing this condition was a letter from the NRA (National Rivers Authority - which was subsumed into the Environment Agency in 1996) to the Chief Planning Officer of WODC dated 22 February 1995 stating that the Authority had no objection to the proposed development but noted that: ***"Burial should not take place within groundwater. A minimum unsaturated zone of 1 metre should be established between burial depth and groundwater".***

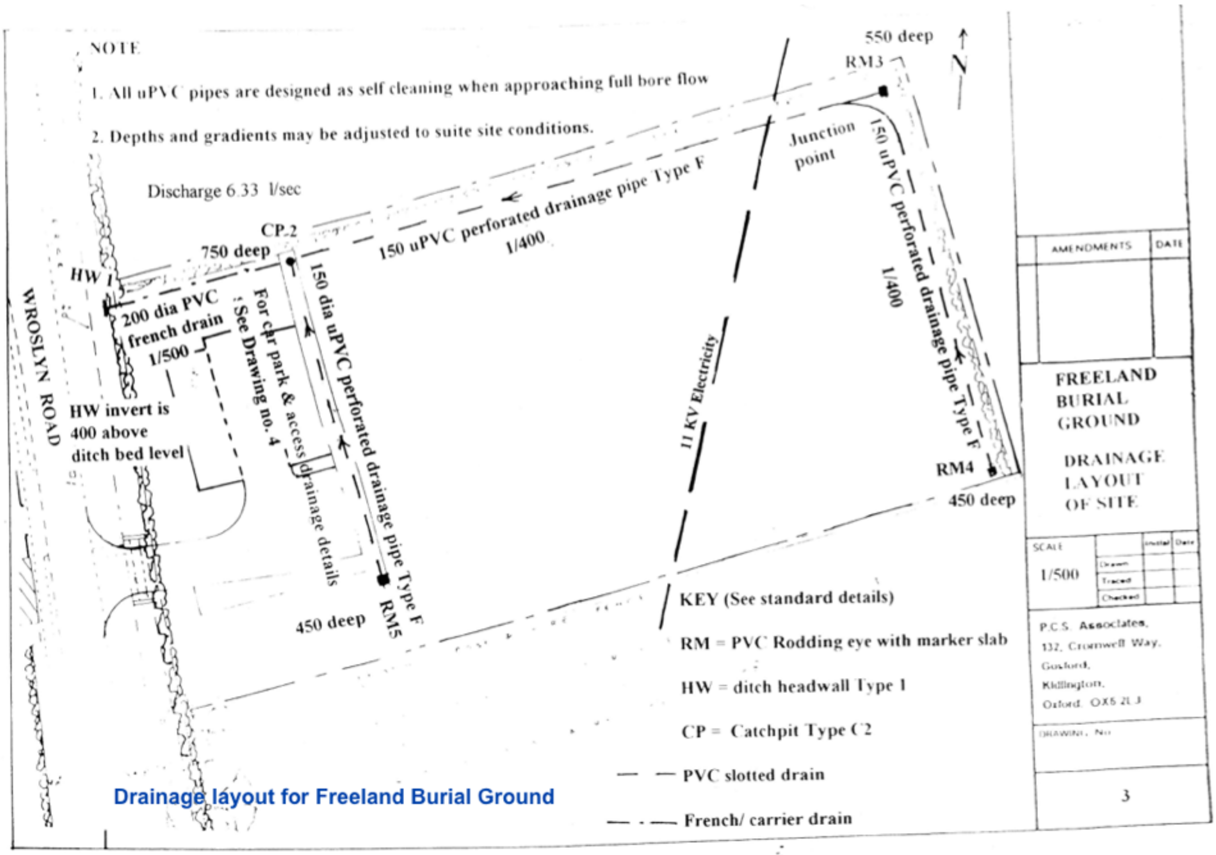
It may seem strange that concern was not raised about the difficulty of complying with these conditions at the time. However, the very dry weather in 1995 and succeeding years may have influenced thoughts about this matter: A recent (2014) report on rainfall from the University of Oxford's 'School of Geography and the Environment' states: "*Over the recent past, rainfall patterns in Oxford have been characterised by large deviations from the long-term averages. A number of dry spells has been registered, most notably between 1988 and 1992, in the summer of 1995 (this was the second driest summer on record since 1767; only 1818 had less rain), and in 1996-97.*"

For us, the problem of ground saturation and high water tables has been brought into sharp focus by recent wet years.

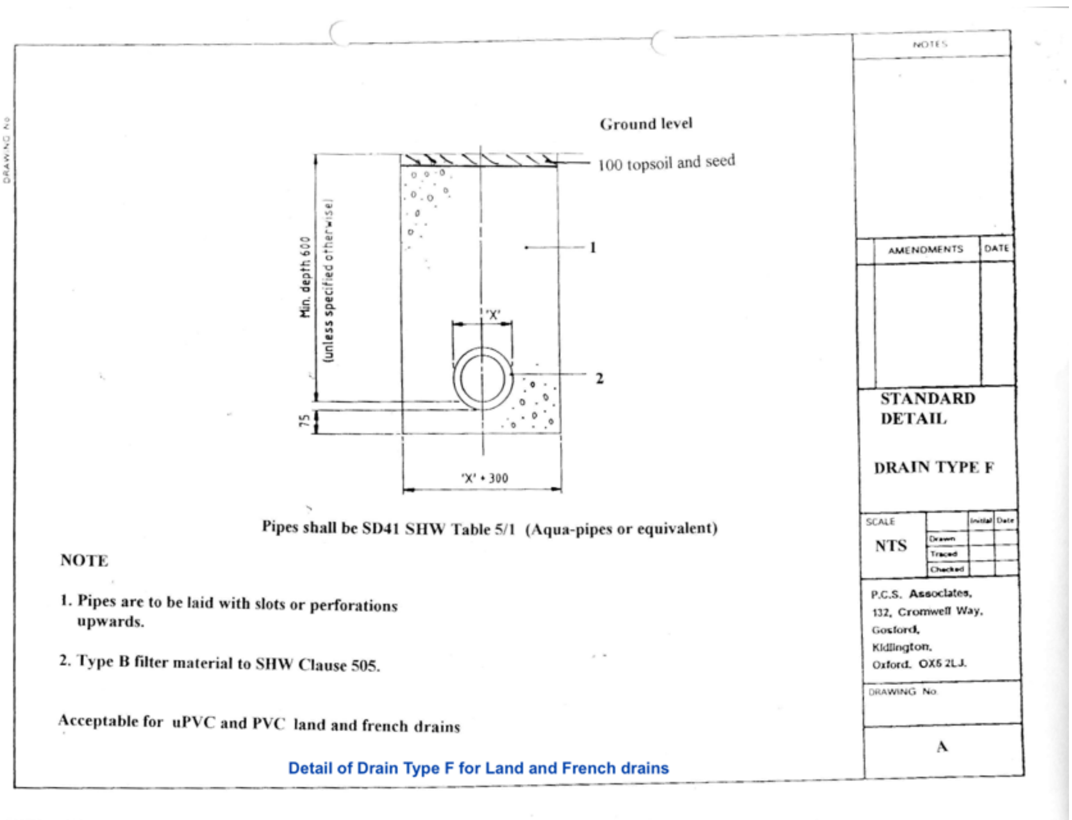
It is interesting that a trial hole had been dug by a grave digger (to an unspecified depth) previously in February 1993 which was left open over two days. The location of the hole is not given, but was presumably at the first site planned for the burial ground at that time in the corner between Pigeon House Lane and Wroslyn Road. The PC minutes for that month record that "during that period of time some water collected" but also note that Miss R.E Kitto from the Environmental Health Department stated that she was *"completely happy with it*".

It should also be noted that the water level was not ignored in the construction of the burial ground. Ground drainage was installed along the northern side and rear boundaries of the plot. It was of a perforated pipe design and, significantly, was shallow - less than a metre deep. The Bill of Quantities for the job indicates: *"150mm dia filter drain in trench group F depth to invert not exceeding 1m, average depth to invert 0.6m."* This perforated pipe was connected to a 200mm PVC French drain leading to the road ditch, as shown in the site layout below.

During recent wet periods, water was seen to be flowing freely from the pipe leading into the ditch along Wroslyn Road - but such a shallow system is clearly inadequate at providing drainage at a depth of lower than 1 metre.



Drainage layout for Freeland Burial Ground



Detail of Drain Type F for Land and French drains

But how is “Groundwater” and “Water Table” defined? Dr Gillian Davies of the Environment Agency has provided clarification of these terms:

“The water table is the top of the groundwater. For instance groundwater in solid geology (Chalk or Limestone or Sandstone) is likely to fluctuate (metres) depending on the season and the volume of water stored in the aquifer. There is also groundwater in drift geology (sand and gravels as with your site) that will fluctuate but not as dramatically as sometimes is seen in solid geology. There is also perched groundwater and this may be referred to as ‘standing water’. There is also pore water in mudstone and siltstone and when a grave is dug into clay, water may accumulate in the bottom of the grave due to seepage. It is for this reason that the [Environment Agency] guidance says ‘have no standing water at the bottom when it is first dug’.

*Due to limited recharge from rain and high evaporation rates, generally the water table is lower in the summer than the winter, but this could be reversed as in the case of a wet summer following a series of dry winters. To obtain a worst case scenario, we usually suggest that measurements of groundwater are taken in the winter months or in sensitive locations over a period of one year. You need to confirm which site you are using, but the fluctuations you are seeing on your site are likely to be the groundwater (water table and not perched water) and **it is the highest level recorded that you should use in your risk assessment.** What you need to avoid is placing a corpse in a dry grave in the summer, only to find that the body is under the water table in the winter. This is why the condition from the council states that the burial excavation should not penetrate the water table. You need to leave a sufficient unsaturated zone between the bottom of the grave and the water table to ensure that the aquifer will not become polluted.*

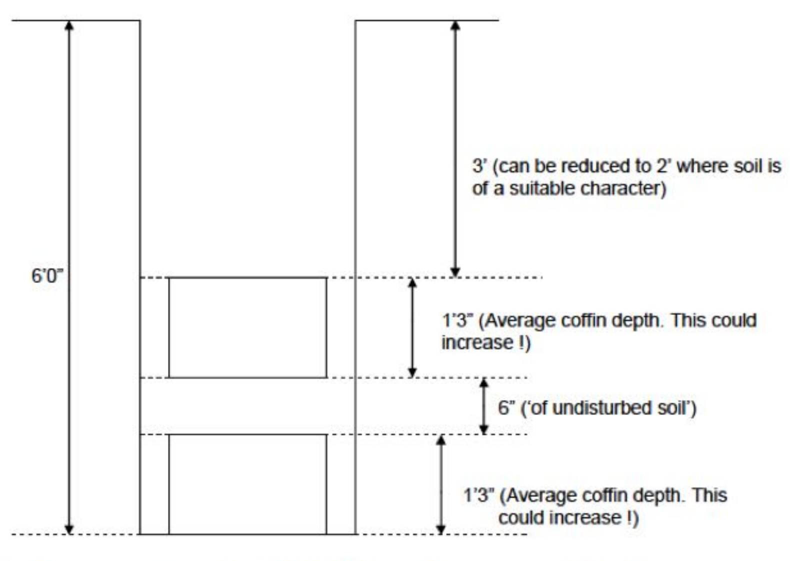
I think the guidance refers to ‘standing water’ because there could also be a situation where water is ‘perched’ over an impermeable layer (for instance a clay lens in limestone) that as the pit is dug deeper the water drains away. If a grave is placed in such a location the impacted earth of the in-filled grave will plug the base of the pit and the perched water has no escape route and once again becomes ‘standing water’. The burial is now into water that could be for instance in continuity with a stream. The decomposing body fluids will then mobilise and potentially cause a pollution issue. In this case the perched water is acting as a pathway for contamination to move sideways. Again the guidance ‘have no standing water at the bottom when it is first dug’ applies in this situation.”

(2) **Required depth of burials**

The Local Authorities Cemeteries Order 1977 (Schedule 2) stipulates that no part of a coffin may be less than three feet below the ground and for a grave with two coffins the grave must be *at least* 6 feet deep. This is illustrated below (taken from the Institute of Cemetery & Crematorium Management “Policy relating to shallow depth graves”, May 2004).

A water table well below 6 feet is clearly required for burials to conform to the Planning Permission Conditions and (NRA) Environment Agency requirements.

The limits imposed by Schedule 2 can be explained diagrammatically as follows:



The above example illustrates the MINIMUM depth that must be achieved for two burials and <u>it is recommended that this minimum depth for new graves is increased in order to build in a contingency against future unknown factors</u>. It should be noted that the average coffin depth used in the above example could be greater in some instances especially where casket burial takes place.

(3) **Geology of Freeland**

In July 2014, at the request of the Clerk, Dr Gillian Davies provided a report on the Geology of the Cemetery site and its suitability for burials. She wrote:

"This parcel of land is underlain by solid geology of Oxford Clay Formation and West Walton Formation (both mudstones) and therefore this geology is not sensitive with respect to groundwater quality. However the mudstone is overlain by Northern Drift Formation Sand and Gravel (Secondary Aquifer). These drift deposits contain groundwater (most of the year) as illustrated by several mapped spring fed streams that flow out of the sands and gravels to the east and south of this burial site. Groundwater levels will vary seasonally and also after heavy rainfall events.

I might have suggested that you select higher ground if there was some on your cemetery extension site and restrict to single depth burials, but the topography suggests that this parcel of land is on the top of a ridge between two valleys and therefore there is no higher ground! The fact that you say that the water table in the new cemetery is extremely high and that the area is very waterlogged suggests that this is not a suitable area for a cemetery. ***It is important that burials are not into groundwater*** *because this might cause a pollution incident firstly in the groundwater and then in the streams. Pollution would be very obvious in terms of odours.*

Do you have alternative locations in mind? I would be happy to check our geology maps to check their suitability. Given the issue you are experiencing it would be preferable to select a site on the mudstone further south if possible."

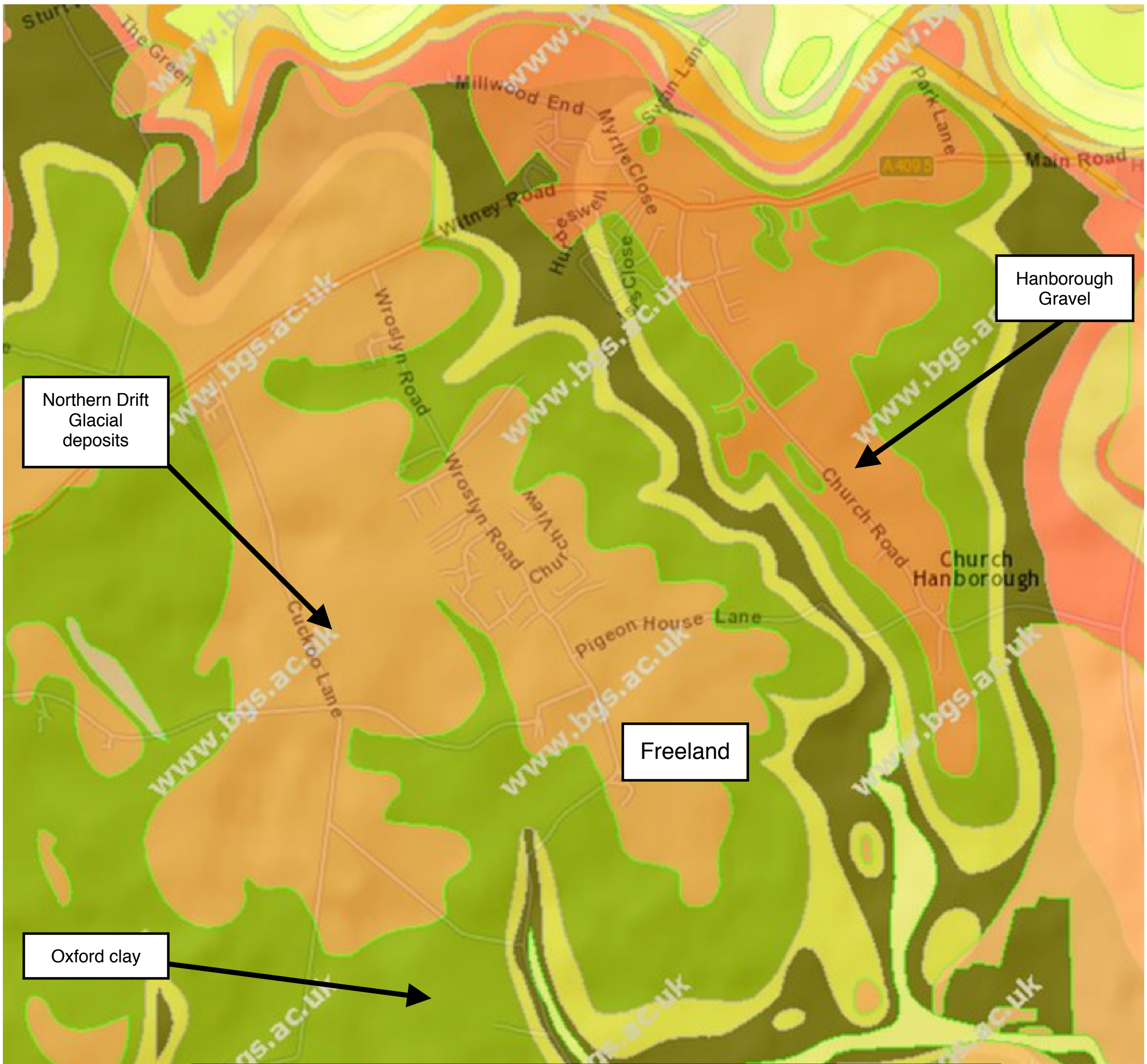
Gillian Davies later sent the geology maps of Freeland that she referred to (Ordnance Survey © 2014) and further maps were obtained from Hugh Dalton (Ordnance Survey Geological Survey of England and Wales 1947) and the British Geological Survey map from the internet. These maps are consistent and show the Northern Drift Glacial Deposits (which were deposited by the retreating glacier towards the end of the last ice age) extending over nearly all the Village. ***The clearest map is probably the British Geological Survey (see below).*** The Northern Drift Glacial Deposits are shown in beige and cover almost the entire village. The 1947 OS Survey map (below bottom) shows these Drift deposits in pale blue.

(4) **Current burials in Freeland Churchyard**

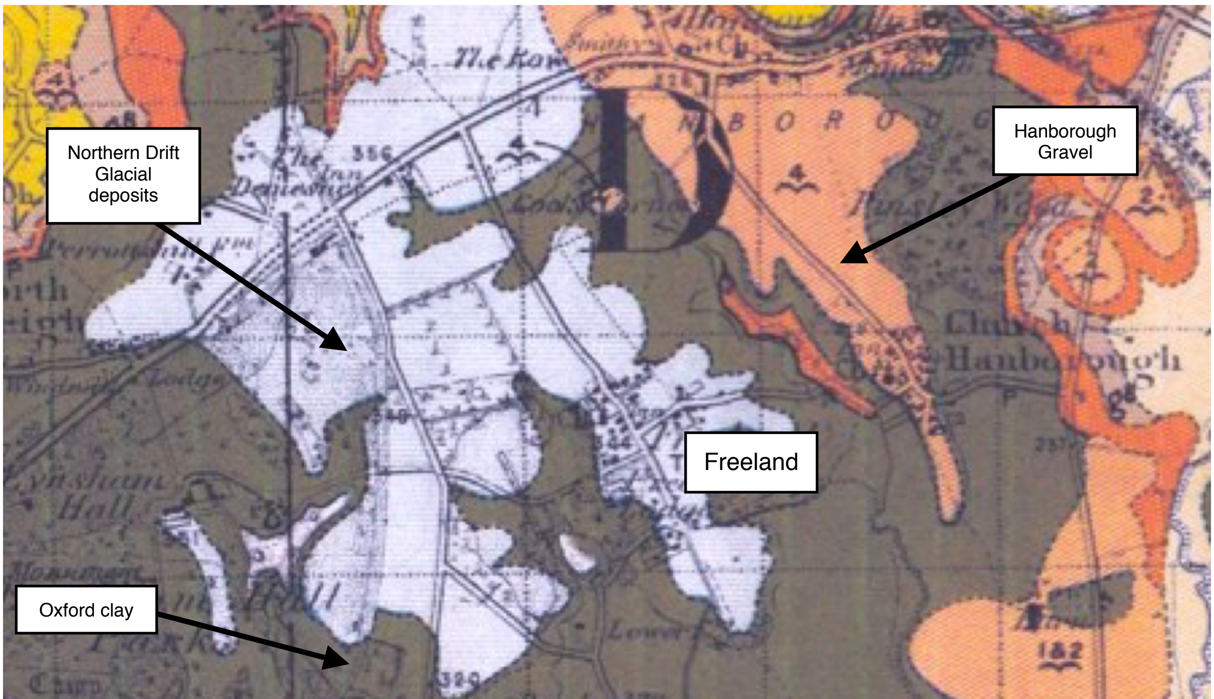
Andy Slade, the local gravedigger has indicated that the soil in Freeland Churchyard is light and easy to dig until you reach the solid grey clay at about 5 feet down. The water table was not a problem in the summer months but for most wet winters it lay around 3ft to 3ft 6inches below the surface and did make digging graves difficult and dangerous to dig with a spade. There was the real danger that the grave would collapse as water came in sideways when you dug below the water level. The way they got around this was to dig the grave the day before it was needed without trying to remove the water (nowadays using a mechanical digger) and then leaving the wet grave covered overnight. Then next day, just before it was to be used (while the mourners and the coffin were actually in the Church) the water was removed from the grave (nowadays using mechanical pumps) and dry straw put into the bottom to mop up residual water and give the appearance of a dry grave for when the coffin was lowered into it. Although such procedures are apparently used in established churchyards, they clearly fall outside both the Planning Conditions and Environment Authority regulations for establishing new burial grounds.

(5) **Risk Assessment**

The Environment Agency indicates that a Risk Assessment should be carried out to help with the assessment of the proposed ground for burials into the Drift layer. This has been done as shown in the Appendix. Because the water level is less that 5m from the surface in the Winter months (probably 1-2m), the result shows a Moderate or High risk for our proposed burial ground. If such a risk were indeed to be accepted by the Environment Agency (which seems highly unlikely) we would have to dig several boreholes and carry out very detailed and expensive tests both initially and at frequent intervals thereafter (as described in the Appendix).



British Geological Survey map of Freeland showing Northern Drift Glacial Deposits in beige, Hanborough Gravel in orange and Oxford Clay in green



From: Ordnance Survey Geological Survey of England and Wales 1947 showing Northern Drift Glacial Deposits in Pale Blue, the Hanborough Terraced River Gravels in orange and Oxford Clay in grey-green

(6) **Test hole in the burial ground**

A test hole has recently been excavated by Robert Crocker (roughly the size of a grave) with a mechanical digger down to the clay level (about 4 - 5 feet) in the burial ground to test the water level during the winter. At the time of digging, in mid-August 2014 there was no water to be seen in the hole, although later in August (after a wet weekend) a small amount of water had accumulated over the clay layer in the bottom of the hole. (see bottom photo). It is planned to monitor the ground water level throughout the coming Winter to get an accurate picture of the situation.


(7) ***Possible solutions***

A. **Drainage to 6 feet+:** This might, in principle, be feasible but would be an expensive and huge task. Because of the lateral spread of moisture in the Drift soil, a very large area would have to be drained to below 6 feet (or lower to achieve "Low Risk" status as calculated below). Drainage into the current shallow Wroslyn Road ditch would not work, and a system of drains leading to a lower point would have to be devised at considerable cost. There is also the difficulty of the Environment Agency stipulation of a "10m minimum distance between burials and field drains".

B. **Locate another suitable site within Freeland:** The geology maps do not show any obviously suitable sites within the village. There is a tongue of land shown as free from the Drift soil running across Wroslyn Road, but to the East of the Road this appears to be mainly the Pye Homes-owned land in the housing gap next to 71 Wroslyn Road and in the Winter has water running over it from the road and higher fields on the other side and is clearly unsuitable. To the West of Wroslyn Road the tongue of land goes to the rear of house numbers 44-56 heading up to the lake behind the houses on Witney Road but is not easily accessible.

C. **Locate a site on the outskirts of the village:** Gillian Davies suggests that sites where there is no drift that lie to the South of the village might be considered. The area on either side of Eynsham Road and around Bowles Farm might be suitable, although such a site might feel rather remote from the village and it is very uncertain (from the water that collects in the ditches) that the water table would be low enough.

D. **Raise the ground level:** Some other councils with a ground water problem have, according to Andy Slade, circumvented the problem by building up their sites with loads of free-draining earth so that final ground level was well above the high water table. While this might, theoretically, be possible, the amount of new earth necessary would result in Freeland having a burial mound rather than a burial ground.

E. **Re-use old graves in the existing Churchyard:** Apparently in some places, councils have found it easier to keep existing cemeteries in use, rather establish new ones, by reusing old graves. This is lawful after 100 years under the Local Authorities Cemeteries Order, 1977, if the gravestones have become worn and unreadable. It seems very unlikely, however, that this would be a popular solution in Freeland Churchyard and it would in any case be for the PCC rather than the PC to implement.

F. **Make the site a "Natural Burial Ground":** Part of the problem of pollution from burials comes from the materials commonly used to embalm bodies and construct the coffins. Formaldehyde from the embalming process is particularly toxic. With "Natural Burials" these toxic chemicals are banned. However, such burials do not eliminate contamination by biological compounds formed as bodies decompose such as the hazardous volatile amines putrescine and cadaverine (which get their name from their origin in decaying bodies) and other soluble nitrogenous compounds. Decomposition also releases bacterial contaminants such as Clostridia, Streptococci and Enterobacteria as well as infectious viruses such as the Influenza virus which can infect the groundwater. The Planning Conditions and Environment Agency regulations would therefore apply whether we used "Natural Burials" or normal burials.

G. **Sealing coffins in the clay:** Dr Gillian Davies of the Environment Agency has made the following suggestion: *"The only way forward we can suggest for this cemetery is for you to excavate deeper into the Oxford Clay and back fill over the burial with the clay (<u>not the drift</u>) and impact this clay down to seal the burial before replacing the drift. If this procedure is followed then there is not likely to be any impact on the groundwater that feeds the streams. However, it would need careful management to ensure that drift and clay are stock-piled separately and not mixed whilst back filling. In the winter months you would of course need to deal with dewatering the area where the grave would be dug or the entire pit will fill with water. If the procedure we suggest is adhered to rigorously then I would happy to support the risk* *assessment for this site as being 'Low Risk'. Since you have to satisfy a planning condition, I would suggest that you submit a management plan for burials, which to ensure that graves are sealed with clay, includes the overseeing of back-filling by a 'responsible person'."*

The hole in the hard (yet sticky) clay layer below the overlying 1.4m Drift layer would need to be at least 1m deep (0.5 metre for the coffin + 0.5m for clay backfill to seal). The main complication in Winter would be water pouring into such a deep hole, all of which would need to be removed just before burial, and then this has to be treated as potentially contaminated water (coming from the graves alongside) disposed off to the satisfaction of the Environment Agency. On this matter Dr Davies notes:

"the guidance states that there should be a 10 m minimum distance between burials and field drains. In theory, because we have suggested that burials will be encased in mud there should be no impact on groundwater. However, since there are no guarantees, drainage from the site may collect and concentrate any matter that leaches from the graves." She also adds that : "If you leave a 10 m buffer zone between the graves and the field drain then the underlying geology will mitigate any pollutants that might come from the burials (if the sealing with clay is imperfect) before they reach the land drain and only clean water will drain away from the site.

Dewatering of graves is a totally separate issue and there is the potential for groundwater to be contaminated if the graves have not been fully sealed and the pumping needs to be carried out quite close to a recently dug grave. Pumping will draw the groundwater and cause a draw down zone. Apart from disposing off site via tanker there are methods that you could use to treat the contaminated water on site such as using reed beds."

So, while sealing coffins into clay may be possible, it does have severe complications over removal and safe disposal of potentially contaminated water. There would be a considerable cost for these procedures, including setting up reed beds (rather like the Village pond but fenced off and taking considerable amount of space) and then frequent monitoring of water contamination by an expert company. It would be an elaborate solution that would greatly add to the funeral costs if there were only two burials per year.

H. **Use the Cemetery for cremations and as a garden of remembrance and Church Hanborough Cemetery for burials:** Using the cemetery for cremations should not be a problem as only inorganic ashes are spread or interred in urns at depths less than 3 feet. The construction of a memorial garden with small trees and benches around an area for the interment of ashes would provide an important place in the village for private contemplation. For the few burials required (about 2 per year currently), Hanborough Parish Council has agreed to allow the cemetery in Church Hanborough to be used by residents of Freeland for the next five years. Church Hanborough is within walking distance of the village and would probably be closer than any other site which could be found for a Freeland burial ground beyond the Drift area.

Conclusions:

We propose to monitor the test hole in the burial ground to get reliable data on water levels during the next Winter.

The use of Church Hanborough cemetery would seem, at present, to be the simplest and least costly way forward.

Cemetery Working Group, September 2014
(Peter Newell, Martin Shann, Bill Phillips, Mary Ann Canning)

Appendix page 1:
Risk assessment for burials into the Drift material for Freeland Burial Ground

The framework for the required tiered risk assessment of burial grounds is given in the Environment Agency document: “Assessing the Groundwater Pollution Potential of Cemetery Developments”(2004). This document takes its methodology from the paper: “Pollution potential of cemeteries: Draft Guidance by CP Young, KM Blackmore, P. Reynolds and A. Leavens (1999)” an R&D Technical Report of the Environment Agency.
The method used in the Young *et al.* paper is used below for assessing the Risk of using the Freeland Burial Ground.

Table 5.1 of the Young *et al.* paper, (shown below) is a Groundwater Vulnerability Ranking Chart which gives risks (from Very Low to Very High) for different conditions of Drift thickness, water table and other variables. **For Freeland, with a *“Depth to water table”* of <5m (probably <2m in Winter) the groundwater vulnerability indicated is “High” to “Very High”, depending on the relative influence of the Drift composition.**

Table 5.1 Groundwater vulnerability ranking chart

Ranking	Very low	Low	Moderate	High	Very high
Drift type	Clay	Silt	Silty sand	Sand /gravel	Absent
Drift thickness	>5 m	>3 - 5m	3 m	0 - 3m	Absent
Depth to water table	>25 m	11 - 25m	10 m	5 - 9m	< 5m
Flow mechanism	Intergranular				Fissured
Aquifer	Non-aquifer		Minor aquifer		Major aquifer
Abstraction and SPZ	Outside Zone III	Within Zone III	Close to boundary of Zones II & III	Within Zone II	Within Zone I or <250 m from private source
Watercourses, springs	>100 m	>70 <100 m	>50 <70 m	>30 <50 m	<30m
Drains	>100 m	>40 <100 m	30 - 40 m	>10 <30 m	<10 m

Using this groundwater vulnerability assessment in the next chart, Figure 5.2 we can assess the risk for burials from their relationship between burial rates and groundwater vulnerability.

Note that Fig 5.2 shows the risk only up to a groundwater vulnerability of “High” (“Very High is off scale!). “High” requires a depth to the water table of between 5 and 9m! Even with only 2 human burials per year Figure 5.2 suggests that **the level of risk is into the “Moderate risk” category** with a “High” water vulnerability.

With such a Moderate (i.e. “Intermediate”) Risk rating, we would have to carry out very onerous and expensive assessments over 12 months prior to use and then continuous monitoring procedures. These are shown below in pages taken from the Environment Agency Groundwater Pollution document.

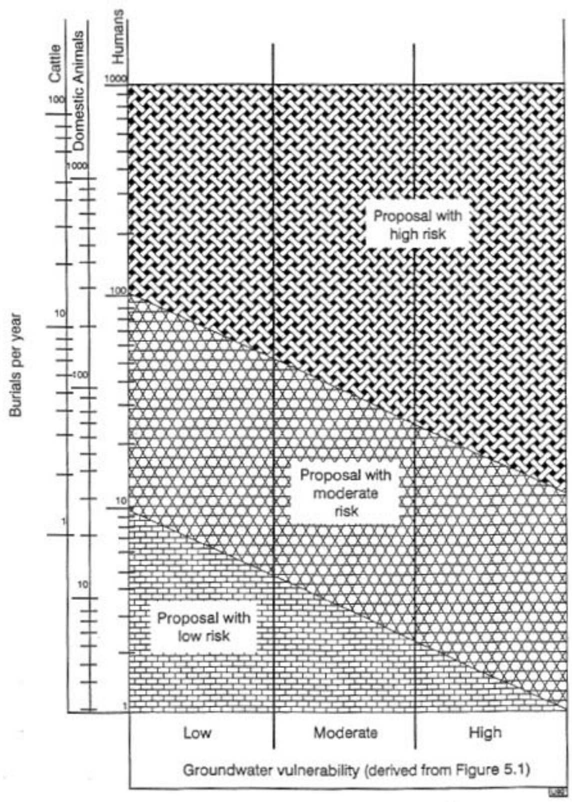


Figure 5.2 Schematic relationship between burial rates, vulnerability class and level of risk

Tier 1 assessment is likely to be of use only for an existing site, with no prior history of environmental problems, where a minor change is proposed. In all other cases, at least a Tier 2 assessment should be carried out.

A Tier 2 assessment should be carried out for sites designated as intermediate-risk sites in Tier 1, or where the risks are not clearly defined. Such sites should be subject to a more detailed desk study, some level of investigation and monitoring to identify the hazards. Applicants will also have to provide additional data, which may include an assessment of the potential contaminant loading and likely attenuation within the transport pathways through simple calculations. **Table 6** lists the minimum information requirements for a Tier 2 assessment.

Information required	Tier 2 Assessment
Site description	Local survey to supplement data on appropriate Ordinance maps Survey (e.g. Superplans).
Number, type and sequence of burials	Projections on which annual numbers are based should be available, along with supporting data and explanation.
Meteorological factors	Long-term average Met. Office data on local rainfall and MORECS soil moisture data.
Soil/subsoil characteristics	Soil Survey maps. Possible site investigation and percolation tests.
Superficial geology/ hydrogeology	Geological and hydrogeological maps and memoirs (British Geological Survey). Limited site investigation (trial pits and drilling) may be necessary if insufficient data is available. Groundwater Vulnerability data and location of any nearby source protection zones.
Solid geology/ hydrogeology	As above, with an assessment of the aquifer characteristics from available published data.
Solid geology/ hydrogeology	If aquifer is present, a minimum of three investigation boreholes are required. One on the up-gradient side of the site boundary and two close to the down-gradient boundary.
Groundwater quality	Background quality data required; quarterly sampling and analysis for at least one year to detect any seasonal variations. See 'Monitoring' section for recommended analytical suites.
Surface water quality	As above, quarterly sampling for at least one year. See 'Monitoring' section.
Proximity to water source/ resource	Environment Agency records of licensed abstraction sources. Local Environmental Health Department records of private domestic sources (these are not comprehensive). Search should include surface and groundwater sources.
Proximity to housing or other developments	Check local/regional/national planning authority for potential residential, educational, commercial/ industrial developments, roads, rail and mineral extractions.
Data assessment protocols	Simple pollutant flux and water balance calculations.

Table 6 Potential information requirements for Tier 2

Appendix page 3

Minimum requirements for ground water monitoring:

	Low-site risk	Intermediate-risk site	High-risk site
Minimum borehole monitoring period	None	12 months before site development and 12 months after site development.	12 months before site development and 12 months after site development.
Minimum number of boreholes for site monitoring	None	One hole on the up-gradient boundary of the site and two boreholes on the down-gradient boundary (spaced no more than 100m apart).	One hole on the up-gradient boundary of the site and two boreholes on the down-gradient boundary (spaced no more than 100m apart).
Off-site monitoring	None	None	Monitoring between the site and receptors at risk down-gradient. One hole for each receptor and/or pathway located on the pathways connecting site and receptor.
Number and frequency of monitoring points for surface waters, if affected	None	One point upstream and one downstream. To be monitored on a monthly basis.	One point upstream and one downstream. To be monitored on a monthly basis.
Frequency of monitoring and suite* of determinands for monitoring of baseline conditions prior to development	None	Quarterly – water level, pH, temperature, electrical conductivity, dissolved oxygen, NH_4, N, Cl. Six monthly – SO_4, TON (sum of NO_3 + NO_2), TOC, BOD, COD, alkalinity, Na, K, Ca, Mg, Fe, Mn, Cd, Cr, Cu, Ni, Pb, Zn, P.	Monthly – water level, pH, temperature, electrical conductivity, dissolved oxygen, NH_4, N, Cl. Quarterly – SO_4, TON (sum of NO_3 + NO_2), TOC, BOD, COD, alkalinity, Na, K, Ca, Mg, Fe, Mn, Cd, Cr, Cu, Ni, Pb, Zn, P.
Frequency of monitoring** and suite of determinands for long-term monitoring once the site is in use (indicators of contamination)	None	Six monthly – water level, pH, temperature, electrical conductivity, dissolved oxygen, TON (sum of NO_3 + NO_2), TOC, BOD, COD, ammoniacal nitrogen, SO_4, Cl, Na, K, Ca, Mg, Fe, P.	Six monthly – water level, pH, temperature, electrical conductivity, dissolved oxygen, TON (sum of NO_3 + NO_2), TOC, BOD, COD, ammoniacal nitrogen, SO_4, Cl, Na, K, Ca, Mg, Fe, P.

* Other determinands that may need to be considered on a site-specific basis are organics, List I & II substances and Red List substances.

** May be reduced to annual monitoring if stable conditions are proven.

Table 7 Recommended minimum requirements for groundwater monitoring

Water level in Cemetery Hole 2014/2015

MONTH	AUG-2014	SEPT-2014	OCT-2014	NOV-2014	DEC-2014	JAN-2015	FEB-2015	MAR-2015	APR-2015	MAY-2015	JUNE-2015	JULY-2015
Depth of water (inches)	0.00	6.00	9.00	39.00	43.00	47.00	42.00	34.00	28.00	27.00	16.00	8.00
Ground to water distance (inches)	56.00	50.00	47.00	17.00	13.00	9.00	14.00	22.00	28.00	29.00	40.00	48.00