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FLOOD RISK ASSESSMENT

ON

Land at Roberttown Lane,

Roberttown,

Huddersfield,

West Yorkshire

FOR

Strata Homes Leeds Ltd. Yorkshire

E14/6063/FRA001

July 2014

T. Haigh B.Sc., C.Eng., M.I.C.E.

Haigh Huddleston Associates is the trading name of Haigh Huddleston Associates Limited
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1.0 INTRODUCTION

1.1 This report is commissioned to investigate and report on the Flood Risk for this site in accordance National Planning Policy Framework 2012, and the proposals for drainage of this site when redeveloped as residential land. The report is based on information supplied by the client and from relevant authorities in both written and verbal format. Some of this information is in verbal form only. No liability can be accepted for information supplied by third parties which is subsequently found to be inaccurate or incorrect.

2.0 THE SITE

2.1 The proposed application site is shown on the location plan attached at Appendix A and comprises approximately 8ha of land in Roberttown, an area which stands between Cleckheaton and Huddersfield. The site is 5 miles to the north east of Brighouse, 5 mile to the south of Bradford and 2.6 miles to the west of Dewsbury. The total site and area of 8.05 ha will be redeveloped for residential housing. This will comprise of a mixture of house types with associated roads and car parking areas. At present the land is principally rough grassland. There are no major trees on the site but there are to the perimeter.

2.2 The site lies around OS ref SE 19975 23015. Site levels vary from around 139.7m in the west corner down to 135m in the eastern corner of the site. The site falls from south to north and from west to east. Falls vary from 1 in 25 to 1 in 8 in places.

2.3 The site currently lies outside, although adjacent to existing residential development to the east and west. There is a major school to the north of the site and a cricket field to the west. To the south is also residential development between the site and the A62 main road.

2.4 The nearest watercourse is Tanhouse Beck which follows on from Lands Beck to the northeast of the site. This is in open channel to the west, but runs in culvert beneath the industrial development in the valley bottom. There is also an unnamed watercourse that enters that site from the north that has been diverted around the new buildings.

Tanhouse Beck/ Lands Beck enters the industrial site in a shallow channel approximately 1.2m. wide by 1.8m. deep and flows into a 900mm diameter pipe that runs at very shallow depth through the site. It flows east and passes beneath an adjacent industrial works still flowing eastwards. The watercourse does not become open again until it is approximately 1 mile east, to the rear of houses on Ashton Clough Road. It Is reported as being large enough to walk through but this has not been verified. It then flows into the River Spen a tributary of the River Calder.

There is a culverted watercourse that flows through the school land to the north of the development site and this appears as a 375mm Diam culvert within the industrial development. This connects into the culverted sections of Tanhouse beck reported on above.

2.5 There are combined sewer systems that run adjacent to the site and serve the residential developments adjacent to the site. These flow away to the east.

2.6 Whilst there are adopted sewers close to the site, Yorkshire water have stated that there is no capacity for surface water discharges into their system and that the current approved hierarchy of surface water discharges from the site will firstly be to infiltration systems where possible, followed by discharges to watercourses. These should be utilised before any discharge to a public sewer could be considered.

3.0 PROPOSED DEVELOPMENT

3.1 It is proposed to develop the site for mixed residential development Linkages in the form of pedestrian and cycle routes are to be provided to the adjacent residential areas. A mix of housing types and tenures is proposed.

4.0 IMPACT OF DEVELOPMENT

4.1 The area for development is currently a permeable open pasture land with little drained impermeable areas. The overland surface water run-off from the site is primarily to the north. The development of the site will introduce new impermeable surfaces in the form of roofs, roads, drives and other hard paved areas. This will increase the run-off from the site significantly. In particular it would increase the speed of discharge from the site.

4.2 The site itself even in its current condition could already generate significant flows from the site dependent on the rainfall patterns falling on the site. There is currently research being carried out to evaluate the risk of storm water run off from saturated agricultural sites. When these catchments have received significant rainfall over winter months they are not capable of absorbing any further rainfall and the water is discharged as an over land flow. In such instances the discharges from agricultural land can be close to the run off for a 100% impermeable area.

4.3 The surface water flows from the existing site appear to be channelled to the north east of the site and probably pass under Robertown road towards a channel or watercourse that runs northwards adjacent to the school and across the playing fields. The watercourse is culverted under industrial development to the north and joins onto TanHouse beck. The existence and details of any on site land drainage systems

have yet to be established. A free discharge onto this system could overload the land drainage system resulting in flooding in the downstream catchment. Whilst there are no reports of flooding on, or adjacent to the site, there are known flooding problems in the downstream catchment. It will therefore be necessary to attenuate these flows down to the current agricultural discharge rates or below.

4.4 The current hierarchy for discharges of rainfall from new development sites are primarily utilisation of infiltration methods, then connections to existing watercourses and then to public water sewer systems. The connections to watercourses should where ever possible maintain the existing watershed of the catchment and should not exceed current discharges rates.

4.5 Previous desktop studies and local knowledge of the area suggests that the site is underlain by a drift layer of glacial Till (clays) over a sandstone or grit-stone. This would deter the use of infiltration systems due to the depth needed to reach a permeable strata. Further on site infiltration testing may be required to validate this appraisal.

4.6 Yorkshire Water have stated that there is no capacity in the existing surface water systems to the north of the site that could serve the residential development. It may be possible to connect the new sewers into the existing sewerage system but attenuate the flows down to an acceptable discharge level with Yorkshire water. This is thought to be unlikely in view of YW restrictions.

4.7 If the above negotiation cannot yield results then the discharge from the site would have to be at agricultural discharge levels. For this area and topography the annual agricultural discharge rate would be around 5 lit/sec/hectare. However due to the existence of flooding problems downstream of the site Kirklees MDC Drainage department and The Environment Agency would want to see it reduced down to 2.5l/s/ha.

5.0 FLOOD RISK

5.1 The site is outside flood zones 2 and 3 as shown on the Environment Agency Websites. The development is classified as More Vulnerable in Table 2 of the Technical Guidance to the National Planning Policy Framework March 2012 and Table 3 of that document also states that the proposed residential development in this area is appropriate.

5.2 Due to the size of the development over 1Ha it will be necessary to prepare a site Specific Flood risk Assessment for the site.

5.3 There are a number of potential flooding mechanisms that NPPF now requires are evaluated for each proposed development site. Each method of flooding requires an assessment to be made on its probability relative to the site development. The requirements of the document is; 1 No Flooding on the site for the 1 in 30 year storm; 2 No flooding of properties for storms up to a 1% probability (a once in a 100 years storm). The risk assessment also includes for possible flooding both on site and off site, and the effects of the development on the downstream catchment or the flow regime of the watercourse. NPPF also requires that the effects of severe storms above the normal 1% probability are reviewed together with the effects of climatic change relating to the design life of the development.

5.4 It also requires that the effects of climate change are taken into account together with the impacts of extreme events and flood defence failures. Prior to this the Sequential Test outlined in NPPF, must also be applied to each development site.

5.5 Based on the published Environment Agency Flood Risk Maps the site does not fall within the 0.1% Flood Risk, nor does it fall within the 1% Flood Risk area. The site therefore falls within the low probability zone 1. The proposed residential development falls within the More Vulnerable Classification in Table 02 Technical Guidance to NPPF.

The sequential test is therefore considered passed and development is considered appropriate in accordance with Table 3 Technical Guidance to NPPF.

5.6 NPPF requires that each flooding mechanism is addressed and levels of risk evaluated. We consider there are three main risks of flooding to the site the alternative mechanisms are not applicable to this site.

5.6.1 Inundation from floodwaters leaving watercourses or rivers entering the site. This can include the effects on culverted watercourses and where the risk of blockage can occur and from breach scenarios.

5.6.2 Rainwater falling on the site and not being able to leave the site at sufficient rate to prevent flooding on the site.

5.6.3 Overland flows from adjacent land sites or due to surcharging of sewerage systems or other watercourses.

5.6.4 The impact of the developed site on the existing drainage systems and off-site surface water systems must also be assessed as part of this flood risk assessment.

6.0 DISCUSSION OF FLOOD RISKS

6.1 Flood Risk from Watercourses, River & Tidal

6.1.1 The site does not to fall within the 1% probability Flood Risk Maps as published by the Environment Agency nor does it fall within the 0.1% Flood Risk Area. The site is therefore considered not at risk from fluvial flooding. The site levels are significantly higher that adjacent primary watercourses.

6.1.2 There are no recorded flood events on site or adjacent to the site but there are reported problems in the downstream catchment. The site is significantly above the bank levels to the watercourses to the north. It is not considered at risk from flooding from this source

6.1.3 The site falls outside all recorded flood zones from fluvial sources. The risk of flooding from river or tidal water is therefore considered acceptable for the type of development.

6.2 Risk of Flooding from overland flows from adjacent land.

6.2.1 The site lies on a sloping site close to the crest of the hill with major roads on either side of it. To the north and east of the site, the land is lower than the site and falls away from the site. To the west the land is higher but and overland flows will be intercepted by the highway and channelled away from the site. To the south the land falls towards the site but the extents of land falling towards the site are not great before the land starts to fall southwards. The possibility of overland flows from this source is therefore very limited and would not generate significant overland flows towards the site. A simple flood routing through the site would ensure the risk to properties is limited to an acceptable level.

6.2.2 The risk of overland flows from adjacent sites is therefore very low and at an acceptable level of risk.

6.3 Risk of Flooding from Rainwater Falling on Site

6.3.1 The risk of flooding from water falling on site and not being able to leave is considered to be low due to the topography of the site. These flows would however need to be attenuated to ensure no surcharging of systems down stream.

6.3.2 The development of the site would increase the impermeable area of the site and hence surface water run off from its current status. This in itself will increase the flood risk to adjacent properties and those in the downstream catchment if flows are not attenuated. The limitation on the current discharge, and the use of infiltration systems for the site, would reduce the off-site flood risk further to an acceptable level.

6.3.3 Storms up to the once in 100 year risk, and allowances to be made for climatic change, can be managed by the use of storm water attenuation and storm water storage systems. The design of these systems would be dependant on the agreed discharge for the site and the form of storage to be utilised. Suffice that the designed system can be detailed to cater for storm up to the 100 year return period with an allowance made for climatic change. This would currently suggest a 20 to 30% increase in storm water storage volume requirements. With this system in place the flows from the site into the surface water systems are considered acceptable and not likely to increase flood risk down stream of the site. In this instance the flows would have to be limited to the current annual storm agricultural discharge rate.

6.3.4 It should be noted that the normal annual agricultural discharge rate would be used to control flows up to the 100 year storm with due allowances for climate change. The normal flows from such storms on the existing land would be greater than this so a small measure of mitigation is applied in such systems, particularly in relation to flood water flows in the downstream watercourse in extreme events.

6.3.5 If the underlying ground is not suitable for percolation, which the desktop study suggests is the case, then the system should be made to connect to the existing land drainage systems serving the land or by a requisition sewer to suitable watercourse. The discharge from this system would be limited to existing agricultural discharge rates. If the Discharge is limited to this level then it will be necessary to provide above or under ground storm water attenuation tanks/basins on site.

The storage system should be designed to cater for a 30 or 100 year storm and additional storage to cater for climatic change could be catered for above ground in designated flood areas such as detention basins or shallow swales in public open spaces.

6.3.6 The storage volumes can be provided by the use of oversized pipes or detention basins or ponds. The use of ponds whilst being a better ecological area can promote concerns for public safety and the use of dry detention basins may be a better concept for this site. The land uptake for these systems can be large due to the maximum depth that they are allowed to operate at.

6.3.7 The flows would have to be controlled by a “Hydrobrake” or similar low maintenance flow control device. If these are provided the risk of onsite flooding from rainfall would be effectively controlled to acceptable levels.

6.3.8 We therefore consider the effects on flood risk to adjacent properties are not significantly affected by the proposed development if attenuation systems are employed.

7.0 PROPOSED SURFACE WATER DRAINAGE

7.1 In the first instance the use of soakaways and infiltration systems should be investigated further and if appears to be unsuitable based on the testing carried out then attenuation of surface water flows would be necessary.

7.2 The un-attenuated surface water run off from this site could overload the downstream sewers and/or land drainage catchment. Therefore discharges should be managed by the use of surface water storage systems. The site currently does not have any existing impermeable areas. The site would have to be designed too achieve agricultural discharge rates. These have previously been agreed with Kirklees

MDC - Land Drainage Department, and the Environment Agency would be 5 lit/sec/ha. The estimated discharges from the site using the Wallingford flood studies report and IH124 are significantly higher but due to the sensitivity of the downstream catchment the agreed discharge rate will have to be acceptable to all parties. This would probably result in a maximum allowable discharge of approx. 20 lit/s for the whole site. This would be pro-rata to 2.5lit/sec/ha.

7.3 If the use of infiltration techniques in this area is likely not to be feasible, due to the depth of overlying clays on the site. The site would therefore have to be attenuated to agricultural rates. The flows will be controlled by a hydraulic flow device such as a Hydrobrake or similar. This would mean that storm-water storage would have to be provided on site. Prior to this however a point of discharge to a surface water sewer or watercourse would have to be agreed with a right to discharge in perpetuity granted. This will entail making agreements with third parties, and riparian owners of the watercourses. Alternatively these sewers and connections to the systems would be requisitioned from Yorkshire Water. The EA would /may also need to approve any such discharge rate and water quality.

7.4 It is proposed to provide storage in oversize pipes and detention basins on the site in the lower north eastern area of the site prior to discharge off site to a suitable drain or watercourse. This will be designed to cater for storms up to and including the 100year storm with due allowances for climate change. In accordance with NPPF this would mean an extra 20%-30% based on the site usage and possible duration of development. The levels of the outfall discharge points to the watercourse should allow gravitational discharges for the whole site. The connection to the watercourse may have to be requisitioned and an agreement to discharge in perpetuity obtained from the riparian owner of the watercourse.

7.5 The sizes of the storm water storage facilities would need to be accurately determined once a final layout is available for the final designs but preliminary calculations have been made and are attached to this report in appendix D. For the 5 lit/s/ha discharge these would be These show that the volumes of storage required would be 1257cum for the 30 year storm, 1814cum for the 100 year storm, and 2705 cu.m for the 100 year storm with 30% allowance for climatic change. For the 2.5Lit/s/ha restriction these volumes would rise to1832, 2435, and 3384 cu.m respectively. This could entail basin areas up to 3800sq.m in area. This is all in accordance with the National Planning policy Framework Technical guidance issued in March 2012 and as previously in PPS 25. The volumes of storage for the 100 year plus climate change can include flooding to roads and designated areas but must ensure that no buildings are flooded. The most economic way of providing this would be in detention basins or ponds but these do take up significant areas of land. For safety reasons we would suggest that the use of a predominantly dry detention basin, with possibly a wetlands area incorporated within it, would be best solution for this site. This would allow a measure of biological treatment to any discharges from the site and a predominantly dry area.

7.6 The site will require off site sewers or an agreement to construct a new watercourse off site. It may be possible to provide some additional storage arrangements with in this system.

7.7 If on-site balancing is utilised then the change in flood risk to downstream properties would be negligible in relation to flood water flows in the downstream catchment.

7.8 If the measures outlined above are implemented we would consider that the site can be developed in accordance with current Water Authority and Land Drainage Authority requirements. The systems can also be adopted as part of the Public Sewer systems or by the Local

Authority under the new Flood and Water Management Act arrangements, once they are fully implemented.

8.0 CONCLUSIONS

8.1 In our opinion the site is not at risk of flooding from river or tidal water up to a 1% return period nor is it at risk for storms in excess of the 0.1% risk level. The site is therefore not considered to be at risk of fluvial flooding from rivers or water courses.

8.2 The development of the site with the use of soakaways or other infiltration should be investigated further, otherwise the use of attenuation methods will be required.

8.3 It would be necessary to attenuate flows from the site down to agricultural levels and provide storm water attenuation facilities on the site. Discharges would have to be limited to agricultural rates of discharge of 5lit/sec/ha, or 2.5lit/sec/ha, to ensure flood risks downstream are not increased. It may be possible to negotiate a discharge into the adjacent public e drainage and Yorkshire water would have to agree to this discharge into the existing sewers, which is unlikely. The current figures are based purely on agricultural discharges.

8.4 The risk of overland flows from adjacent land is considered to be very low due to the topography of the site. It would be prudent to design a flood routing through the site to cater for extreme events.

8.5 If the measures outlined above are implemented, we would consider that the requirements of NPPF can be satisfied and development of the site could proceed.

T.Haigh B.Sc., C.Eng., M.I.C.E.

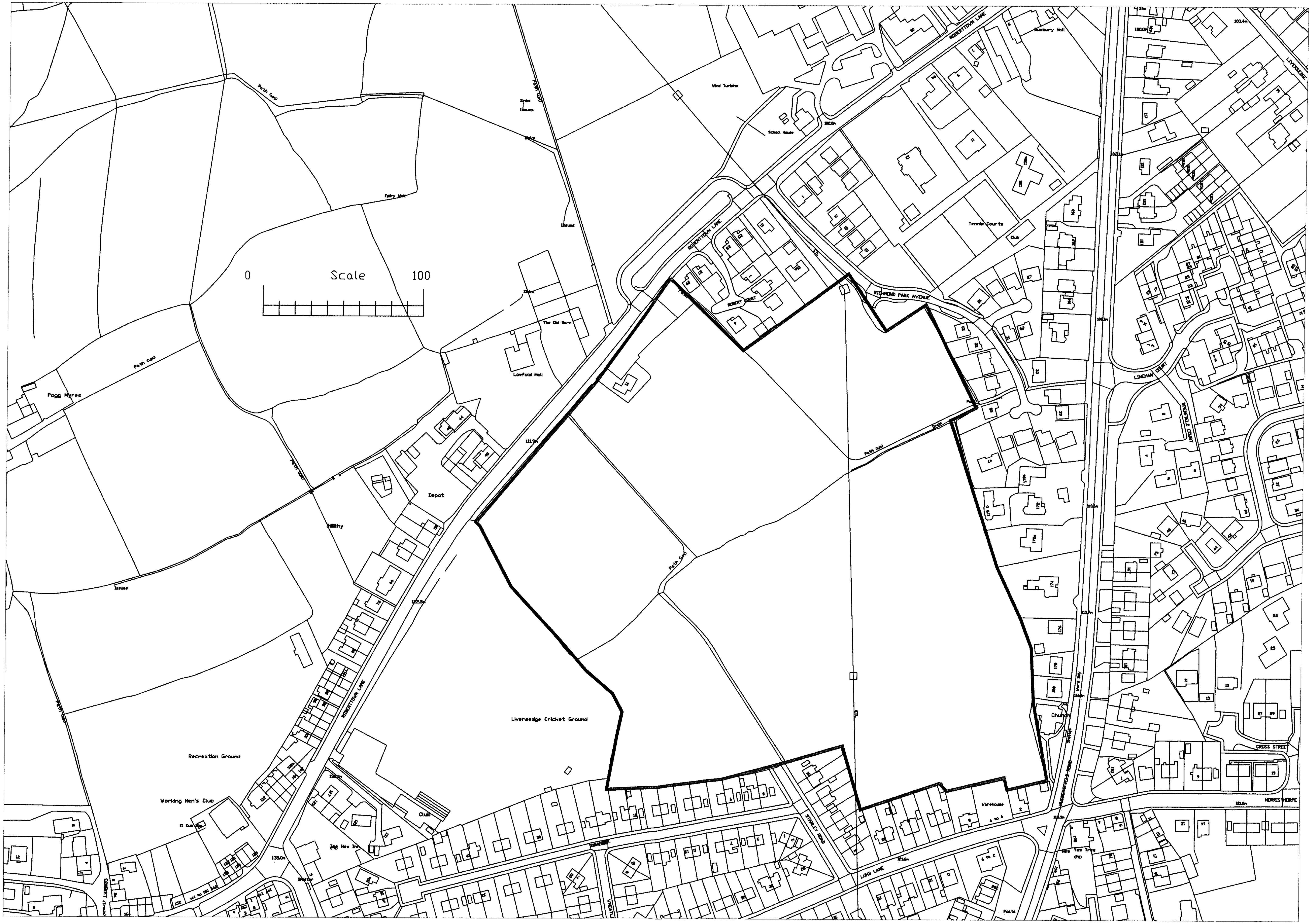
APPENDIX A

LOCATION PLAN


wn Ln, Liversedge, WF15, UK
Robertlown Ln
Huddersfield Rd
Liversedge Hall Ln
Victoria Rd
Hall Close
Willow Walk
Lineham Cl
Hall Park Ave
Park Ave
Norristhorpe Ave
Cross St
Norristhorpe Ln
Stanley Rd
Lumb Ln
Wheatlands Dr
Echo St
John Booth Close
Lincoln Dr
Lincoln Grove
Aston Close
Balmfield
Balmfield Cl
A62
Robertlown

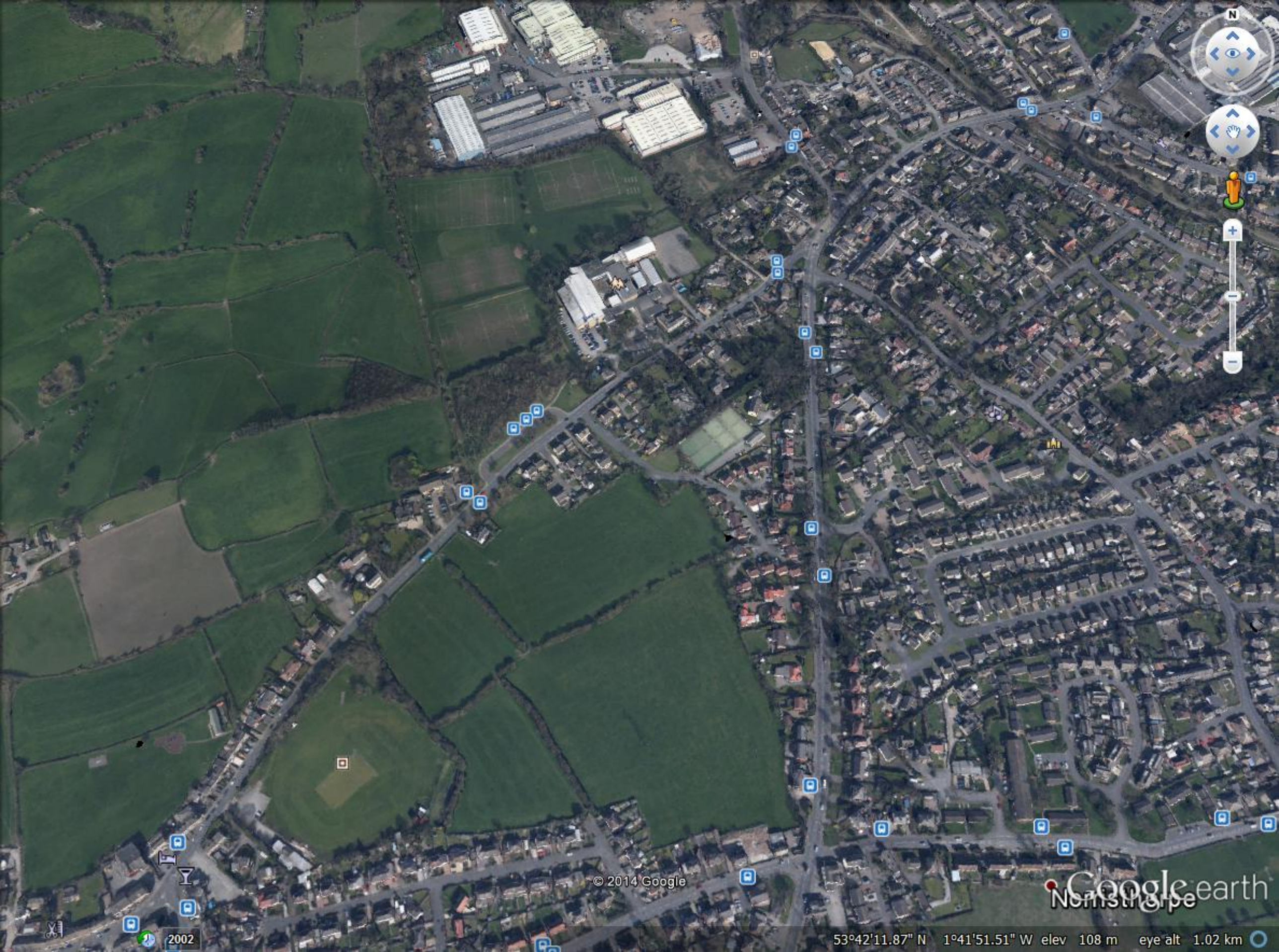
APPENDIX B

SITE PLAN


0
Scale
100
Pogg Myres
Path (um)
Fairy Well
Issues
Sinks
Wind Turbine
School House
ROBERTTOWN LANE
Sudbury Hall
Tennis Courts
Club
RICHMOND PARK AVENUE
ROBERT COURT
The Old Barn
Loefold Hall
Depot
LINEHAM COURT
Liversedge Cricket Ground
Recreation Ground
Working Men's Club
The New Inn
STANLEY ROAD
LUMB LANE
Church
CROSS STREET
MORRISTHORPE
Warehouse

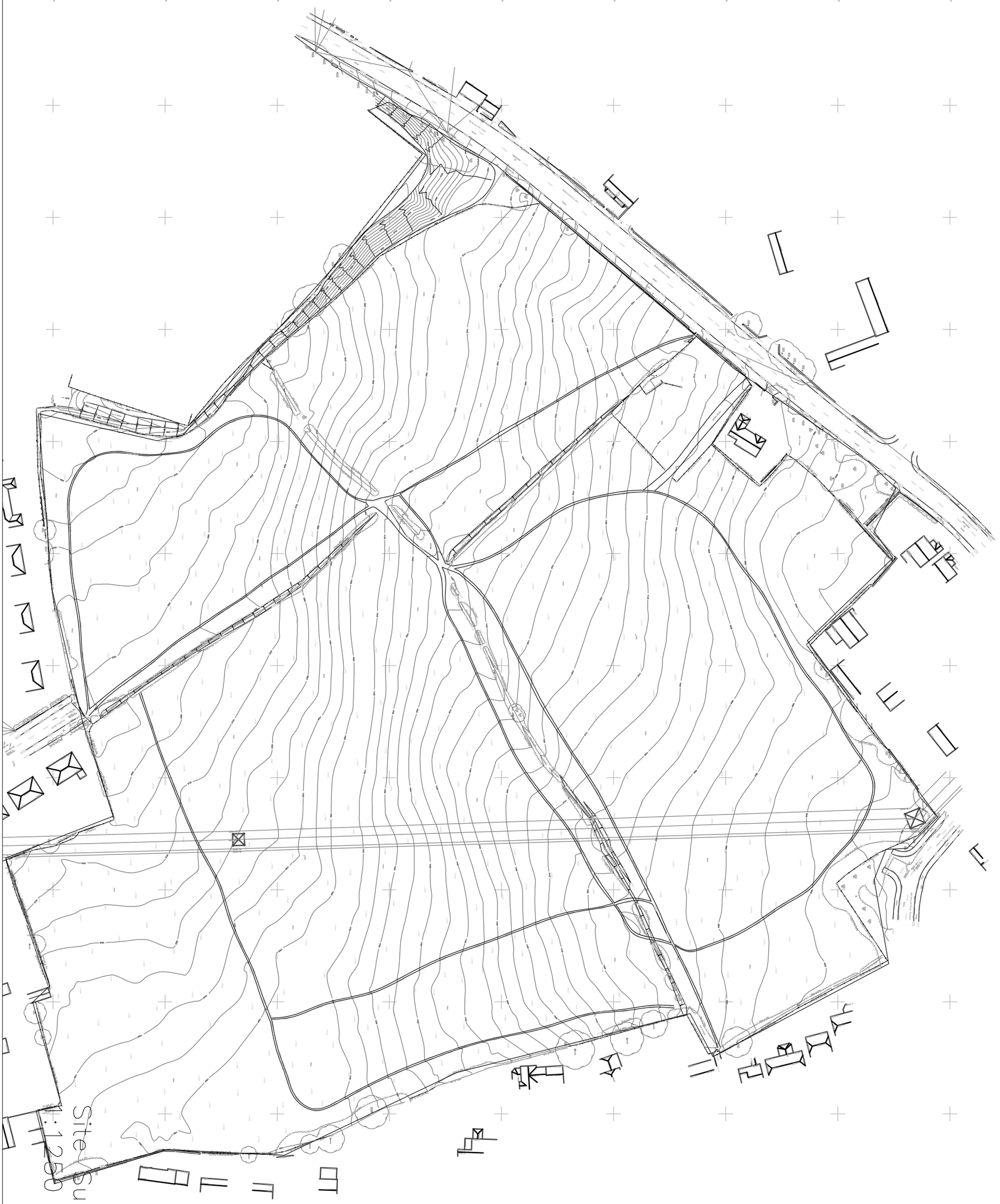
APPENDIX C

AERIAL VIEW


N
© 2014 Google
Google earth
Normanton
2002
53°42'11.87" N 1°41'51.51" W elev 108 m eye alt 1.02 km

APPENDIX D

SITE SURVEY



Site Survey
1:1250

APPENDIX E

FLOOD RISK MAPS

Environment Agency

Enter a postcode or place name: WF1 1AD Go

Other topics for this area... Flood Map for Planning (Rivers and Sea)

Flood Map for Planning (Rivers and Sea)

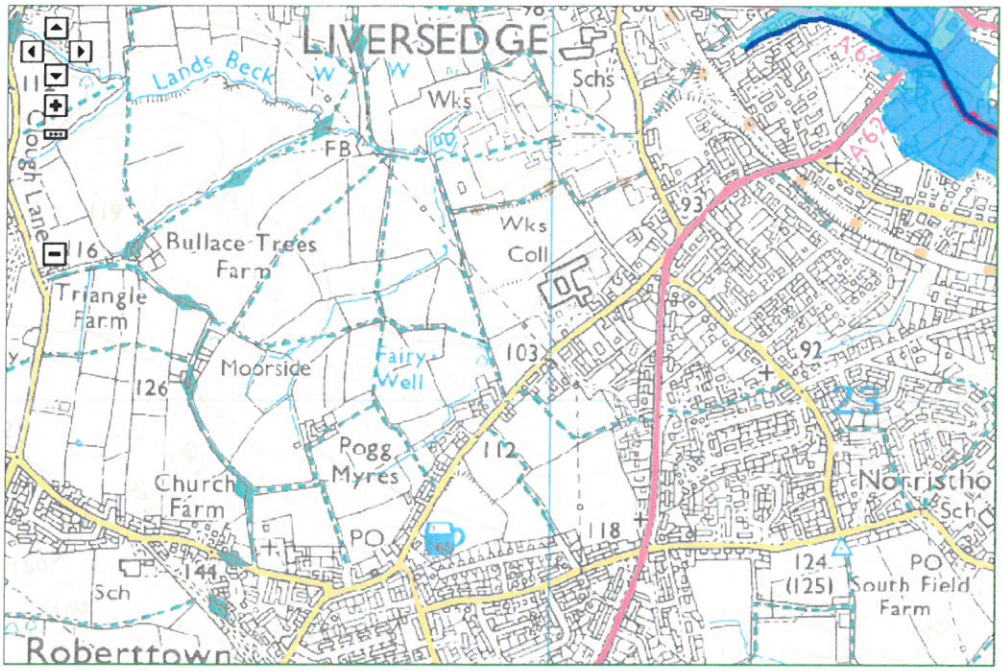
Map legend

Click on the map to see what Flood Zone (National Planning Policy Guidance definitions) the proposed development is in.

- Flood Map for Planning (Rivers and Sea)
- Flood Zone 3
- Flood Zone 2
- Flood defences (Not all may be shown*)
- Areas benefiting from flood defences (Not all may be shown*)
- Main rivers

X: 419,902;Y: 423,128 at scale 1:10,000

Other maps Data search Text only version



More about flooding:

Understanding the Flood Map for Planning (Rivers and Sea)

A more detailed explanation to help you understand the flood map shown above.

Current flood warnings

We provide flood warnings online 24 hours a day. Find out the current flood warning status in your local area.

* **Legend Information:** Flood defences and the areas benefiting from them are gradually being added through updates. Please contact your local environment agency office for further details.

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Author: The Environment Agency | enquiries@environment-agency.gov.uk
Last updated: 10th July 2014

Environment Agency

Enter a postcode or place name: Other topics for this area...

Go | Risk of Flooding from Surface Water | View other Interactive Maps

Risk of Flooding from Surface Water

Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead.

The shading on the map shows the risk of flooding from surface water in this particular area.

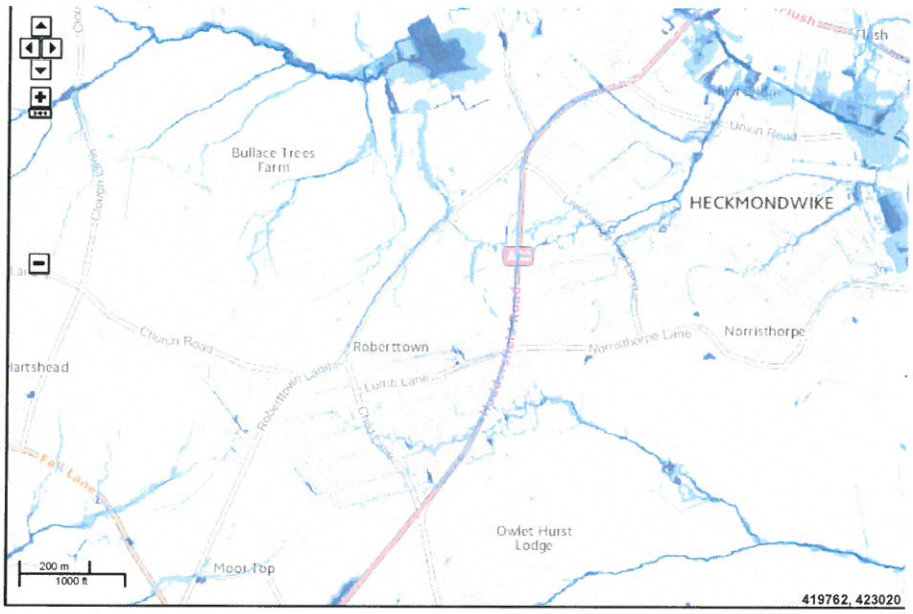
Click on the map for a more detailed explanation.

Map of X: 420,039; Y: 422,825 at scale 1:10,000

Map legend

- Risk of Flooding from Surface Water
  - High
  - Medium
  - Low
  - Very Low

Data search



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Author: The Environment Agency | enquiries@environment-agency.gov.uk
Last updated: 17 July 2014

APPENDIX F

DRAINAGE RECORDS

6063

YorkshireWater

RECEIVED
11 APR 2014
MWA

Yorkshire Water Services
Developer Services
Sewerage Technical Team
PO BOX 52
Bradford
BD3 7AY

Tel: 0845 120 8482
Fax: (01274) 372 834

Email:
Technical.Sewerage@yorkshirewater.co.uk

For telephone enquiries ring:

Kashif Khan on (0845)120 8482

Haigh Huddleston & Associates
Firth Buildings
99-101 Leeds Road
Dewsbury
WF12 7BU

FAO M Dean

Your Ref:
Our Ref: Q005682

9th April 2014

Dear Sir,

Roberttown Lane, Roberttown, Liversedge - Pre-Planning Enquiry on P392462

Thank you for your recent enquiry. Our charge of £89.00 (plus VAT) will be added to your account with us, reference MWA057. You will receive an invoice for your account in due course.

Please find enclosed a complimentary extract from the Statutory Sewer Map which indicates the recorded position of the public sewers. Please note that as of October 2011 and the private to public sewer transfer, there are many uncharted Yorkshire Water assets currently not shown on our records. The following comments reflect our view, with regard to the public sewer network only, based on a 'desk top' study of the site and are valid for a maximum period of twelve months:

Development of the site should take place with separate systems for foul and surface water drainage. The separate systems should extend to the points of discharge to be agreed.

Foul water domestic waste should discharge to the 300 mm diameter public combined sewer recorded in Roberttown Lane, at a point adjacent to the site.

The developer's attention is drawn to Requirement H3 of the Building Regulations 2000. This establishes a preferred hierarchy for surface water disposal. Consideration should firstly be given to discharge to soakaway, infiltration system and watercourse in that priority order.

Sustainable Drainage Systems (SuDS), for example the use of soakaways and/or permeable hardstanding etc, may be a suitable solution for surface water disposal appropriate in this situation. You are advised to seek comments on the suitability of SuDS in this instance from the appropriate authorities.

The local public sewer network does not have capacity to accept any discharge of surface water from the proposal site. If SuDS are not viable, the developer is advised to contact the Environment Agency/local Land Drainage Authority with a view to establishing a suitable watercourse (if any nearby) for discharge.

It is understood that watercourses are located through/to the north of the site. This appears to be the obvious place for surface water disposal (if SuDS are not viable).

Please note further restrictions on surface water disposal from the site may be imposed by other parties. You are strongly advised to seek advice/comments from the Environment Agency/Land Drainage Authority, with regard to surface water disposal from the site.

Prospectively adoptable sewers and pumping stations must be designed and constructed in accordance with the WRc publication "Sewers for Adoption - a design and construction guide for developers" 6th Edition as supplemented by Yorkshire Water's requirements, pursuant to an agreement under Section 104 of the Water Industry Act 1991. An application to enter into a Section 104 agreement must be made in writing prior to any works commencing on site. Please contact our Developer Services Team (telephone 0845 120 84 82) for further information.

The public sewer network is for domestic sewage purposes. This generally means foul water for domestic purposes and, where a suitable surface water or combined sewer is available, surface water from the roofs of buildings together with surface water from paved areas of land appurtenant to those buildings. Land and highway drainage have no right of connection to the public sewer network. No land drainage to be connected/discharged to public sewer.

Any new connection to an existing public sewer will require the prior approval of Yorkshire Water. You may obtain an application form from our website (www.yorkshirewater.com) or by telephoning 0845 120 84 82.

All the above comments are based upon the information and records available at the present time. The information contained in this letter together with that shown on any extract from the Statutory Sewer Map that may be enclosed is believed to be correct and is supplied in good faith. Please note that capacity in the public sewer network is not reserved for specific future development. It is used up on a 'first come, first served' basis. You should visit the site and establish the line and level of any public sewers affecting your proposals before the commencement of any design work.

Yours faithfully

Developer Services Team

Wind Turbine
Path (um)
Sinks
Issues
Sinks
Issues
Sinks
The Old Barn
Lowfold Hall
Depot
Liversedge Cricket Ground
Club
Path (um)
Path
ROBERT COURT
ROBERT TOWN LANE
School House
102.0m
ROBERT TOWN LANE
ETL
RICHMOND PARK AVENUE
Duxbury Hall
Tennis Courts
Club
102.1m
106.1m
LINELANE COURT
Post
Drain
Path (um)
111.9m
122.5m
110.6m
113.7m
116.1m
Church
Shelter
Ward Bdy
HUDDERSFIELD ROAD
SUNNYSIDE AVENUE
WHEATLANDS DRIVE
STANLEY ROAD
LUMB LANE
121.6m
126.2m
132.9m
Warehouse
4 to 6
3 to 9
New Yew Tree (PH)
Posts
119.8m
El Sub Sta
APRIL COURT
LINCOLN DRIVE
BALMFIELD
ETL

419872 : 422686	Map Name : SE1922NE	Title
YorkshireWater	Yorkshire Water, PO Box 500, Halifax Road, Bradford BD6 2LZ Contact Name : K KHAN Contact Tel :	Notes
Partial Key Foul Sewer = F Combined Sewer = C Surface Water Sewer = SW Trade Sewer = TD Partially Separate = PS		This plan is furnished as a general guide only and no warranty as to its correctness is given or implied. This plan must not be relied upon in the event of excavations or other works made in the vicinity of public sewers. No house or property connections are shown.
Date Req : 09/04/2014, 12:33:20		Date Gen : 09/04/2014, 12:33:31
Source : Sewer Network Enquiry		

UPN: Undefined Originator: K KHAN, New Development - Waste Water,

APPENDIX G

STORMWATER STORAGE CALCULATIONS

HAIGH HUDDLESTON ASSOCIATES **Stormwater Storage Calculations**

Client **Strata homes Leeds**

Site **Robertown Liversedge** **2.5 l/s/ hectare**

Design storm 100 M5-60 19 mm
r 0.37
Site area sq m. 80485
Imp Area sq m. 40000
T of Conc min 4 Time to Flow
Allow Discharge 20 Lit / sec Imp Ratio 0.50

Storm Duration	Intensity	Depth	Vol In	Vol Out	Storage	Q	t	100 year storm Intensity	Depth	Vol In	Vol Out	Storage		100year plus 30% climate Intensity	Depth	Vol In	Vol Out	Storage
Mins	mm/hr	mm	cu.m	cu.m	cu.m.			mm/hr	mm	cu.m	cu.m	cu.m.		mm/hr	mm	cu.m	cu.m	cu.m.
10	81.8	13.63	545.33	16.69	528.64	909.62	0.1	101.27	16.88	675.12	16.69	658.43		131.65	21.94	877.66	16.69	860.97
20	59.8	19.93	797.33	28.66	768.68	664.98	0.1	74.03	24.68	987.10	28.66	958.44	ddedit	96.24	32.08	1283.23	28.66	1254.57
30	47.6	23.80	952.00	40.62	911.38	529.31	0.2	58.93	29.46	1178.58	40.62	1137.96		76.61	38.30	1532.15	40.62	1491.53
50	34.4	28.67	1146.67	64.55	1082.12	382.53	0.2	42.59	35.49	1419.57	64.55	1355.02		55.36	46.14	1845.45	64.55	1780.90
60	30.3	30.30	1212.00	76.52	1135.48	336.94	0.2	37.51	37.51	1500.46	76.52	1423.94		48.76	48.76	1950.59	76.52	1874.08
120	18.7	37.40	1496.00	148.34	1347.66	207.94	0.4	23.15	46.30	1852.05	148.34	1703.71		30.10	60.19	2407.66	148.34	2259.32
180	14.1	42.30	1692.00	220.19	1471.81	156.79	0.5	17.46	52.37	2094.70	220.19	1874.51		22.69	68.08	2723.10	220.19	2502.92
240	11.5	46.00	1840.00	292.05	1547.95	127.88	0.6	14.24	56.95	2277.92	292.05	1985.87		18.51	74.03	2961.30	292.05	2669.25
300	9.8	49.00	1960.00	363.92	1596.08	108.98	0.7	12.13	60.66	2426.48	363.92	2062.56		15.77	78.86	3154.42	363.92	2790.50
360	8.7	52.20	2088.00	435.81	1652.19	96.74	0.8	10.77	64.62	2584.94	435.81	2149.14		14.00	84.01	3360.43	435.81	2924.62
420	7.9	55.30	2212.00	507.71	1704.29	87.85	0.9	9.78	68.46	2738.46	507.71	2230.75		12.71	89.00	3559.99	507.71	3052.29
480	7.5	60.00	2400.00	579.65	1820.35	83.40	1.0	9.29	74.28	2971.20	579.65	2391.55		12.07	96.56	3862.56	579.65	3282.91
540	6.9	62.10	2484.00	651.55	1832.45	76.73	1.0	8.54	76.88	3075.19	651.55	2423.64		11.10	99.94	3997.75	651.55	3346.20
600	6.38	63.80	2552.00	723.45	1828.55	70.95	1.1	7.90	78.98	3159.38	723.45	2435.93		10.27	102.68	4107.19	723.45	3383.74

				Storage	1832.45				Storage	2435.93			Storage	3383.74
Length of 1800	720.10					Length of 1800	957.25592			Length of 1800	1329.72			
Length of 1500	1037.04	Culvert	2.4*1.5m	509.01		Length of 1500	1378.5677			Length of 1500	1914.96			
Length of 1200	1620.20	culvert	3.6*1.8m	282.79		Length of 1200	2153.7835			Length of 1200	2991.81			
Length of 1050	2115.99					Length of 1050	2812.85			Length of 1050	3907.32			
Length of 900	2881.21					Length of 900	3830.08			Length of 900	5320.35			
Length of 750	4145.82					Length of 750	5511.15			Length of 750	7655.52			
Length of 600	6475.09					Length of 600	8607.52			Length of 600	11956.7			

	Footprint Area (m)				
Aquacell Storage Crates	4822.240	30 year	Pond 900mm deep sq.m	2036.06	30 year
(400mm deep)	6410.340	100 year		2706.59	100 year
	8904.584	100 year plus climatic		3759.71	100 year plus climatic

HAIGH HUDDLESTON ASSOCIATES **Stormwater Storage Calculations**

Client **Strata homes Leeds**

Site **Robertown Liversedge** **5 l/s/ hectare**

Design storm 100 M5-60 19 mm
r 0.37
Site area sq m. 80485
Imp Area sq m. 40000
T of Conc min 4 Time to Flow
Allow Discharge 40 Lit / sec Imp Ratio 0.50

Storm Duration									100 year storm						100year plus 30% climate					
Mins	Intensity mm/hr	Depth mm	Vol In cu.m	Vol Out cu.m	Storage cu.m.	Q	t		Intensity mm/hr	Depth mm	Vol In cu.m	Vol Out cu.m	Storage cu.m.		Intensity mm/hr	Depth mm	Vol In cu.m	Vol Out cu.m	Storage cu.m.	
10	81.8	13.63	545.33	33.18	512.16	909.62	0.2		101.27	16.88	675.12	33.18	641.94		131.65	21.94	877.66	33.18	844.48	
20	59.8	19.93	797.33	57.02	740.31	664.98	0.2		74.03	24.68	987.10	57.02	930.08	ddedit	96.24	32.08	1283.23	57.02	1226.21	
30	47.6	23.80	952.00	80.87	871.13	529.31	0.3		58.93	29.46	1178.58	80.87	1097.70		76.61	38.30	1532.15	80.87	1451.27	
50	34.4	28.67	1146.67	128.60	1018.07	382.53	0.4		42.59	35.49	1419.57	128.60	1290.98		55.36	46.14	1845.45	128.60	1716.85	
60	30.3	30.30	1212.00	152.46	1059.54	336.94	0.5		37.51	37.51	1500.46	152.46	1348.00		48.76	48.76	1950.59	152.46	1798.13	
120	18.7	37.40	1496.00	295.75	1200.25	207.94	0.8		23.15	46.30	1852.05	295.75	1556.29		30.10	60.19	2407.66	295.75	2111.91	
180	14.1	42.30	1692.00	439.15	1252.85	156.79	1.0		17.46	52.37	2094.70	439.15	1655.55		22.69	68.08	2723.10	439.15	2283.95	
240	11.5	46.00	1840.00	582.60	1257.40	127.88	1.3		14.24	56.95	2277.92	582.60	1695.32		18.51	74.03	2961.30	582.60	2378.70	
300	9.8	49.00	1960.00	726.08	1233.92	108.98	1.5		12.13	60.66	2426.48	726.08	1700.40		15.77	78.86	3154.42	726.08	2428.35	
360	8.7	52.20	2088.00	869.63	1218.37	96.74	1.7		10.77	64.62	2584.94	869.63	1715.31		14.00	84.01	3360.43	869.63	2490.80	
420	7.9	55.30	2212.00	1013.23	1198.77	87.85	1.8		9.78	68.46	2738.46	1013.23	1725.23		12.71	89.00	3559.99	1013.23	2546.76	
480	7.5	60.00	2400.00	1157.00	1243.00	83.40	1.9		9.29	74.28	2971.20	1157.00	1814.20		12.07	96.56	3862.56	1157.00	2705.56	
540	6.9	62.10	2484.00	1300.60	1183.40	76.73	2.1		8.54	76.88	3075.19	1300.60	1774.60		11.10	99.94	3997.75	1300.60	2697.15	
600	6.38	63.80	2552.00	1444.19	1107.81	70.95	2.3		7.90	78.98	3159.38	1444.19	1715.19		10.27	102.68	4107.19	1444.19	2663.00	

				Storage	1257.40							Storage	1814.20					Storage	2705.56	
Length of 1800		494.13						Length of 1800		712.93446				Length of 1800		1063.22				
Length of 1500		711.60	Culvert	2.4*1.5m	349.28			Length of 1500		1026.7144				Length of 1500		1531.16				
Length of 1200		1111.76	culvert	3.6*1.8m	194.04			Length of 1200		1604.071				Length of 1200		2392.19				
Length of 1050		1451.97						Length of 1050		2094.92				Length of 1050		3124.21				
Length of 900		1977.05						Length of 900		2852.52				Length of 900		4254.03				
Length of 750		2844.80						Length of 750		4104.53				Length of 750		6121.19				
Length of 600		4443.12						Length of 600		6410.62				Length of 600		9560.3				

	Footprint Area (m)				
Aquacell Storage Crates	3308.955	30 year	Pond 900mm deep	1397.11	30 year
(400mm deep)	4774.222	100 year		2015.78	100 year
	7119.906	100 year plus climatic		3006.18	100 year plus climatic