Surface Water Drainage Strategy

Land at Llanellen Court, Llanellen, Monmouthshire

On Behalf of

Trustees of Morspan Pension Scheme Ltd

Quality Management

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1 Introduction

1.1 Background

Hydrogeo Limited (Hydrogeo) have been commissioned by the Trustees of Morspan Pension Scheme Ltd (the Client) to undertake a Surface Water Drainage Strategy Report for a parcel of land at Llanellen Court, Llanellen, Monmouthshire (the Site).

This report has been prepared to promote the Site for inclusion in the Monmouthshire County Council (MCC) Local Development Plan (LDP) for residential land use. In order for the Site to be subject to a successful future planning application the surface water discharges would need to meet current planning requirements.

1.2 Surface Water Discharge Planning Requirements

A development of more than 100 square metres would need a Sustainable Drainage System (SuDS) designed, submitted to and approved by the Monmouthshire Council SuDS Approving Body (SAB) in order to gain full planning approval.

A Sustainable Drainage System is designed to replicate, as closely as possible, the natural drainage from a site (before development) to ensure that the flood risk downstream of that site does not increase as a result of the land being developed.

SuDS can also significantly improve the quality of water leaving a site and can enhance the amenity and biodiversity that a site has to offer.

The implications of the SuDS requirements for development at the Site are a key focus of this report, and are discussed in greater detail in Section 4, with discussion of the site-specific options included in Section 6.

2 Location & Development Description

2.1 Site Location

The Site is located on land off the A4042 at Llanellen Court, Llanellen, Monmouthshire, NP7 9HP. The National Grid Reference for the Site is 330317, 210655.

The location of the Site has been shown in Figure 2-1 and the Site boundary has been shown in Figure 2-2.

Figure 2-1 Site Location

Figure 2-2 Site boundary

2.2 Existing Development

The Site comprises an undeveloped parcel of land at Llanellen Court, as shown in Figure 2-2. The parcel of land has an area of approximately 3.5ha and is currently used for pasture.

The land falls towards the north east with a break in slope halfway to a level area at the northern half. The maximum elevation is approximately 64m above ordnance datum (mAOD) along the south west boundary, and the minimum elevation is approximately 53mAOD across the flat northern part.

The land falls within a wider ownership boundary which includes a number of former farming buildings, residential buildings and dwellings.

2.3 Potential Development

The land at the Site is a LDP candidate sites for MCC, with a proposed residential end use. Planning permission for development at the Site has not been sought yet.

The development layout plan for the site is attached at Appendix A.

2.4 Geology

British Geological Survey (BGS) data have been used to describe the geology below the Site.

Artificial Geology

No artificial geology is indicated to be present below the Site on BGS mapping.

Superficial Geology

Superficial deposits are present at the Site and comprise mainly Glaciofluvial Sheet Deposits. These are sand and gravel deposits formed by glacial processes during the Quaternary Period within the last 2 million years.

Superficial deposits at the flat northern part of the northern parcel of land are marked as Alluvium: clay, silt, sand and gravel deposited in a fluvial environment during the Quaternary Period within the last 2 million years.

Bedrock Geology

BGS mapping indicates that the bedrock geology present at the Site comprises the St. Maughans Formation, which consists of fluvially derived interbedded sandstone and argillaceous rocks dating from the Devonian Period, approximately 393 to 419 million years ago.

2.5 Hydrogeology

The following aquifer classifications have been assigned by NRW to the superficial and bedrock geology below the Site:

- Groundwater vulnerability, superficial geology: *Medium vulnerability, secondary aquifer.*
- Groundwater vulnerability, bedrock geology: *Medium vulnerability, secondary aquifer.*
- Aquifer designation, superficial geology: Secondary A.
- Aquifer designation, bedrock geology: Secondary A.

Secondary A Aquifers are 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.

Soil Type

Information from the National Soil Resource Institute identifies the Site as being situated on Soilscape 6: freely draining slightly acid loamy soils.

2.6 Catchment Hydrology

Available Ordnance Survey (OS) mapping has been used to determine the surface water features in the vicinity of the Ownership Site. (Drawing 1)

A site walkover was conducted by Hydrogeo on the 30th July 2021 in order to identify surface water features and gain an understanding of the general site layout relative to site drainage. The site walkover is discussed in Section3.

No surface water features are present directly within the boundary of the Site. OS mapping indicates that a spring is present 210m south west of the northern parcel of land. The spring feeds a small pond to the west of residential buildings within the site ownership boundary; the pond outfall is then culverted below an area of woodland down slope to the north east, in the direction of the Site.

The culverted watercourse has been surveyed by CCTV and dye tracing by PM Consultants (Appendix D)

The culvert is concrete and starts at a diameter of 225mm, then increases to 300mm after MH1 where the private surface water sewer from Llanellen Village joins. The culvert leaves the land ownership in the north and it is understood that there is another access manhole on the field to the north east. The OS map shows a short section of open watercourse in the north of the field (Drawing 1), which then passes beneath the B4269 and the A4042 prior to another open section which discharges to the River Usk south of the road bridge. It is assumed that this is the route of the culverted watercourse, which can be surveyed further and cleaned / reinstated where required by the landowners under Riparian Rights.

A plan of the surface water features in the vicinity of the Site has been shown on Drawing 1.

2.7 Flooding

NRW data have been used to summarise the flood hazards at the Site. A plan of the flooding hazards has been shown on Drawing 2.

Flooding from Rivers and Sea

- The Site is not at risk of flooding from the sea.
- The Site is not at risk of flooding from rivers.

Flooding from Surface Water and Small Watercourses

- The Site is not at risk of flooding from small watercourses.
- A small area at the north eastern corner of the northern parcel of land at the Site is at high risk of surface water flooding.
- A small strip of land at the south western corner of the southern parcel of land at the Site is at low risk of surface water flooding.

2.8 Sensitive Land Uses

NRW data has been used to determine whether any sensitive land uses are present in the vicinity of the Site.

A list of sensitive land uses has been shown below:

- SSSI: River Usk (Lower Usk) located 0.3km NE
- SAC: River Usk located 0.3km NE
- AONB: None within 2km
- Local Nature Reserve: None within 2km
- National Park: Brecon Beacons NP located 0.3km W
- RAMSAR: None within 2km

2.9 Sewers

Sewer plans have been requested from Dŵr Cymru Welsh Water (DCWW); the sewer plan and DCWW correspondence has been attached at Appendix B. A private sewer from Llanellen village discharges to the culverted watercourse which crosses the site.

3 Site Walkover

3.1 Introduction

A site walkover was conducted by Hydrogeo in order to identify surface water features and gain an understanding of the general site layout relevant to drainage.

Photographs taken during the site walkover have been shown in Table 3-1. A plan of the photograph locations has been shown in Drawing 3.

Table 3-1 Site walkover photographs

Reference	Description	Photograph
1	Looking north from the southern boundary of the northern parcel of land.	
2	Looking north from the south western corner of the northern parcel of land.	

Reference	Description	Photograph
3	Looking east from the western boundary of the northern parcel of land. The break of slope to the flat section of this area of the Site is visible.	
4	Looking south from the north eastern corner of the northern parcel of land.	
5	Culvert conveying a watercourse towards the north east. Entrance to the culvert is located outside site boundary but within the Client ownership boundary. (drain survey from this location undertaken)	

4 Surface Water Drainage

4.1 Introduction

This drainage statement complies with the principles of SuDS in Wales presented in the 'Statutory Standards for Sustainable Drainage Systems – Designing, constructing, operating and maintaining surface water drainage systems'.

The six standards that need to be met are as follows:

- S1 – Surface water run-off destination
- S2 – Surface water runoff hydraulic control
- S3 – Water Quality
- S4 – Amenity
- S5 – Biodiversity
- S6 – Designing drainage for construction, operation, maintenance and structural integrity.

A sustainable drainage system is designed to replicate, as closely as possible, the natural drainage from a site (before development) to ensure that the flood risk downstream of the Site does not increase as a result of the land being developed. SuDS can also significantly improve the quality of water leaving a site and can enhance the amenity and biodiversity that a site has to offer.

Projections of future climate change in the UK, indicate more frequent, short-duration, high intensity rainfall and more frequent periods of long duration rainfall. As such, the recommended national precautionary sensitivity range for peak rainfall intensity is 40%.

5 S1: Surface Water Run-Off Destination

5.1 Introduction

As part of the SuDS Standards the management of run-off from developments should be prioritised as to the choice of discharge destination. The priority hierarchy is listed below:

1. Collect for re-use;
2. Infiltrate to ground;
3. Discharge to a surface water body;
4. Discharge to a surface water sewer/highway drain;
5. Discharge to a combined sewer.

5.2 Collect for re-use

The reuse of water from roofed areas to provide grey (non-potable) water for toilet flushing and washing can reduce storm run-off without the need for treatment or oil separators as the risk of spillage or contamination is low.

It is expected that there will be a demand for water at development for use in toilet flushing and potentially a washing machine, however the yield is expected to exceed demand. As such, rain water harvesting is unlikely to be a viable or cost-effective method of managing surface water run-off.

Small amounts of surface water run-off from the developed building roof can be collected and stored in water butts provided at each property for future use in the gardens.

5.3 Infiltrate to ground

Soakaway testing was undertaken on land directly adjacent to the site in 2017 to support the Access Road Drainage Statement (Appendix E). The test results provide an indication of the potential infiltration rates in the part of the site near the access road. Infiltration rates were measured between 4.39×10^{-5} m/s and 4.71×10^{-5} m/s. No groundwater was encountered in trial pits excavated to 2.7m depth. This does indicate that some infiltration SuDS techniques, such as soakaways could be included in the scheme as viable method of surface water discharge, following further testing.

5.4 Discharge to a surface water body

The small stream which passes beneath the site in the north in a culvert is considered to be a viable option for drainage discharge at the Site.

5.5 Discharge to sewers

A private surface water sewer flows onto the site from Llanellen village and discharges to the culverted watercourse. Due to the proximity of the existing culverted watercourse, discharge to sewers is not a required drainage option for the Site at this time.

6 S2: Surface Water Run-Off Hydraulic Control

6.1 Introduction

The objective of this drainage strategy is to ensure that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water run-off from the development of the Site. The drainage strategy takes into account the following principles.

- No increase in the volume or rate of surface water run-off from the development of the Site;
- No increase in flooding to people or property off-Site as a result of the development of the Site;
- The proposals take into account a 40% increase in rainfall intensity due to climate change during the next 100 years;
- The proposals take into account a 10% increase in impermeable surfaces as a result of urban creep.

6.2 Site Areas

The current Site areas have been calculated from satellite imagery and the Site visit, the end-Site areas have been calculated from the proposed layout plans given to Hydrogeo by the Client team and attached as Appendix A.

The total area of the development Site has been calculated to be approximately 34,000m^2. The Site is currently greenfield used primarily for grazing. The proposal is for a residential development with driveways, access roads, footpaths and soft landscaped areas. The roofs of the buildings and tarmac access road would be impermeable, however pavements, patios, driveways and footpaths would be constructed as permeable surfaces. The total impermeable area at the end-Site will have increased.

These Site areas are summarised in Table 6-1, and show that the area of impermeable surfaces on Site is planned to increase.

Table 6-1 – Site features and surfaces.

Feature	Current Area (m²)	Proposed Area (m²)	Permeability
Total Site	35,280	35,280	Mixed
Roofs	0.0	2,926	Impermeable
Garages	0.0	280	Impermeable
Access Road	0.0	1,675	Impermeable
External patios/paths	0.0	1,280	Permeable
Pavement/pathways/parking	0.0	3,375	Permeable
Grass/Soft Landscaping	35,280	25,744	Permeable

6.3 Surface Water Run-Off Rates

For discharge to a surface water body an analysis of the current surface water run-off rates from the Site is required to be made using the appropriate hydraulic modelling software.

As the Site is a greenfield site, the surface water run-off rate has been calculated Causeway Flow. The full calculations are attached as Appendix C.

6.4 Surface Water Attenuation Estimation

An estimation of surface water run-off volume is required to permit effective surface water management and prevent any increase in flood risk to off-Site receptors.

According to regulations, the sizing of surface water drainage features must be calculated based on the volume of surface water run-off during a 1 in 100-year rainfall event. The calculations must also take into account a 40% increase in future rainfall due to climate change, as well as a 10% increase in impermeable surfaces on Site due to urban creep. Site specific rainfall design data was obtained from the Flood Estimation Handbook (FEH) web service.

The surface water run-off storage volume has been calculated using Causeway Flow, and the full results from this tool are attached as Appendix C.

The tool calculates that a 1m deep attenuation basin would require a surface area of approximately 1800m^2.

6.5 Drainage Strategy

At this stage a detailed surface water drainage design has not been undertaken, however it is necessary to demonstrate that the surface water from the proposed development can be discharged safely and sustainably. The surface water drainage strategy at the Site will include the following:

- Interception, treatment and attenuation of surface water run-off;
- Restricted discharge from the Site, set to the greenfield 1 in 100-year run-off rate.

Interception, treatment and attenuation of the surface water run-off will be provided by the permeable paving surfaces, plot scale rain gardens and a grassy detention basin.

Outflow from the detention basin will be restricted via a flow control device. The outflow will then be transported via underground pipes to the northern part of the site to a new connection with the existing culverted watercourse within the ownership boundary.

The proposed surface water drainage layout within the development Site boundary is presented in Drawing 4.

6.6 Interception

The interception of the first 5mm of rainfall at the Site will be provided by a combination of the permeable surfaces, plot scale rain gardens and a grassy detention basin.

According to the Welsh standards, all permeable surfaces, whether lined or not, can be assumed to provide interception provided there is no additional area drained to them. The standards also state that rain gardens can provide interception where the impermeable surface area being drained is less than 5 times the vegetated surface area receiving the run-off.

Pedestrian areas and parking areas, will be permeable surfaces to provide interception. The run-off from the impermeable surfaces (roofs) will be directed through the permeable surfaces to the rain gardens to provide the interception. The permeable surfaces will be able to provide temporary storage for the surface water run-off, decreasing the required size of the attenuation feature.

6.7 Designing for Local Drainage System Failure/Design Exceedance

When considering residual risk, it is necessary to make predictions as to the impacts of a storm event that exceeds the design event, or the impact of a failure of the local drainage system. The drainage strategy applies a safe and sustainable approach to discharging rainfall run-off from the Site and this reduces the risk of flooding. However, it is not possible to completely remove the risk. This section is therefore associated with the way the residual risk is managed.

As part of the drainage strategy, it must be demonstrated that the flooding of property would not occur in the event of local drainage system failure and/or design exceedance. It is not economically viable or sustainable to build a drainage system that can accommodate the most extreme events. Consequently, the capacity of the drainage system may be exceeded on rare occasions, with excess water flowing above ground.

The drainage components would be designed to accommodate the 1 in 100-year critical rainfall event plus an allowance for climate change and urban creep. Flows from an exceedance event (>1 in 100-year rainfall event) and/or component failure are expected to result in overtopping of the subbases. Any surface water run-off from the Site would be expected to flow east onto the public road and not towards any properties. The risk to the proposed development from flooding as a result of an exceedance event or system failure is negligible.

7 S3: Water Quality

The Simple Index Approach Tool from the SuDS Manual has been used to assess the pollution mitigation capacity of the proposed SuDS features at the Site.

The pollution hazard level of different surfacing types has been shown in, based on Table G3.1 of the Welsh statutory standards and Table 26.2 of the SuDS Manual. The development is proposed to contain residential roofs, property driveways and car parking spaces and a shared access road.

Table 7-1 - Potential pollution source and hazard indices.

Source	Hazard Level	Total Suspended Solids	Metals	Hydrocarbons
Residential roof	Very low risk	0.2	0.2	0.05
Low traffic roads/Residential driveways and car parking	Low risk	0.5	0.4	0.4

Note – The indices range from 0 (no pollution hazard for this contaminant type) to 1 (high pollution for this contaminant type).

It is considered that the Site falls under the “low risk” level of hazard.

In order to deliver adequate treatment, the SuDS components should have a total pollution mitigation index for each contaminant type that is equal to or greater than the pollution hazard index for that contaminant type. Where SuDS components are used in a sequential train, a factor of 0.5 must be applied to each subsequent feature to account for the reduced performance.

It is assumed that all surface water run-off will first go through the permeable paving before entering the rain garden, therefore the same mitigation will be applied to all rainfall, and the mitigation of the rain garden will have a factor of 0.5 applied.

The pollution mitigation for discharges to surface waters for the SuDS components are shown in Table 7-2, based on Table 26.3 of the SuDS Manual.

Table 7-2 – Mitigation indices for SuDS components.

Type of SuDS Component	Total Suspended Solids	Metals	Hydrocarbons
Permeable Paving	0.7	0.6	0.7
Rain Garden	0.8	0.8	0.8
Detention basin	0.5	0.5	0.6

Note – The indices range from 0 (no pollution mitigation for this contaminant type) to 1 (high pollution mitigation for this contaminant type).

The proposed SuDS features will be capable of mitigating any potential pollution from the surface water run-off before discharge to the local surface water course.

8 S4 & S5: Amenity and Biodiversity

8.1 Amenity and Biodiversity Benefits

The proposed development plans for the Site includes large areas of soft landscaping with the planting of native trees, native species hedgerows, residential lawns and public open space. These features will help support flora and fauna for the benefit of the development community, as well as providing air quality improvements in accordance with the SuDS Manual.

The proposed rain gardens to each individual dwelling plot will provide amenity and biodiversity benefits for the development as the vegetation will be native plants to help support the local flora and fauna.

9 S6: Designing Drainage for Construction, Operation, Maintenance and Structural Integrity

9.1 Introduction

The SuDS components have been designed for easy maintenance to comprise:

- Regular day-to-day care, such as regular land maintenance to control excessive vegetation growth and checking inlets where water enters the SuDS features;
- Occasional tasks, such as checking the SuDS features and removing any silt build-up;
- Remedial work, such as repairing damage where necessary.

9.2 SuDS Maintenance and Management

A management and maintenance plan will be developed as part of the full design application. A construction and phasing plan to mitigate impacts of surface water run-off during construction and provided details of development phases will be developed with the full design application.

It is proposed that SuDS devices are constructed toward the very end of the development in order to prevent damage or silt build-up of the components.

9.3 Design Life

The design life of the development is likely to exceed the design life of each of the SuDS components for the Site. During the routine inspections of any SuDS components, it may become apparent that they have reached the end of their functional lifetime. In the interest of sustainability, repairs should be the first choice of solution where possible. If this is not the case it will be necessary to undertake complete replacement of the component in question.

When undertaking maintenance, repairs or replacement, all engineering drawings used in the design, construction and installation of the SuDS components should be referred to for construction and specification details. This will help to ensure satisfactory performance of each of the SuDS components.

10 Conclusion

10.1 Introduction

Hydrogeo Limited (Hydrogeo) have been commissioned by the Trustees of Morspan Pension Scheme Ltd (the Client) to undertake a Surface Water Drainage Strategy Report for a parcel of land at Llanellen Court, Llanellen, Monmouthshire (the Site).

This report has been prepared to promote the Site for inclusion in the Monmouthshire County Council (MCC) Local Development Plan (LDP) for residential land use. In order for the Site to be subject to a successful future planning application the surface water discharges would need to meet current planning requirements.

10.2 Surface Water Drainage

The surface water drainage strategy ensures that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water run-off from development at the Site.

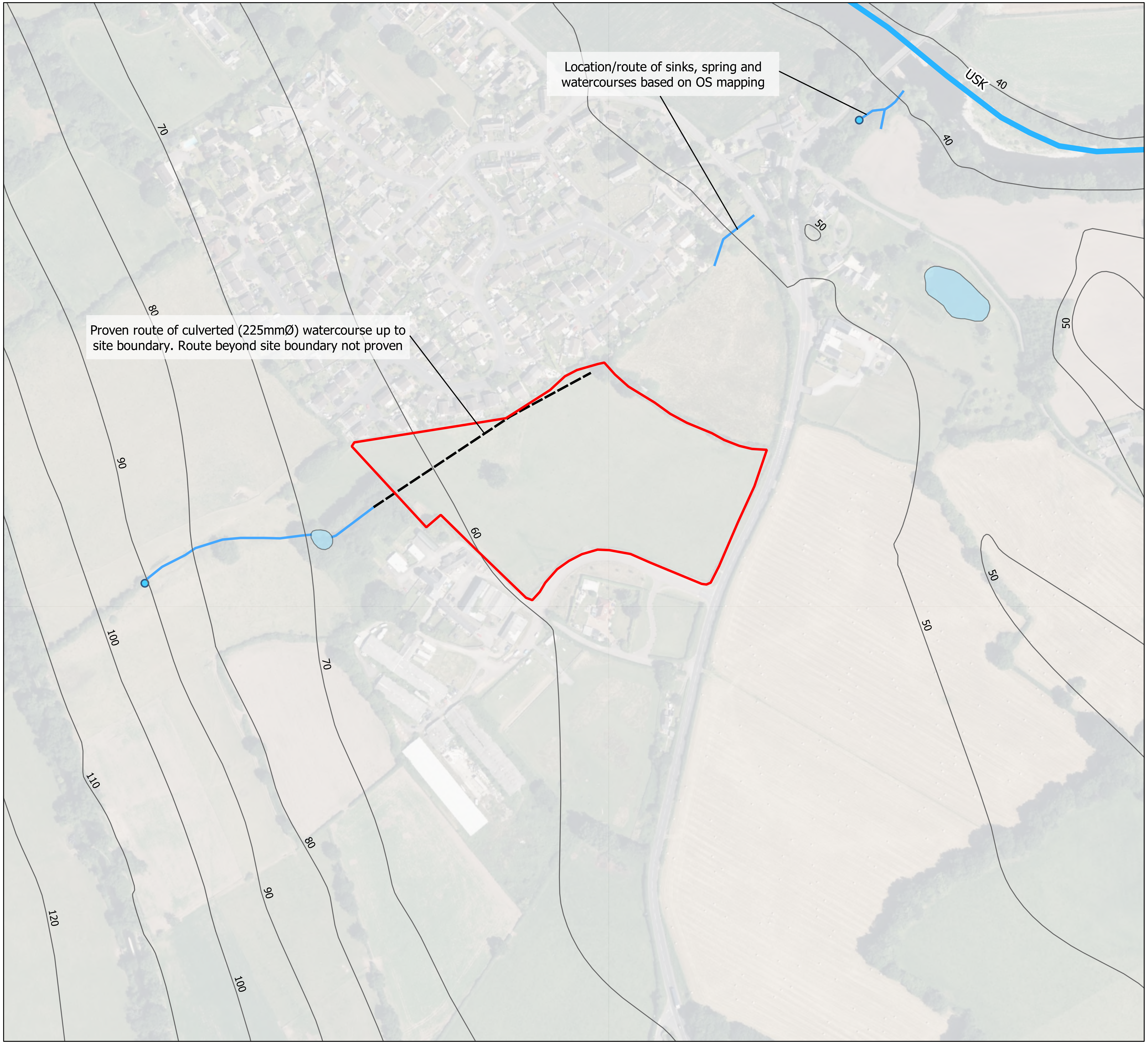
At this stage a detailed drainage design has not been undertaken, however it is necessary to demonstrate that the surface water from the proposed development can be discharged safely and sustainably.

The proposed development will incorporate a number of linked SuDS features including permeable surfaces, plot scale rain gardens and a grassy detention basin. The scheme will capture and treat surface water run-off from the impermeable surfaces on the developed Site and will then release this stored water at a set rate into the existing culverted watercourse that passes through the site.

Drawings

Drawing 1

Surface water features plan



HYDROGEO

HYG953 Llanellen

DRAWING 1

Surface water features

KEY

- Site boundary
- Pond
- Elevation contour (mAOD)
- Main River
- Watercourse
- Culverted watercourse (225mmØ)
- Spring

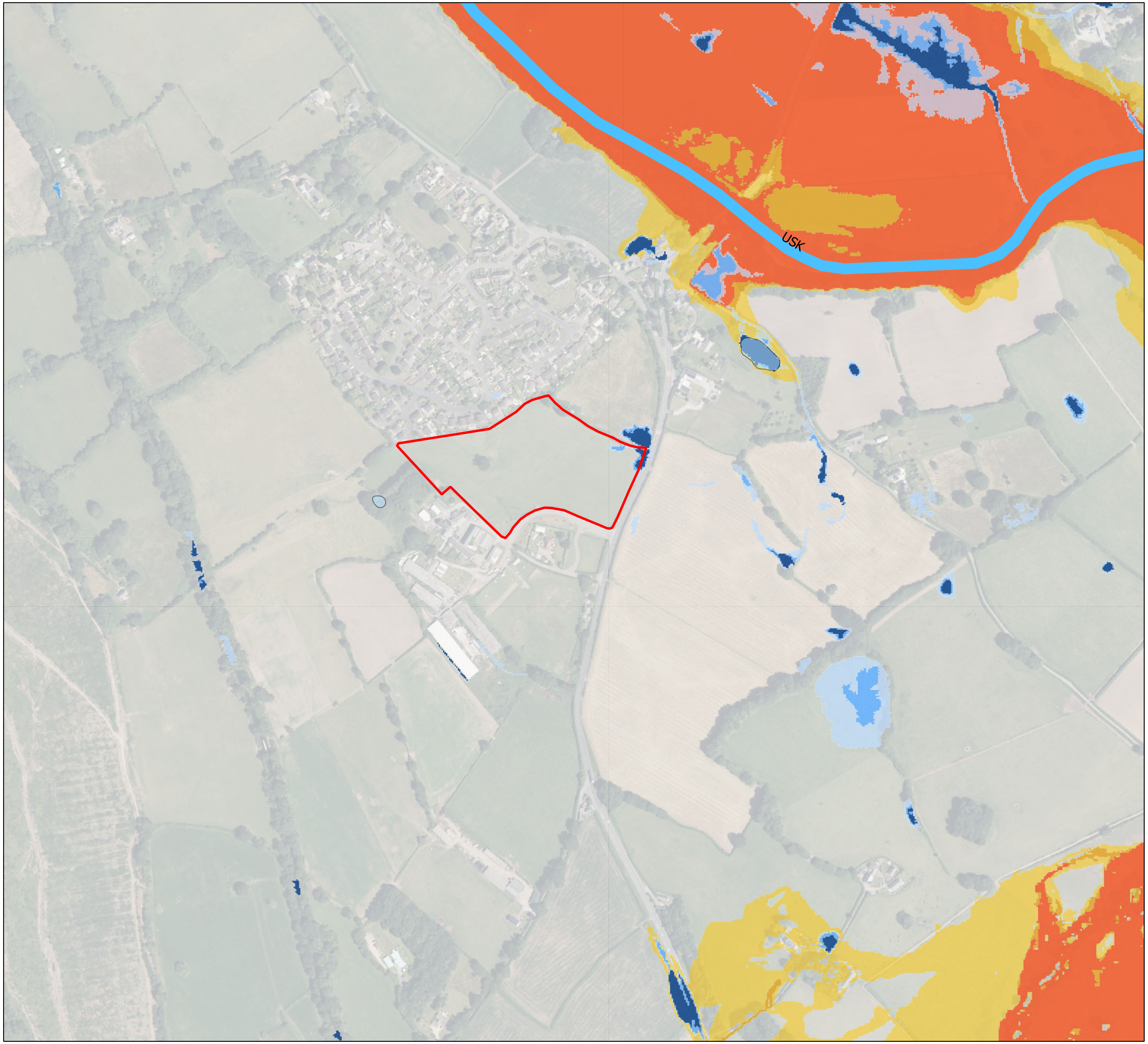
50 0 50 100 m

N

Date	By	Paper	Scale	Rev
12 2023	TP	A3	1:3,000	2

Drawing 2

Flooding hazard plan



HYDROGEO

HYG953 Llanellen

DRAWING 2

Flooding hazard plan

KEY

Site boundary

Main River

Watercourse

Flooding Hazard - Rivers

High Risk

Medium Risk

Low Risk

Flooding Hazard - Surface Water

High Risk

Medium Risk

Low Risk

100 0 100 200 m

N

Date	By	Paper	Scale	Rev
12 2023	TP	A3	1:5,000	2

Drawing 3

Photo location plan

HYDROGEO

HYG953 Llanellen

DRAWING 3

Photo location plan

KEY

Site boundary

Photo location

50 0 50 100 m

N

Date	By	Paper	Scale	Rev
12 2023	TP	A3	1:3,000	2

Drawing 4

Drainage Layout

HYDROGEO

HYG953 Llanellen

DRAWING 4

Surface water drainage plan

KEY

Site boundary (approximate)

Existing drainage features

Culverted watercourse

Manhole

Proposed surface water drainage features

Detention basin

Pipe

Drawing adapted from 'Site block plan as proposed', Reference: 1434 (3K) 01B, November 2023, Buckle Chamberlain Partnership

10 0 10 20 30 40 50 m

N

Date	By	Paper	Scale	Rev
12 2023	TP	A3	1:1,100	1

Appendices

Appendix A

Proposed site layout plan

SITE BLOCK PLAN AS PROPOSED (NORTH SITE)
scale 1:1000

REF	UNIT TYPE	FLOOR AREA	No	
A	2 BED / 4 PERSON	83.0m²	4	AFFORDABLE (16 No) 50%
B	3 BED / 5 PERSON	94.0m²	4	
C	2 BED / 4 PERSON	83.0m²	4	
D	1 BED / 2 PERSON (WALK UP)	52.0m²	4	
E	4B / 7 PERSON	130m²	7	OPEN MARKET (16 No 50%
F	4B / 7 PERSON	170m²	4	
G	5B / 8 PERSON	170m²	3	
H	3B / 5 PERSON (BUNG)	120m²	2	
		TOTAL	32	

DRAFT PLAN FOR COMMENT

REV. B NOV. 2023 GB.
Layout revised for 32 UNITS
(16 AFFORDABLE, 16 OPEN MARKET)

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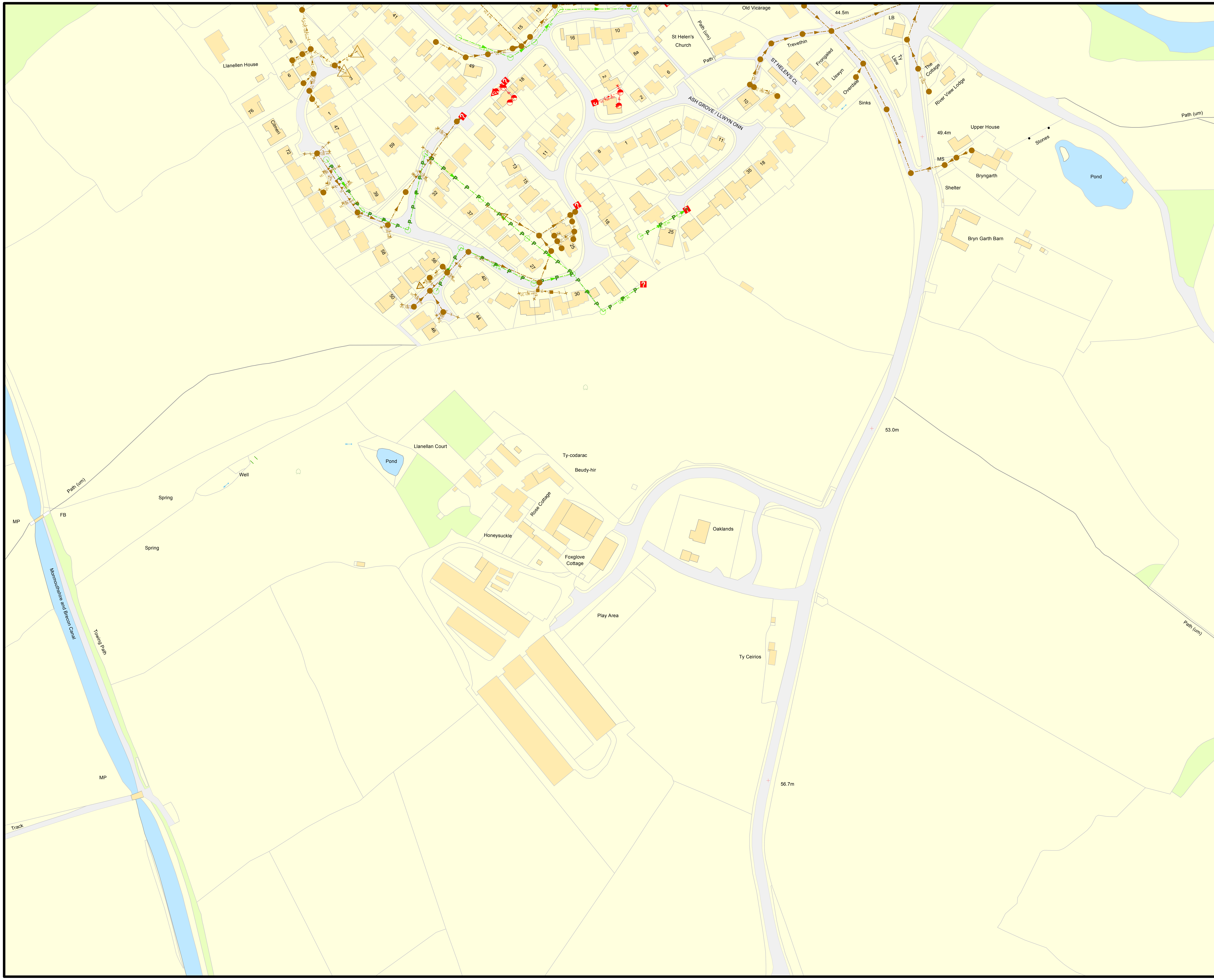
Client	TRUSTEES OF MORSPAN PENSION SCHEME
Project	PROPOSED CANDIDATE SITE AT LLANELLEN COURT, LLANELLEN, ABERGAVENNY (NORTH SITE PROPOSAL)
Drawing	SITE BLOCK PLAN AS PROPOSED
Date	NOV. 2023
Scale	1:1000
Drawn by	GB
Checked by	
Status	
Drawing No	1434 (SK) 01B

Appendix B

DCWW sewer plan



Dŵr Cymru
Welsh Water

PPA0005955 Sewer Plan

N
W
E
S

LEGEND(Representative of most common features)

Waste network:

	Foul chamber		Outfall
	Surface water chamber	LH	Lamphole
	Combined chamber		Storm Overflow
C O	Combined sewer overflow		Rising main
SPC	Special purpose chamber		Gravity sewer
	Treatment works	P	Private sewer
	Pumping station	S 104 P	Private sewer subject to Sect. 104 adoption agreement
		T	Private Sewer Transfer
		L	Lateral Drain
			Inspection Chamber

NB: Sewer symbol colour indicates the type.

RED - Combined
GREEN - Surface Water
BROWN - Foul
Purple - Former S24 sewers (for indicative purposes only)

Notes:

Whilst every reasonable effort has been taken to correctly record the pipe material of DCWW assets, there is a possibility that in some cases pipe material (other than Asbestos Cement or Pitch Fibre) may be found to be asbestos cement (AC) or Pitch Fibre (PF). It is therefore advisable that the possible presence of AC or PF pipes be anticipated and considered as part of any risk assessment prior to excavation

Dŵr Cymru Cyfyngedig ('the Company') gives this information as to the position of its underground apparatus by way of general guidance only and on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon in the event of excavations or other works made in the vicinity of the company's apparatus. The onus of locating apparatus before carrying out any excavations rests entirely on you. The information which is supplied by the Company, is done so in accordance with statutory requirements of sections 198 and 199 of the Water Industry Act 1991 which is based upon the best Information available and, in particular, but without prejudice to the generality of the foregoing, it should be noted that the records that are available to the Company may not disclose the existence of a water main, service pipe, sewer, lateral drain or disposal main and any associated apparatus laid before 1 September 1989, or, if they do, the particulars thereof including their position underground may not be accurate. It must be understood that the furnishing of this information is entirely without prejudice to the provision of the New Roads and Street Works Act 1991 and the Company's right to be compensated for any damage to its apparatus.

Service pipes are not generally shown but their presence should be anticipated.

EXACT LOCATIONS OF ALL APPARATUS TO BE DETERMINED ON SITE.

Map Ref: 330250,210575
Map scale: 1:1250
Printed by: Jonathan Hobson
Printed on: 20 Aug 2021

Appendix C

Causeway Flow Calculations

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	1.000	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Easting (m)	Northing (m)	Depth (m)
Basin	1.033	5.00	53.000	330379.000	210644.000	1.000

Simulation Settings

Rainfall Methodology	FEH-22	Drain Down Time (mins)	240	100 year (l/s)	5.7
Summer CV	1.000	Additional Storage (m³/ha)	0.0	Check Discharge Volume	✓
Winter CV	1.000	Check Discharge Rate(s)	✓	100 year 360 minute (m³)	266
Analysis Speed	Normal	1 year (l/s)	2.3		
Skip Steady State	x	30 year (l/s)	4.7		

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	40	10	0
30	40	10	0
100	40	10	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.80
Greenfield Method	FEH	Growth Factor 100 year	2.18
Positively Drained Area (ha)	1.033	Betterment (%)	0
SAAR (mm)	1139	QMed	2.4
Host	6	QBar	2.6
BFIHost	0.812	Q 1 year (l/s)	2.3
Region	9	Q 30 year (l/s)	4.7
QBar/QMed conversion factor	1.075	Q 100 year (l/s)	5.7
Growth Factor 1 year	0.88		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	0
Positively Drained Area (ha)	1.033	Storm Duration (mins)	360
Soil Index	2	Betterment (%)	0
SPR	0.30	PR	0.353
CWI	125.348	Runoff Volume (m³)	266

Node Basin Online Orifice Control

Flap Valve	x	Design Depth (m)	1.000	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Design Flow (l/s)	2.3		
Invert Level (m)	52.000	Diameter (m)	0.033		

Node Basin Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	10.0	Invert Level (m)	52.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1400.0	0.0	1.000	1826.2	0.0

Results for 2 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute winter	Basin	1440	52.494	0.494	24.0	743.0314	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
1440 minute winter	Basin	Orifice	1.6	105.3

Results for 30 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute winter	Basin	1440	52.838	0.838	41.7	1323.2760	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
1440 minute winter	Basin	Orifice	2.1	140.1

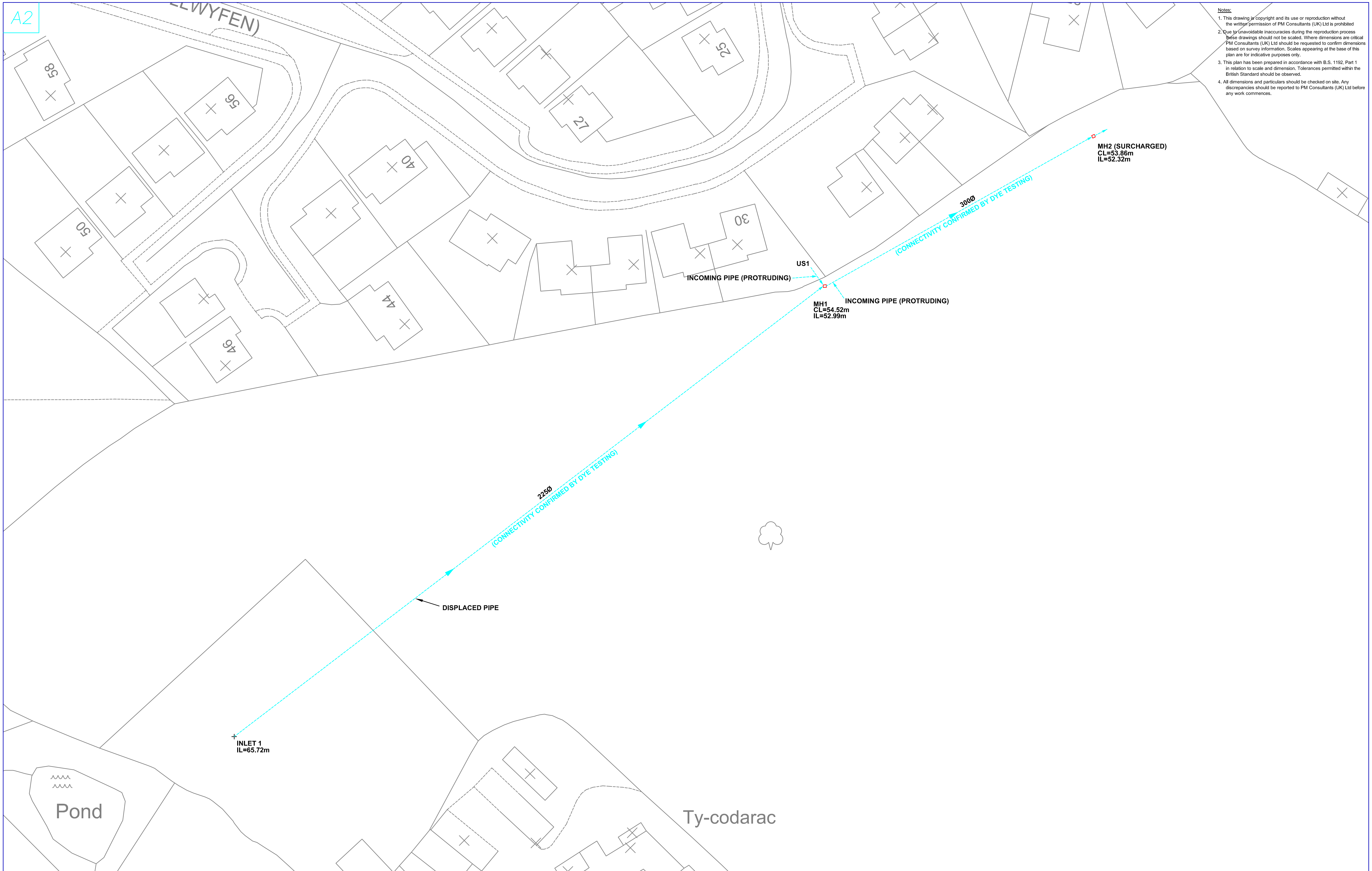
Results for 100 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute winter	Basin	1440	52.985	0.985	49.6	1586.0590	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
1440 minute winter	Basin	Orifice	2.2	152.8

Appendix D

Drainage Survey and Topographic Survey



Notes:

1. This drawing is copyright and its use or reproduction without the written permission of PM Consultants (UK) Ltd is prohibited
2. Due to unavoidable inaccuracies during the reproduction process these drawings should not be scaled. Where dimensions are critical PM Consultants (UK) Ltd should be requested to confirm dimensions based on survey information. Scales appearing at the base of this plan are for indicative purposes only.
3. This plan has been prepared in accordance with B.S. 1192, Part 1 in relation to scale and dimension. Tolerances permitted within the British Standard should be observed.
4. All dimensions and particulars should be checked on site. Any discrepancies should be reported to PM Consultants (UK) Ltd before any work commences.

NOTES:

LEVELS AND CO-ORDINATE GRID ARE RELATED TO GPS SURVEY DATUM DERIVED FROM ORDNANCE SURVEY DATUM VIA OSTN15

ALTHOUGH O.S. CO-ORDINATES ARE SHOWN ON THIS PLAN THE GRID IS TO BE TREATED AS ARBITRARY.

NO SCALE FACTOR HAS BEEN APPLIED TO THE SURVEY THEREFORE THE CO-ORDINATES SHOWN ARE NOT TRUE O.S. CO-ORDINATES.

ISSUE	REVISION	DATE

Job: DRAINAGE SURVEY
LLANELLEN COURT FARM
LLANELLEN

Scale:	Date:	Drawn By:	Checked By:	Job Ref.
1:500	24/11/23	EH	NM	LCF/BCP/001

Client: Buckle Chamberlain Partnership
Mill House, Llancayo Court
Llancayo, Usk
Monmouthshire, NP15 1HY

ISO 9001 REGISTERED FIRM

PM CONSULTANTS (UK) LTD
48 Park Avenue, Abergavenny
Monmouthshire, NP7 5SP
Web: pmconsultants.co.uk Tel: (01873) 850667
E-Mail: surveys@pmconsultants.co.uk

KEY

38.32	SPOT LEVEL	TS	TRAFFIC SIGNAL	G	GULLY	1.0BR	BRICK WALL
TAR	TARMAC	TSC	TRAFFIC SIGNAL CONTROLLER	WM	WATER METER	1.0BL	BLOCK WALL
GR	GRASS	IC	INSPECTION COVER	SV	SLUICE VALVE	1.0ST	STONE WALL
H/S	HARDSTANDING	MH	MANHOLE	ST	STOP TAP		HEDGEROW/TREE CANOPY
BL	BOLLARD	MH	MANHOLE	FH	FIRE HYDRANT	2.0 P+W	FENCE
BB	BELISHA BEACON	MP	MARKER POST	BT	BRITISH TELECOM	DK	DROPPED KERB
RS	ROAD SIGN	TP	TELEGRAPH POLE	CATV	CABLE TV		
SIGN	SIGN	LC	LIGHTING COLUMN	TV	CABLE TV		
NP	STREET NAMEPLATE			GV	GAS VALVE		

APPROX N

NOTES:

LEVELS ARE RELATED TO AN ARBITRARY DATUM

SITE GRID IS BASED ON ARBITRARY CO-ORDINATES

ISSUE	REVISION	DATE
A	Existing dwellings Oaklands & Ty Ceirios indicated by BCP	Nov'08
B	Overlay showing new access & gas main	Aug'18
C	Access Road As Built indicated by BCP	Sep'21

Job: TOPOGRAPHICAL SURVEY
LLANELLEN COURT FARM
LLANELLEN

Scale:	Date:	Drawn By:	Checked By:	Job Ref.
1:500	12/06/07	NM	SR	BC\LCF\001

Client: Buckle Chamberlain
Llancayo Court
Llancayo

constructionline
Chas Accredited

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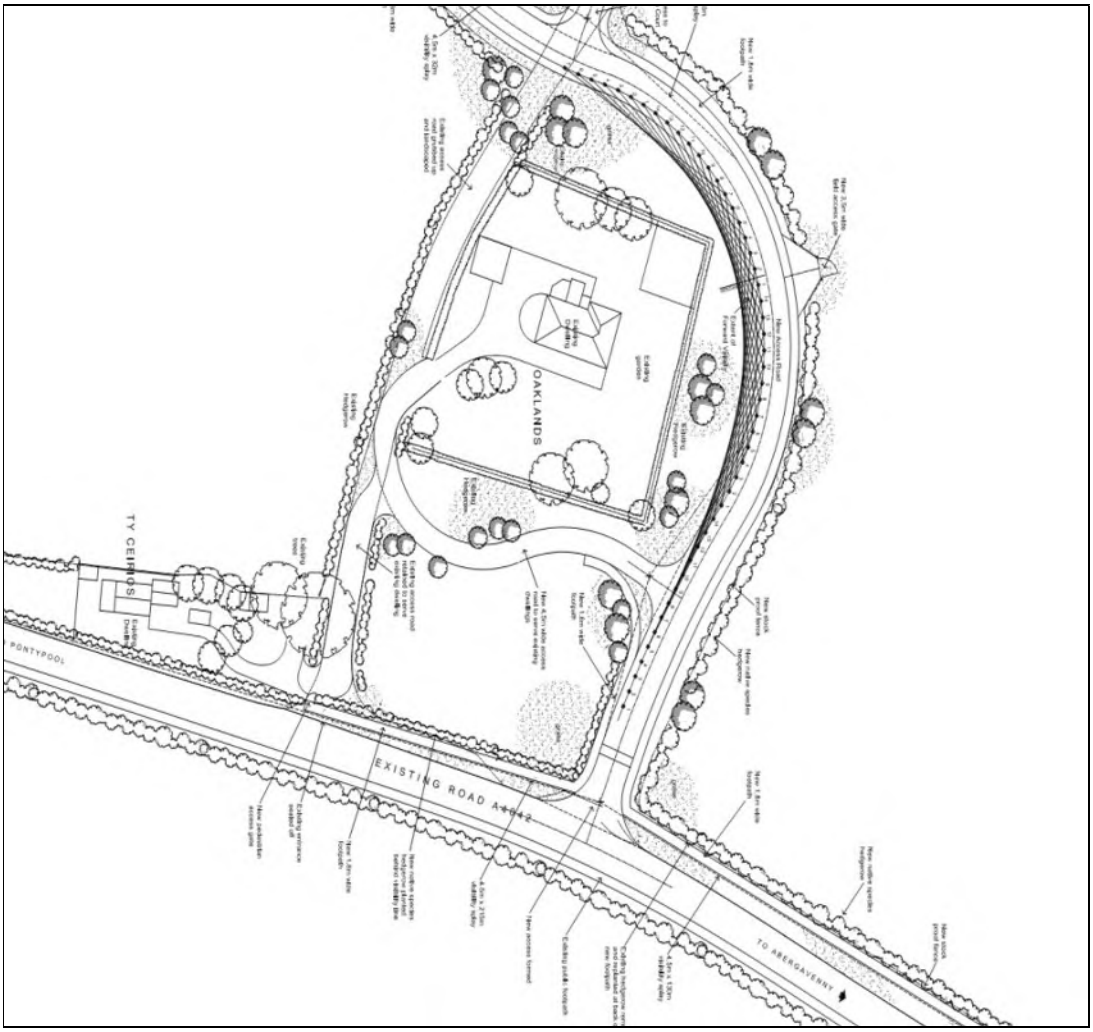
ISO 9001 : 2000 REGISTERED FIRM
Civil Engineering SURVEYORS

Appendix E

Llanellen Access Road Drainage Statement (2017)

Llanellen Court

Approved access road



Highway Drainage Statement

April 2017

Traffic and Transport Planning

Contents

Figures

Appendix

1 Introduction

1.1 The approved new access road to Llanellen Court is located on the west of Route A4042. Adjacent to the site the road has a west to east cross-fall away from the proposed access to a number of gullies which appear to drain into adjacent fields.

1.2 The junction of the access road with the trunk road will be located at the bellmouth of an existing field gate approximately 10 metres wide and 5 metre deep. It falls away from the road so surface run-off drains into the adjacent field.

1.3 10m south of the new access junction a lay-by extends for some 30m to the existing access to Llanellen Court which drains towards the trunk road. Neither the lay-by nor the existing access road has drainage gullies.

2 Works associated with new access

2.1 When the new access road has been constructed the lay-by will become a grass verge and there will be little or no run-off onto A.4042. The existing access to Llanellen Court adjacent to the lay-by will be closed off, grubbed up and seeded so there will be no run-off onto the trunk road.

2.2 A section of access road will be adopted by Welsh Government. The boundary between the public and private highways will be marked by the installation of gullies on both sides of the road which will drain into soakaway SA1 designed to BRE Digest 365 standards (Appendix A). From this point the road will continue to slope away from the trunk road until it reaches a low point some 10m from the adopted boundary. Gullies will be installed on both sides of the road draining into soakaway SA2 (Appendix A).

2.3 From this point gullies will be constructed on both sides of the road at appropriate intervals draining into soakaways SA3 and SA4 (Appendix A).

3 Soakaway Design

3.1 Soil infiltration tests were carried out in accordance with BRE Digest 365 Soakaway Design on April 4, 5 and 6 2017 and the weather was dry. Two trial pits were excavated to a depth of approximately 2.7m at the locations shown in Fig 1. The pits had vertical sides trimmed square and groundwater was absent. They were filled three times with water to the invert level using a water bowser. The time taken for the water level to drain from invert level to empty was observed and recorded. The infiltration rates calculated for TP1 and TP2 were 4.39×10^{-5} and 4.707×10^{-5} respectively (Appendix B)

3.3 The soakaway pit (SA1) that will serve the new junction will be 6.1x6.1x2.8 metres with a 1.2m diameter concrete chamber and the catch-pit (CP1) will be a 1.2m diameter concrete chamber (Appendix C).

3.4 The soakaway pit (SA2) serving the access road near the new junction will be

5.80x5.80x3.2 metres with a 1.2m concrete chamber and the catch-pit (CP2) will be similar to CP1.

3.5 The dimensions for each soakaway will be based on standard detail (Appendix E).

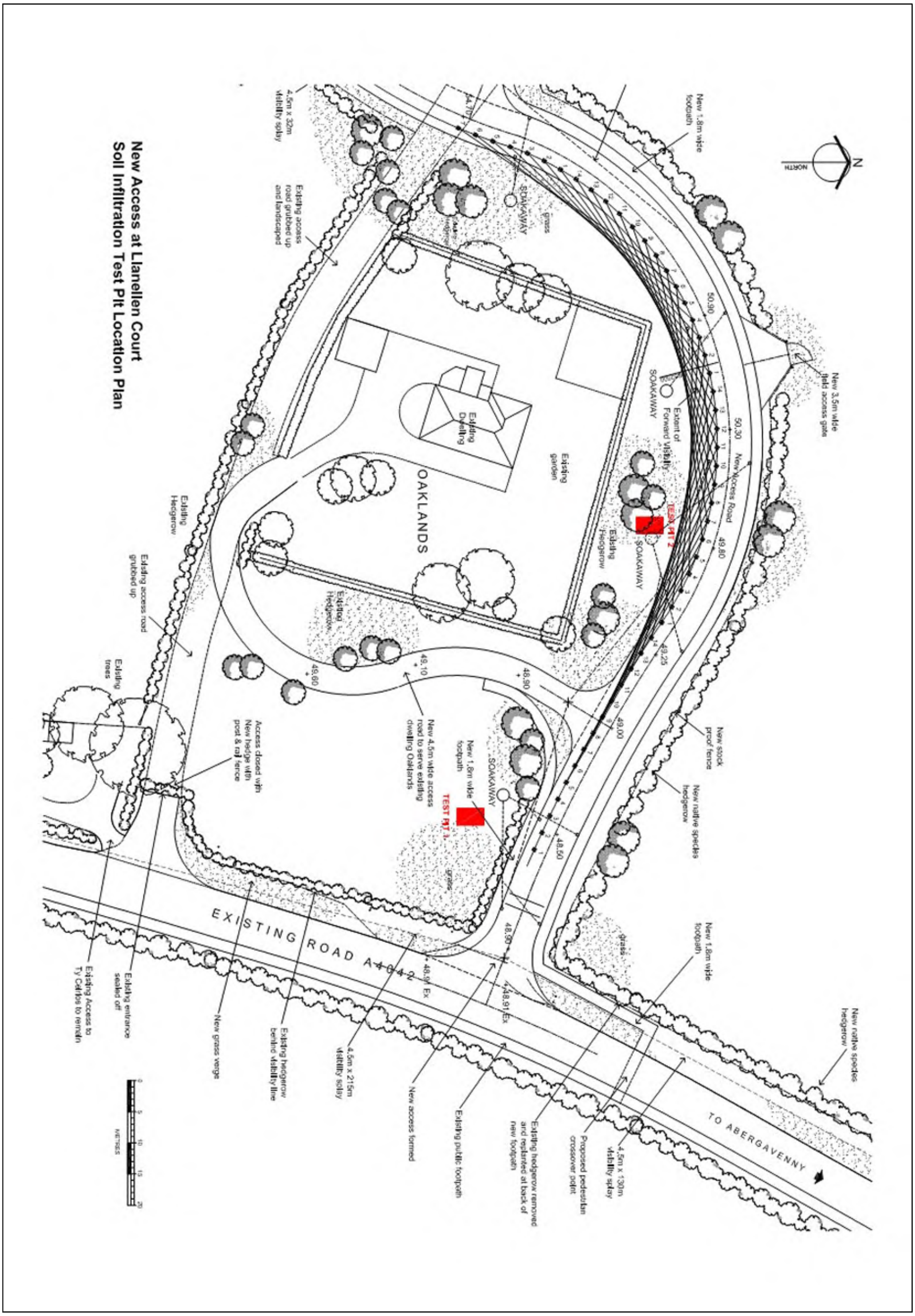
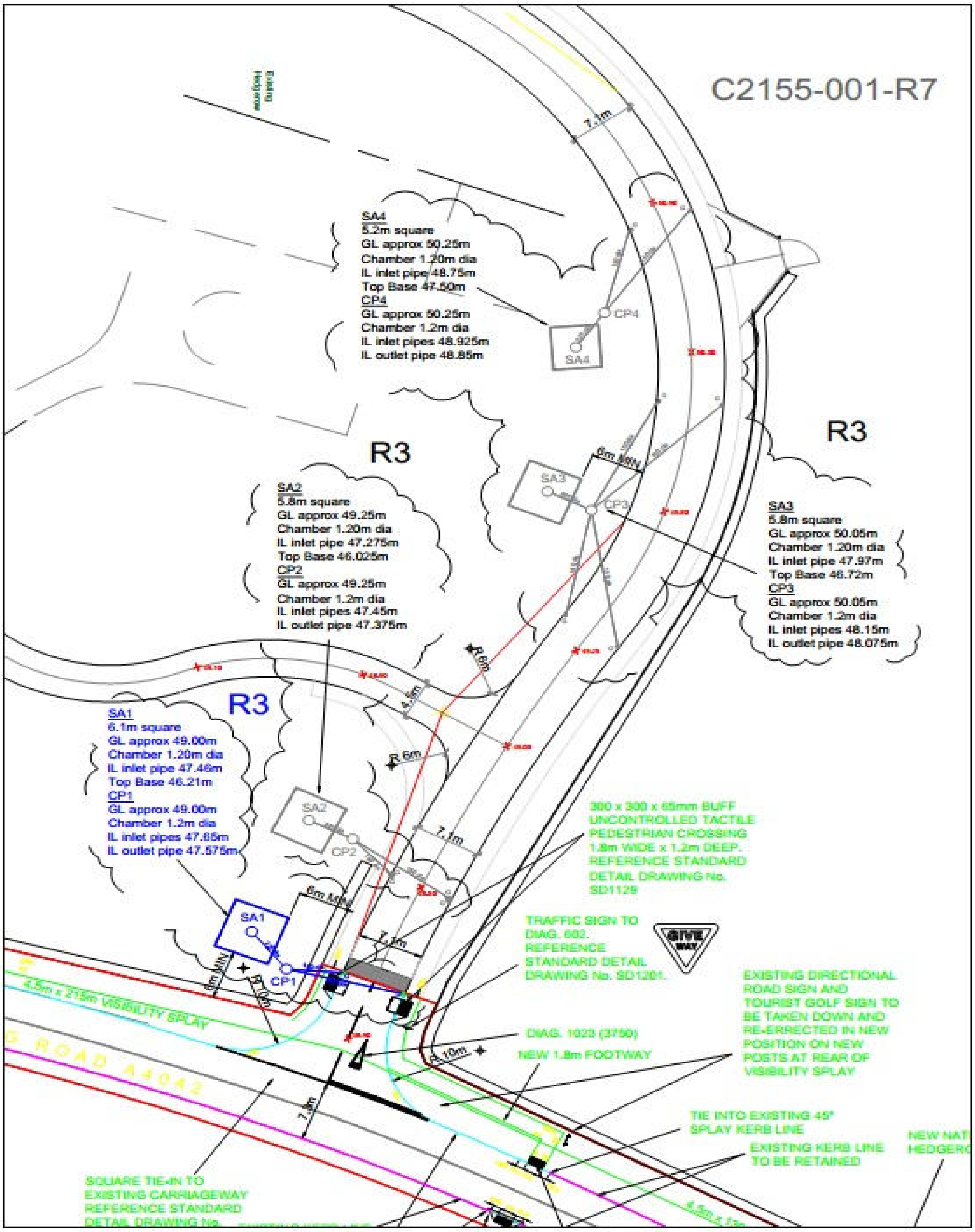

New Access at Llanellen Court
Soil Infiltration Test Pit Location Plan
OAKLANDS
EXISTING ROAD A4042
TO ABERGAVENNY
TEST PIT 1
TEST PIT 2
SOAKAWAY
New Access Road
Existing Dwelling
Existing garden
Existing Hedgerow
New 1.8m wide footpath
New 3.5m wide field access gate
New stock proof fence
New native species hedgerow
Existing public footpath
New access formed
New grass verge
Existing entrance sealed off
Existing Access to Ty Cafrib to remain
4.5m x 215m visibility splay
4.5m x 130m visibility splay
4.5m x 32m visibility splay
Proposed pedestrian crossover point
Existing access road grubbed up
Access closed with New hedge with post & rail fence
New 4.5m wide access road to serve existing dwelling Oaklands
METRES

Fig 1 Location of Trial Pits

Appendix A Location of Soakaways and Catch-pits



Appendix B Soil Infiltration Rates

Project	MORSPAN HOLDINGS LTD PROPOSED ACCESS ROAD AT LLANELLEN COURT, LLANELLEN ABERGAVENNY			TRAFFIC AND TRANSPORT PLANNING	
Element	DRAINAGE	Project No.	C2155	Sheet No. 1 of 12	Rev.
Ref.	Calculations			Output	

SOIL INFILTRATION RATE

Soil infiltration tests were carried out in accordance with BRE 365.
Two trial pits were dug at locations indicated on Fig 1. after trimming of the sides both TP1 & TP2 were:-
2.2m long × 1.3m wide × 2.7m deep (max)
Because the base of the trial pits could not be cleaned effectively an O/A depth of 2.6m was adopted.
The trial pits were filled 3 times and the time for the water to drain from the max effective depth (1.5m below GL) to empty was recorded,
ref:- site record sheets TP1 & TP2,
from these record sheets graphs were plotted for each set of results,
reference graphs TP1/1 to TP1/3 and TP2/1 to TP2/3.

From BRE 365

soil infiltration rate $f = \dfrac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

where V_{p75-25} = effective storage volume water between 75% & 25% effective depth — m^3

Calculations			Revision					
By	Date		By	Date	Checked	By	Date	Checked
DA	14/4/17							

Project	MORSPAN HOLDINGS LTD PROPOSED ACCESS ROAD AT LLANELLEN COURT, LLANELLEN ABERGAVENNY			TRAFFIC AND TRANSPORT PLANNING
Element	DRAINAGE	Project No.	C2155	Sheet No. 2 of 12 Rev.

Ref.	Calculations	Output
	BRE 365 cont'd	
	a_{p50} = internal surface area of trial pit upto 50% effective depth inc. base area	m^2
	t_{p75-25} = time for water to fall from 75% to 25% effective storage depth	sec.
	<u>CALCULATIONS</u>	
	IL of incoming pipe approx 1.5m below GL.	Max effective depth 1.5m
	common to both trial pits	
	Effective storage depth $= 2.6 - 1.5m = 1.1m$	Effective storage depth 1.1m
	Level @ 75% Full $= \frac{1.1}{4} + 1.5 = 1.775m$	75% Full = 1.775m
	Level @ 25% Full $= \left(\frac{1.1}{4} \times 3\right) + 1.5 = 2.325m$	25% Full = 2.325m
	$\therefore V_{p75-25} = 2.2 \times 1.3 \times (2.325 - 1.775) = 1.573\ m^3$	$V_{p75-25} = 1.573\ m^3$
	$\therefore a_p = (2.2 \times 0.55 \times 2) + (1.3 \times 0.55 \times 2) + (2.2 \times 1.3)$ $= 2.42 + 1.43 + 2.86 = 6.71\ m^2$	$a_p = 6.71\ m^2$
	<u>Graph TP1/1</u>	
	$t_{75-25} = 90 - 15 = 75\ min$	
	$\therefore f_{TP1/1} = \frac{1.573}{6.71 \times 75 \times 60} = 5.21 \times 10^{-5}$	$f_{TP1/1} = 5.21 \times 10^{-5}$

Calculations By	Date		Revision By	Date	Checked	By	Date	Checked
AB	14/4/17							

Project	MORSPAN HOLDINGS LTD PROPOSED ACCESS ROAD AT LLANELLEN COURT, LLANELLEN ABERGAVENNY			TRAFFIC AND TRANSPORT PLANNING	
Element	DRAINAGE	Project No.	C2155	Sheet No. 3 of 12	Rev.
Ref.	Calculations			Output	

CALCULATIONS cont'd

Graph TP1/2

$t_{75-25} = 118 - 31 = 87 \text{ min}$

$\therefore f_{TP1/2} = \dfrac{1.573}{6.71 \times 87 \times 60} = 4.49 \times 10^{-5}$ — $f_{TP1/2} = 4.49 \times 10^{-5}$

Graph TP1/3

$t_{75-25} = 111 - 22 = 89 \text{ min}$

$\therefore f_{TP1/3} = \dfrac{1.573}{6.71 \times 89 \times 60} = 4.39 \times 10^{-5}$ — $f_{TP1/3} = 4.39 \times 10^{-5}$

For TP1 use $f = 4.39 \times 10^{-5}$ — TP1 $f = 4.39 \times 10^{-5}$

Graph TP2/1

$t_{75-25} = 98 - 33 = 65 \text{ min}$

$\therefore f_{TP2/1} = \dfrac{1.573}{6.71 \times 65 \times 60} = 6.011 \times 10^{-5}$ — $f_{TP2/1} = 6.011 \times 10^{-5}$

Graph TP2/2

$t_{75-25} = 124 - 47 = 77 \text{ min}$

$\therefore f_{TP2/2} = \dfrac{1.573}{6.71 \times 77 \times 60} = 5.074 \times 10^{-5}$ — $f_{TP2/2} = 5.074 \times 10^{-5}$

Graph TP2/3

$t_{75-25} = 126 - 43 = 83 \text{ min}$

$\therefore f_{TP2/3} = \dfrac{1.573}{6.71 \times 83 \times 60} = 4.707 \times 10^{-5}$ — $f_{TP2/3} = 4.707 \times 10^{-5}$

For TP2 Use $f = 4.707 \times 10^{-5}$ — TP2 $f = 4.707 \times 10^{-5}$

Calculations		Revision					
By	Date	By	Date	Checked	By	Date	Checked
DA	14/4/17						

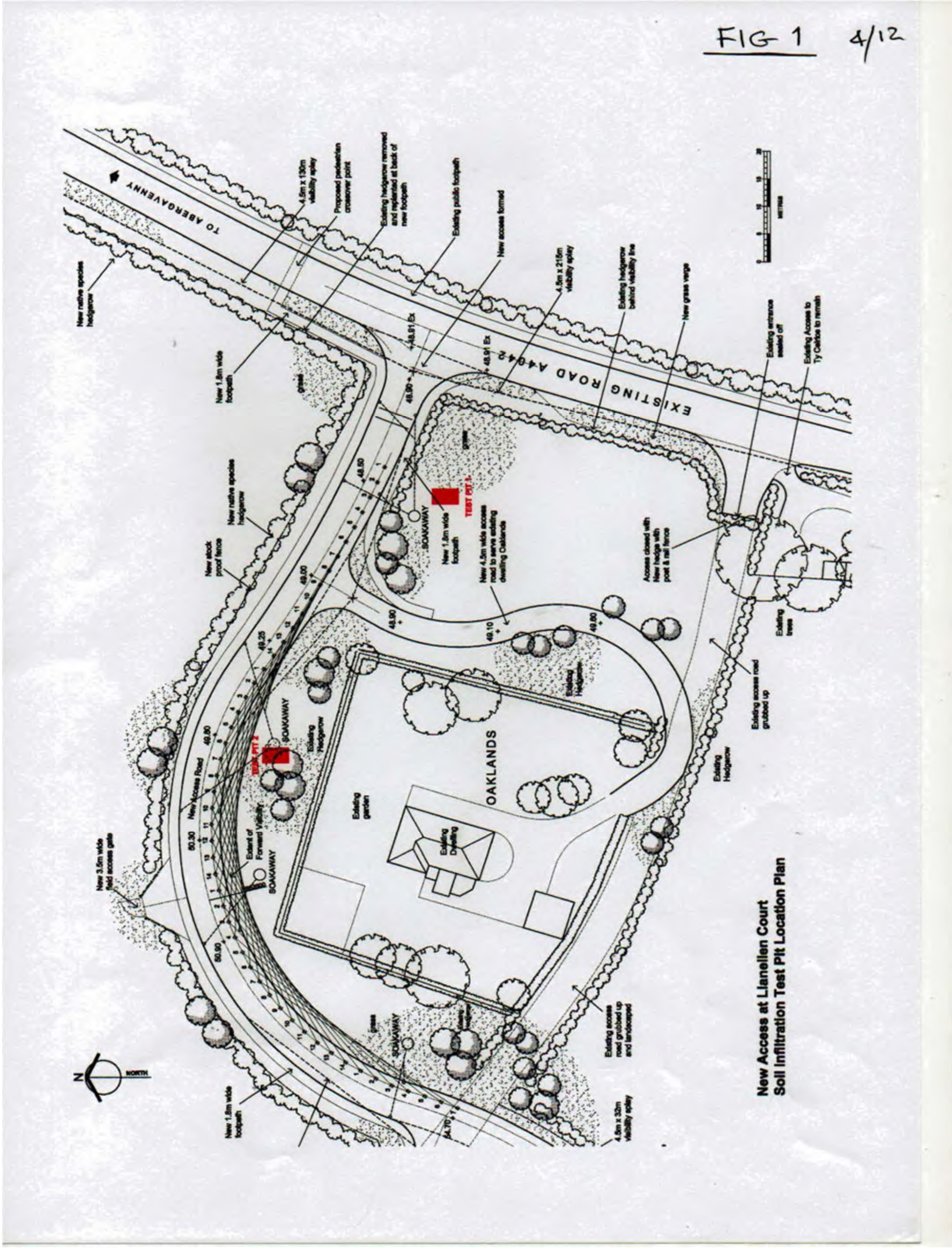
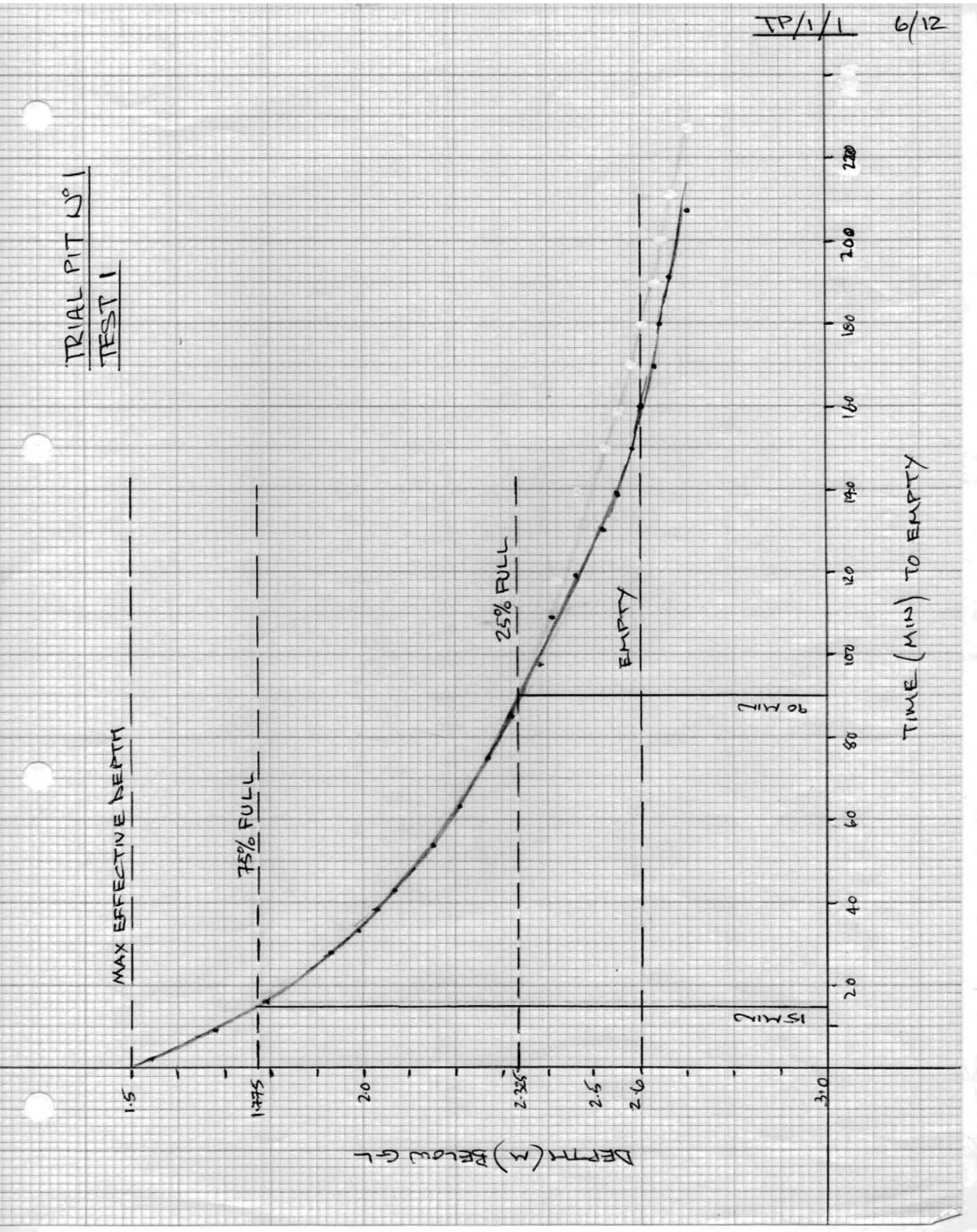


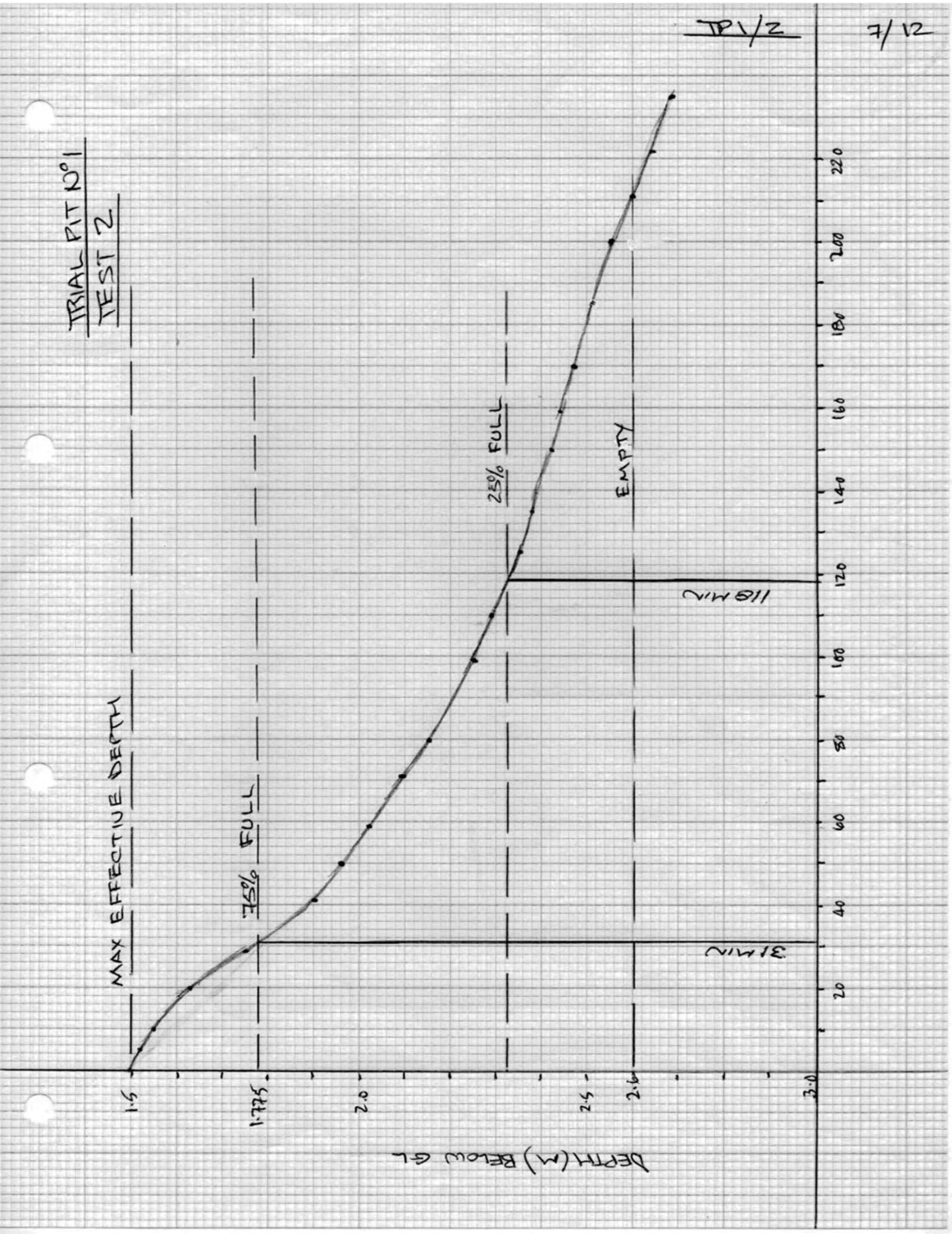
FIG 1 4/12
TO ABERGAVENNY
EXISTING ROAD A4042
OAKLANDS
TEST PIT 1
TEST PIT 2
SOAKAWAY
SOAKAWAY
SOAKAWAY
SOAKAWAY
NORTH
New Access at Llanellen Court
Soil Infiltration Test Pit Location Plan

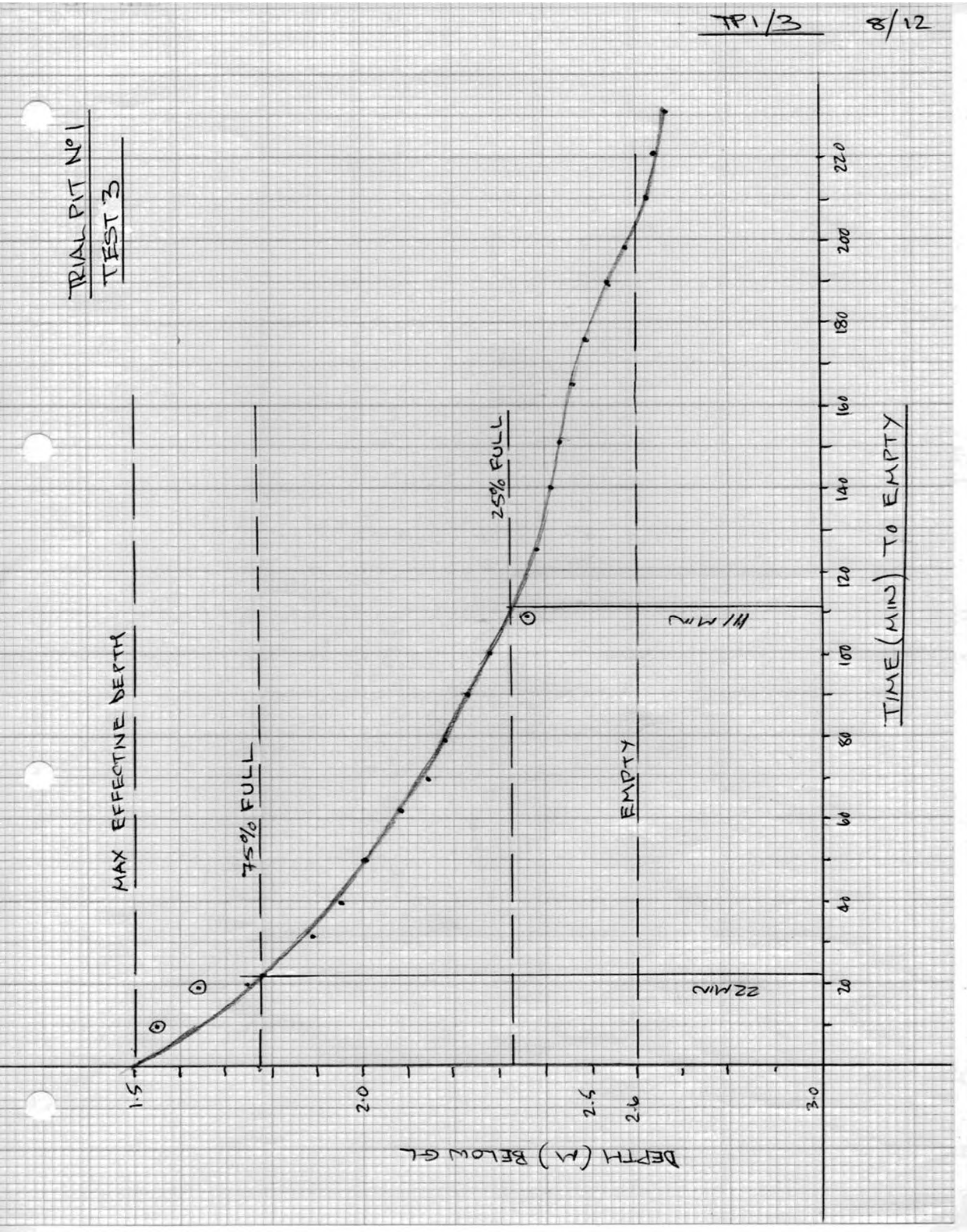
TP1 5/12

Hole 1

4/4/17 TP1/1			5/4/17 AM TP1/2			5/4/17 PM TP1/3		
Time	MIN	DROP	Time	MIN	DROP	Time	MIN	DROP
11.10		1.5	0810		1.50	1305		1.50
11.12	2	1.54	0815	5	1.52	1315	10	1.55
11.19	9	1.68	0820	10	1.55	1324	19	1.64
11.26	16	1.79	0830	20	1.63	1325	20	1.75
11.38	28	1.93	0839	29	1.75	1336	31	1.89
11.43	33	1.99	0851	41	1.90	1345		1.95
11.53	43	2.07	0900	50	1.96	1355	50	2.00
12.04	54	2.15	0909	59	2.02	1407	62	2.08
12.13	63	2.21	0921	71	2.09	1415	70	2.14
12.25	75	2.27	0930	80	2.15	1424	79	2.18
12.35	85	2.32	0949	99	2.25	1435	90	2.23
12.48	98	2.38	1000	110	2.29	1445	100	2.28
12.58	108	2.41	1015	125	2.35	1459	114	2.34
13.09	119	2.46	1025	135	2.38	1510	125	2.38
13.20	130	2.52	1040	150	2.42	1525	140	2.41
13.29	139	2.55	1049	159	2.44	1536	151	2.43
13.40	150	2.58	1100	170	2.47	15.50	165	2.46
13.50	160	2.60	1115	185	2.51	16.01	176	2.49
14.00	170	2.63	11.30	200	2.55	16.15	190	2.54
14.10	180	2.64	1141	211	2.60	16.28	198	2.58
14.21	191	2.66	1152	222	2.64	16.40	210	2.62
14.37	207	2.70	1205	235	2.68	16.51	124	2.64
			R			17.02	232	2.66


TP/1/1
6/12
TRIAL PIT No 1
TEST 1
MAX EFFECTIVE DEPTH
75% FULL
25% FULL
EMPTY
15 MIN
90 MIN
TIME (MIN) TO EMPTY
DEPTH (M) BELOW G.L
1.5
1.775
2.0
2.325
2.5
2.6
3.0
20
40
60
80
100
120
140
160
180
200
220

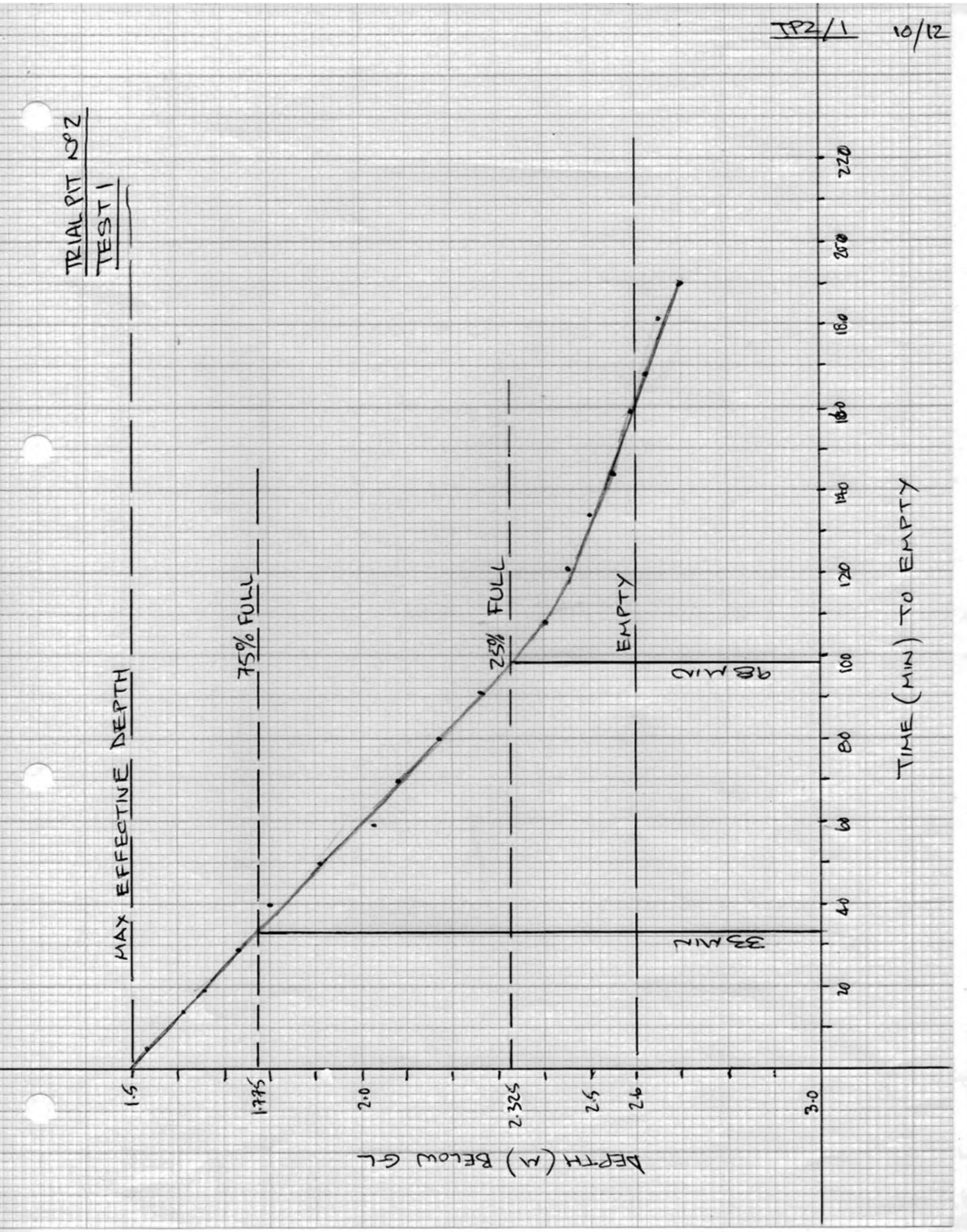

TP1/2
7/12
TRIAL PIT No 1
TEST 2
MAX EFFECTIVE DEPTH
75% FULL
25% FULL
EMPTY
31 MIN
118 MIN
DEPTH (M) BELOW GL
1.5
1.775
2.0
2.5
2.6
3.0
20
40
60
80
100
120
140
160
180
200
220

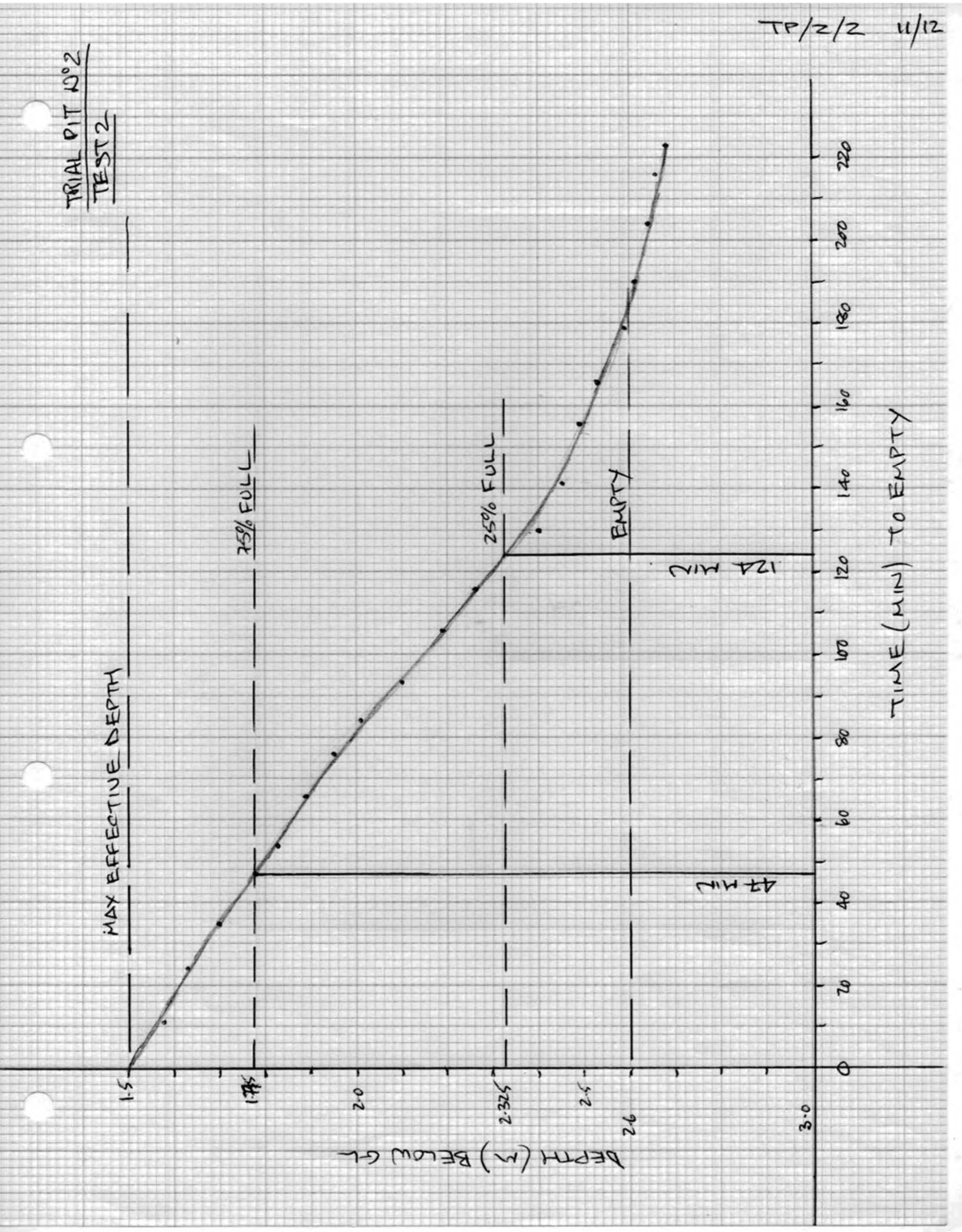

TP1/3
8/12
TRIAL PIT No 1
TEST 3
MAX EFFECTIVE DEPTH
75% FULL
25% FULL
EMPTY
22 MIN
111 MIN
TIME (MIN) TO EMPTY
DEPTH (M) BELOW GL
1.5
2.0
2.5
2.6
3.0
20
40
60
80
100
120
140
160
180
200
220

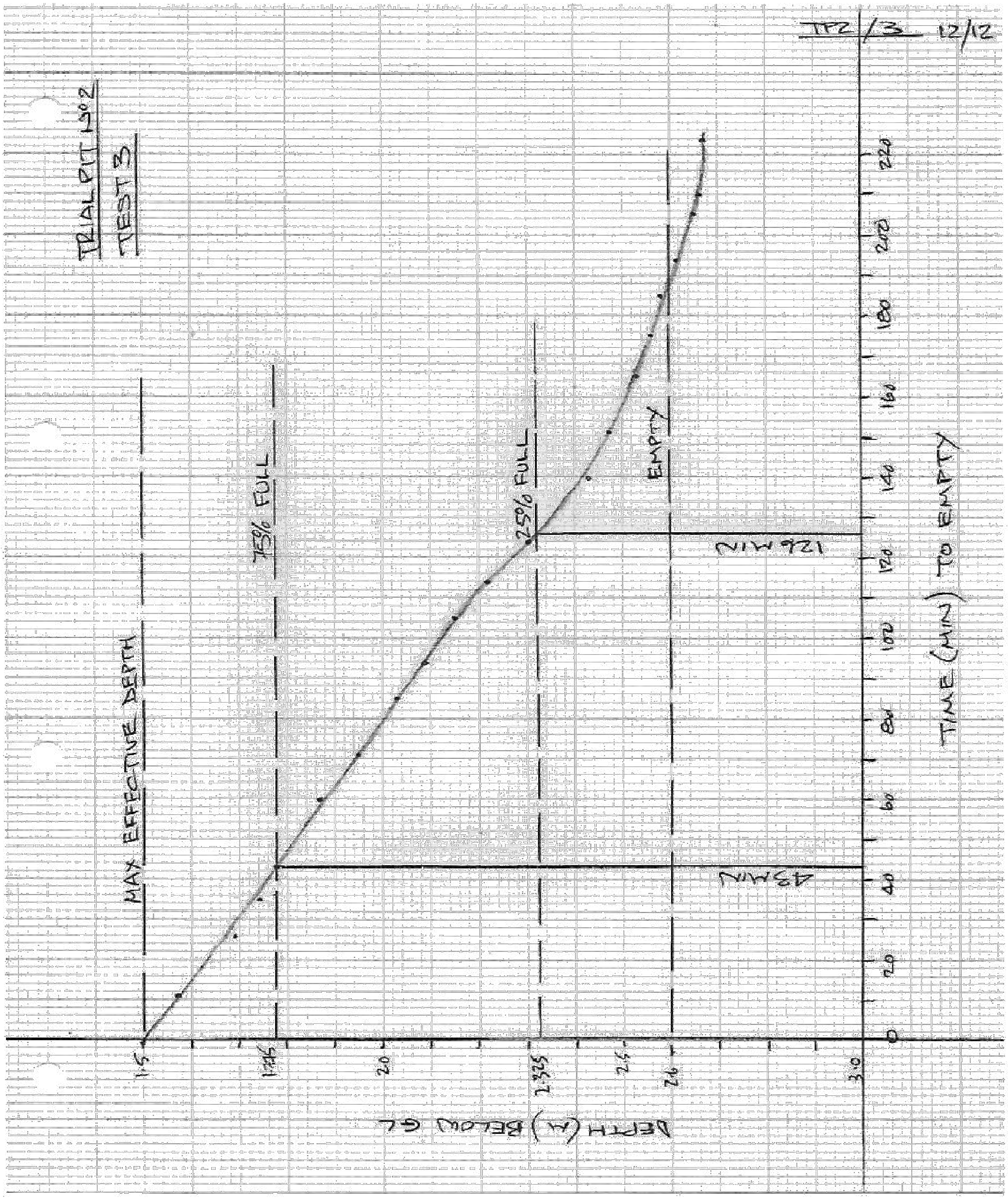
TP2 9/12

Hole 2

	5/4/17 AM TP2/1		5/4/17 pm TP2/2			6/4/17 AM TP2/3		
0800	MIN	1.50	1250	MIN	1.50	0820	MIN	1.50
0805	5	1.53	1301	11	1.58	0831	11	1.57
0814	14	1.61	1314	24	1.63	0846	26	1.69
0819	19	1.66	1325	35	1.70	0855	35	1.74
0829	29	1.73	1337	47	1.78	0903	43	1.78
0840	40	1.80	1344	54	1.83	0920	60	1.87
0850	50	1.91	1356	66	1.89	0931	71	1.95
0859	59	2.03	1406	76	1.95	0945	85	2.03
0910	70	2.08	1414	84	2.01	0954	94	2.09
0920	80	2.17	1423	93	2.10	1005	105	2.15
0931	91	2.26	1436	106	2.19	1014	114	2.22
0948	108	2.40	1446	116	2.26	1024	124	2.30
1001	121	2.45	1500	130	2.40	1040	140	2.43
1014	134	2.50	1511	141	2.45	1051	151	2.47
1024	144	2.55	1526	156	2.49	1105	165	2.53
1039	159	2.59	1536	166	2.53	1115	175	2.56
1048	168	2.62	1549	179	2.59	1125	185	2.58
1101	181	2.65	16.00	190	2.61	1134	194	2.61
1110	190	2.70	16.14	204	2.64	1145	205	2.63
			16.26	216	2.66	1156	216	2.65
			16.33	223	2.68	1200	220	2.66
						1204	224	2.67


TP2/1
10/12
TRIAL PIT No 2
TEST 1
MAX EFFECTIVE DEPTH
75% FULL
25% FULL
EMPTY
98 MIN
33 MIN
TIME (MIN) TO EMPTY
DEPTH (m) BELOW G.L
1.5
1.775
2.0
2.325
2.5
2.6
3.0
20
40
60
80
100
120
140
160
180
200
220


TP/2/2 11/12
TRIAL PIT No 2
TEST 2
MAX EFFECTIVE DEPTH
75% FULL
25% FULL
EMPTY
124 MIN
47 MIN
TIME (MIN) TO EMPTY
DEPTH (m) BELOW GL
0
20
40
60
80
100
120
140
160
180
200
220
1.5
1.75
2.0
2.325
2.5
2.6
3.0


TP2 / 3 12/12
TRIAL PIT No 2
TEST 3
MAX EFFECTIVE DEPTH
75% FULL
25% FULL
EMPTY
43MIN
126MIN
TIME (MIN) TO EMPTY
DEPTH (m) BELOW GL
1.5
1.745
2.0
2.325
2.5
2.6
3.0
0
20
40
60
80
100
120
140
160
180
200
220

Appendix C New Junction Soakaway and Catch-pit

Project	MORSPAN HOLDINGS LTD PROPOSED ACCESS ROAD AT LLANELLEN COURT, LLANELLEN ABERGAVENNY			TRAFFIC AND TRANSPORT PLANNING	
Element	SECTION 278 WORKS DRAINAGE	Project No.	C2155	Sheet No. 1 of 5	Rev.
Ref.	Calculations			Output	

SOAKAWAY DESIGN

Spreadsheet used in design based on BRE 365 method.

Ref. Test spread sheet based on design example page 7 (Sheet 5/5)

Soakaway SA1

Calculations	Output
Max. area of new junction draining to gullies located at extent of 278 works = 500 m² (Reference Fig 2)	Input to Spreadsheet A = 500 m²
Effective depth soakaway 1.1 m	d = 1.1 m
f = 4.39 × 10⁻⁵ (Trial Pit N° 1)	f = 4.39 × 10⁻⁵
Dia soakaway chamber 1200 mm dia	DI = 1.2 m
Wall thickness of chamber ring 70 mm	Twall = 0.07 m
r from 'The Wallingford Procedure Vol 3 Maps' Ratio of M5-60 min to M5-two day rainfalls = 0.25	r = 0.25
From input, results of spreadsheet indicate a critical size soakaway = 6.05 × 6.05 m and time to empty 50% = 3.06 hrs.	< 24 hrs BRE 365

Calculations By	Date	Revision By	Date	Checked	By	Date	Checked
[signature]	14/4/17						

Project	MORSPAN HOLDINGS LTD PROPOSED ACCESS ROAD AT LLANELLEN COURT, LLANELLEN ABERGAVENNY			TRAFFIC AND TRANSPORT PLANNING	
Element	SECTION 278 WORKS DRAINAGE	Project No.	C2155	Sheet No. 2 of 5	Rev.
Ref.	Calculations			Output	

Soakaway SA1 contd

Make soakaway pit 6.10 m sq.

chamber 1200 mm dia

GL Approx 49.00 m

IL Inlet pipe 47.46 m

Top Base 46.21 m.

Catch Pit CP1

chamber 1200 mm dia

GL Approx 49.00 m

IL Inlet pipe (150 dia) 47.65 m

IL Outlet pipe (225 dia) 47.575 m

SA1

Size 6.10 m sq.

1.2 m dia

GL 49.00

IL inlet 47.46 m

Top Base 46.21 m

CP1

1.2 m dia

GL 49.00 m

IL (150) 47.65 m

IL (225) 47.575 m

Calculations		Revision					
By	Date	By	Date	Checked	By	Date	Checked
[signature]	14/4/17						

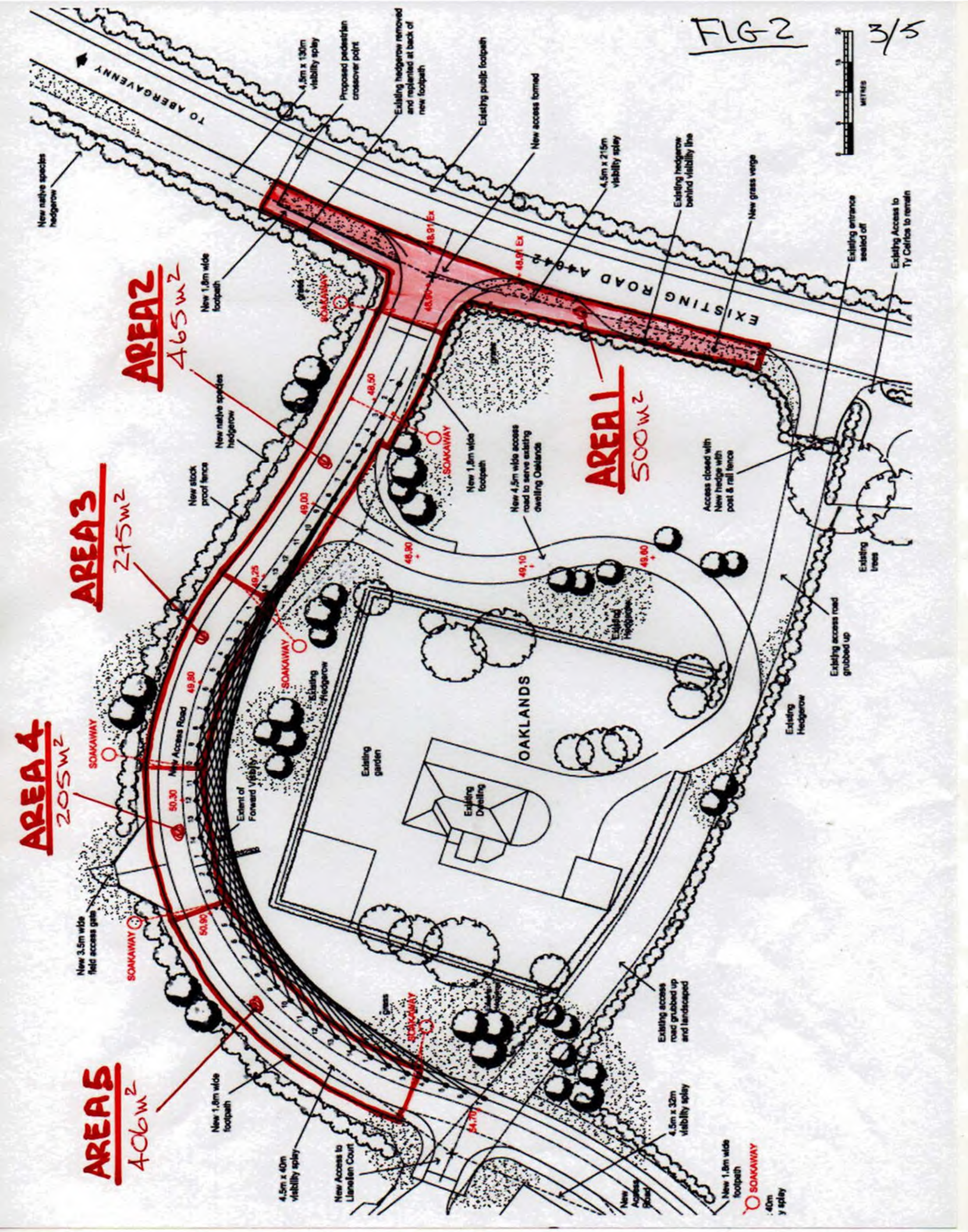


FIG 2
3/5
TO ABERGAVENNY
EXISTING ROAD A4042
AREA 1 500m²
AREA 2 465m²
AREA 3 275m²
AREA 4 205m²
AREA 5 406m²
OAKLANDS
SOAKAWAY
New native species hedgerow
4.5m x 130m visibility splay
Proposed pedestrian crossover point
Existing hedgerow removed and replanted at back of new footpath
Existing public footpath
New access formed
4.5m x 215m visibility splay
Existing hedgerow behind visibility line
New grass verge
Existing entrance sealed off
Existing Access to Ty Cerrlos to remain
New 1.8m wide footpath
New stock proof fence
New 4.5m wide access road to serve existing dwelling Oaklands
Access closed with New hedge with post & rail fence
Existing trees
Existing access road grubbed up
Existing Hedgerow
Existing garden
Existing Dwelling
Existing Hedgerow
New Access Road
Extent of Forward Visibility
New 3.5m wide field access gate
Existing access road grubbed up and landscaped
4.5m x 32m visibility splay
4.5m x 40m visibility splay
New Access to Llanellen Court
New Access Road
grass

4/5

Job No	C2155	Date	13/04/17
Project	Llanellen Court Access Road SOAKAWAY SA1	By	DA

SOAKAWAY DESIGN TO BRE 365

A	500	m2	Impermeable Surface Area of Catchment
f	4.39E-05	m/sec	Infiltration rate **f** of soil into which soakaway drains
d	1.1	m	Effective storage depth of soakaway
VR	0.3		Free volume (void) ratio of fill to pit around rings
Twall	0.07	m	Wall Thickness of rings
D1	1.2	m	Internal diameter of Ring 1
Vol R1	1.24		Storage capacity of ring 1 (= 3.142 * (D1*0.5)^2 * d m3)
Void R1	0.465		Equivalent volume of Ring 1 (incl wall) at void ratio of outer fill (= 3.142*(D1+Twall)^2*d*VR m3)
D2	0	m	Internal diameter of Ring 2
Vol R2	0.00		Storage capacity of ring 2 (= 3.142 * (D2*0.5)^2 * d m3)
Void R2	0.000		Equivalent volume of Ring 2 (incl wall) at void ratio of outer fill (= 3.142*(D2+Twall)^2*d*VR m3)
M5-60 min	20	mm	Base Rainfall
D			Storm duration (in minutes)
r	0.25		Rainfall ration (From BRE 365 Figure 1)
Z1			Factor from BRE 365 Table 1 based on M5-D and 'r' from Fig 1
M5-D			Total rainfall in design storm duration D for 5-year return period (=Z1*D mm)
Location			England and Wales
Z2			Factor from BRE 365 Table 2 based on M5-D
M10-D			Total rainfall in design storm duration D for 10 year return period (=M5-D*Z2 mm)
R			=M10-D
I			Total inflow to soakaway (=A*R/1000 m3)
L			Minimum length for side of square pit [= -O/L + (O/L^2+4*[Vol Pit/L2]*Y)^0.5 / (2 * [Vol Pit/L^2])]
A_{s50}			Internal surface area of soakaway to 50% effective depth; excl. base area
A_{s50} / L	2.20		
O			Outflow from soakaway (=A_{s50}*f*D m3)
Vol Pit			Effective storage volume of whole pit (ignoring the rings)
Vol Pit/L^2	0.33		
X	0.78		= (VolR1+VolR2)-(VoidR1+VoidR2)
Y			Inflow (I) minus value X

D minutes	Z1	M5-D mm	Inflow Z2	R=M10-D mm	I=A*R	O / L	Y	L (m)
5	0.33	6.60	1.19	7.85	3.93	0.0290	3.15	3.05
10	0.48	9.60	1.22	11.71	5.86	0.0579	5.08	3.84
15	0.58	11.60	1.24	14.38	7.19	0.0869	6.41	4.28
30	0.76	15.20	1.24	18.85	9.42	0.1738	8.65	4.86
60	1.00	20.00	1.24	24.80	12.40	0.3477	11.62	5.43
120	1.27	25.40	1.22	30.99	15.49	0.6954	14.72	5.71
240	1.64	32.80	1.19	39.03	19.52	1.3908	18.74	5.72
260	1.88	37.60	1.17	43.99	22.00	1.5066	21.22	6.05
600	2.24	44.80	1.14	51.07	25.54	3.4769	24.76	4.87
1440	3.10	62.00	1.13	70.06	35.03	8.3445	34.25	3.59

For square pit:

Critical Length L = 6.05 m

Time to Empty 50% = 3.06 hrs

Consider rectangular alternative:

Perimeter P = 4*L = 2*A + 2*B

Adopt A =	6.05	1.20	3.00	m
Then B =	6.05	10.91	9.11	m

SA 1.xls - 14/04/17

Test 5/5 Spreadsheet

Job No	Test	Date	06/01/09
Project	Based on BRE Digest 365 Worked Example page 7	By	DA

SOAKAWAY DESIGN TO BRE 365

A	95	m2	Impermeable Surface Area of Catchment
f	3.30E-05	m/sec	Infiltration rate f of soil into which soakaway drains
d	1.5	m	Effective storage depth of soakaway
VR	0.3		Free volume (void) ratio of fill to pit around rings
Twall	0.07	m	Wall Thickness of rings
D1	0.9	m	Internal diameter of Ring 1
Vol R1	0.95		Storage capacity of ring 1 (= 3.142 * (D1*0.5)^2 * d m3)
Void R1	0.382		Equivalent volume of Ring 1 (incl wall) at void ratio of outer fill (= 3.142*(D1+Twall)^2*d*VR m3)
D2	0	m	Internal diameter of Ring 2
Vol R2	0.00		Storage capacity of ring 2 (= 3.142 * (D2*0.5)^2 * d m3)
Void R2	0.000		Equivalent volume of Ring 2 (incl wall) at void ratio of outer fill (= 3.142*(D2+Twall)^2*d*VR m3)
M5-60 min	20	mm	Base Rainfall
D			Storm duration (in minutes)
r	0.35		Rainfall ration (From BRE 365 Figure 1)
Z1			Factor from BRE 365 Table 1 based on M5-D and 'r' from Fig 1
M5-D			Total rainfall in design storm duration D for 5-year return period (=Z1*D mm)
Location			England and Wales
Z2			Factor from BRE 365 Table 2 based on M5-D
M10-D			Total rainfall in design storm duration D for 10 year return period (=M5-D*Z2 mm)
R			=M10-D
I			Total inflow to soakaway (=A*R/1000 m3)
L			Minimum length for side of square pit [= -O/L + (O/L^2+4*[Vol Pit/L2]*Y)^0.5 / (2 * [Vol Pit/L^2])]
A_{s50}			Internal surface area of soakaway to 50% effective depth; excl. base area
A_{s50} / L	3.00		
O			Outflow from soakaway (=A_{s50}*f*D m3)
Vol Pit			Effective storage volume of whole pit (ignoring the rings)
Vol Pit/L^2	0.45		
X	0.57		= (VolR1+VolR2)-(VoidR1+VoidR2)
Y			Inflow (I) minus value X

D minutes	Z1	Inflow M5-D mm	Z2	R=M10-D mm	I=A*R	O / L	Y	L (m)
5	0.34	6.80	1.19	8.09	0.77	0.0297	0.20	0.63
10	0.49	9.80	1.22	11.96	1.14	0.0594	0.56	1.06
15	0.59	11.80	1.24	14.63	1.39	0.0891	0.82	1.25
30	0.77	15.40	1.24	19.10	1.81	0.1782	1.24	1.48
60	1.00	20.00	1.24	24.80	2.36	0.3564	1.78	1.63
120	1.25	25.00	1.22	30.50	2.90	0.7128	2.33	1.62
240	1.57	31.40	1.19	37.37	3.55	1.4256	2.98	1.44
260	1.78	35.60	1.17	41.65	3.96	1.5444	3.38	1.52
600	2.12	42.40	1.14	48.34	4.59	3.5640	4.02	1.00
1440	2.84	56.80	1.13	64.18	6.10	8.5536	5.53	0.63

For square pit:

Critical Length L = 1.63 m

Time to Empty 50% = 1.52 hrs

Consider rectangular alternative:

Perimeter P = 4*L = 2*A + 2*B

Adopt A =	1.63	0.90	8.00 m
Then B =	1.63	2.37	-4.73 m

Soakaway design 2.xls - 15/04/17

Appendix D Access Road Soakaways and Catch-pits

Project	MORSPAN HOLDINGS LTD PROPOSED ACCESS ROAD AT LLANELLEN COURT, LLANELLEN ABERGAVENNY			TRAFFIC AND TRANSPORT PLANNING	
Element	PROPOSED ACCESS ROAD DRAINAGE	Project No.	C2155	Sheet No. 1 of 8	Rev.
Ref.	Calculations			Output	

SOAKAWAY DESIGN

Spreadsheet used in design based on BRE 365 method.

Ref. Test spreadsheet based on design example page 7 (sheet 8/8)

Calculations	Output
Soakaway SA2	Input to Spreadsheet
Area drained = 465 m² (Ref Fig 2)	A = 465 m²
Effective depth soakaway 1.1 m	d = 1.1 m
f = 4.39 × 10⁻⁵ (Trial Pit No 1)	f = 4.39×10⁻⁵
Dia soakaway chamber 1200 mm dia	DI = 1.2 m
Wall thickness 70 mm	Twall = 0.07 m
r = 0.25	r = 0.25
From input, results of spreadsheet indicate a critical size soakaway = 5.77 × 5.77 m	
and time to empty 50% = 2.93 hrs	< 24 hrs BRE 365
Make soakaway pit 5.80 m sq.	Size 5.8 m sq
GL Approx 49.25 m	GL = 49.25 m
Inlet IL 47.275 m	Inlet 47.275 m
Top Base 46.025 m	Top Base 46.025 m
Chamber dia 1200 mm	Dia 1.2 m

Calculations		Revision					
By	Date	By	Date	Checked	By	Date	Checked
DA	15/4/17						

Project	MORSPAN HOLDINGS LTD PROPOSED ACCESS ROAD AT LLANELLEN COURT, LLANELLEN ABERGAVENNY			TRAFFIC AND TRANSPORT PLANNING	
Element	PROPOSED ACCESS ROAD DRAINAGE	Project No.	C2155	Sheet No. 2 of 8	Rev.

Ref.	Calculations	Output
	Soakaway SA3	Input to Spreadsheet
	Area draining = Area 3 + Area 4	
	(Ref Fig 2) = 275 + 205 = 480m²	A = 480 m²
	Effective depth soakaway 1.1m	d = 1.1m
	f = 4.707 × 10⁻⁵ (Trial Pit No 2)	f = 4.707×10⁻⁵
	Chamber dia 1200 mm	DI = 1.2m
	Wall thickness 70 mm	Twall = 0.07m
	r = 0.25	r = 0.25
	From results of spreadsheet critical size soakaway = 5.78m	
	Time to empty 50% = 2.74 hrs	< 24hrs BRE365
	Make soakaway 5.80 m sq.	Size 5.8msq
	GL Approx 50.05m	GL 50.05m
	Inlet IL 47.97 m	Inlet 47.97
	Top Base 46.72 m	T/Base 46.72m
	chamber dia 1200 mm	dia 1.20m
	Soakaway SA4	Input
	Area 5 draining = 406m²	A = 406m²
	remainder of input to spreadsheet same as for SA3	
	From results of spreadsheet critical size soakaway = 5.15m sq.	
	Time to empty 50% = 2.48hrs	< 24hrs BRE365

Calculations		Revision					
By	Date	By	Date	Checked	By	Date	Checked
DA	13/4/17						

Project	MORSPAN HOLDINGS LTD PROPOSED ACCESS ROAD AT LLANELLEN COURT, LLANELLEN ABERGAVENNY			**TRAFFIC AND TRANSPORT PLANNING**	
Element	PROPOSED ACCESS ROAD DRAINAGE	Project No.	C2155	Sheet No. 3 of 8	Rev.
Ref.	Calculations			Output	

Soakaway SA4 contd

Make soakaway 5.20 m sq. — Size 5.20 m sq

GL Approx 50.25 m — GL = 50.25 m

Inlet IL 48.75 m — Inlet 48.75 m

Top Base 47.50 m — Top base 47.50 m

Chamber dia 1200 mm — Dia 1.2 m

Calculations		Revision					
By	Date	By	Date	Checked	By	Date	Checked
DB	15/4/17						

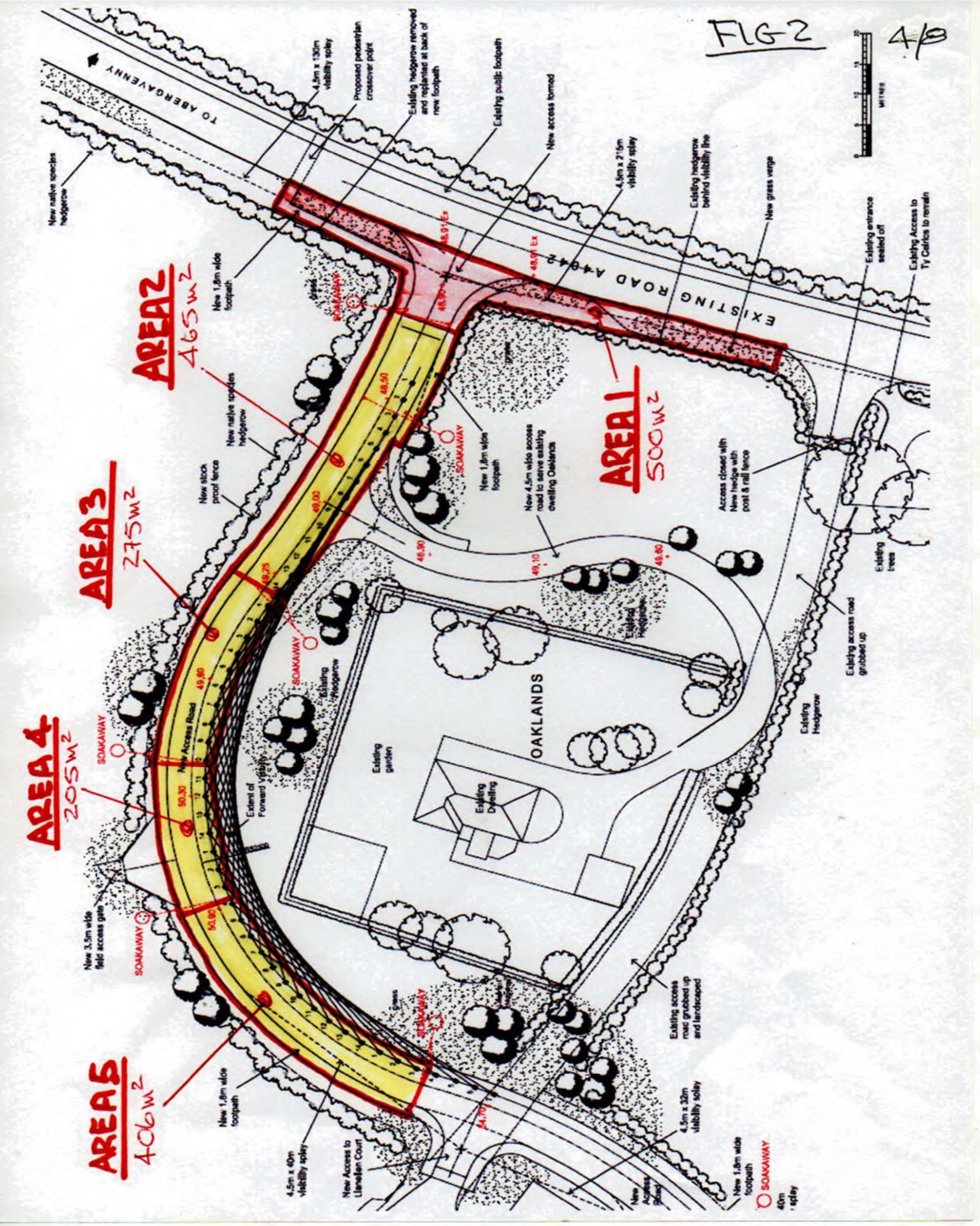


FIG 2
AREA 1
500m²
AREA 2
465m²
AREA 3
275m²
AREA 4
205m²
AREA 5
406m²
TO ABERGAVENNY
EXISTING ROAD A4042
OAKLANDS
New Access Road
SOAKAWAY
Existing Dwelling
Existing garden

5/8

Job No	C2155		Date	13/04/17
Project	Llanellen Court Access Road	SOAKAWAY SA2	By	DA

SOAKAWAY DESIGN TO BRE 365

A	465	m2	Impermeable Surface Area of Catchment
f	4.39E-05	m/sec	Infiltration rate **f** of soil into which soakaway drains
d	1.1	m	Effective storage depth of soakaway
VR	0.3		Free volume (void) ratio of fill to pit around rings
Twall	0.07	m	Wall Thickness of rings
D1	1.2	m	Internal diameter of Ring 1
Vol R1	1.24		Storage capacity of ring 1 (= 3.142 * (D1*0.5)^2 * d m3)
Void R1	0.465		Equivalent volume of Ring 1 (incl wall) at void ratio of outer fill (= 3.142*(D1+Twall)^2*d*VR m3)
D2	0	m	Internal diameter of Ring 2
Vol R2	0.00		Storage capacity of ring 2 (= 3.142 * (D2*0.5)^2 * d m3)
Void R2	0.000		Equivalent volume of Ring 2 (incl wall) at void ratio of outer fill (= 3.142*(D2+Twall)^2*d*VR m3)
M5-60 min	20	mm	Base Rainfall
D			Storm duration (in minutes)
r	0.25		Rainfall ration (From BRE 365 Figure 1)
Z1			Factor from BRE 365 Table 1 based on M5-D and 'r' from Fig 1
M5-D			Total rainfall in design storm duration D for 5-year return period (=Z1*D mm)
Location			England and Wales
Z2			Factor from BRE 365 Table 2 based on M5-D
M10-D			Total rainfall in design storm duration D for 10 year return period (=M5-D*Z2 mm)
R			=M10-D
I			Total inflow to soakaway (=A*R/1000 m3)
L			Minimum length for side of square pit [= -O/L + (O/L^2+4*[Vol Pit/L2]*Y)^0.5 / (2 * [Vol Pit/L^2])]
A_{s50}			Internal surface area of soakaway to 50% effective depth; excl. base area
A_{s50} / L	2.20		
O			Outflow from soakaway (=A_{s50}*f*D m3)
Vol Pit			Effective storage volume of whole pit (ignoring the rings)
Vol Pit/L^2	0.33		
X	0.78		= (VolR1+VolR2)-(VoidR1+VoidR2)
Y			Inflow (I) minus value X

D minutes	Z1	M5-D mm	Inflow Z2	R=M10-D mm	I=A*R	O / L	Y	L (m)
5	0.33	6.60	1.19	7.85	3.65	0.0290	2.87	2.91
10	0.48	9.60	1.22	11.71	5.45	0.0579	4.67	3.67
15	0.58	11.60	1.24	14.38	6.69	0.0869	5.91	4.10
30	0.76	15.20	1.24	18.85	8.76	0.1738	7.99	4.66
60	1.00	20.00	1.24	24.80	11.53	0.3477	10.75	5.21
120	1.27	25.40	1.22	30.99	14.41	0.6954	13.63	5.46
240	1.64	32.80	1.19	39.03	18.15	1.3908	17.37	5.45
260	1.88	37.60	1.17	43.99	20.46	1.5066	19.68	5.77
600	2.24	44.80	1.14	51.07	23.75	3.4769	22.97	4.60
1440	3.10	62.00	1.13	70.06	32.58	8.3445	31.80	3.36

For square pit:

Critical Length L = 5.77 m
Time to Empty 50% = 2.93 hrs

Consider rectangular alternative:

Perimeter P = 4*L = 2*A + 2*B

Adopt A =	5.77	1.20	3.00	m
Then B =	5.77	10.34	8.54	m

SA 2.xls - 14/04/17

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Job No	C2155	Date	13/04/17
Project	Llanellen Court Access Road SOAKAWAY SA3	By	DA

SOAKAWAY DESIGN TO BRE 365

A	480	m2	Impermeable Surface Area of Catchment
f	4.71E-05	m/sec	Infiltration rate **f** of soil into which soakaway drains
d	1.1	m	Effective storage depth of soakaway
VR	0.3		Free volume (void) ratio of fill to pit around rings
Twall	0.07	m	Wall Thickness of rings
D1	1.2	m	Internal diameter of Ring 1
Vol R1	1.24		Storage capacity of ring 1 (= 3.142 * (D1*0.5)^2 * d m3)
Void R1	0.465		Equivalent volume of Ring 1 (incl wall) at void ratio of outer fill (= 3.142*(D1+Twall)^2*d*VR m3)
D2	0	m	Internal diameter of Ring 2
Vol R2	0.00		Storage capacity of ring 2 (= 3.142 * (D2*0.5)^2 * d m3)
Void R2	0.000		Equivalent volume of Ring 2 (incl wall) at void ratio of outer fill (= 3.142*(D2+Twall)^2*d*VR m3)
M5-60 min	20	mm	Base Rainfall
D			Storm duration (in minutes)
r	0.25		Rainfall ration (From BRE 365 Figure 1)
Z1			Factor from BRE 365 Table 1 based on M5-D and 'r' from Fig 1
M5-D			Total rainfall in design storm duration D for 5-year return period (=Z1*D mm)
Location			England and Wales
Z2			Factor from BRE 365 Table 2 based on M5-D
M10-D			Total rainfall in design storm duration D for 10 year return period (=M5-D*Z2 mm)
R			=M10-D
I			Total inflow to soakaway (=A*R/1000 m3)
L			Minimum length for side of square pit [= -O/L + (O/L^2+4*[Vol Pit/L2]*Y)^0.5 / (2 * [Vol Pit/L^2])]
A_{s50}			Internal surface area of soakaway to 50% effective depth; excl. base area
A_{s50} / L	2.20		
O			Outflow from soakaway (=A_{s50}*f*D m3)
Vol Pit			Effective storage volume of whole pit (ignoring the rings)
Vol Pit/L^2	0.33		
X	0.78		= (VolR1+VolR2)-(VoidR1+VoidR2)
Y			Inflow (I) minus value X

D minutes	Z1	M5-D mm	Inflow Z2	R=M10-D mm	I=A*R	O / L	Y	L (m)
5	0.33	6.60	1.19	7.85	3.77	0.0311	2.99	2.96
10	0.48	9.60	1.22	11.71	5.62	0.0621	4.84	3.74
15	0.58	11.60	1.24	14.38	6.90	0.0932	6.13	4.17
30	0.76	15.20	1.24	18.85	9.05	0.1864	8.27	4.73
60	1.00	20.00	1.24	24.80	11.90	0.3728	11.13	5.27
120	1.27	25.40	1.22	30.99	14.87	0.7456	14.10	5.50
240	1.64	32.80	1.19	39.03	18.74	1.4912	17.96	5.46
260	1.88	37.60	1.17	43.99	21.12	1.6154	20.34	5.78
600	2.24	44.80	1.14	51.07	24.51	3.7279	23.74	4.54
1440	3.10	62.00	1.13	70.06	33.63	8.9471	32.85	3.28

For square pit:

Critical Length L = 5.78 m

Time to Empty 50% = 2.74 hrs

Consider rectangular alternative:

Perimeter P = 4*L = 2*A + 2*B

Adopt A =	5.78	1.20	3.00	m
Then B =	5.78	10.35	8.55	m

SA 3.xls - 14/04/17

7/8

Job No	C2155	Date	13/04/17
Project	Llanellen Court Access Road SOAKAWAY SA4	By	DA

SOAKAWAY DESIGN TO BRE 365

A	406	m2	Impermeable Surface Area of Catchment
f	4.71E-05	m/sec	Infiltration rate f of soil into which soakaway drains
d	1.1	m	Effective storage depth of soakaway
VR	0.3		Free volume (void) ratio of fill to pit around rings
Twall	0.07	m	Wall Thickness of rings
D1	1.2	m	Internal diameter of Ring 1
Vol R1	1.24		Storage capacity of ring 1 (= 3.142 * (D1*0.5)^2 * d m3)
Void R1	0.465		Equivalent volume of Ring 1 (incl wall) at void ratio of outer fill (= 3.142*(D1+Twall)^2*d*VR m3)
D2	0	m	Internal diameter of Ring 2
Vol R2	0.00		Storage capacity of ring 2 (= 3.142 * (D2*0.5)^2 * d m3)
Void R2	0.000		Equivalent volume of Ring 2 (incl wall) at void ratio of outer fill (= 3.142*(D2+Twall)^2*d*VR m3)
M5-60 min	20	mm	Base Rainfall
D			Storm duration (in minutes)
r	0.25		Rainfall ration (From BRE 365 Figure 1)
Z1			Factor from BRE 365 Table 1 based on M5-D and 'r' from Fig 1
M5-D			Total rainfall in design storm duration D for 5-year return period (=Z1*D mm)
Location			England and Wales
Z2			Factor from BRE 365 Table 2 based on M5-D
M10-D			Total rainfall in design storm duration D for 10 year return period (=M5-D*Z2 mm)
R			=M10-D
I			Total inflow to soakaway (=A*R/1000 m3)
L			Minimum length for side of square pit [= -O/L + (O/L^2+4*[Vol Pit/L2]*Y)^0.5 / (2 * [Vol Pit/L²])]
A_{s50}			Internal surface area of soakaway to 50% effective depth; excl. base area
A_{s50} / L	2.20		
O			Outflow from soakaway (=A_{s50}*f*D m3)
Vol Pit			Effective storage volume of whole pit (ignoring the rings)
Vol Pit/L²	0.33		
X	0.78		= (VolR1+VolR2)-(VoidR1+VoidR2)
Y			Inflow (I) minus value X

D minutes	Z1	M5-D mm	Inflow Z2	R=M10-D mm	I=A*R	O / L	Y	L (m)
5	0.33	6.60	1.19	7.85	3.19	0.0311	2.41	2.66
10	0.48	9.60	1.22	11.71	4.76	0.0621	3.98	3.38
15	0.58	11.60	1.24	14.38	5.84	0.0932	5.06	3.78
30	0.76	15.20	1.24	18.85	7.65	0.1864	6.87	4.29
60	1.00	20.00	1.24	24.80	10.07	0.3728	9.29	4.77
120	1.27	25.40	1.22	30.99	12.58	0.7456	11.80	4.96
240	1.64	32.80	1.19	39.03	15.85	1.4912	15.07	4.87
260	1.88	37.60	1.17	43.99	17.86	1.6154	17.08	5.15
600	2.24	44.80	1.14	51.07	20.74	3.7279	19.96	3.96
1440	3.10	62.00	1.13	70.06	28.44	8.9471	27.67	2.80

For square pit:

Critical Length L = 5.15 m

Time to Empty 50% = 2.48 hrs

Consider rectangular alternative:

Perimeter P = 4*L = 2*A + 2*B

Adopt A =	5.15	1.20	3.00 m
Then B =	5.15	9.10	7.30 m

SA 4.xls - 14/04/17

Test 8/8
Spreadsheet

Job No	Test	Date	06/01/09
Project	Based on BRE Digest 365 Worked Example page 7	By	DA

SOAKAWAY DESIGN TO BRE 365

A	95 m2	Impermeable Surface Area of Catchment
f	3.30E-05 m/sec	Infiltration rate f of soil into which soakaway drains
d	1.5 m	Effective storage depth of soakaway
VR	0.3	Free volume (void) ratio of fill to pit around rings
Twall	0.07 m	Wall Thickness of rings
D1	0.9 m	Internal diameter of Ring 1
Vol R1	0.95	Storage capacity of ring 1 (= 3.142 * (D1*0.5)^2 * d m3)
Void R1	0.382	Equivalent volume of Ring 1 (incl wall) at void ratio of outer fill (= 3.142*(D1+Twall)^2*d*VR m3)
D2	0 m	Internal diameter of Ring 2
Vol R2	0.00	Storage capacity of ring 2 (= 3.142 * (D2*0.5)^2 * d m3)
Void R2	0.000	Equivalent volume of Ring 2 (incl wall) at void ratio of outer fill (= 3.142*(D2+Twall)^2*d*VR m3)
M5-60 min	20 mm	Base Rainfall
D		Storm duration (in minutes)
r	0.35	Rainfall ration (From BRE 365 Figure 1)
Z1		Factor from BRE 365 Table 1 based on M5-D and 'r' from Fig 1
M5-D		Total rainfall in design storm duration D for 5-year return period (=Z1*D mm)
Location		England and Wales
Z2		Factor from BRE 365 Table 2 based on M5-D
M10-D		Total rainfall in design storm duration D for 10 year return period (=M5-D*Z2 mm)
R		=M10-D
I		Total inflow to soakaway (=A*R/1000 m3)
L		Minimum length for side of square pit [= -O/L + (O/L^2+4*[Vol Pit/L2]*Y)^0.5 / (2 * [Vol Pit/L²])]
A_{s50}		Internal surface area of soakaway to 50% effective depth; excl. base area
A_{s50} / L	3.00	
O		Outflow from soakaway (=A_{s50}*f*D m3)
Vol Pit		Effective storage volume of whole pit (ignoring the rings)
Vol Pit/L²	0.45	
X	0.57	= (VolR1+VolR2)-(VoidR1+VoidR2)
Y		Inflow (I) minus value X

D minutes	Z1	Inflow M5-D mm	Z2	R=M10-D mm	I=A*R	O / L	Y	L (m)
5	0.34	6.80	1.19	8.09	0.77	0.0297	0.20	0.63
10	0.49	9.80	1.22	11.96	1.14	0.0594	0.56	1.06
15	0.59	11.80	1.24	14.63	1.39	0.0891	0.82	1.25
30	0.77	15.40	1.24	19.10	1.81	0.1782	1.24	1.48
60	1.00	20.00	1.24	24.80	2.36	0.3564	1.78	1.63
120	1.25	25.00	1.22	30.50	2.90	0.7128	2.33	1.62
240	1.57	31.40	1.19	37.37	3.55	1.4256	2.98	1.44
260	1.78	35.60	1.17	41.65	3.96	1.5444	3.38	1.52
600	2.12	42.40	1.14	48.34	4.59	3.5640	4.02	1.00
1440	2.84	56.80	1.13	64.18	6.10	8.5536	5.53	0.63

For square pit:

Critical Length L = 1.63 m

Time to Empty 50% = 1.52 hrs

Consider rectangular alternative:

Perimeter P = 4*L = 2*A + 2*B

Adopt A =	1.63	0.90	8.00 m
Then B =	1.63	2.37	-4.73 m

Soakaway design 2.xls - 15/04/17

Appendix E Soakaway Detail