Blackpool Council

Blackpool SWMP

Blackpool SWMP Modelling report

REP/227357/001

Draft 2 | 26 March 2013

Job number 227357

Admiral House Rose Wharf
78 East Street
Leeds LS9 8EE
United Kingdom
www.arup.com

ARUP

Document Verification

ARUP

Job title	Blackpool SWMP	**Job number**	227357
Document title	Blackpool SWMP Modelling report	**File reference**	
Document ref	REP/227357/001		

Revision	**Date**	**Filename**			
Draft 1	6 Feb 2013	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name	Daniel van der Leer		
		Signature			
Draft 2	26 March 2013	**Filename**			
		Description	Draft for issue		
			Prepared by	Checked by	Approved by
		Name	Daniel van der Leer	Luke Ballantyne	Katherine Pygott
		Signature			K. Pygott
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

1 Introduction

A Surface Water Management Plan (SWMP) for Blackpool is being developed to understand and communicate surface water flood risk and to develop solutions to manage this risk. The Risk Assessment phase of the study aims to 1) undertake a strategic council-wide assessment of surface water flood risk; and 2) identify high risk areas and properties as potential candidates for further analysis and scoping of mitigation options where appropriate. Strategic-scale hydraulic modelling has been undertaken for the entire council area to enable these aims to be achieved.

This document describes the hydraulic modelling and associated hydrology undertaken to support the Risk Assessment phase of the SWMP. The subsequent quantitative assessment of surface water flood risk and identification of high risk areas and properties, using the outputs from the model, is described elsewhere[1].

2 Data

The following data has been used to develop the TUFLOW model:

- Blackpool council boundary: This was obtained in GIS format from the Ordnance Survey national dataset "OS District_Borough_Unit_May_2010" and was used to derive a suitable extent for the hydraulic model.
- Light Detection and Ranging (LiDAR) ground level data: All filtered LiDAR data available from the Environment Agency's Geomatics site was collected for the model extent. The filtered data represents a 'bare earth' scenario where features such as buildings and tree canopies have been removed through a filtering process. The vast majority of the data was available from the 1m resolution composite dataset with a few small areas where the 2m resolution composite dataset was obtained to fill gaps present in the 1m dataset. The LiDAR catalogue shows that most of the 1m LiDAR in the study area originates from a survey carried out in November 2010. The LiDAR tiles obtained were merged to form a continuous Digital Terrain Model (DTM) covering the entire model extent with ground levels taken from the more accurate 1m LiDAR where this overlapped with the 2m LiDAR data.
- Ordnance Survey background mapping
- Ordnance Survey Mastermap data: This was obtained in GIS format from Blackpool Council and was used to define surface roughness coefficients and also to define areas of different infiltration and drainage capacity to enable suitable net rainfall boundary conditions to be applied.

[1] Blackpool SWMP Risk Assessment Report, Arup (2013).

3 Hydrological analysis

3.1 Rainfall profiles

Rainfall totals were extracted from the FEH CD-ROM to assess the spatial variation in rainfall totals across the study area (Figure B1) and to select the most representative location for which to extract rainfall hyetographs. Rainfall profiles were extracted for six different sub-catchments within the modelled area for a range of return periods from 1:10yr to 1:500yr. This was carried out for three different storm durations: 1hr, 3hr and 12hr.

The rainfall total values show that rainfall totals do not vary significantly across the modelled area, as was anticipated given the relatively small variation in ground levels across the area. The maximum deviation from the average rainfall total for the data extracted was found to be 2.1%.

The sub-catchment with the most representative rainfall profiles was selected and the catchment descriptors were exported from the FEH CD-ROM and imported into an ISIS ReFH unit. The ISIS FEH unit was then used to extract areal rainfall profiles (rainfall depth vs. time) for the 1:20, 1:30, 1:75, 1:100 and 1:1000yr return periods, each of which were extracted for a range of storm durations (0.25, 0.5, 1, 2, 3, 6 and 12hrs). It was subsequently decided to also extract the areal rainfall profiles for the 1:2yr return period to enable a reality check to be carried out on the model assumptions and to improve accuracy of any subsequent assessment of flood damages.

Rainfall profile generation by use of the FEH requires the duration to be an odd integer multiple of the time step (data interval). This feature means that the exact durations actually used in the modelling differ from the values listed by either 0.025hrs or 0.05hrs; the impact of this difference is not significant.

The areal reduction factor calculated by ISIS was noted for each storm duration and used to convert the areal rainfall profiles to rainfall profiles, i.e. point rainfall, which is considered a more realistic conservative method for surface water flooding given the sub catchments contributing to surface water flooding in urban areas are likely to be small.

3.2 Standard Percentage Runoff

The Standard Percentage Runoff (SPR) for the modelled area was derived using information from the Soil Map (Soil Survey of England and Wales) following the method outlined in “Hydrology of soil types: a hydrologically based classification of the soils of the United Kingdom (Institute of Hydrology, 1995). The soil types within the modelled area were identified from the Soil Map (Figure 1). The soil types identified were then used to derive the HOST Classes, which were used to derive the recommended SPR value. This derivation is shown in Table 1.

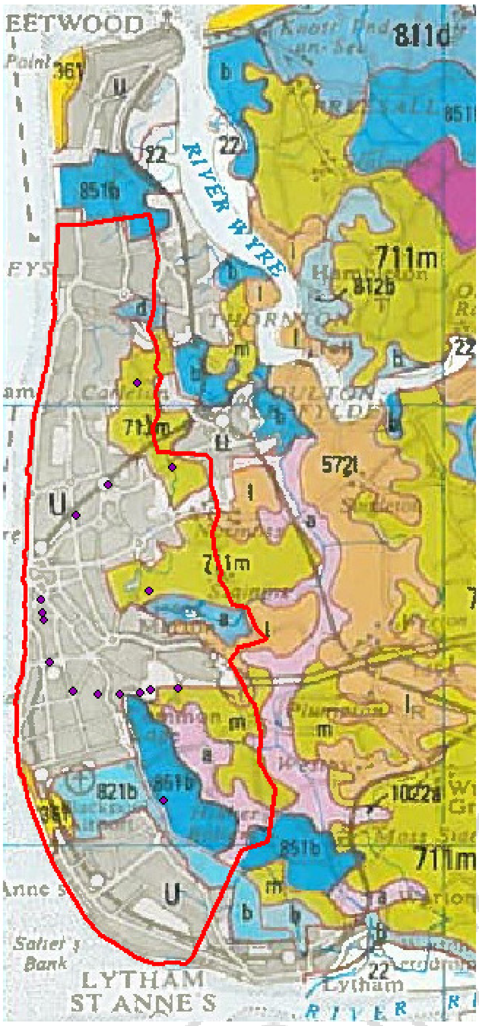


Figure 1: Extract of soil map showing modelled area

Table 1. Derivation of SPR values.

Soil type (1)	HOST Class (2)	Proportion (2)	Recommended SPR value (3)		Comment
572l	18	87.5	47.2		
	24	12.5	39.7		Small area compared
			SPR =	**46.3**	to other soil types.
651a	4	18.75	2		Quite small area
	15	81.25	48.4		compared to other soil
			SPR =	**39.7**	types.
711m	18	18.75	47.2		Largest area within
	24	81.25	39.7		model (apart from
			SPR =	**41.1**	urban area).
821b	7	9.52	44.3		
	10	90.48	25.3		
			SPR =	**27.1**	Similar in area to 851b.
851b	9	71.43	25.3		
	10	28.57	25.3		
			SPR =	**25.3**	

References:
1) Soil map (Soil Survey of England and Wales)
2) source: IH Report 126, Table 4.16
3) source: IH Report 126, Appendix B

Areas with similar SPR were rationalised, resulting in two main soil types:

1. Area containing 821b and 851b assigned an SPR = 26.2 (average of these soil types).
2. All other areas assigned an SPR = 41.1 (the soil type with the largest area).

To enable suitable runoff coefficients to be used in green spaces within the urban area, the above two soil type areas were extended into the urban area using best judgment.

3.3 Percentage Runoff

Percentage Runoff (PR) has been calculated from the SPR using the following equation (Flood Estimation Handbook Volume 4, page 27):

$PR_{(rural)} = SPR + DPR_{(CWI)} + DPR_{(RAIN)}$

where

$DPR_{(CWI)} = 0.25\ (CWI - 125)$

$DPR_{(RAIN)} = 0$ for $P < 40mm$

$$= 0.45\,(P - 40)^{0.7} \quad \text{for } P > 40\text{mm}$$

where CWI is the Catchment Wetness Index and P is the total rainfall depth.

The CWI for the representative subcatchment within the modelled areas was obtained from the ISIS FEH unit and was found to be 123.17.

The "$DPR_{(CWI)} + DPR_{(RAIN)}$" component has been calculated for each storm duration from the CWI and P values. This has then been added to the SPR value to give a PR, which is then used to derive a net rainfall for the rural areas.

3.4 Urban drainage capacity

Given the scope of the project, a very simple method to very approximately account for the urban drainage capacity has been adopted. This method is to simply remove a given rainfall depth from the net rainfall falling on urban areas. The approach is based on guidance shown within paragraph c9 on page 12 of the SWMP Technical Guidance Annex C, which suggests a range of 12mm/hr to 16mm/hr. United Utilities, who are acting as partners for the Blackpool SWMP, are in agreement with this approach. Following discussion between Arup and United Utilities, a value of 16mm/hr has been selected.

3.5 Model boundary conditions

The TUFLOW 2D model uses rainfall boundaries, which are directly applied to the topography represented in the model. Each value in the rainfall profile must be specified as the depth of rainfall that falls within the specified data interval. A data interval of 0.05hrs has been adopted for all TUFLOW model rainfall boundaries with the exception of the 15 minute storm duration profiles which use a data interval of 0.025hrs to better define the shape of these profiles.

To account for infiltration in rural areas and the drainage capacity in urban areas, appropriate 'net rainfall' profiles (depth vs. time) have been calculated from the raw rainfall profiles using PR (calculated from SPR, CWI and P), drainage capacity assumptions (16mm/hr) and the proportion of urbanisation / hardstanding area.

Ordnance Survey Mastermap data and soil map data have been used to specify areas with different infiltration and drainage capacity. The resulting net rainfall boundaries are listed below and shown in Figure B4.

Net rainfall profiles are defined for the following:

- s1_u0_d0: Soil type 1 rural area with 0% hardstanding area and no drainage capacity.
- s2_u0_d0: Soil type 2 rural area with 0% hardstanding area and no drainage capacity.
- s1_u1_d1: Completely urban area with 100% hardstanding area and 16mm/hr drainage capacity.

- s1_u2_d2: Soil type 1 gardens with 20% hardstanding area and 16mm/hr drainage capacity.
- s2_u2_d2: Soil type 2 gardens with 20% hardstanding area and 16mm/hr drainage capacity.
- openwater: Open water with no infiltration and no drainage capacity.

The percentages of hardstanding within gardens were estimated from review of GIS layers against satellite photography. A sensitivity test considered the impact of an assumption of 40% hardstanding on the 100yr 30min event.

4 Baseline model development

4.1 Modelling approach

A TUFLOW hydraulic model using a ‘direct rainfall’ approach was selected as being the most appropriate tool to assess surface water flood risk across Blackpool Council given the project scope and constraints. TUFLOW is a computer program for modelling two-dimensional (2D) flows using a regular grid, and stands for Two-dimensional Unsteady FLOW. It is able to represent floodplain flow routes and calculates depth, velocity and flood hazard at every location within the modelled area. The ‘direct rainfall’ modelling approach simulates rainfall being applied spatially over the modelled area, with losses applied to represent rural infiltration as well urban drainage capacity. The resulting flow is then routed overland by the model based on the topography.

The ‘direct rainfall’ modelling approach satisfies requirements of the Defra SWMP Technical Guidance Document and contributes to EU targets for production of depth and velocity plots of surface water sources in a GIS format. Given the constraints of the project, an integrated sewer network-surface water model has not been developed at this stage of the study. Instead, urban drainage capacity is considered by applying a global loss in rainfall over the urban area. This assumption is described in Section 3.

The modelling approach adopted enables a consistent council-wide assessment of surface water flood risk and enables strategic options to alleviate surface water flooding to be assessed quantitatively.

4.2 Model extent

The extent of the model was defined to include all catchment areas that contribute surface water flows into flowpaths through, into and out of the Blackpool Council administrative area. These areas were identified by inspecting the DTM (Digital Terrain Model) in GIS (Geographical Information System) software. The study area (Blackpool Council) is shown in Figure B1 and the derived model extent is shown overlaid in Figure B2 with the DTM.

4.3 Model geometry

The model extent is represented in the model by defining the ‘active’ area, which is used in the model to select the 2D grid cells that are used in the model calculations. The cell size, i.e. the resolution of the 2D grid, has been set to 10m to give the best compromise between accuracy and computational requirements/ model run time. Ground levels are incorporated into the model by specifying a grid file extracted from the DTM.

Relatively small or narrow topographic features such as embankments, cuttings, underpasses and roads raised above surrounding ground levels may not be accurately represented using the 2D grid in the model. Consequently, topographic features that may affect flow routes and flood risk have been identified from the full resolution DTM in GIS software and incorporated into the model using breaklines and polygons (Figure B3).

4.4 Surface roughness

Surface roughness in the model is specified using Manning's *n* roughness coefficients assigned to different types of landuse. The landuse has been specified across the entire modelled area using Ordnance Survey Mastermap data. The main types of landuse in the model and the roughness coefficient assigned to each are given in Table 2. These roughness coefficients have been adopted in previous studies.

Table 2. Surface roughness coefficients.

Landuse	**Manning's *n* roughness coefficient**
Hardstanding areas including roads,	0.015
Open water	0.02
Agricultural areas, fields, parks and	0.05
Woodland	0.10
Buildings	0.10

The resistance to flow due to the presence of buildings is represented in the model using a relatively high roughness value. This is preferred over alternative methods, such as removing buildings from the model completely as these alternative methods can prevent the narrower flow routes around buildings being represented unless the model is of very high resolution.

Sensitivity of model results to roughness coefficients has been assessed as part of sensitivity analysis (Section 5.3).

4.5 Model boundaries

The TUFLOW 2D model uses net rainfall boundaries, which are directly applied to the topography represented in the model. The derivation of the net rainfall boundaries is described in Section 3.5.

Flooding from other sources, such as overtopping from the tide and the rivers and drains is not considered within the model, given the analysis for this study is purely focussed on surface water flooding from overland flow.

4.6 Critical storm duration

A critical storm duration analysis has been carried out for the 1:100 year return period event to identify the storm duration(s) that result in greatest overall risk from surface water flooding. Model results were analysed in GIS (Geographical Information System) to calculate the area of flooding in the urban area of Blackpool Council where the flood depth is greater than 0.1m and 0.3m. The results (Table 3) show that the shorter storm durations of 0.25 and 0.5hrs result in the greatest areas of flooding for flood depths above 0.1m and 0.3m, respectively. Therefore, two critical storm durations have been selected, these being 0.25 and 0.5hrs.

The critical storm durations of 0.25 and 0.5hrs have been adopted in the final design event simulations for the remaining return periods.

Table 3. Summary of results of critical storm duration analysis.

Storm duration (hrs)	Urban flooded area > 0.1m depth (Hectares)	Urban flooded area > 0.3m depth (Hectares)
0.25	420.1	47.2
0.5	416.2	49.5
1.0	399.3	48.8
3.0	363.3	43.8
6.0	331.6	38.9
12.0	232.7	29.2

5 Model proving

5.1 Runtime parameters

The model has been run using the double precision version of TUFLOW version 2012_05_AC. The double precision version of TUFLOW is used instead of the standard single precision version to ensure any mass balance errors associated with the direct rainfall approach are kept to a minimum. The TUFLOW model runtime parameters used in the design event simulations are given in Table 4. The simulation start time is set at -0.1 hrs to enable the rainfall boundary conditions to be correctly applied at 0.0 hrs.

Table 4. TUFLOW model runtime parameters.

Parameter	Value
Start time	-0.1 hrs
End time	30 hrs (36hrs used for 12hr storm duration)
Timestep	3.0 seconds
Map Output Interval	3600 seconds
Store Maximums	ON (Maximums only)
Map Output types	Depth, water level, flow, velocity, UK flood

5.2 Runtime performance

The model run time for the 1:100 year return period event for a 12hr storm duration is approximately 7hrs using a dual core Intel E6850 3GHz workstation. This would increase to approximately 56hr if a 5m grid resolution was used.

The cumulative mass balance error output during the TUFLOW simulation provides an indication of the performance of a model where high errors can indicate a problem with the model leading to inaccurate results. Relatively large mass balance errors can occur when using the direct rainfall approach due to rounding errors in the calculations associated with the very small changes in flood depths that occur. The largest mass balance error for the 1: 100 year return period simulations occurred during the 12hr storm duration simulation and was found to peak at 1.9% while the largest error for the 0.25hr and 0.5hr storm durations was 0.5%. This is a relatively small error for a direct rainfall model and is indicative of a healthy model with no significant loss in accuracy due to rounding errors in the calculations performed by the modelling software.

5.3 Sensitivity analysis

The following sensitivity analyses have been carried out for the 1:100 year return period flood, for one of the two the critical storm durations identified in Section 4.6, this being the 0.5hr storm duration, in order to better understand the uncertainty in model results:

- Storm duration
- Drainage capacity

- Proportion of hardstanding area in gardens
- Surface roughness

5.3.1 Storm duration

The impact of storm duration on flood risk was assessed as part of the critical storm duration analysis, which is described in Section 4.6. This analysis showed that model results were sensitive to storm duration when the storm duration exceeded 2hrs with area of flooding reducing with increasing storm duration.

5.3.2 Drainage capacity

To understand the uncertainty in model results associated with global drainage capacity assumptions, a sensitivity test was carried out where the drainage capacity was set changed from 16mm to 0mm. This represents a situation where there is no drainage capacity. The results show that the area of flooding is sensitive to drainage capacity with a 23% increase in flooded area over 0.1m deep and 51% increase in flooded area over 0.3m deep.

5.3.3 Proportion of hardstanding area in gardens

To understand the uncertainty in model results associated with the assumed proportion of hardstanding area in gardens, a sensitivity test was carried out where the proportion was changed from 20% to 40%. The results show that the area of flooding is relatively insensitive to this proportion with a 4% increase in flooded area over 0.1m deep and 6% increase in flooded area over 0.3m deep.

5.3.4 Surface roughness

To understand the uncertainty in model results associated with surface roughness assumptions, two sensitivity tests were carried out where the roughness coefficients were changed by +/- 20%. The results show that the area of flooding is insensitive to roughness with a maximum difference of approximately 1% in flooded area over 0.1m deep and flooded area over 0.3m deep.

5.4 Calibration and validation

Flood depths and extents for a range of return periods were output from the model and reviewed by the project team and the client against local knowledge. In addition to the agreed design event return periods listed in Chapter 6, a 1 in 2 year event was modelled to enable a reality check on the model assumptions.

The model outputs were also compared against the national ‘Areas Susceptible to Surface Water Flooding’ map, used within the Blackpool Council SFRA, and were found to identify the same or similar surface water flood risk areas.

6 Model simulations and results

6.1 Design event simulations – present day

The baseline model has been used to simulate the following return period flood events for the critical storm duration(s) identified in Section 4.6, which are in line with the Defra SWMP Technical Guidance Document:

- 5% (1 in 20yr): In line with EA Functional Floodplain 3b;
- 3.3% (1in 30yr): United Utilities level of service requirement;
- 1.3% (1 in 75yr): Typically used by the insurance industry;
- 1% (1 in 100yr): In line with EA Zone 3;
- 0.1% (1 in 1000yr): In line with EA Zone 2.

6.2 Design event simulations – future

A future scenario version of the baseline model has been set up to better represent flood risk in the future (2080s onwards). The following changes have been applied to represent future conditions:

- Climate change: A 20% increase in rainfall depth has been applied to account for the effects of climate change. This is consistent with the latest Environment Agency climate change guidance[2], which provides a change factor of 20% for the increase in extreme rainfall intensity for the 2080s onwards.
- Increased urbanisation: Increased urbanisation has been represented by increasing the proportion of hardstanding area in gardens from 20% to 40%.
- Urban creep: Urban creep has been represented by replacing rural areas in the model with urban areas at the potential development sites identified in the Blackpool Council SFRA (2009). The net rainfall boundaries applied to these areas assume a mixture of hardstanding areas and gardens.

The future scenario baseline model has been used to simulate the return period flood events listed in Section 6.1 for the critical storm duration(s) identified in Section 4.6.

6.3 Model outputs

Maximum depth, velocity and flood hazard rating were extracted from the raw TUFLOW model results for all return periods and inspected in GIS software.

Two classifications of flood risk areas have been derived from the flood depth results:

[2] Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities, Environment Agency, 2011.

- Areas where maximum surface water flood depth > 0.1m: This is indicative of flood depth that is likely to cause disruption to pedestrians and traffic in some areas.
- Areas where maximum surface water flood depth > 0.3m: This is indicative of flood depth that is likely to cause internal flooding to properties.

These classifications are consistent with Defra SWMP technical guidance. The resulting flood risk areas are presented for each return period in Appendix C, Figures C1 to C7.

These figures clearly show specific hotspots where surface water flood depths over 0.3m are predicted across an area, though this is most noticeable for the more extreme flood events. Hotspots in urban areas identified from the 1:100 year results include (but are not limited to):

- Gretna Crescent
- Cranbrook Avenue
- Ingthorpe Avenue
- Bromley Close
- Enfielf Road
- Gorton Street
- Collingwood Avenue
- Albert Road
- Between Mere Road and Harley Road
- Hodder Avenue
- Falkland Avenue

For a more detailed assessment in relation to receptors, please refer to the Risk Assessment Report1.

The figures also illustrate how the area of surface water flood risk is predicted to increase with return period and how they are predicted to increase into the future for the 1:100 year return period flood. A relatively large increase in flood extents and depths is predicted between the 1:100 and 1:1000 year return period floods.

All GIS files presented within the figures is also provided as part of the project deliverables.

6.4 Risk assessment and identification of high risk areas

The outputs from the model have been analysed with reference to the National Receptor Database information to identify and summarise the receptors at risk of surface water flooding, to assess the flood damages and to identify areas in Blackpool Council with high surface water flood risk. The methodology and findings are described in the risk assessment report (Arup, 2013).

7 Limitations

The hydraulic modelling and associated hydrological analysis makes best use of available data and considers key issues related to surface water flooding including storm duration, permeability, drainage capacity, overland flow routes, flood depths and flood hazard.

As with all models, the Blackpool SWMP model has known limitations, the main ones are discussed below:

- Underground sewer system: The effect of the sewer system is represented in the model by assuming a uniform 16mm/hr reduction in rainfall depth. This simple approach does not consider the spatial variation in drainage capacity that would occur in reality or how the capacity might vary over time during the flood event. It is recommended that future modelling should consider the sewer system in more detail, e.g. by developing a sewer network model and integrating this with a 2D overland flow model. This type of integrated model could be developed using Infoworks ICM and could be used to assess options specifically relating to the sewer system.

- Buildings: Buildings have been represented in the 2D model domains using high roughness areas. While this widely recognised approach is considered appropriate, it is recognised that the local scale flooding mechanisms around and through the building are necessarily generalised and may not closely match observed local scale flooding mechanisms. However, this approach does enable flow where there are narrow flow routes that may not be represented if a different approach were to be adopted.

- Grid size: The model grid cell size is 10m, which was selected to give the best balance between accuracy and computational requirements for this strategic study. Features such as embankments and underpasses and cuttings, that may affect flow paths, have been identified and incorporated into the model. However, there will be small variations in geometry that the model is unable to represent, and the role of streetscape features such as kerbs and boundary walls would be expected to induce variations in flooding at the local scale. It is recommended that a grid cell size no larger than 6m is adopted in any subsequent detailed modelling of high risk areas.

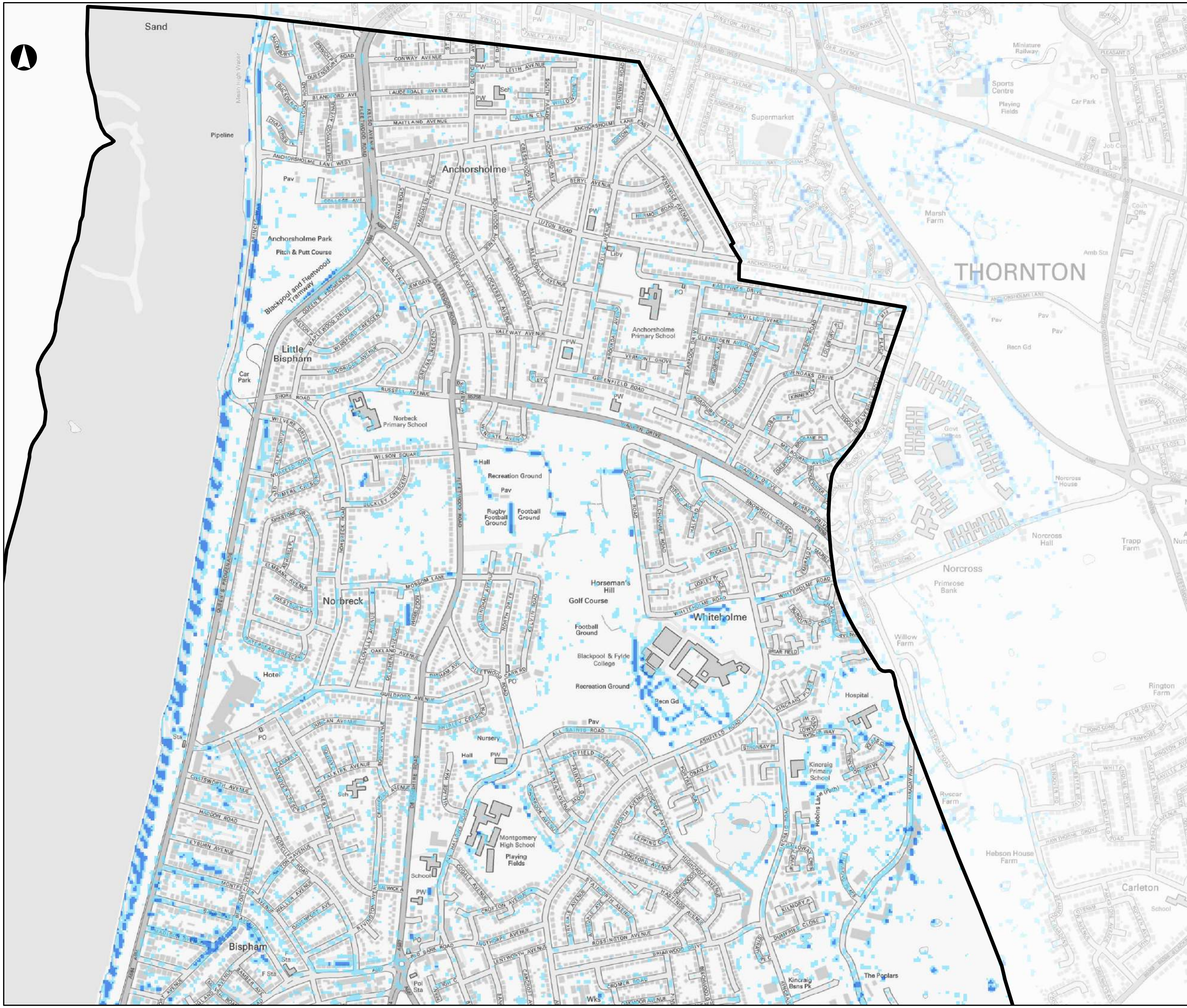
- The hydraulic modelling uses filtered LiDAR ground elevation data and therefore the outputs from the model are dependent on the accuracy of this data. Anomalies in LiDAR data can sometimes occur due to the filtering process not correctly representing floor levels of buildings in dense urban areas. This is a common problem, particularly for large buildings or groups of buildings. Ground models can be improved by collecting topographic survey data at buildings to better represent building threshold levels, which can be used to improve the filtered LiDAR data.

- Calibration: A comprehensive model calibration exercise with reference to multiple past flood events was not within the scope of this project and has not been carried out. However, a qualitative validation exercise has been undertaken by the project team and the client based on local knowledge of surface water flooding in the catchment. The model outputs were also compared against the national 'Areas Susceptible to Surface Water Flooding' map and were found to identify the same or similar surface water flood risk areas. Outputs from the model were also compared against the areas identified in the Blackpool Strategic Flood Risk Assessment (SFRA) to be at risk form surface water flooding.

The model developed for the Blackpool SWMP has been designed to be appropriate for its intended use. Before it is used for any other purpose, it is recommended that a review of the hydrology and hydraulic model is undertaken to ensure it is suitable. The following work should also be considered:

- Review of development within the catchment that has taken place since this model was constructed, including the effect on ground levels and landuse.
- Identification of any new topographic data such as more recent LiDAR surveys in the catchment.
- Identification of any new information relating to the sewer system that could be used to refine the representation of the drainage capacity/characteristics.
- Review of observed flood information that could be used to further calibrate/validate the model.

A3



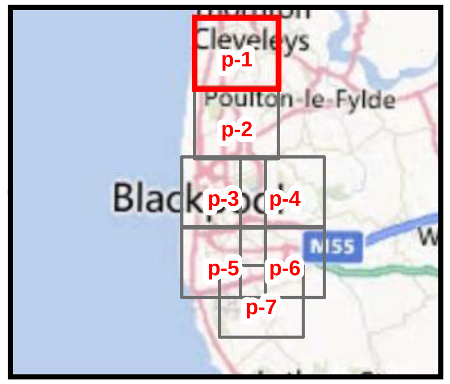
Legend

Blackpool Council boundary

50% (1 in 2yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



Issue	Date	By	Chkd	Appd
D1	2013-03-26	DVDL	LB	KP

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 50% (1 in 2yr)

Scale at A3

1:10,000

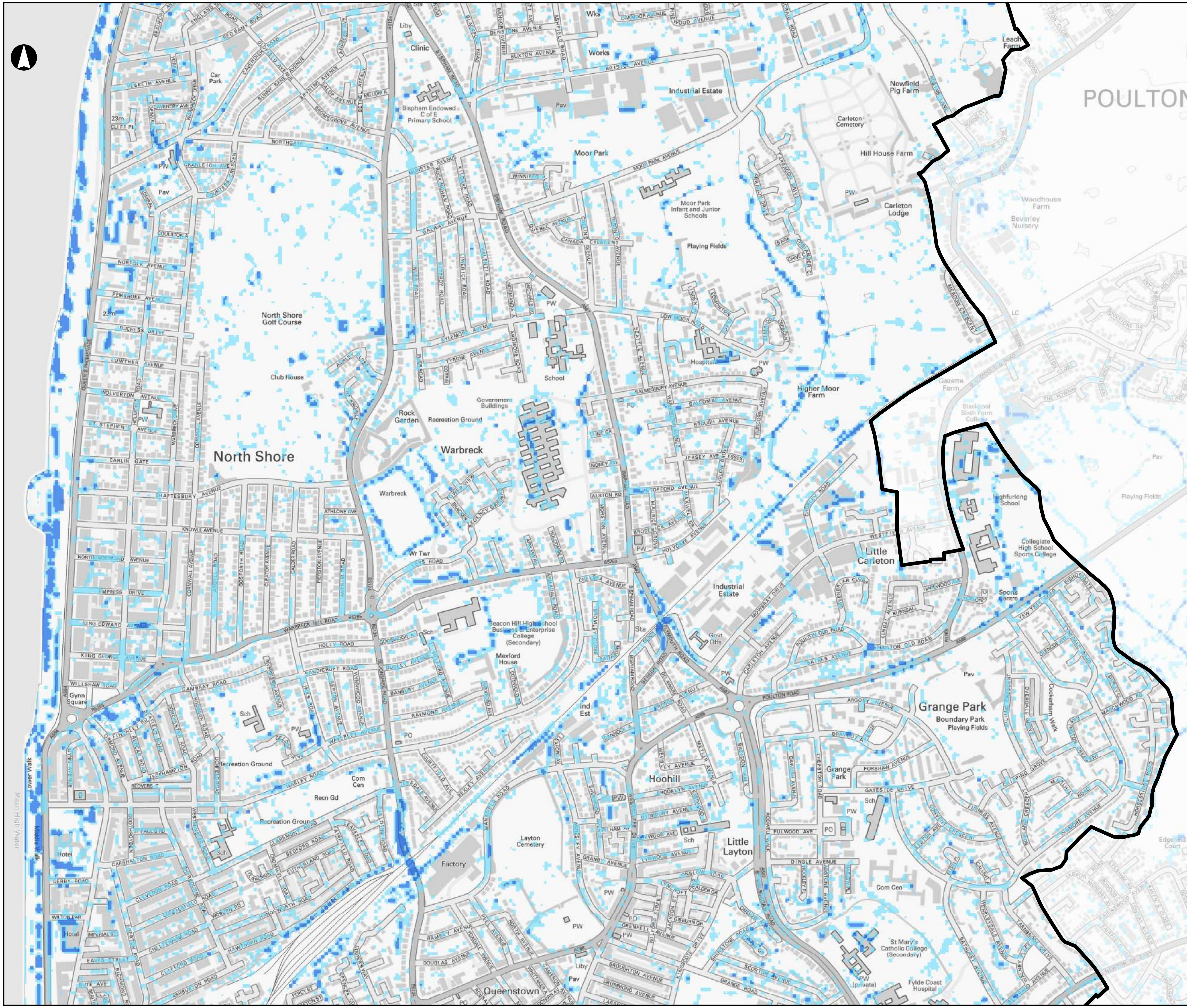
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C1.1	D1

26/03/2013 12:11:06

MXD Location

A3



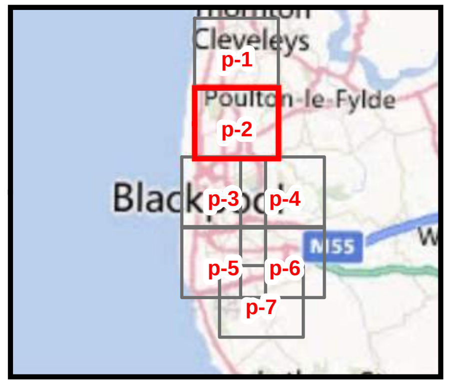
Legend

Blackpool Council boundary

50% (1 in 2yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



Issue	Date	By	Chkd	Appd
D1	2013-03-26	DVDL	LB	KP

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 50% (1 in 2yr)

Scale at A3

1:10,000

Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C1.2	D1

26/03/2013 12:11:14

MXD Location

A3

Legend

Blackpool Council boundary

50% (1 in 2yr)

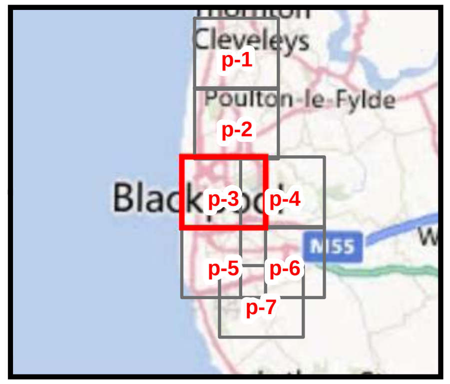
Maximum flood depth (m)

< 0.1

0.1 - 0.3

> 0.3

Contains Ordnance Survey data © Crown copyright and database right 2013



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 50% (1 in 2yr)

Scale at A3

1:10,000

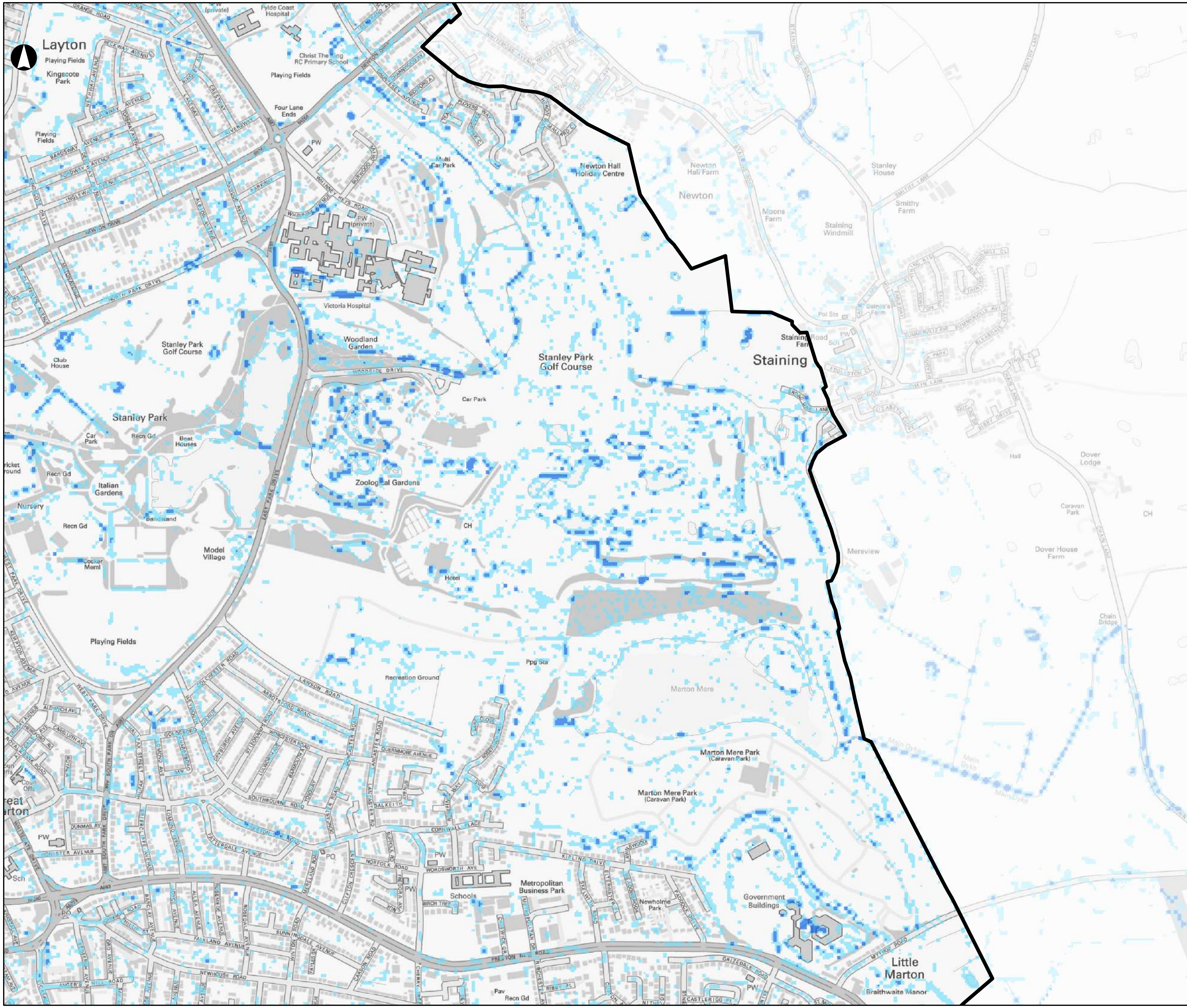
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C1.3	D1

26/03/2013 12:11:21

MXD Location

A3



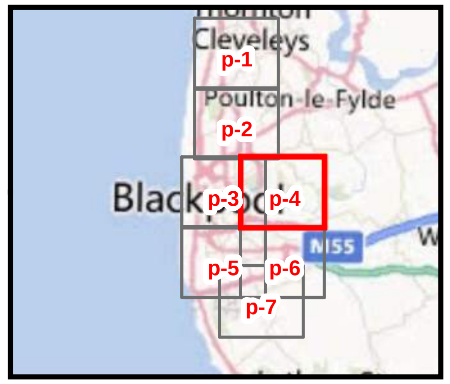
Legend

Blackpool Council boundary

50% (1 in 2yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



Issue	Date	By	Chkd	Appd
D1	2013-03-26	DVDL	LB	KP

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 50% (1 in 2yr)

Scale at A3

1:10,000

Job No **227357**

Drawing Status **For Issue**

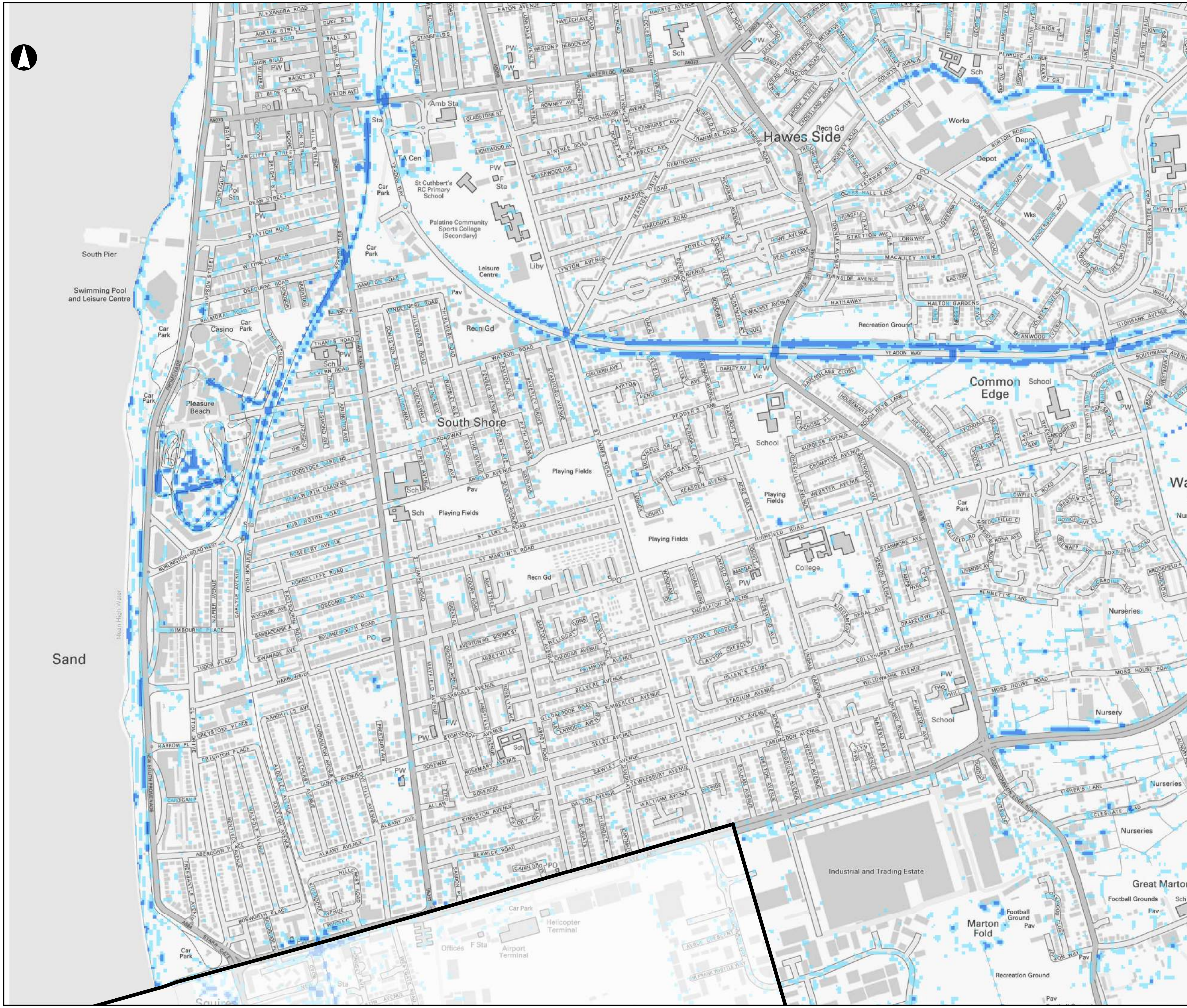
Drawing No **C1.4**

Issue **D1**

26/03/2013 12:11:29

MXD Location

A3



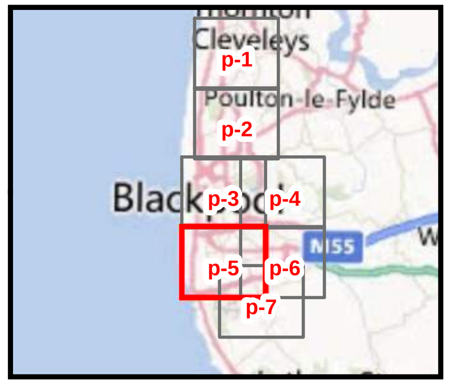
Legend

Blackpool Council boundary

50% (1 in 2yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 50% (1 in 2yr)

Scale at A3

1:10,000

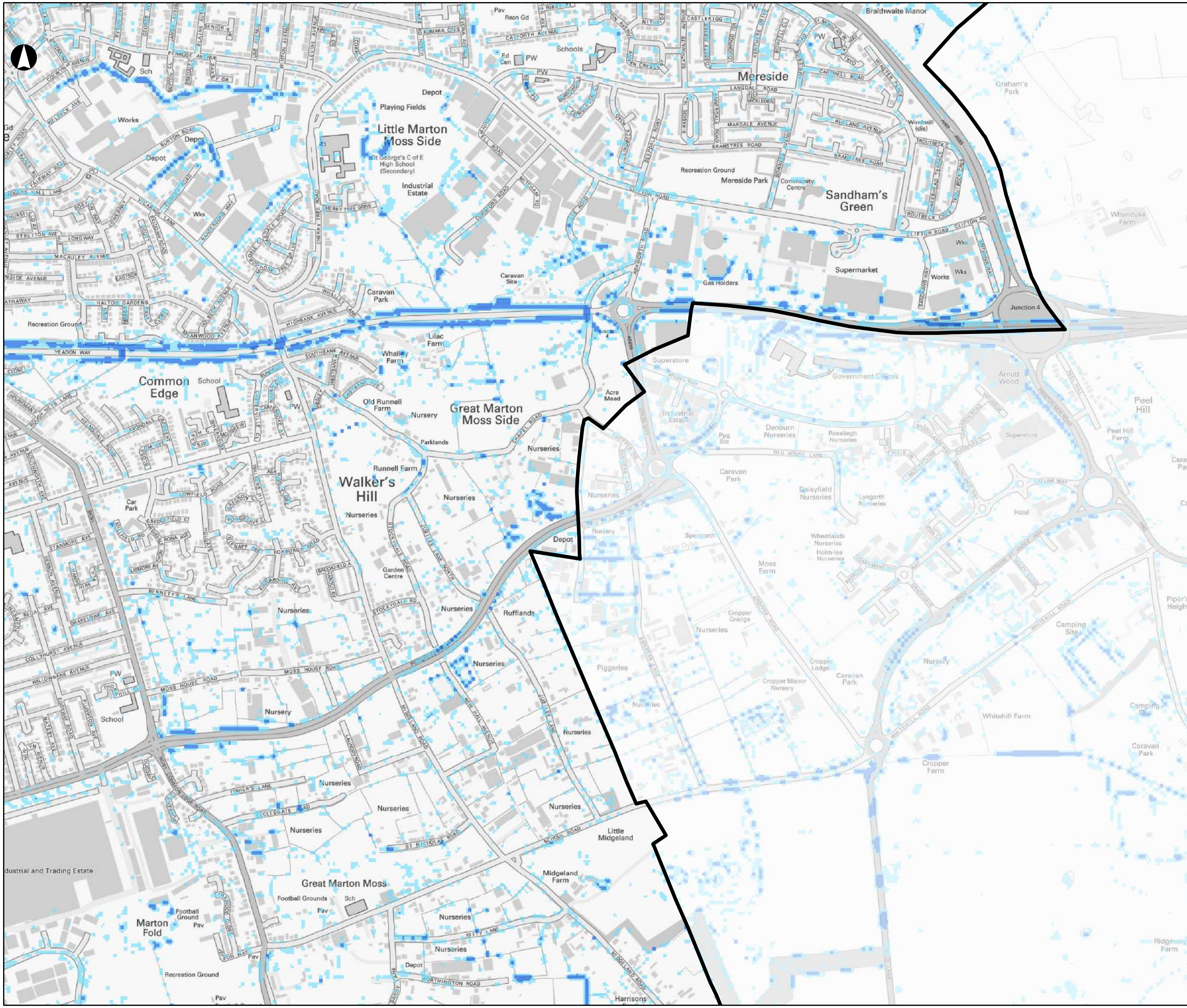
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C1.5	D1

26/03/2013 12:11:36

MXD Location

A3



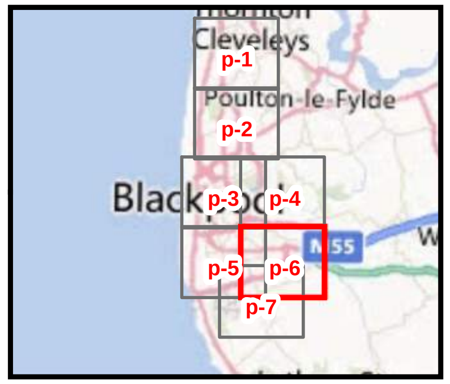
Legend

Blackpool Council boundary

50% (1 in 2yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 50% (1 in 2yr)

Scale at A3

1:10,000

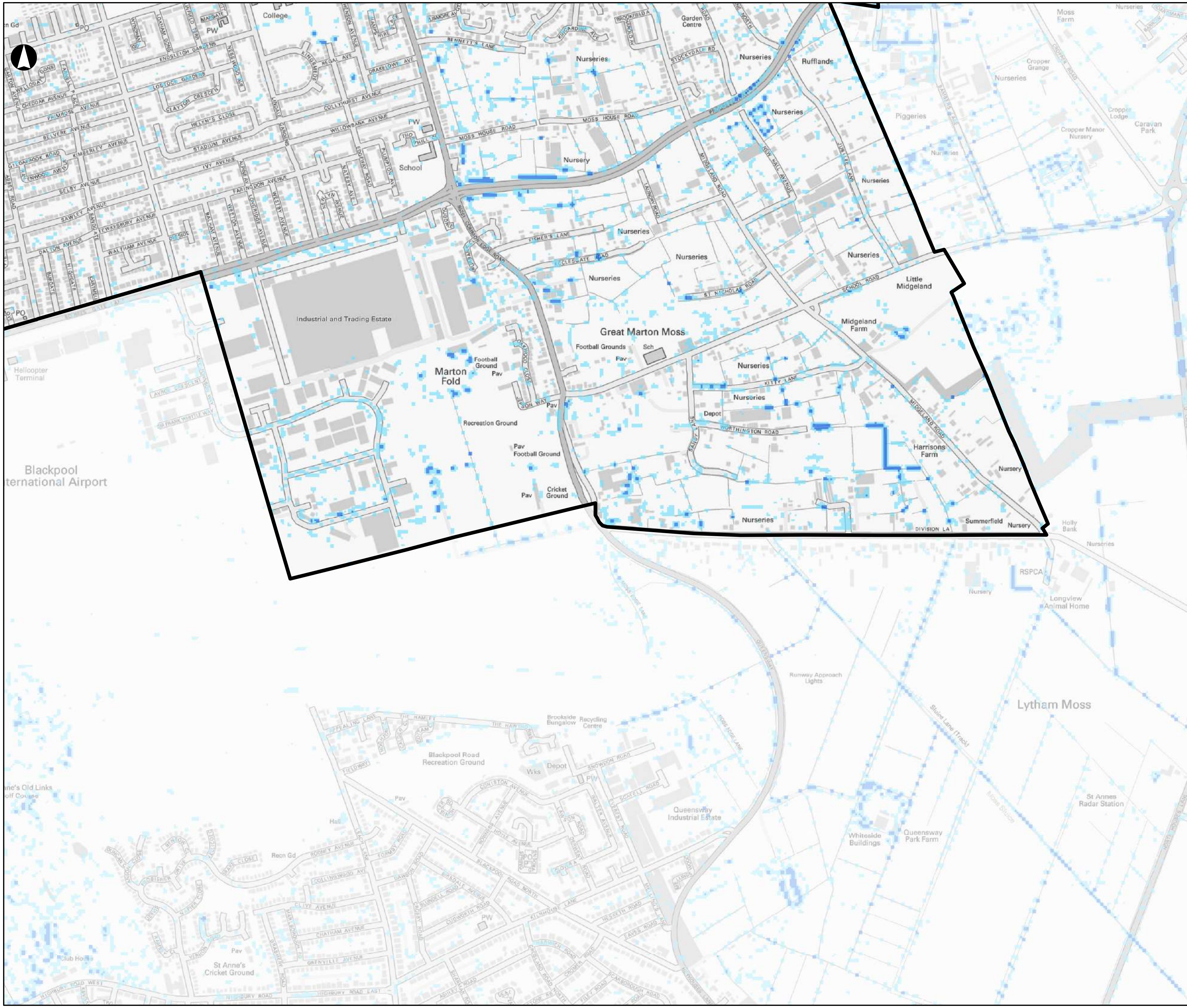
Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C1.6	**D1**

26/03/2013 12:11:43

MXD Location

A3



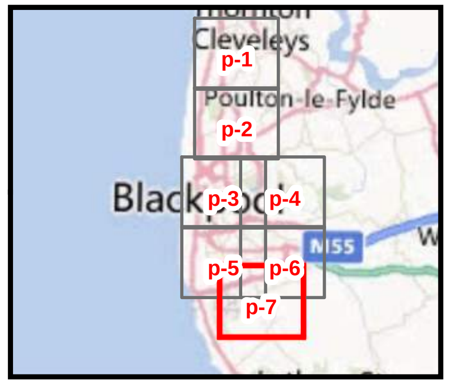
Legend

Blackpool Council boundary

50% (1 in 2yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 50% (1 in 2yr)

Scale at A3

1:10,000

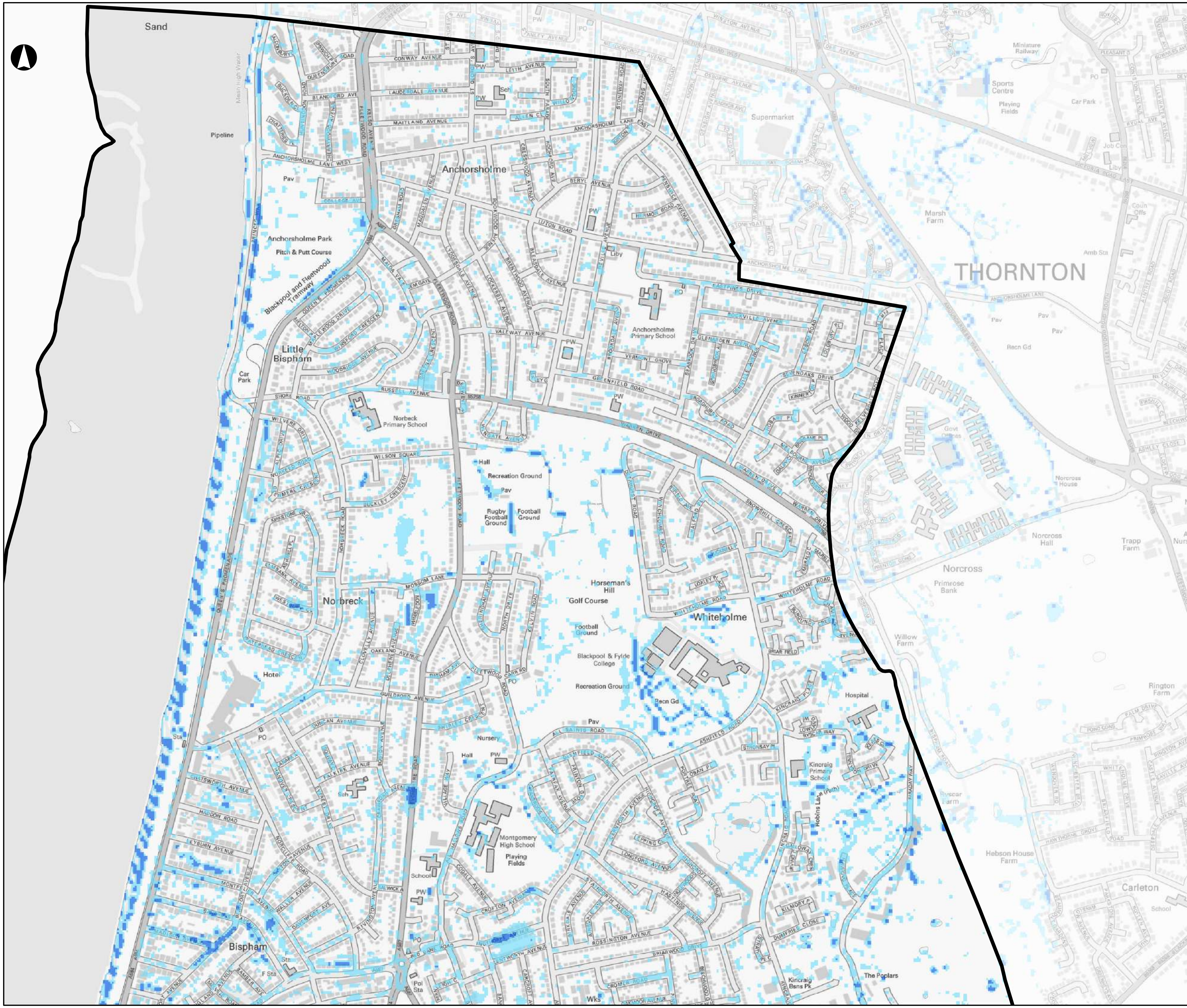
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C1.7	D1

26/03/2013 12:11:51

MXD Location

A3



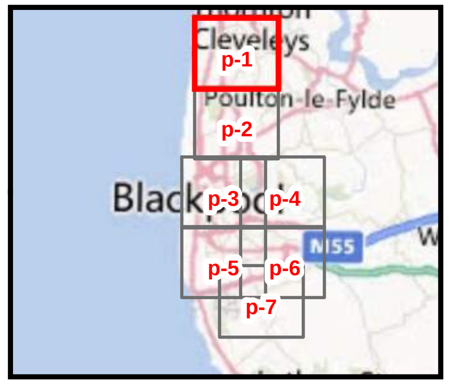
Legend

Blackpool Council boundary

5% (1 in 20yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



Issue	Date	By	Chkd	Appd
D1	2013-03-26	DVDL	LB	KP

Metres: 0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client
Blackpool Council

Job Title
Blackpool Surface Water Management Plan

Surface water flood risk areas 5% (1 in 20yr)

Scale at A3
1:10,000

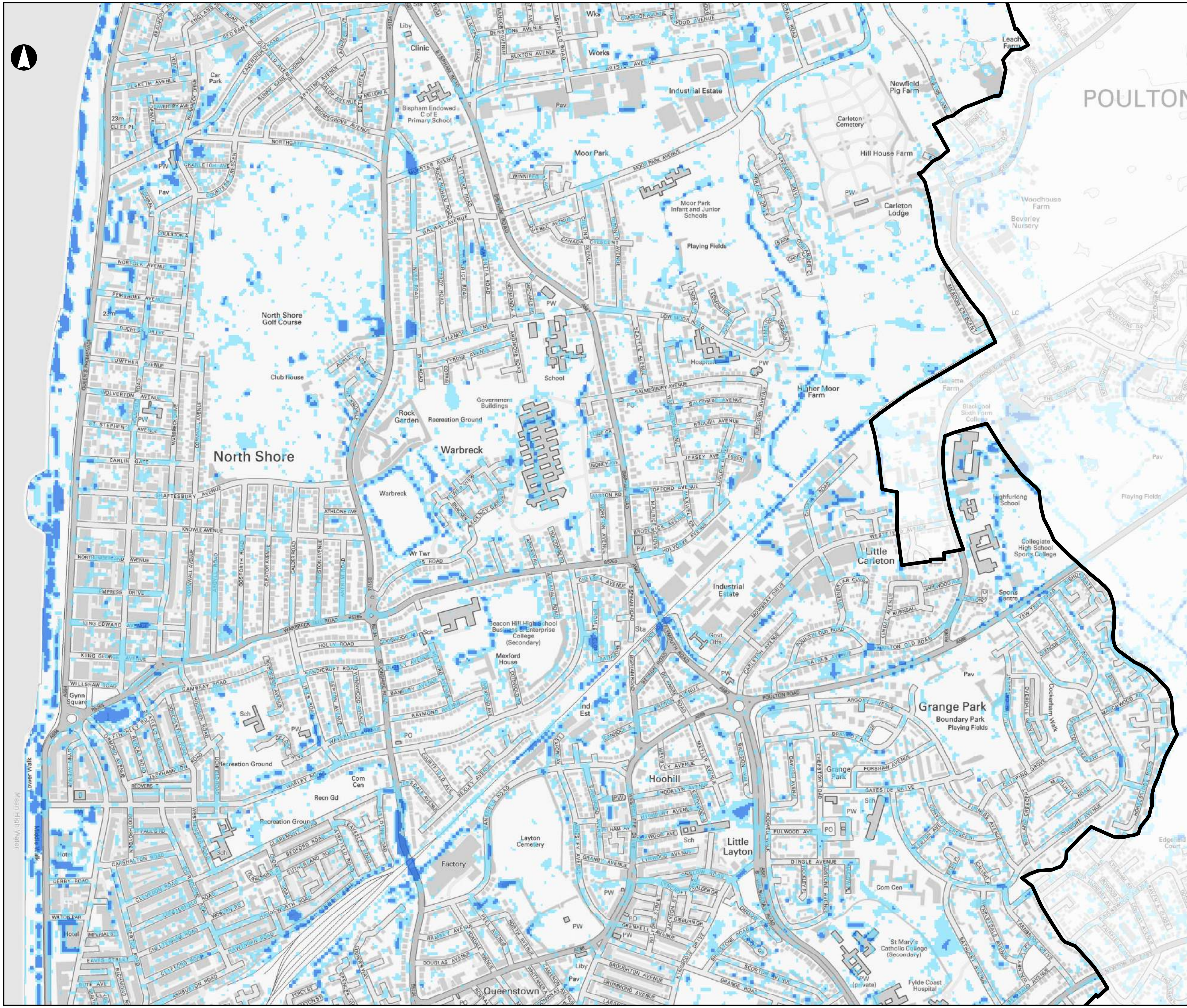
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C2.1	D1

26/03/2013 12:11:57

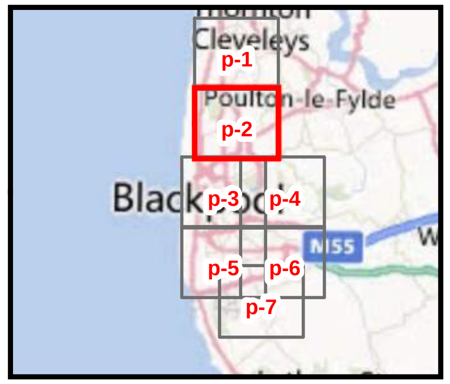
MXD Location

A3



Legend

- Blackpool Council boundary
- 5% (1 in 20yr)
- Maximum flood depth (m)
  - < 0.1
  - 0.1 - 0.3
  - > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres
0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client
Blackpool Council

Job Title
Blackpool Surface Water Management Plan

Surface water flood risk areas 5% (1 in 20yr)

Scale at A3
1:10,000

Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C2.2	**D1**

26/03/2013 12:12:05

MXD Location

A3

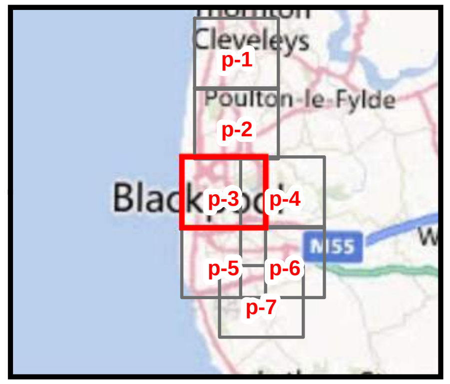
Legend

Blackpool Council boundary

5% (1 in 20yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



Issue	Date	By	Chkd	Appd
D1	2013-03-26	DVDL	LB	KP

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 5% (1 in 20yr)

Scale at A3

1:10,000

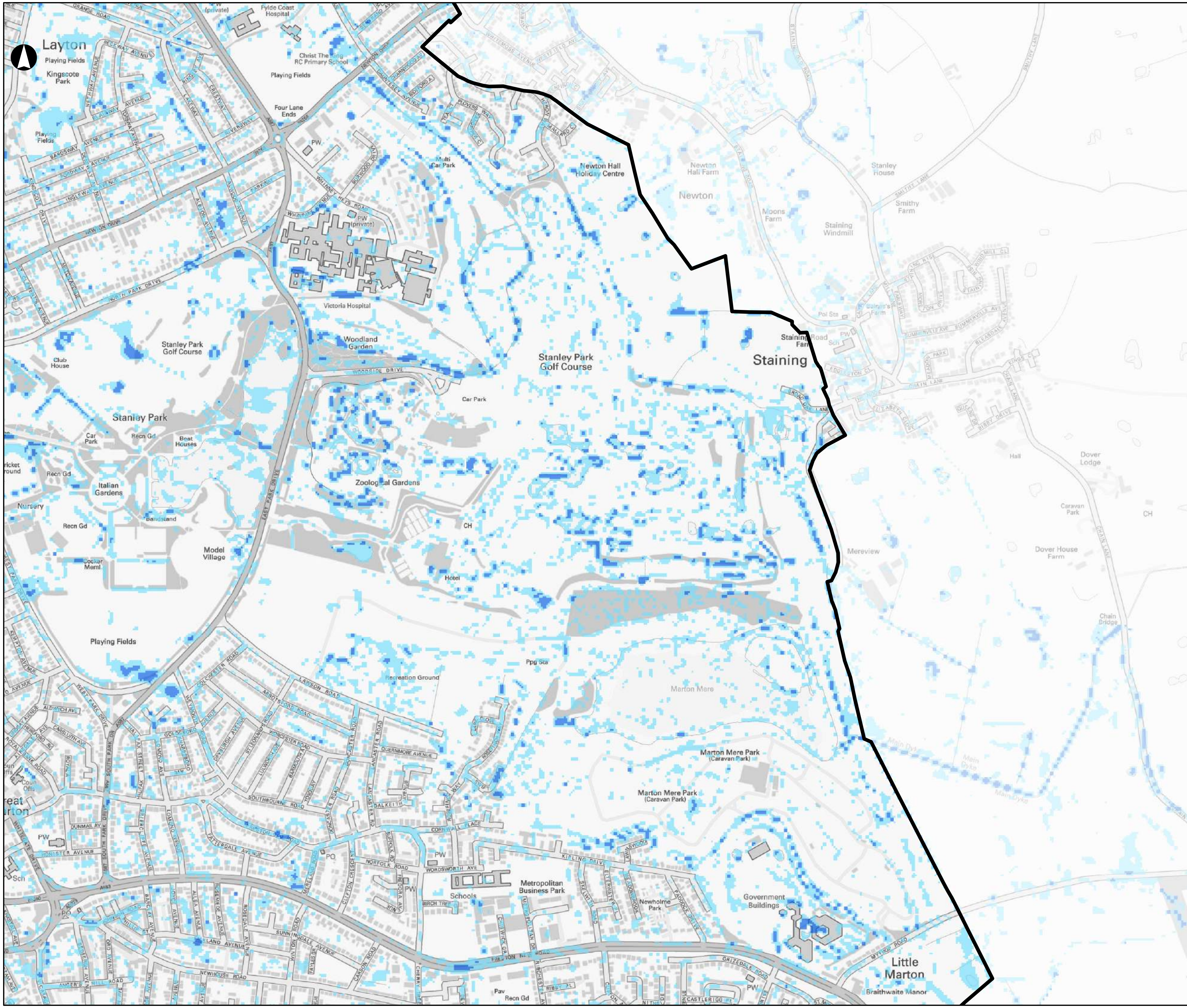
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C2.3	D1

26/03/2013 12:12:13

MXD Location

A3



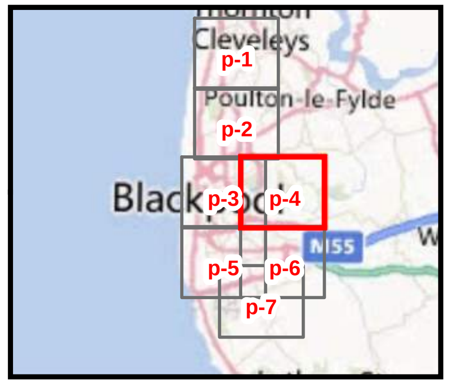
Legend

Blackpool Council boundary

5% (1 in 20yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



Issue	Date	By	Chkd	Appd
D1	2013-03-26	DVDL	LB	KP

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 5% (1 in 20yr)

Scale at A3

1:10,000

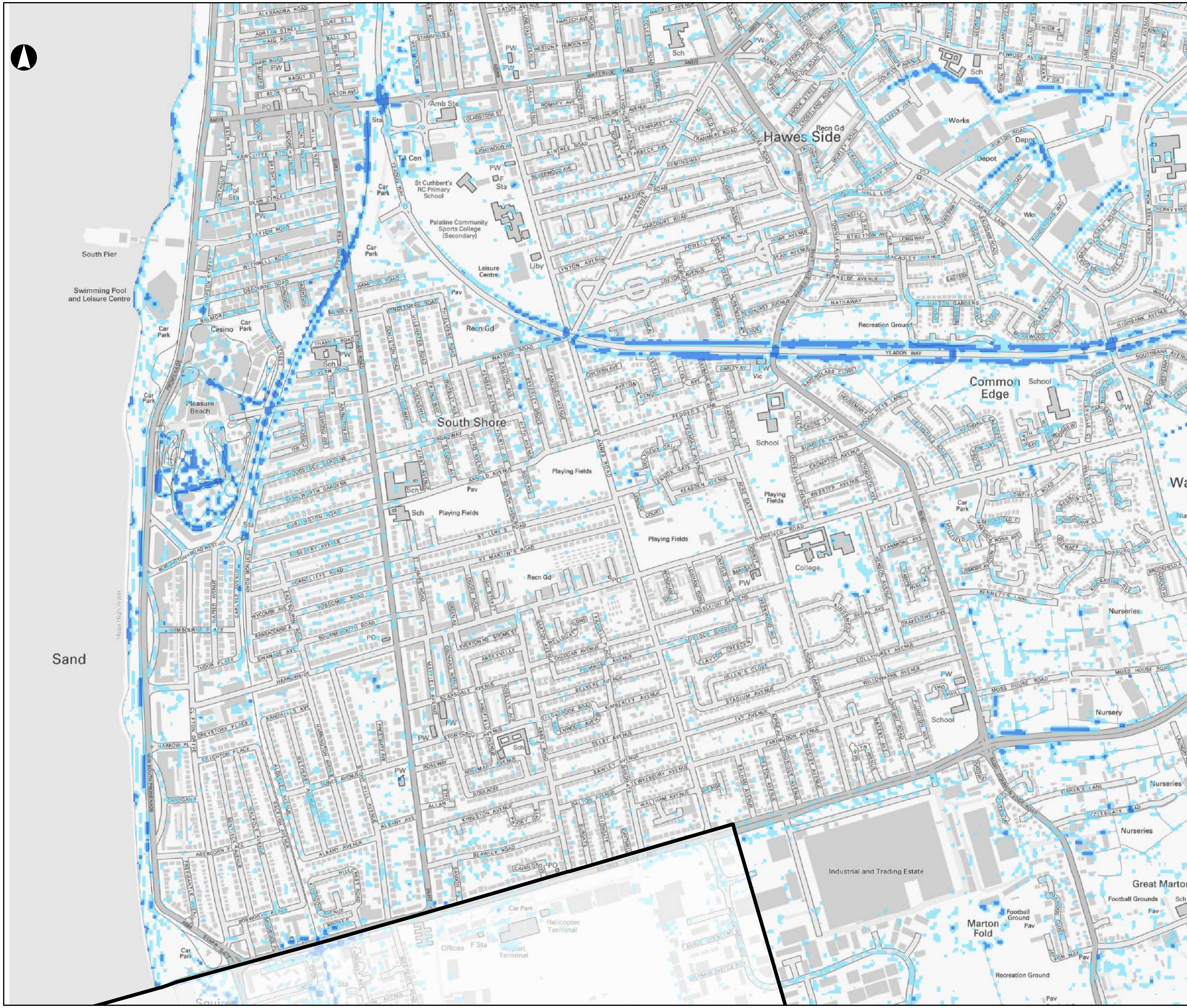
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C2.4	D1

26/03/2013 12:12:20

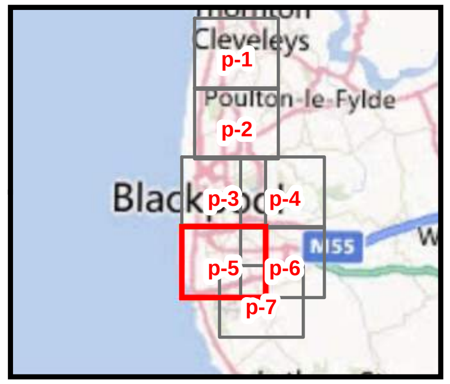
MXD Location

A3



Legend

- Blackpool Council boundary
- 5% (1 in 20yr)
- Maximum flood depth (m)
  - < 0.1
  - 0.1 - 0.3
  - > 0.3



Issue	Date	By	Chkd	Appd
D1	2013-03-26	DVDL	LB	KP

Metres: 0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client
Blackpool Council

Job Title
Blackpool Surface Water Management Plan

Surface water flood risk areas 5% (1 in 20yr)

Scale at A3
1:10,000

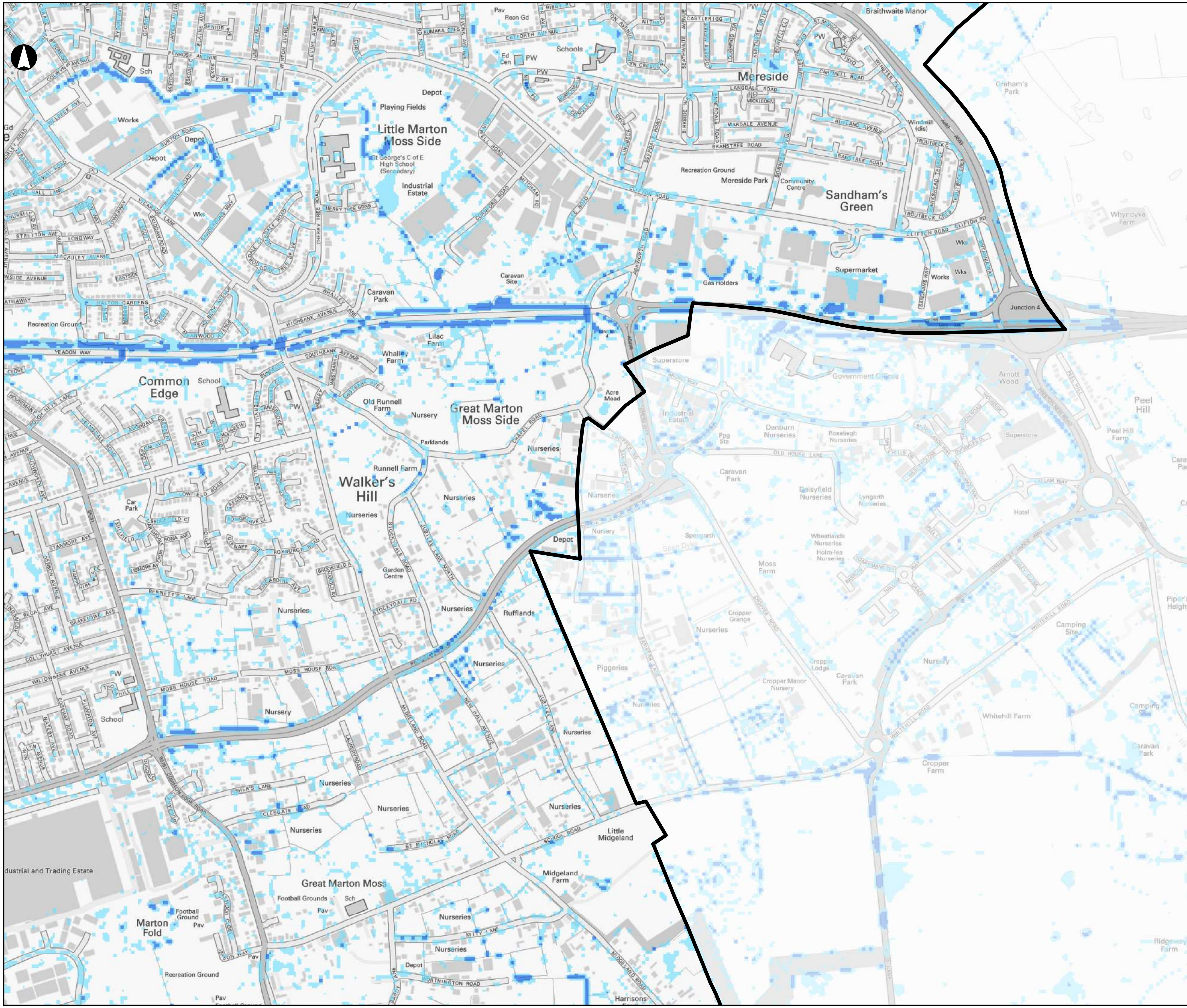
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C2.5	D1

26/03/2013 12:12:27

MXD Location

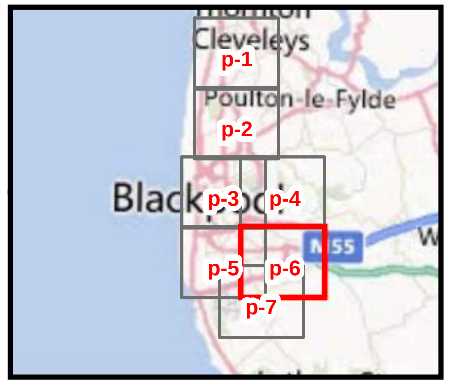
A3



Legend

- Blackpool Council boundary
- 5% (1 in 20yr)
- Maximum flood depth (m)
  - < 0.1
  - 0.1 - 0.3
  - > 0.3

Contains Ordnance Survey data © Crown copyright and database right 2013



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres: 0, 137.5, 275, 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 5% (1 in 20yr)

Scale at A3

1:10,000

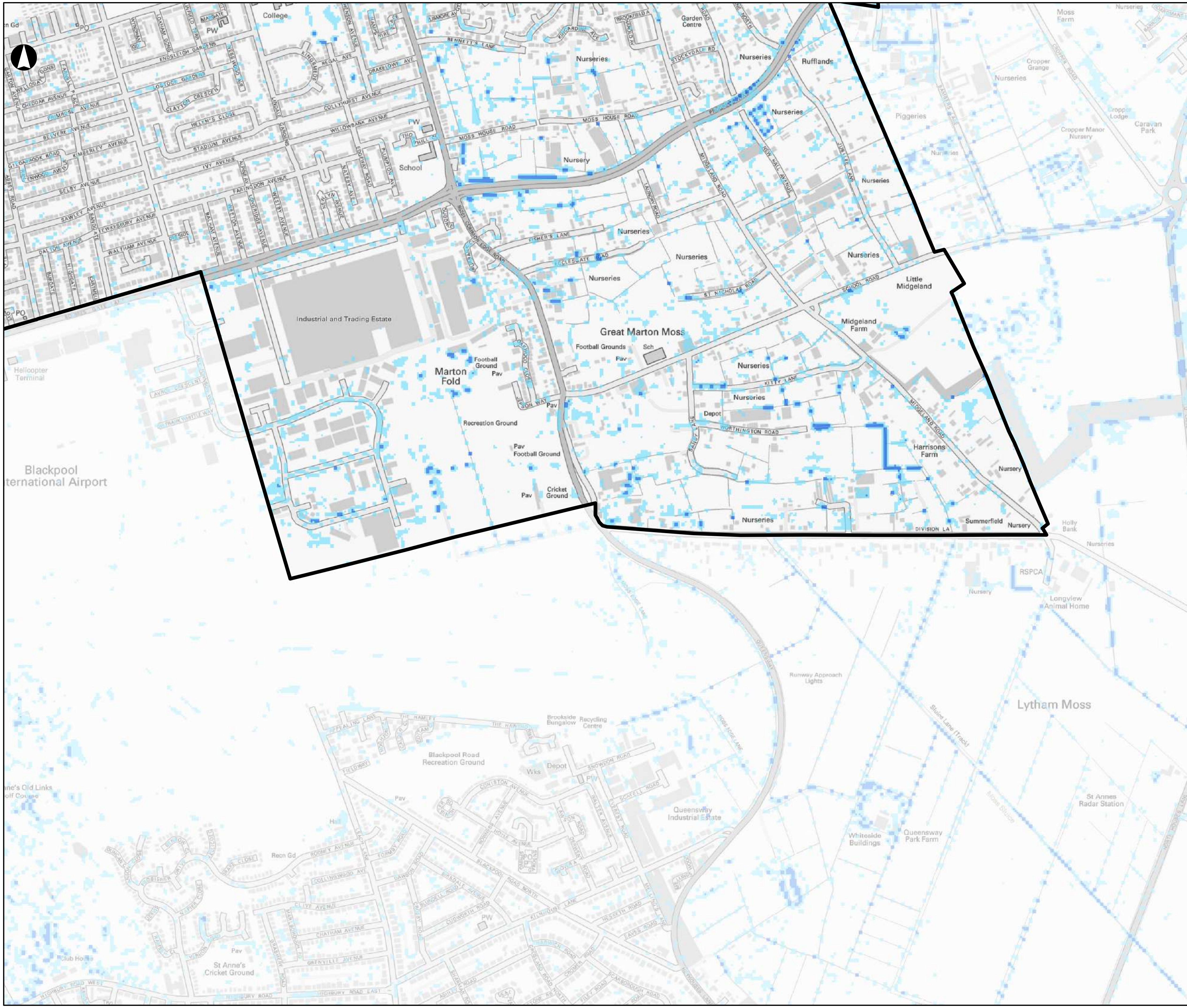
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C2.6	D1

26/03/2013 12:12:34

MXD Location

A3



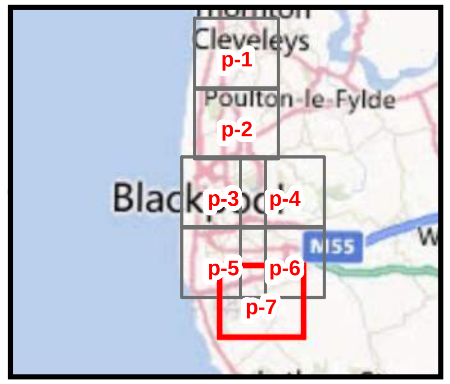
Legend

Blackpool Council boundary

5% (1 in 20yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres
0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client
Blackpool Council

Job Title
Blackpool Surface Water Management Plan

Surface water flood risk areas 5% (1 in 20yr)

Scale at A3
1:10,000

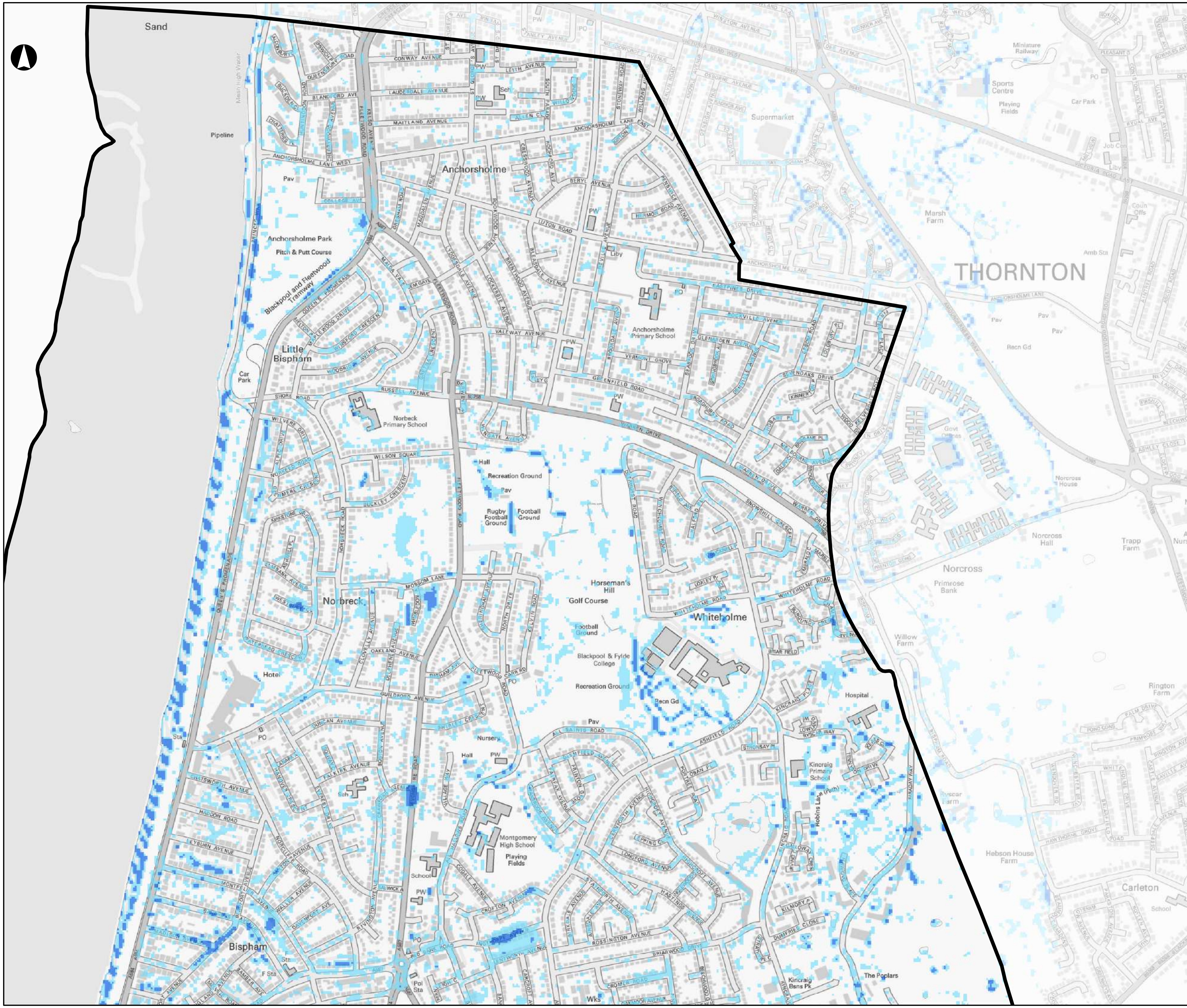
Job No	Drawing Status
227357	For Issue

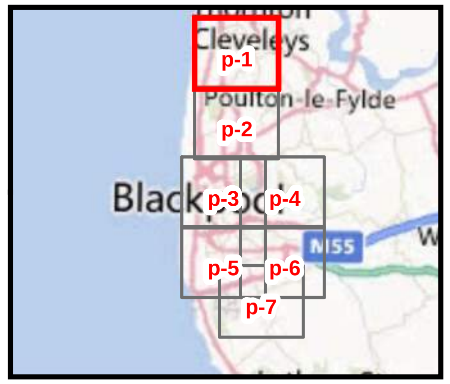
Drawing No	Issue
C2.7	D1

26/03/2013 12:12:41

MXD Location

A3





Legend

Blackpool Council boundary

3.3% (1 in 30yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3

D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 3.3% (1 in 30yr)

Scale at A3

1:10,000

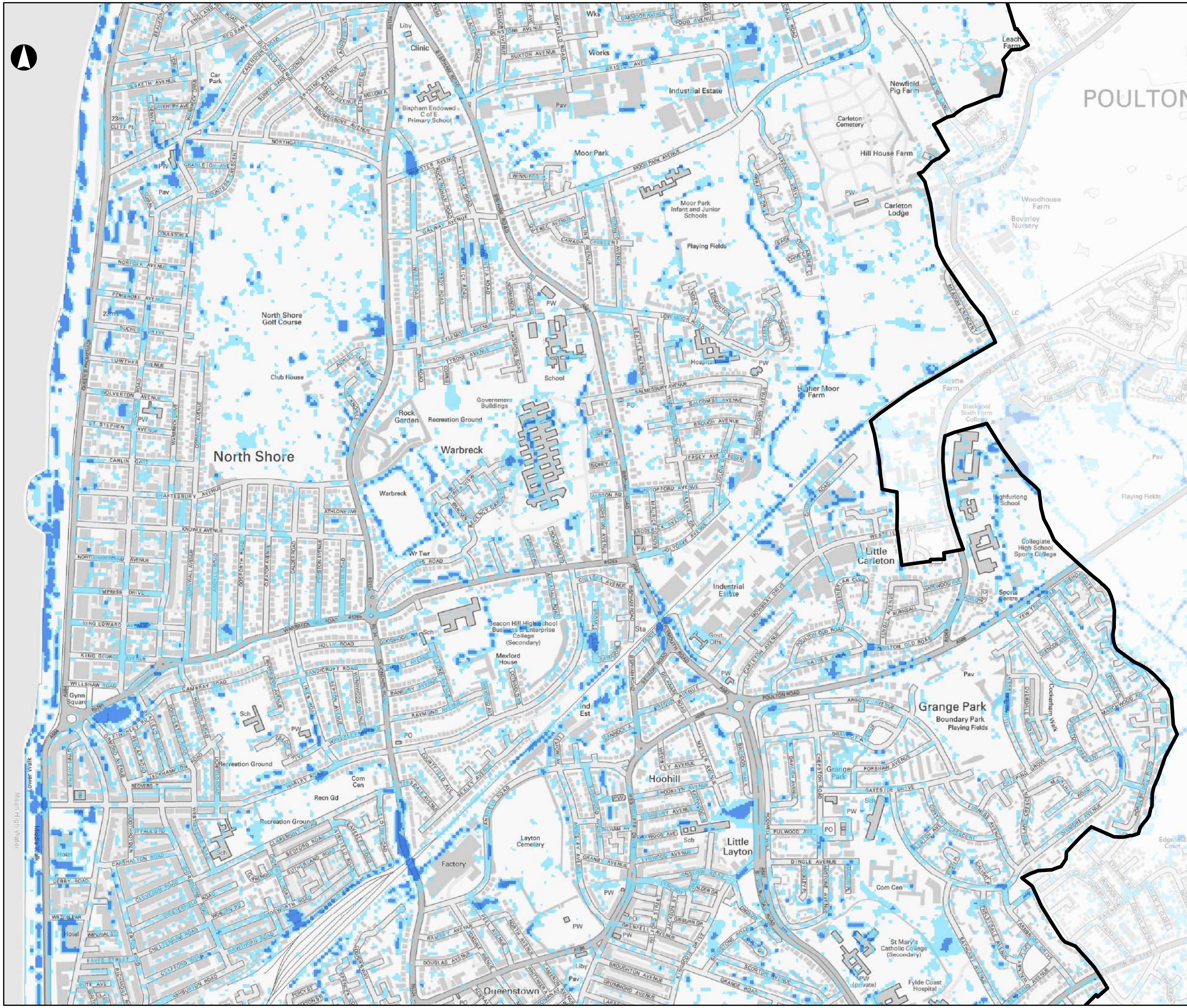
Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C3.1	**D1**

26/03/2013 12:12:48

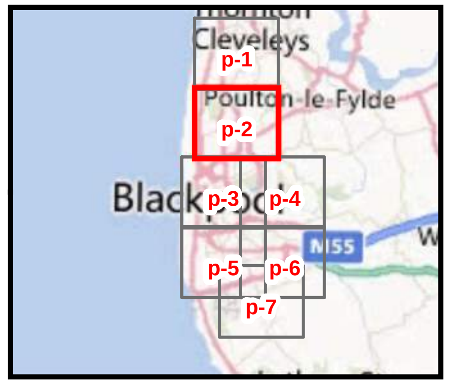
MXD Location

A3



Legend

- Blackpool Council boundary
- 3.3% (1 in 30yr)
- Maximum flood depth (m)
  - < 0.1
  - 0.1 - 0.3
  - > 0.3



Issue	Date	By	Chkd	Appd
D1	2013-03-26	DVDL	LB	KP

Metres: 0 – 137.5 – 275 – 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 3.3% (1 in 30yr)

Scale at A3: **1:10,000**

Job No: **227357**

Drawing Status: **For Issue**

Drawing No: **C3.2**

Issue: **D1**

26/03/2013 12:12:55

MXD Location

A3

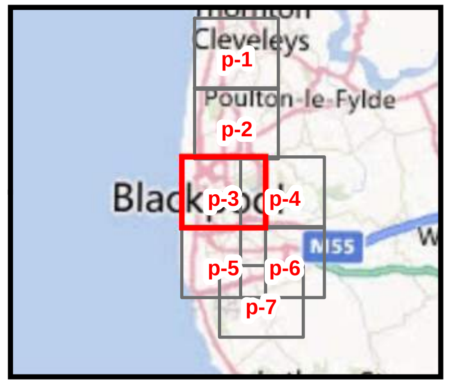
Legend

Blackpool Council boundary

3.3% (1 in 30yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



Issue	Date	By	Chkd	Appd
D1	2013-03-26	DVDL	LB	KP

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 3.3% (1 in 30yr)

Scale at A3

1:10,000

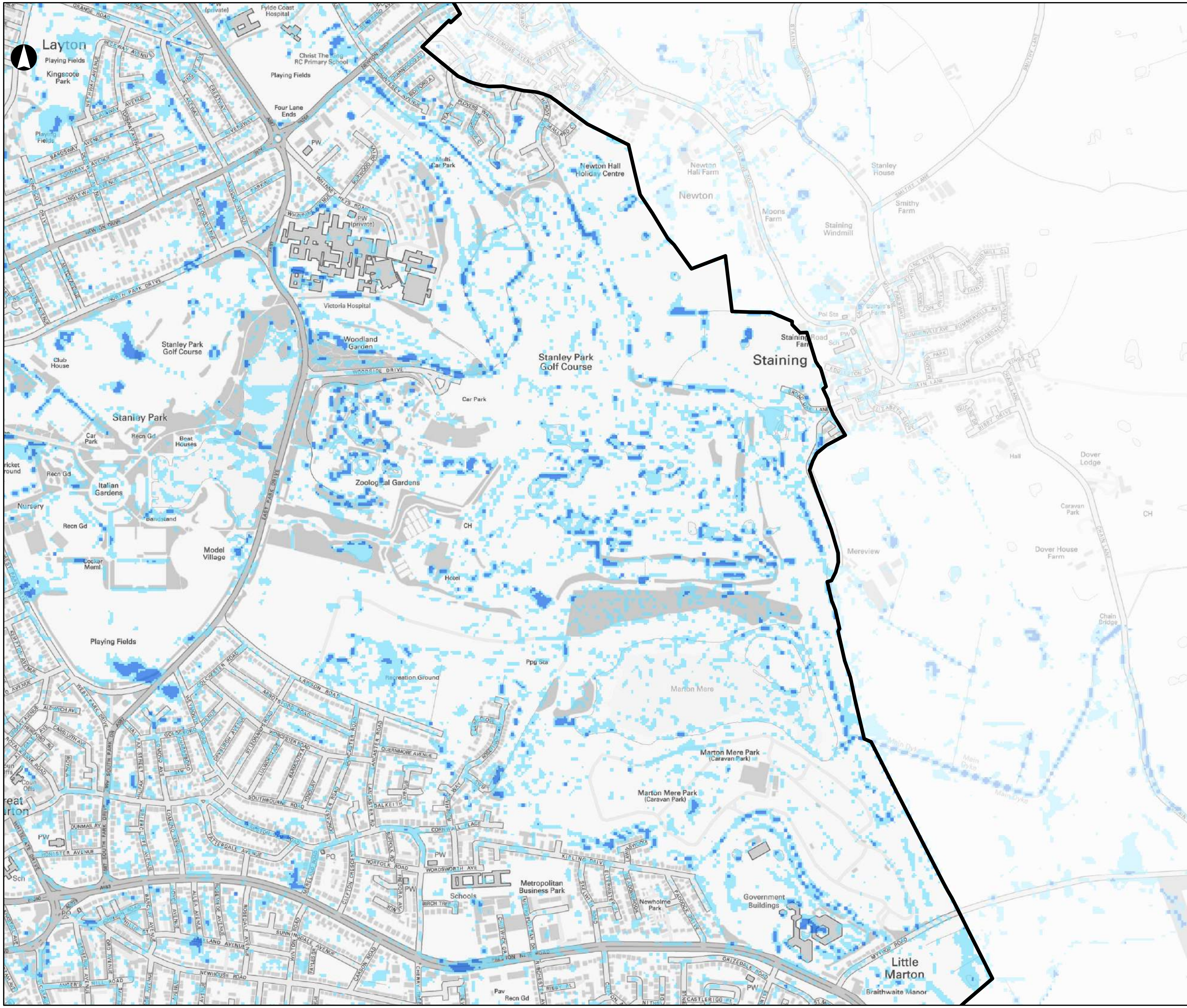
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C3.3	D1

26/03/2013 12:13:01

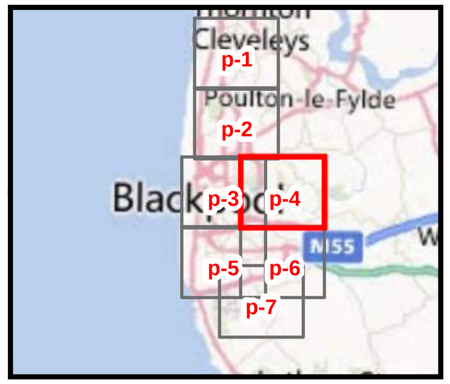
MXD Location

A3



Legend

- Blackpool Council boundary
- 3.3% (1 in 30yr)
- Maximum flood depth (m)
  - < 0.1
  - 0.1 - 0.3
  - > 0.3



Issue	Date	By	Chkd	Appd
D1	2013-03-26	DVDL	LB	KP

Metres: 0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 3.3% (1 in 30yr)

Scale at A3

1:10,000

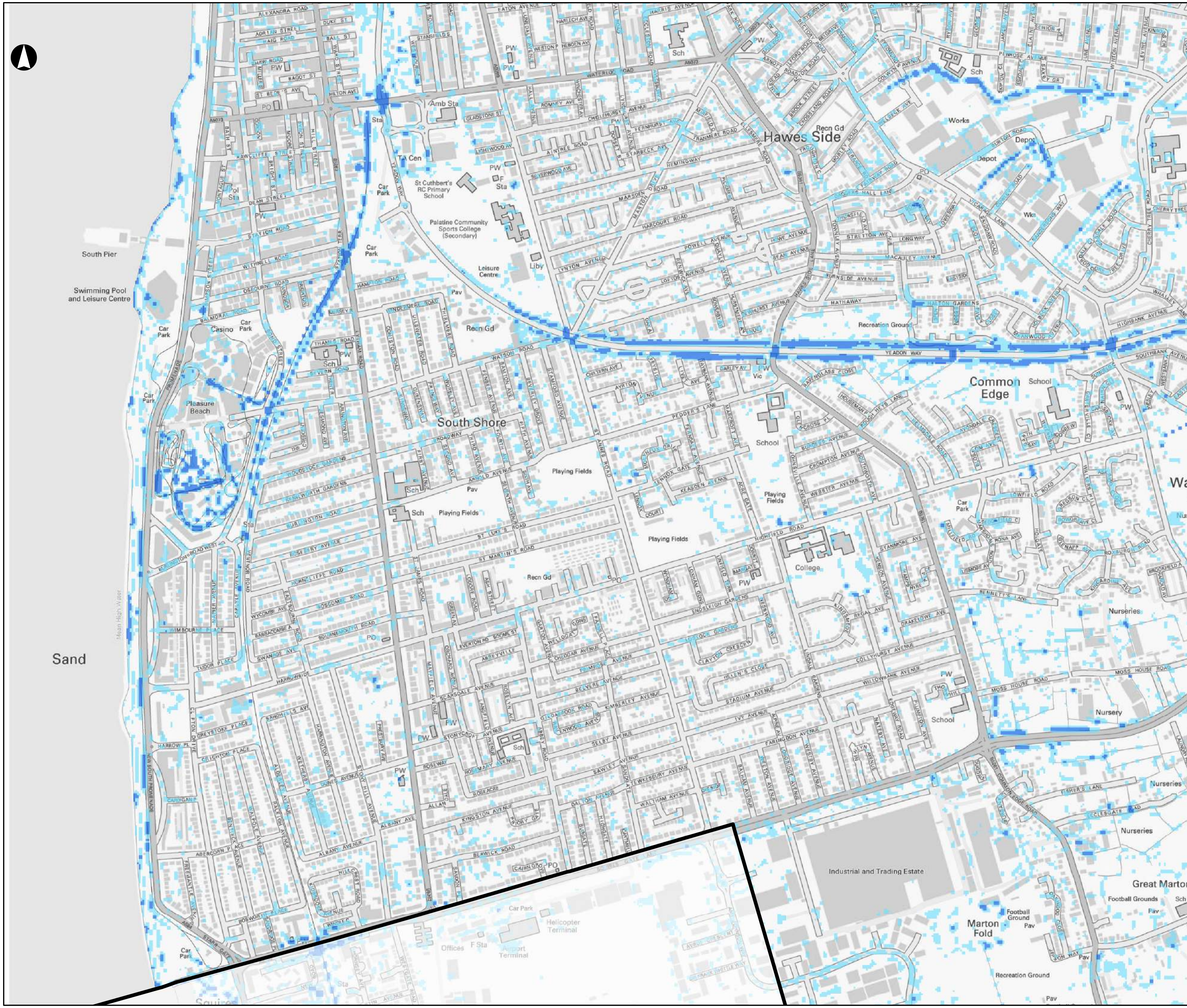
Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C3.4	**D1**

26/03/2013 12:13:08

MXD Location

A3



Legend

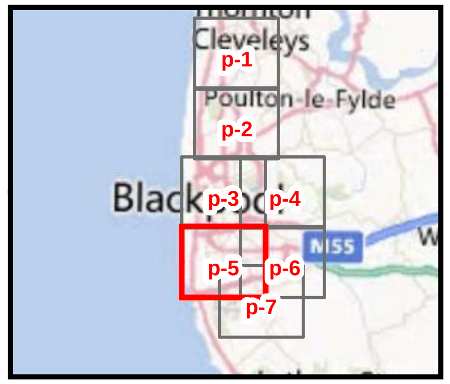
Blackpool Council boundary

3.3% (1 in 30yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3

Contains Ordnance Survey data © Crown copyright and database right 2013



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres
0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 3.3% (1 in 30yr)

Scale at A3

1:10,000

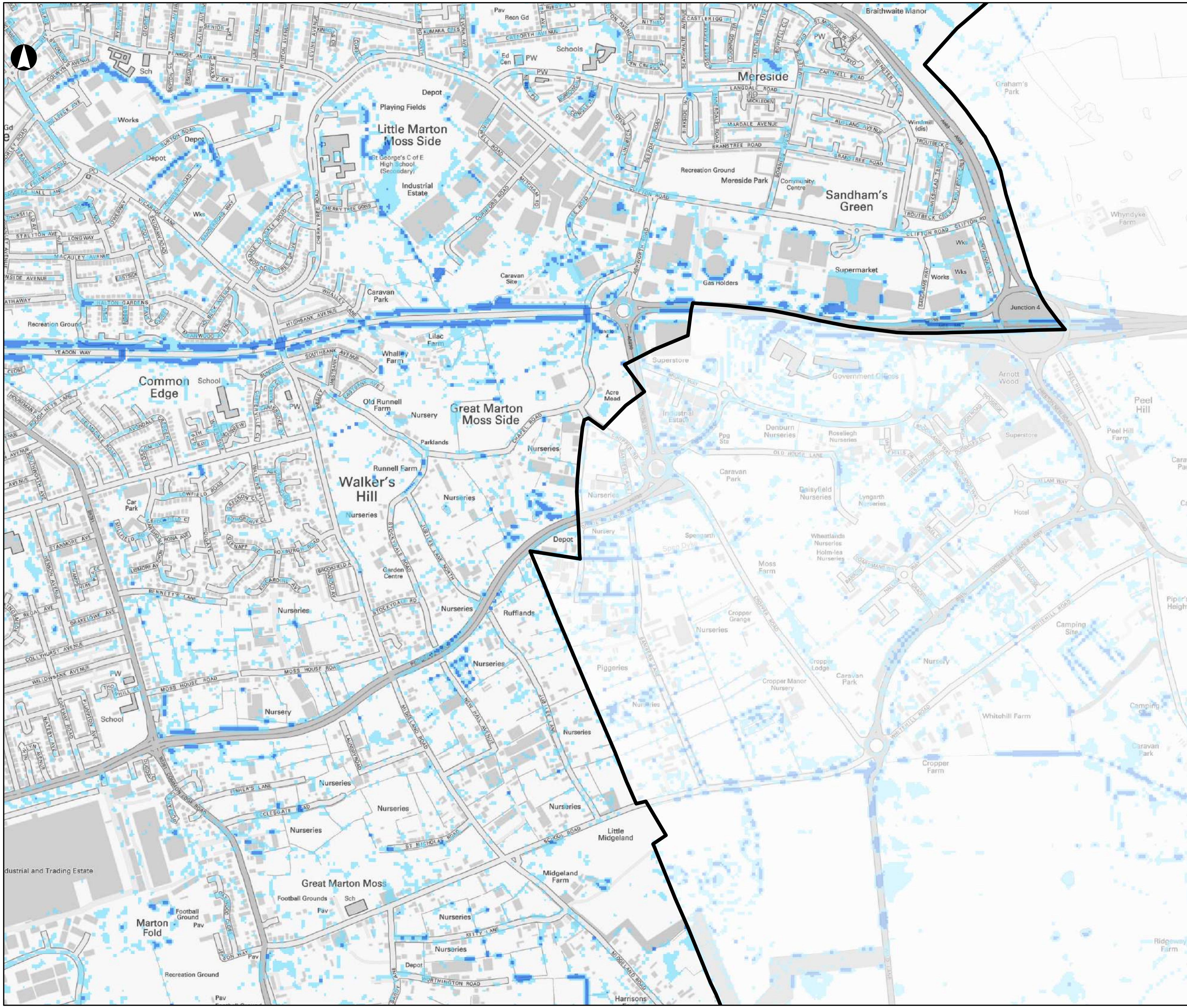
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C3.5	D1

26/03/2013 12:13:21

MXD Location

A3



MXD Location

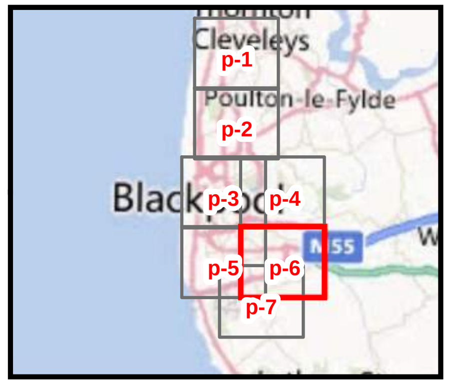
Legend

Blackpool Council boundary

3.3% (1 in 30yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 3.3% (1 in 30yr)

Scale at A3

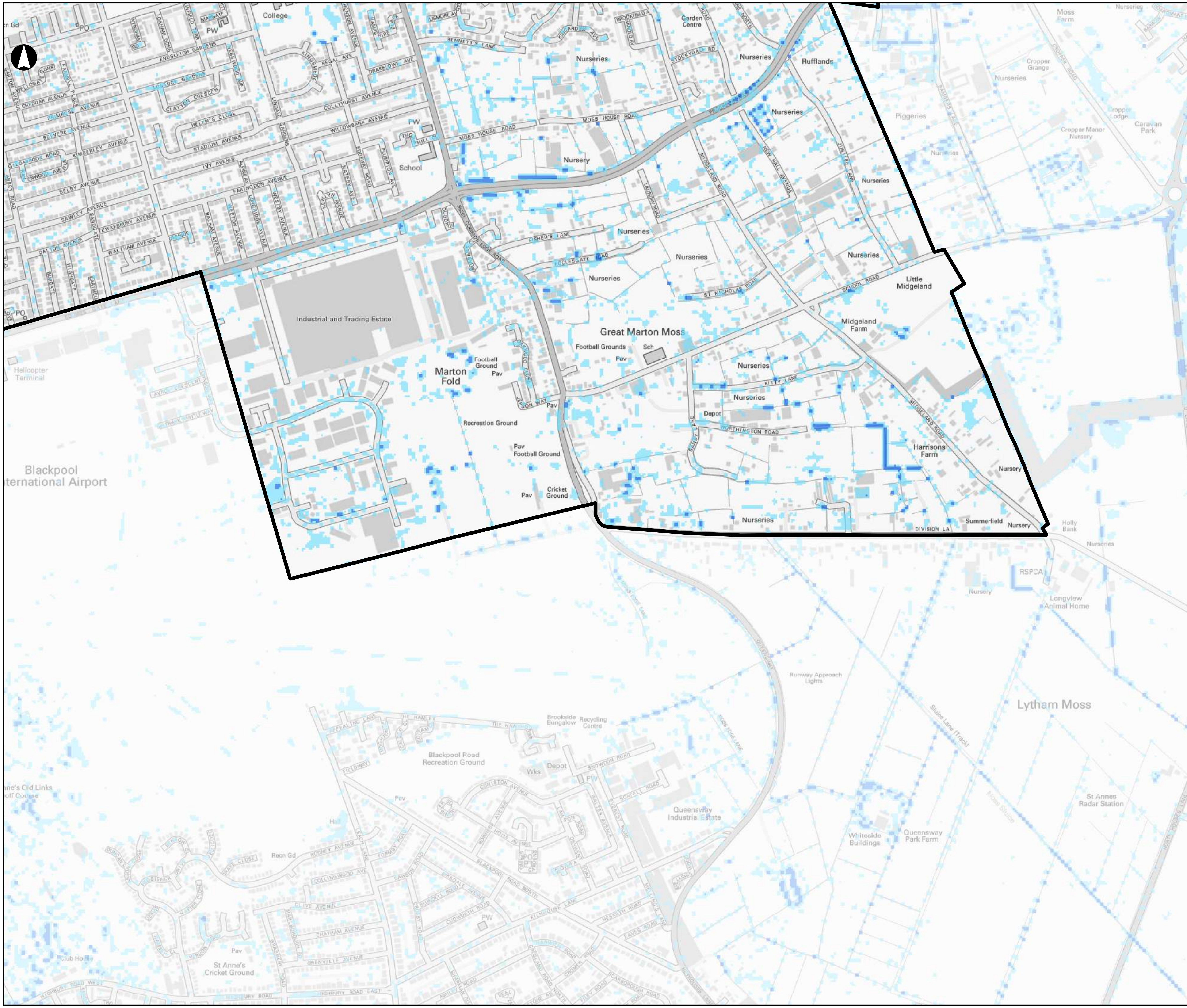
1:10,000

Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C3.6	D1

26/03/2013 12:13:28

A3



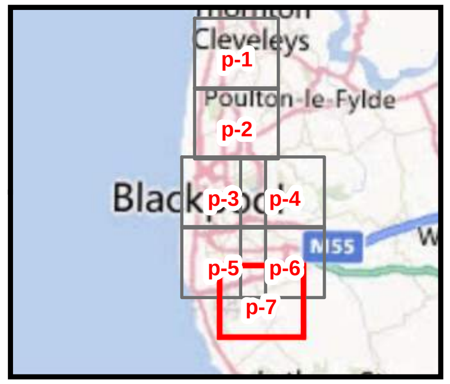
Legend

Blackpool Council boundary

3.3% (1 in 30yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 3.3% (1 in 30yr)

Scale at A3

1:10,000

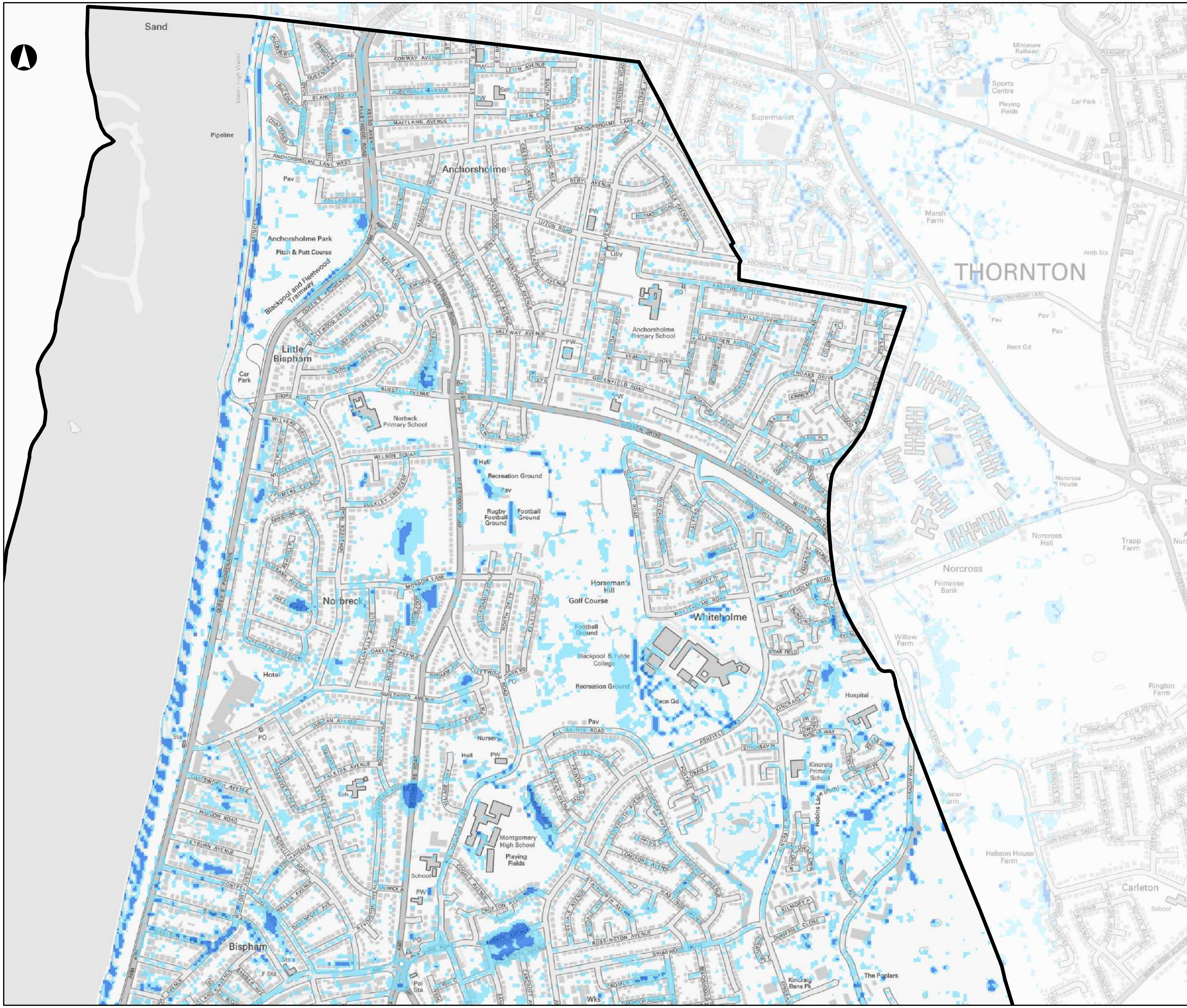
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C3.7	D1

26/03/2013 12:13:35

MXD Location

A3



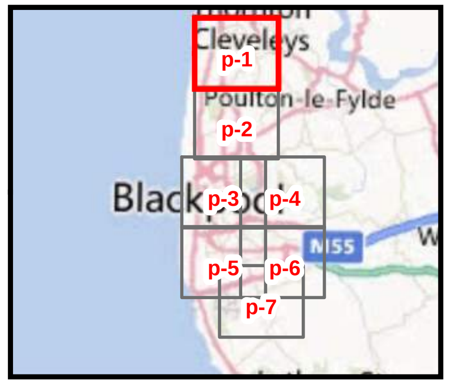
Legend

- Blackpool Council boundary

1.3% (1 in 75yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



Issue	Date	By	Chkd	Appd
D1	2013-03-26	DVDL	LB	KP

Metres: 0, 137.5, 275, 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 1.3% (1 in 75yr)

Scale at A3: **1:10,000**

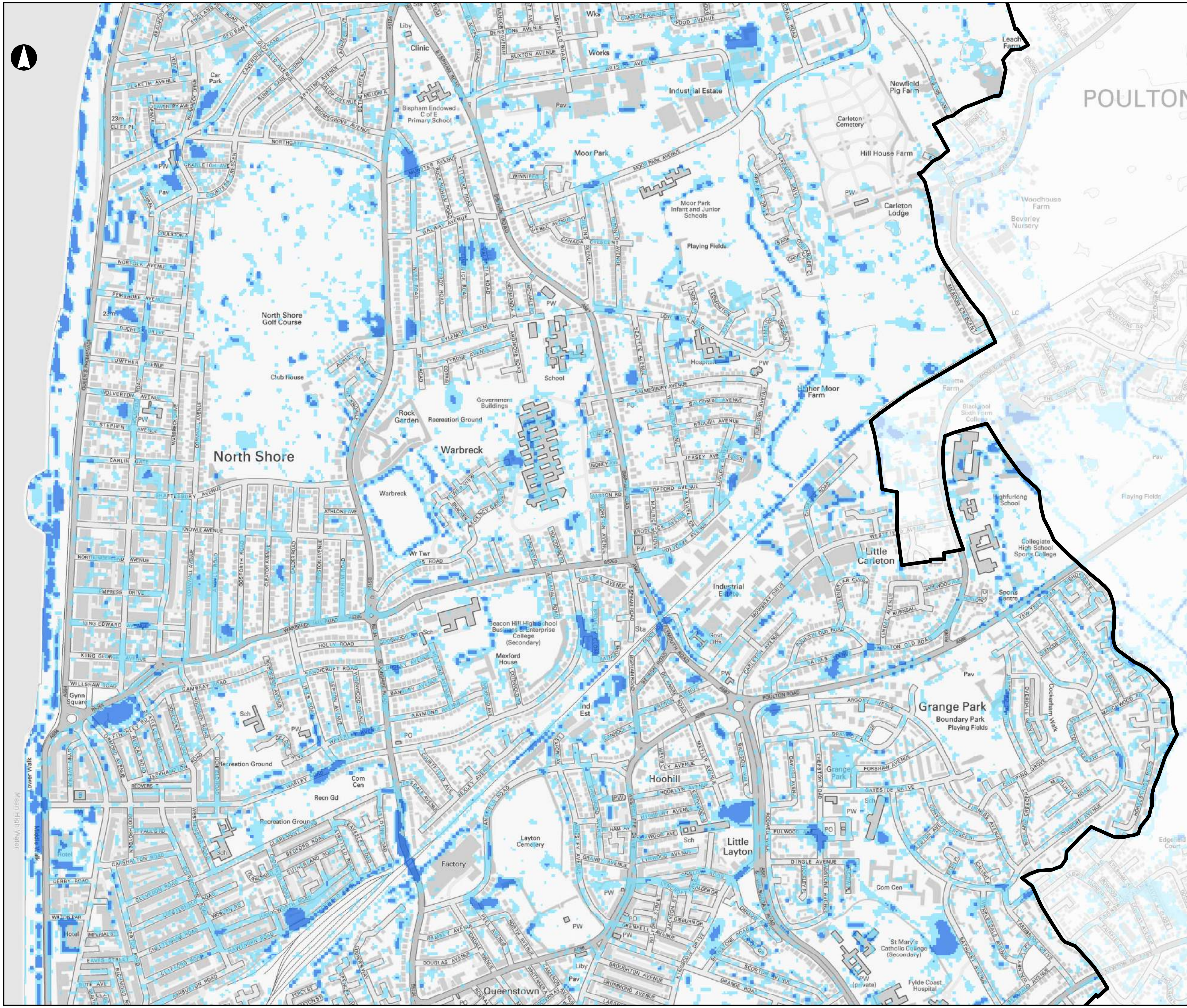
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C4.1	D1

26/03/2013 12:13:41

MXD Location

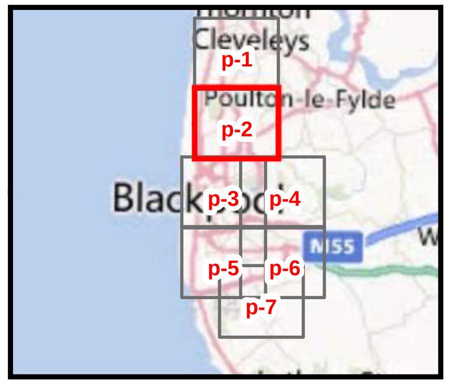
A3



Legend

- Blackpool Council boundary
- 1.3% (1 in 75yr)
- Maximum flood depth (m)
  - < 0.1
  - 0.1 - 0.3
  - > 0.3

Contains Ordnance Survey data © Crown copyright and database right 2013



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 1.3% (1 in 75yr)

Scale at A3

1:10,000

Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C4.2	**D1**

26/03/2013 12:13:49

MXD Location

A3

Legend

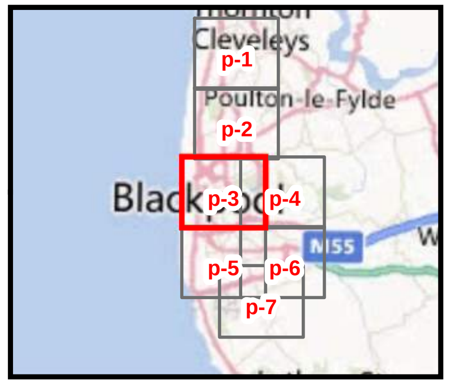
Blackpool Council boundary

1.3% (1 in 75yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3

Contains Ordnance Survey data © Crown copyright and database right 2013



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 1.3% (1 in 75yr)

Scale at A3

1:10,000

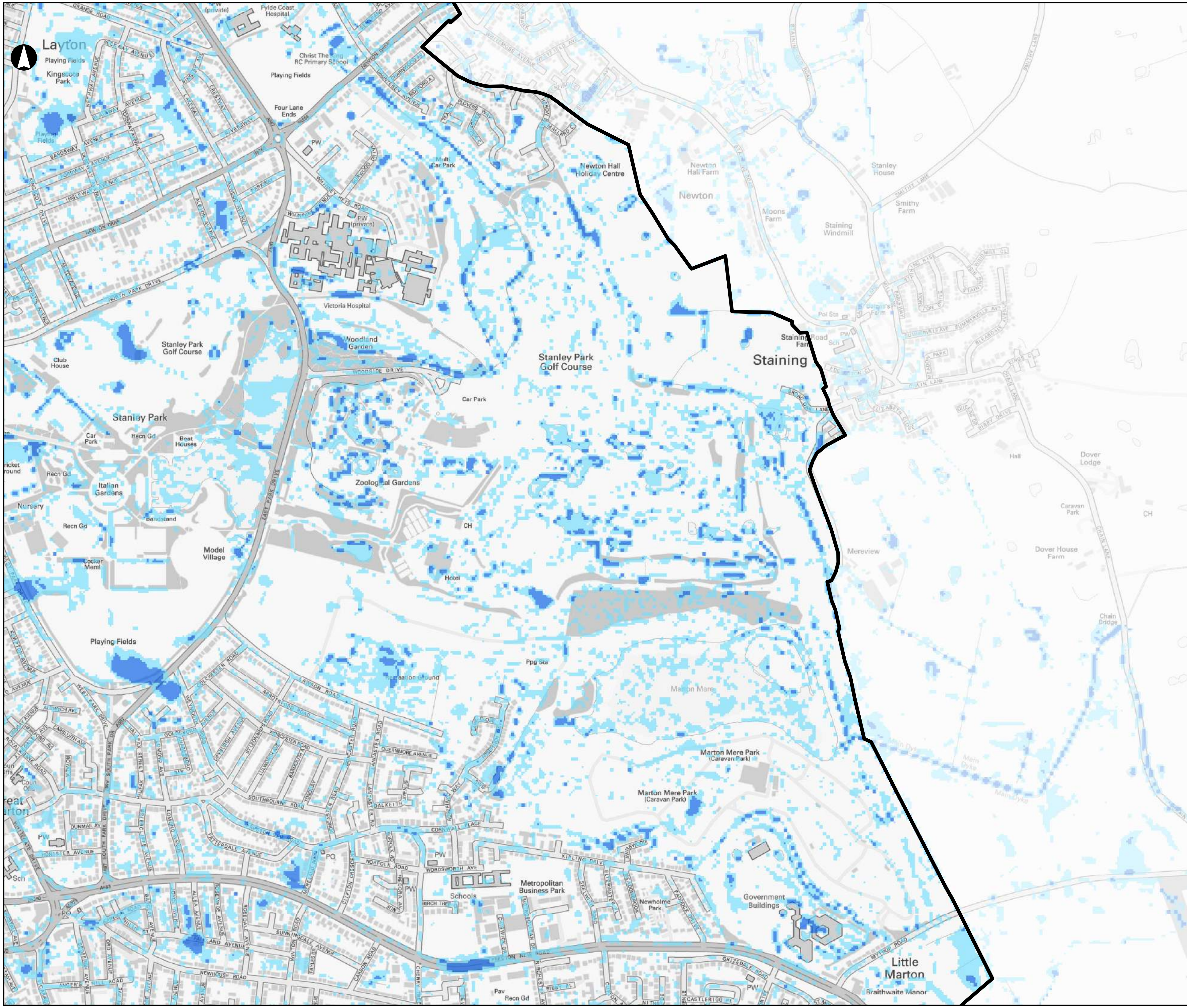
Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C4.3	**D1**

26/03/2013 12:13:56

MXD Location

A3



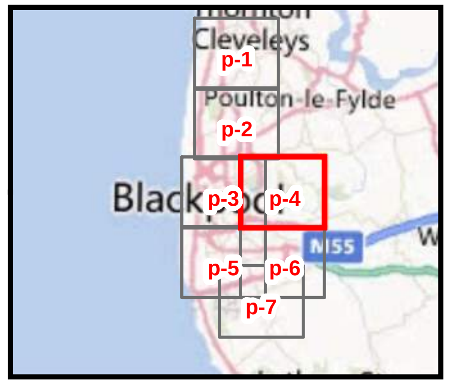
Legend

- Blackpool Council boundary

1.3% (1 in 75yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 1.3% (1 in 75yr)

Scale at A3

1:10,000

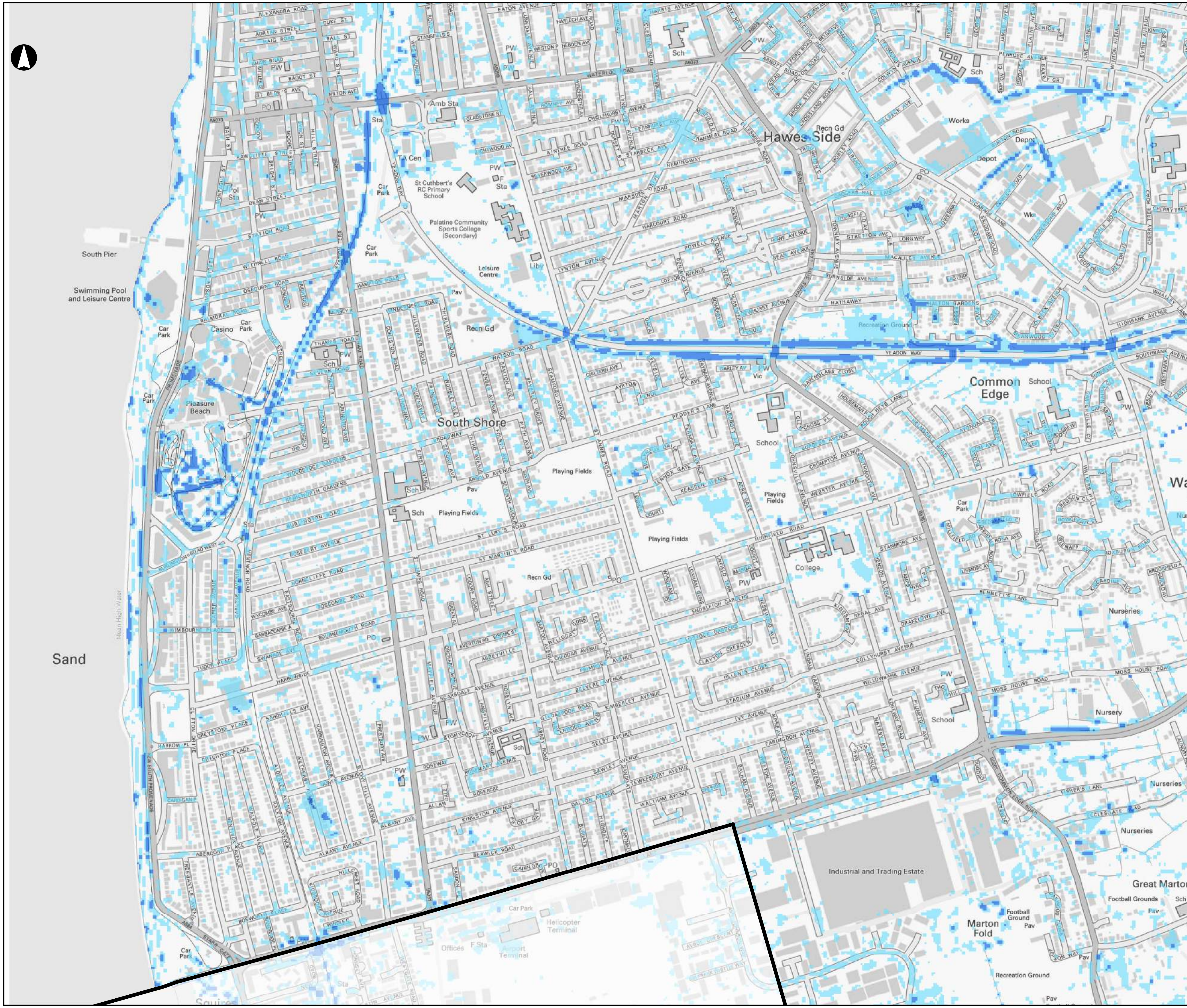
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C4.4	D1

26/03/2013 12:14:03

MXD Location

A3



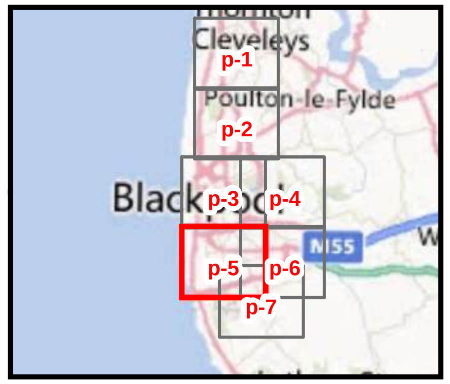
Legend

Blackpool Council boundary

1.3% (1 in 75yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 1.3% (1 in 75yr)

Scale at A3

1:10,000

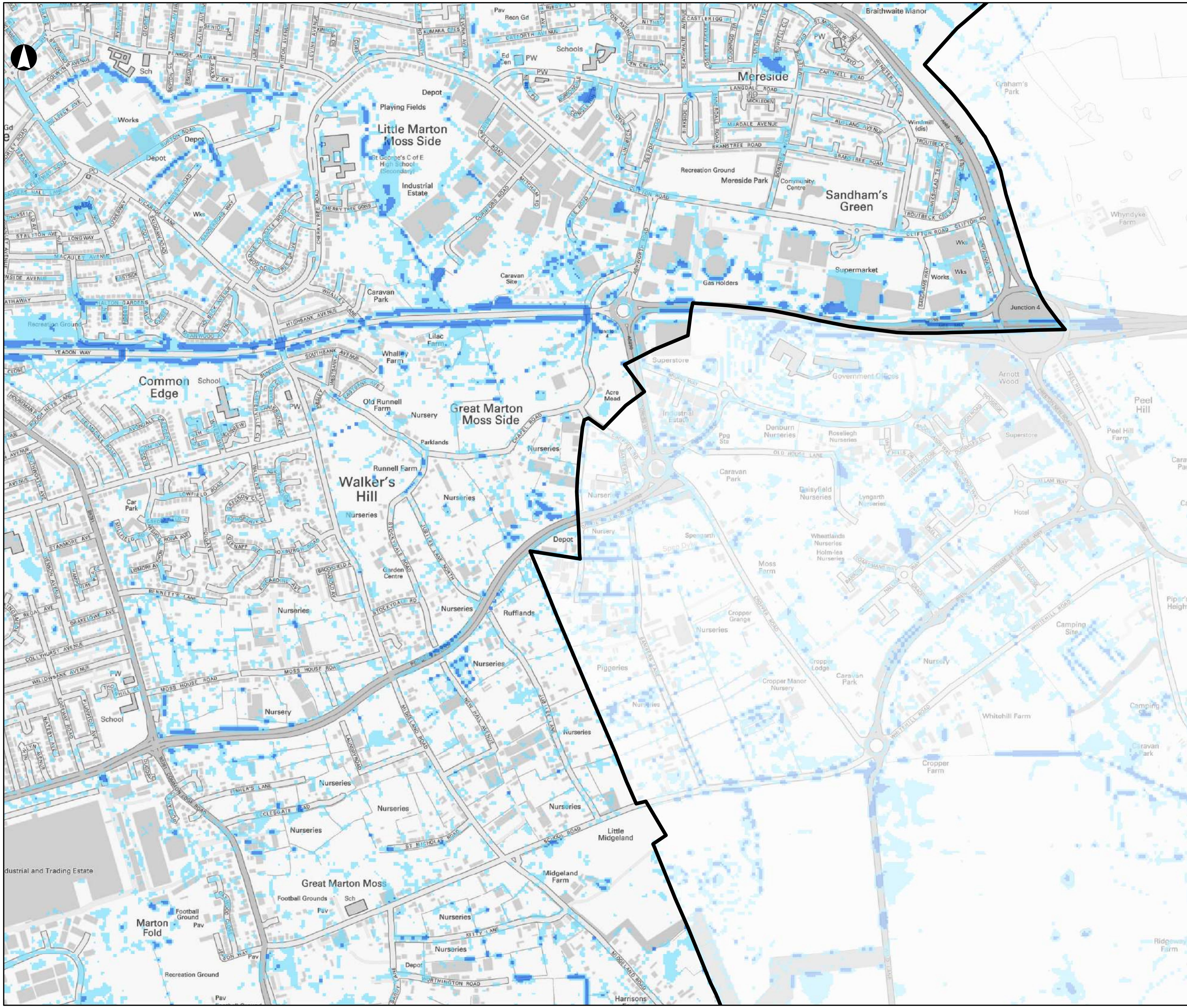
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C4.5	D1

26/03/2013 12:14:10

MXD Location

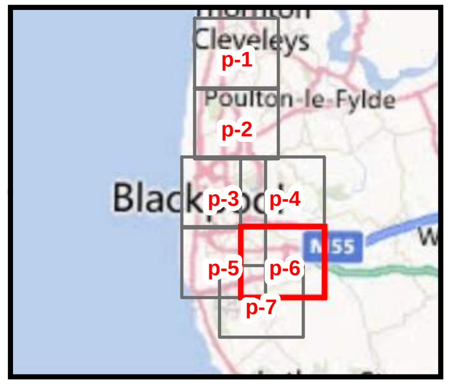
A3



Legend

- Blackpool Council boundary
- 1.3% (1 in 75yr)
- Maximum flood depth (m)
  - < 0.1
  - 0.1 - 0.3
  - > 0.3

Contains Ordnance Survey data © Crown copyright and database right 2013



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres
0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client
Blackpool Council

Job Title
Blackpool Surface Water Management Plan

Surface water flood risk areas 1.3% (1 in 75yr)

Scale at A3
1:10,000

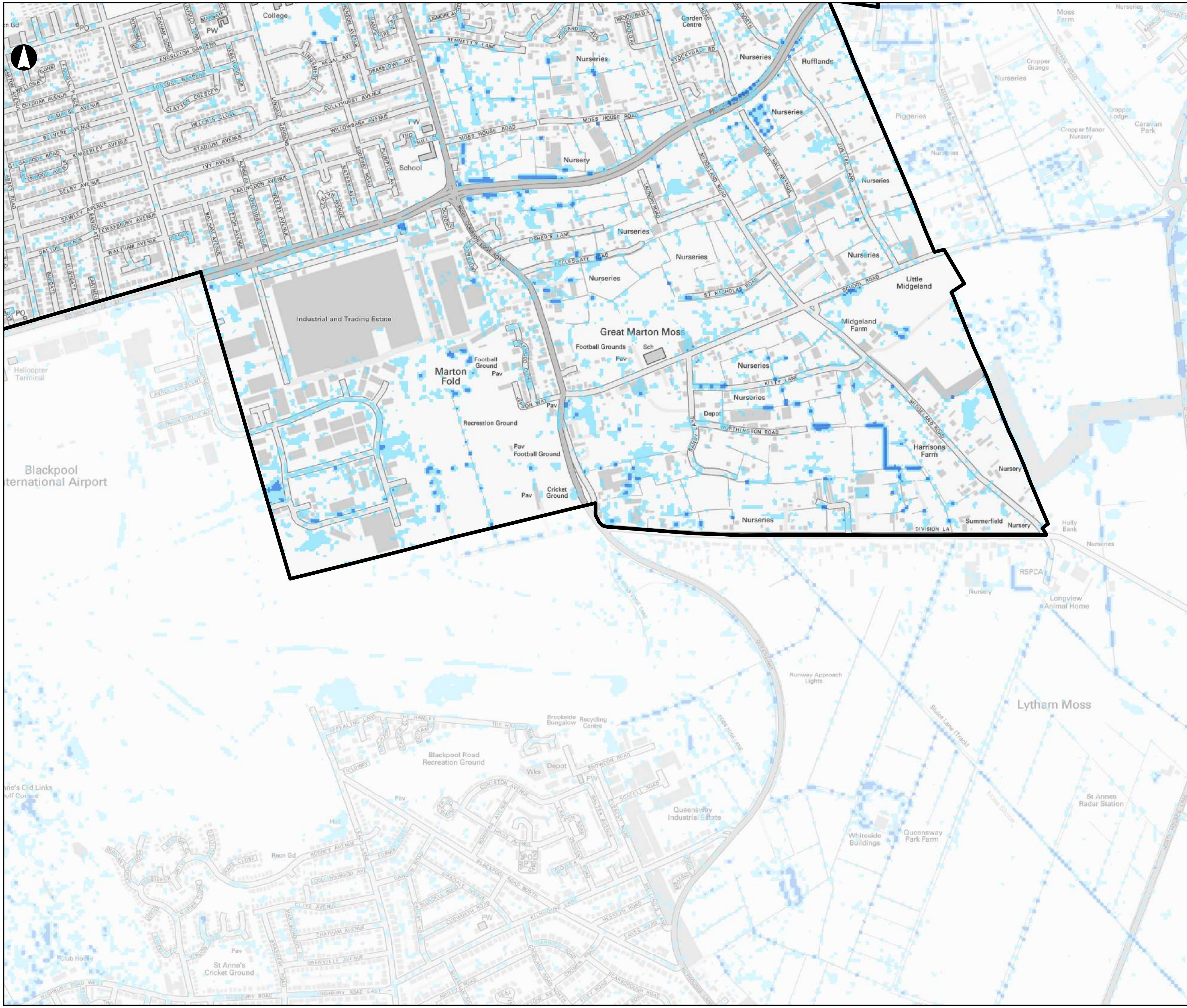
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C4.6	D1

26/03/2013 12:14:17

MXD Location

A3



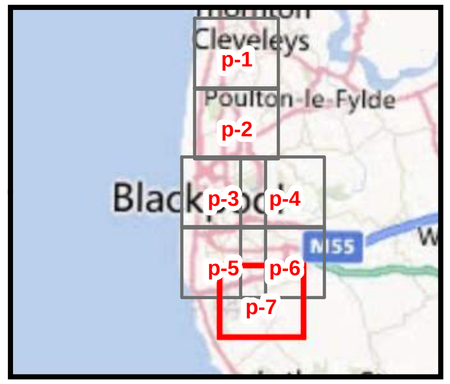
Legend

Blackpool Council boundary

1.3% (1 in 75yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



Issue	Date	By	Chkd	Appd
D1	2013-03-26	DVDL	LB	KP

Metres

0 137.5 275 550

26/03/2013 12:14:24

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 1.3% (1 in 75yr)

Scale at A3

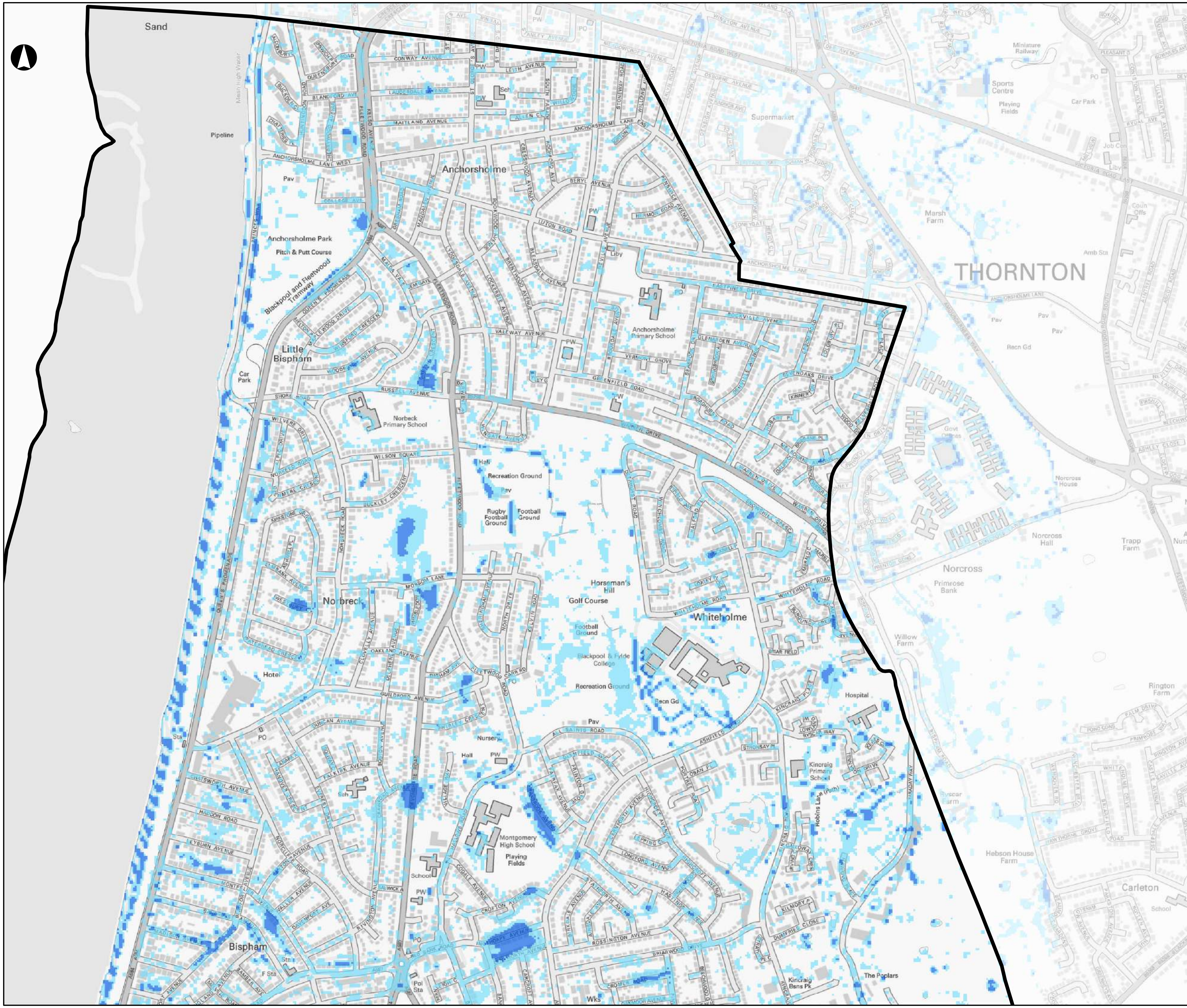
1:10,000

Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C4.7	D1

MXD Location

A3



Legend

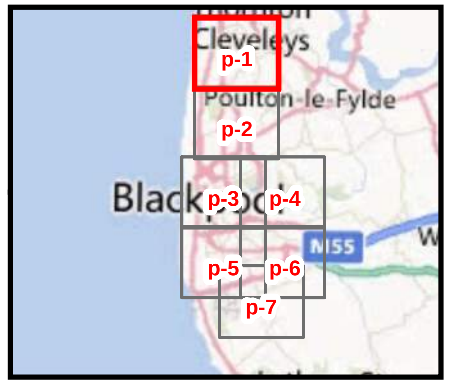
Blackpool Council boundary

1% (1 in 100yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3

Contains Ordnance Survey data © Crown copyright and database right 2013



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 1% (1 in 100yr)

Scale at A3

1:10,000

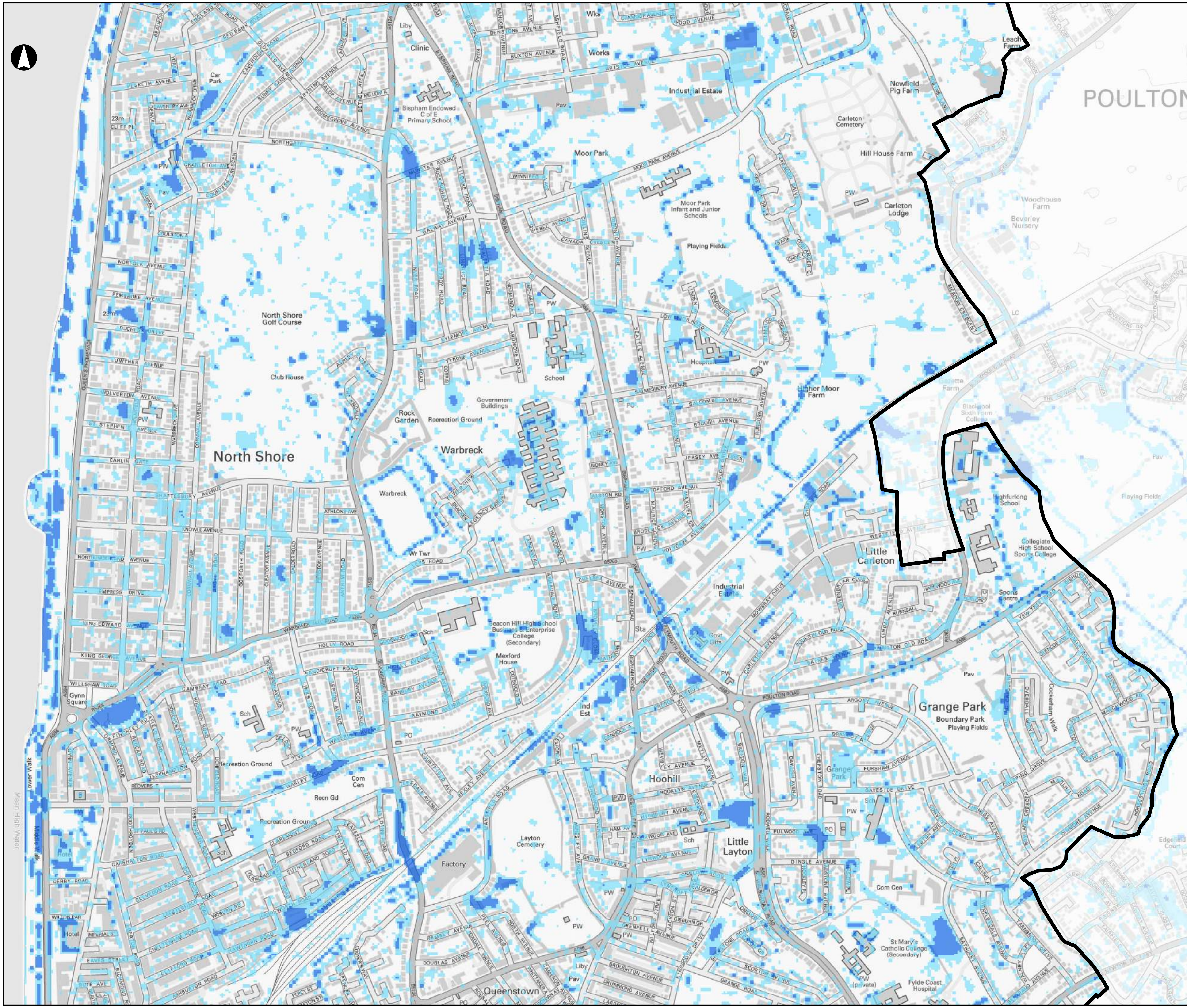
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C5.1	D1

26/03/2013 12:14:31

MXD Location

A3



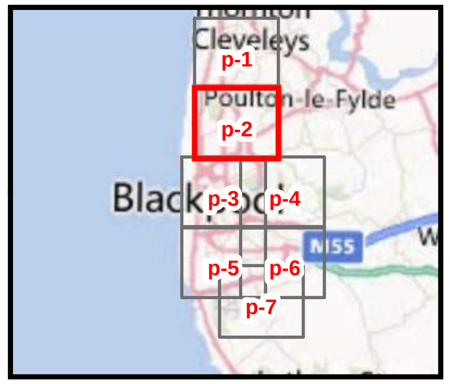
Legend

Blackpool Council boundary

1% (1 in 100yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres: 0 — 137.5 — 275 — 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 1% (1 in 100yr)

Scale at A3

1:10,000

Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C5.2	**D1**

26/03/2013 12:14:39

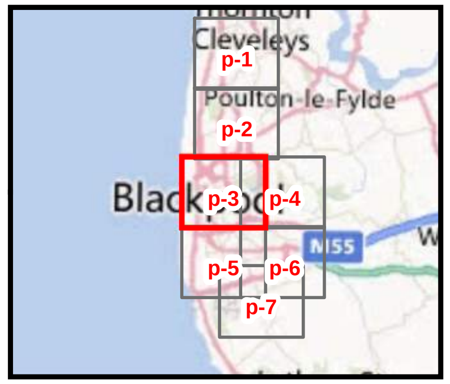
MXD Location

A3

Legend

- Blackpool Council boundary
- 1% (1 in 100yr)
- Maximum flood depth (m)
  - < 0.1
  - 0.1 - 0.3
  - > 0.3

Contains Ordnance Survey data © Crown copyright and database right 2013



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres
0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client
Blackpool Council

Job Title
Blackpool Surface Water Management Plan

Surface water flood risk areas 1% (1 in 100yr)

Scale at A3
1:10,000

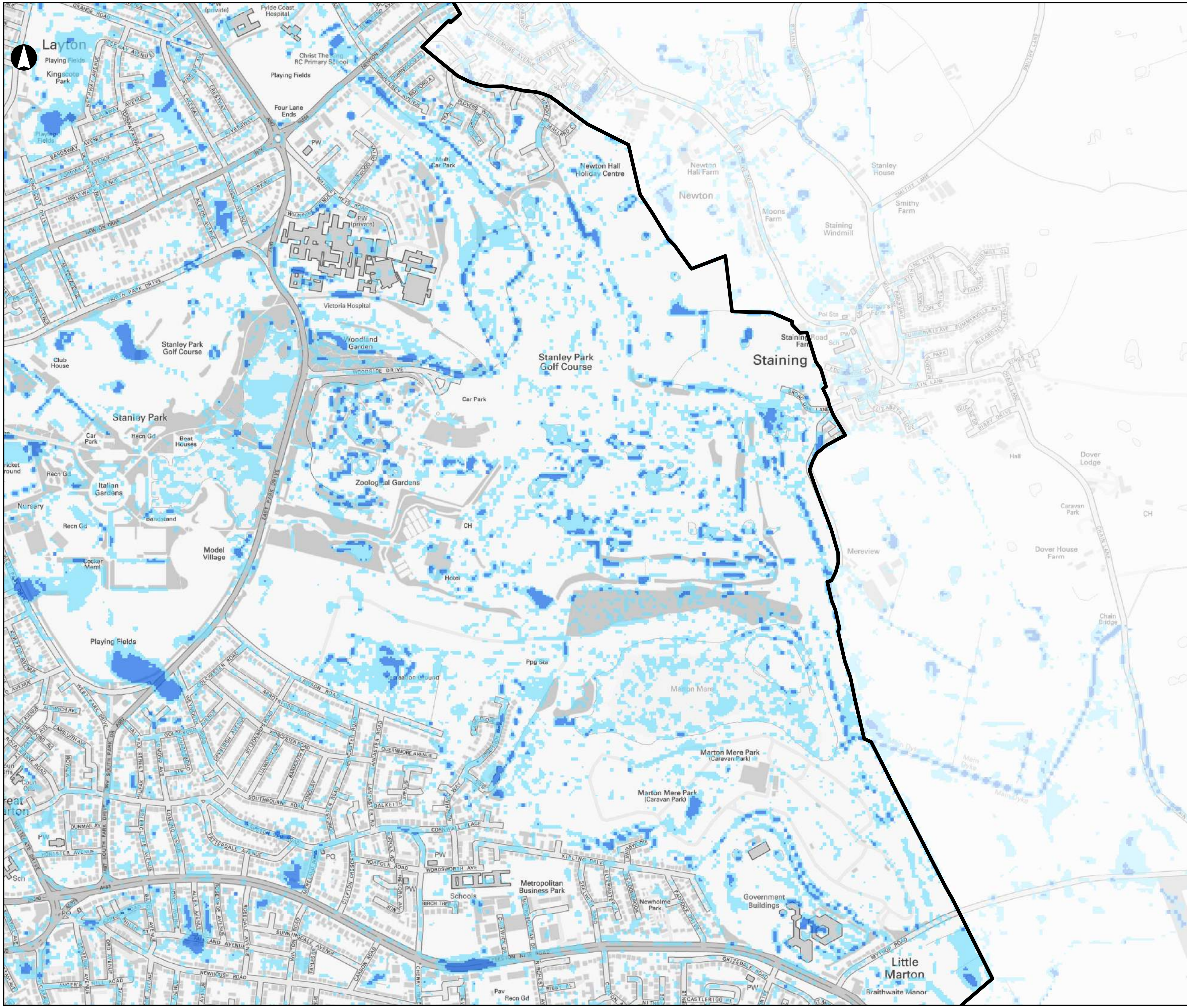
Job No **227357**
Drawing Status **For Issue**

Drawing No **C5.3**
Issue **D1**

26/03/2013 12:14:46

MXD Location

A3



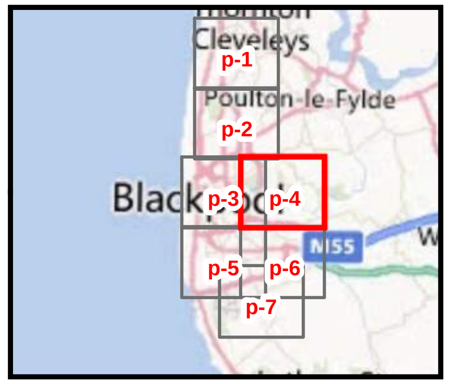
Legend

Blackpool Council boundary

1% (1 in 100yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 1% (1 in 100yr)

Scale at A3

1:10,000

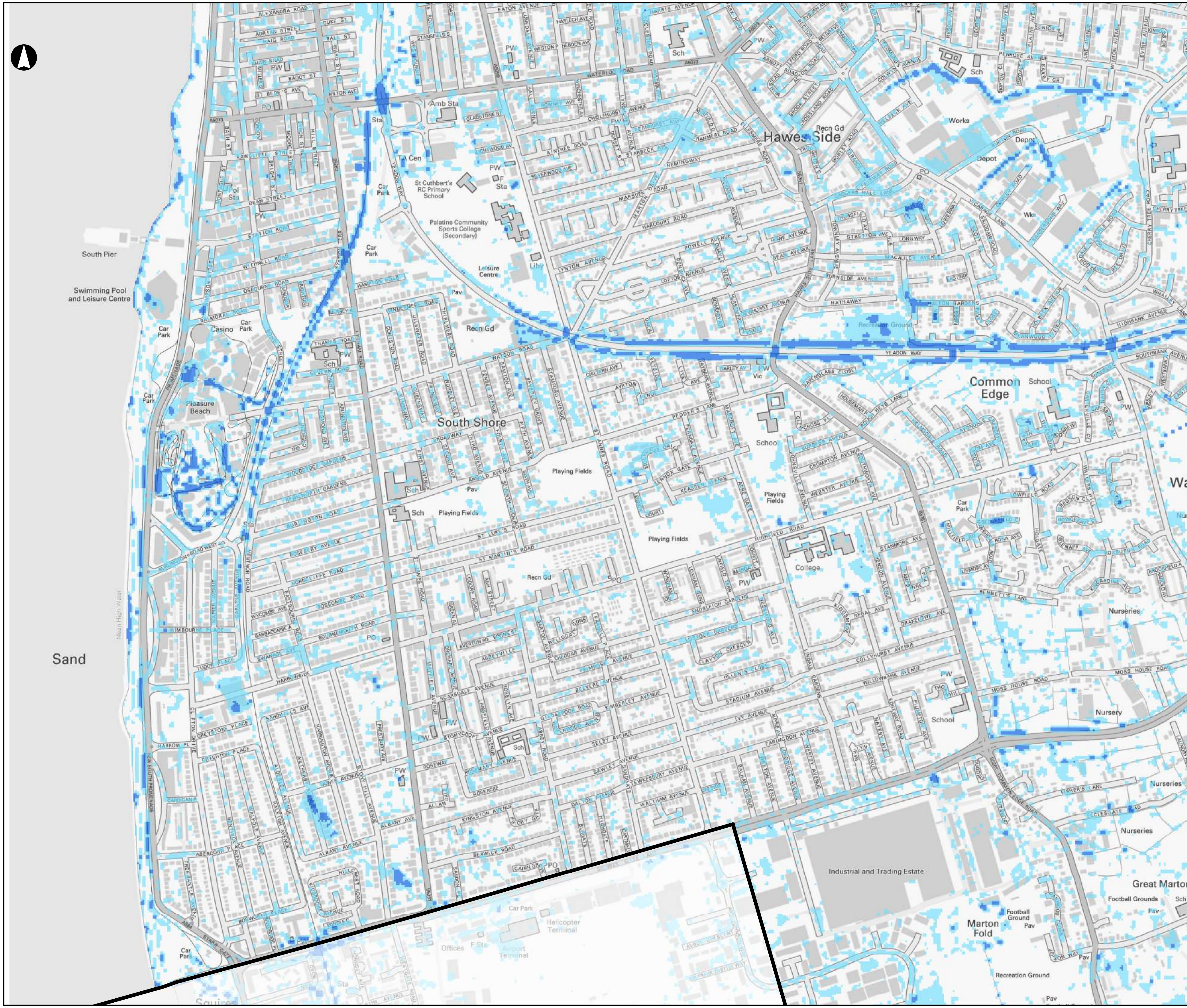
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C5.4	D1

26/03/2013 12:14:53

MXD Location

A3



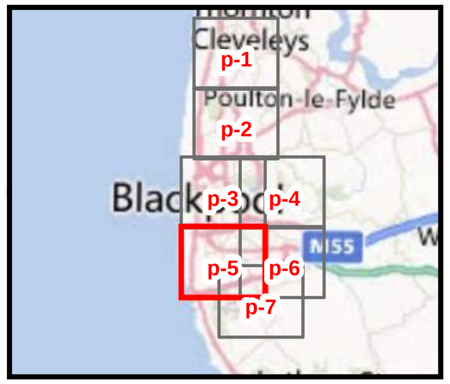
Legend

Blackpool Council boundary

1% (1 in 100yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres: 0, 137.5, 275, 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 1% (1 in 100yr)

Scale at A3

1:10,000

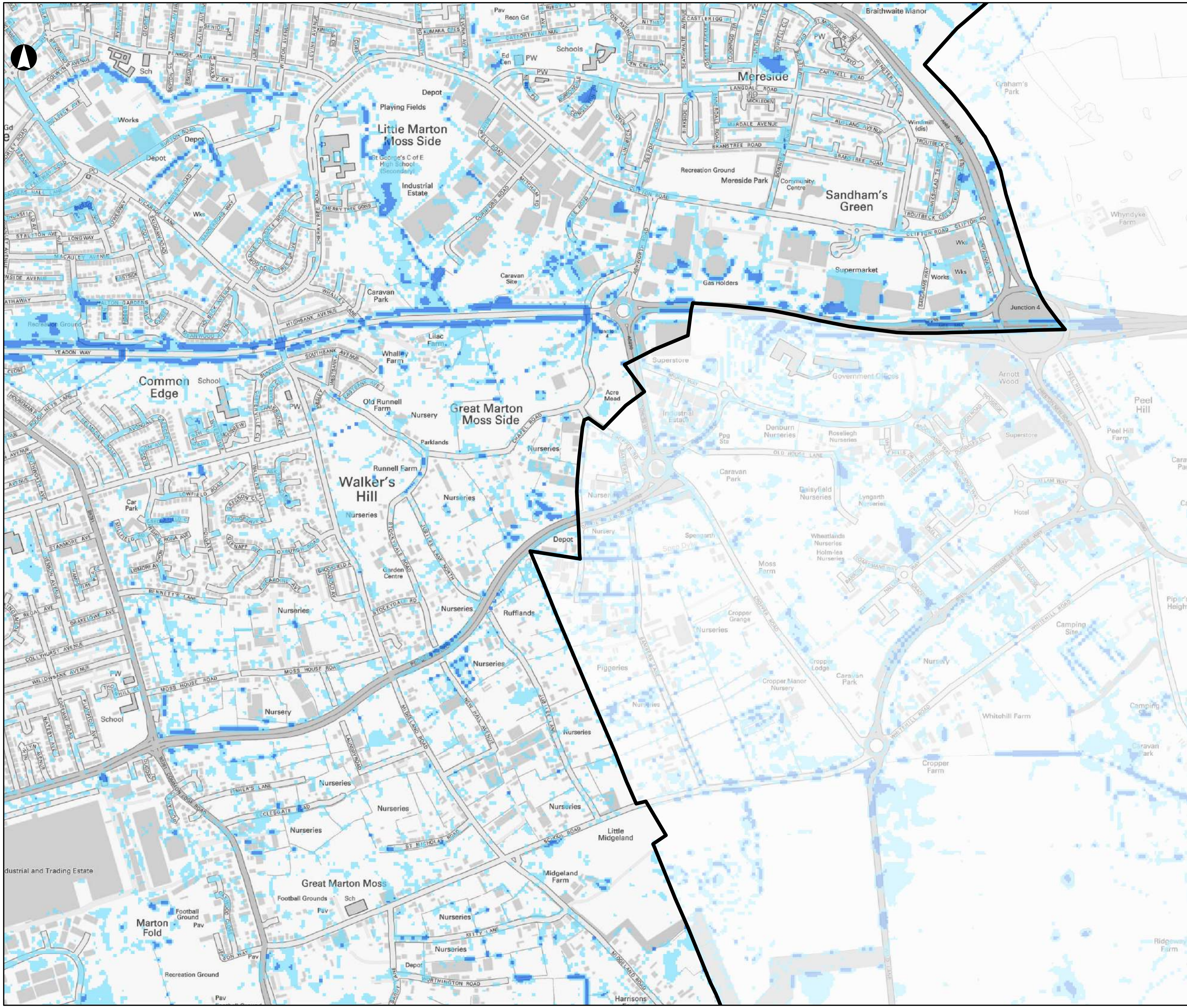
Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C5.5	**D1**

26/03/2013 12:15:01

MXD Location

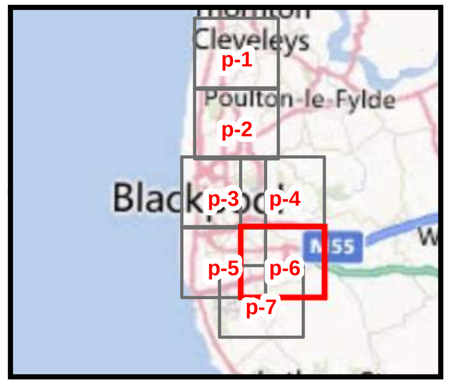
A3



Legend

- Blackpool Council boundary
- 1% (1 in 100yr)
- Maximum flood depth (m)
  - < 0.1
  - 0.1 - 0.3
  - > 0.3

Contains Ordnance Survey data © Crown copyright and database right 2013



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres
0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 1% (1 in 100yr)

Scale at A3

1:10,000

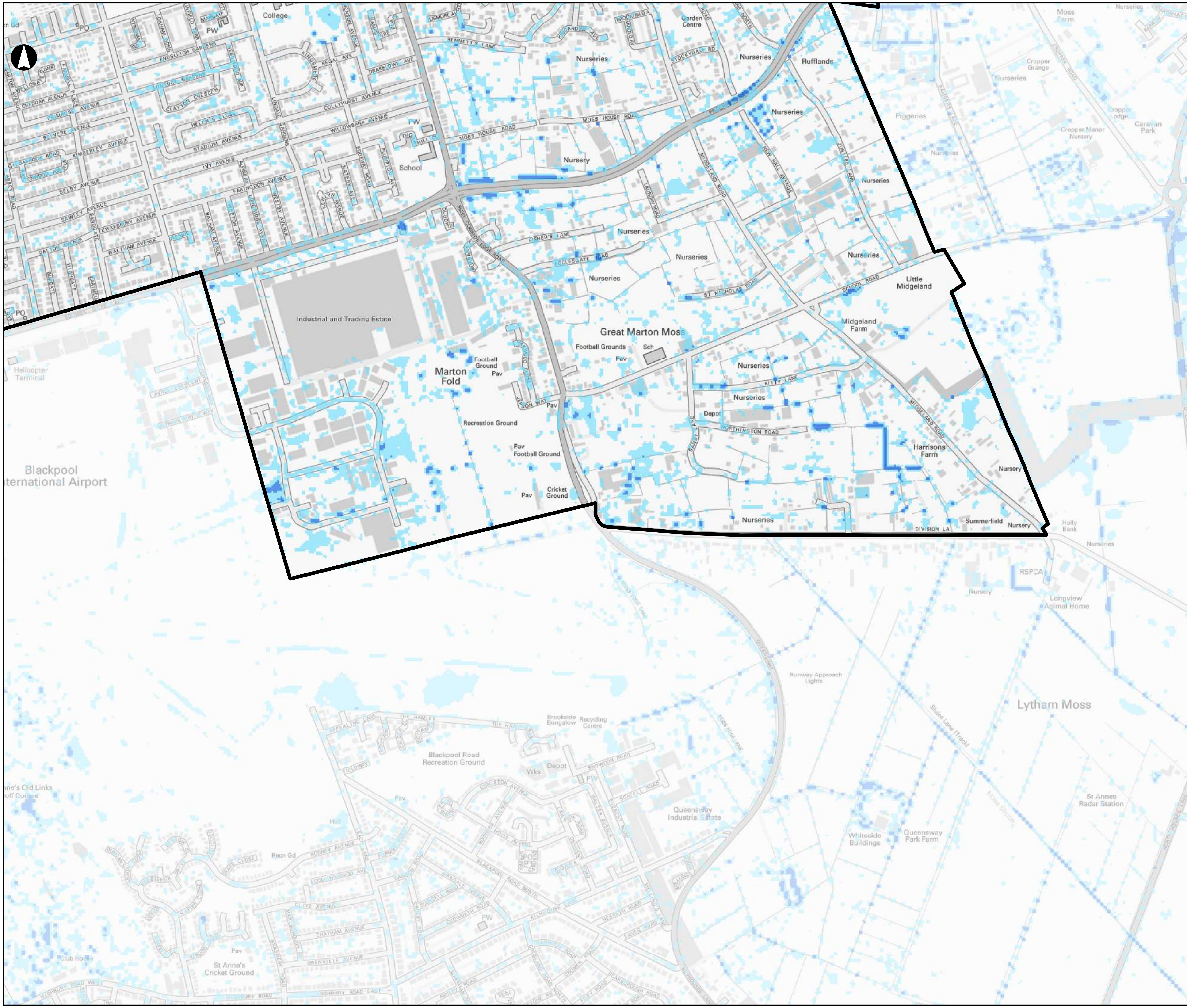
Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C5.6	**D1**

26/03/2013 12:15:08

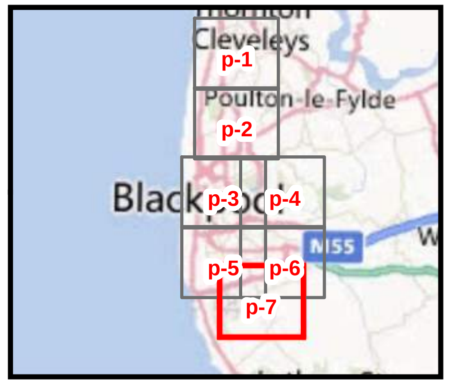
MXD Location

A3



Legend

- Blackpool Council boundary
- 1% (1 in 100yr)
- Maximum flood depth (m)
  - < 0.1
  - 0.1 - 0.3
  - > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 1% (1 in 100yr)

Scale at A3

1:10,000

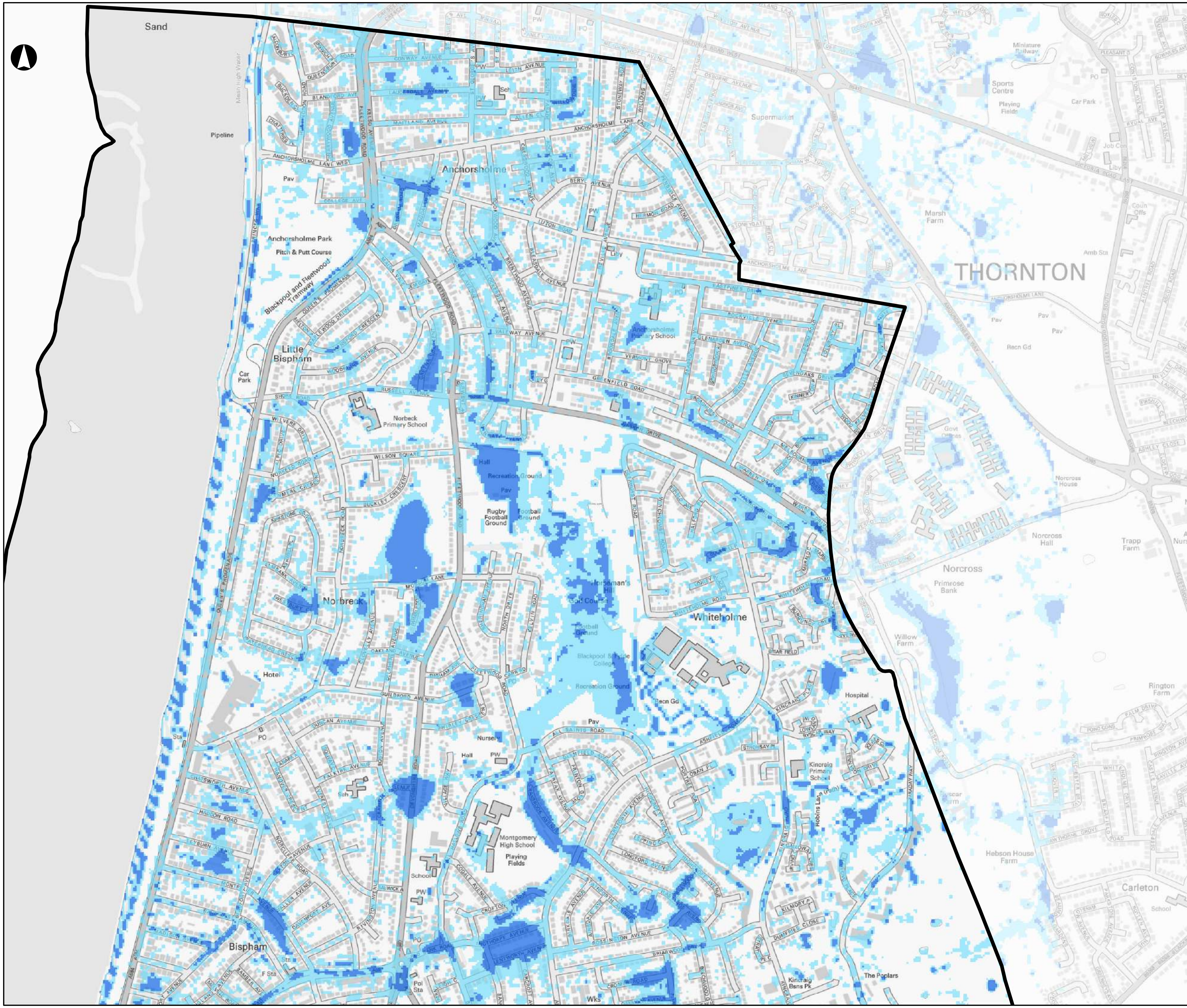
Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C5.7	**D1**

26/03/2013 12:15:15

MXD Location

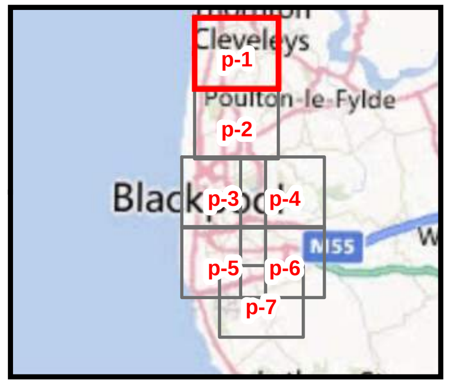
A3



Legend

- Blackpool Council boundary
- 0.1% (1 in 1000yr)
- Maximum flood depth (m)
  - < 0.1
  - 0.1 - 0.3
  - > 0.3

Contains Ordnance Survey data © Crown copyright and database right 2013



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres
0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client
Blackpool Council

Job Title
Blackpool Surface Water Management Plan

Surface water flood risk areas 0.1% (1 in 1000yr)

Scale at A3
1:10,000

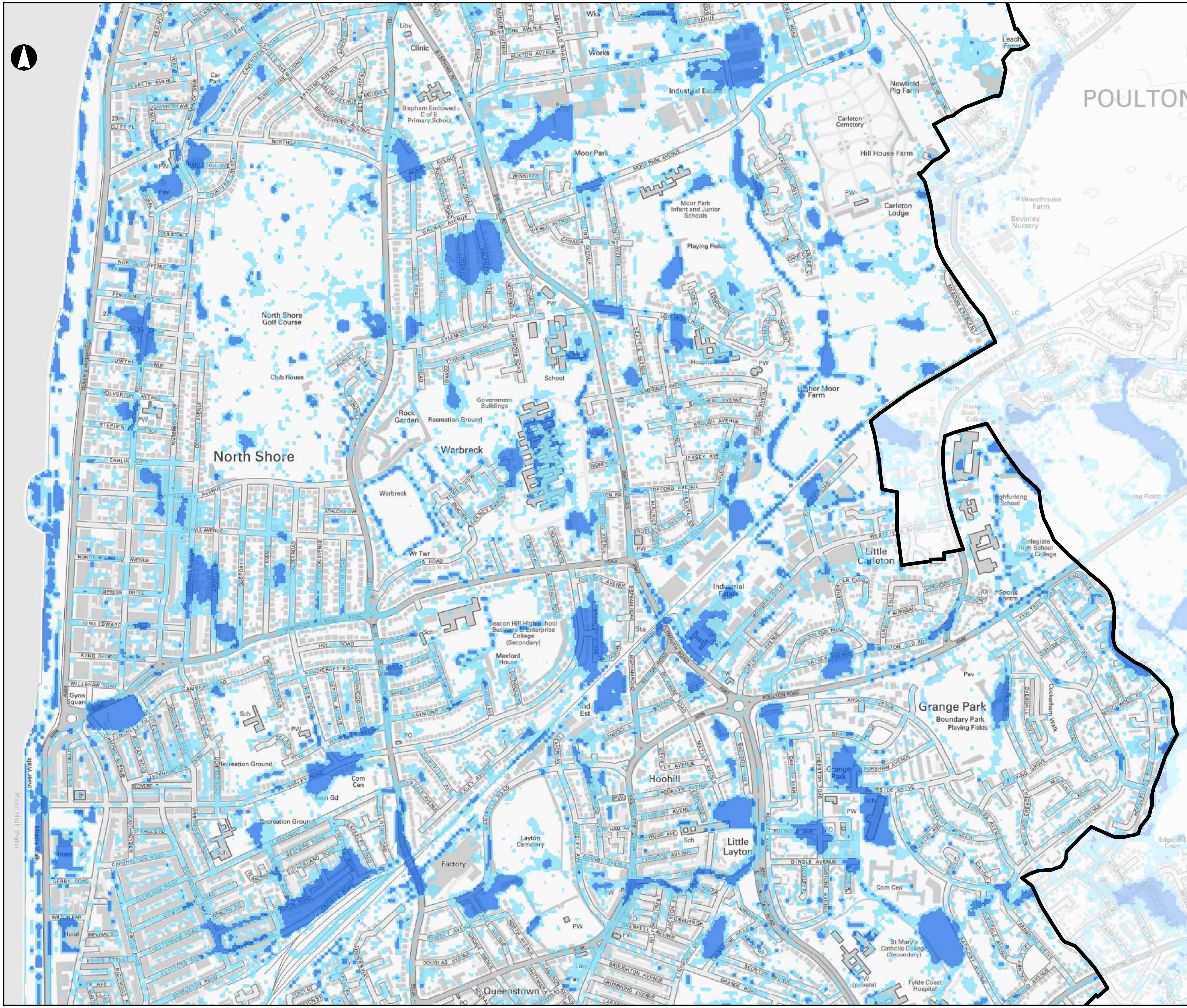
Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C6.1	**D1**

26/03/2013 12:15:23

MXD Location

A3



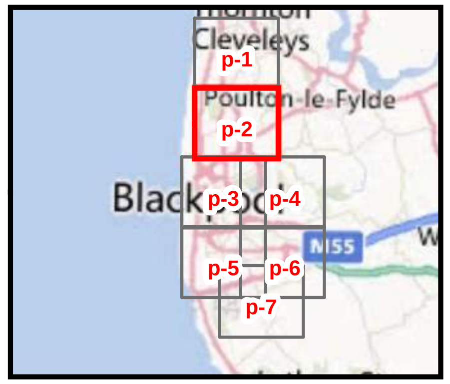
Legend

Blackpool Council boundary

0.1% (1 in 1000yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 0.1% (1 in 1000yr)

Scale at A3

1:10,000

Job No **227357**

Drawing Status **For Issue**

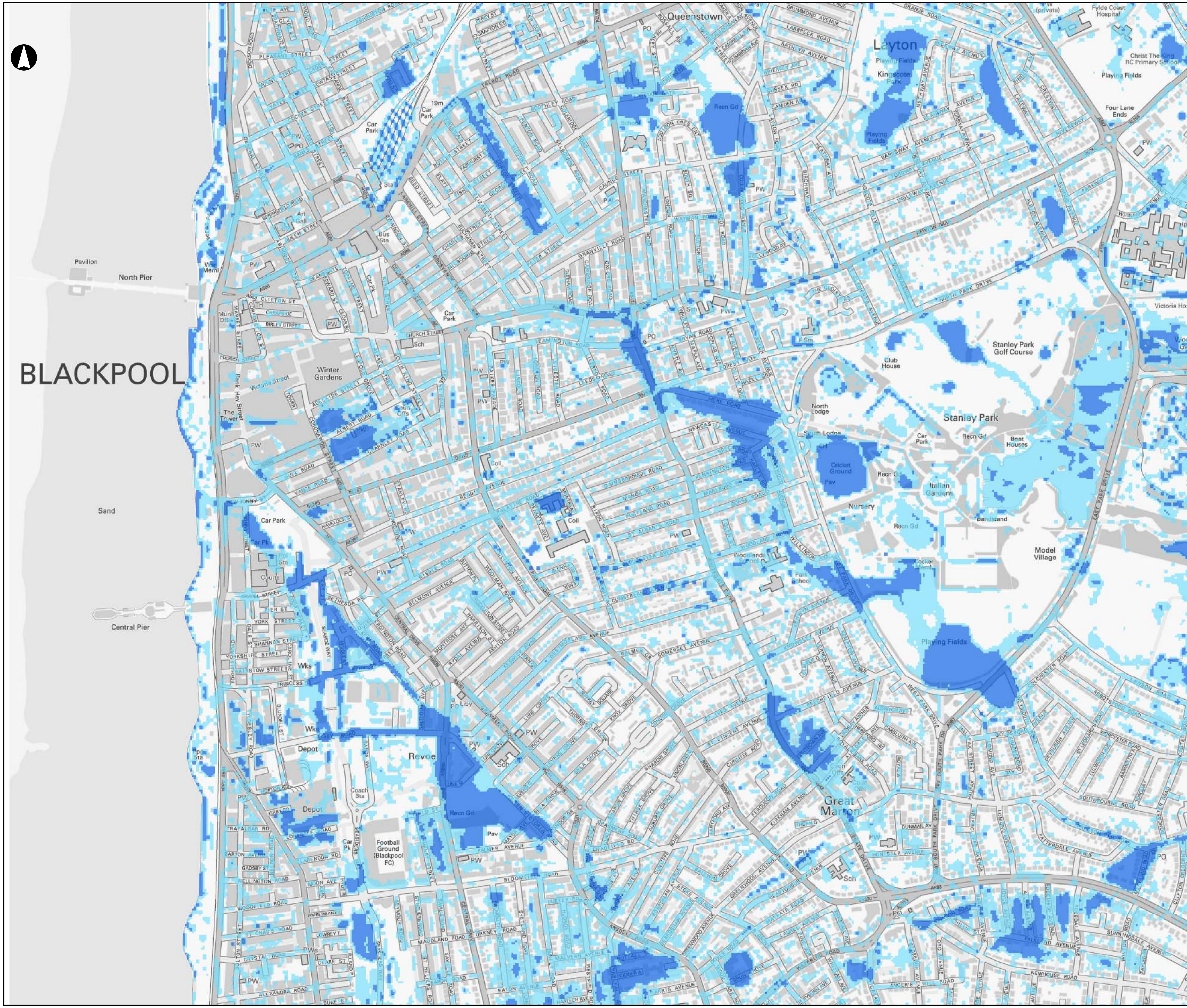
Drawing No **C6.2**

Issue **D1**

26/03/2013 12:15:31

MXD Location

A3



Legend

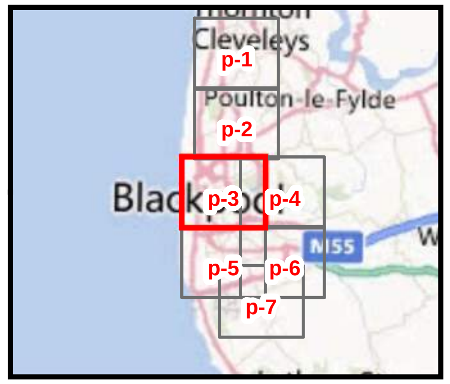
Blackpool Council boundary

0.1% (1 in 1000yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3

Contains Ordnance Survey data © Crown copyright and database right 2013



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 0.1% (1 in 1000yr)

Scale at A3

1:10,000

Job No

227357

Drawing Status

For Issue

Drawing No

C6.3

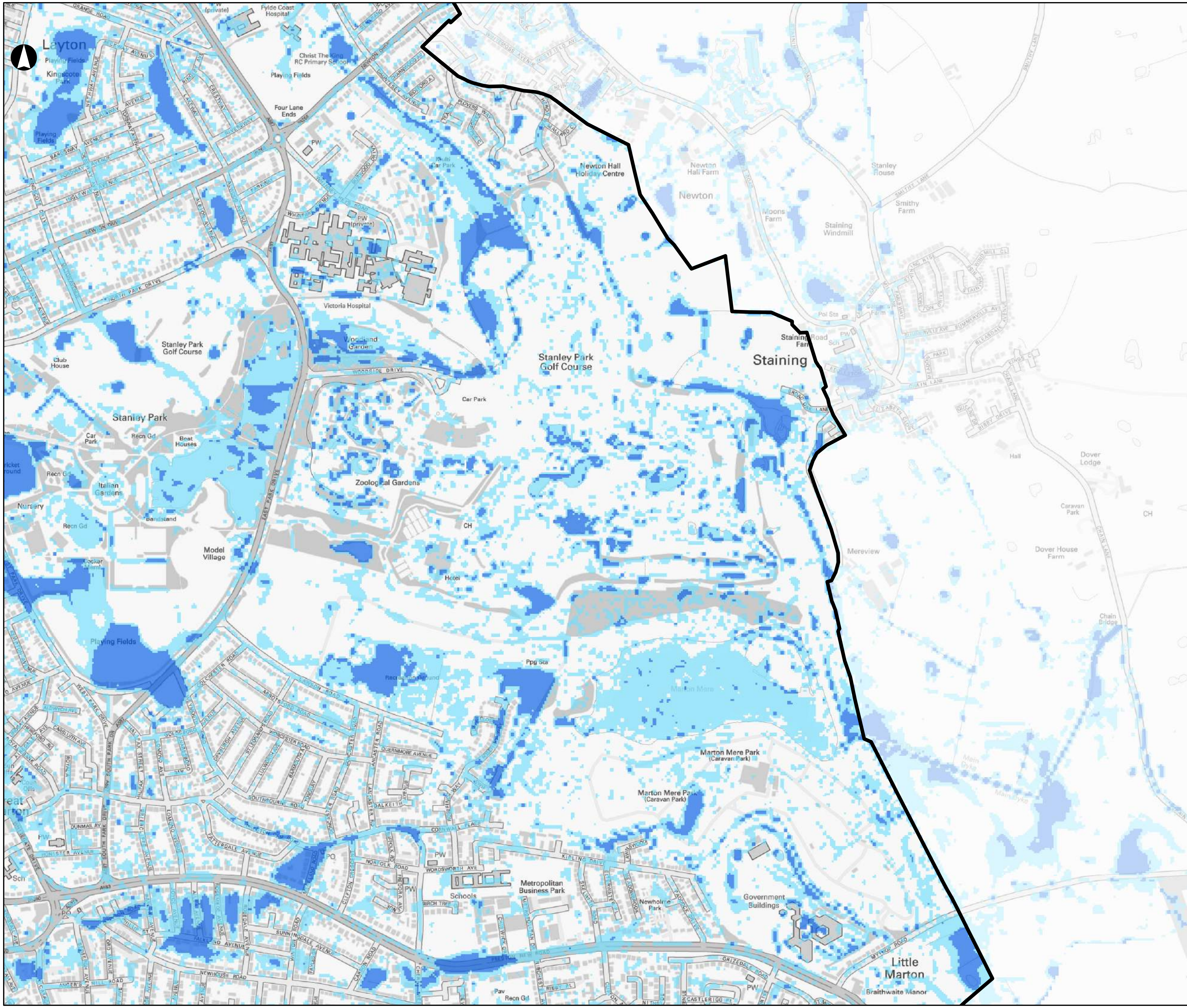
Issue

D1

26/03/2013 12:15:40

MXD Location

A3



Legend

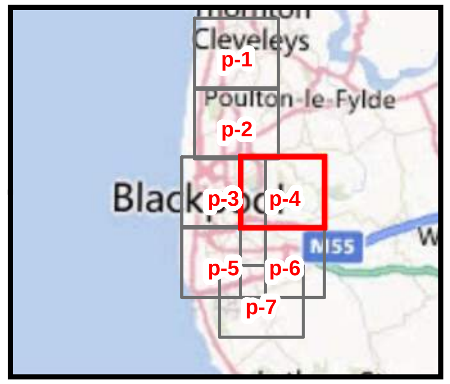
Blackpool Council boundary

0.1% (1 in 1000yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3

Contains Ordnance Survey data © Crown copyright and database right 2013



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 0.1% (1 in 1000yr)

Scale at A3

1:10,000

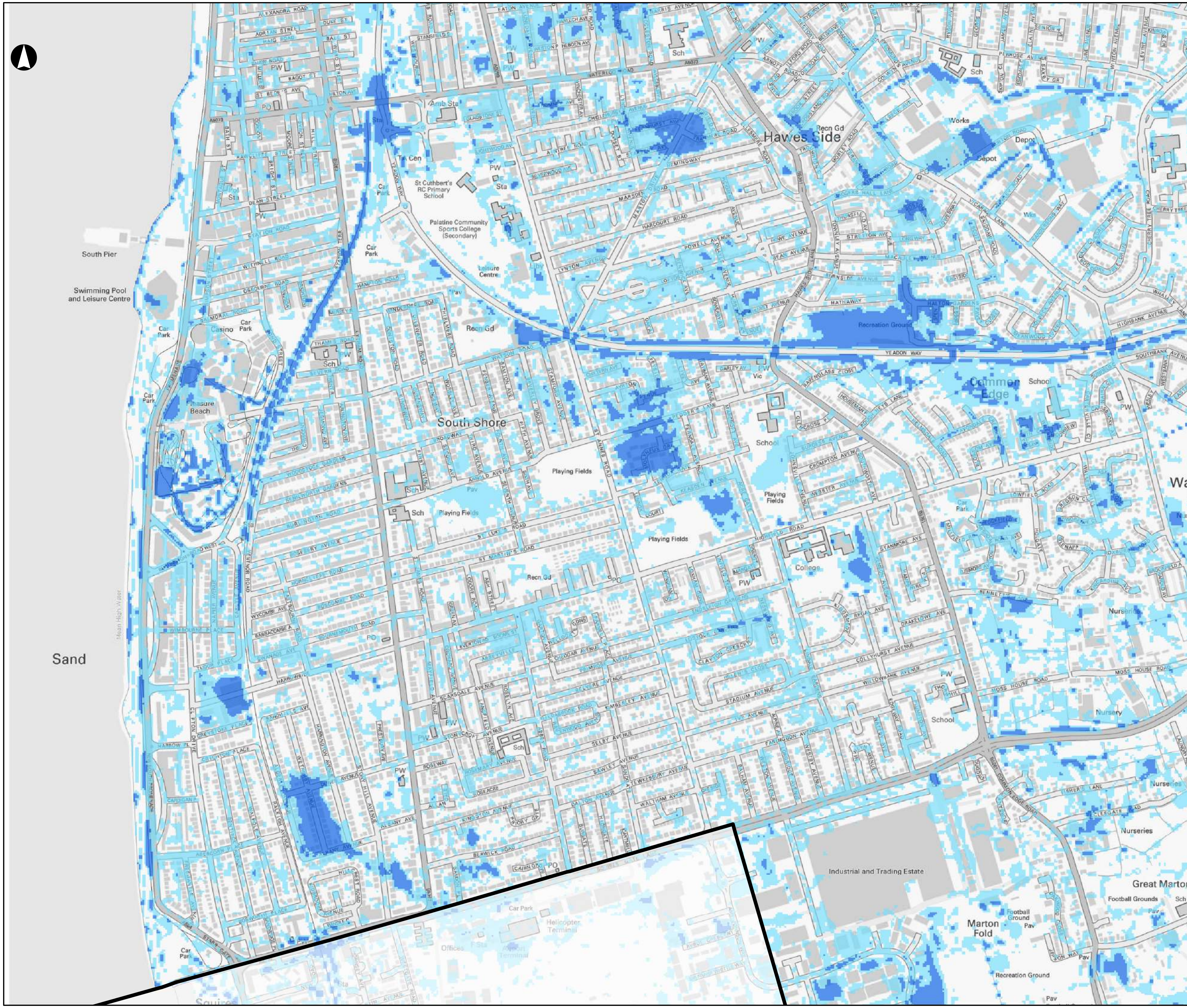
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C6.4	D1

26/03/2013 12:15:47

MXD Location

A3



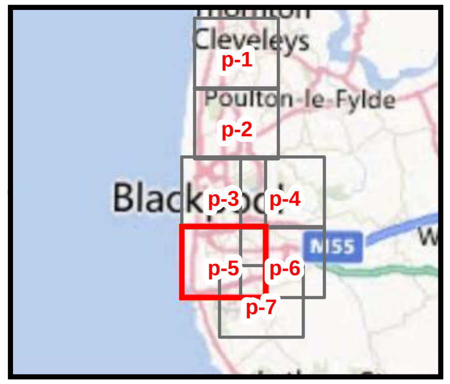
Legend

Blackpool Council boundary

0.1% (1 in 1000yr)

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 0.1% (1 in 1000yr)

Scale at A3

1:10,000

Job No **227357**

Drawing Status **For Issue**

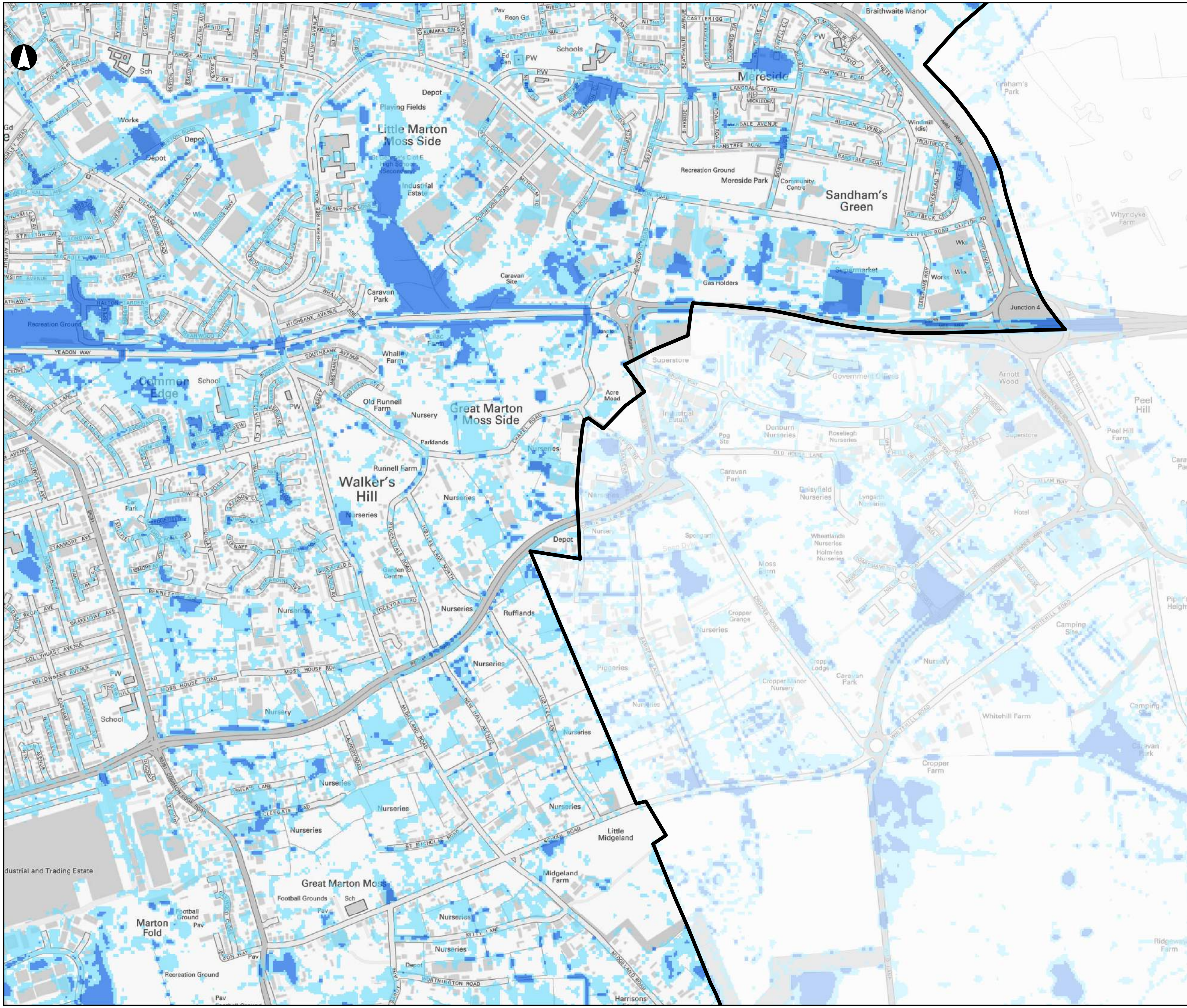
Drawing No **C6.5**

Issue **D1**

26/03/2013 12:15:57

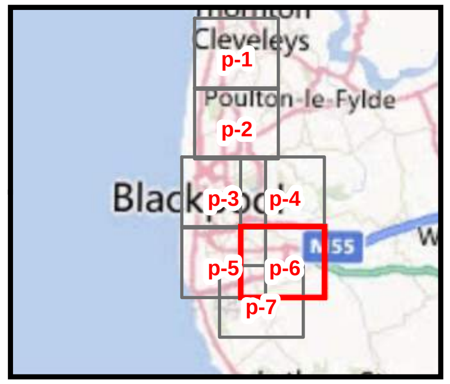
MXD Location

A3



Legend

- Blackpool Council boundary
- 0.1% (1 in 1000yr)
- Maximum flood depth (m)
  - < 0.1
  - 0.1 - 0.3
  - > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres
0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas 0.1% (1 in 1000yr)

Scale at A3

1:10,000

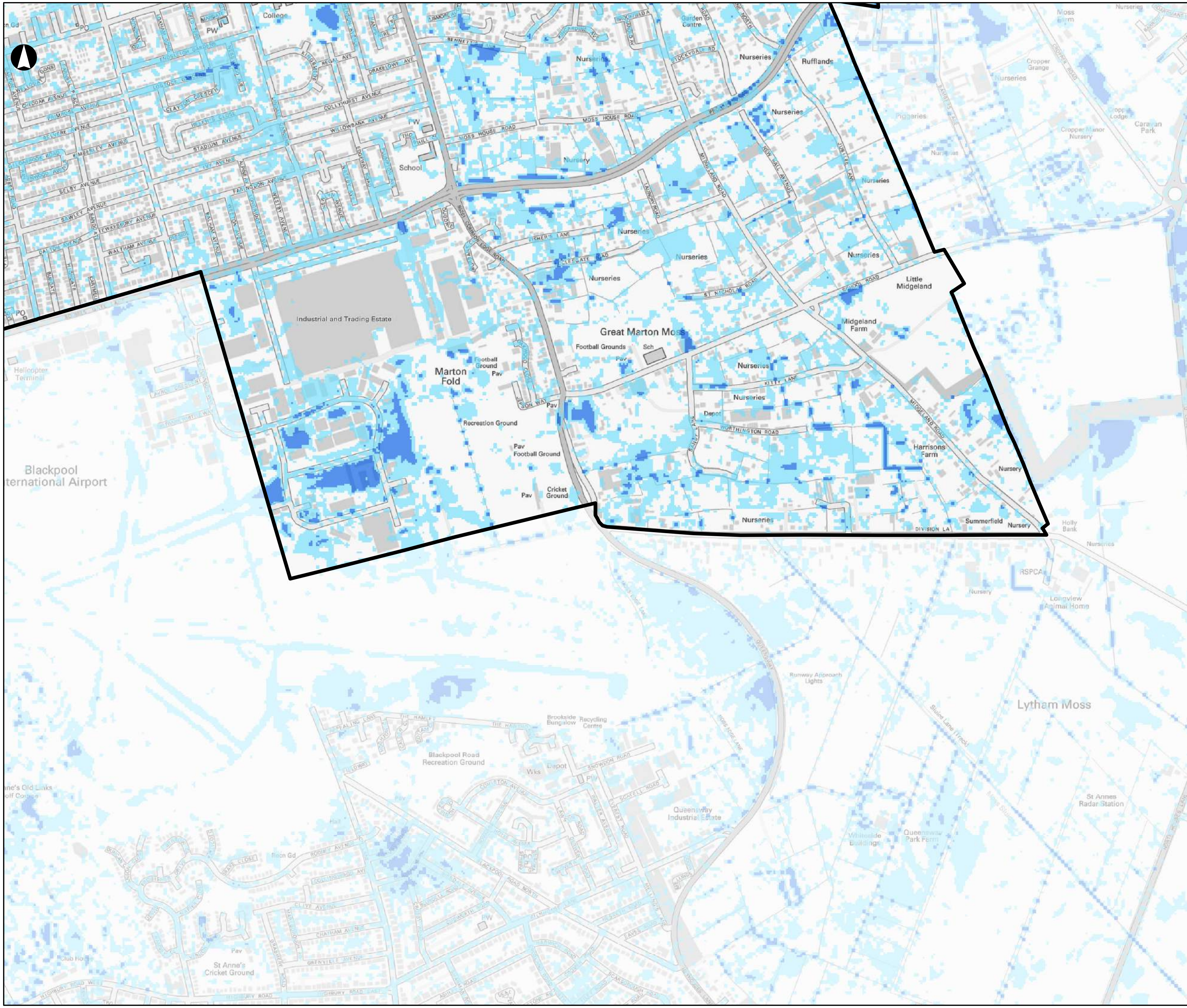
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C6.6	D1

26/03/2013 12:16:05

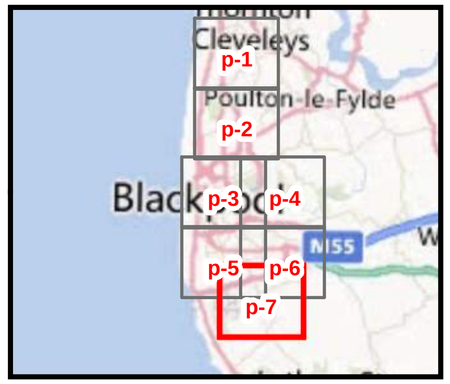
MXD Location

A3



Legend

- Blackpool Council boundary
- 0.1% (1 in 1000yr)
- Maximum flood depth (m)
  - < 0.1
  - 0.1 - 0.3
  - > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres
0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client
Blackpool Council

Job Title
Blackpool Surface Water Management Plan

Surface water flood risk areas 0.1% (1 in 1000yr)

Scale at A3
1:10,000

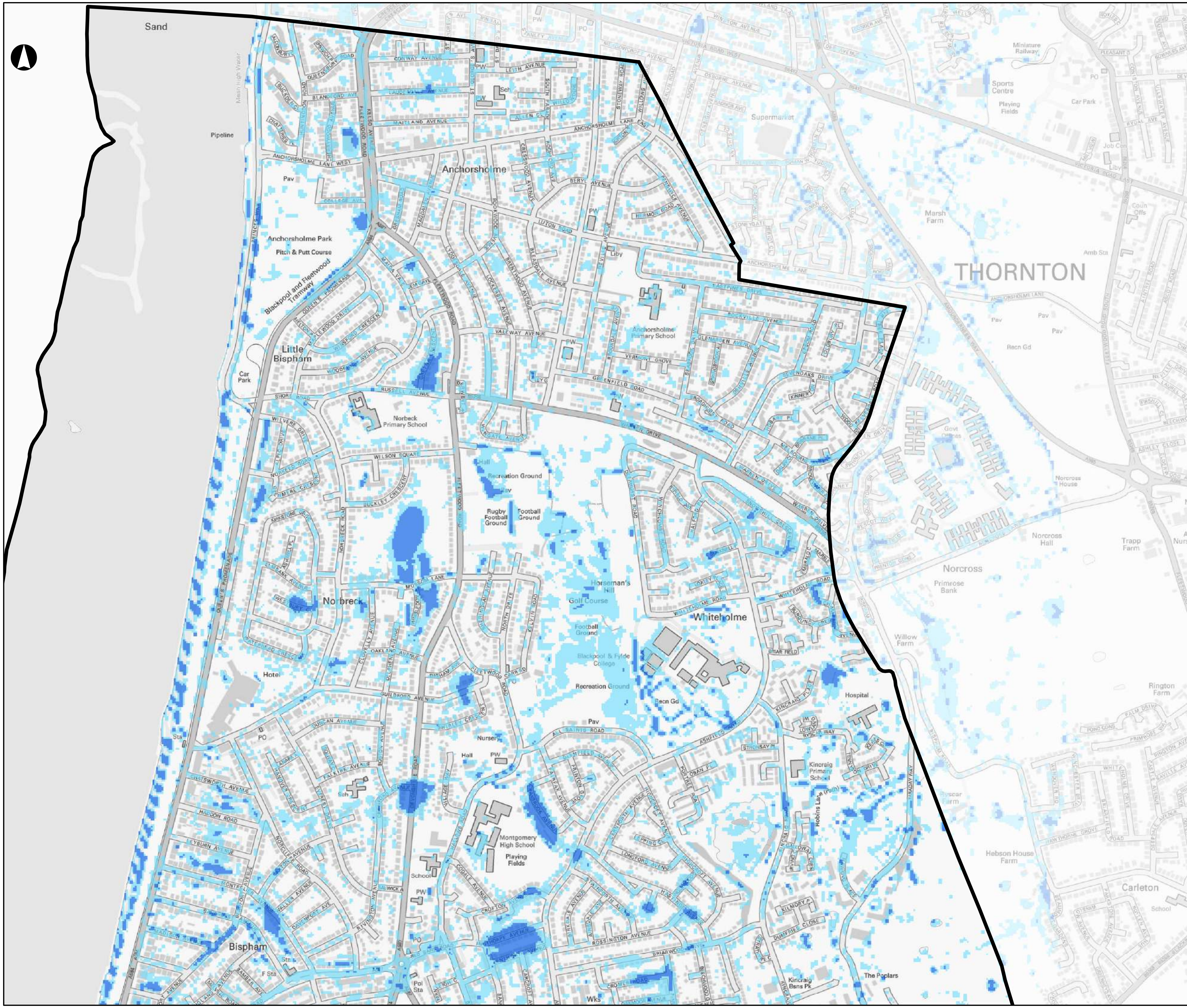
Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C6.7	**D1**

26/03/2013 12:16:14

MXD Location

A3



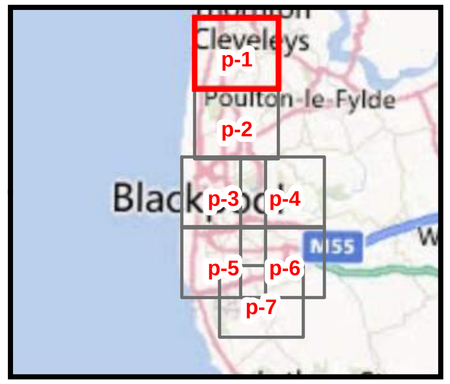
Legend

Blackpool Council boundary

1% (1 in 100yr) future scenario

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas Future scenario 1% (1 in 100yr)

Scale at A3

1:10,000

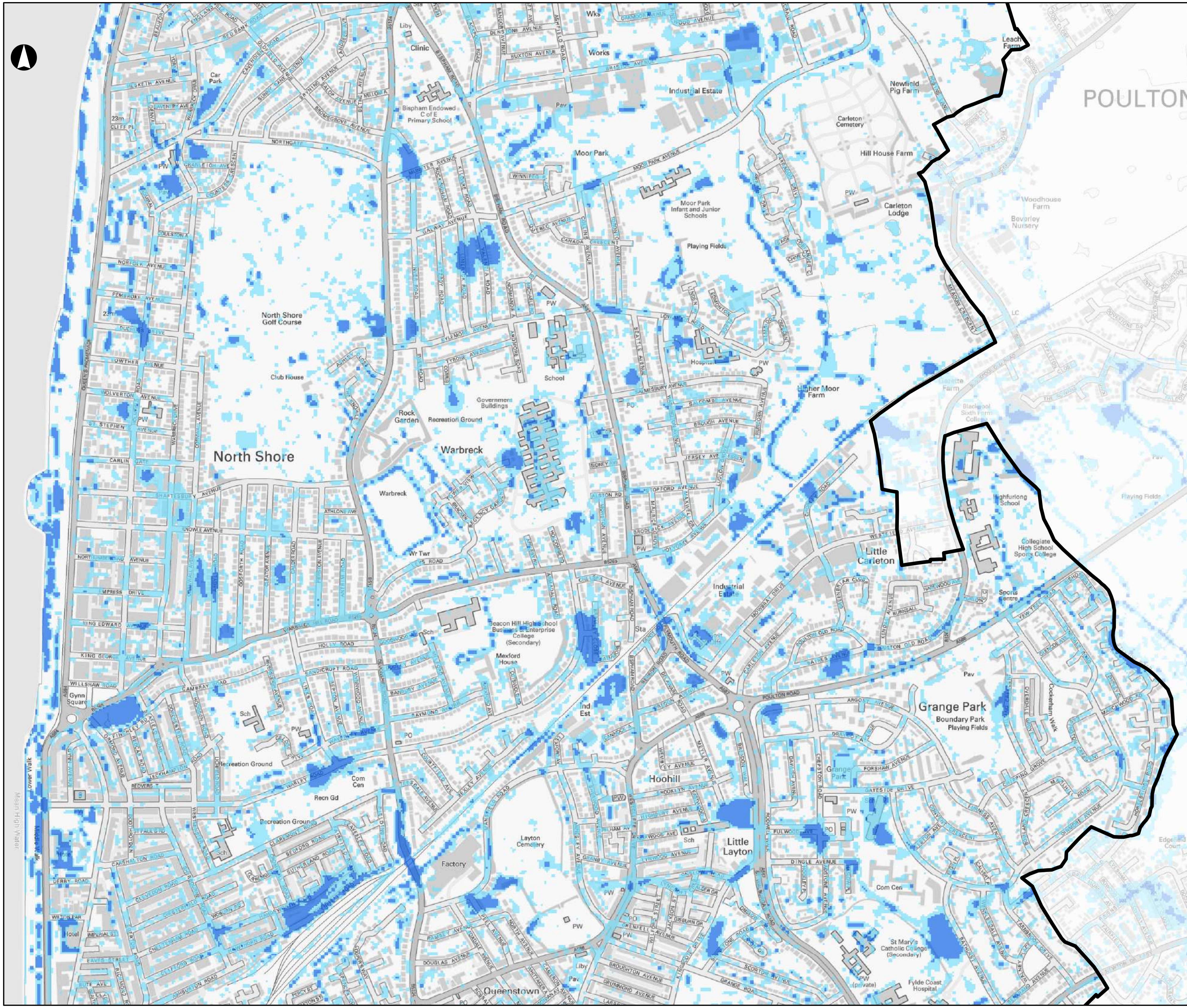
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C7.1	D1

26/03/2013 12:16:22

MXD Location

A3



Legend

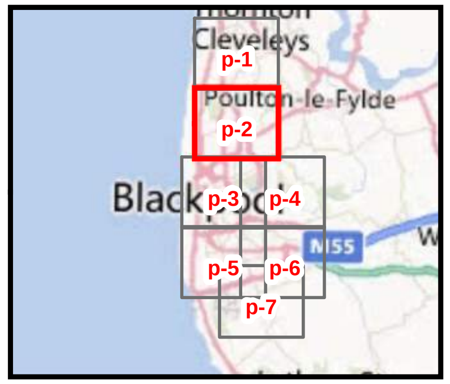
Blackpool Council boundary

1% (1 in 100yr) future scenario

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3

Contains Ordnance Survey data © Crown copyright and database right 2013



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas
Future scenario 1% (1 in 100yr)

Scale at A3

1:10,000

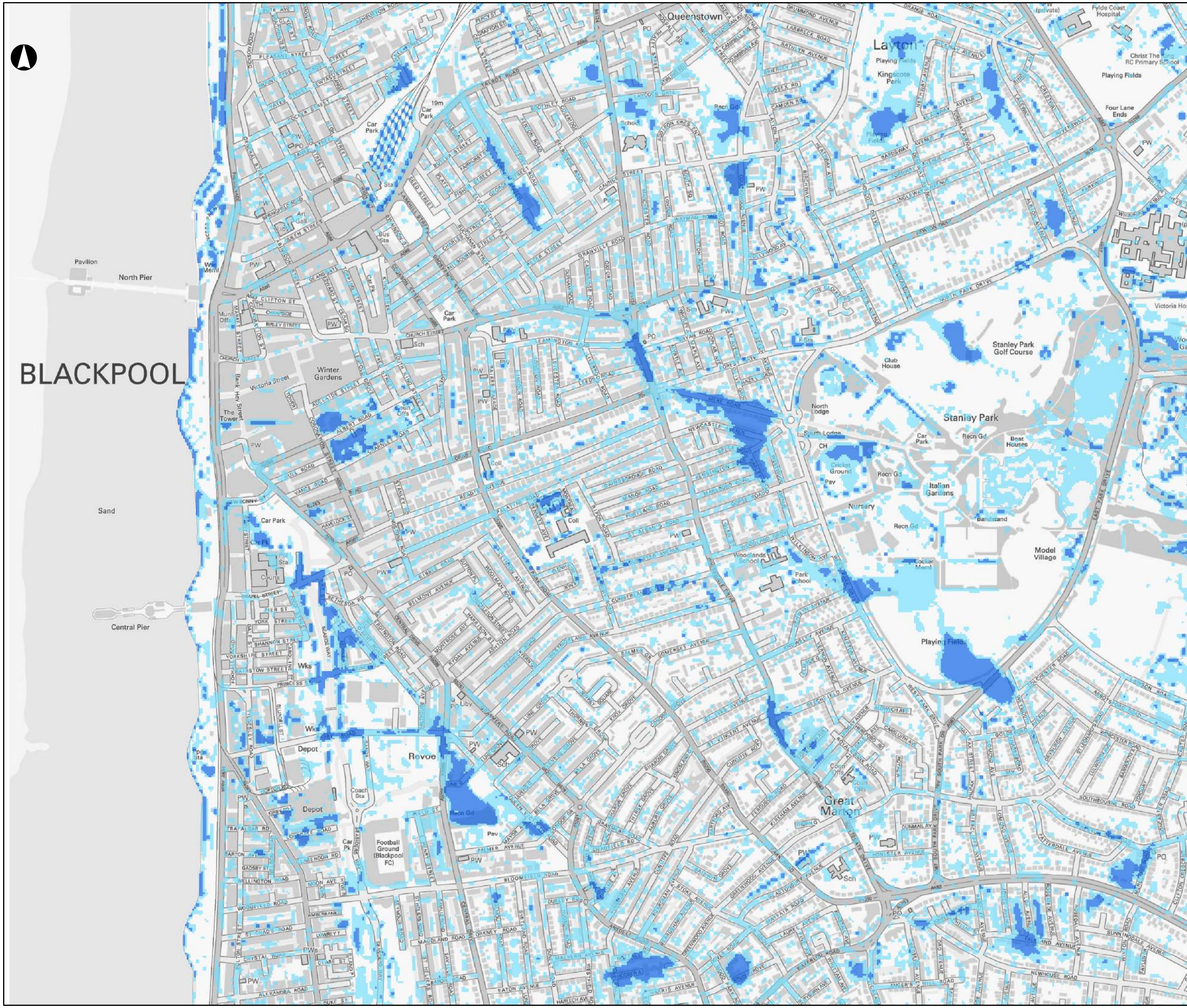
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C7.2	D1

26/03/2013 12:16:32

MXD Location

A3



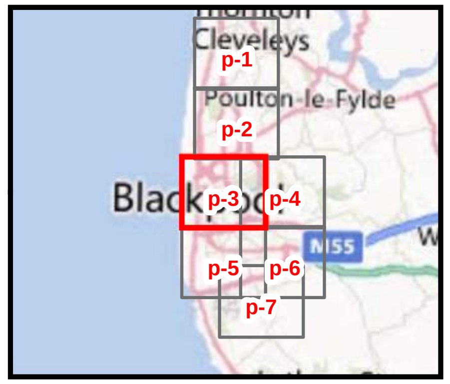
Legend

Blackpool Council boundary

1% (1 in 100yr) future scenario

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas Future scenario 1% (1 in 100yr)

Scale at A3

1:10,000

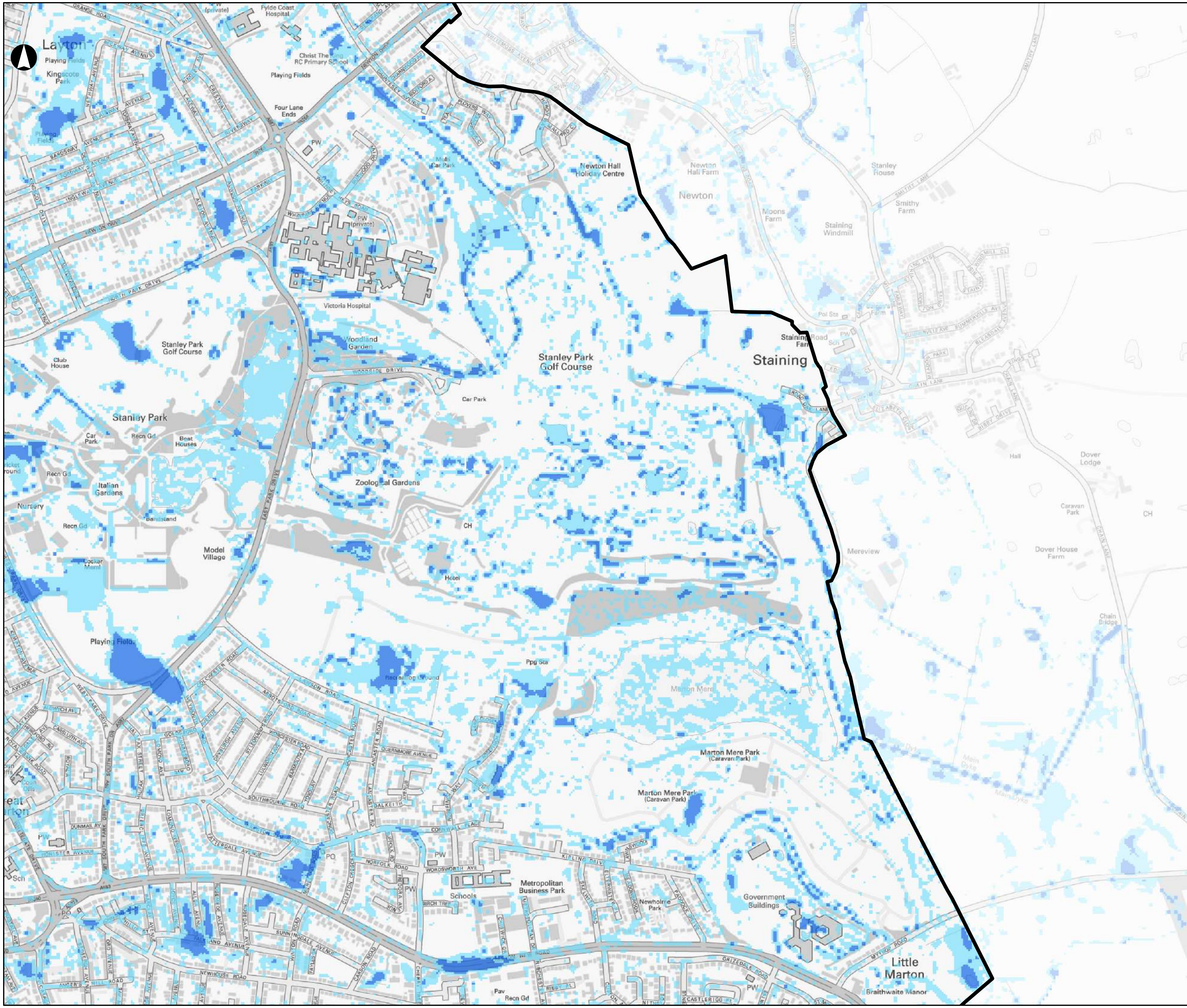
Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C7.3	**D1**

26/03/2013 12:16:41

MXD Location

A3



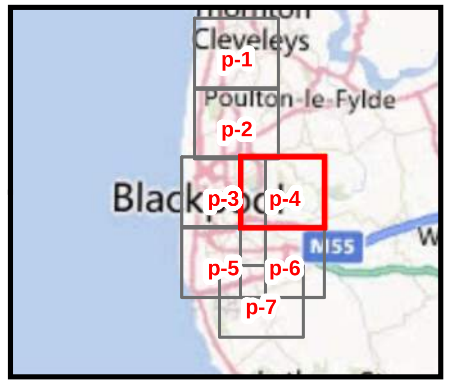
Legend

Blackpool Council boundary

1% (1 in 100yr) future scenario

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

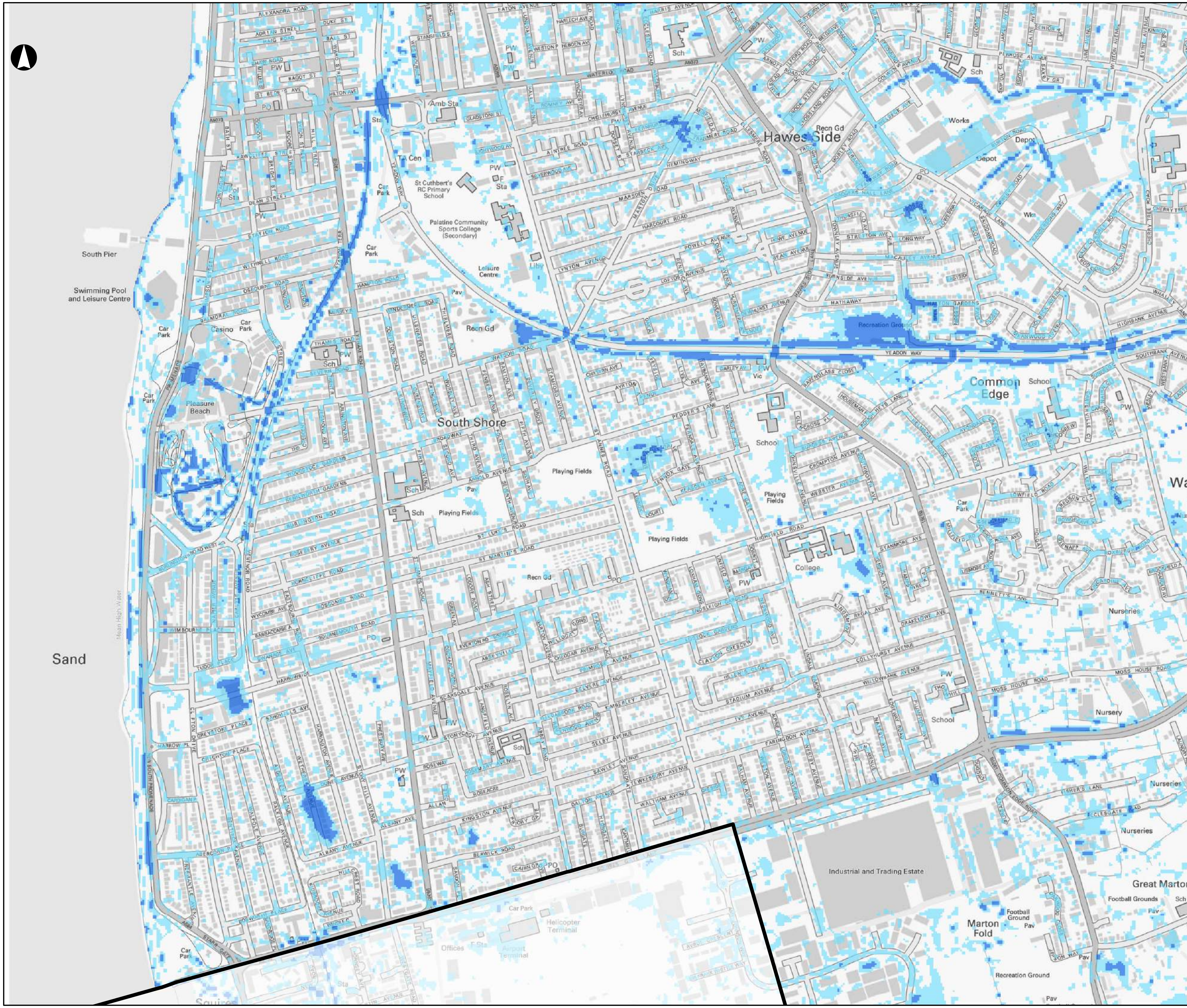
Surface water flood risk areas
Future scenario 1% (1 in 100yr)

Scale at A3	
1:10,000	
Job No	Drawing Status
227357	For Issue
Drawing No	Issue
C7.4	D1

26/03/2013 12:16:51

MXD Location

A3



Legend

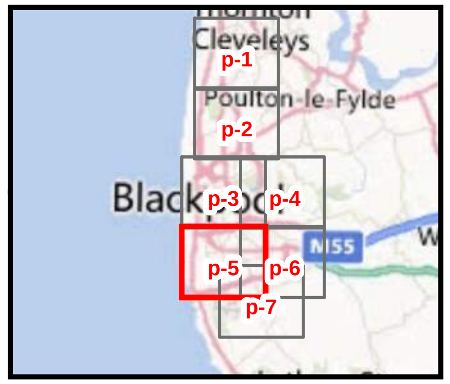
Blackpool Council boundary

1% (1 in 100yr) future scenario

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3

26/03/2013 12:17:01



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas Future scenario 1% (1 in 100yr)

Scale at A3

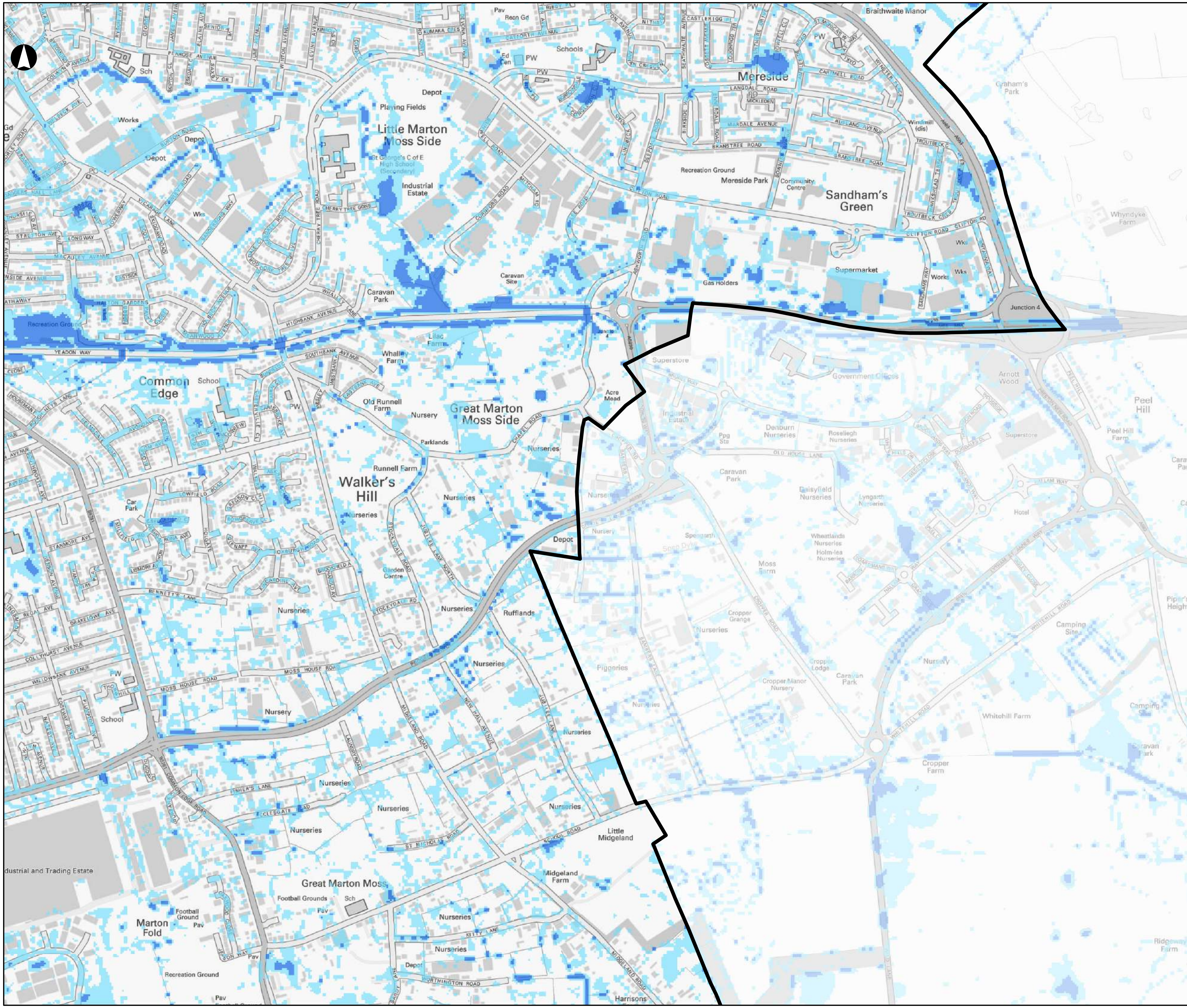
1:10,000

Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C7.5	D1

MXD Location

A3



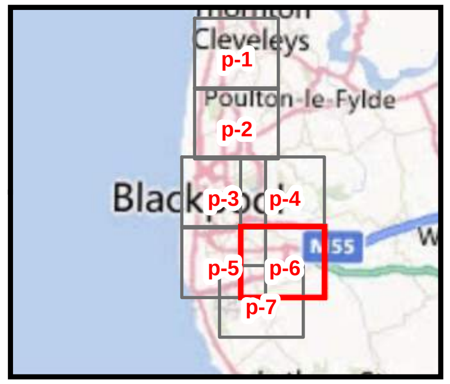
Legend

Blackpool Council boundary

1% (1 in 100yr) future scenario

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas Future scenario 1% (1 in 100yr)

Scale at A3

1:10,000

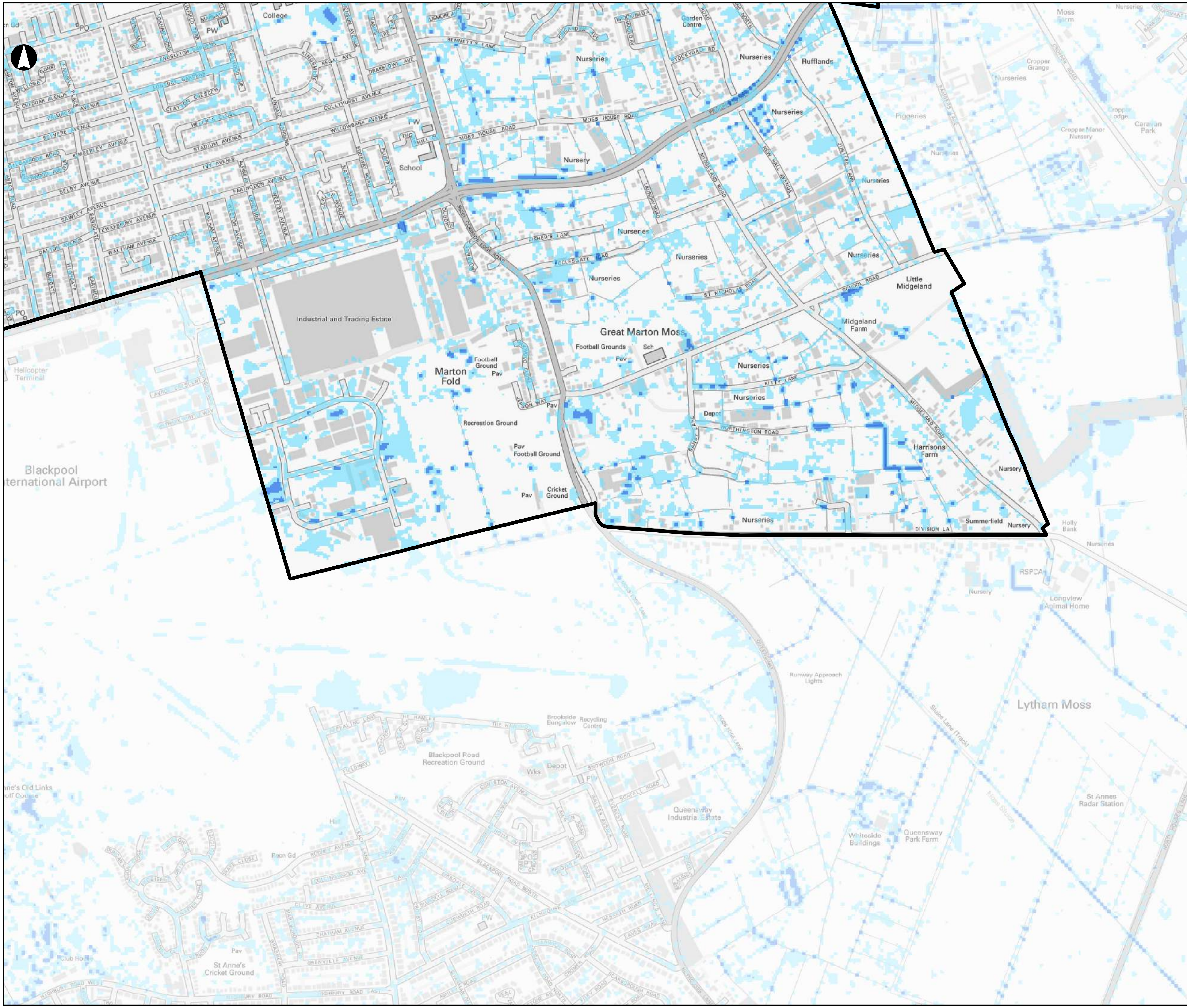
Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
C7.6	**D1**

26/03/2013 12:17:10

MXD Location

A3



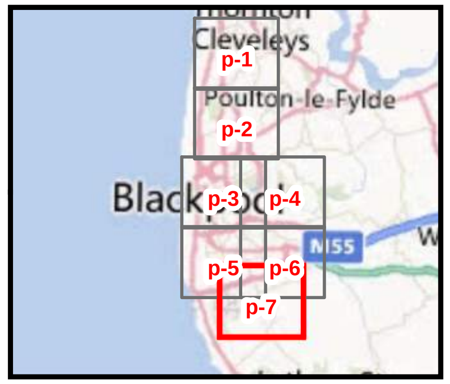
Legend

Blackpool Council boundary

1% (1 in 100yr) future scenario

Maximum flood depth (m)

- < 0.1
- 0.1 - 0.3
- > 0.3



D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 137.5 275 550

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Surface water flood risk areas
Future scenario 1% (1 in 100yr)

Scale at A3

1:10,000

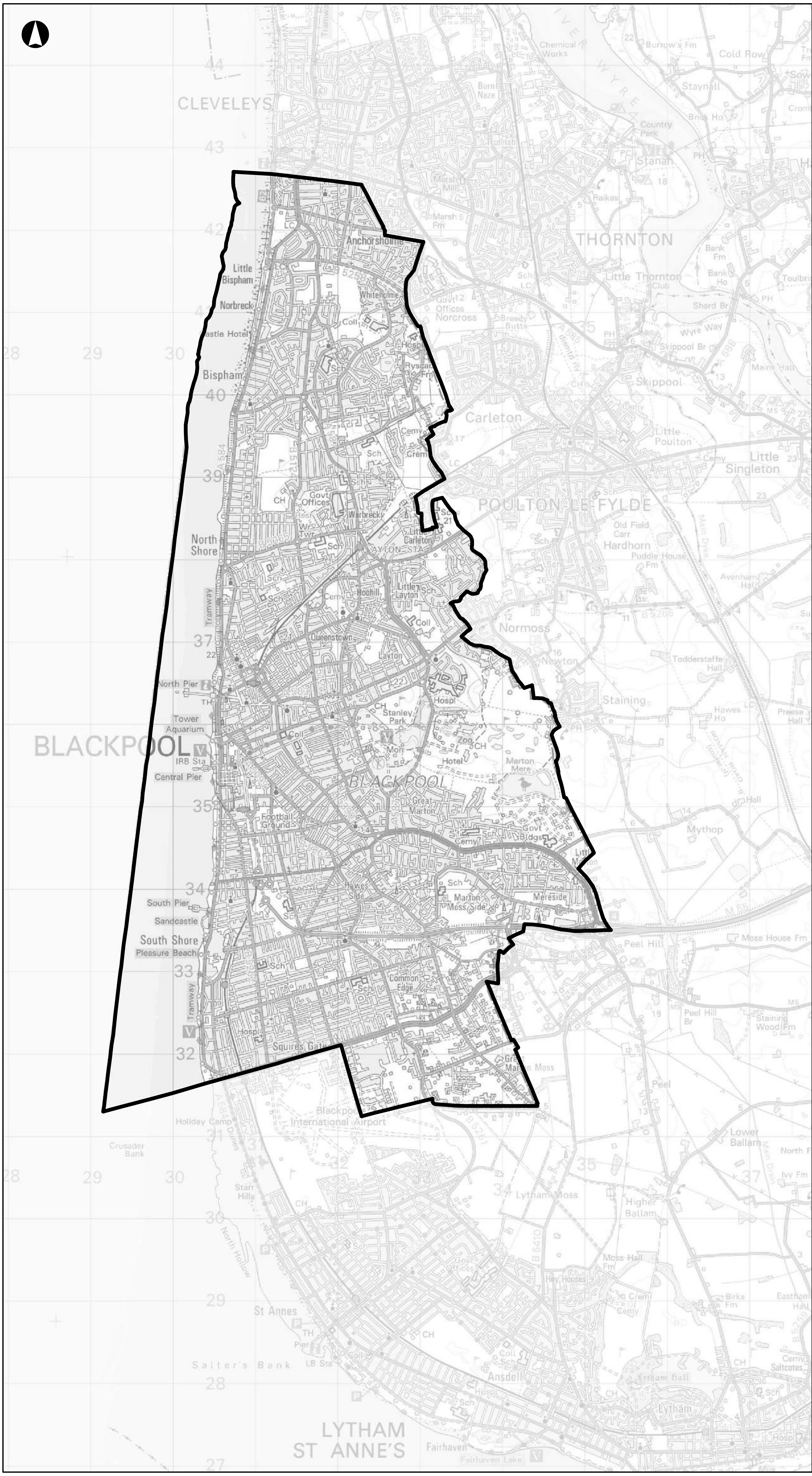
Job No	Drawing Status
227357	For Issue

Drawing No	Issue
C7.7	D1

MXD Location

26/03/2013 12:17:17

A3



Legend

Blackpool Council boundary

D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 600 1,200 2,400

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Study boundary

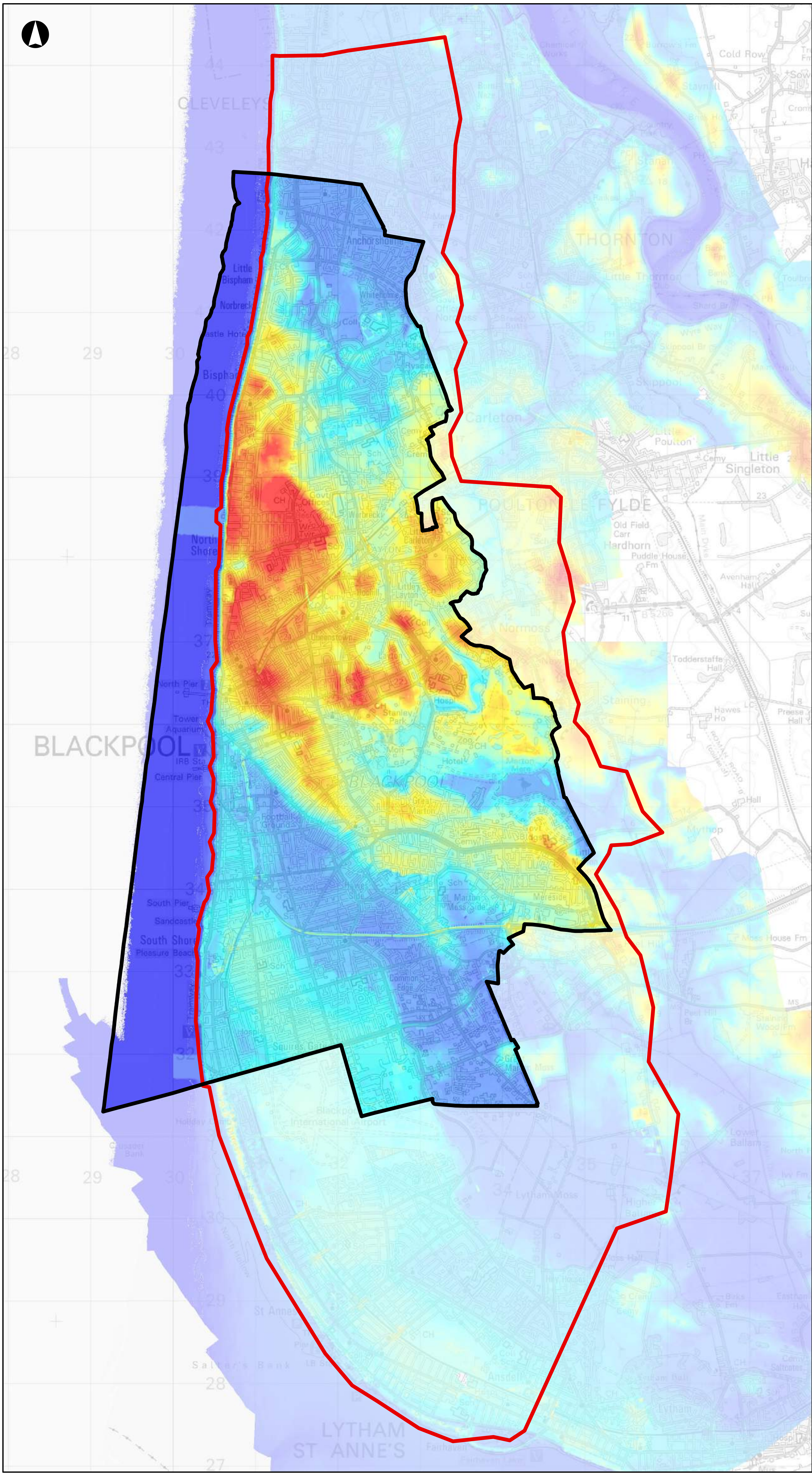
Scale at A3

1:45,000

Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
B1	**D1**

A3



26/03/2013 11:49:43

Legend

Blackpool Council boundary
Model extent
Ground Levels (m AOD)
High : 25
Low : 0

Contains Ordnance Survey data © Crown copyright and database right 2013

D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres
0 600 1,200 2,400

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client
Blackpool Council

Job Title
Blackpool Surface Water Management Plan

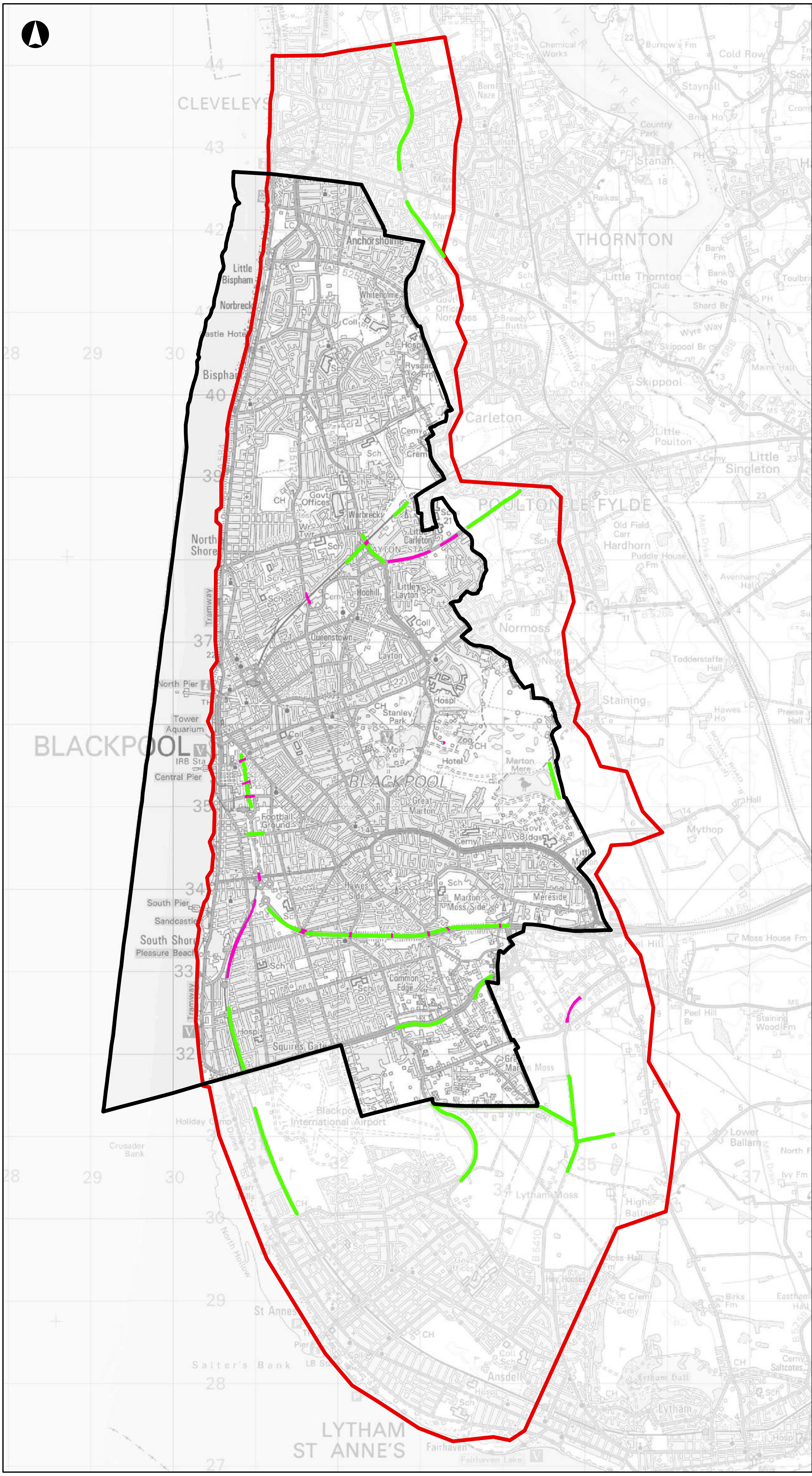
Model extent showing ground levels

Scale at A3
1:45,000

Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
B2	**D1**

A3



Legend

- Blackpool Council boundary
- Gullys
- Ridges
- Model extent

Contains Ordnance Survey data © Crown copyright and database right 2013

D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres
0 600 1,200 2,400

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client
Blackpool Council

Job Title
Blackpool Surface Water Management Plan

Topographic features

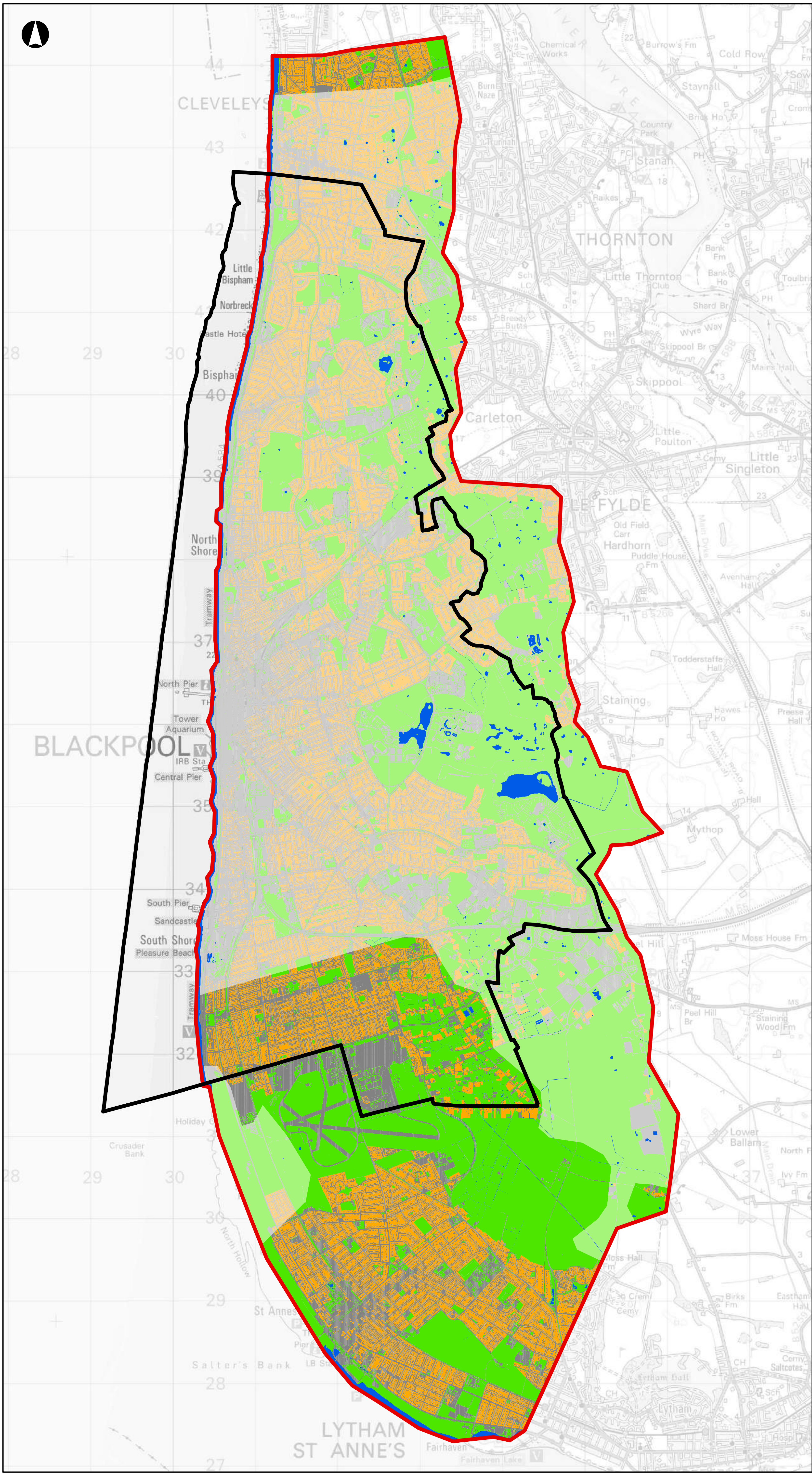
Scale at A3
1:45,000

Job No	Drawing Status
227357	**For Issue**

Drawing No	Issue
B3	**D1**

26/03/2013 11:49:49

A3



Legend

- Blackpool Council boundary
- Model extent

Name

- openwater
- s1_u0_d0
- s1_u1_d1
- s1_u2_d2
- s2_u0_d0
- s2_u1_d1
- s2_u2_d2

26/03/2013 11:49:53

D1	2013-03-26	DVDL	LB	KP
Issue	Date	By	Chkd	Appd

Metres

0 600 1,200 2,400

ARUP

Rose Wharf 78 East Street
Leeds LS9 8EE United Kingdom
t +44 113 237 8344 f +44 113 242 8573
www.arup.com

Client

Blackpool Council

Job Title

Blackpool Surface Water Management Plan

Rainfall boundaries

Scale at A3

1:45,000

Job No

227357

Drawing Status

For Issue

Drawing No

B4

Issue

D1