FLOOD RISK ASSESSMENT
DALFABER, AVIEMORE

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The proposed drainage and attenuation system at the site should be designed to take climate change into account and should be implemented and operational prior to the occupation of the development in order to prevent potential water pollution.

1. INTRODUCTION

1.1. PURPOSE OF THE REPORT

1.1.1. Waterman Civils Ltd have been appointed by Ramsay & Chalmers to carry out a Flood Risk Assessment in support of a Planning Application in accordance with Scottish Planning Policy 7 (SPP7) Planning and Flooding.

1.2. APPROACH

1.2.1. A detailed hydraulic model of the River Spey has been carried out using Infoworks RS for the 1 in 200 year storm event with a 20% Climate Change allowance also included. The impact of the development on other surrounding properties has been assessed along with any potential impact on flood plain storage.

2. DESCRIPTION OF SITE

2.1. SITE AND USAGE

2.1.1. The site covers approximately 11.1ha and is located to the North East of Aviemore at Grid reference NH 906 137.

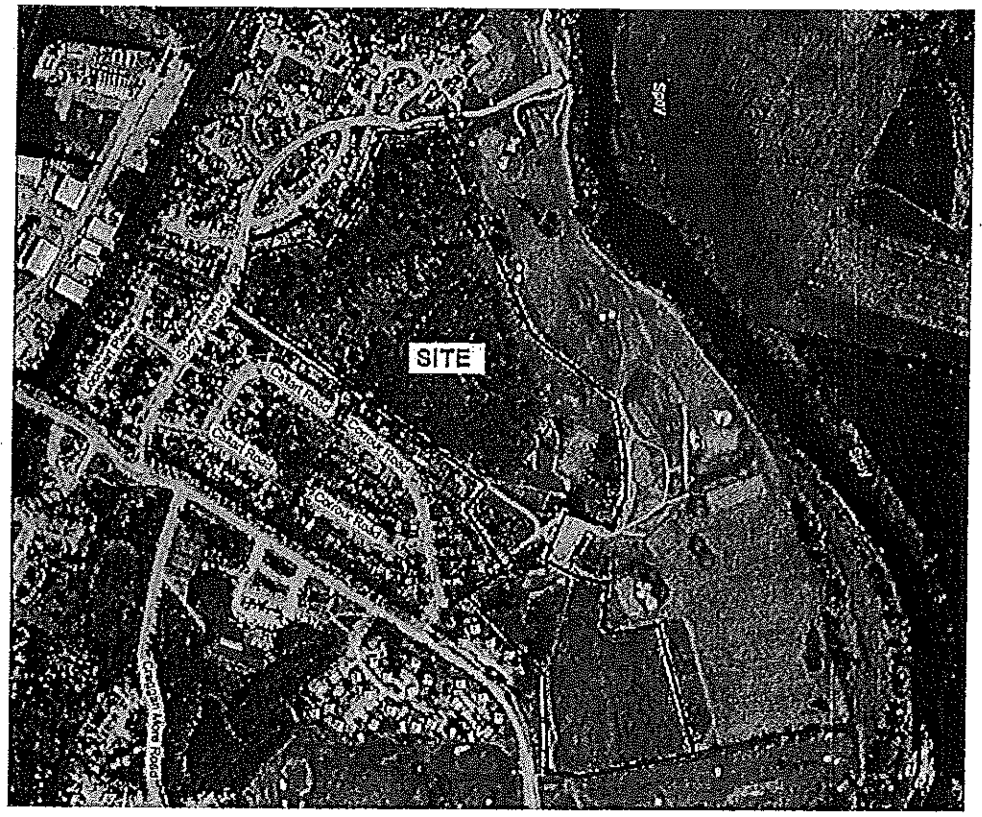


Figure 2.1-A: Aerial Photograph of Site

2.1.2. The eastern boundary lies approximately 120m from the River Spey and the area of ground between them is being developed as a golf course. To the south of the site is

4. SITE INVESTIGATIONS

4.1. SUMMARY

4.1.1. The following is a summary of information available from Addendum A "Geotechnical Considerations" for Dalfaber Residential Development as carried out by LPG - Grampian Soil Surveys (2004).

4.2. SOIL

4.2.1. The British Geological Survey Map indicates that the uppermost topsoil horizon is generally underlain by late Quaternary and Holocene deposits. Below this, Pleistocene deposits predominantly in the form of silty sands, silty gravelly sands, and silty sand and gravel deposits and beneath this is generally intrusive Granite of Ordovician age.

4.2.2. Wallingford Maps Volume 3 shows the site as having a "Type 2" soil classification.

4.2.3. Excavation of 41 trail pits using a non targeted strategy revealed the topsoil to be immediately underlain by gravelly sand to an average depth of 0.3m. Beneath the gravelly sand layer is glacial till deposits of silty gravelly fine sand with occasional small rounded cobbles and occasionally sandy gravelly clay.

4.3. ROCK

4.3.1. Bedrock was not identified in the investigation to a depth of 4.00mbegl. Granite of Ordovician Stratigraphic age was said to be expected at greater depths.

4.4. INFILTRATION TESTING

4.4.1. Soil Infiltration Tests were carried out in TP2, TP24, TP28, TP34 and TP47 at depths of 2.0m. These show a range of infiltration rates for the site from 8.7×10^{-5} to 5.6×10^{-4}.

Location	Average Infiltration Rate (m/s)	Depth (m)	Groundwater Level (m)
TP2	1.9×10^{-4}	2	N/A
TP24	2.3×10^{-4}	2	N/A
TP28	5.6×10^{-4}	2	N/A
TP34	8.7×10^{-5}	2	N/A
TP47	4.5×10^{-4}	2	N/A

Table 4.1-A: Average BRE 365 Infiltration Rates

5. CONSULTATIONS AND DATA ACQUISITION

5.1. SEPA

5.1.1. A telephone consultation was carried out with Ron Murdoch of SEPA's Elgin office regarding flood risk in this area. SEPA advised the following:

- A flood level for the 1 in 200 year storm event was not available for the proposed site, however it was confirmed that the upstream monitor at Kinrara on the River Spey provided a flow of 481m^3/s (catchment 1012 km^2) for the 1 in 200 year storm event.
- The east of the site was stated to lie within indicative limits of flooding from the 1829 flood on the River Spey according to information derived from the 1998 edition of Sir Thomas Dick Lauder's book "The Great Moray Floods of 1829"). It should be noted that as with the SEPA flood maps this is an indicative indication only and is not site specific.
- SEPA advised that the River Druie connected to the River Spey downstream of the Kinrara monitoring station and would need to be taken into account when assessing the 1 in 200 flood level for the proposed site.
- SEPA also advised that climate change should be taken into account in the design of any flood alleviation scheme.

5.1.2. Derek Fraser of SEPA Aberdeen office supplied peak flows from three gauging stations on the River Spey near the site at Grantown, Kinrara and Goat of Garten with flow records at these stations dating back 55, 55 and 53 years respectively.

5.1.3. The Grantown station recorded its max flow of 508m^3/s on 06 Feb 1989, Kinrara with max flow of 481m^3/s on 18 Dec 1966 and the Goat of Garten with a max flow of 368.8m^3/s on 17 Jan 1993.

5.2. LOCAL AUTHORITY / DEVELOPMENT CONTROL

5.2.1. Highland Council (HC) were consulted and Andrew MacIver of HC has supplied a copy of the 1991 Flood Alleviation Report for the River Spey.

5.2.2. No information relevant to or potentially affecting the proposed site is included in this report.

6. RELEVANT LEGISLATION AND GUIDANCE

6.1. SCOTTISH PLANNING POLICY 7 (SPP7) - PLANNING AND FLOODING

6.1.1. Flood risk is a material consideration in determining planning applications, and the relevant guidance policy in Scotland is SPP7. This policy defines procedures for carrying out assessments allowing for a risk based approach, that considers both the probability of an event and the consequences depending on the vulnerability of the user.

6.2. SCOTTISH EXECUTIVE (2001), PLANNING ADVICE NOTE (PAN) 69 PLANNING AND FLOODING

6.2.1. PAN 69 offers provide improved guidance to local authorities on building in areas where there is a risk of flooding, and is a starting point in defining the responsibilities of local authorities and developers in ensuring that future built development is not located in areas with a significant risk of flooding, including functional flood plains. However, there are circumstances where development would benefit from selecting designs, forms of construction and materials which may help to minimise the effects of a flood event on the property.

7. SOURCES OF FLOOD RISK

7.1. FLOOD ZONING

7.1.1. The SEPA flood map indicatively shows the site lying on the boundary of the Flood Plain (Category 3) of the River Spey, with the annual probability of watercourse or tidal flooding greater than >0.5% (1:200). See Figure 7.1-A below for illustration.

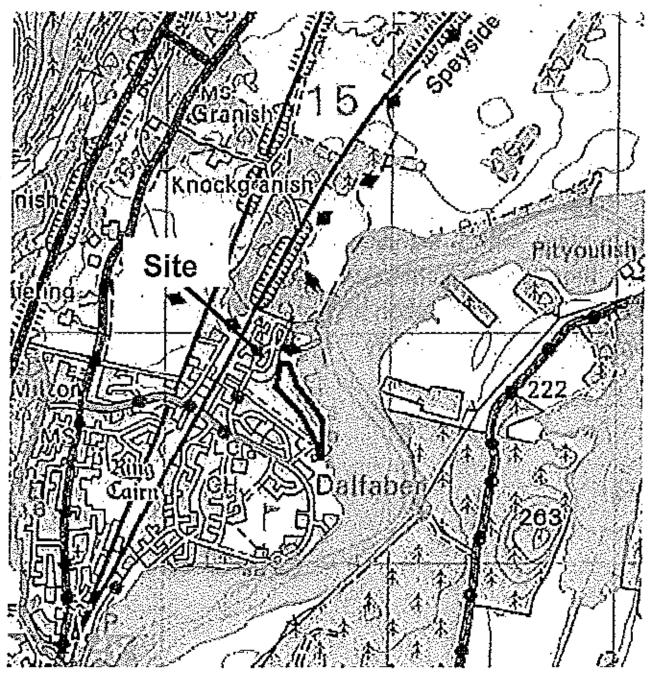


Figure 7.1-A: SEPA Plan

7.1.2. The flood map has primarily been developed to provide a strategic national overview of flood risk in Scotland. It does not provide enough detail to accurately estimate the flood risk associated with individual properties or specific point locations.

7.1.3. Furthermore, the flood map only shows flooding from rivers or the sea and does not account for flooding from other sources such as surface water runoff, surcharged culverts (where rivers which have been channelled underground flood) or drainage systems.

7.1.4. Review of the flood and land maps would suggest that the primary risk of flooding to the site is:

- Flooding from the River Spey, approximately 120m to the East of the site.
- Back up of drainage systems.
- Ground Water flooding to the North of the site.

7.2. EXISTING FLOOD DEFENCES

7.2.1. There are no formal flood defences adjacent to the site.

7.3. GROUNDWATER

7.3.1. Groundwater levels in permeable soils may be responsive to fluctuating levels in the adjacent watercourse. This may occasionally appear as surface ponding in extreme events.

7.3.2. Groundwater was not encountered in 'most of the trial pits' dug during the site geo-technical investigation by Grampian Soil Surveys (2004). However, the report states that groundwater was found in "kettle-hole" depressions across the northern area of the site. The peat and clay deposits in this area would have created marshy areas and the report states that these are likely to be permanently waterlogged throughout the year.

7.3.3. In this case, it is likely that for development to occur on or near the Kettle Hole depressions, land drainage devices will have to be installed in these areas and/or there may also be potential to raise the groundlevel to an appropriate elevation depending on the height of groundwater test results.

7.3.4. In general, there is considered to be a low risk of groundwater flooding for the majority of the site due to:

- The elevation of the site above the river level
- The gradient of the site is unlikely to lead to ponding

7.3.5. SuDS design considerations must take into account the seasonal variations in the water table and the groundwater should not rise to the level of e.g. the base of a soakaway.

7.4. FLOODING FROM OVERLAND FLOW

7.4.1. Overland or sheeting flow may occur when intense rainfall exceeds the infiltration capacity of the ground, or when it is already saturated.

7.4.2. Flood risk to the site may occur if it lies between a catchment and the natural drainage channel.

7.4.3. There are no large areas of farmland or hardstanding above the site that could potentially lead to sheeting flow.

7.5. FLOODING FROM DRAINAGE SYSTEMS

7.5.1. No drainage system can be economically designed to cope with extreme rainfall events, and so flooding from new systems should be routed away from buildings.

7.5.2. The general guide is that systems should be designed such that they do not surcharge under rainfall events below 1:2 year return period, nor flood below 1:30 year events, according to Building Regulations and Sewers for Adoption, 5th Edition, Section 212.

7.5.3. No detailed hydraulic assessment of the proposed drainage system has been carried out for the purposes of this report.

7.5.4. Fitting a proprietary non return valve at the outfall pipe or the last manhole to the site will assist in reducing the risk of external flood waters entering the site through the drainage system.

7.6. FLOODING FROM TIDE

7.6.1. There is considered to be a low risk of flooding from tidal influences with the coastline being approximately 40km to the North.

8. HISTORY OF FLOODING

8.1. RECORDED EVENTS

8.1.1. A search through the British Chronology of Hydrological Events ("Hydrochronology") has not shown results for the key words of River Spey, Dalfaber and Aviemore.

8.1.2. The Hydrochronology is voluntarily contributed to by researchers and generally records noted events up to 1935, so not all events are therefore recorded.

8.1.3. Whilst the absence of a record does not mean that the area has never flooded, generally areas that are prone to flooding do appear regularly.

8.1.4. Roger Knight, Director of Spey Fisheries Board has stated that they have no records of the Spey flooding at or near the site in their records.

8.1.5. The East of the site is stated to lie within limits of flooding from the 1829 flood on the River Spey according to the 1998 edition of Sir Thomas Dick Lauder's book "The Great Moray Floods of 1829". However, it should be noted that this, as with the SEPA flood maps, is an indicative indicator of past flooding.

9. RISK FRAMEWORK

9.1. FLOOD RISK CATEGORY OF PROPOSED DEVELOPMENT SITE

9.1.1. Section 10 of SPP7 describes The Risk Framework – The Planning Response to Flood Risk (Coastal and Watercourses).

9.1.2. This framework divides flood risk into three categories, as follows:

1. Little or No Risk Areas
2. Low to Medium Risk Area
3. High Risk Areas

It is considered that part of the site falls within Category 3(a) – 'High Risk Area within areas already built up' and the rest of the site falls within category 1 or 2.

The High Risk Area subset has two subcategories. These are described in the following excerpt:

3. **High risk area (see the 2 sub areas below)**

Annual probability of watercourses, tidal or coastal flooding: 0.5% (1:200) or greater

Subject to operational requirements in terms of response times, the high risk area is generally not suitable for essential civil infrastructure, such as hospitals, fire stations, emergency depots etc. and ground based telecommunications equipment.

3(a) Within areas already built-up – Appropriate Planning Response

These areas may be suitable for residential, commercial and industrial development provided the appropriate minimum standard of flood defences already exists, are under construction or are planned as part of a long term development strategy in a structure plan context, and will be maintained for the lifetime of the development. In allocating sites preference should be given to those areas already defended to that standard. In allocating or permitting sites for development, authorities should seek to avoid areas that will be needed or have significant potential for coastal managed realignment or washland creation as part of the overall flood defence. Flood resistant construction may be required.

3(b) Undeveloped and sparsely developed areas – Appropriate Planning Response

These areas which include the functional flood plain, are generally not suitable for residential, commercial and industrial development unless a particular location is essential, e.g. for navigation and water-based recreation uses, agriculture and essential transport and utilities infrastructure, and an alternative lower-risk location is not available. Essential infrastructure should be designed and constructed so as to remain operational even at times of flood. They may be suitable for some recreation, sport, amenity and nature conservation uses (provided adequate warning and evacuation procedures are in place). General purpose housing or other development comprising residential or institutional accommodation should not normally be permitted. Residential uses should be limited to job-related accommodation (e.g. caretakers and operational staff). Caravan and camping sites should generally not be located in these areas. Where exceptionally, built development is permitted, the appropriate minimum standard of flood defence may be required and should not impede flood flows or result in a net loss of flood plain storage. Flood resistant construction may be required.

10. FLOOD HYDROLOGY – FLUVIAL FLOODING

10.1. OVERVIEW

10.1.1. Flow calculations were required in order to determine the 200 year (0.5% AEP) flow plus an allowance for Climate Change at the proposed site in accordance with SPP7.

10.1.2. This flow was then routed through a hydraulic model of the River Spey at the subject site to estimate peak flood levels.

10.2. FEH STATISTICAL METHOD

10.2.1. The Flood Estimation Handbook (FEH) statistical method was used as the means of calculating flows at the site.

10.2.2. HiFlows UK website was used as the preferred source of annual maxima per site, as well as the current preferred network of gauging stations within the UK to be used for pooling groups and data transfer.

10.2.3. Three donor sites were used to create an FEH pooling group using Winfap-FEH software with each site chosen having demonstrated suitable limits with respect to DISTANCE, AREA, SAAR, BFIHOST, SPRHOST and FARLAND.

10.2.4. WINFAP-FEH is designed to provide single-site and pooled (i.e. regional) methods of frequency analysis based on annual maxima in support of the FEH.

10.2.5. The gauging sites suitable for the site catchment and thus included in the pooling group were Spey @ Kinrara, Spey @ Boat of Garten and Spey @ Invertruim.

10.2.6. The catchment descriptors for the proposed site, as shown in Table 10.2-C, were found using the sites National Grid Reference with the FEH-CDRom.

10.2.7. A weighting was then assigned to each gauging station dependent on the length of flow records for each station and this was used to assess the Qmed of the river Spey at the site.

10.2.8. The subsequent design flow used to assess the flood risk of the 200 year plus climate change flood event at the proposed development site was **814m^3/s**. The pooling output for the existing 1 in 200 year flow is shown in Table 10.2-A.

YEARS	L-CV	L-SKEWNESS	L-KURTOSIS	DISCORDANCY	STAT. DISTANCE	X	Y	ACTUAL DISTANCE (KM)
SPEY @ KINRARA	0.209	0.238	0.112	1.15	0	288100	808200	6
SPEY @ BOAT OF GARTEN	0.238	0.285	0.105	0.889	0.186	294600	819100	7
SPEY @ INVERTRIUM	0.286	0.277	0.122	0.597	0.6	294600	819100	7

TABLE 10.2-A: POOLING GROUP DETAILS AND STATION DISTANCES

10.2.9. The following growth factors and associated flows from the pooling group were then constructed via the FEH statistical method into a Flood Frequency Curve, shown in Figure 10.2-B below:

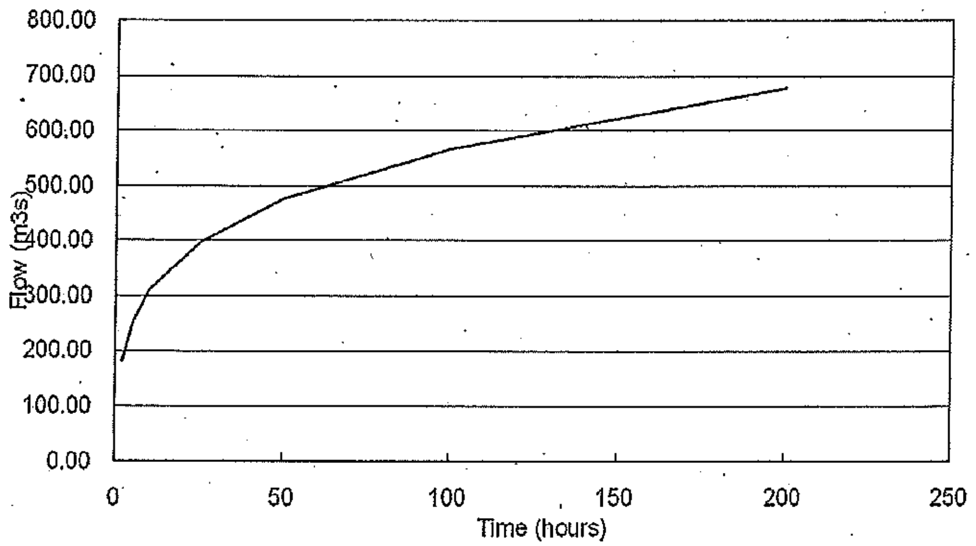


FIGURE 10.2-B: FLOOD FREQUENCY CURVE (1:200 FLOOD EVENT)

CALCULATION OF CATCHMENT DESCRIPTORS	
Name of site	Dalfaber
Name of watercourse	River Spey
NGR	290950 813600
AREA	1198.08
FARL	0.922
PROPWET	0.71
ALTBAR	534
ASPBAR	351
ASPVAR	0.04
BFIHOST	0.461
DPLBAR	40.41
DPSBAR	178.1
LDP	79.13
RMED-1H	9.5
RMED-1D	36.6
RMED-2D	53
SAAR	1299
SAAR4170	1327
SPRHOST	48.5
URBCONC	-999999
URBEXT1990	0
URBLOC	-999999
C	-0.022
D1	0.42
D2	0.482
D3	0.428
E	0.26
F	2.343
C(1km)	-0.021
D1(1km)	0.424
D2(1km)	0.487
D3(1km)	0.401
E(1km)	0.258
F(1km)	2.205

TABLE 10.2-A: FEH CATCHMENT DESCRIPTORS DATA

FLOOD MODELLING

10.3. FLOOD MODELLING SOFTWARE

10.3.1. InfoWorks RS is a market leader in the production of flood maps and geographical based flood output information. Although the hydraulic principles are the same as HEC RAS, InfoWorks can use groundmodels to build 3D images showing flood depths at the site and surrounding area.

10.3.2. In order to show the extent of flooding to the site, it was considered necessary to extend the survey extent to show flow paths. The model cross sections through the river have been taken by Granite City Surveys and are spliced together with LIDAR map data to give a greater overview of the existing area. The Granite City Survey of the area was carried out in March 2009 and the LIDAR data was surveyed in 2004 and consists of data of a 5m data point resolution and approximately 500mm vertical accuracy.

10.4. HYDRAULIC MODELLING USING INFOWORKS RS

10.4.1. A new ground model was created in Infoworks RS using the relevant survey information.

10.4.2. Figure 10.4-A overleaf shows a 3D Geoplan of the Infoworks ground model used. LIDAR information was used as the basis for the ground model for the River channel.

10.4.3. The boundary node in Infoworks RS includes the FEH statistical method with the catchment descriptors as given in Table 10.2-A. The normal boundary where the flow exits the model set-up contains the slope which follows the existing bed level of 0.0033.

10.4.4. The highest annual maxima flow on the River Spey as per Hiflow-UK was recorded at Grantown station at 508.78m^3/s which modelled in Infoworks equates to approximately a 1:100year event. Kinrara station recorded its highest annual maxima of 481m^3/s.

10.4.5. Our model was run for the 1:200 plus 20% climate change event which equated to a flow of 814m^3/s.

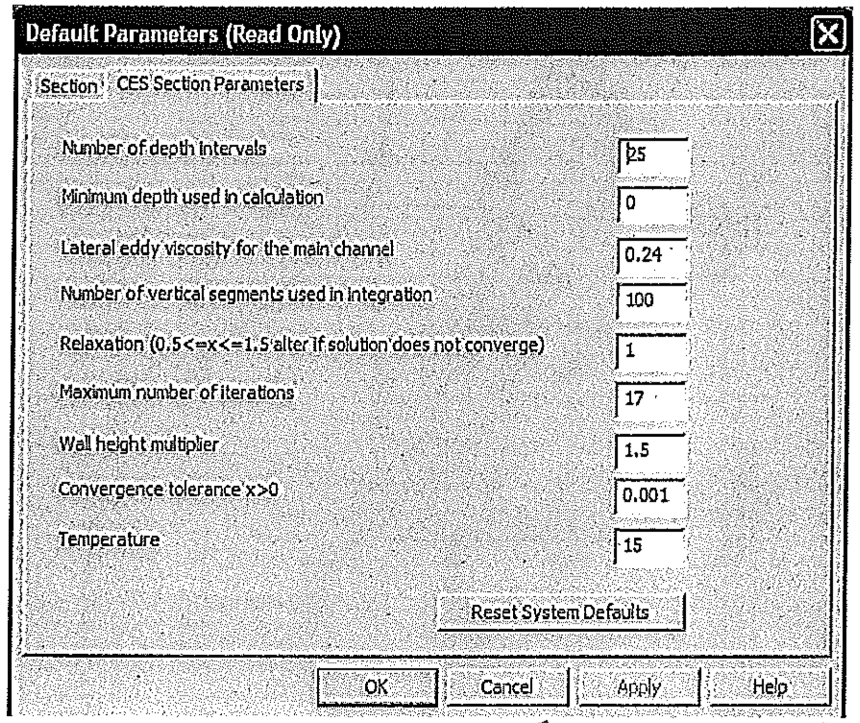


Figure 10.4-C: Infoworks RS Section Parameters

Figure 10.4-A: Lidar Ground Model and River Spey Cross-Sections in Inforworks RS

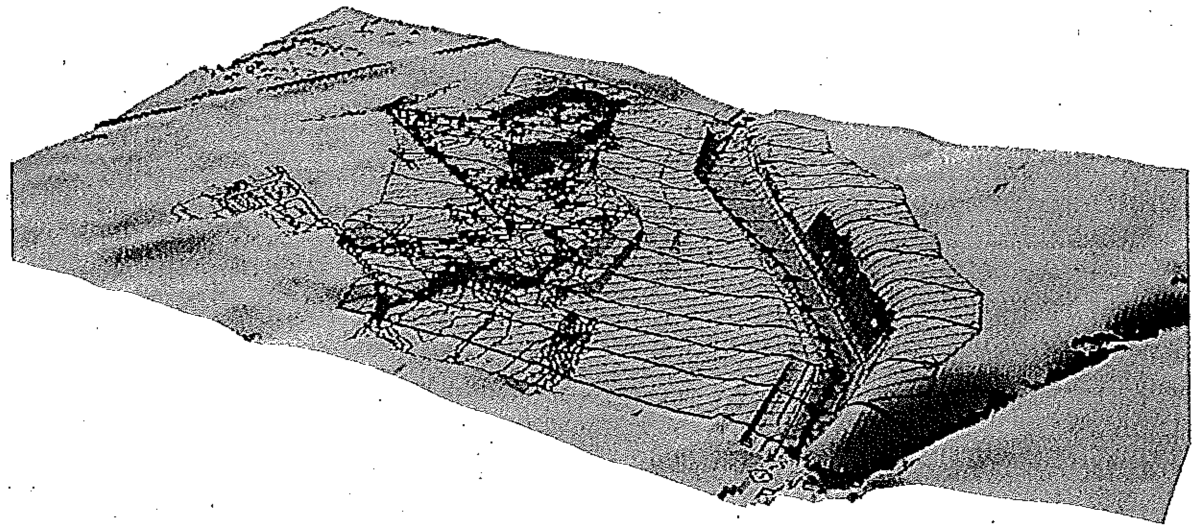


Figure 10.4-B: 3d View of Geoplan in Infoworks RS

10.5. HYDRAULIC MODELLING RESULTS

10.5.1. The design flow used to assess the flood risk of the 200yr+20% flood at the proposed development site was **814 m³/s.**

10.5.2. The steady state QMED channel flow of 31.8m³/s is illustrated in the 3D view in Figure 10.5-A below.

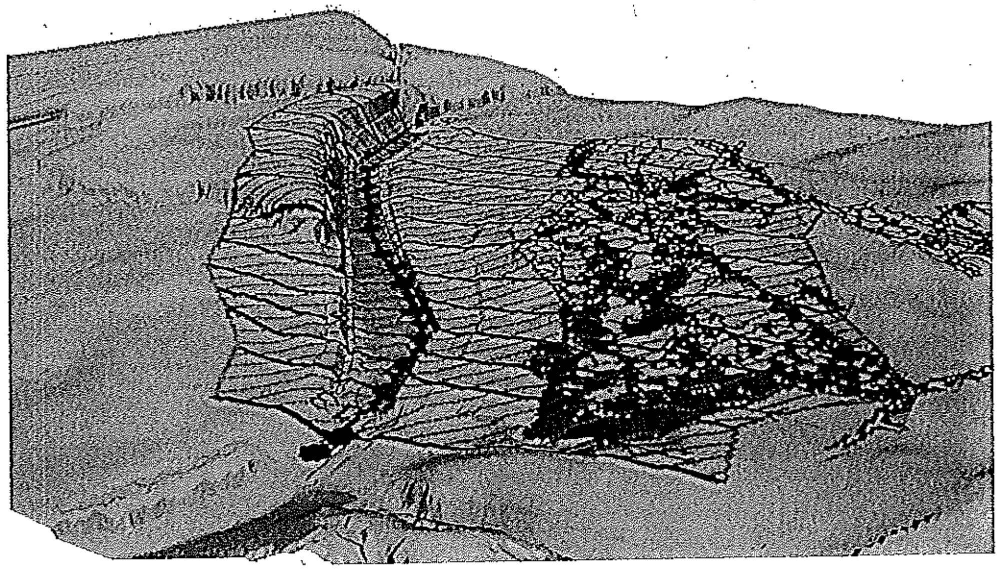


Figure 10.5-A: 3D Illustrated Steady State QMED

10.5.3. As illustrated above, the flow from the River Spey remains within its channel banks for the steady flow analysis with a QMED of 31.8m³/s.

10.5.4. The flow for the unsteady state M200-60 plus 20% climate change was then run in the model with the steady flow results being used as a initial conditions for the M200-60 plus 20% run. These results are shown schematically in Figure 10.5-B overleaf.

10.5.5. It is noted from Figure 10.5-B that under the M200 plus 20% climate change unsteady event, the proposed development site is infringed to the South-East by flooding water from the river. A more detailed schematic of this flood area is shown in Appendix C.

10.5.6. It is also noted from Figure 10.5-B that the existing pond area in the centre of the site is deemed to be flooding from the M200-60 plus 20% storm event as Infoworks RS model runs are two dimensional. However Figure 10.5-J demonstrates that floodwater would not reach this location due to physical barriers.

10.5.7. The site outline and architects masterplan layout is shown with the 1:200yr +climate change flow imposed in Appendix D. It was determined that the critical storm duration for the catchment equated to approximately 11 hours. From this maxima event, it was illustrated that River Spey has a maximum stage of 207.818 m AOD adjacent to the site.

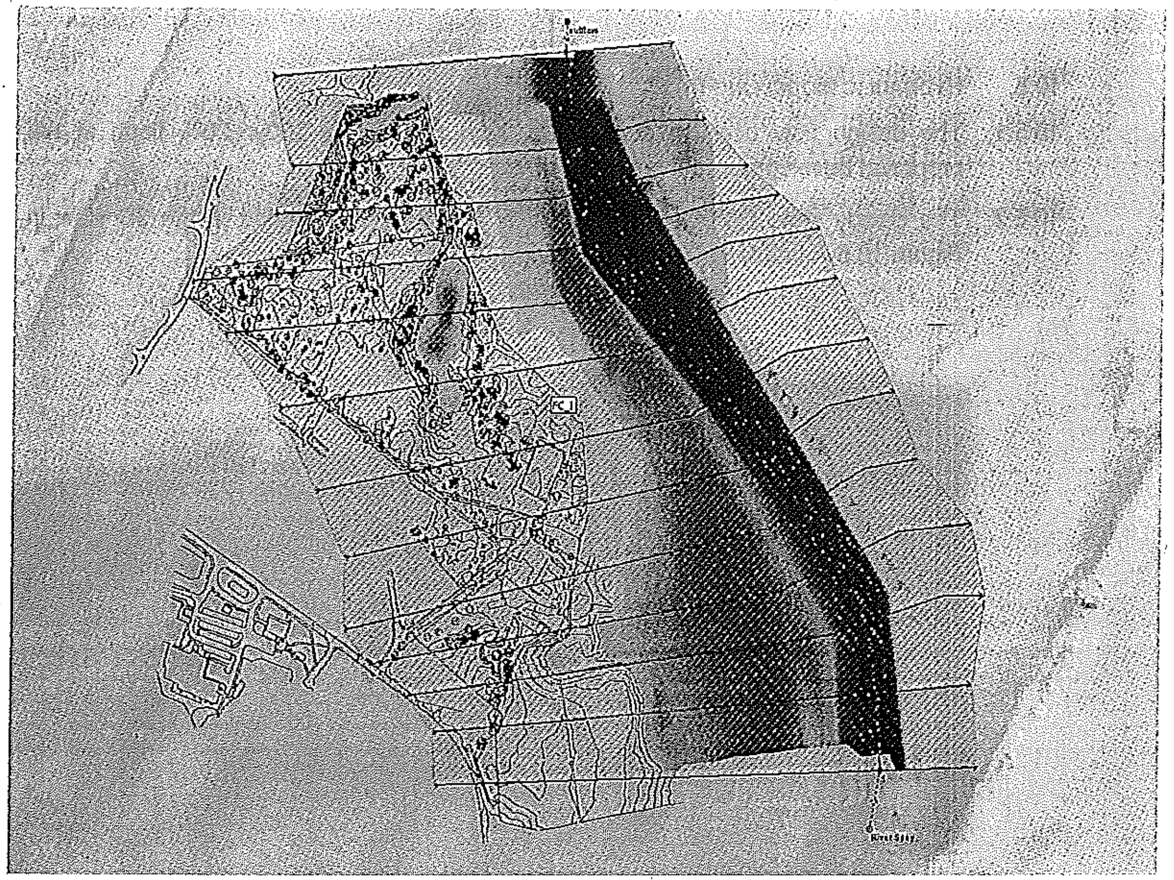


Figure 10.5-B: M200-60 plus 20% Climate Change Event

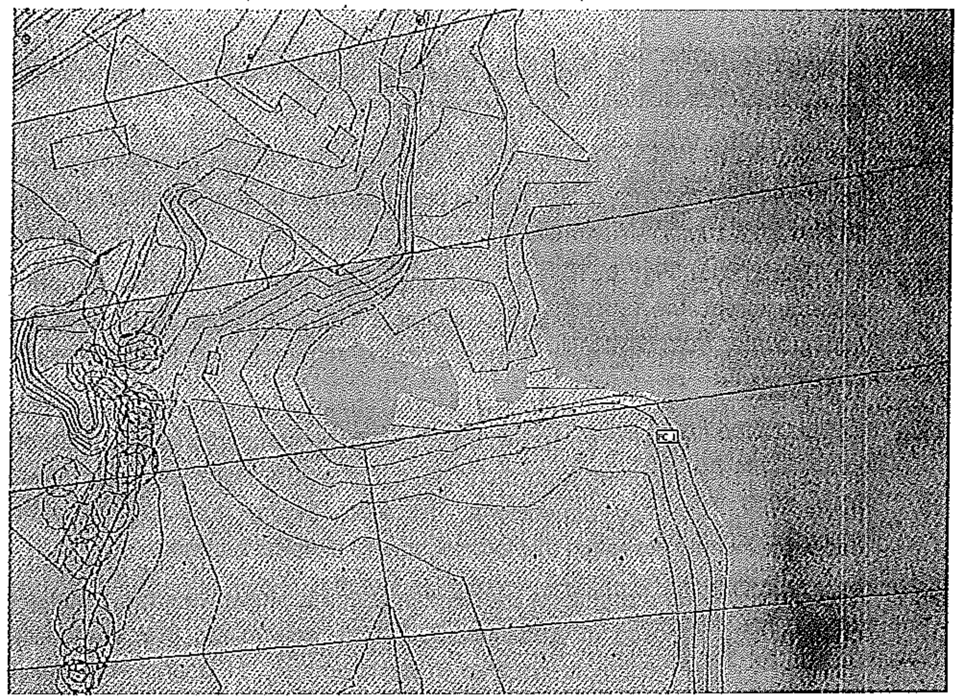


Figure 10.5-C: Enlarged View of River Spey Flood (M200-60) to the South-East of the proposed site

Node	Total Energy (m)	Flow (m³/s)	Froude	Max Total Energy (m)	Max Flow (m³/s)	Max Froude	Max Stage (m AD)	Max State	Max Velocity (m/s)	Min Total Energy (m)	Min Flow (m³/s)	Min Froude No	Min Stage (m AD)	Min State	Min Velocity (m/s)	Stage (m AD)	Velocity (m/s)
[illegible]	207.903	814.628	0.448	207.903	814.663	0.448	207.818	0.000	1.559	203.395	31.839	0.378	203.362	0.000	0.842	207.818	1.559
[illegible]	207.544	813.877	0.563	207.544	813.677	0.563	207.430	0.000	1.498	202.990	31.112	0.300	202.921	0.000	1.150	207.430	1.498
[illegible]	207.510	813.559	0.830	207.510	813.593	0.830	207.367	0.000	1.873	202.777	31.008	0.361	202.828	0.000	1.527	207.367	1.873
[illegible]	207.450	813.522	0.805	207.450	813.522	0.805	207.274	0.000	2.259	202.468	30.821	0.401	202.293	0.000	1.710	207.274	2.259
[illegible]	207.345	813.385	0.650	207.345	813.385	0.650	207.313	0.000	2.448	202.150	30.745	0.382	202.072	0.000	1.241	207.313	2.448
[illegible]	207.872	814.546	0.517	207.872	814.548	0.517	207.799	0.000	1.794	203.360	31.839	0.239	203.324	0.000	0.839	207.799	1.794
[illegible]	207.837	814.457	0.742	207.837	814.457	0.742	207.763	0.000	2.577	203.300	31.838	0.264	203.217	0.000	1.384	207.762	2.577
[illegible]	207.804	814.285	0.552	207.804	814.258	0.553	207.731	0.000	1.858	203.247	31.832	0.224	203.212	0.000	0.757	207.736	1.858
[illegible]	207.759	814.149	0.560	207.759	814.149	0.560	207.653	0.000	2.017	203.221	31.799	0.161	203.199	0.000	0.654	207.653	2.017
[illegible]	207.699	814.089	0.556	207.695	814.059	0.555	207.531	0.000	2.133	203.203	31.625	0.184	203.173	0.000	0.654	207.531	2.133
[illegible]	207.630	813.978	0.545	207.633	813.979	0.545	207.422	0.000	2.185	203.174	31.560	0.235	203.145	0.000	0.700	207.422	2.185
[illegible]	207.561	813.868	0.432	207.531	813.908	0.432	207.437	0.000	1.774	203.131	31.400	0.254	203.102	0.000	0.723	207.437	1.774
[illegible]	207.574	813.786	0.366	207.574	813.784	0.365	207.483	0.000	1.472	203.084	31.256	0.273	203.064	0.000	0.723	207.483	1.472

Table 10.5-D: FLOW RATES FOR THE UNSTEADY MODELLED 1:200 YR STORM EVENT PLUS 20% CLIMATE CHANGE ALLOWANCE

10.5.8. It is recommended that the two houses nearest the peak flood as shown in Appendix D have their finished floor levels set at a minimum of 208.028m AOD which provides a 450mm freeboard allowance over the 1:200+20% climate change storm event.

10.5.9. For the Infoworks RS model, the Manning levels set for the left and right banks of the River Spey were 0.05, with 0.03 being used for the Channel bed. Sensitivity analysis was subsequently carried out to analyse the affect of a positive and negative 10% difference on the manning figures and illustrate any change in stage.

Cross Section No.	Mannings M AOD	+ 10% M AOD	-10% M AOD
1	207.818	207.981	207.630
2	207.799	207.958	207.616
3	**207.578**	207.921	207.578
4	207.731	207.888	207.548
5	207.653	207.814	207.464
6	207.531	207.700	207.330
7	207.422	207.595	207.213
8	207.437	207.599	207.242
9	207.483	207.635	207.299
10	207.430	207.584	207.243
11	207.367	207.527	207.168
12	207.274	207.447	207.046
13	207.113	207.301	206.858

Table 10.5--E: Sensitivity Analysis

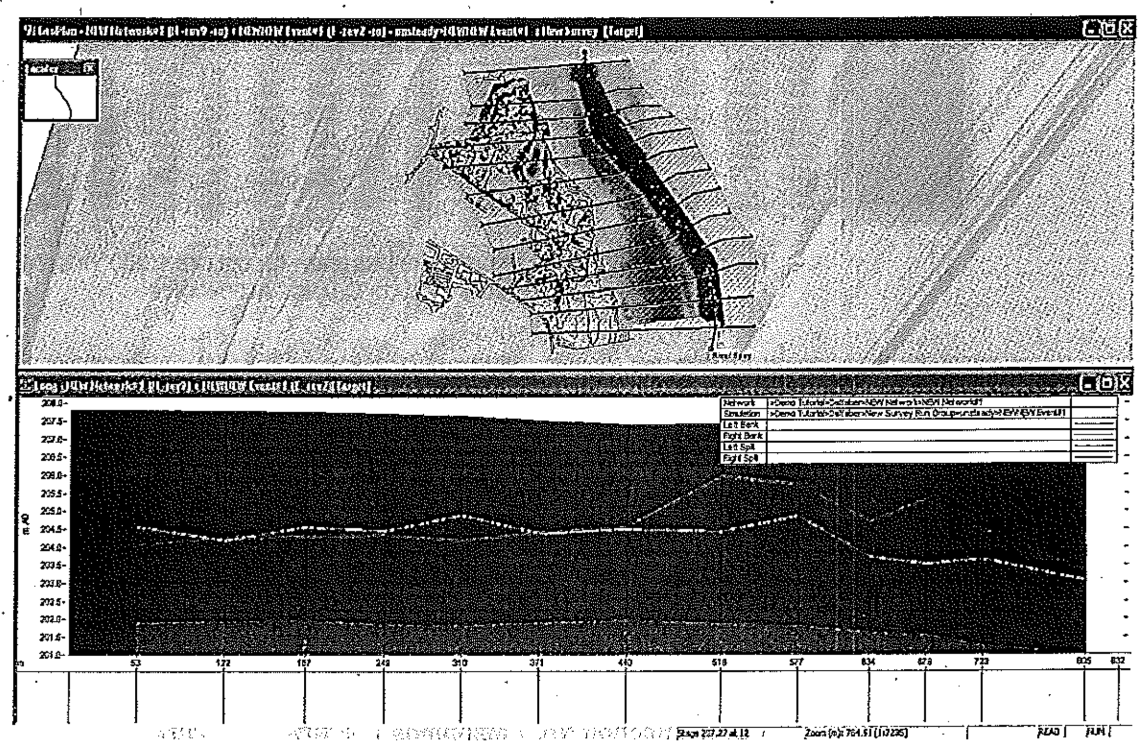


Figure 10.5-F: Long Section through River Spey adjacent to site

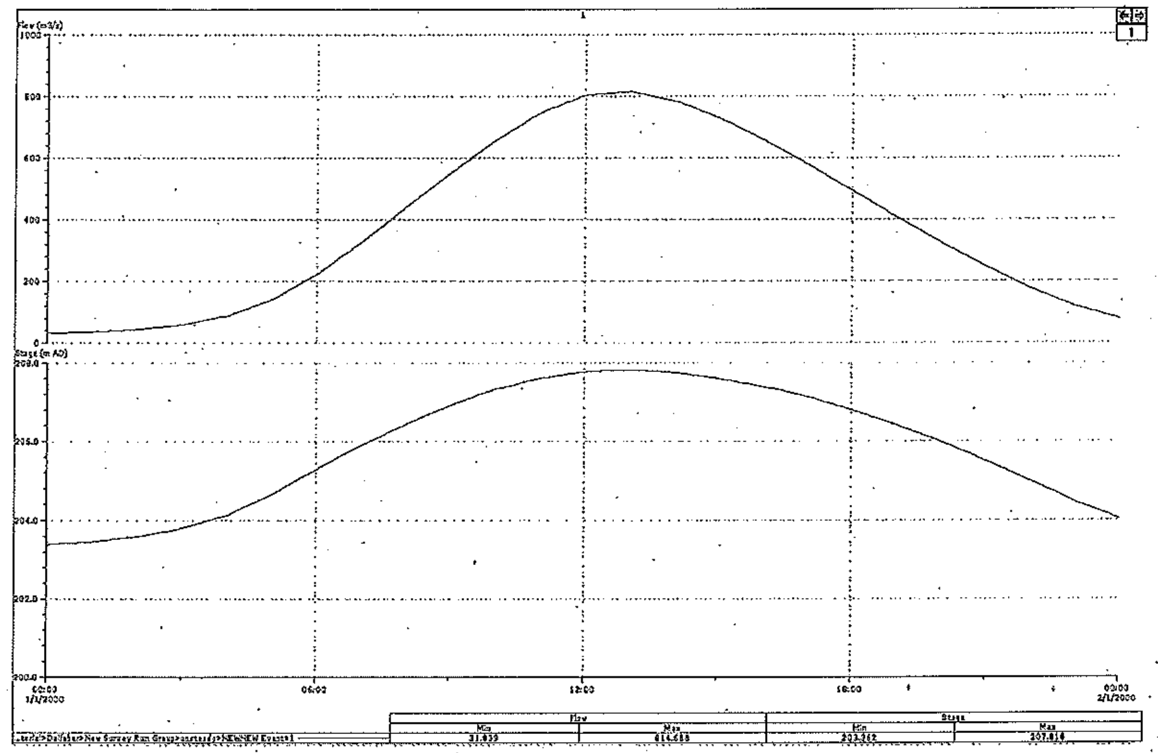


Figure 10.5-G: Flow, Stage and Outputs for model (1:200 plus 20% Event)

10.5.10. The below figures, showing sections through 2, 5, 8 and 11 show some representative examples of river sections through the floodplain. All breach their banks for the 1:200yr plus climate change flow.

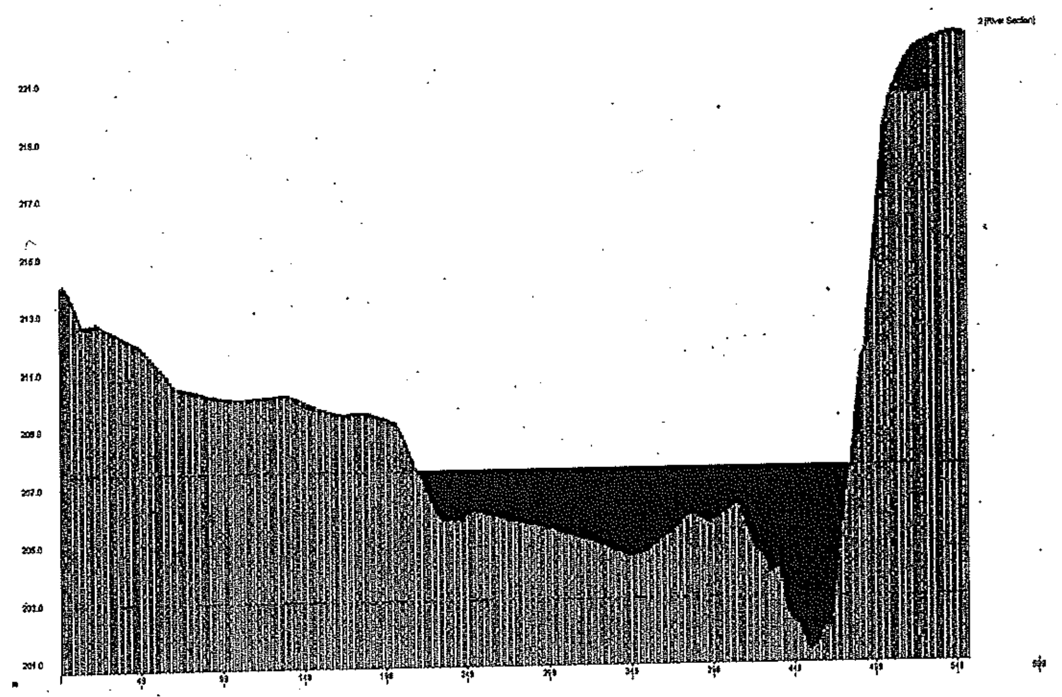


Figure 10.5-H: Section 2 through the Flood Plain

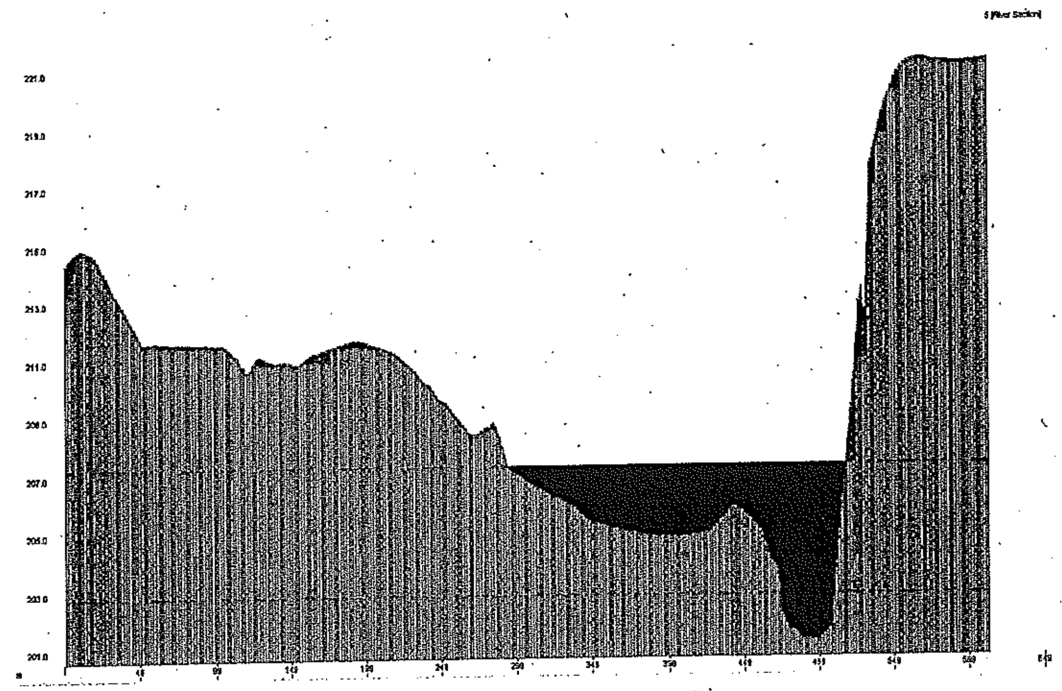


Figure 10.5-I: Section 5 through the Flood Plain

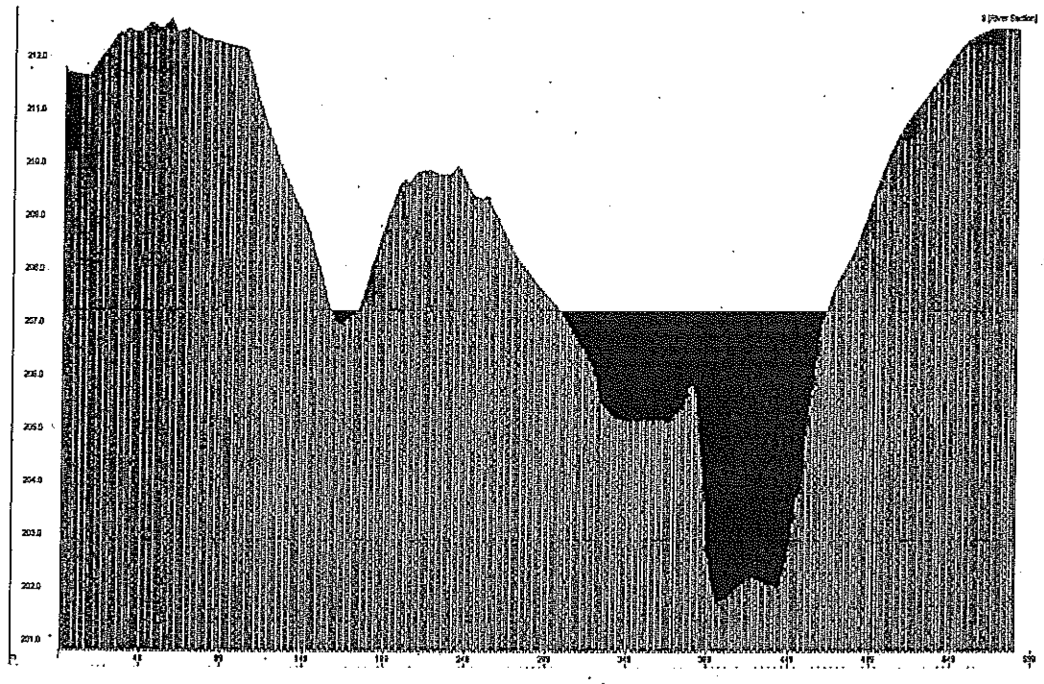


Figure 10.5-J: Section 8 through the Flood Plain

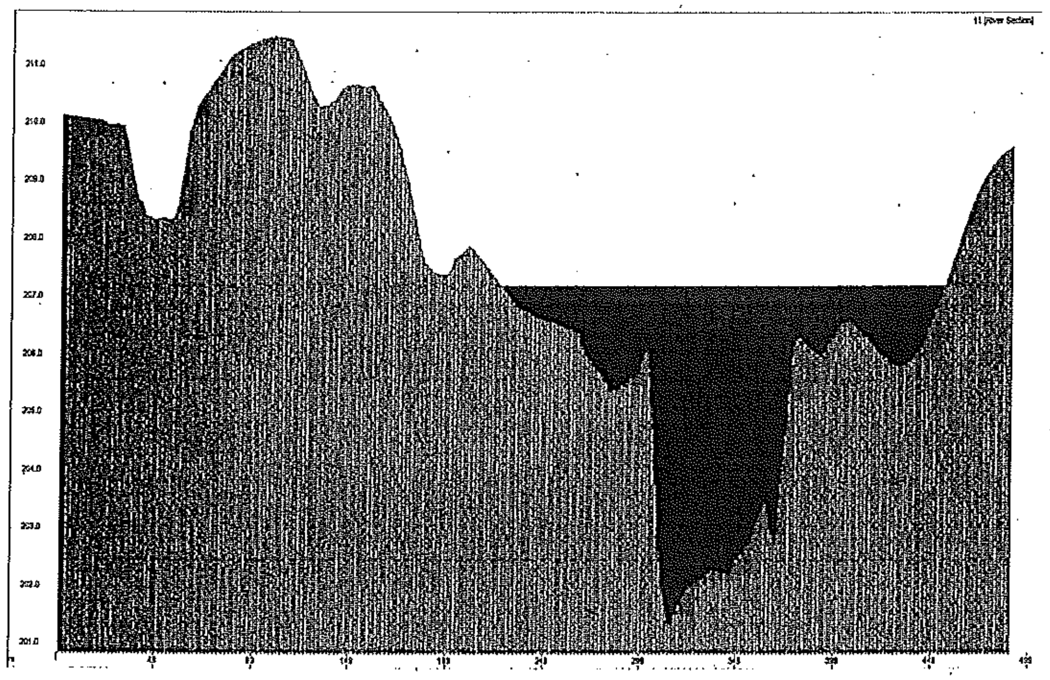


Figure 10.5-K: Section 5 through Flood Plain

PREDICTED IMPACTS

10.6. UPSTREAM EFFECTS

10.6.1. The proposals do not narrow, obstruct or change the line of the River Spey, and therefore there will be no additional risk to upstream properties.

10.7. DOWNSTREAM EFFECTS

10.7.1. An increase in impermeable area on the site may have the effect of increasing peak discharges in a storm event.

10.7.2. It will be necessary to limit the peak discharge to below predevelopment levels to avoid increased risk to downstream areas by the use of Sustainable Urban Drainage (SUDS) techniques.

10.7.3. Typical SUDS measures can include:

10.7.3.1. 'Source control' techniques, including swales, filter strips, infiltration measures and porous pavements.

10.7.3.2. 'End of Line' techniques such as retention ponds, wetlands, tanks or repumping systems.

10.7.4. From the Drainage Impact Statement and site investigation results Ramsay and Chalmers propose individual infiltration devices such as concrete ring soakaways and filter trenches as suitable drainage devices for flows from the houses and estate roads.

10.7.5. The residential area of the site is considered to be at low risk of flooding from an external source, and therefore land raising and compensation storage are not proposed although it will be necessary to manage rates of runoff to predevelopment levels to limit risk to downstream properties.

10.7.6. As the proposals do not affect the River Spey's floodplain no additional risk downstream of the development will be created.

12. CONCLUSIONS

A Flood Risk Assessment has been carried out on behalf of Ramsay and Chalmers for a proposed residential development in Dalfaber, Aviemore. The report describes the existing site and proposed development, a description of potential risks, and their implications for the new development.

There is a recorded history of flooding in the vicinity of the site.

There are no existing defences protecting the immediate site.

Consultations have been carried out with SEPA and the Highland Council.

An architect's masterplan layout for the residential housing is available for the site.

There is considered to be a low risk of fluvial flooding from the River Spey for the majority of the site.

- There is considered to be a low risk of flooding from the coastline approximately 40 km away to the north.
- **There is a low risk of groundwater flooding for the majority of the site. However, for the Northern part of the site there is considered to be a medium risk of flooding in the development unless land drainage is installed or ground levels are raised appropriately to cater for seasonal fluctuations in groundwater levels.**
- There is considered to be a low risk of flooding due to infrastructure failure.
- There is considered to be a low risk of flooding due to blockage of structure.
- There will be increase in impermeable area to the site as a result of the development. However, these are to be mitigated using appropriate SUDS/attenuation techniques, filter trenches and soakaways, such that the predevelopment run off rate is not exceeded.
- Access to the site will be maintained during a flood event via Dalfaber Drive.

Infoworks RS flow modelling has been carried out for the site using the 1:200 plus 20% climate change storm event which equated to a flow of 814m^3/s. The highest annual maxima on the River Spey was recorded at Grantown station of 508.78m3/s which approximately equates to a 1:100 year storm event.

It is concluded that the development has acceptable risk of flooding, and acceptable impact, provided the following recommendations are carried out:

- **Finished floor levels for the two proposed houses nearest the 1:200yr +20% climate change flood line to the South-West are set at a minimum of 208.517m AOD which includes a 450mm freeboard allowance.**
- Site levels are designed such that any flooding from sewers is routed away from buildings. This is a precautionary measure such that any levels within the roads and car parking areas are set at a lower level than the external levels at buildings.
- Surface water discharges are restricted to below predevelopment run-off rates.

No landraising is proposed in the River Spey floodplain and so compensation storage is not required to be provided on a volume for volume and level-for-level basis.

It is recommended that water control and water quality SUDS are incorporated into the design and include measures such as porous paving, filter trenches, enlarged storage pipes, attenuation tanks and outflow control and adequate space provided for the SuDS features within the development.

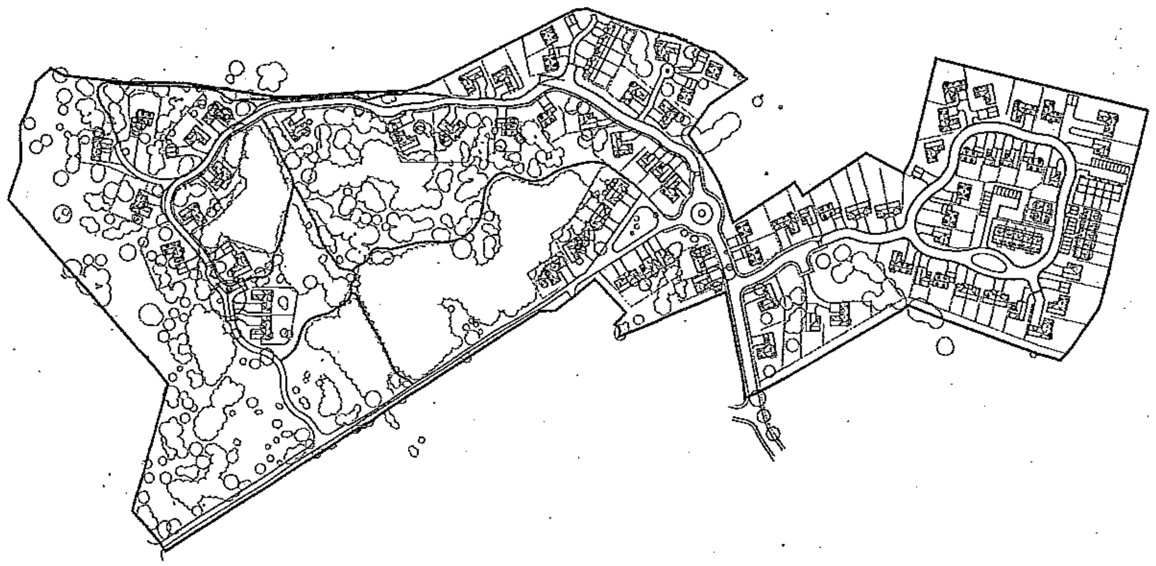
The site investigation carried out showed the site is underlain by a layer of sand and gravel and therefore SuDS infiltration devices would be applicable to this site.

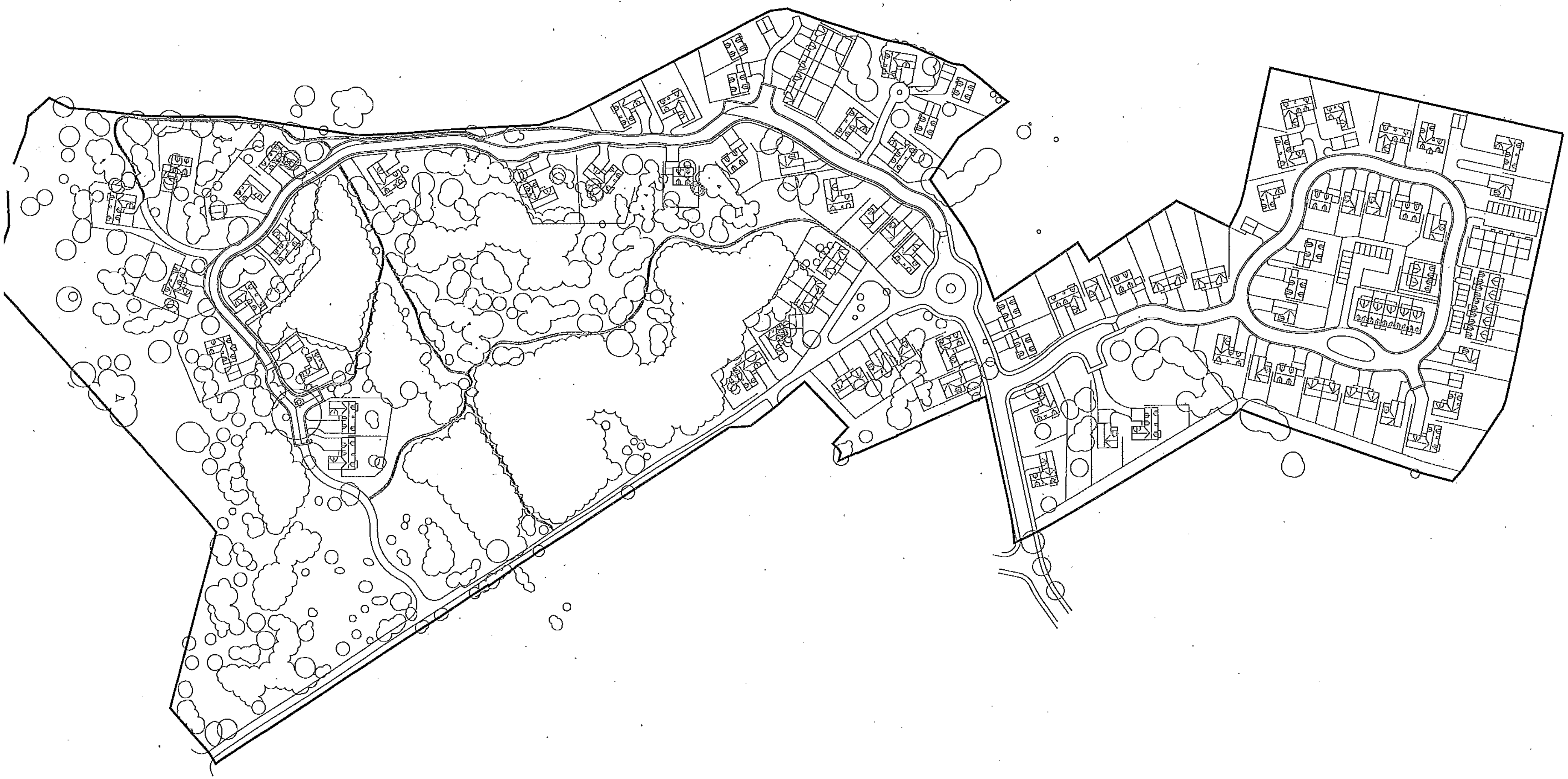
The proposed drainage and attenuation system at the site should be designed to take climate change into account and should be implemented and operational prior to the occupation of the development in order to prevent potential water pollution.

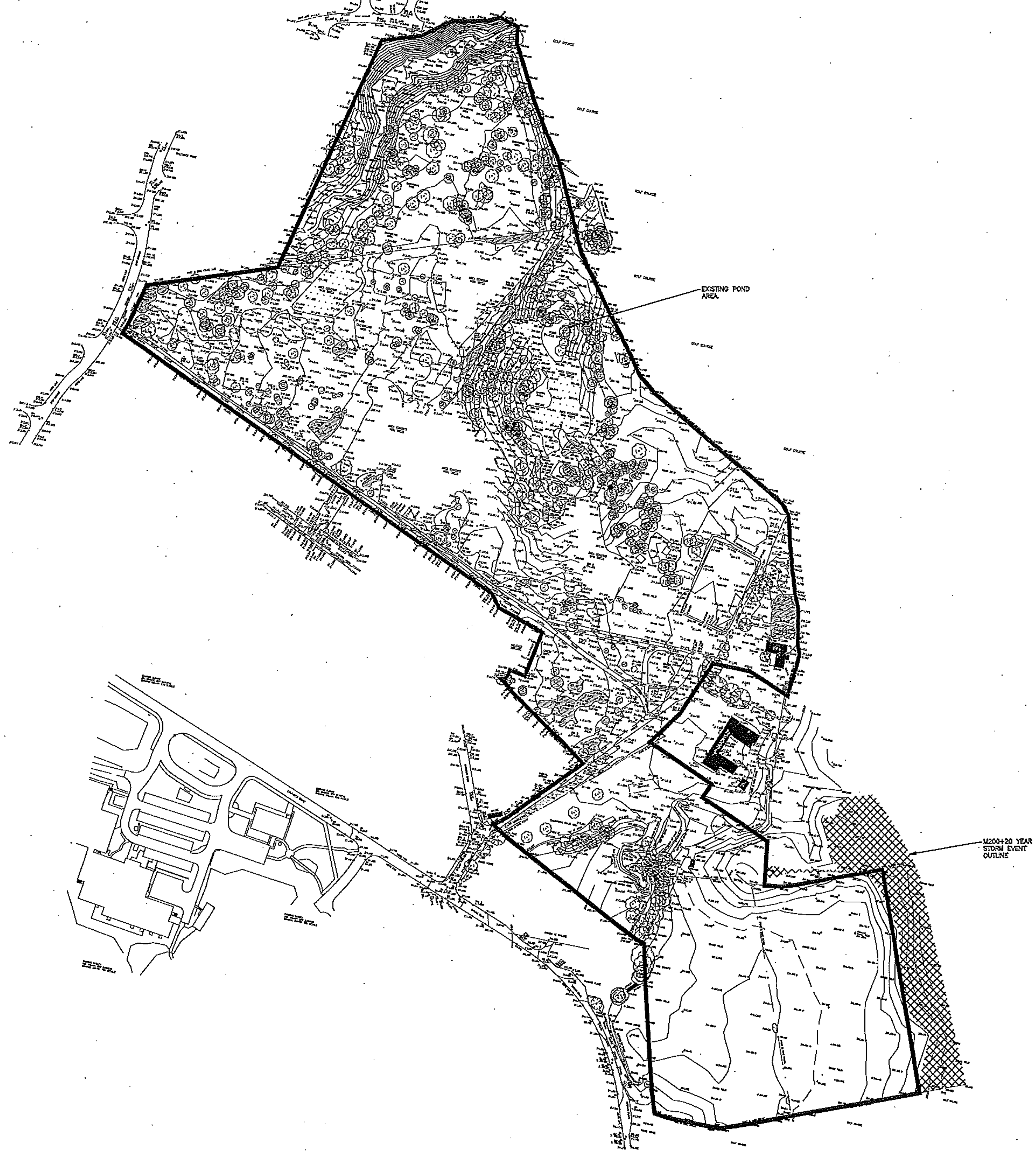
APPENDIX A: TOPOGRAPHIC SURVEY

APPENDIX B: PROPOSED MASTERPLAN LAYOUT

Appendix D: Proposed Masterplan & Flood Outline







GENERAL NOTES

Rev	Date	Description
		Amendments

Project: DALFABER, AVIEMOR

Title: TOPOGRAPHICAL SURVE & FLOOD OUTLINE

Client

Waterman Civils
Consulting Engineers

Drawing Status: INFORMATION

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Drawn by	AG	Date	June 2008
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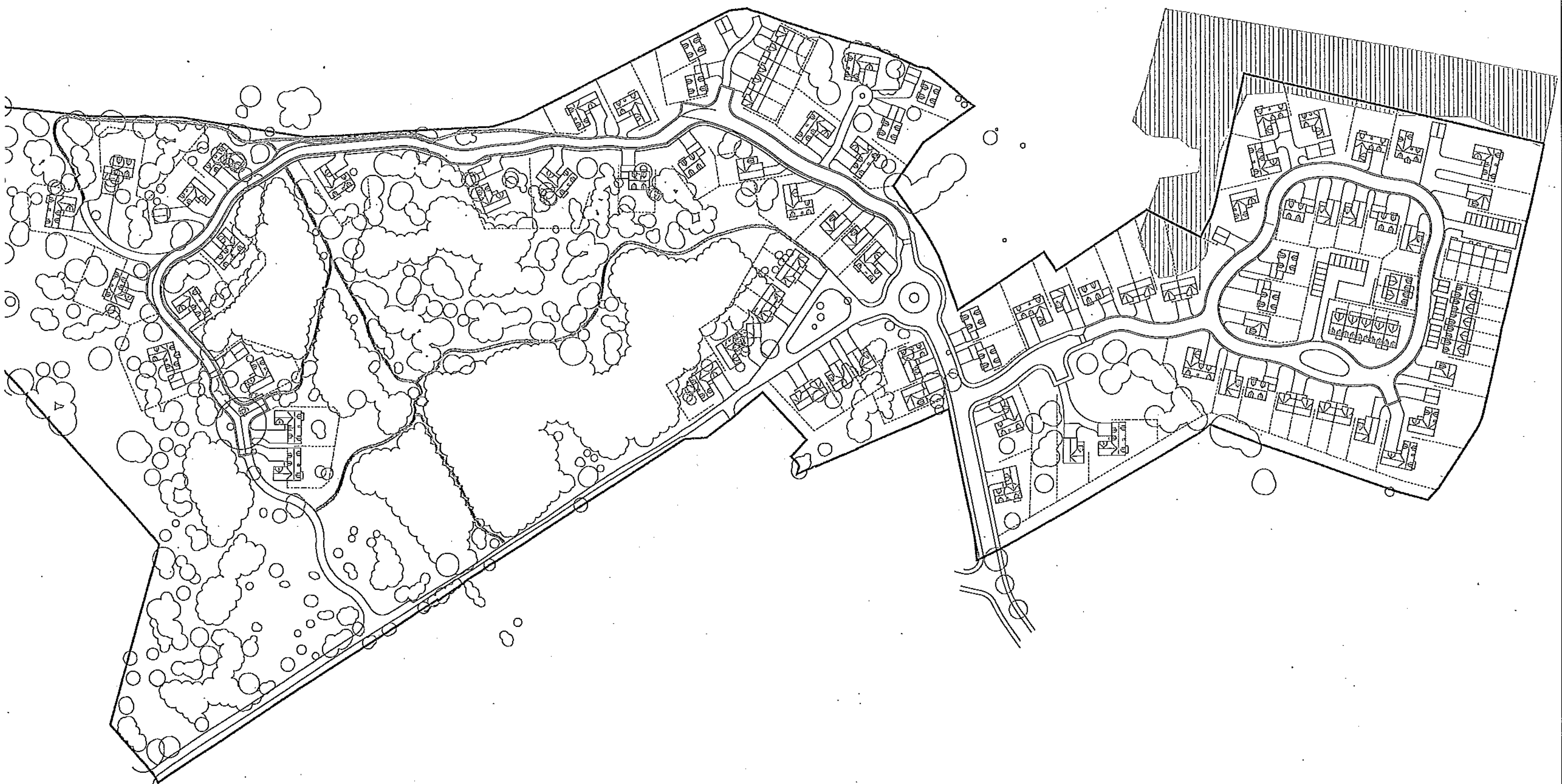

GENERAL NOTES

Rev	Date	Description	By

Amendments

Project
DALFABER, AVIEMORE

Title
REVISED LAYOUT
SHOWING FLOOD OUTLINE

Client

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