Appendix 11.3

Flood Risk Assessment

Contents

Tables

Figures

1 Introduction

1.1 A Flood Risk Assessment (FRA) has been carried out by the CH2M/ Fairhurst Joint Venture (CFJV) on behalf of Transport Scotland, as part of the '*Design Manual for Roads and Bridges*' (DMRB) Stage 3 Environmental Impact Assessment (EIA) for Project 7 - Glen Garry to Dalwhinnie (Central Section) of the A9 Dualling Programme. This FRA report will be included as a supporting appendix to **Chapter 11** (Road Drainage and the Water Environment) of the EIA.

1.2 Project 7 upgrades approximately 10km (9.5km plus tie-ins) of the A9 between Glen Garry and Dalwhinnie to dual carriageway, replacing the existing single carriageway. Project 7 crosses and is close to several ecologically sensitive areas and watercourses, some of which have specific ecological designations and protections. Project 7 is also contained wholly within the Cairngorms National Park (CNP).

1.3 In the context of this report, 'Proposed Scheme' describes all permanent works proposed as part of the Dualling Programme within Project 7. These include the Proposed Mainline of the A9 itself, access roads, diversion channels and drainage features. 'Existing Road' is used to refer to the existing A9 road surface within the limits of Project 7 extents.

1.4 In accordance with DMRB (Vol. 5, S. 1, Pt. 2 TD37/93), Project 7 has been progressed through the DMRB Stage 1 and Stage 2 assessment processes. The DMRB Stage 3 Assessment considers the Proposed Scheme in greater detail and requires the assessment of significant environmental effects in accordance with Section 20A and 55A of the Roads (Scotland) Act 1984, including this FRA, to determine the potential impacts on local and downstream flood risk.

Approach

1.5 **Section 2** of this report introduces the development site and surrounding water environment, and lists the survey information acquired for this assessment. Available information on local flood risk has been reviewed and is summarised in **Section 3**; this includes the work done at DMRB Stage 1 and Stage 2, as well as feedback from stakeholders.

1.6 Aspects of the Proposed Scheme that may affect the water environment with regards to flood risk are outlined in **Section 4**.

1.7 **Section 5** outlines potential sources, before pre- and post-development flood risk is assessed for both the Existing Road and the Proposed Scheme in **Section 7**, and is assessed at key locations outwith the Proposed Scheme in **Section 8**. The assessment has been undertaken in accordance with Scottish Environment Protection Agency (SEPA) Technical Flood Risk Guidance for Stakeholders (2016) and DMRB; cognisant of best practice and other planning legislation and design standards where noted.

1.8 Fluvial flood risk is assessed with the aid of a Hydrological and Hydraulic Modelling (H&HM) study, which has been developed with the aid of SEPA consultations and feedback on previous iterations of the modelling study undertaken and consulted on at earlier DMRB stages and early in the Stage 3 assessment process. This FRA includes a discrete branch of the H&HM study – a 'full-length' model – undertaken to inform the assessment of cumulative changes to the hydraulic environment within Project 7. **Section 6** summarises the H&HM approach ahead of the risk assessment sections introduced above. Further H&HM details are provided in **Annex B**.

1.9 Until **Section 9** – *Mitigation,* design proposals are considered as they were in February 2017. Assessment findings have been fed back into the design, and mitigation options have been developed as part of the evolving design. **Section 9** accounts for changes made to the Proposed Scheme since the February 2017 design iteration, and outlines the mitigation measures recommended to alleviate flood risk. Compensatory storage is the preferred mitigation for replacement of lost floodplain volume. Like-for-like replacement has been designed using a volume-slices approach. Compensatory storage is not modelled due to the complexity and uncertainty associated with representing it effectively in hydraulic models (as per SEPA Technical Guidance 2015, supported by SEPA consultation Nov. 2016). **Section 9** concludes with an assessment of the Proposed Scheme 'post-mitigation', noting potential residual flood risks and residual impacts on flood risk elsewhere.

Legislation & Design Standards

1.10 Scottish Planning Policy (SPP, 2014) sets out national planning policies which reflect Scottish Ministers' priorities for operation of the planning system and for the development and use of land. A precautionary approach to flood risk is promoted. The flood risk hierarchy prioritises flood avoidance, flood reduction and avoidance of increased surface water flooding. This includes locating development away from 'functional flood plain' and 'Medium to High Risk' areas (0.5% [1:200] probability of flooding in any one year).

1.11 The flood risk framework included in SPP to guide development includes three categories of flood risk. For areas at Medium to High Risk, the framework notes that undeveloped and sparsely developed locations may be suitable for development that is essential for transport infrastructure "*…which should be designed and constructed to be operational during floods and not impede water flow''*.

1.12 The Framework goes on to note that where built development is permitted on Medium to High Risk land *''…measures to protect against or manage flood risk will be required and any loss of flood storage capacity mitigated to achieve a neutral or better outcome"* [built development is not explicitly defined]. SPP also includes a list of factors to consider in applying the Risk Framework, which includes taking account of *"cumulative effects, especially the loss of flood storage capacity''.*

1.13 The Flood Risk Management (Scotland) Act 2009 places specific roles and responsibilities on local authorities and SEPA in relation to flood risk management. The Act also requires that all sources of flooding be considered in the assessment of flood risk including fluvial, coastal, pluvial, sewer and groundwater flooding.

1.14 The Highland Council (THC) general policy on flood risk requires avoidance of flood risk areas and promotes sustainable flood management measures. Perth and Kinross Council (P&KC) Policy (EP2) on New Development and Flooding has a general presumption against proposals for built development or land raising on a functional floodplain, and demands a freeboard allowance be incorporated into any development within the 200yr floodplain. Both Councils have Supplementary Guidance for the assessment of flood risk (adopted January 2013 (THC) and June 2014 (P&KC)) outlining suggested FRA content and providing advice in line with SPP.

1.15 The SEPA Technical Flood Risk Guidance for Stakeholders (SS-NFR-P-002) outlines methodologies that may be appropriate for hydrological and hydraulic modelling studies, and sets out what information SEPA requires to be submitted as part of a Flood Risk Assessment report.

1.16 The DMRB contains requirements and advice relating to works on trunk roads for which one of the Overseeing Organisations (in this case Transport Scotland) is the highway authority. It is written to reflect Highways England standards; therefore, the manual is required to be interpreted with a view to Scottish standards when influencing design in Scotland.

1.17 DMRB Volume 11, Section 3 '*Environmental Assessment Techniques*' gives guidance for the environmental assessment of projects and covers statutory EIA. Chapter 5 '*Procedure for*

Assessing Impacts' includes guidance on how the flooding impacts should be assessed in relation to road projects. Furthermore, Chapters 6 and 7 provide additional information on the scope and level of assessment required and the reporting of the assessment process and findings.

1.18 Where design decisions have been particularly influenced by legislation, or follow specific design standards in relation to flood risk, it is noted within the body of this report.

2 Existing Conditions

Location and Topography

2.1 The A9 provides a strategic link between the Highlands and the Central Belt of Scotland. Project 7 of the A9 Dualling Programme is in the River Truim and River Garry valleys, within the CNP. Project 7 covers approximately 10km (9.5km plus tie-ins), from the existing dual carriageway at Dalnaspidal Lodge (Glen Garry) to Dalwhinnie.

2.2 Much of this upland area is dominated by rough pasture. The Highland Main Line (HML) railway runs along the western side of the A9 for the extent of Project 7. Flows from the River Garry are located to the far west of the HML railway. The River Truim flows between the A9 and the HML railway for the extent of Project 7, apart from between the two rail bridges adjacent to the A9 at ch. 4,950 and ch. 6,150 where the HML is near to the road.

2.3 There are several spatial constraints identified within the study area, including the River Truim, River Garry, and the HML railway. A length of the Beauly to Denny Powerline (BDL) with its associated access track is upslope of the A9 in the northern half of Project 7. Significant environmental constraints include internationally and nationally designated ecological sites, specifically the River Spey Special Area of Conservation (SAC) (which includes the River Truim), and the Drumochter Hills area which is also a designated SAC, Special Protection Area (SPA) and Site of Special Scientific Interest (SSSI). The Allt Dubhaig is of national interest for its fluvial (river) geomorphology and is a Geological Conservation Review Site (GCR). It is also the qualifying geodiversity feature of the Drumochter Hills SSSI.

Watercourses

2.4 Watercourses are classified as 'Major' where they are shown on 1:50,000 Ordnance Survey (OS) mapping; all other watercourses (identified via OS 1:10,000 mapping, topographical survey, site visits and review of Transport Scotland records) are classified as 'Minor'. Watercourse labels and crossing identifications (IDs) are marked on the 'Water Features Survey' figures provided in **Annex C**. In this report, 'tributaries' is used to describe watercourses crossing the A9, as described below, whereas 'land drains' is used to describe smaller features that do not have an associated crossing under the A9.

2.5 The most significant watercourses near the A9 within Project 7 are the River Truim and the River Garry.

River Truim

2.6 The River Truim flows in a northerly direction and is located to the west of the A9 from ch. 3,700 to the northern end of the project. The distance from the A9 to the main river channel of the River Truim varies from 7m to 160m within the Project 7 extents. The high ground to the east drains toward the River Truim: the A9 crosses 36 tributaries of the River Truim within the length of Project 7. The overall catchment draining to the River Truim grows from approximately 2.7km^2 at the source of the Truim within Project 7, to 30km^2 at the northern end of the project, as it is joined by the tributary catchments on the valley slopes.

Allt Dubhaig/ River Garry

2.7 The Allt Dubhaig flows in a southerly direction starting at the Pass of Drumochter, flowing into the Tay catchment from ch. 3,200 and joins the River Garry at ch.0,500. The flows from the Allt Dubhaig into the River Garry are controlled by a dam. The Garry, a tributary within the wider catchment of the River Tay, flows in a southerly direction to the west of the HML railway. The distance from the road to the main river channel of the Allt Dubhaig varies from 160m to 620m within the Project 7 extents, with the road approximately 20m or more above the main channel. The A9 crosses 24 tributaries to the Allt Dubhaig/ River Garry within the length of Project 7. The catchment draining to the Allt Dubhaig at the point at which it joins the Garry is approximately 18km^2.

Other Water Features

2.8 There are several land and road earthwork drainage ditches along the route of the existing A9 within Project 7.

2.9 Loch Garry and a 700m length of the Garry (approximately 5ha at the downstream end of its 'Allt Dubhaig' reach) are subject to impoundment adjacent to Project 7, and are considered Reservoirs under the Reservoirs (Scotland) Act 2011.

Survey Information

2.10 In addition to 1:10,000 scale and 1:25,000 scale OS mapping used under licence, a number of ground surveys have been used to inform this assessment:

- High precision 1:500 topographic mapping of the carriageway envelope, based on LiDAR and ground survey, produced by Blom for the project in 2014
- Photogrammetry and accompanying aerial photographs undertaken by Blom for the project in 2014

River survey campaigns October 2015 and June 2016

2.11 A topographical survey was specified to gather information on channel shapes, including cross-sections and levels at key locations along the Rivers Spey, Truim and Allt Dubhaig/ Garry to support the DMRB Stage 3 H&HM study. The survey was targeted to describe key locations in terms of potential impact, based on design information from earlier stages of the DMRB process.

2.12 The river survey includes cross-sections of the river bed and details of potentially influential structures on watercourses (e.g. HML railway crossings). It was carried out in two stages due to access restrictions associated with the fish spawning season.

Other survey and geographical information

2.13 Other survey and geographical information includes:

- Peat survey (incl. probing, coring and other Ground Investigation (GI)) information predominantly gathered in 2016, but dating back to 2011 and currently ongoing
- As-built information for the A9 received from THC
- National Vegetation Classification (NVC), as a shapefile in GIS received from Scottish Natural Heritage (SNH)
- Walkover surveys conducted in 2016 to support the DMRB Stage 3 Assessment – including information gathered to clarify crossing connectivity and size

SNH environmental information

2.14 Processed environmental survey information is publically available on the SNH website. A number of these GIS shapefiles were used to inform placement of mitigation areas as part of the ongoing design and wider environmental assessment. This information includes:

- Ancient Woodland Inventory
- Geological Conservation Review Sites
- Sites of Special Scientific Interest (SSSI)
- Special Areas of Conservation (SAC)
  NB - The SAC boundary itself has not been used, as a review of the design against BLOM topographical survey and aerial photography revealed that the River Truim had migrated outside the defined SAC boundary, in cases closer to the existing A9, and SNH has confirmed that it is the watercourse, banks and supporting habitats that are protected, not a fixed area in a static shapefile. An appropriate offset has been taken from the river itself based on up-to-date survey information.
- Special Protection Areas (SPA)
- World Heritage Sites (Natural Heritage)
- Wetlands of International Importance (Ramsar)

3 Flood Risk Information

3.1 Flood risk to the Proposed Scheme is primarily associated with fluvial flooding from the two main rivers, and associated tributaries, within the vicinity of Project 7. Other sources of flooding, such as surface water, ground water and sewer flooding, are also addressed within this section.

SEPA Flood Maps

3.2 SEPA Flood Maps provide guidance on the possible extent, depth and velocity for different likelihoods ('High, Medium and Low') of three different sources of flooding (River, Coastal and Surface Water), alongside other associated information. Caveats to the mapping note that "*…they are indicative and of a strategic nature… It is inappropriate for these Flood Maps to be used to assess flood risk to an individual property*."

3.3 The river flood map is based on a two-dimensional flood modelling method applied across Scotland to all catchments greater than 3km^2 and includes hydraulic structures "*where appropriate information was available*"; thus many of the tributaries are not considered and flood extents may be particularly unrepresentative at watercourse crossings.

3.4 Some of the mapping in the road corridor appears to have been generated using Nextmap digital terrain data. The 5m spatial resolution of the dataset does not provide sufficient topographic detail to represent smaller watercourses – limiting the reliability of the mapped flood extents.

3.5 Within Project 7 the SEPA Flood Maps indicate that lengths of the A9 have a likelihood of fluvial flooding (10yr, 200yr and 1000yr) from the Allt Coire Chùirn and the Allt Coire Dubhaig, both tributaries on the eastern side of the River Truim basin indicated to overtop channel their banks above the A9. A short length of the A9 is shown to have a likelihood of flooding from the Allt Coire Mhic-sith where the road crosses the watercourse, but this may be a side-effect of the representation of the crossing in the model used to generate the flooding likelihoods. The A9 does not appear to be within the flood extents marked for the River Truim, or the Allt Dubhaig or River Garry; flood extents from the latter two in particular are shown to be contained within the wider floodplain several contour lines (OS background) below the A9.

3.6 Whilst the SEPA Flood Maps can be a useful tool for initially considering whether a site may be at risk of flooding, more detailed analysis is required to assess flood risk around the A9 corridor.

A9 Strategic Flood Risk Assessment

3.7 The A9 Strategic Flood Risk Assessment (SFRA), published in 2013, considers the entire 177km of the A9 between Perth and Inverness and breaks the road into sections. Project 7 of the dualling programme is covered in Section C. In Section 3.2 the SFRA identifies two major catchment areas within Project 7: the River Truim and the River Garry. The River Truim flows in a northerly direction and the River Garry flows in a southerly direction.

3.8 The SEPA indicative flood maps (now 'SEPA Flood Maps') are analysed for a 1 in 200 year fluvial event and indicate a number of locations along the A9 route which are within SEPA indicative flood zone. These locations are mainly where the A9 crosses a watercourse and flows are confined. As the SEPA flood maps do not take into account any structures the results are likely to be conservative. The SFRA also shows areas of the A9 which are within the flood plain and not related to a watercourse crossing. Within Project 7 there are two areas shown to the north and one area at the far south which indicate that they are within the flood plain of a 1 in 200 year event.

3.9 The SFRA refers to historic flooding in Section 4.2.2 and states that data has been collated from P&KC and THC's biennial flood report, SEPA, P&KC, THC, and Transport Scotland's Operating Company. Historic Scotland, Scottish Water and Cairngorms National Park Authority (CNPA) were also contacted however they did not hold any additional information.

3.10 Section 4.2.2 includes a review of historic flood events: "*Review of the flood history indicated that most known flooding issues occurred around residential properties away from A9 route corridor. Where the source of flooding was provided for these known flooding events, they were generally caused by rivers. However, review of the incident reports provided by Transport Scotland's Operating Company indicated some flooding due to surface water runoff*'. Several these events were located close to the A9, with "…*six flood records recorded within the 200m wide A9 dualling corridor.*" However, precaution should be taken as the area surrounding the A9 is largely rural and flooding incidents may not have been reported.

3.11 With regards to surface water flooding to the A9, Transport Scotland's local Operating Company have provided reports for all flooding incidents on the A9 between 2009 and 2013. Within Project 7 there is an area which is reported to have frequent flooding. This location is at the southern end of Project 7 where the road becomes a single carriageway.

3.12 The SFRA has used Digital Terrain Model (DTM) information that is available for the area and has identified a correlation between the locations of frequent flooding and the steep hill sides adjacent to the road: "*Using available Digital Terrain Model information, the locations where road flooding is frequently reported were noted to be along the stretches within cuts adjacent to steep hill sides".*

3.13 To prevent surface water runoff flooding a carriageway, roadside filter drains or open ditches are generally designed into a typical carriageway. These filter drains or open ditches capture any surface water runoff from the surrounding steep hills and divert it through the road drainage system carrying it away from the carriageway; therefore, any surface water flooding events on the A9 are likely to be related to the efficiency of the highway drainage. The SFRA summarises the Operating Company flood reports into 5 areas which indicate a common issue:

- Heavy rain
- Snow melt from hills
- Runoff from fields/ hills onto road
- Runoff contained sediment (sand, silt)
- Flooding from French drains

3.14 The above descriptions suggest a typical hillside runoff flood mechanism where flooding is caused by issues related to roadside drainage in collection and draining of the surface water runoff from the fields or hillside during heavy rain or snowmelt.

3.15 It is noted that infrastructure failure, such as reservoir failure, could in theory also impact the A9, although it is considered unlikely.

Findhorn, Nairn and Speyside Local Flood Risk Management Plan (2016)

3.16 The first Local Flood Risk Management (FRM) Plan for Findhorn, Nairn and Speyside was published by Moray Council in June, 2016 in agreement with THC, Scottish Water, SEPA, Forestry Commission Scotland and CNPA. It follows the Draft FRM produced by SEPA in 2014.

3.17 Dalwhinnie, adjacent to the north of Project 7, is identified within a PVA factsheet for an area of approximately 63km^2 including the town and surrounding rural area, large parts of which are within the CNP. The River Truim is the main river in this PVA and there are many small burns draining off the steep hillsides. There are approximately 20 residential and fewer than 10 non-residential properties at risk of flooding. The Annual Average Damages are approximately £170,000, all caused by river flooding. Three locations on the A9, with a total length of 330m, are noted as being at risk from flooding.

Other Studies

3.18 A review of other studies in the area was carried out at an earlier stage of the road design. No studies have been identified within Project 7.

Previous Stages of the Proposed Scheme Flood Risk Assessment

3.19 This Stage 3 FRA follows on from the (2013) A9 Dualling SFRA, prepared in support of the DMRB Stage 1 Strategic Environmental Assessment (SEA), and Chapter 11 of the CFJV (2015) DMRB Stage 2 Environmental Assessment: Road Drainage and the Water Environment, which is a comparative assessment of the potential environmental impacts, including flood risk, of the proposed road alignment options. This report takes the SFRA into account; the Stage 3 work builds on and hence supersedes the Stage 2 flood risk findings, and follows the approach laid out in the DMRB Stage 3 Hydrology & Hydraulic Modelling Approach report (2016), reiterated in **Section 6** of this report.

SEPA, THC and P&KC Information

3.20 SEPA and THC have provided datasets indicating locations of historical flood events in the vicinity of the Glen Garry to Kincraig A9 route. The majority of this data is considered in the A9 Dualling SFRA, which was prepared in support of the DMRB Stage 1 Strategic Environmental Assessment (SEA). P&KC have advised they have no record of historical flooding within Project 7.

3.21 SEPA have also provided information on their flow gauge at Kingussie and provided feedback on the hydrological and hydraulic modelling approach taken at previous stages of the Proposed Scheme. The latest SEPA advice note, based on the Stage 3 H&HM Approach report, advises that the hydrology approach (adoption of Stage 2 flows and the tributary approach) is suitable and reasonable, and welcomes the use of a full-length model to further investigate floodplain capacity. Gauge information is provided in **Annex A**. Hydrology is discussed in more detail in **Section 6.**

4 Proposed Scheme Design

4.1 The Proposed Mainline is to follow the same line as the Existing Road. The Proposed Scheme includes measures that change the way the road interacts with the water environment, such as widening the road surface for the dual carriageway itself; the provision of access roads, drainage and watercourse crossings and diversion channels that meet modern design standards; and the introduction of mitigation to alleviate adverse environmental impacts.

Design Freeze

4.2 Throughout the DMRB Stage 3 iterative design process, several environmentally-led workshops considered each aspect of the developing design and made recommendations for certain features to be included in the next design iteration.

4.3 The main body of this assessment, particularly the hydraulic modelling study, is based on proposals included in the '4th Iteration' Design Freeze, completed in February 2017. Several design iterations have been required to avoid and minimize potential clashes with environmental or physical constraints, and further develop the preferred option to better meet stakeholder needs (e.g. refinement of track location to maintain access and avoid deep peat).

4.4 The findings of this assessment have been fed back into the design and mitigation options have been developed where necessary as part of the evolving design. **Section 9** of this report accounts for changes made since the 4th Iteration Design Freeze, describes the flood risk mitigation recommended and includes an assessment of residual risk for the Assessment Design (October 2017), including mitigation.

Key Design Features

4.5 A number of features of the design intrinsically affect flood risk to the Proposed Scheme itself, as well as the potential impacts of the Proposed Scheme on flood risk elsewhere, notably:

- Upsizing **watercourse crossings** to have capacity for the 200yr design event, with a climate change and freeboard allowance (culverts below 1200mm in height are to allow for 300mm freeboard, those larger have a freeboard one quarter of their height), and setting a minimum 900mm diameter crossing size of 900mm *(see crossing design note at the end of this section for more detail on this philosophy*)
- Raising **road levels** to accommodate for increase watercourse crossing heights, as well as a minimum of 2m above culvert crowns for road build up, drainage and services, and 600mm freeboard to the functional floodplain, with climate change allowance
- Providing **Sustainable Drainage Systems** (SuDS) to manage surface water runoff and water quality
- Providing and upgrading **tracks** and other operational assets for local users or maintenance access, as, depending on end-user requirements and other planning constraints, on a case by case basis the defined standard for the Proposed Mainline may not apply and 200yr floodwaters may be affected
- Providing **compensatory storage** to mitigate for loss of floodplain volume

4.6 In order to maintain a precautionary approach to the assessment, with the exception of **Section 9** this FRA considers the Proposed Scheme without compensatory storage.

Other Pertinent Changes

4.7 The Proposed Scheme will inherently change the road infrastructure within Project 7 extents. Changes likely to impact on the water environment include:

- The **earthworks footprint** of the Proposed Mainline versus the Existing Road. Though it is to remain online, the dualling process will increase the road footprint, with potential implications on local watercourse floodplains, channels and drainage requiring consideration
- **Channel diversions**. The new road footprint and profile may necessitate the diversion of some watercourse channels, either to relocate outwith the footprint as noted above, or to upgrade channels to meet Proposed Scheme design standards. Diversion channels are sized to accommodate 200yr design flows
- Changes to **road drainage**. The Proposed Scheme will affect the characteristics of the road surface drainage. The Existing Road drainage will be replaced by a new drainage system and all areas catered for by the existing drainage will be catered for in the Proposed Scheme

4.8 The implications of these changes are assessed in **Section 7** and **Section 8** of this report.

Context for Culvert Design Approach

4.9 Within the study area for this project the existing A9 mainline crosses watercourses that range in size from small open channels such as field drains to much larger watercourses requiring significant structures to bridge. To support the dualling of the A9, the Proposed Scheme will include the extension or replacement of many culverts which convey these flows.

4.10 The design process for the watercourse crossings is complex, taking account of a range of design criteria and constraints to develop the most appropriate crossing for each watercourse. The primary technical standards driving the design of culverts are DMRB HA107/04 Design of Outfall and Culvert Details (2004) and the CIRIA Culvert design and operation guide (C689) (2010). However, in addition to these technical standards, across all project areas there are other drivers that influence the culvert design which include:

- **Flood risk**. In the event that a culvert is either extended (based on current geometry) or replaced, the impact on flood sensitive receptors may change by either retaining more water on the upstream side of the A9 or by passing more water through the culvert. Extending a culvert in the absence of any other change may increase flood levels upstream, while replacing an existing culvert with a larger one will increase the flow downstream, possibly reducing water level upstream and increasing water level downstream
- **Maintenance requirements**. Maintenance of culverts to meet DMRB standards (as defined by HA107/04) requires consideration of a minimum culvert size. This culvert may be larger than the culvert size required from a hydraulic perspective, in which case increasing the culvert size may have an impact on flood sensitive receptors downstream
- **Ecological considerations**. When designing new culverts, consideration is given to the provision of adequate integrated mammal passage, which if required will influence culvert size. In addition, consideration is given to maintaining a natural bed level within the culvert barrel by burying the culvert invert such that the culvert is sized to carry both flood flow and river bed sediment

- **Geomorphological considerations**. When increasing the size of a culvert there is the potential for influencing sediment transport which occurs during a flood, thereby impacting on either erosion or sedimentation in the vicinity of the culvert, both upstream and downstream
- **Road drainage design**. The culvert design, in terms of both gradient and cross-section, needs to be considered so that it does not conflict with the Proposed Scheme i.e. the proposed road structure and drainage system

4.11 These factors have been considered on a case-by-case basis to develop the most appropriate culvert design for each crossing. This design process is iterative, such that the final design meets the fundamental design standard, which is that the Proposed Scheme remains free from flooding in the 0.5% AEP (200-year) design flood event plus an allowance for climate change (increase in flow of 20%), and freeboard (typically 600mm). In this context freeboard is defined as the difference between the Proposed Scheme road level and the peak water level during the 0.5% AEP (200-year) plus climate change event.

4.12 The design approach for the watercourse crossings, which takes account of the culvert design guidance, allows for a degree of flexibility and engineering judgement to be applied to the culvert design, to account for the various influencing factors outlined above. Watercourse crossings are designed to comply with this guidance, with a focus on design considerations set out in CIRIA C689 and DMRB HA107/04.

5 Potential Sources of Flood Risk

5.1 The following have been identified as potential sources of flood risk over the length of Project 7:

- **Fluvial flows:** Extreme fluvial flood events have the potential to cause rapid inundation of land whilst posing a threat to the welfare of occupants and potentially preventing emergency access to properties and essential infrastructure. The site may be at risk of direct fluvial flooding from the River Truim, River Garry and its tributaries. In addition, any change on the hydrological environment brought about by the Proposed Scheme may change the hydrological or hydraulic behaviour of local watercourses, potentially increasing flood risk to parts of the Proposed Scheme or elsewhere. The effect of the Proposed Scheme on flood risk at local and wider scales requires consideration
- **Infrastructure failure:** Flooding due to the failure of man-made water infrastructure. The failure or blockage of conveyance infrastructure, such as culverts or bridges, could increase the risk of flooding at the site. Local drainage infrastructure is also a potential source of flood risk, including any locations where SUDS are to impound water. In addition, where there are bodies of water compounded in the wider Truim/ Garry catchment, such as Loch Ericht and Loch Garry, there may be a risk associated with the failure of these structures
- **Overland flow:** Overland flow occurs when the infiltration capacity of the ground is exceeded in a storm event. This could result in water travelling as sheet flow overland or excess water being conveyed from one location to another by local road networks. Overland flow from the hillside to the east is a potential source of flood risk
- **Groundwater:** Groundwater flooding could occur at low points on any given site, particularly if that site is next to a water feature or below local land features. Groundwater is likely to be a flooding mechanism that contributes to other flooding. It has the potential to extend the duration or extent of flooding in low-lying areas and may be important to consider in flood mitigation strategies
- **Sewer flooding:** If the capacity of surface, combined or foul sewers is exceeded in an extreme event, or a blockage occurs, surcharging of the network can result in surface flooding

5.2 One potential source has been discounted based on the location of the development site:

- **Coastal flooding:** the site is not at risk from tidal inundation or coastal waves due to its elevation over 250m above sea level

6 Hydraulic Modelling Study

Overview

6.1 It is recognised that the Proposed Scheme may impact on flood risk elsewhere, and that both the Existing Road and Proposed Mainline could be at risk of fluvial flooding. A Hydrological and Hydraulic Modelling (H&HM) study has been undertaken to aid the assessment of both aspects of fluvial flood risk.

6.2 The DMRB Stage 3 H&HM approach has been developed with the aid of SEPA consultations and feedback on previous iterations of the modelling study undertaken and consulted at earlier DMRB stages and early in the DMRB Stage 3 Assessment itself. The hydrological analysis has been reviewed following consultation with SEPA and hydraulic models have been refined; in particular, targeted ground survey data has been used to refine the model surface at key locations, and 2D models have been 'enhanced' with the addition of 1D elements where watercourses are crossed by smaller structures.

6.3 'Stage 3' models have been developed to consider the reaches of the River Truim and River Garry adjacent Project 7, including pertinent tributaries of these watercourses. The design information from the 4th Iteration Design Freeze (Feb. 2017), including Proposed Mainline, tracks, SuDS basins and watercourse diversions has been used to create post-development versions of each model reach in order to analyse the effect of the Proposed Scheme, and the findings have been fed back into the ongoing design process, as they were at earlier DMRB stages.

Full-length Model

6.4 As the River Truim model is split into several reaches (described in *Approach* below), a separate model of the River Truim has been constructed, in addition to the main modelling study, to assess cumulative flood risk impacts within Project 7 – supporting the assessment of the potential impact of the Proposed Scheme on flood risk downstream. This 'full-length' model is reported separately at the end of this section.

Further modelling – Assessment Design

6.5 One of the Stage 3 model reaches has been extended to assess the impacts of the Assessment Design around crossing ID52 (ch. 7,200) on local flood risk, and investigate mitigation options. This further modelling is discussed in **Section 9**.

Scope

6.6 The modelling output is intended to provide the assessor with information on predicted changes in flood level, depth and velocity, as well as define the functional floodplain of key watercourses. These outputs allow for the potential impact of the Proposed Scheme to be assessed at receptors, and are supplied to other disciplines for input to the wider EIA (e.g. hydromorphology assessment).

6.7 The H&HM study considers design proposals as they were in the February 2017 4th Iteration Design Freeze. Given the complexity involved and uncertainty with representing compensatory storage using hydraulic models, compensatory storage areas (CSAs) are not included in the scope of the H&HM study, in order to maintain a precautionary approach to the assessment.

6.8 Changes made since the 4th Iteration Design Freeze are considered in **Section 9**, where measures to alleviate flood risk are recommended. Where these measures include compensatory storage, storage areas have been sized following SEPA's preferred method of like-for-like replacement.

Approach

6.9 Though one model reach is sufficient to cover the River Garry adjacent to Project 7, due to the length and complexity of the River Truim catchment, it is split into six reaches for the purposes of the modelling study. Each reach generally extends from the confluence of one significant tributary to immediately upstream of the confluence with the next significant tributary. This has the benefit of allowing the critical duration event to be assessed for each modelled reach, providing a worst-case 200-year return period flood extent for each, as opposed to the whole extent only. Each model overlaps with its neighbours, sharing water level to provide a smooth transition from one modelled reach to the next (initial conditions for each are provided by the water level predicted for the neighbouring model downstream). The split-reach approach also eases the computational demands and allows simulations for each reach to be run in parallel, significantly reducing overall model run times. **Figures 1 to 3** overleaf show the Stage 3 model reaches.

6.10 A variety of standard techniques have been used to represent structures in the models, including applying head loss and creating cuts in the DTM. These representations have been tested and a precautionary approach applied. Relative to blockage and other factors considered in the sensitivity analysis, model results are insensitive to changes in bridge parameter.

6.11 Design flows are required for the River Truim, River Garry and each of the modelled tributaries of these – those that are crossed by the A9. In addition, flows have been derived for two relatively large tributaries on the west side of the River Truim basin.

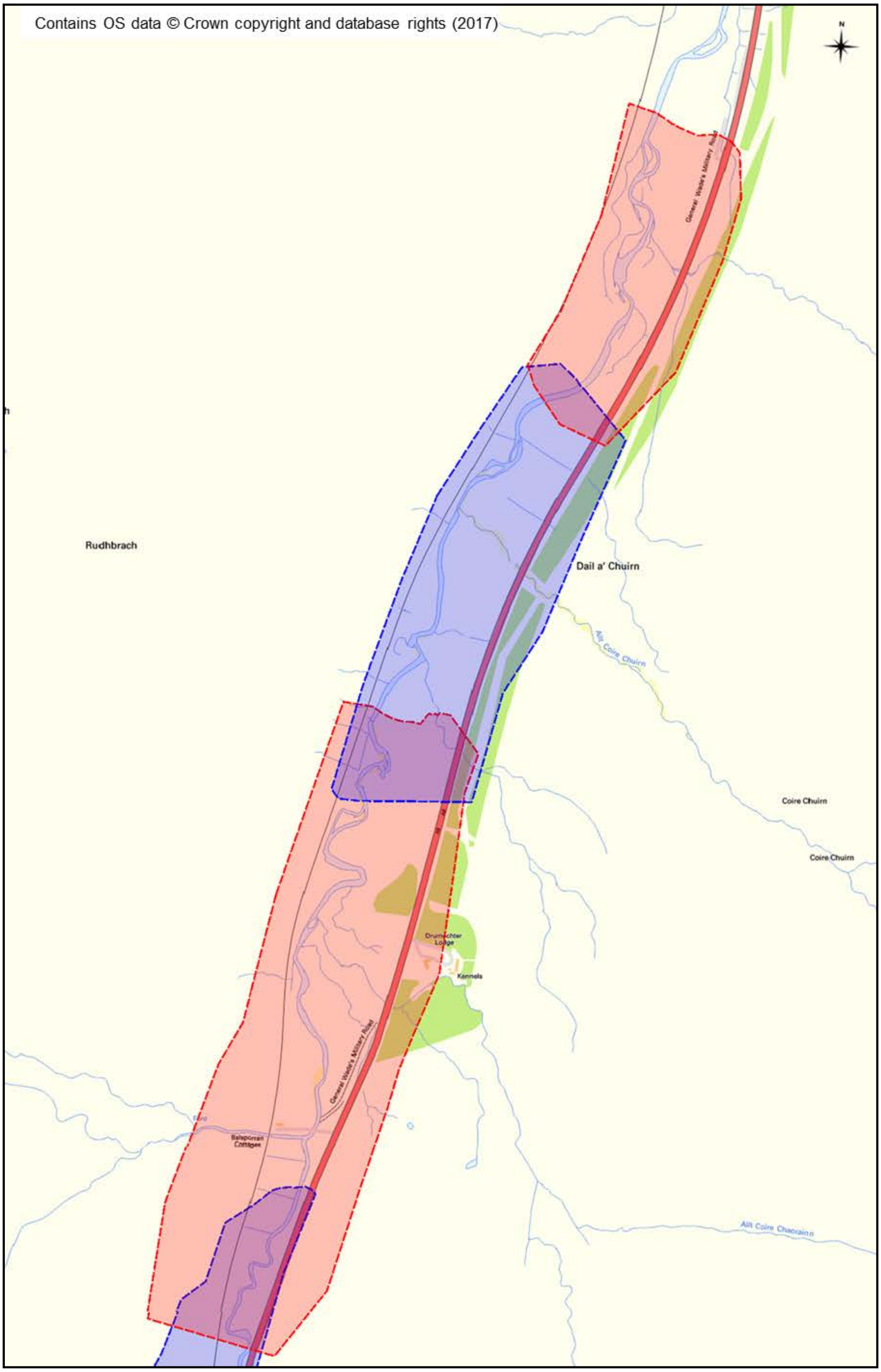


Figure 1: River Truim Stage 3 model reaches (1)

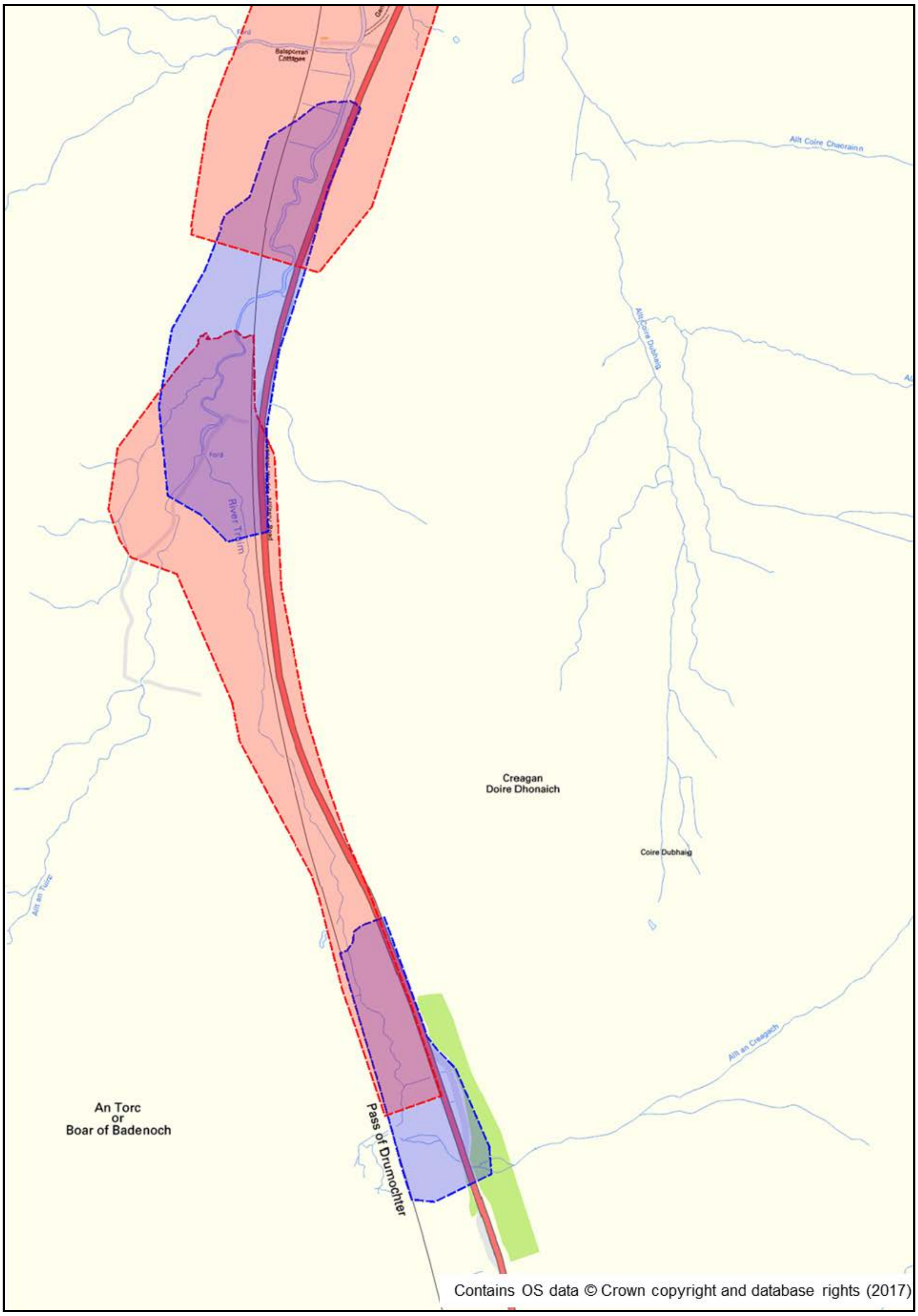


Figure 2: River Truim Stage 3 model reaches (2)

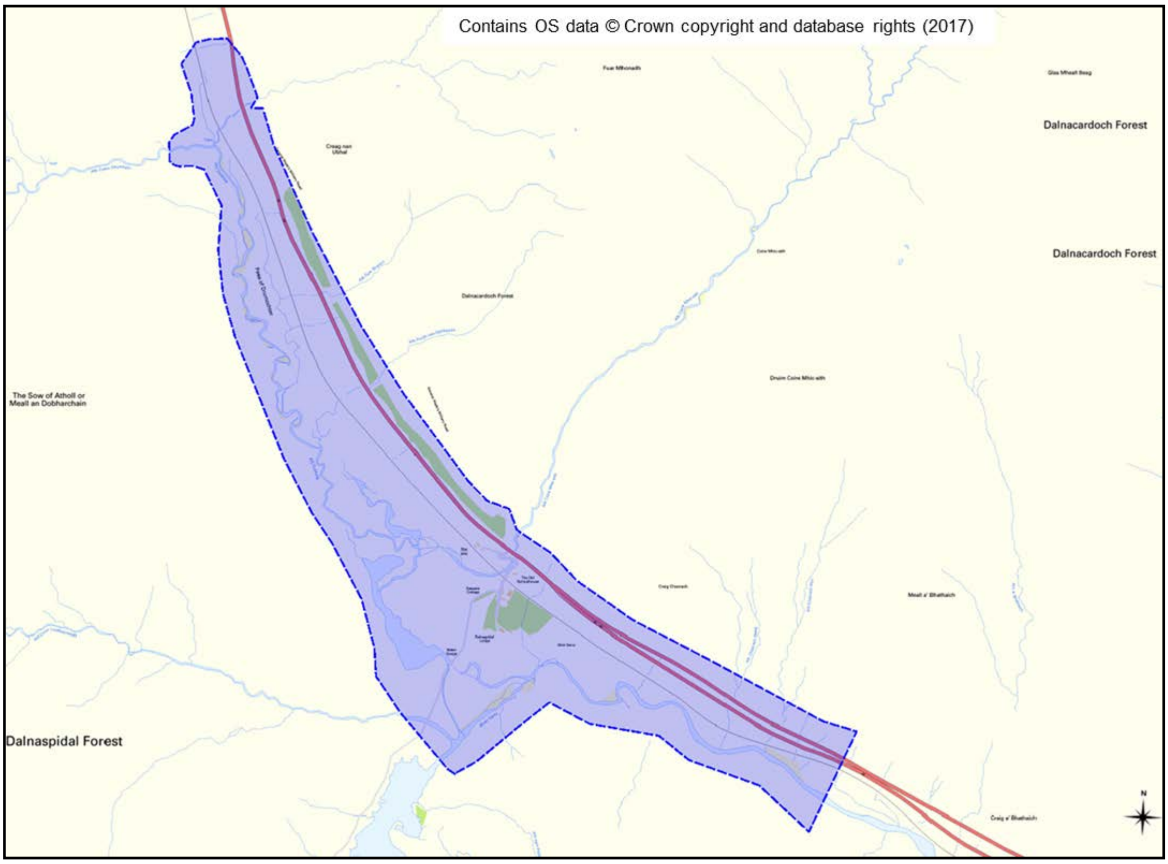


Figure 3: River Garry Stage 3 model reach

Hydrological Assessment

River Truim

6.12 Precautionary design flows adopted for the H&HM work undertaken at DMRB Stage 2 have been checked against those derived from an updated hydrological assessment of the catchment, considering the revised Annual Maximum (AMAX) record which accounts for the updated rating at Invertruim. Gauge information received from SEPA, including the AMAX calculated using this revised rating, is included in **Annex A**.

6.13 Flows for 16 nested sub-catchments of the Truim catchment have been derived using a series of hydrological techniques, including Flood Estimation Handbook (FEH, 1999) statistical methods (single site and enhanced single site at Gauge 8007, pooling group for the River Truim), applying growth curves to index-flood (QMED) transferred from the gauge record at Invertruim. Flows for these sub-catchments were also calculated using FEH rainfall-runoff (FEH RR) and revitalised rainfall-runoff model version 2.2 (ReFH2) methods.

6.14 200yr flows produced by the FEH statistical methods are between 43% and 66% of those produced using FEH RR with Standard Percentage Runoff (SPR) adjusted. ReFH2 produces 200yr estimates between 55% and 79% of the FEH RR values (this range is 61% to 91% if considering a summer storm profile). Catchment descriptors and other details of the hydrological data and methods used for the Stage 3 analysis are provided in **Annex A**.

6.15 There is uncertainty over how representative flows recorded at the Invertruim gauge are of the mechanisms in the Truim catchment. The gauge is located on the Spey just downstream of the confluence with the Truim. The Truim catchment makes up approximately a third of the area draining to the gauge. Although the descriptors for these two major catchments just upstream of the gauge are similar in terms of values typically checked for the suitability of QMED donation, such as FARL (0.974 & 0.932), FPEXT (0.046 & 0.058) and URBEXT (0 & 0.0001), there is no data available on the River Truim itself to verify the approach.

6.16 During DMRB Stage 2 a ratio between 200yr flow estimates at the Invertruim gauge on the Spey (just downstream of the confluence with the Truim) produced by single site analysis and the FEH RR model was established and accordingly a factor of 0.86 was used to scale the FEH RR hydrographs used to define design flow in the Truim. Storm durations for each nested sub-catchment have been selected to provide the critical duration as defined in the FEH units, as earlier model runs show that these (peak flow) hydrographs produce the highest flood level predictions in this reach of the Truim.

6.17 Given the inherent uncertainty in hydrological methods for estimation of design flood flows on ungauged catchments, the flows derived at DMRB Stage 2 have been adopted as a precautionary approach for the Stage 3 Assessment. As part of this precautionary approach, the SPR used in the FEH RR calculation has been adjusted to 57.37 where it would otherwise be lower, based on the low range marked for the Truim on the Base Flow Index (BFI) map of Scotland (Gustard et al, 1986).

6.18 Unlike other flows entering the River Truim from the west side of the basin, discrete flows have been derived for the relatively large catchments of the Allt an Tuirc (confluence with the River Truim at ch. 05,700) and the Allt Beul an Sporain (confluence at ch. 06,800, Balsporran), in order to estimate more representative design flood behaviour at these locations.

River Garry

6.19 The primary hydrology used in the model for the River Garry utilises the FEH Rainfall Runoff Method to estimate the flows in the watercourses based on FEH catchment descriptors.

6.20 In addition to this, for the flows from Loch Garry a basic routing model has been created in ISIS to represent the attenuation behind the dam at the east end of Loch Garry. The storm duration for this was optimised to find the critical storm duration that would result in the highest peak flow through the dam and the water level that this occurred at. Due to the complex hydraulics surrounding the flows into and out of the dam the maximum water level corresponding to the critical storm duration was set upstream of the dam to provide a conservative estimate of the flow passing through the dam.

Catchments at Tributary Crossings

6.21 A review of the hydrological assessment carried out at DMRB Stage 2 for the tributaries crossed by the A9 considered has been undertaken. ‘Other’ watercourses (i.e. not shown on OS 1:50,000 or OS 1:10,000 scale mapping) were scoped out of the Stage 2 Assessment and a simplified equal distribution of flows had been applied to groups of ‘Other’ crossings. In contrast, all watercourses crossed by the A9 were initially considered at Stage 3.

6.22 Design flows for tributaries with catchments greater than 0.5km^2 have been derived using the FEH RR method, with SPR raised to match the SPR applied to the Truim catchments where necessary. Institute of Hydrology (IH) Report No.124 (IH124, 1994) methodology has been adopted for catchments below 0.5km^2. Flows were derived using the ReFH2 method for comparison with those derived using the adopted methods in a variety of guises.

6.23 Catchment areas draining to these watercourses at the point they are crossed by the A9 were estimated using 1:25,000 scale OS mapping, survey information on the watercourse channel adjacent to the road and, where catchment boundaries are unclear from OS contour lines, aerial photography and site observations. A figure showing the catchments adopted for the study is provided in **Annex C**.

6.24 For the proposed modelling, catchment areas were determined in cognisance of the 4th Iteration Design Freeze proposals for diversions and crossings, with capacity assumptions as noted in the **Section 4** of this report.

6.25 FEH CD-ROMv3 catchment descriptors have been used to inform the parameters within both hydrological methods. Values are donated from the nearest appropriate FEH catchment. A new online tool for catchment descriptors (FEH Web Service) became available during the study and, as for other variations in estimation techniques noted above, the sensitivity of flow estimates to the newer descriptors and rainfall profiles (FEH13) was found to be within the bounds of typical sensitivity tests.

6.26 As many of the smaller IH124 catchments are located lower on the hillside than the centroids of the FEH catchments, the donated 1961-90 standard-period average annual rainfall (SAAR) value is likely to be precautionary. Where a flow is estimated using the FEH RR method and the difference between estimated area and catchment descriptor area is significant, other key descriptors such as Drainage Path Length (DPL) have been checked against the estimated area (in the case of DPL, using the alternative FEH calculation) and adjusted to be precautionary.

6.27 Post-development, design flows are predicted to be larger at three crossings (ID 3, ID21 and ID64) where the sizes of the catchments draining to these crossings are judged to be materially increased by the Proposed Scheme due to watercourse diversions.

Stage 3 Models

Model Surface

6.28 Ground levels in the computational grid are informed by ground models consisting of the:

- DTM generated using the combined LiDAR and ground survey dataset within the 200m corridor of the A9
- DTM generated from photogrammetry based on 10cm ortho-photographs within the 1km corridor of the road
- additional survey information collected along the River Truim in June 2016

6.29 The addition of the June 2016 information at Stage 3 improves the channel definition where greater resolution is beneficial (i.e. near receptors, including the road). Improved representation is also possible for remote structures and at the location of the proposed crossing of the Truim at the road junction which will serve Dalwhinnie.

6.30 A 2m computational grid has been adopted for the assessment. This grid size provides a reasonable representation of the Truim channel within the 200m road corridor, where findings are most relevant (the accuracy of the model output is limited by the DTM resolution available beyond the 200m corridor) whilst allowing for reasonable computational run time.

6.31 The 4th Iteration Design Freeze for the Proposed Scheme is represented in the proposed models by amending the DTM used by the existing models with the proposed earthworks footprint. Access road levels and watercourse diversion channels have also been imposed on the DTM for the proposed runs.

Tributary Crossings

6.32 A screening exercise was undertaken on the tributary crossings to consider whether they have the potential to impact on flood risk. All crossings with 200yr flow greater than $1.1m^3/s$ have been implemented in the Stage 3 models. $1.1m^3/s$ represents the full bore capacity of a 900mm diameter circular culvert, the minimum culvert size in the proposed conditions. Where the 200yr flows are less than $1.1m^3/s$, the capacity of the existing crossing is compared to the proposed to establish if the 900mm diameter culverts of the Proposed Scheme will remove an existing flow constraint. If so, the crossing has been implemented in the existing and proposed models to assess the impact of its removal. Remaining crossings are screened out of the H&HM study.

6.33 Existing crossing geometry has been updated to reflect the findings of the detailed surveys. Crossings themselves are represented as nested 1D elements in the Stage 3 2D model. A list of the crossings included in the H&HM study, showing dimensions and assumptions, is included in **Annex B** of this report.

Model Boundaries

6.34 Each River Truim reach model is run in sequence from downstream to upstream. The downstream boundary of each reach is informed by the flood levels predicted within the reach further downstream. The downstream boundary of the lowest reach was informed by the flood level predicted by a separate model reach downstream, developed as part of the Project 8 Dalwhinnie to Crubenmore H&HM exercise.

6.35 The main channel inflows for each River Truim model reach are obtained by applying the scaled FEH Rainfall-Runoff approach (described above) to the corresponding contributing catchment for each reach. The inflows are ramped up to the peak value and remain constant, giving steady-state-type conditions within the modelled reach, before the addition of tributary inflows. Tributaries inflows are represented using simplified hydrographs and input to the model upstream of each crossing.

6.36 Localised patches of high Manning's roughness have been used to stabilise model boundaries where necessary (typically on steep channels).

Limitations

6.37 Models have been developed to assess existing flood risk within a realistic timeframe, budget, and with consideration of the limits of the topographic information, hydrological information, hydraulic modelling methods and computational power available, as appropriate and suitable for a DMRB Stage 3 Assessment of flood risk.

6.38 It is important to understand the limitations of any modelling study before interpreting the results of simulations, whether they are presented graphically or otherwise. Where a modelling assumption has a clear bearing on assessment of flood risk it is highlighted in the relevant section of the FRA.

6.39 The model grid resolution does not allow for small channels to be represented within the model. The DTM has been checked for potential issues with grid sampling (e.g. false blockages) and is considered to represent the wider River Truim floodplain and potential overland flood routes suitably for the relatively large 200yr return period flows being considered. Where channels have been enforced on the DTM, because they are deemed large enough to carry 200yr flow, the model potentially overestimates channel capacity. This is necessary to maintain a precautionary approach to assessment of potential impacts downstream, but limits the accuracy with which the model can predict the capacity of the proposed diversion channels. Where this may impact on the assessment findings it is noted in the relevant section.

6.40 There are uncertainties in relation to the design flow. The return period approach represents the industry standard approach for planning and design; however, the hydrology of a catchment the size of the Truim, with its many sub-catchments, is complex. In the absence of local gauging and fully representative rainfall records a conservative approach has been adopted for the peak flow estimation. An idealised triangular hydrograph shape has been adopted for the tributary crossings. This may not provide 'worst case' results where flows are predicted to back up from crossings; however, this potential difference is allowed for in the freeboard. River Truim flows are run at a steady maximum flow as part of the precautionary approach to flood risk analysis.

6.41 With the exception of the Truim and Garry, each watercourse has been modelled within the road corridor only. Where desk study review within the corridor suggests that floodwaters may spill out-of-bank upstream to approach the road along different flow routes than otherwise would be considered, an effort has been made to represent this in the model. There is a risk that flood waters in catchments upstream may approach the road in an unpredicted manner. Similarly, the characteristics of watercourse channels upstream of the road may change over time. This risk is considered appropriate for the assessment and, as with other modelling assumptions, is highlighted where it may be of note.

Model Results

6.42 2D results (depth varying output) have been produced and interrogated to inform the FRA. This interrogation of results is recorded in tables provided in **Annex B2** (describing the sifting exercise used to interpret clashes with the floodplain extent) and **Annex B3** (recording the impacts predicted by the Stage 3 models). Flood extent figures showing 200yr flood depths predicted for both the pre- and post-development case are included in **Annex C**. Predicted flood depth, level, velocity, stream power and bed shear stress have been exported as TIF files and fed to other disciplines as part of the wider EIA process at DMRB Stage 3.

6.43 The flood extents identified during DMRB Stage 2 have been are superseded by those of this DMRB Stage 3 Assessment. Notable differences in predictions include increased flood extents of both the Garry and the Truim over the HML railway at Drumochter Pass due to refined structure information and representation, flooding over the HML railway north of Balsporran where the Allt Beul an Sporain has been modelled at DMRB Stage 3, and increased extents adjacent to the A9 at ch. 8,450-ch. 8,700 due to changes in the DTM.

6.44 Model results are discussed in **Section 7** and **Section 8**.

Sensitivity Analysis

6.45 In the absence of local gauged flow records to calibrate the models, proving techniques have been adopted to assess the influence of three key model parameters – Manning's 'n' roughness coefficient (+20%), design flow (+20%) and bridge coefficients.

6.46 Flood levels produced by the design flow test for the River Garry model are higher than base case flood levels; the largest increases in flood levels in the main river floodplain are around 150mm higher. The largest differences in flood level predictions are at several of the major crossings under the A9. Levels at these are approximately 500 - 750mm higher in this sensitivity scenario. In these locations, the level of the road is more than 1m higher than the maximum water levels in the increased flow scenario. The results of the roughness parameter test are similar to those of the flow test, but less pronounced. Flood level predictions are relatively insensitive to variations in the structure parameters.

6.47 The results of the flow tests for the River Truim reaches give maximum increases in flood levels in the main river floodplain of approximately 100mm higher than base case levels. The largest difference in flood levels on the main watercourse is upstream of where the HML railway crosses the River Truim. At this location levels are predicted to increase by approximately 300mm in this scenario due to the constriction of the bridge. Adjacent to these locations the road is well above the maximum level in the river. Several of the tributaries spill over the A9 as a result of undersized crossings. At these locations it is noted that in the increased flow scenario the maximum depths on the road increase by around 50mm. The results of the roughness parameter test are similar to those of the flow test, but less pronounced. Flood level predictions are relatively insensitive to variations in the structure parameters.

6.48 Overall the models behave as expected to changes in key parameters.

Full-length Model

6.49 A new TUFLOW 2D model has been built of the full length of the River Truim as it passes Project 7, to support the assessment of the cumulative impact of the Proposed Scheme on flood risk downstream. The model takes its information from each reach of the Stage 3 model (including DTM, Domain, 1D elements).

6.50 Discretized hydrology has been prepared to include contributing catchments from the west of the Truim valley. All inflows to the full-length model are described using hydrographs derived using the FEH RR method, with otherwise the same parameters and scaling adopted for the main study. Considering the nested sub-catchments on the River Truim as their constituent sub-catchments generally results in higher peak inflows than those used to define the reaches of the Stage 3 model, resulting in an approximately 15% higher peak flow estimate at the downstream reach of Project 7.

6.51 The full-length model has been run for 1.7hr, 2.7hr, 3.5hr, 4.5hr and 5.3hr duration storms. Existing and proposed conditions (4th Iteration Design Freeze, without mitigation) have been compared for each run and a difference of approximately 3mm in 200yr flood levels predicted at the northernmost extent of the Project is found, corresponding to an increase of approximately 0.05% in the 200yr peak flow passed downstream. The model does not consider mitigation options, or the updated modelling upstream of crossing ID52 (Drumochter), discussed further in **Section 8** and **Section 9**.

7 Flood Risk Assessment (Existing Road and Proposed Scheme)

7.1 Sources of flood risk identified in **Section 5** are assessed in this section by category (Fluvial, Infrastructure Failure, Overland Flow, Groundwater and Sewer Flooding), considering both the Existing Road and the Proposed Scheme (February 2017 4th Iteration Design Freeze) without specific flood risk mitigation measures such as compensatory storage.

7.2 The potential impacts of the Proposed Scheme on flood risk to receptors other than those making up the Proposed Scheme itself are assessed in **Section 8**. All impacts are summarised in **Section 9** and the effect of changes made to the design since the 4th Iteration Design Freeze are considered. Potential additional mitigation options are considered as part of the assessment of residual risks and impacts.

Fluvial

River Truim, River Garry and modelled tributaries

7.3 Fluvial flood risk from the River Truim, River Garry and their larger tributaries has been assessed with the aid of the hydraulic modelling study detailed in the previous chapter of this report. Project 7 extents from Glen Garry to Dalwhinnie and, whilst the hydraulic models include the larger watercourses crossing under the A9, they are dominated by the River Truim and the River Garry. Figures showing the predicted flood extents and depths for the design 200yr return period flood both pre- and post-development are provided in **Annex C**.

River Truim

7.4 The 200yr floodplain of the River Truim is predicted to reach the foot of the Existing Road and the Proposed Scheme Mainline embankment (Proposed Mainline) at six locations within Project 7: ch. 3,950-ch. 4,100, ch. 4,650-ch. 5,000, ch. 6,100-ch. 6,300, ch. 6,600-ch. 6,750, and ch. 9,100-ch. 9,150. The River Truim is not predicted to overtop the Existing Road.

7.5 At these locations the Existing Road is at least 3m above the 200yr flood levels estimated in the adjacent River Truim channel. Similarly, the Proposed Mainline is at least 2.4m above adjacent flood levels at these points, and elsewhere in Project 7 as the Proposed Mainline passes alongside the River Truim. These differences in elevation allow for uncertainties in the hydraulic modelling process, as well as predicted sensitivity of flood levels to future climate change. The Proposed Mainline has a very low risk of flooding from the River Truim.

7.6 The proposed realignment of the NCN7 track at ch. 3,950-ch. 4,100 is at risk of flooding from the River Truim in the 200yr event. This is a shorter length than is at risk pre-development. Where SuDS ponds are proposed within the 200yr floodplain in the 4th Iteration Design Freeze, at ch. 6,100, ch. 6,300, ch. 6,500 and ch. 6,900, the engineering design indicates that tops of the pond berms are over a metre above 200yr flood level in both existing and proposed model scenarios.

River Garry

7.7 The HML railway passes between the A9 and the 200yr floodplain of the River Garry. The Existing Road is approximately 20m above the 200yr flood levels estimated in the adjacent River Garry channel. The Proposed Mainline is also 20m or more above adjacent flood levels. These differences in elevation allow for uncertainties in the hydraulic modelling process, as well as predicted sensitivity of flood levels to future climate change. The Proposed Scheme has a very low risk of flooding from the River Garry.

7.8 Other aspects of the 4th Iteration Design Freeze, in particular the proposed access roads, are at risk of flooding from the River Garry in discreet locations.

Hydro-morphology – lateral migration

7.9 There is a risk that the River Truim channel may change position to increase flood risk to the A9 in the future. The Truim is closest to both the Existing Road and the Proposed Scheme at ch. 4,650-ch. 4,950, ch. 6,100-ch. 6,300 and ch. 6,600-ch. 6,750, where the banks of the watercourse pass within 10m of the existing and proposed road embankments.

7.10 It is assumed that any gradual impingement on the road embankments by these watercourses will be picked up by monitoring and can be mitigated as necessary by bank reinforcement or other suitable targeted mitigation as and when required. Flood risk to the Existing Road and Proposed Scheme is therefore not likely to be exacerbated by channel migration.

Modelled Tributaries

7.11 The Existing Road is at risk of flooding from the larger tributaries of the River Truim. At many of the larger tributaries flood waters are predicted to back up from existing crossings, resulting in little difference between predicted 200yr flood levels and the Existing Road. In two locations the Existing Road is predicted to be overtopped in the design event:

- Watercourse MW7.11 is predicted to overtop the Existing Road at crossing ID31 and spill across the road surface at depths of up to 170mm. The model predicts floodwater spilling from the channel above crossing ID31 to spill overland northwards into adjacent watercourses W7.93 and W7.94 (to flow through crossings ID33 and ID34)
- Floodwaters from watercourse MW7.18 are predicted to back up to overtop channel banks upstream of crossing ID52, spilling overland to overtop the road between crossing ID54 and ID55, with predicted flood depths across the road surface up to 200mm

7.12 As part of the Proposed Scheme, crossing ID31 and the channel capacity upstream are to be upsized, allowing for 300mm freeboard from culvert soffit to 200yr water level. The Proposed Mainline is set further above the soffit level of the pipe. This is the case at all other large tributary crossings, except where recommended otherwise as part of mitigation measures discussed in **Section 9**.

7.13 The Proposed Scheme is at very low risk of flooding from large tributaries in a 200yr event.

<u>Minor watercourses (not modelled)</u>

7.14 There are several small watercourses on the hillsides above the A9 where approximately 6.35km of the Proposed Mainline is to be in cut. The cut slope is vulnerable to out-of-bank flow from upslope watercourses. In addition, where the road is in cut, there is little or no attenuation volume upstream and the road is the next viable flood relief route. Flood risk from natural catchment runoff is considered within the *Overland Flow* sub-section of this assessment. The Existing Road is at risk of flooding should flows exceed the capacity of minor watercourse channels upslope of the A9, or the culverts carrying these watercourses underneath the A9.

7.15 Extreme flow predictions for small steep catchments carry more uncertainty than those for larger watercourses, though the ceiling for extreme flows is also limited by their small catchment area. Proposed earthworks drainage has been designed to have capacity for 75yr events (plus climate change allowance). Proposed Watercourse Diversion channels are sized for 200yr design flows. The Proposed Scheme may be at low risk of flooding from the minor watercourses sifted from the modelling study in extreme flood events, with much of the residual risk in a 200yr event alleviated by responsible drainage design.

Climate change

7.16 Prediction of the possible impact of climate change on extreme weather events is problematic, in part because the processes causing extremes (such as floods and droughts) are complex and their representation is at the limit of the current capability of climate models. SEPA generally recommend a climate change allowance of +20% be applied to the 200yr design flow (SEPA 2015) in order to assess the impact of climate change on fluvial flood risk. This 20% value was confirmed during Design Guide consultation with SEPA Hydrologists (A9 Dualling Programme Environmental Design Guide CH2M, 2015). The potential impacts of climate change on fluvial flood risk to the Proposed Scheme are assessed in this report using the results of the +20% flow model run undertaken as part of the hydraulic modelling study sensitivity analysis.

7.17 The largest difference in flood levels on the River Truim is upstream of where the HML railway crosses the main river channel adjacent to ch. 4,950. At this location levels are predicted to increase by approximately 300mm in this scenario due to the constriction of the bridge. The Existing Road level is over 2m above the +20% flow level in the river. Several of the tributaries spill over the Existing Road as a result of undersized crossings. At these locations the maximum depths on the road are approximately 50mm higher in the +20% flow scenario.

7.18 The largest differences in flood levels predicted by the River Garry model are upstream of several of the major crossings under the A9. Levels at these are approximately 500 - 750mm higher in the +20% flow sensitivity scenario. In these locations the level of the Existing Road is more than 1m higher than the maximum water levels in the increased flow scenario.

7.19 Flooding at minor watercourses not included in the modelling study is also likely to be exacerbated by climate change. Calculations using Haested Methods CulvertMaster software indicate that the flood level for a 900mm diameter crossing (the smallest diameter crossing proposed) could increase by 0.06m with +20% change in the largest design flow for which this size of crossing is proposed. A minimum 0.3m freeboard between soffit level and 200yr flood level is allowed for in the sizing of proposed crossings.

7.20 All proposed watercourse crossings have been checked for free discharge against respective 200yr +20% flows. This allows for over 600mm freeboard to the Proposed Mainline road surface. Proposed watercourse diversion have been designed to have a 200yr capacity, using precautionary approach to hydrology.

7.21 The Proposed Mainline is at low risk of fluvial flooding when considering the design 200yr event with future climate change.

7.22 SuDS access tracks are predicted to be at risk of flooding in three locations in the 200yr +20% flow scenario: ch. 7,900, ch. 8,200 and ch. 8,300, to a depth of approximately 20mm. These tracks are outwith the 200yr floodplain, and as they are non-critical infrastructure are not required to meet the same design standard as the Proposed Mainline.

Summary of fluvial flood risk to the A9 pre- and post-Scheme

7.23 The Existing Road is predicted to be at risk of fluvial flooding.

7.24 There is a very low risk of fluvial flooding to the Proposed Mainline. With the exception of the proposed realignment of the NCN7 track at ch. 3,950-ch. 4,100, all other aspects of the Proposed Scheme are at low risk of fluvial flooding.

Infrastructure Failure

7.25 The Existing Road is at risk of flooding from infrastructure failure - existing fluvial flood risk will be exacerbated by any blockage or otherwise failure of conveyance infrastructure on the River Truim and River Garry, or their tributaries.

Conveyance Infrastructure in the adjacent Truim/ Garry floodplain

7.26 The Proposed Mainline is significantly higher (over 3m) than the levels at which flood waters may find relief spilling across adjacent structures, such as HML railway adjacent to ch. 2,700 (R. Garry) and ch. 5,000 (R. Truim).

Crossings under the Proposed Mainline

7.27 Proposed Scheme watercourse crossings are typically designed to convey the 200yr flow with a 300mm freeboard to structure/ culvert soffit, and the 200yr flow plus climate change allowance allowing for a freeboard of 600mm to the proposed road surface, and as such are typically larger than existing crossings and inherently less likely to block. The risk of a full blockage of any of the crossings considered in the hydraulic modelling study is low as all are 900mm diameter or larger and are expected to be regularly checked and responsibly cleared of debris as part of future maintenance activities. Any changes to proposed culverts, such as restricting flows below this 200yr flow standard as part of mitigation measures discussed in **Section 9**, will maintain the 900mm minimum culvert size requirement.

7.28 Seven watercourse crossings considered in the modelling study cross the Proposed Mainline where it is raised above adjacent ground: crossings ID2, ID52, ID57, ID59, ID61, ID63 and ID64. Flows backing up from blockages at crossings ID63 and ID64 will find relief through each other. Likewise, flood waters backing up at ID59 and ID61 will find relief through crossings to the north. Due to the local topography, in the event of blockage at crossing ID57 flood waters are likely to pond to a shallow depth across a wide area of land. The proposed crossing has capacity for a 200yr event (without surcharging) if the capacity were to halved by a blockage. In this extreme scenario flooding to the Proposed Mainline would be partly alleviated by waters backing up the earthworks drainage channels to the north to flow to crossing ID58.

7.29 Crossings ID2 and ID52 will both be structures. Unlike at crossing ID52, at crossing ID2 there are no trees or upslope development (200yr flow 32m^3/s, 7.2km^2 catchment); however, there is a risk of blockage of the culvert by bed material. If the crossing were to block in an extreme event, flood waters would find relief through the adjacent underpass (ch.0,500). There is a small patch of trees upstream of crossing ID52 (200yr flow 18m^3/s, 3.5km^2 catchment), as well as the built development and car park of Drumochter Lodge. The channel upstream of the existing crossing does not have capacity for the 200yr event and flood waters pre-development are predicted to spill out-of-bank to overtop the Existing Road, whereas the Proposed Scheme is raised above the floodplain and floodwaters are predicted to pond behind the Proposed Mainline and landscaped bund. There may be a risk of flooding to the Proposed Scheme if the crossing were to block in an extreme event.

7.30 Four watercourse crossings considered in the modelling study cross the Proposed Mainline where the road to either side of the channel is in cut on the upslope side: crossings ID8, ID13, ID23 and ID31. This arrangement means storage upstream of the crossings is limited and it's less likely that water would find relief to an adjacent crossing before overtopping the road in a blockage scenario. At ID23 the new underpass proposed to share this crossing structure (ch. 3,000) will act as an emergency flood relief route in the event of blockage of the watercourse channel. Catchment areas draining to crossings ID8 and ID13 are both approximately 0.5km^2. The catchment draining to ID31 is slightly larger at 0.8km^2. Catchments of these sizes have limited peak flow and blockage potential.

7.31 Significant blockage is generally considered unlikely with appropriate maintenance, due to the size of the crossings relative to catchment size and the lack of vegetation or other source of debris upstream. The Proposed Scheme earthworks drainage and road drainage would help to mitigate flooding and disperse floodwaters should floodwaters back up from a blockage to overtop onto the road surface.

Local Drainage Infrastructure

7.32 The BDL is located on the otherwise undeveloped hillside above the Proposed Scheme. Flood waters arising from a blockage of field drains will be limited and likely to be caught by earthworks drainage and diversions put in place to alleviate flooding from the hillside above the Proposed Scheme. However, if watercourse crossings under the BDL access track were to block in an extreme event, floodwaters would be diverted out of channel where there is not a wider defined channel, to flow overland towards the A9.

7.33 A data request has been made to BEAR Scotland regarding records of 'special inspections'. These records are compiled in order to inform whether to implement some form of remedial work at crossing structures, (such as debris removal, replacement of scour protection or repair of structural damage) and would highlight those structures at risk, or previously impacted by, flood events.

Impoundments

7.34 Loch Garry and a 700m length of the River Garry (approximately 5ha at the downstream end of its 'Allt Dubhaig' reach) are subject to impoundment adjacent to Project 7, and large enough to be considered reservoirs under the Reservoirs (Scotland) Act 2011. As they are inspected and maintained under the Act, both structures are considered to have a very low probability of failure. SEPA's Controlled Reservoirs Register for Scotland displays the potential extent and impact of uncontrolled releases of water from a reservoir should they occur; the A9 is outwith the extent of flooding shown on the Register.

Summary of risk from Infrastructure Failure

7.35 Any risk of conveyance infrastructure failure exacerbates fluvial flood risk to the Existing Road.

7.36 There is generally a low risk of flooding to the Proposed Mainline from infrastructure failure; however, the Proposed Mainline may be at risk of flooding should a blockage occur at ID52, or at crossings on the BDL access track. It is recommended that the risk of blockage be accounted for and that other crossings are maintained with a view to minimising the risk of blockage. It is recommended that upgraded BDL track crossings are maintained with a view to minimising the residual risk from these structures. Where the BDL track above the A9 is not part of the Proposed Scheme, this risk should be mitigated by other suitable targeted mitigation where required, and should be considered further at the detailed design stage.

Overland Flow

Direct rainfall - road surface drainage

7.37 SEPA flood maps identify pluvial flooding within Project 7. Discrete lengths of the existing A9 are marked as potentially at risk in a 200yr event. These are low points in the road surface where water will gather during intense rainfall events. The SFRA notes that the southern end of

Project 7, at the tie-in to the single-carriageway, is reported to have had frequent surface water flooding.

7.38 The drainage design for the Proposed Scheme will comprise several new and independent gravity drainage networks designed to collect and convey surface water runoff from impermeable surfaces, in accordance with DMRB standards. The system is designed to shed any excess floodwater safely from the road surface. Performance of the system in exceedance events should be considered as part of the detailed drainage design to confirm that flood risk elsewhere is not increased.

Natural Catchment Runoff

7.39 In the event that rainfall exceeds the infiltration capacity of the natural ground, excess water will flow overland. This may present a flood risk to the Existing Road where ground levels fall towards the road.

7.40 The SFRA notes that there is a relationship between the areas which have frequent flooding events and the steepness of the surrounding hillsides: *"Using available Digital Terrain Model information, the locations where road flooding is frequently reported were noted to be along the stretches within cuts adjacent to steep hill sides".*

7.41 The majority of the land to the east of Project 7 is steep mountainous topography with numerous 'flashy' watercourses flowing off the hillside – much of any overland flow in these areas will be collected by local watercourses before reaching the Existing Road. However, the Existing Road may be at risk of flooding from natural catchment runoff approaching the road overland. In particular in the lengths of the road in cut – noted in the *Infrastructure Failure* sub-section above.

7.42 The Proposed Scheme will be afforded some protection from new earthworks drainage (designed to 75yr standard plus climate change allowance and freeboard) intercepting overland flow and diverting it safely to the nearest watercourse. The Proposed Scheme earthworks drainage and road drainage would help to mitigate flooding and disperse floodwaters. There may be a residual risk of flooding in a 200yr event.

7.43 The storm events critical for the road drainage network will be shorter and more intense than those producing the peak flows in the natural catchments. If any flow were to overtop onto the Proposed Mainline the severity of any surface flooding will be eased by the proposed drainage network.

Summary of flood risk from overland flows

7.44 The Existing Road may be at risk of flooding from these sources.

7.45 The Proposed Scheme will be designed to an appropriate DMRB standard and allow for the safe passage of excess surface water. There may be a residual risk of flooding in a 200yr event.

Groundwater

7.46 SEPA flood maps provide a guide as to where groundwater could influence the duration and extent of flooding from other sources rather than where groundwater alone could cause flooding. There are no such areas identified within the Project 7 corridor.

7.47 Where the Proposed Mainline is raised above local ground levels and adjacent watercourse levels there is a very low risk of groundwater flooding.

Groundwater Flow

7.48 Approximately 6.35km of the Proposed Mainline is to be cut into the adjacent hillside. The adjacent valleys are at lower levels than the road; however, the land to the east is higher than the Proposed Scheme and there is a risk that ground water flow may emerge from the cut embankment, resulting in surface water flooding on the carriageway if not collected by road drainage.

7.49 Groundwater flow within the superficial deposits is considered likely to predominantly follow surface topography, towards local surface watercourses. However, shallow flows are also likely to be locally complex, influenced by the presence of peat, local lower permeability deposits, shallow rock and the presence of culverts; while overland flows may also be locally significant.

7.50 Any flooding from this source is likely to be limited and, if present at all, provide a minor contribution to the risk of flooding considered in the *Overland Flow* sub-section above – any flood risk to the Proposed Scheme will be alleviated by the proposed earthworks and drainage system.

Groundwater Table

7.51 Any risk of groundwater flooding would be exacerbated by a high water table. Initial GI carried out by Raeburn in 2015 recorded groundwater in several boreholes and trial pits, with water strikes at depths between 0.70m Below Ground Level (BGL) (at TP7-001) and 9.08m BGL (BH7-003) in the superficial deposits.

Groundwater Summary

7.52 There is no evidence that the water table exacerbates flood risk to the A9. **Chapter 10** of the EIA 'Geology, Soils and Groundwater' provides a detailed review and assessment of the existing geology and hydrogeology of the area.

7.53 It is recommended that the output from DMRB Stage 3 Site Investigation is reviewed and appropriate measures taken during detailed design to mitigate any risk from this source.

Sewer Flooding and the Road Drainage Network

7.54 The A9 within Project 7 passes through almost exclusively non-serviced rural land and the flood risk to the Existing Road from sewer flooding is low.

7.55 The drainage design for the Proposed Scheme will comprise several new and independent gravity drainage networks designed to collect and convey surface water runoff from impermeable surfaces, in accordance with DMRB standards. The system is designed to shed any excess floodwater safely from the road surface. Drainage network design has been checked against the 200yr flood event and the filter media is predicted to accommodate excess flood volume. It is recommended that the performance of the system in exceedance events is considered as part of the detailed drainage design.

7.56 There is a very low risk of flooding from local sewer networks or the road drainage network to the Proposed Scheme.

8 Impact of the Proposed Scheme (on other receptors)

8.1 In accordance with the requirements of the DMRB (Volume 11, Environmental Assessment), this section identifies the potential impacts of the Proposed Scheme on flood risk elsewhere. To support decision making, this process identifies receptors outwith the Proposed Scheme itself that may be at increased risk due to the impact on the water environment.

8.2 As noted in the **Section 4**, the Proposed Scheme is considered here as it was in the 4th Iteration Design Freeze (Feb. 2017), without specific flood risk mitigation measures such as compensatory storage areas. Further design development, including mitigation, and assessment of residual impacts is discussed in **Section 9.**

Receptors

8.3 Potential flood risk receptors in the watercourse basins adjacent to the Proposed Scheme have been identified using SEPA's Flood Risk Appraisal Baseline Receptor Datasets (GIS shapefile) reviewed and augmented by information from OS OpenData (District Vectors).

8.4 Receptors identified as being at risk of flooding pre-development include the HML railway and residential properties. Land classifications have been downloaded from The James Hutton Institute website. Figures showing receptors in relation to the predicted pre-development 200yr floodplain are included in **Annex C**. Environmental designated sites alongside Project 7 are predominantly the Drumochter Hills SSSI and others fundamentally part of the water environment; these are not highlighted on the receptor figures. There are no utilities, community services or cultural heritage sites vulnerable to changes in the functional floodplain adjacent to Project 7.

Fluvial Flood Risk

8.5 The impacts of the Proposed Scheme on 200yr flood extents of the Truim/ Garry and their major tributaries outside the boundary of the Proposed Scheme have been assessed by comparing pre- and post-development results from the Hydraulic Modelling Study. Potential impacts on fluvial flood risk are assessed by comparing model results at and adjacent to receptors.

8.6 Aspects of the Proposed Scheme represented in the post-development hydraulic model include embankments and cuts to reflect the Proposed Mainline, channel diversions, new access roads and junctions. Post-development, design flows are predicted to be larger at three crossings (ID 3, ID21 and ID64) where the sizes of the catchments draining to these crossings are judged to be materially increased by the Proposed Scheme due to watercourse diversions.

8.7 The Proposed Scheme is likely to have an impact on fluvial flood risk in the following cases:

- **Encroachments:** where the footprint of the Proposed Mainline embankment encroaches into the existing 200yr floodplain, floodplain volume is lost and design flood levels may increase locally as less attenuation is available for flood flows. The characteristics peculiar to each watercourse will determine how far downstream flood levels and flows are impacted
- **Access tracks and SuDS basins:** although access tracks are to be designed to retain existing ground levels as far as possible, where they encroach on the 200yr floodplain the effect is classified separately to encroachments by the Proposed Mainline as it is more likely there is scope to reposition these features

- **Crossings:** larger flows may be passed downstream in an extreme flood event where proposed crossings provide greater capacity than crossings under the Existing Road. Similar to encroachments into the floodplain, there may be an impact on flood levels and flows downstream where floodplain volume upstream of the Existing Road is lost due to the Proposed Scheme design. In addition, where the positions of crossing inlets and outlets have changed there are local impacts on the floodplain
- **Diversions:** downstream of the tributary crossings flood flow may be impacted by the diversion of watercourses, or otherwise the inclusion of designed channels with larger capacity than existing channels adjacent to the road. As well as having a local impact on the floodplain, diversions have the potential to route water more quickly to the receiving watercourse and impact on downstream flood risk, depending on local flow characteristics. This may also be the case where catchments draining to crossings are larger and/ or a greater amount of flow is caught by earthworks drainage and improved channel diversion upstream of the crossing

8.8 Predicted impacts of the Proposed Scheme (4th Iteration Design Freeze, without mitigation) on fluvial flood risk are summarised in **Table 1** below. Specific findings are noted alongside comment on floodplain predictions in **Annex B3**. Comments on the Assessment Design have been included for clarity, for more on the assessment of the Assessment Design see **Section 9**.

Table 1: Predicted impacts summary (fluvial flood risk) by receptor type.

Receptor	Impact	Comment
Residential property	1nr location where freeboard to 200yr flood level is marginally reduced 10nr locations with 'no measurable change'	Approximately **10mm** increase in depth of overland flood route across Residential receptor due to proposed access track ('D-010' on **Figure PFR-6**) *Assessment Design comment: addition of a landscaped bund causes **800mm rise** in flood levels ponding behind the A9, reducing freeboard from receptor to 200yr WL to approximately 500mm*
Non-residential property	5nr locations with 'no measurable change'	-
Roads	No local roads affected *[2 lengths of the A9 trunk road removed (raised) from 200yr floodplain]*	Fluvial flood risk to other roads unaffected *[As noted in **Section 7**, where the existing A9 is within the 200yr floodplain (two lengths, totalling approximately 600m, 'OSR-001' and 'OSR-002' on **Figure PFR-4** and **Figure-PFR-6**), the Proposed Mainline is raised above the floodplain and predicted to be free of flood risk in a 200yr event]*
HML railway	<u>Where HML railway is within the 200yr floodplain</u> 1nr location with raised 200yr flood level 4nr locations with 'no measurable change'	Less than **3mm** rise in flood level at one location where the HML is predicted to be overtopped by 200yr flood waters in existing 'baseline' conditions ('HML-001' on **Figure PFR-3**)
	<u>Where 200yr floodwaters are adjacent to the HML</u> 4nr locations where freeboard to 200yr flood level is marginally reduced	Between **10mm** and **60mm** predicted rise in 200yr flood level at 4 locations adjacent to HML railway. At these locations the railway is 0.5m or more above the raised 200yr flood level

Receptor	Impact	Comment
Agricultural land	Approximately 3.6ha rough grazing land removed from 200yr 'functional' floodplain (LCA6.2 and 6.3) Flood risk increased at 12nr locations within the functional floodplain	Proposed Scheme design removes two wide overland flood routes due to changes around crossings ID31 (capacity increased) and ID52 (road raised). A watercourse diversion downstream of crossing ID57 reduces the flood extent locally 200yr flood level raised locally at 12nr locations within the 200yr floodplain, extending functional floodplain (totalling less than 0.1ha)

8.9 It is necessary to mitigate local impacts on fluvial flood risk as well as losses of floodplain volume, which potentially impact flood risk downstream. Assessment findings have been fed back into the design and mitigation options have been developed accordingly. **Section 9** accounts for changes made to the Proposed Scheme since the February 2017 design iteration, and outlines the mitigation measures recommended to alleviate flood risk impacts.

Flood Risk Downstream

8.10 The potential impact on fluvial flood risk on the River Truim and River Garry downstream of Project 7 has been assessed by analysing the results of the Stage 3 models, in particular changes in 200yr water level downstream of areas the Proposed Scheme may influence the water environment, and the results from the Project 7 'full-length' model developed specifically to assess the potential cumulative impact of the Proposed Scheme on the River Truim.

8.11 The Stage 3 model results indicate that the impacts the Proposed Scheme is predicted to have on water levels along the River Truim are relatively local to source – where changes in flood levels are passed downstream the effect is predicted to fade to nothing over the reach length. The River Garry model shows an increase in 200yr flood level of up to 1mm at the south-eastern (downstream) extents of the model, without mitigation. There is not predicted to be any material increase in flood risk passed downstream the River Garry.

8.12 The full-length model of the River Truim predicts that cumulative impact on flood risk may be an approximately 0.05% increase in the peak 200yr flow passed to the River Truim downstream (corresponding to an increase of up to 3mm in flood levels at the northernmost extent of the Project, post-development); however, the model is conservative around Drumochter - assuming that the Proposed Scheme removes all storage from the Allt-Coire Dubhaig catchment upstream of crossing ID52 to give the most precautionary estimate of potential effect of crossing upsizing. This approach has been revisited for the assessment of the Assessment Design, discussed in **Section 9**, and the findings of the amended model suggest that the predicted impact of the Proposed Scheme on flood risk downstream may be much reduced.

8.13 Neither the Stage 3 models, nor the full-length model, consider mitigation options. Residual impacts are discussed in **Section 9** of this appendix.

Road Drainage Network

<u>Discharge from the Road Drainage Network</u>

8.14 The construction of the Proposed Scheme will increase the proportion of impermeable surfaces in the catchment. This will increase the volume and rate of surface water runoff via the road drainage network. The uncontrolled discharge of surface water runoff from the road drainage network to existing watercourses during storm events would have the potential to cause localised flooding and increase the risk of flooding downstream, although consequential damage and disturbance to residential and natural features is likely to be marginal.

8.15 The Proposed Scheme employs SuDS to alleviate the potential impacts of increased surface runoff rates and reduce flood risk in the receiving watercourses. Site controls such as extended detention basins – attenuation and treatment of surface water runoff prior to discharge – are to be included in the drainage design, and attenuation basins are to be designed to attenuate a 200yr storm to 2yr greenfield runoff rates. Where drainage networks cross catchment watersheds the allowable discharge is based on the greenfield runoff from the receiving catchment. Attenuation (greenfield) calculations consider the road as greenfield land and therefore provide a betterment downstream.

Overland Flow Routes from SuDS Basins

8.16 Proposed SuDS basin locations (4^{th} Iteration Design Freeze) are shown on the flood extents figures provided in **Annex C**. In the event of design capacity exceedance, blockage of the outfall, or otherwise failure of the basins, flood waters would spill onto the surrounding land. SuDS will be designed with emergency spillways to direct excess flood water safely away from nearby receptors to the receiving watercourse, via overland flow routes or through overflow pipes.

8.17 All SuDS basins are located next to receiving watercourses, thus overland flow routes do not impact on property or infrastructure.

Exceedance of Road Drainage Capacity

8.18 Road drainage is designed to DMRB standards and represents a betterment on the existing arrangement. The system is designed to shed any excess floodwater safely from the road surface. Drainage network design has been checked against the 200yr flood event and the filter media is predicted to accommodate excess flood volume. Flood risk elsewhere will not be increased by the road drainage proposals.

Infrastructure Failure

8.19 The Proposed Scheme reduces the likelihood of a blockage of watercourse crossings under the road in an extreme event, due to the majority of crossings beneath the A9 being increased. Associated flood risk is also reduced due to the upgrade of the earthworks and road drainage. In the case of a failure of other local or neighbouring infrastructure (e.g. blockage of bridges or failure of impounded water storage) the Proposed Scheme represents a betterment of the existing arrangement, helping to alleviate any flooding from these sources.

Overland Flow

8.20 The earthworks drainage and watercourse diversion channels upslope of the Proposed Scheme are designed to modern standards, and will better manage design flows with less chance of exceedance and failure. The Proposed Scheme will provide a betterment to overland flood risk downstream.

8.21 There is a marked reduction in overland flood risk downstream in the two locations (ch. 3,750-ch. 3,950, adjacent to crossing ID31, and ch. 7,250-ch. 7,450, adjacent to crossing ID52) where 200yr floodwaters are not predicted to overtop the A9 in the post-development case.

8.22 The Proposed Scheme has a positive impact on overland flood risk to receptors downstream.

Groundwater

8.23 Development at Dalnaspidal and on the opposite bank of the River Truim at Balsporran is at a lower level than the adjacent A9. Where the Proposed Scheme is raised above existing levels it is unlikely to have any material impact on the effect that groundwater may have on flood risk elsewhere, and may present a betterment if intercepting floodwaters from groundwater springs or similar. There are no soakaways proposed as part of the roads drainage. The Proposed Scheme will not have an adverse impact on this source of flood risk.

9 Mitigation (and Residual Impacts)

9.1 There are no major adverse impacts from the Proposed Scheme on flood risk to receptors. Without mitigation, the Proposed Scheme (4th Iteration Design Freeze) is predicted to have only limited adverse impacts, whilst removing flood risk from the A9 itself:

- Minor local increases in flood level and changes in flood extent, notably adjacent to Residential Property at Drumochter
- Increases in 200yr flood level adjacent to the HML railway
- Possible increase in cumulative flood risk downstream on the River Truim (full-length model results) and River Garry

9.2 Measures to mitigate these impacts (including compensatory storage to replace lost floodplain volume) are outlined in this section. The potential impact at Drumochter warranted further study; the results of this work are discussed before residual impacts are summarised at the close of this section with recommendations.

Approach

9.3 As the design has progressed from the 4th Iteration Design Freeze (Feb. 2017) to the Assessment Design (October 2017), many of the potential impacts noted above have been designed out, with a preference for removal of floodplain encroachments – a flood risk alleviation hierarchy of avoidance, then reduction, and finally mitigation has been followed, as described below. No additional mitigation is proposed to specifically target local impacts from diversion channels.

9.4 When the 4th Iteration Design Freeze was assessed, compensatory storage areas (CSAs) were recommended to replace lost floodplain volume, using the approach detailed overleaf. CSAs were refined alongside the design as encroachments were removed and minimised, and the areas were considered holistically alongside other environmental disciplines. The CSAs proposed as part of the Assessment Design are assessed in the *Recommended Mitigation* sub-section of this section.

Encroachments

9.5 Encroachments into the functional floodplain have been avoided where possible. Many have been removed from the floodplain as the design has been refined. Locations where the Proposed Scheme (4th Iteration Design Freeze) was found to encroach on the existing 200yr floodplain are noted in **Annex B2**, with an indicative encroachment volume and note on measures taken to minimise or reduce the encroachment for the Assessment Design. **Annex B2** also records the sifting exercise undertaken to identify encroachments from areas where the Proposed Scheme overlays the 200yr floodplain in plan, but other aspects of the Proposed Scheme – notably upsized diversion channels – act to compensate for lost volume at the same like-for-like levels, or the proposed crossing size and headwall detailing will remove the footprint from the floodplain. In these cases there is no net loss of storage and no further mitigation is proposed. In one location, encroachment has been slightly increased in the Assessment Design: the NCN7 track has been raised and realigned along the length within floodplain from ch. 3,800 to ch. 4,050.

Crossings

9.6 Upsizing watercourse crossings to meet Proposed Scheme design standards may result in loss of floodplain storage upstream, such as upstream of crossing ID63. Reducing flood levels upstream also increases the area required for effective compensatory storage measures upstream of a crossing.

9.7 A number of non-flood-risk considerations may impact on crossing capacity, such as provision of mammal passage and geomorphological issues.

9.8 Where it is recommended that the potential for limiting capacity of crossings is further investigated it is noted in **Table 2**, within the *Recommended Mitigation* sub-section below.

Compensatory Storage Areas

9.9 It is recommended that CSAs are provided to replace floodplain lost to encroachments. The potential to provide compensatory storage to replace lost volume has been investigated, within the wider constraints on the Proposed Scheme such as land classification, location of receptors and how they tie-in with local hydrology post-development.

9.10 CSAs have been initially sized assuming that the encroachment into the 200yr floodplain gives a reasonable guide to the volume of floodplain required to be compensated between each design flood return period level. This assumption has been verified against cross-sections through the land at the encroachments. The initial plan area has been sized to account for likely differences between return period water depths at the encroachment and potential CSA locations, measured from the profile of the 200yr flood level in cross-section. The plan areas also account for 1:3 side slopes to the lowest level from surrounding land.

9.11 During detailed design, CSAs should be sized using a volume-balance approach, on a 'return period slices' basis. 200, 100, 50, 30 and 10 year return period flood levels will be available from the DMRB Stage 3 H&HM study. The recommended mitigation for the Assessment Design has been developed ahead of this information being available, using the method outlined in the preceding paragraph.

9.12 The volume-balance approach provides compensation for floodplain loss on both a volume-for-volume and a level-for-level basis. Level-for-level storage can be provided where CSAs are adjacent to the lost floodplain. Otherwise, where storage is remote to the source of floodplain loss, the return period slices approach enables elevation to be considered relative to the water surface profile of the river and not Ordnance Datum, so that storage effects the flood hydrograph in the same manner pre- and post-development.

9.13 The areas of compensatory storage proposed minimise the impact on the environment and flood risk. They are local to storage losses and will be accessible for maintenance. Where there is an encroachment into the floodplain upstream of a watercourse crossing, like-for-like replacement of lost floodplain storage is more comparable if the crossing is not upsized. At appropriate locations it is recommended in **Table 2** and **Table 3** below to maintain the existing capacity of watercourse crossings in order to preserve the depth between return periods upstream, and hence maximise the effective use of land upstream of the crossings. At some locations it is not possible to provide fully effective storage to replace lost floodplain volume.

Proposed Mitigation

9.14 CSAs have been proposed in thirteen locations, alongside other measures to mitigate the potential impacts of the Proposed Scheme on local and downstream flood risk. Details are provided in **Table 2**, below. Plans of CSAs alongside respective encroachments are shown on CSA figures provided in **Annex C**.

Table 2: CSAs and associated mitigation to replace lost floodplain volume in the Assessment Design

** 'Direct replacement' = on the watercourse it is lost from.*

CSA & location (P07 ch. and OS ref.)	Floodplain loss	Assessment Design comment
Spey catchment – THC area		
CSA093 ch. 9,300-ch. 9,325 [u/s of ID64] E263770 N781430 *See **Figure CS-7***	ch. 9,300 Mainline encroachment on floodplain of MW7.23, where floodwaters back up from crossing ID64	Direct replacement* of lost volume – additional storage built into watercourse diversion channel upstream of crossing, local to the storage loss Recommended that crossing is sized to restrict flow to existing flow restriction, in order to avoid storage loss and optimise storage provided, allowing for a freeboard between road surface and soffit to avoid introducing flood risk to the mainline. This restriction is not included in the Assessment Design
CSA092 ch. 9,175-ch. 9,300 [u/s of ID63] E263770 N781430 *See **Figure CS-7***	ch. 9,200-ch. 9,275 Mainline encroachment on floodplain of W7.23, where floodwaters back up from crossing ID63	Direct replacement of lost volume – additional storage built into watercourse diversion channel upstream of crossing, local to the storage loss Recommended that channel is sized to restrict flow to existing flow restriction, in order to avoid storage loss and optimise storage provided, allowing for a freeboard between road surface and soffit to avoid introducing flood risk to the mainline. This restriction is not included in the Assessment Design
CSA079 ch. 7,850-ch. 7,950 [u/s of ID57] E263180 N780160 *See **Figure CS-6***	ch. 7,875-ch. 7,950 Mainline encroachment on MW7.20 upstream of crossing ID57 – flood waters backing-up behind the culvert and spreading laterally	Direct replacement of lost volume – additional storage built into watercourse diversion channel upstream of crossing, local to the storage loss Recommended that crossing is sized to restrict flow to existing flow restriction, in order to avoid upstream storage loss and optimise storage provided, allowing for a freeboard between road surface and soffit to avoid introducing flood risk to the mainline. This restriction is not included in the Assessment Design
CSA071 ch. 7,050-ch. 7,200 [d/s of ID52] E262850 N779470 *See **Figure CS-5***	ch. 7,150-ch. 7,450 Mainline encroachment upstream of crossing ID52 into flood waters spilling from MW7.19	Indirect replacement of lost volume, on the River Truim floodplain upstream of its confluence with MW7.19 *Direct replacement precluded by spatial (local residence) and topographic restraints (steep contours exaggerate land-take)* ***See 'Drumochter' sub-section following this table***
CSA070 ch. 6,950-ch. 7,000 [River Truim] E262730 N779290 *See **Figure CS-5***	ch. 6,900-ch. 6,950 SuDS069 encroaches into the River Truim floodplain	Direct replacement of lost volume located within the River Truim floodplain
CSA066 ch. 6,550-ch. 6,600 [River Truim] E262725 N778930 *See **Figure CS-4***	ch. 6,500-ch. 6,550 SuDS065 encroaches into the River Truim floodplain	Partial direct local replacement of lost volume, downstream of encroachment *Provides full replacement with CSA064* *Full replacement of encroachment volume upstream precluded by spatial constraints (Scheme/ floodplain/ access to opposite bank). NB removal of adjacent SuDS063 from floodplain would free land upstream (currently identified as CSA for SuDS063 encroachment) to compensate for SuDS065*
CSA064 ch. 6,400-ch. 6,450 [River Truim] E262660 N778800 *See **Figure CS-4***	ch. 6,300-ch. 6,400 SuDS063 encroaches into the River Truim floodplain ch. 6,500-ch. 6,550 SuDS065 encroaches into the River Truim floodplain	Direct local replacement of lost volume, downstream of encroachment *Replacement of encroachment volume upstream precluded by spatial and environmental constraints (Scheme /floodplain/ blanket bog)* Partial direct local replacement of lost volume, upstream of encroachment *Provides full replacement in combination with CSA066*

CSA & location (P07 ch. and OS ref.)	Floodplain loss	Assessment Design comment
CSA049, CSA050 ch. 4,900, ch. 4,950 [River Truim] E262625 N777285 E262610 N777330 See ***Figure CS-3***	ch. 4,925 Mainline embankment footprint encroaches into River Truim floodplain	Direct replacement of lost volume can be provided across two areas immediately upstream and downstream of the encroachment
CSA048 ch. 4,750-ch. 4,775 [River Truim] E262675 N777160 *See **Figure CS-3***	ch. 4,800-ch. 4,825 Mainline embankment footprint encroaches into River Truim floodplain	Direct replacement of lost volume can be provided immediately upstream
CSA046 ch. 4,575-ch. 4,625 [River Truim] E262740 N777010 *See **Figure CS-3***	ch. 4,650-ch. 4,700 Mainline encroachment into the River Truim floodplain	Direct replacement of lost volume can be provided immediately upstream
CSA040 ch. 4,025-ch. 4,200 [River Truim] E262850 N776530 *See **Figure CS-2***	ch. 3,950-ch. 4,100 NCN7 track realignment encroachment into floodplain, and earthworks footprint where track rises to mainline level around ch. 4,050	Direct replacement of lost volume can be provided on opposite bank of the River Truim
Tay catchment – P&KC area		
CSA032, CSA033 ch. 3,150-ch. 3,300 [W7.81, u/s and d/s of crossing ID25] E263140 N775740 E263250 N775700 *See **Figure CS-1***	ch. 3,100-ch. 3,200 Mainline encroachment into W7.81 floodplain upstream of crossing ID25	Direct replacement of lost volume upstream and downstream of crossing
CSA030, CSA031 ch. 3,000-ch. 3,050 [MW7.9, u/s and d/s of crossing ID23] E263210 N775520 E263290 N775520 *See **Figure CS-1***	ch. 3,000-ch. 3,075 Mainline and underpass encroachment into MW7.9 floodplain, upstream of crossing ID23. Upsizing of ID23 removes storage volume currently behind crossing constriction	Partial direct replacement of lost volume upstream of crossing Partial direct replacement of lost volume immediately downstream of crossing *Full replacement of storage volume upstream and downstream of crossing precluded by spatial and Scheme constraints (hillside/ underpass)* **Potential minor residual impact**

Drumochter

9.15 The Allt Coire Dubhaig (MW7.18) crosses the A9 through crossing ID52 (ch. 7,200) at Drumochter. A landscaped bund is included in the Assessment Design. The Stage 3 model has been extended eastwards to assess the impacts of the proposed bund.

9.16 The extended model indicates that the Allt Coire Dubhaig channel further upstream does not have capacity for 200yr design flows. Flood waters are predicted to overtop the right-hand bank of the watercourse, spilling overland towards the A9. The Proposed Mainline is raised above the floodplain and floodwaters will back up behind it in a 200yr event. **Figure 4** below shows 200yr depths, pre- and post-development, with the outline of the Assessment Design.

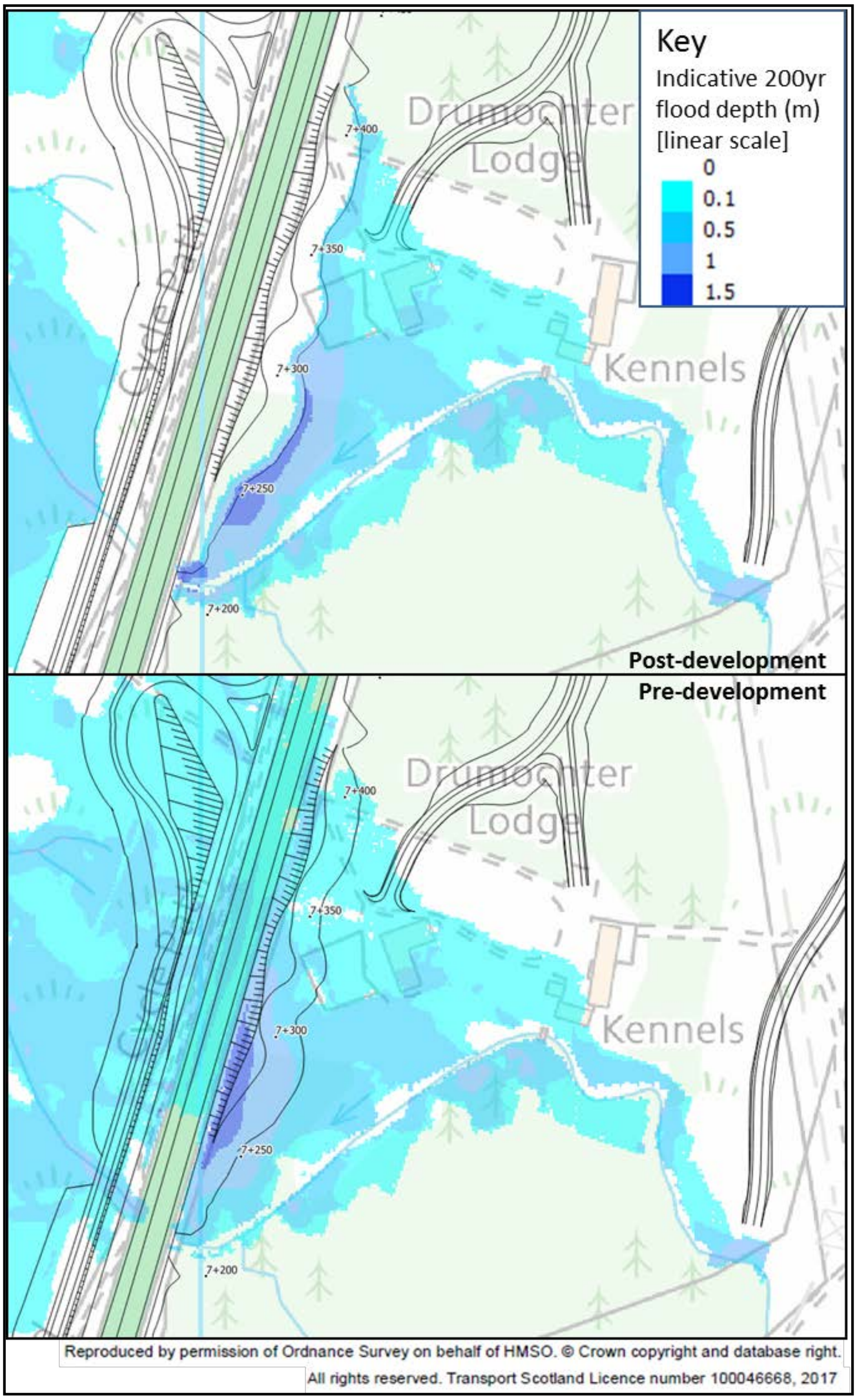


Figure 4: Further modelling at Drumochter – pre- and post-development flood extents

9.17 The new access track impacts on flood depths on the overland flow route adjacent to the Residential Property at ch. 7,350 [receptor D-010]. The proposed bund raises 200yr flood level adjacent to the Residential Property, reducing the freeboard from the property to flood waters ponding behind the A9 and increasing flood risk to the property in a blockage event. The Proposed Mainline is at a higher level than the adjacent property. It is recommended that flood alleviation culverts are added under the Proposed Scheme here to mitigate against the potential increase in flood risk to the property – allowing for some floodplain volume to be displaced behind the bund whilst providing flood relief below the level of the property similar to that presented by the spill across the A9 pre-development.

9.18 Indirect replacement of floodplain volume lost to the encroachment into the floodplain predicted to pond behind the Existing Road is provided within the Assessment Design on the River Truim floodplain upstream of its confluence with MW7.19. Direct replacement is precluded by spatial (local receptor) and topographic restraints (steep contours exaggerate land-take).

9.19 The results of the extended modelling study indicate that, for the Assessment Design, there are no impacts passed to flood levels downstream on the River Truim, beyond the local increase in flood level at the confluence with M7.19/ River Truim confluence due to the concentration of the existing overland flood route. The inclusion of flood alleviation culverts is not predicted to have a material residual impact on flood levels downstream on the River Truim, when considering the displaced volume upstream and CSA upstream on the River Truim.

9.20 Recommendations for flood risk in the Drumochter area are included within the residual impacts in **Table 3**, below.

Post-mitigation - Residual Impacts & Recommendations

9.21 Potential impacts on flood risk are identified in **Section 8** and impacts are quantified in **Annex C Table 10**. Compensatory Storage Areas have been provided to replace lost floodplain volume. Locations where floodplain volume is lost in the Assessment Design are noted in **Table 3** below, alongside other residual impacts. Residual impacts in this table are based on the Assessment Design. The table includes recommendations for project specific mitigation to address these.

Table 3: Residual impacts (Assessment Design) and recommendations

Approx. location (P07 ch. and OS ref.)	Proposed Scheme impact and proposed mitigation	Residual impact & recommendation
Spey catchment – THC area		
ch. 9,300 [u/s of ID64] E263770 N781430	Mainline encroachment on floodplain of MW7.23, where floodwaters back up from crossing ID64 CSA093 provided	Residual impact: Loss of floodplain volume Recommendation: Recommended that crossing is sized to restrict flow to existing flow restriction, in order to avoid storage loss and optimise storage provided, allowing for a freeboard between road surface and soffit to avoid introducing flood risk to the mainline
ch. 9,200-ch. 9,275 [u/s of ID63] E263770 N781430	Mainline encroachment on floodplain of W7.23, where floodwaters back up from crossing ID63 CSA092 provided	Residual impact: Loss of floodplain volume Recommendation: Recommended that channel is sized to restrict flow to existing flow restriction, in order to avoid storage loss and optimise storage provided, allowing for a freeboard between road surface and soffit to avoid introducing flood risk to the mainline
ch. 7,875-ch. 7,950 [u/s of ID57] E263180 N780160	Mainline encroachment on MW7.20 upstream of crossing ID57 – flood waters backing-up behind the culvert and spreading laterally CSA079 provided	Residual impact: Loss of floodplain volume Recommendation: Recommended that crossing is sized to restrict flow to existing flow restriction, in order to avoid upstream storage loss and optimise storage provided, allowing for a freeboard between road surface and soffit to avoid introducing flood risk to the mainline

Approx. location (P07 ch. and OS ref.)	Proposed Scheme impact and proposed mitigation	Residual impact & recommendation
ch. 7,150-ch. 7,450 [MW7.19/ River Truim] E263000 N779550 'Drumochter'	1] Access track in overland flood route adjacent to receptor (Residential Property D-010) 2] Mainline and visual bund encroachment into flood waters spilling from MW7.19 upstream of crossing ID52 CSA071 provides indirect replacement of lost volume, on the River Truim floodplain upstream of its confluence with MW7.19	Residual impact: 1] Flood depths on overland flood route adjacent to receptor increased by approximately 10mm 2a] Flood waters ponding adjacent to receptor (Residential Property D-010) raised by approximately 800mm Residential Property retains approximately 500mm freeboard to 200yr flood level and is not at risk of flooding in relation to the A9 works 2b] Flood level adjacent to downstream receptor (HML railway) may be raised by up to 30mm in 200yr event due to concentration of flood route *HML railway approximately 3m above adjacent 200yr flood level* Recommendation: 1] Design and construct access track to avoid impact on overland flows and flood route 2a] Flood relief culverts should be included to protect the property (i.e. allowing an overspill downstream to prevent flood water ponding behind A9 rising to level of property) 2b] CSA071 should be designed to account for the effect of the flood relief culverts on displaced floodplain volume upstream of bund
ch. 6,500-ch. 6,550 [River Truim] E262680 N778880	SuDS065 encroaches into the River Truim floodplain CSA066 and CSA064 provide direct local replacement of lost volume, both upstream and downstream of encroachment	Residual impact: Local flood level predicted to be raised by up to 60mm in 200yr event *No local receptor* Recommendation: None
ch. 6,300-ch. 6,400 [River Truim] E262630 N778720	SuDS063 encroaches into the River Truim floodplain CSA064 provides direct local replacement of lost volume, downstream of encroachment	Residual impact: Flood level adjacent to receptor (HML railway) predicted to be raised by up to 10mm in 200yr event *HML railway approximately 3m above adjacent 200yr flood level* Recommendation: None
ch. 6,125-ch. 6,225 [River Truim] E262600 N778550	Track encroaches into the River Truim floodplain	Residual impact: Local flood level predicted to be raised by up to 9mm in 200yr event Loss of floodplain volume (approximately 50m^3) *No local receptor* Recommendation: Track embankment should be redesigned to avoid floodplain
ch. 3,800-ch. 4,000 [MW7.11/ River Truim] E262900 N77600	Overland flow (Existing Road) concentrated through crossing ID31 (Proposed Scheme) and MW7.11 channel	Residual impact: Flood level adjacent to receptor (HML railway) predicted to be raised by up to 30mm in 200yr event *HML railway approximately 1.5m above adjacent 200yr flood level* Recommendation: None

Approx. location (P07 ch. and OS ref.)	Proposed Scheme impact and proposed mitigation	Residual impact & recommendation
Tay catchment – P&KC area		
ch. 2,750-ch. 2,950 [MW7.9] E263220 N775280	Mainline and underpass encroachment into MW7.9 floodplain, upstream of crossing ID23. Crossing upsizing removes storage volume currently behind crossing constriction CSA030 and CSA031 provide partial replacement of lost volume, upstream and downstream of crossing ID23	Residual impact: Loss of floodplain volume Flood level at receptor (HML railway) predicted to be raised by up to 3mm No material effect predicted on flood levels further downstream the River Garry *HML railway within 200yr floodplain* Recommendation: None

9.22 In the 3 locations where flood levels are predicted to rise adjacent to the railway (Assessment Design) the HML railway itself is 0.5m or more above 200yr flood level. There is no material increase in flood risk to the railway in these locations.

9.23 With appropriate mitigation, including the proposed compensatory storage and design revisions included in the Assessment Design and the recommendations made in Table 3 above, the potential local impacts of the Proposed Scheme will have no cumulative impact to flood risk on either the River Truim or the River Garry downstream.

10 Conclusion

10.1 Sources of flood risk to the Existing Road and the Proposed Scheme have been assessed. The potential impacts of the Proposed Scheme on fluvial flood risk has been assessed with the aid of a Hydrological and Hydraulic Modelling study, developed with the aid of stakeholder consultations at earlier stages in the DMRB process. The design information from the 4th Iteration Design Freeze (February 2017) has been used to create post-development models, and the findings have been fed back into the ongoing design process.

10.2 The Existing Road is predicted to be at risk of fluvial flooding from the River Truim. There is a low risk of fluvial flooding to the Proposed Mainline – an approximately 600m length of the road (across 2 locations) will be removed from the 200yr floodplain. Flood extents figures showing predicted 200yr flood depths pre- and post- development (4th Iteration Design Freeze) are included in **Annex C**.

10.3 It is recommended that the Beauly to Denny Powerline access track crossings are upgraded and maintained with a view to minimising the residual risk from these structures. The Proposed Scheme is at low risk of flooding from overland flow during events exceeding the design capacity of the road drainage.

10.4 The Proposed Scheme represents a betterment to flood risk to adjacent land, reducing the land flooded in a 200yr event adjacent to Project 7 by approximately 3.6ha. Without mitigation, the cumulative impacts on flood risk throughout Project 7 could result in an increase of approximately 1% in the peak flow passed down the River Truim in the 200yr design event.

10.5 Flood risk assessment findings have been fed back into the ongoing design, and mitigation options have been developed accounting for the Assessment Design (October 2017). CSAs proposed as part of the Assessment Design are shown on the CSA figures provided in **Annex C**. The Assessment design at Drumochter reduces the freeboard to flood waters backing up behind the road at a local receptor. It is recommended that the proposed access track here takes flood risk from overland flow into account, and that flood alleviation culverts are included to protect the adjacent receptor from flood water ponding behind the Proposed Scheme.

10.6 There are other locations where it may not be possible to avoid a minor residual impact on flood risk locally. The results of the hydraulic modelling study indicate that the impact of the Proposed Scheme (without mitigation) on flood risk will be minimal, with no material increase in flood risk to adjacent receptors. Recommendations for design are included in **Table 3** within **Section 9**.

10.7 With appropriate mitigation, including the proposed compensatory storage and design revisions included in the Assessment Design and the recommendations made in Table 3 above, the potential local impacts of the Proposed Scheme will have no cumulative impact to flood risk on either the River Truim or the River Garry downstream.

Annex A - Hydrology

A.1 Watercourse Descriptions

Major Watercourses (shown on 1:50,000 scale OS maps)

[Summarised from the DMRB Stage 3 EIA Chapter 11: Road Drainage and the Water Environment report for Project 7]

River Garry (MW 7.1)

The River Garry is a major tributary of the River Tummel and River Tay. It generally flows in a south easterly direction via Glen Garry before discharging into Loch Faskally (NGR 292314, 758586) and the River Tummel (NGR 293578, 757756).

The Garry is fed by a series of tributaries which originate from the west of the Grampian Mountains and cross underneath the A9. The water body has been designated as a heavily modified water body (HMWB) on account of physical alterations that cannot be addressed without a significant impact on water storage for hydroelectricity generation. It has a WFD classification of 'Bad ecological Potential' – from Garry Intake to Errochty Water confluence (2015) due to pressures including water abstraction, water storage and barriers to fish migration.

The River Garry and its upper tributaries support important but limited populations of Atlantic salmon (Salmo salar). The watercourse is sinuous in planform, and varied hydromorphological features such as pools, riffles and bar development are evident. The restriction of natural sediment supply is associated with the dam intake.

Allt Chaorach Mor (Hydro ID -3/ MW 7.24)

Allt Chaorach Mor is a tributary of the River Garry with a catchment size of 1.1km^2 and a length of approximately 1.5km, flowing in a south westerly direction from its source within the foothills of the Grampian Mountains. It flows under the A9 and the HML railway before discharging into the River Garry at approximately NGR 265818, 772356.

The watercourse is considered likely to receive some untreated/ partially treated road drainage from the A9 and is not known to support any important species or habitats. Extensive sediment supply has been transported from the upper catchment and deposited along the channel as evidenced by the braiding, pools and riffles. There is also evidence of hard engineering both in the form of bed armouring and bank reinforcements.

Photograph A- 1: Allt Chaorach Mor (Hydro ID -3, MW 7.24)

a) Upstream view east from A9

b) Downstream looking at A9 from east

Allt Chaorach Beag (Hydro ID -2/ MW 7.25)

Allt Chaorach Beag is a tributary of the River Garry with a catchment size of 0.4km² and a length of approximately 1.5km, flowing in a southerly direction from its source adjacent to the Craig Chaorach foothill of the Grampian Mountains. It flows under the A9 and the HML railway before discharging into the River Garry at approximately NGR 265594, 772362.

The watercourse is considered likely to receive some untreated/ partially treated road drainage from the A9 and not known to support any important species or habitats. The channel has been heavily modified with stone bank revetment and concrete lining upstream and downstream of the channel.

Photograph A- 2: Allt Chaorach Beag (Hydro ID -2, MW7.25)

a) Downstream view west of A9

b) HML railway crossing

Allt Dubhaig (MW7.2)

The Allt Dubhaig is formed at the confluence of the Allt a'Chaorainn and Allt Coire Dhomhain, and it flows in a southerly direction before discharging into the River Garry at NGR 263108, 775321. The Allt Coire Dhomhain has a WFD Overall Classification of 'Poor Status' *(2015)*. The upper tributary catchments of the Allt Dubhaig are situated in the Drumochter Hills SSSI/ SAC. The River Garry and its upper tributaries support important but limited populations of Atlantic salmon (*Salmo salar*).

The Allt Dubhaig is a Geological Conservation Review (GCR) site associated with an alluvial fan feature and progressive changes in planform ranging from braided to sinuous channel types.

Allt Coire Mhic Sith (Hydro ID 2/ MW 7.3)

Allt Coire Mhic Sith is a tributary of the River Garry with a catchment size of approximately 7.2km² and a length of 5.0km, flowing in a south westerly direction from its source at Glas Mheall Beag in the foothills of the Grampian Mountains. The watercourse flows underneath a section of access track, the existing A9, HML railway and lies adjacent to the settlement of Dalnaspidal. It receives a point source discharge from Station Cottages, which provides a potential source of pollutant that may affect water quality.

There is also a Hydro Scheme upstream of the A9, and the Dalnacardoch abstraction return may impact on the natural hydrology of the watercourse as well as pollutant dilution/ dispersal capacity. There is extensive sediment supply available from the catchment and incision downstream of the crossing results in a debris fan feature where the slope reduces.

Photograph A- 3: Allt Coire Mhic Sith (Hydro ID 2/ MW 7.3)

a) Downstream view of channel modifications west of A9

b) Upstream view of the Hydro Scheme east of A9

Allt Ruidh nan Sgoilearnan (Hydro ID 8/ MW 7.4)

Allt Ruidh nan Sgoilearnan is a tributary of the Allt Dubhaig, with a catchment size of approximately 0.2km² and a length of 1.2km, flowing in a south westerly direction. It is likely to receive some pollutants in the form of untreated/ partially treated road runoff, and there are existing pressures from engineering at the inlet and outlet which are likely to affect biodiversity.

The watercourse flows underneath access tracks, the existing A9 and the HML railway prior to discharging at the confluence with Allt Dubhaig at NGR 263620, 773848. Sediment is generated from incision upstream of the crossing, and downstream the there is evidence of incision, bank erosion and lateral migration.

Photograph A- 4: Allt Ruidh nan Sgoilearnan (Hydro ID 8/ MW 7.4)

a) Upstream view east of A9, showing evidence of deposition

b) Downstream view west of A9, showing bank erosion and lateral migration

Unnamed Watercourse (Hydro ID 12/ MW 7.5)

This unnamed watercourse is a short tributary of Allt Dubhaig, which has a catchment size under 0.1km² and a length of 0.5km. The watercourse crosses underneath the existing A9, National Cycle Network 7 (NCN7) cycle path and HML railway. It is likely to receive some pollutants in the form of untreated/ partially treated road runoff.

There is damaged bed armouring where the channel is vertically unstable, and there has been an adjustment to a more stable bed slope at the crossing upstream and downstream. This evidence of accelerated incision may be due to increases in discharge due to felling and other anthropogenic influences within the catchment. There is evidence of natural fluvial and morphological features, as well as modifications and anthropogenic influences.

Photograph A- 5: Unnamed Watercourse (Hydro ID 12/ MW 7.5)

a) Upstream view of damage to bed armouring east of A9

b) Downstream view east of A9 showing evidence of incision

Allt Fuar Bheann (Hydro ID 13/ MW 7.6)

Allt Fuar Bheann is a tributary of Allt Dubhaig, with a catchment size of approximately 0.7km² and a length of 1.8km originating from its source within the foothills of the Grampian Mountains. It is likely that the Allt Fuar Bheann receives some untreated or partially treated road runoff.

The watercourse crosses beneath General Wade's Military Road, the existing A9, an NMU footpath and HML railway before discharging at the confluence at NGR 263429, 774571. There is evidence of sediment transport through the A9 and NMU crossings, with deposition downstream of the railway crossing in the form of an alluvial fan. Lateral channel migration is also evident downstream of the A9, where no bank protection is in place.

Photograph A- 6: Allt Fuar Bheann (Hydro ID 13/ MW 7.6)

a) Upstream view east of A9, showing evidence of bank protection

b) Downstream view west of A9 showing evidence of lateral channel migration

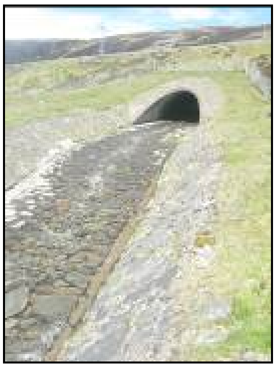
Allt a' Chaorainn (Hydro ID 23/ MW 7.9)

Allt a Chaorainn has a catchment size of approximately 3.0km² and a length of 3.1km, flowing in a westerly direction before discharging at the confluence with the Allt Dubhaig at NGR 263108, 775332. It is likely that the watercourse intercepts some road runoff at the road crossing.

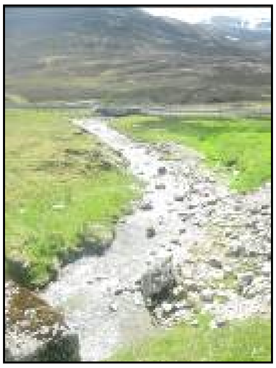
There is evidence of localised erosion directly upstream and downstream of the crossing providing a local sediment source. A downstream crossing is also fixing channel bed and bank positions, creating a large step in the channel bed and causing incision.

Photograph A- 7: Allt a Chaorainn (Hydro ID 23/ MW 7.9)

a) Upstream view east of the A9, showing bed and bank protection



b) Downstream view west of A9 showing bed protection



c) Downstream view west of A9

Unnamed Watercourse (MW 7.10)

This unnamed watercourse has a length of approximately 0.4km and discharges into the Allt Dubhaig at 263107, 775325. It is likely that the watercourse intercepts some road runoff at the road crossing. The watercourse is shown to be incised and meandering, with evidence of deposition bars and pools and riffles in places.

River Truim (MW 8.1)

The River Truim is a major watercourse throughout the Project 7 extent. It is a tributary of the River Spey draining the western edges of the Cairngorms Mountains with a catchment area of approximately 125km^2. Its headwaters are situated in the Pass of Drumochter, approximately 8km south of Dalwhinnie.

The River Truim has a WFD classification of 'Good ecological potential' from source to Allt Cuaich confluence, and 'Moderate ecological potential' lower catchment. It is designated as part of the River Spey SAC for its populations of Atlantic salmon (Salmo salar) (the Truim is noted as important for its salmonid smolt production), and otter (Lutra lutra). Sea lamprey (Petromyzon marinus) and freshwater pearl mussel (Margaritifera margaritifera) are also qualifying features of the River Spey SAC; no evidence has been determined in the River Truim Project 7 extents, however, their presence has been assumed. It is situated in the Cairngorms National Park and its source is also within the Drumochter Hills SSSI/ SAC.

The River Truim exhibits a natural range of morphological features (e.g. pools, riffles, bars, varied natural river bank profiles), with limited signs of artificial modifications or morphological pressures.

Allt an Creagach (Hydro ID 31/ MW 7.11)

The Allt an Creagach has a catchment size of approximately 0.8km² and a length of 2.1km, which generally flows in a westerly direction, passing underneath the A9 and the HML railway prior to its discharge into the River Truim at NGR 262795, 776313. It is likely that the watercourse intercepts some road runoff at the road crossing.

It is likely that the watercourse intercepts some road runoff at the road crossing, and therefore has been assigned a medium water quality sensitivity classification. There is a large sediment supply associated with the steep catchment slopes, and the watercourse crossing is situated in the vicinity of an active alluvial fan depositional feature.

Photograph A- 8: Allt an Creagach (Hydro ID 31/ MW 7.11)

a) Upstream view east of A9, showing evidence of bed protection

b) Downstream view west of A9

Unnamed Watercourse (MW 7.19)

This unnamed watercourse is a small tributary of Allt Coire Dubhaig, which flows from a pond in a north-westerly direction for approximately 0.5km via a forestry plantation prior to its confluence at NGR 263016, 779504. A point source discharge from Drumochter Lodge (DISC 7.8) is located downstream. Sediment has been supplied in the upper catchment and transported downstream, depositing in a series of bars where the slope becomes reduced.

Allt Coire Chaorainn (Hydro ID 52/ MW 7.18)

The Allt Coire Chaorainn has a catchment area of approximately 3.5km² and a length of 3.4km, flowing in a north-easterly direction underneath the Drumochter Lodge access track, existing A9, General Wade's Road before discharging into the River Truim at NGR 262793, 779739. The Allt Coire Chaorainn receives a point source discharge from Drumochter Lodge (DISC 7.8), and is likely to receive some untreated or partially treated runoff from the existing A9.

There is evidence of active morphological processes across the catchment, and an alluvial fan is situated immediately upstream of the watercourse crossing which is associated with potential risk for channel migration. The Allt Coire Chaorainn provides a locally important social use given that it is as utilised as surface water abstraction (private water supply) for Drumochter Lodge.

Photograph A- 9: Allt Coire Chaorainn (Hydro ID 52/ MW 7.18)

a) Upstream view east of A9

b) Downstream view west of A9, showing areas of deposition

Unnamed Watercourse (Hydro ID 57/ MW 7.20)

This unnamed watercourse has a catchment area of approximately 0.5km² and a length of 1.0km, generally flowing in a westerly direction, crossing under the existing A9 and NCN7 cycle track before discharging into the River Truim at NGR 263080, 780415. It is likely that the watercourse will receive some form of untreated or partially treated road runoff.

It is likely that the watercourse will receive some form of untreated or partially treated road runoff. There are artificial channel modifications in the form of bank protection at the crossing inlet. The upstream channel is incised and confined by valley sides in some locations with potential for future erosion and sediment delivery.

Photograph A- 10: Unnamed Watercourse (Hydro ID 57/ MW 7.20)

a) Upstream view east of A9, showing bank protection

b) Downstream view west of A9

Allt Coire Chuirn (Hydro ID 59/ MW 7.22)

The Allt Coire Chuirn has a catchment area of approximately 3.6km² and a length of 4.3km, generally flowing in a north westerly direction, crossing under the existing A9 and NCN7 cycle track before discharging into the River Truim at NGR 263167, 780815. There are likely to be only a small proportion of pollutant sources and ecological permeability is facilitated within the span bridge crossing.

The Allt Coire Chuirn is located within a steep sided V- shaped valley and an extensive sediment supply from the upper catchment is transported and deposited along a major alluvial fan. The fan is largely contained within the channel, which helps contribute towards active morphological processes and further sediment production. The existing A9 crossing creates a pinch-point which restricts the passage of sediment and debris movement.

Photograph A- 11: Allt Coire Chuirn (Hydro ID 59/ MW 7.22)

a) Upstream view east of A9, showing areas of sediment deposition

b) Downstream view west of A9, showing pinch-point to sediment movement

Allt Coire Bhotie (Hydro ID 64/ MW 7.23)

The Allt Coire Bhotie has a catchment area of approximately 1.4km² and a length of 3.1km, generally flowing in a north westerly direction, crossing under the existing A9 and NCN7 cycle track before discharging into the River Truim at NGR 263676, 781545. There are likely to be only a small proportion of pollutant sources relative to watercourse flow.

The Allt Coire Bhotie receives sediment supply from coupled hillslope failures upstream, transported along a steep, confined channel. There is an area of sediment deposition adjacent to a section of channel realignment. Erosion downstream of the crossing has also resulted in channel incision and bank collapse.

Photograph A- 12: Allt Coire Bhotie (Hydro ID 64, MW7.23)

a) Upstream view east of A9, showing areas of sediment deposition adjacent to channel realignment

b) Downstream view west of A9, showing bank collapse and a channel bar

Minor Watercourses & Ditches

There are numerous other watercourses, and other land and road earthwork drainage ditches, along the route of the existing A9 within Project 7. The majority of the minor watercourses in Project 7 have relatively short longitudinal profiles, ranging from a few hundred metres to approximately 1km, with largely straight channel planforms.

Many of the minor watercourse channels are narrow (i.e. between 0.5 and 1.5 m wide), with few exhibiting significant evidence of geomorphic diversity. The terrain is dominated by heather, grassland and bog; on gentler gradients near the A9, watercourses flow through established channels, both engineered and following the natural gradient over vegetation, where there is some deposition of small-grained materials, i.e. sands and silts.

To the east of both the River Truim and River Garry, minor watercourses drain the lower slopes of the Cairngorms and exhibit steeper gradients. These higher energy channels are more incised into the fluvio-glacial deposits, supplying larger sediment materials available for transport downstream. Some geomorphic diversity and fluvial processes are evident such as bank erosion and the development of small lateral gravel bars and deposition of gravel, pebble and cobble-sized materials. Several of the minor watercourses have engineering work in the form of gabion walls and mattresses, cascades and drops.

A.2 River Truim Catchments

Catchment Descriptors

Annex Table 1: River Truim and watercourses at Invertruim

LABEL	Truim-01	Truim-02	Truim-03	Truim-04	Truim-05	Truim-06	Truim-07	Truim-08	Truim-09	Truim-10	Truim-11	Truim-12	Truim-13	Truim-14	Truim-15	Truim-16	Truim-17	8007	*Spey*
Easting	262650	262800	262750	263100	263600	263850	263900	263850	264000	264150	265250	265400	267500	267650	267650	268350	268700	268650	*268600*
Northing	777300	779100	779700	780700	781450	782350	783000	783850	785300	785450	787400	787550	265460	791050	791450	792800	796150	796200	*796150*
AREA	2.73	7.79	15.93	21.79	27.19	30.05	33.6	36.55	42.59	45.81	58.16	62.6	105.68	112.59	116.84	119.99	124.8	401.59	*276.78*
ALTBAR	603	597	639	635	644	638	633	630	619	604	584	571	566	559	556	551	541	518	*507*
ASPBAR	228	73	78	51	22	8	352	343	331	335	351	0	344	338	337	339	340	311	*179*
ASPVAR	0.27	0.15	0.24	0.16	0.15	0.16	0.18	0.2	0.25	0.22	0.2	0.19	0.18	0.2	0.21	0.2	0.2	0.03	*0.06*
BFIHOST	0.407	0.384	0.409	0.408	0.413	0.41	0.408	0.407	0.405	0.411	0.417	0.41	0.401	0.4	0.4	0.404	0.413	0.411	*0.411*
DPLBAR	1.57	3.06	3.56	4.29	4.9	5.55	5.86	6.47	7.6	7.39	9.43	9.14	11.88	12.42	12.52	14.27	17.64	21.54	*23.2*
DPSBAR	265.4	262.6	258.4	251.1	250.2	245.5	238.5	233.9	222.5	213.3	205.1	196	195.6	194.2	192.4	192.8	189.1	181.3	*177.7*
FARL	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.97	0.97	0.97	0.97	0.95	*0.93*
FPEXT	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.04	0.04	0.05	0.05	*0.06*
FPDBAR	0.323	0.417	0.333	0.349	0.374	0.39	0.384	0.4	0.466	0.502	0.596	0.607	0.605	0.607	0.594	0.588	0.615	0.807	*0.893*
FPLOC	0.799	0.622	0.622	0.661	0.649	0.674	0.718	0.729	0.694	0.638	0.647	0.64	0.697	0.718	0.738	0.781	0.813	0.803	*0.786*
LDP	3.71	5.88	6.58	7.87	8.93	9.97	10.72	11.68	13.34	13.58	16.46	16.7	20.88	22.05	22.5	24.58	28.6	41.13	*41.06*
PROPWET	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.75	*0.77*
RMED-1H	11	10.9	10.8	10.8	10.8	10.7	10.7	10.7	10.6	10.6	10.4	10.4	10.2	10.1	10.1	10.1	10	10	*10*
RMED-1D	47.4	46.6	44.5	44.6	44.3	44.1	43.9	43.6	43.1	42.8	41.4	41.1	39.3	38.9	38.7	38.5	38.2	39.5	*40.1*
RMED-2D	70.6	69.1	65.1	65.2	64.6	64.2	63.8	63.3	62.3	61.9	59.5	58.8	56	55.5	55.1	54.8	54.4	55.6	*56.1*
SAAR	1764	1762	1786	1753	1740	1723	1704	1691	1659	1632	1563	1538	1476	1456	1444	1435	1417	1431	*1437*
SPRHOST	55.8	54.18	55.55	55.52	55.84	55.72	55.6	55.56	55.13	54.18	52.4	52.4	53.05	52.88	52.7	52.36	51.58	51.15	*50.96*
URBEXT90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0001	*0.0001*
URBEXT00	0	0	0	0	0	0	0	0	0	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0	*0*
Qmed cds	4.1	10.5	18.3	23.4	27.7	30.1	32.9	35.1	39.3	40.5	46.4	49.3	67.6	70.8	72.3	72.9	72.7	180.4	*126.0*
Qmed s,adj	3.4	8.6	15.0	19.3	22.8	24.7	27.0	28.8	32.2	33.1	37.7	40.0	54.8	57.4	58.5	59.0	58.8	-	*96.3*

8007 Gauge Data

New rating received June 2015 from SEPA, along with reworked AMAX backdated through entire period of record. The 2016 water year AMAX was added to this record using the rating equation provided, after a 0.05m stage adjustment based on the drawdown reported in SEPA advice.

Annex Table 2: Current AMAX values alongside historic for 8007@Invertruim.

Hiflows WINFAPv3 (historic)		AMAX received 2014 (historic)		AMAX received 2015 plus 2016 value (current)	
DATE	FLOW	DATE	FLOW	DATE	FLOW
02-Sep-53	56.601	02-Sep-53	67.070	02-Sep-53	57.798
07-Nov-53	74.849	07-Nov-53	84.050	07-Nov-53	73.636
04-Dec-54	109.050	04-Dec-54	111.500	04-Dec-54	99.389
28-Dec-55	114.66	28-Dec-55	118.000	28-Dec-55	103.249
15-Dec-56	101.861	15-Dec-56	107.000	15-Dec-56	94.310
20-Dec-57	74.849	20-Dec-57	84.620	20-Dec-57	73.636
19-Jan-59	43.566	19-Jan-59	53.490	19-Jan-59	41.167
17-Oct-59	72.030	17-Oct-59	66.790	17-Oct-59	71.305
28-Sep-61	83.748	28-Sep-61	91.410	28-Sep-61	80.760
11-Feb-62	232.586	11-Feb-62	198.200	11-Feb-62	170.486
15-Dec-62	73.431	15-Dec-62	82.920	15-Dec-62	72.467
21-Oct-63	36.542	21-Oct-63	37.640	21-Oct-63	38.918
11-Jan-65	74.849	11-Jan-65	79.520	11-Jan-65	73.636
01-Nov-65	56.601	01-Nov-65	60.280	01-Nov-65	57.798
17-Dec-66	274.680	17-Dec-66	259.500	18-Dec-66	190.317
27-Mar-68	126.455	27-Mar-68	131.900	27-Mar-68	111.098
30-Oct-68	59.001	30-Oct-68	63.210	31-Oct-68	59.990
17-Mar-70	86.866	02-Nov-69	91.080	17-Mar-70	83.177
09-Jan-71	91.687	09-Jan-71	89.070	09-Jan-71	86.842
22-Oct-71	90.060	22-Oct-71	88.330	22-Oct-71	85.615
13-Dec-72	54.268	13-Dec-72	53.990	13-Dec-72	55.630
18-Jan-74	166.191	18-Jan-74	153.700	18-Jan-74	135.351
20-Dec-74	113.901	20-Dec-74	120.600	20-Dec-74	102.732
07-Jan-76	78.034	07-Jan-76	81.720	07-Jan-76	76.225
27-Nov-76	51.222	27-Nov-76	52.170	27-Nov-76	52.742
30-Oct-77	70.511	30-Oct-77	72.660	30-Oct-77	70.032
02-Mar-79	245.673	02-Mar-79	274.500	02-Mar-79	176.822
27-Jul-80	80.857	04-Dec-79	75.250	27-Jul-80	78.483
20-Sep-81	128.086	20-Sep-81	108.000	20-Sep-81	112.158
20-Nov-81	86.551	03-Mar-82	82.650	20-Nov-81	82.934
05-Jan-83	123.833	05-Jan-83	133.200	05-Jan-83	109.383
31-Dec-83	237.204	31-Dec-83	254.000	31-Dec-83	172.741

Hiflows WINFAPv3 (historic)		AMAX received 2014 (historic)		AMAX received 2015 plus 2016 value (current)	
DATE	FLOW	DATE	FLOW	DATE	FLOW
27-Nov-84	119.871	27-Nov-84	122.100	27-Nov-84	106.760
22-Mar-86	130.976	22-Mar-86	128.700	22-Mar-86	114.019
07-Dec-86	116.380	07-Dec-86	114.800	07-Dec-86	104.416
19-Apr-88	62.221	19-Apr-88	62.222	18-Apr-88	62.876
15-Jan-89	267.896	15-Jan-89	267.901	15-Jan-89	188.769
05-Feb-90	272.633	05-Feb-90	272.638	04-Feb-90	191.869
02-Jan-91	94.163	02-Jan-91	94.165	01-Jan-91	88.692
02-Jan-92	228.330	02-Jan-92	228.334	02-Jan-92	168.389
17-Jan-93	270.935	17-Jan-93	270.940	16-Jan-93	188.614
08-Mar-94	165.703	08-Mar-94	165.706	08-Mar-94	135.070
11-Dec-94	146.979	11-Dec-94	146.982	10-Dec-94	124.003
24-Oct-95	114.660	24-Oct-95	114.662	24-Oct-95	103.249
02-Mar-97	204.449	02-Mar-97	204.453	01-Mar-97	156.263
18-Nov-97	112.018	18-Nov-97	112.020	18-Nov-97	101.442
27-Dec-98	49.906	27-Dec-98	51.641	27-Dec-98	51.473
30-Nov-99	100.811	30-Nov-99	100.813	30-Nov-99	93.555
20-Dec-00	50.123	20-Dec-00	52.056	20-Dec-00	51.684
06-Mar-02	133.066	06-Mar-02	133.069	06-Mar-02	115.353
22-Nov-02	45.173	22-Nov-02	47.249	21-Nov-02	46.798
08-Jan-04	97.534	08-Jan-04	97.536	08-Jan-04	91.177
10-Jan-05	181.012	10-Jan-05	181.015	09-Jan-05	143.694
12-Nov-05	118.505	12-Nov-05	118.507	11-Nov-05	105.847
[END]		14-Dec-06	209.544	13-Dec-06	158.902
Median	**101.336**	26-Jan-08	220.484	26-Jan-08	171.988
		11-Jan-09	127.363	11-Jan-09	120.061
		26-Nov-09	119.235	26-Nov-09	114.685
		16-Jan-11	126.740	16-Jan-11	119.655
		27-Nov-11	163.663	27-Nov-11	142.128
		12-Dec-12	135.231	12-Oct-12	125.097
		23-Feb-14	114.542	23-Feb-14	111.495
		[END]		08-Mar-15	202.678
		Median	**113.281**	05-Dec-15	203.468
				[END]	
				Median	**103.249**

Statistical Methods

PROJECT	A9 Dualling	JOB No	97318	Calculated by	JMcN
		PAGE	1 of 3		
TITLE	River Truim at Crubenmore Bridge [T15] Pooling Group	DATE	11/11/2016	Checked by	LG

Pooling group generated using WINFAP-FEH v4.1 dataset

Pooling Group Details

Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
47020 (Inny @ Bealsmill)	0.279	32	34.422	0.226	0.079	1.304
47004 (Lynher @ Pillaton Mill)	0.284	53	43.741	0.218	0.283	0.53
46008 (Avon @ Loddiswell)	0.297	34	63.421	0.174	0.06	1.409
60006 (Gwili @ Glangwili)	0.353	46	78.452	0.164	0.168	0.397
72015 (Lune @ Lunes Bridge)	0.39	35	201.71	0.128	0.028	0.32
203033 (Upper Bann @ Bannfield)	0.397	39	67.053	0.122	-0.014	0.412
47005 (Ottery @ Werrington Park)	0.399	50	64.369	0.148	0.105	0.055
79004 (Scar Water @ Capenoch)	0.425	43	132.92	0.087	0.07	0.678
47024 (Tavy @ Tavistock Abbey Bridge)	0.45	5	130	0.339	0.422	2.886
203039 (Clogh @ Tullynewey)	0.464	33	38.1	0.054	-0.06	1.258
67005 (Ceiriog @ Brynkinalt Weir)	0.471	56	29.78	0.199	0.213	0.465
79003 (Nith @ Hall Bridge)	0.476	47	70.779	0.193	0.427	2.341
45009 (Exe @ Pixton)	0.483	49	47.153	0.224	0.148	0.946
Total		522				
Weighted means				0.169	0.136	

Station	Distance	AREA	SAAR	FPEXT	FARL	URBEXT 2000
47020 (Inny @ Bealsmill)	0.279	102.05	1429	0.036	1	0.004
47004 (Lynher @ Pillaton Mill)	0.284	135.29	1423	0.034	0.996	0.008
46008 (Avon @ Loddiswell)	0.297	102.37	1549	0.03	0.986	0.006
60006 (Gwili @ Glangwili)	0.353	131.05	1603	0.029	0.999	0.004
72015 (Lune @ Lunes Bridge)	0.39	140.83	1630	0.055	0.993	0.002
203033 (Upper Bann @ Bannfield)	0.397	101.64	1261	0.062	0.951	0.001
47005 (Ottery @ Werrington Park)	0.399	121.64	1199	0.047	0.999	0.005
79004 (Scar Water @ Capenoch)	0.425	142.76	1627	0.032	0.999	0.001
47024 (Tavy @ Tavistock Abbey Bridge)	0.45	95.63	1666	0.032	0.998	0.004
203039 (Clogh @ Tullynewey)	0.464	98.37	1296	0.074	0.986	0.001
67005 (Ceiriog @ Brynkinalt Weir)	0.471	111.76	1198	0.023	1	0.001
79003 (Nith @ Hall Bridge)	0.476	155.76	1512	0.066	0.973	0.003
45009 (Exe @ Pixton)	0.483	147.85	1375	0.017	0.95	0.001

PROJECT	A9 Dualling	JOB No	97318	Calculated by	JMcN
		PAGE	2 of 3		
TITLE	River Truim at Crubenmore Bridge [T15]	DATE	11/11/2016	Checked by	LG
	Pooling Group				

Heterogeneity Test

H2= 3.3782
H1= 7.8506
Heterogeneous and review undertaken; none removed

Distributions	Goodness-of-fit
	Z value
Generalised Logistic (GL)	0.2880
Generalised Extreme Value (GEV)	-1.9547

Growth Curve Fitting

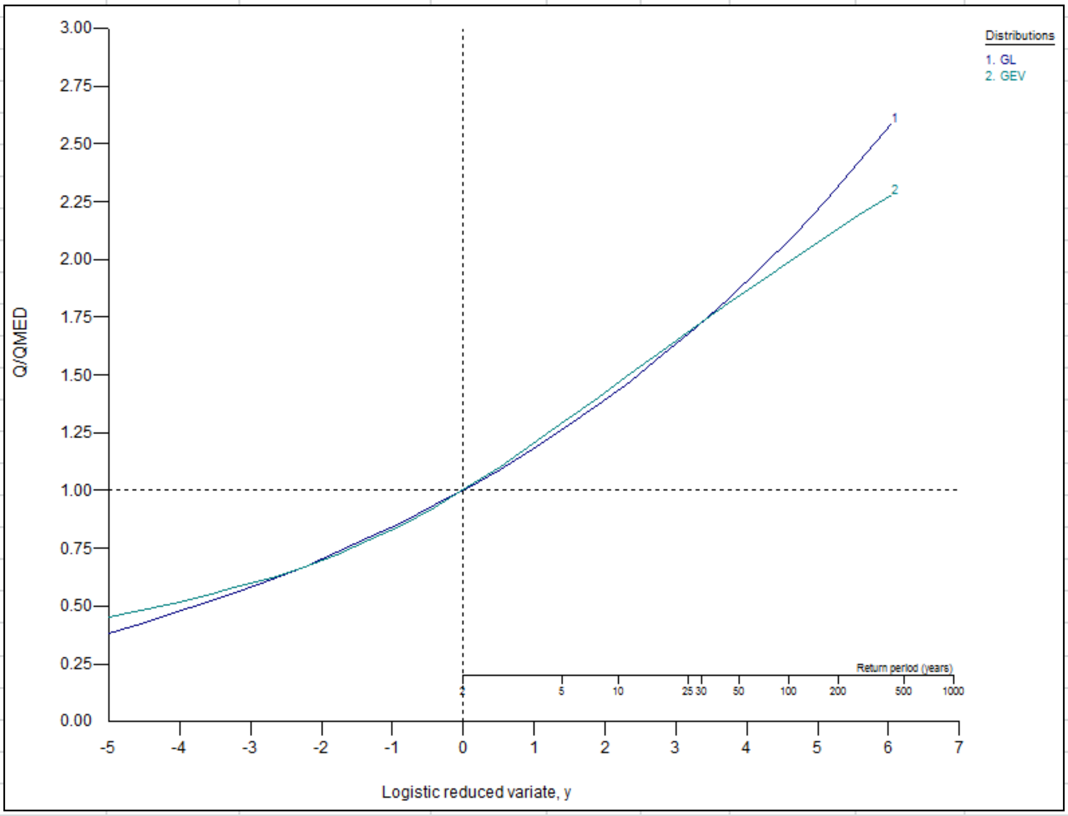
Return Period	GL	GEV
2	1	1
5	1.26	1.288
10	1.436	1.469
25	1.677	1.688
30	1.728	1.729
50	1.874	1.843
100	2.087	1.991
200	2.32	2.133
500	2.662	2.312
1000	2.95	2.442

Fitting for FFC Qmed= 72.282 m^3/s (catchment descriptors)

Return Period	GL	GEV
2	72.3	72.3
5	91.1	93.1
10	103.8	106.2
25	121.2	122.0
30	124.9	125.0
50	135.5	133.2
100	150.9	143.9
200	167.7	154.2
500	192.4	167.1
1000	213.2	176.5

PROJECT	A9 Dualling	JOB No	97318	Calculated by	JMcN
		PAGE	3 of 3		
TITLE	River Truim at Crubenmore Bridge [T15]	DATE	11/11/2016	Checked by	LG
	Pooling Group				

Growth Curves



PROJECT	A9 Dualling	JOB No	97318	Calculated by	JMcN
		PAGE	1 of 3		
TITLE	River Spey at Invertruim - 8007	DATE	11/11/2016	Checked by	LG
	Enhanced Single Site & Single Site Analysis				

Pooling group generated using WINFAP-FEH v4.1 dataset
and updated 8007 (Spey@Invertruim) record (June 2015 rating curve with 2016 value added).

Pooling Group Details

Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
8007 (Spey @ Invertruim)	0	64	103.249	0.231	0.139	1.141
27043 (Wharfe @ Addingham)	0.306	41	262.267	0.167	0.062	0.87
79006 (Nith @ Drumlanrig)	0.393	39	336.556	0.133	0.132	0.449
21007 (Ettrick Water @ Lindean)	0.412	45	241.075	0.195	0.036	1.77
7001 (Findhorn @ Shenachie)	0.424	47	248.084	0.198	0.162	0.628
202001 (Roe @ Ardnargle)	0.424	39	149.642	0.088	0.017	1.366
45002 (Exe @ Stoodleigh)	0.436	54	140.766	0.18	0.286	2.295
81002 (Cree @ Newton Stewart)	0.456	43	226.806	0.148	0.038	0.365
27034 (Ure @ Kilgram Bridge)	0.469	47	243.408	0.129	0.084	0.917
77002 (Esk @ Canonbie)	0.476	44	354.566	0.13	0.16	0.534
25008 (Tees @ Barnard Castle)	0.481	47	261.3	0.175	0.156	0.664
Total		510				
Weighted means				0.216	0.123	

Station	Distance	AREA	SAAR	FPEXT	FARL	URBEXT 2000
8007 (Spey @ Invertruim)	0	401.59	1431	0.054	0.945	0
27043 (Wharfe @ Addingham)	0.306	429.98	1385	0.035	0.975	0.004
79006 (Nith @ Drumlanrig)	0.393	468.87	1485	0.041	0.99	0.002
21007 (Ettrick Water @ Lindean)	0.412	502.73	1306	0.039	0.928	0.002
7001 (Findhorn @ Shenachie)	0.424	415.59	1217	0.039	0.982	0
202001 (Roe @ Ardnargle)	0.424	365.69	1250	0.059	0.993	0.006
45002 (Exe @ Stoodleigh)	0.436	420.71	1361	0.022	0.979	0.002
81002 (Cree @ Newton Stewart)	0.456	366.25	1757	0.07	0.932	0.002
27034 (Ure @ Kilgram Bridge)	0.469	510.9	1338	0.045	0.99	0.004
77002 (Esk @ Canonbie)	0.476	495.37	1423	0.035	0.994	0.001
25008 (Tees @ Barnard Castle)	0.481	510.17	1310	0.035	0.912	0.00

Note: Superseded 8007 (Spey@Invertruim) in WINFAP-FEH v4.1 dataset marked "not suitable for Pooling".

PROJECT	A9 Dualling	JOB No	97318	Calculated by	JMcN
		PAGE	2 of 3		
TITLE	River Spey at Invertruim - 8007	DATE	11/11/2016	Checked by	LG
	Enhanced Single Site & Single Site Analysis				

Heterogeneity Test

H2= 2.3767
H1= 8.1217
Heterogeneous and review undertaken; none removed

Distributions	Goodness-of-fit Z value
Generalised Logistic (GL)	5.5893
Generalised Extreme Value (GEV)	2.2607

Growth Curve Fitting - Enhanced Single Site

Return Period	GL	GEV
2	1	1
5	1.332	1.369
10	1.555	1.596
25	1.855	1.866
30	1.917	1.917
50	2.097	2.055
100	2.358	2.232
200	2.64	2.4
500	3.05	2.609
1000	3.392	2.757

Growth Curve Fitting - Single Site

Return Period	GL	GEV
2	1	1
5	1.361	1.4
10	1.607	1.654
25	1.944	1.961
30	2.014	2.019
50	2.22	2.18
100	2.52	2.39
200	2.848	2.592
500	3.332	2.849
1000	3.74	3.035

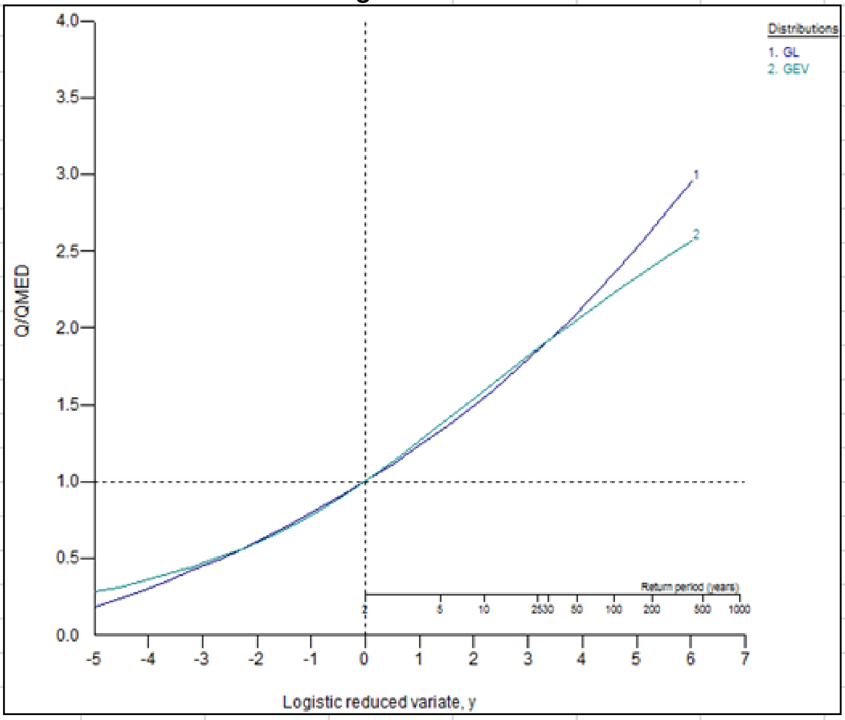
Fitting for FFC Qmed= 103.249 m^3/s (from 8007 AMAX)

Return Period	GL	GEV
2	103.2	103.2
5	137.5	141.3
10	160.6	164.8
25	191.5	192.7
30	197.9	197.9
50	216.5	212.2
100	243.5	230.5
200	272.6	247.8
500	314.9	269.4
1000	350.2	284.7

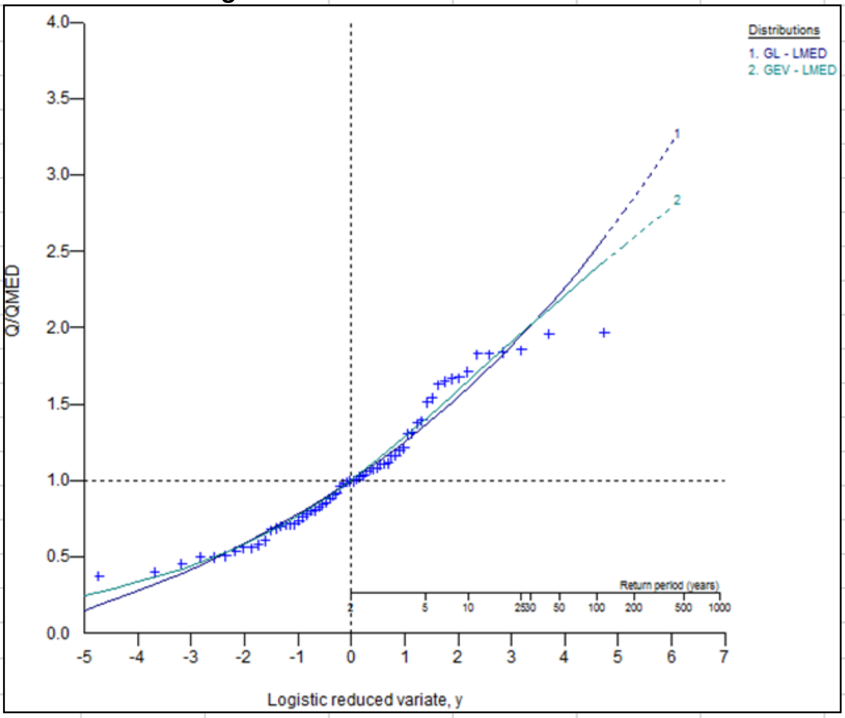
Return Period	GL	GEV
2	103.2	103.2
5	140.5	144.5
10	165.9	170.8
25	200.7	202.5
30	207.9	208.5
50	229.2	225.1
100	260.2	246.8
200	294.1	267.6
500	344.0	294.2
1000	386.2	313.4

PROJECT	A9 Dualling	JOB No	97318	Calculated by	JMcN
		PAGE	3 of 3		
TITLE	River Spey at Invertruim - 8007 Enhanced Single Site & Single Site Analysis	DATE	11/11/2016	Checked by	LG

Growth Curves - Enhanced Single Site



Growth Curves - Single Site



Rainfall Runoff Methods

Example - Spey at Invertruim (8007)

FEH RR – 200yr using FEHcds with SPR adjusted to 37.420 (gauge BFI 0.52) and winter profile

Unit hydrograph time to peak	:	4.617 hours
Instantaneous UH time to peak	:	4.567 hours
Data interval	:	0.100 hours
Design storm duration	:	11.300 hours
Critical storm duration	:	11.224 hours
Return period for design flood	:	200.000 years
requires rain return period	:	246.667 years
ARF	:	0.889
Design storm depth	:	87.445 mm
CWI	:	124.937
Standard Percentage Runoff	:	37.420 %
Percentage runoff	:	44.113 %
Snowmelt rate	:	0.000 mm/day
Unit hydrograph peak	:	19.135 (m3/s/mm)
Quick response hydrograph peak	:	521.364 m3/s
Baseflow	:	17.254 m3/s
Baseflow adjustment	:	0.000 m3/s
Hydrograph peak	:	538.618 m3/s
Hydrograph adjustment factor	:	1.000

Flags
=====

Unit hydrograph flag	:	FSRUH
Tp flag	:	FEHTP
Event rainfall flag	:	FEHER
Rainfall profile flag	:	WINRP
Percentage Runoff flag	:	FEHPR
Baseflow flag	:	F16BF
CWI flag	:	FSRCW v

ReFH2 – 200yr using FEHcds and winter profile

Site details

Checksum: 5DAB-D54D

Site name: 8007

Easting: 268650

Northing: 796200

Country: Scotland

Catchment Area (km²): 401.59

Using plot scale calculations: No

Site description: None

Model run: 200 year

Summary of results

Rainfall - FEH 1999 (mm):	74.83	Total runoff (ML):	9877.37
Total Rainfall (mm):	54.39	Total flow (ML):	21027.23
		Peak flow (m³/s):	655.48
Peak Rainfall (mm):	12.36		

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.

** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 1999 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	05:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.85	No
ARF (Areal reduction factor)	0.85	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	133.52	No
Cmax (mm)	355.41	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	2.12	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m³/s)	25.01	No
BL (hr)	30.47	No
BR	1.13	No

Method Analysis

Annex Table 3: 200yr flow estimates (m^3/s) for Truim catchments produced by a range of methods

LABEL	Truim-01	Truim-02	Truim-03	Truim-04	Truim-05	Truim-06	Truim-07	Truim-08	Truim-09	Truim-10	Truim-11	Truim-12	Truim-13	Truim-14	Truim-15	Truim-16	Truim-17	8007	Spey for comparison
Easting	262650	262800	262750	263100	263600	263850	263900	263850	264000	264150	265250	265400	267500	267650	267650	268350	268700	268650	268600
Northing	777300	779100	779700	780700	781450	782350	783000	783850	785300	785450	787400	787550	265460	791050	791450	792800	796150	796200	796150
AREA	2.73	7.79	15.93	21.79	27.19	30.05	33.6	36.55	42.59	45.81	58.16	62.6	105.68	112.59	116.84	119.99	124.8	401.59	276.78
$Qmed_{cds}$	4.1	10.5	18.3	23.4	27.7	30.1	32.9	35.1	39.3	40.5	46.4	49.3	67.6	70.8	72.3	72.9	72.7	180.4	126.0
$Qmed_{s,adj}$	3.4	8.6	15.0	19.3	22.8	24.7	27.0	28.8	32.2	33.1	37.7	40.0	54.8	57.4	58.5	59.0	58.8	-	96.3
FEH RR	16.3	36.1	69.0	88.0	104.7	110.2	119.2	124.3	133.6	140.4	153.7	163.7	242.6	250.9	256.4	249.7	235.5	700.9	485.3
FEH RR SPR(BFI)	16.7	38.0	71.0	90.6	107.3	113.0	122.5	127.9	138.4	147.7	166.5	177.3	259.9	269.6	276.3	270.5	258.5	538.6	374.5
REFH2	9.2	26.3	48.2	64.1	75.9	81.1	88.6	95.7	104.5	109.7	127.0	135.6	205.6	213.8	218.8	220.3	206.2	655.5	461.7
SingleSite (GL)	9.6	24.6	42.9	54.9	64.9	70.4	76.8	82.0	91.7	94.2	107.4	114.0	156.1	163.4	166.7	168.0	167.5	294.1	274.2
Enhanced SS (GL)	8.9	22.8	39.7	50.9	60.2	65.3	71.2	76.0	85.0	87.3	99.6	105.6	144.7	151.4	154.6	155.7	155.3	272.6	254.2
Pooling (at T15)	7.8	20.0	34.9	44.8	52.9	57.4	62.6	66.8	74.7	76.7	87.5	92.8	127.2	133.1	135.8	136.9	136.4	239.5	223.4

$Qmed_{cds}$ = Qmed calculated from descriptors; $Qmed_{s,adj}$ = Qmed transferred from 8007 [$Qmed_{obs}$ 103.249] (Kjeldsen et al, 2008).

A.3 River Garry Catchments

Catchment Descriptors

Annex Table 4: River Truim and watercourses at Invertruim

LABEL	Allt Dubhaig *Upstream junction with R.Garry*	Allt Dubhaig *Upstream of Coire Mhic-sith*	R. Garry *Upstream junction with Allt Dubhaig*	R. Garry *Downstream Dalnaspidal*	Allt Coire Mhic-Sith *Junction with Allt Dubhaig*
Easting	264300	264100	264300	265200	264550
Northing	772500	773350	772400	772600	773300
AREA	25.82	17.61	65.16	92.3	7.26
ALTBAR	682	674	627	640	731
ASPBAR	179	161	113	130	193
ASPVAR	0.15	0.07	0.16	0.13	0.34
BFIHOST	0.396	0.382	0.358	0.369	0.437
DPLBAR	5.86	5.2	9.08	9.38	3.49
DPSBAR	254.9	259.2	180.5	201.7	265.1
FARL	0.954	1	0.843	0.875	1
FPEXT	0.0258	0.0268	0.0327	0.0319	0.0055
FPDBAR	0.344	0.345	0.39	0.407	0.079
FPLOC	0.462	0.391	0.93	0.856	0.146
LDP	11.07	9.84	18.44	19.8	5.89
PROPWET	0.72	0.73	0.74	0.74	0.72
SAAR	1836	1863	1792	1800	1808
SPRHOST	56.49	56.16	56.97	56.77	57.85
URBEXT90	0.0001	0	0	0	0
URBEXT00	0	0	0	0	0

Routing exercise

A routing model of Loch Garry was prepared using Flood Modeller Software.

Due to the intake on the Allt Dubhaig and associated derivation canal, Loch Garry is partially filled with flows from Allt Dubhaig and Allt Coire Mhic-Sith. The routing model therefore includes the contribution from the Allt Dubhaig, Allt Coire Mhic-Sith and the River Garry.

Two control structures, the intake on Allt Dubhaig and the dam on Loch Garry are included into the model. Their description is based on topographical information.

The Stage-Area curve describing Loch Garry reservoir storage is based on 1:25,000 OS contours and account for storage area available upstream of Allt Dubhaig retaining structure.

The initial water level in Loch Garry was set to the crest level of dam to the east of Loch Garry (414.4mAOD).

The 200yr critical duration was found to be 29hrs. The resulting 200yr flood level in Loch Garry (as well as upstream of the Allt Dubhaig retaining structure) is 415.318mAOD.

The corresponding contributing peak flows are:

- Allt Dubhaig (u/s Allt Coire Mhic-Sith): 20.73m^3/s
- Allt Coire Mhic-Sith: 17.45m^3/s
- River Garry: 70.99m^3/s

200yr Peak flows for the 2D model

- Allt Dubhaig: 70.81m^3/s
- Allt Coire Mhic-Sith: 32.22m^3/s
- Loch Garry: 415.318mAOD

A.4 Catchments at A9 crossings

Catchment Descriptors

Annex Table 5: Catchments at A9 crossings: donor FEH catchment descriptors

LABEL	NN65797246	NN64557330	NN63507460	NN63207550	NN62957635	NN62807970	NN63108040	NN63208080	NN63758145
Easting	265800	264550	263500	263200	262950	262800	263610	263200	263750
Northing	772450	773300	774600	775500	776350	779700	779790	780800	781450
AREA	1.09	7.26	0.54	2.22	0.79	3.46	0.62	3.57	1.26
ALTBAR	658	731	613	762	752	688	501	769	744
ASPBAR	193	193	231	243	222	307	304	323	299
ASPVAR	0.84	0.34	0.83	0.68	0.84	0.57	0.86	0.47	0.56
BFIHOST	0.286	0.437	0.376	0.45	0.449	0.419	0.373	0.467	0.434
DPLBAR	1.35	3.49	1.09	2.06	1.53	2.56	0.94	3.0	2.05
DPSBAR	177.6	256.1	165.3	238.6	175.4	252.5	191.5	276.9	276.1
FARL	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
LDP	2.38	5.89	2.3	3.4	2.61	4.1	1.82	4.96	3.28
PROPWET	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
SAAR	1699	1808	1687	1805	1826	1740	1538	1789	1717
SPRHOST	56.47	57.85	54.85	58.07	58.83	56.64	51.4	59.17	57.87
URBEXT1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
URBEXT2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Flow Estimates

Annex Table 6: Design flow estimates at crossings – Baseline

Crossing ID	Watercourse Category	Donor catchment	FEH area (km2)	Estimated area	5yr (m3/s)	10yr (m3/s)	30yr (m3/s)	50yr (m3/s)	200yr (m3/s)	1000yr (m3/s)
01	minor	NN63507460		0.208	0.42	0.51	0.66	0.75	0.88	1.28
02	Major	NN64557330	7.26	7.155	13.48	16.21	21.47	24.28	27.89	46.14
03	minor	NN63507460		0.004	0.01	0.02	0.02	0.02	0.03	0.04
03a	minor	NN63507460		0.033	0.08	0.10	0.13	0.15	0.17	0.25
04	minor	NN63507460		0.057	0.13	0.16	0.21	0.24	0.28	0.41
05	minor	NN63507460		0.141	0.30	0.36	0.47	0.53	0.62	0.91
06	minor	NN63507460		0.045	0.11	0.13	0.17	0.19	0.22	0.33
07	minor	NN63507460		0.146	0.31	0.37	0.48	0.55	0.64	0.94
08	Major	NN63507460		0.340	0.66	0.79	1.03	1.16	1.36	1.99
10	minor	NN63507460		0.125	0.27	0.33	0.42	0.48	0.56	0.82
12	minor	NN63507460		0.170	0.35	0.43	0.55	0.63	0.73	1.07
13	Major	NN63507460	0.54	0.573	1.49	1.79	2.39	2.72	3.15	5.32
14	minor	NN63507460		0.071	0.16	0.20	0.25	0.29	0.34	0.49
15	minor	NN63507460		0.090	0.20	0.24	0.31	0.36	0.42	0.61
17	minor	NN63507460		0.014	0.04	0.05	0.06	0.07	0.08	0.12
18	minor	NN63507460		0.123	0.27	0.32	0.41	0.47	0.55	0.81
20	minor	NN63507460		0.038	0.09	0.11	0.15	0.17	0.19	0.28
21	minor	NN63507460		0.008	0.02	0.03	0.04	0.04	0.05	0.07
22	minor	NN63507460		0.093	0.21	0.25	0.32	0.37	0.43	0.63
23	Major	NN63207550	2.22	2.300	5.18	6.20	8.26	9.37	10.80	18.02
25	minor	NN63207550		0.074	0.18	0.22	0.29	0.32	0.38	0.55
27	minor	NN63207550		0.149	0.34	0.41	0.53	0.60	0.71	1.03
28	minor	NN62957635		0.209	0.47	0.57	0.73	0.83	0.97	1.42
30	minor	NN62957635		0.020	0.06	0.07	0.09	0.10	0.12	0.18
31	Major	NN62957635	0.79	0.823	1.98	2.37	3.16	3.59	4.14	6.93
32	minor	NN62957635		0.027	0.08	0.09	0.12	0.13	0.16	0.23
33	minor	NN62957635		0.027	0.08	0.09	0.12	0.13	0.16	0.23
34	minor	NN62957635		0.227	0.50	0.61	0.78	0.89	1.04	1.52
35	minor	NN62957635		0.099	0.24	0.29	0.38	0.43	0.50	0.73
36	minor	NN62957635		0.148	0.34	0.42	0.54	0.61	0.71	1.04
37	minor	NN62957635		0.030	0.08	0.10	0.13	0.15	0.17	0.25
38	minor	NN62957635		0.044	0.12	0.14	0.18	0.21	0.24	0.35
39	minor	NN62957635		0.034	0.09	0.11	0.14	0.16	0.19	0.28
40	minor	NN62957635		0.099	0.24	0.29	0.38	0.43	0.50	0.73
42	minor	NN62957635		0.190	0.43	0.52	0.67	0.76	0.89	1.30
43	minor	NN63108040		0.405	0.69	0.83	1.07	1.22	1.43	2.09
44	minor	NN63108040		0.091	0.18	0.22	0.28	0.32	0.38	0.55
45	minor	NN63108040		0.175	0.33	0.40	0.51	0.58	0.68	0.99
46	minor	NN63108040		0.039	0.09	0.10	0.13	0.15	0.18	0.26
47	minor	NN63108040		0.033	0.07	0.09	0.12	0.13	0.15	0.22

Crossing ID	Watercourse Category	Donor catchment	FEH area (km2)	Estimated area	5yr (m3/s)	10yr (m3/s)	30yr (m3/s)	50yr (m3/s)	200yr (m3/s)	1000yr (m3/s)
49	minor	NN63108040		0.014	0.03	0.04	0.05	0.06	0.07	0.10
50	minor	NN63108040		0.003	0.01	0.01	0.01	0.02	0.02	0.03
51	minor	NN63108040		0.117	0.23	0.28	0.36	0.40	0.47	0.69
52	Major	NN62807970	3.46	3.462	7.29	8.73	11.69	13.27	15.31	25.64
54	minor	NN63108040		0.005	0.01	0.02	0.02	0.02	0.03	0.04
55	minor	NN63108040		0.042	0.09	0.11	0.14	0.16	0.19	0.28
56	minor	NN63108040		0.046	0.10	0.12	0.16	0.18	0.21	0.30
57	Major	NN63108040	0.62	0.545	1.46	1.76	2.34	2.68	3.11	5.35
58	minor	NN63108040		0.130	0.25	0.30	0.39	0.44	0.52	0.76
59	Major	NN63208080	3.57	3.602	7.43	8.92	11.89	13.47	15.51	25.84
60	minor	NN63108040		0.024	0.06	0.07	0.09	0.10	0.12	0.17
61	minor	NN63108040		0.247	0.44	0.54	0.69	0.79	0.92	1.34
62	minor	NN63108040		0.031	0.07	0.08	0.11	0.12	0.14	0.21
63	minor	NN63758145	0.62	0.737	2.16	2.61	3.44	3.95	4.60	7.90
64	Major	NN63758145	1.26	1.167	2.63	3.15	4.20	4.77	5.51	9.28

IH124 parameters: SOIL 0.5.

FEH RR parameters: DPL for ID63 calculated from estimated area using FEH, otherwise from donor catchment. SPR adjusted to 57.37 where otherwise lower.

Annex Table 7: 200yr flow estimates at crossings – Stage 3 4th Iteration Design Freeze

Crossing ID	Watercourse Category	Donor catchment	FEH area (km2)	Estimated area	5yr (m3/s)	10yr (m3/s)	30yr (m3/s)	50yr (m3/s)	200yr (m3/s)	1000yr (m3/s)
01	minor	NN63507460		0.208	0.42	0.51	0.66	0.75	0.99	1.28
02	Major	NN64557330	7.26	7.158	13.49	16.21	21.48	24.29	32.23	46.15
03	minor	NN63507460		0.033	0.08	0.10	0.13	0.15	0.19	0.25
04	minor	NN63507460		0.058	0.14	0.16	0.21	0.24	0.32	0.41
05	minor	NN63507460		0.140	0.30	0.36	0.47	0.53	0.70	0.90
06	minor	NN63507460		0.045	0.11	0.13	0.17	0.19	0.25	0.33
07	minor	NN63507460		0.146	0.31	0.37	0.48	0.55	0.73	0.94
08	Major	NN63507460		0.340	0.66	0.79	1.03	1.16	1.54	1.99
10	minor	NN63507460		0.125	0.27	0.33	0.42	0.48	0.63	0.82
12	minor	NN63507460		0.170	0.35	0.43	0.55	0.63	0.83	1.07
13	Major	NN63507460	0.54	0.573	1.49	1.79	2.39	2.72	3.66	5.32
14	minor	NN63507460		0.071	0.16	0.20	0.25	0.29	0.38	0.49
15	minor	NN63507460		0.090	0.20	0.24	0.31	0.36	0.47	0.61
21	minor	NN63507460		0.183	0.38	0.46	0.59	0.67	0.89	1.15
22	minor	NN63507460		0.093	0.21	0.25	0.32	0.37	0.49	0.63
23	Major	NN63207550	2.22	2.300	5.18	6.20	8.26	9.37	12.50	18.02
25	minor	NN63207550		0.074	0.18	0.22	0.29	0.32	0.43	0.55
27	minor	NN63207550		0.149	0.34	0.41	0.53	0.60	0.80	1.03
28	minor	NN62957635		0.209	0.47	0.57	0.73	0.83	1.10	1.42
30	minor	NN62957635		0.020	0.06	0.07	0.09	0.10	0.14	0.18
31	Major	NN62957635	0.79	0.823	1.98	2.37	3.16	3.59	4.80	6.93
33	minor	NN62957635		0.027	0.08	0.09	0.12	0.13	0.18	0.23
34	minor	NN62957635		0.227	0.50	0.61	0.78	0.89	1.18	1.52
35	minor	NN62957635		0.099	0.24	0.29	0.38	0.43	0.56	0.73
36	minor	NN62957635		0.148	0.34	0.42	0.54	0.61	0.81	1.04
37	minor	NN62957635		0.030	0.08	0.10	0.13	0.15	0.19	0.25
38	minor	NN62957635		0.044	0.12	0.14	0.18	0.21	0.27	0.35
39	minor	NN62957635		0.034	0.09	0.11	0.14	0.16	0.22	0.28
40	minor	NN62957635		0.031	0.09	0.10	0.13	0.15	0.20	0.26
41a	minor	NN62957635		0.026	0.07	0.09	0.11	0.13	0.17	0.22
41b	minor	NN62957635		0.040	0.11	0.13	0.17	0.19	0.25	0.33
42	minor	NN62957635		0.087	0.21	0.26	0.33	0.38	0.50	0.65
42a	minor	NN62957635		0.130	0.31	0.37	0.48	0.54	0.72	0.93
43	minor	NN63108040		0.380	0.65	0.79	1.02	1.15	1.53	1.97
44	minor	NN63108040		0.091	0.18	0.22	0.28	0.32	0.43	0.55
45	minor	NN63108040		0.175	0.33	0.40	0.51	0.58	0.77	0.99
46	minor	NN63108040		0.039	0.09	0.10	0.13	0.15	0.20	0.26
47	minor	NN63108040		0.033	0.07	0.09	0.12	0.13	0.17	0.22
49	minor	NN63108040		0.014	0.03	0.04	0.05	0.06	0.08	0.10
50	minor	NN63108040		0.003	0.01	0.01	0.01	0.02	0.02	0.03
51	minor	NN63108040		0.117	0.23	0.28	0.36	0.40	0.53	0.69

Crossing ID	Watercourse Category	Donor catchment	FEH area (km2)	Estimated area	5yr (m3/s)	10yr (m3/s)	30yr (m3/s)	50yr (m3/s)	200yr (m3/s)	1000yr (m3/s)
52	Major	NN62807970	3.46	3.462	7.29	8.73	11.69	13.27	17.74	25.64
54	minor	NN63108040		0.005	0.01	0.02	0.02	0.02	0.03	0.04
55	minor	NN63108040		0.042	0.09	0.11	0.14	0.16	0.21	0.28
56	minor	NN63108040		0.046	0.10	0.12	0.16	0.18	0.23	0.30
57	Major	NN63108040	0.62	0.545	1.46	1.76	2.34	2.68	3.64	5.35
58	minor	NN63108040		0.130	0.25	0.30	0.39	0.44	0.59	0.76
59	Major	NN63208080	3.57	3.602	7.43	8.92	11.89	13.47	17.95	25.84
60	minor	NN63108040		0.024	0.06	0.07	0.09	0.10	0.13	0.17
61	minor	NN63108040		0.247	0.44	0.54	0.69	0.79	1.04	1.34
62	minor	NN63108040		0.031	0.00	0.00	0.00	0.00	0.00	0.00
63	minor	NN63758145	0.62	0.737	2.16	2.61	3.44	3.95	5.37	7.90
64	Major	NN63758145	1.26	1.317	2.96	3.55	4.73	5.37	7.21	10.45

Annex B - Hydraulic Modelling

[For flood extents figures see Annex C]

B.1 Modelling Notes

Annex Table 8: Mainline crossing modelling properties

Crossing ID	Existing Model Crossing Dimensions (m)	Existing Model Crossing Description	Proposed Model Crossing Dimensions (m)	Proposed Model Crossing Description
2	W=5.97 H=3.80	1d culvert	N/A	Outfall
8	D=1.40	1d culvert	N/A	Outfall
13	D=1.10	1d culvert	N/A	Outfall
23	W=5.00 H=3.00	1d culvert	N/A	Outfall
25	D=0.35	1d culvert	N/A	Outfall
31	W=1.31 H=0.69	1d culvert	N/A	Outfall
34	D=0.90	1d culvert	N/A	Outfall
43	D=0.90	1d culvert	N/A	Outfall
52	W=6.16 H=0.93	1d culvert	N/A	Outfall
57	D=1.20	1d culvert	N/A	Outfall
59	D=0.90	1d culvert	N/A	Outfall
61	D=0.90	1d culvert	N/A	Outfall
63	D=1.70	1d culvert	N/A	Outfall
64	W=1.33 H=0.79	1d culvert	N/A	Outfall

Key

D	Diameter of circular culvert.
W	Width of the box culvert (or topography cut).
H	Height of box culvert.
1d culvert	Modelled using a 1d culvert ESTRY unit in TUFLOW.
Cut	DTM cut either while producing the DTM or using a ZSH shape file in TUFLOW.
Outfall	Inflow boundary located downstream of mainline (crossing sized to pass 1 in 200 year flow).

B.2 Analysis: Sifting Exercise – Identifying Encroachments

Sifting exercise carried out on 4th Iteration Design Freeze.

Annex Table 9: Sifting exercise – encroachments from clashes

* Conservative estimates: 'encr' = floodplain displaced by encroachment, 'cap' = floodplain lost due to removal of flow constriction.
NB estimates are indicative only, and do not account for 3D shape or channel flow volume (therefore may significantly over-estimate volume).

** 'Ruled out' = clash on plan view (between pre-development 200yr flood extents and Proposed Scheme) rejected as a tangible encroachment.
'Encroachment' = area of floodplain volume loss identified, see FRA **Section 8** and **Section 9**.

Chainage	Associated feature	*Indicative vol. lost (200yr, m^3)	Characteristics of floodplain	Sifting decision** *{Assessment Design comment}*
Tay catchment – P&KC area				
Ch. 0,400	MW7.3	N/A	Thin line of out-of-bank flow upstream of crossing ID2; in-channel flow of major watercourse	Ruled out: new crossing will span the floodplain
Ch. 0,400	MW7.3	N/A	Track crosses major watercourse downstream of crossing ID2	Ruled out: proposed track crossing will have similar capacity and conveyance
Ch. 1,500	MW7.4	N/A	Small area of out-of-bank flow upstream of crossing ID8; flow in major watercourse channel	Ruled out: proposed crossing will have similar capacity and conveyance
Ch. 2,025	MW7.6	N/A	Mainline footprint over major watercourse channel at crossing ID13	Ruled out: proposed crossing will have similar capacity and conveyance
Ch. 3,000 – ch. 3,100	MW7.9	250 (encr) 300 (cap)	Mainline footprint across floodwaters backing up from crossing ID23, and major watercourse channel	[Upstream] Encroachment: floodplain lost upstream [Downstream] Ruled out: proposed crossing will have similar capacity and conveyance
Ch. 3,100 – ch. 3,200	W7.81	200 (encr)	Mainline footprint across floodwaters backing up from crossing ID25, and major watercourse channel	[Upstream] Encroachment [Downstream] Ruled out: proposed crossing will have similar capacity and conveyance
Spey catchment – THC area				
Ch. 3,750 – ch. 3,950	MW7.11 W7.94	N/A	Mainline and realigned NCN7 track footprint across flows backing-up from crossing ID31 to spill overland, across the A9 and floodplain to the west. Mainline footprint across watercourse channels	[Overland flow] Ruled out: this area of conflict has been identified as an overland flow path, precluded by crossing upsizing and replaced by watercourse diversion, and therefore not storage within the floodplain in terms of the Scheme footprint. Potential impact downstream is assessed separately [Channels] Ruled out: proposed crossing will have similar capacity and conveyance

Chainage	Associated feature	*Indicative vol. lost (200yr, m^3)	Characteristics of floodplain	Sifting decision** *{Assessment Design comment}*
Ch. 3,950	W7.8 W7.94 W7.95	350 (encr)	Realigned NCN7 track footprint across combined floodplain west of crossings ID34 and ID35	Encroachment *{Track encroachment INCREASED to 400m^3 in Assessment Design}*
Ch. 4,650 – ch. 4,700	MW8.1	20 (encr)	Track/ Mainline footprint in River Truim floodplain	Encroachment
Ch. 4,800 – ch. 4,850	MW8.1	20 (encr)	Track/ Mainline footprint in River Truim floodplain	Encroachment
Ch. 4,900 – ch. 9,050	MW8.1	10 (encr)	Track/ Mainline footprint in River Truim floodplain	Encroachment
Ch. 6,130 – ch. 6,150	MW8.1	40 (encr)	SuDS footprint in River Truim floodplain	Encroachment *{Track encroachment REMOVED in Assessment Design}*
Ch. 6,150 – ch. 6,200	MW8.1 W7.133	40 (encr)	Track/ Mainline footprint in combined floodplain, and over watercourse channel	[Floodplain] Encroachment [Channel] Ruled out: proposed crossing will have similar capacity and conveyance
Ch. 6,300 – ch. 6,400	MW8.1	140 (encr)	SuDS footprint in River Truim floodplain	Encroachment
Ch. 6,500 – ch. 6,550	MW8.1	150 (encr)	SuDS footprint in River Truim floodplain	Encroachment *{Encroachment REDUCED to approximately 100m^3 in Assessment Design}*
Ch. 6,900 – ch. 6,950	MW8.1	200 (encr)	SuDS footprint in River Truim floodplain	Encroachment.
Ch. 7,150 – ch. 7,450	MW7.18	1800 (encr)	Mainline and landscaping berm in floodplain upstream and downstream of crossing ID52	[Upstream] Encroachment [Downstream] Ruled out: overland flow path – not storage within floodplain (see also below)
Ch. 7,250 – ch. 7,600	MW7.18 [W7.154-7]	N/A	Mainline and track footprint across flows spilling overland across the A9 and land beyond. Proposed Scheme Junction footprint across this flow route. Mainline footprint across watercourse channels	(see also above) [Overland flow] Ruled out: this area of conflict has been identified as an overland flow path, precluded by changes to floodplain extents due to the Proposed Scheme, and therefore not storage within the floodplain in terms of the Proposed Scheme footprint [Channels] Ruled out: proposed crossings and upstream watercourse diversions will have similar capacity and conveyance
Ch. 7,800	MW8.1	10 (encr)	SuDS footprint in River Truim floodplain	Encroachment *{Encroachment REMOVED in Assessment Design}*
Ch. 7,900	MW7.20	10 (encr)	Access track footprint in major watercourse floodplain	Encroachment *{Encroachment REMOVED in Assessment Design}*

Chainage	Associated feature	*Indicative vol. lost (200yr, m^3)	Characteristics of floodplain	Sifting decision** *{Assessment Design comment}*
Ch. 7,900 – ch. 7,950	MW7.20	60 (encr)	Mainline footprint across floodwaters backing up from crossing ID57, and out of bank flooding downstream	[Upstream] Encroachment, and floodplain lost to increased crossing capacity [Downstream] Ruled out due to proposed crossing capacity and new watercourse diversion; out-of-bank flow downstream ruled out, as it is overland flow and not floodplain storage *{Encroachment REMOVED in Assessment Design}*
Ch. 8,400	MW7.22	N/A	Mainline footprint across floodwaters in and alongside major watercourse channel	Ruled out: proposed structure will span floodplain
Ch. 8,700	W7.21	N/A	Track footprint across watercourse channel	Ruled out: proposed crossing will have similar capacity and conveyance
Ch. 9,100	MW8.1 W7.22	20 (encr)	Track footprint in combined floodplain and watercourse channel	Encroachment *{Encroachment REMOVED in Assessment Design}*
Ch. 9,200 – ch. 9,300	W7.23	200 (encr) 300 (cap)	Mainline footprint across floodwaters backing up from crossing ID63, and watercourse channel up and downstream	[Upstream] Encroachment, and floodplain lost to increased crossing capacity *{Encroachment reduced in Assessment Design}* [Channels] Ruled out: proposed crossing and channel will have similar capacity and conveyance
Ch. 9,300	MW7.23	10 (encr) 60 (cap)	Mainline footprint across floodwaters backing up from crossing ID64, and major watercourse channel up and downstream	[Upstream] Encroachment, and floodplain loss to increased crossing capacity. Proposed crossing part spans floodplain *{Encroachment reduced in Assessment Design}* [Downstream] Ruled out: proposed crossing and channel will have similar capacity and conveyance

B.3 Analysis: Impacts on 200yr Floodplain

Impacts estimated using H&HM model based on 4th Iteration Design Freeze, without mitigation.

Annex Table 10: Comparison of Stage 3 model results (post-development versus existing case)

*Elements of the Proposed Scheme categorized as: 'Mainline', 'SuDS' or 'Track' (encroachments), 'Crossing' (watercourse crossing structure/ culvert changed) and 'Diversion' (watercourse channel moved and or significantly enlarged).

**Changes described as the post-development results relative to the baseline model results.

Chainage	Feature	Changes affecting the floodplain*	Comparison of indicative 200yr floodplains**	Overall impact and effect on flood risk Incl. adverse impact at receptors	Assessment Design comment
Tay catchment – P&KC area					
Ch. 0,400	MW 7.3	Crossing ID2	Locally: No measurable change in predicted 200yr water level downstream of the crossing Allt Dubhaig (River Garry): Flood levels unaffected	No impact on flood risk	-
Ch. 1,500	MW 7.4	Crossing ID8 Diversion	Locally: Negligible change in predicted 200yr water level up to 30m downstream of the crossing Allt Dubhaig (River Garry): Flood levels unaffected	No impact on flood risk	-
Ch. 2,025	MW 7.6	Crossing ID13	Locally: Negligible change in predicted 200yr water level Allt Dubhaig (River Garry): Flood levels unaffected	No impact on flood risk	-
Ch. 3,000	MW 7.9	Mainline Track Crossing ID23	Locally: Upstream of the A9, out of bank flooding removed and flood levels reduced. Downstream, minor increase in predicted 200yr water level (< 4mm) Allt Dubhaig (River Garry): Flood levels may be affected further downstream (< 1mm)	Overall reduction in flood risk HML: rise (<4mm) in estimated 200yr WL upstream of HML crossing and where floodwaters predicted to overtop the railway (<3mm) pre-development (adjacent to ch. 2,750) Agricultural land: negligible change in area of land inundated that wasn't before (+-10m^2)	-

Chainage	Feature	Changes affecting the floodplain*	Comparison of indicative 200yr floodplains**	Overall impact and effect on flood risk Incl. adverse impact at receptors	Assessment Design comment
Ch. 3,200	W7.81	Mainline Crossing ID25 Diversion	Locally: Upstream, flood extent reduced. Flood waters no longer predicted to back up behind crossing. Downstream, flood extent shifted to the north and reduced (channel capacity not fully represented in H&HM results). 200yr flood level potentially raised by up to 60mm Allt Dubhaig (River Garry): Minimal effect on flood levels (<3mm at confluence, fading to <1mm 150m further downstream)	Overall reduction in flood risk local to the A9 HML: rise (<60mm) in estimated 200yr WL upstream of HML railway, and at the crossing under the railway(<50mm). The railway is approximately 0.5m above the 200yr floodplain at this location Agricultural land: approximately 200m^2 net reduction in area of land inundated downstream, with potentially the same area introduced to the floodplain	Improved watercourse channel downstream reduces floodplain extent
Spey catchment – THC area					
Ch. 3,750 – ch. 4,100	MW 7.11 W7.94	Crossing ID31 Crossing ID34 Diversion Track	Locally: Flood extent reduced by approximately 2ha as 200yr flood waters are predicted not to overtop the A9 in the post-development scenario. Predicted 200yr water level up to 70mm higher in places, though proposed channel not fully represented in Stage 3 model, and flood extents are expected to be confined to the proposed watercourse diversion channel downstream. River Truim: Approximately 20mm increase in predicted 200yr WL at the confluence, fading to 5mm by the confluence with W7.94, 100m downstream	Overall reduction in flood risk A9: Flood risk REMOVED. Flood extent over NCN7 reduced HML: rise (<30mm) in 200yr WL adjacent to HML. Railway here is approximately 1.5m above 200yr flood level Agricultural land: approximately 1.5ha removed from the 200yr floodplain	WD realigned Encroachment increased Impact reduced and NCN7 realignment raised from floodplain
Ch. 4,650 – ch. 4,950	MW 8.1	Mainline/ Track	[Three encroachments] Locally: Approximately 20mm increase in flood levels adjacent to ch. 4,650 encroachment, fading to nothing 70m up and downstream; flood extents materially unaffected (approximately 10m^2 added to the functional floodplain) River Truim downstream: Flood levels unaffected	Minor local increase in flood risk HML: Flood levels unaffected where HML railway is predicted to be overtopped Agricultural land: negligible increase in area of land inundated that wasn't before (+-10m^2)	-
Ch. 6,150 – ch. 6,200	MW 8.1 W7.133	Mainline/ Track SuDS Crossing ID43 Diversion	Locally: No change in levels adjacent to SuDS and track encroachment. Increase in flood levels (<20mm) at confluence with W7.133 [partly due to model boundary influence] River Truim downstream: Flood levels up to 6mm higher	Minor local increase in flood risk HML: Rise in predicted 200yr WL adjacent to HML railway (<6mm). Railway approximately 3m above 200yr flood level in this location Agricultural land: negligible increase in area of land inundated that wasn't before (+-10m^2)	SuDS removed Impact removed
Ch. 6,300 – ch. 6,400	MW 8.1	SuDS	Locally: Minor increase in flood levels (<10mm) adjacent to encroachment River Truim downstream: Flood levels up to 7mm higher	Minor local increase in flood risk HML: Rise in predicted 200yr WL adjacent to HML railway (<10mm). Railway approximately 3m above 200yr flood level in this location Agricultural land: negligible increase in area of land inundated that wasn't before (+-10m^2)	-

Chainage	Feature	Changes affecting the floodplain*	Comparison of indicative 200yr floodplains**	Overall impact and effect on flood risk Incl. adverse impact at receptors	Assessment Design comment
Ch. 6,500 – ch. 6,550	MW 8.1	SuDS	Locally: Increase in predicted 200yr flood levels (approximately 40mm) adjacent to encroachment, affecting water levels up to 70m upstream River Truim downstream: Flood levels up to 5mm higher for 100m	Minor local increase in flood risk Agricultural land: negligible increase in area of land inundated that wasn't before (+-10m^2)	-
Ch. 6,900 – ch. 6,950	MW 8.1	SuDS Track	Locally: Increase in predicted 200yr flood levels local to the pond (approximately 100mm), negligible difference in flood level predictions 40m from the encroachment River Truim downstream: Flood levels 3mm higher up to 100m downstream	Minor local increase in flood risk Residential Property [D-009]: No change in flood level HML: Rise in predicted 200yr WL adjacent to HML railway (<3mm). Railway approximately 3m higher than 200yr flood level in this location Agricultural land: negligible increase in area of land inundated that wasn't before (+-10m^2)	Track removed Impact reduced
Ch. 7,200 – ch. 7,400	MW 7.18	Mainline Crossing ID52	Locally: Flood waters upstream of crossing not predicted to overtop A9 post-development. Downstream of the crossing increases in 200yr WL around the channel are predicted, ranging from 100mm local to the crossing, to 30mm at the River Truim to the west River Truim downstream: Impact on 200yr flood levels negligible 75m and more downstream of Truim confluence Other: Floodplain reduced to north, as existing overland flood precluded by raised Proposed Mainline	Reduction in flood risk to the A9; however, potential increase in flood risk to local receptors and loss of floodplain storage A9: Flood risk removed Residential Property [D-010]: potential increase in flood risk HML: Rise in predicted 200yr WL adjacent to HML railway (<30mm). Railway approximately 3m higher than 200yr flood level in this location HML: No impact on adjacent flow routes overtopping the HML railway (from Balsporran Cottages to the south) Agricultural land: approximately 3.0ha removed from the 200yr floodplain	Addition of landscaped bund Flood risk increased – see 'Drumochter ' in **Section 9**
Ch. 7,900-ch. 7,950	MW 7.20	Mainline Crossing ID57 Diversion	Locally: Flood extent upstream no longer backing up from crossing, flood extent downstream confined to new channel. At mouth of new channel predicted 200yr WL <50mm higher locally River Truim downstream: Flood levels unaffected	Overall reduction in flood risk Agricultural land: approximately 0.1ha removed from the 200yr floodplain	-
Ch. 8,400	MW 7.22	Crossing ID59	Locally: Negligible change in flood levels and flood extent locally due to localised effect of model boundary – relocation of MW7.22 inflow downstream of crossing ID59 (precautionary approach to analysis of downstream risk) River Truim downstream: Flood levels unaffected	No impact on flood risk	-

Chainage	Feature	Changes affecting the floodplain*	Comparison of indicative 200yr floodplains**	Overall impact and effect on flood risk Incl. adverse impact at receptors	Assessment Design comment
Ch. 8,700	W7.21	Crossing ID61 Diversion	Locally: Flood extent upstream no longer backing up from crossing, flood extent downstream confined to new channel. Negligible increase in predicted 200yr WL and flood extents at the mouth of the new channel River Truim downstream: Flood levels unaffected	Overall reduction in flood risk Agricultural land: approximately 100m^2 net reduction in area of land inundated downstream, with approximately 100m^2 area introduced to the floodplain	-
Ch. 9,100	W7.22/ MW 8.1	Track	Local change in predicted 200yr WL (up to 150mm) and flood extent due to track footprint Flood levels unaffected downstream	Minor local increase in local flood risk Agricultural land: approximately 350m^2 of land inundated that wasn't before	Removed
Ch. 9,200 – ch. 9,300	W7.23	Mainline Crossing ID63 Diversion	Locally: Flood extents removed upstream due to channel upsizing, with negligible impact on WL downstream due to channel diversion River Truim downstream: Flood levels unaffected	Overall reduction in flood risk	-
Ch. 9,300	MW 7.23	Mainline Crossing ID64 Diversion	Locally: Although peak 200yr flow estimate increased (6.4 to 7.2m^3/s due to estimated impact of Proposed Scheme on upstream catchment), flood extents removed upstream due to channel upsizing, with negligible impact on WL downstream due to channel diversion River Truim downstream: Flood levels unaffected	Overall reduction in flood risk	-

Annex C – Figures

Water Features Plans

Figure WFP1 – A9P07-CFJ-EWE-L_ML000_ZZ-DR-EN-0001 version C01

Figure WFP2 – A9P07-CFJ-EWE-L_ML006_ZZ-DR-EN-0001 version C01

Figure WFP3 – A9P07-CFJ-EWE-L_ML022_ZZ-DR-EN-0001 version C01

Figure WFP4 – A9P07-CFJ-EWE-L_ML038_ZZ-DR-EN-0001 version C01

Figure WFP5 – A9P07-CFJ-EWE-L_ML038_ZZ-DR-EN-0002 version C01

Figure WFP6 – A9P07-CFJ-EWE-L_ML070_ZZ-DR-EN-0001 version C01

Figure WFP7 – A9P07-CFJ-EWE-L_ML086_ZZ-DR-EN-0001 version C01

Catchment Plan

Figure CTP1– EIA Drawing 07-CFJ-EWE-L_ZZZZZ_ZZ-DR-EN-0001 version C01

Flood Extents

Pre-development showing 4th Iteration Design Freeze (as modelled)

Figures FEX1 to FEX7

Post-development showing 4th Iteration Design Freeze (as modelled)

Figures FPO1 to FPO7

Potential Flood Risk Receptors

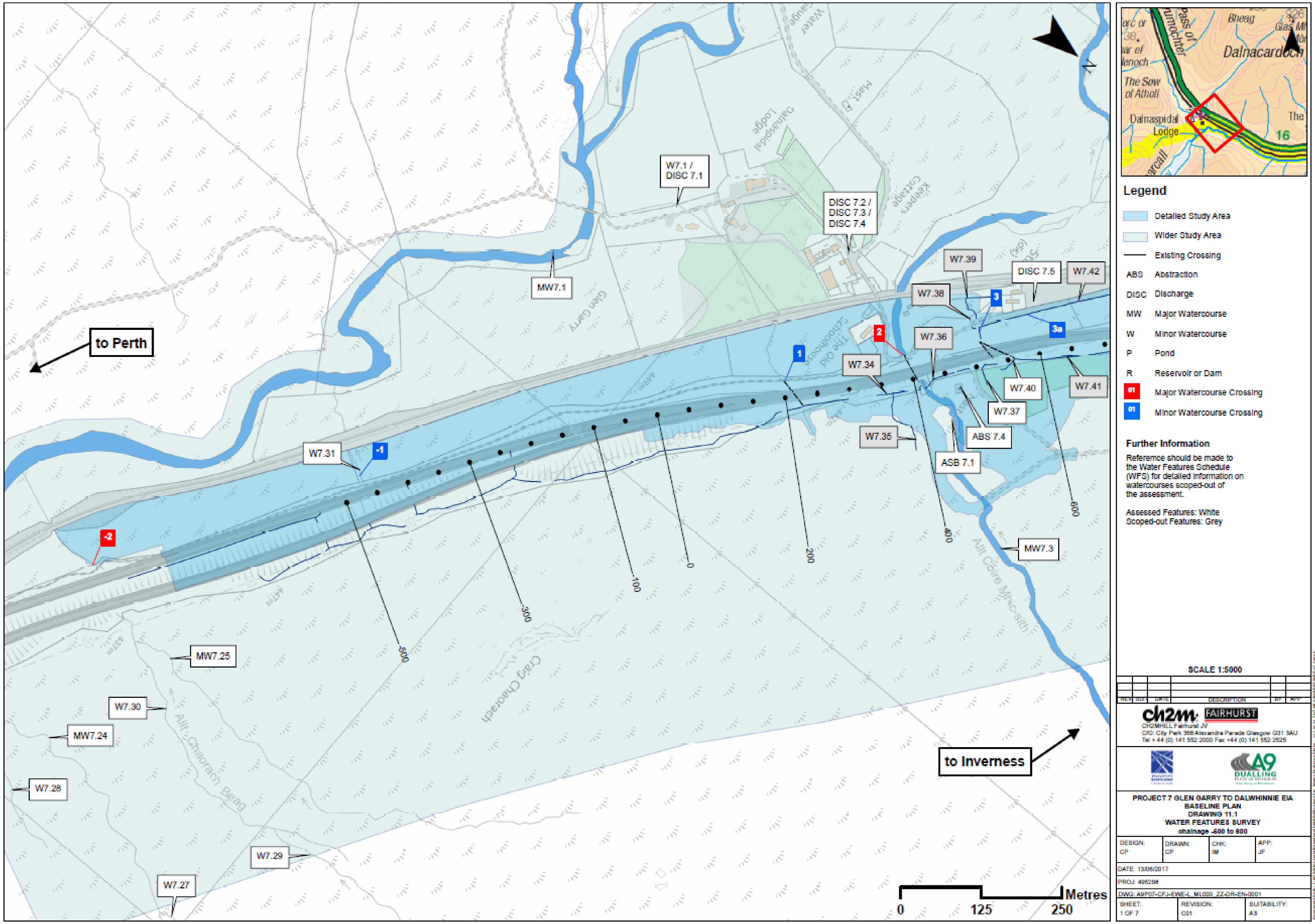
Figures PFR-1 to PFR-7

Compensatory Storage Areas

Figures CS-1 to CS-7

Water Features Plans

Figure WFP1



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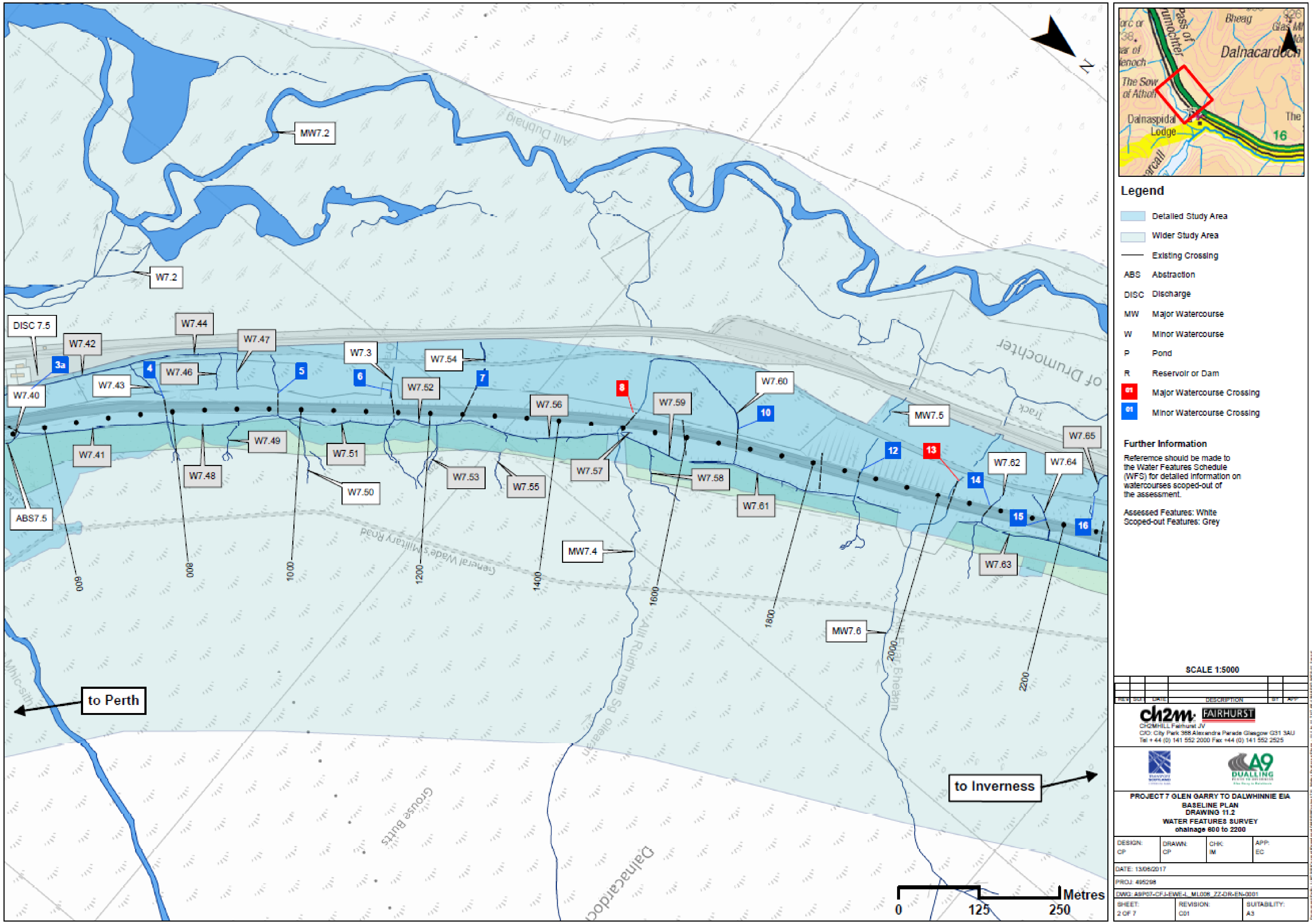
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DISC 7.5
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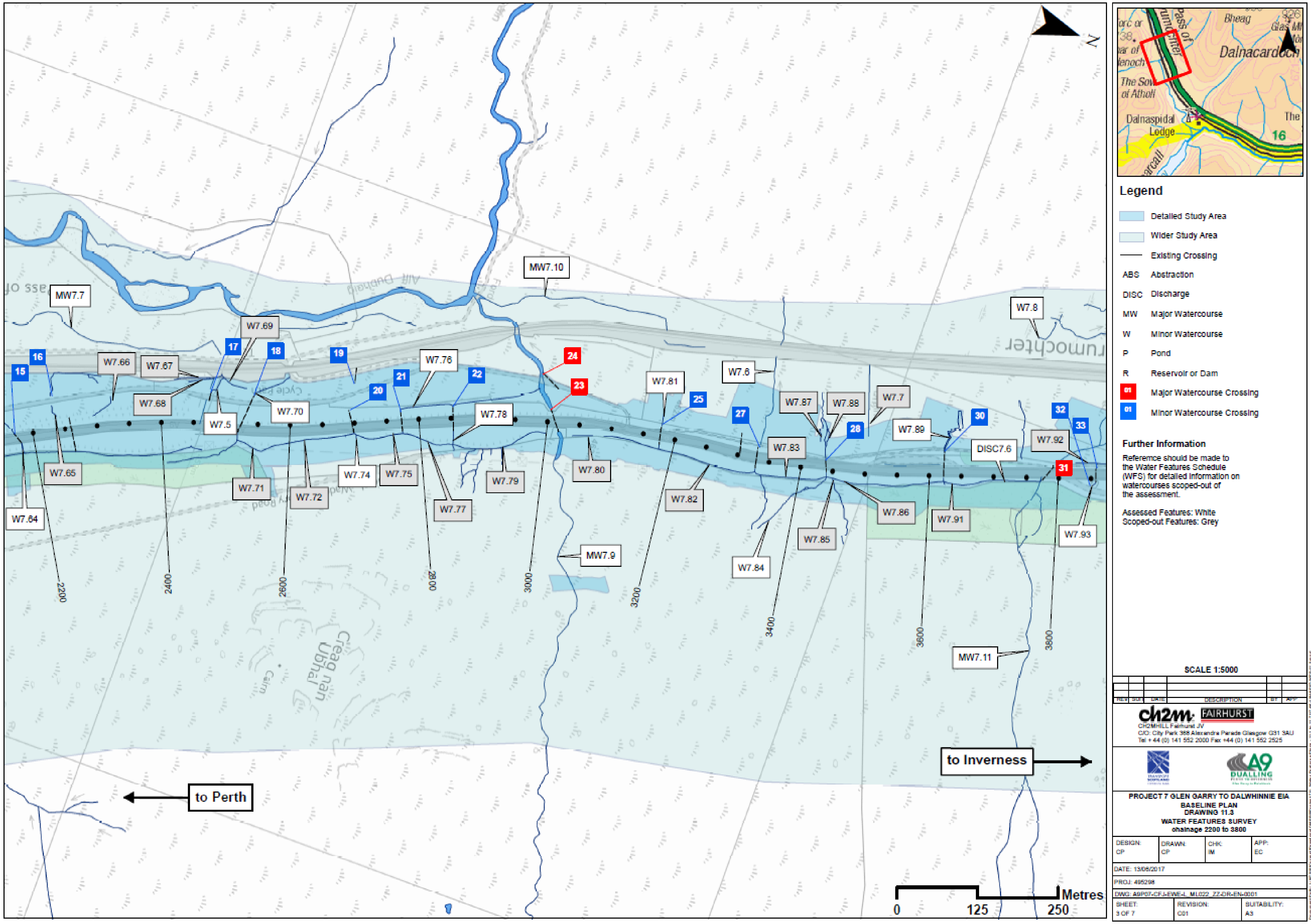
W7.57
W7.58
W7.61
W7.62
W7.64
W7.63
ABS7.5
MW7.4
MW7.6
to Perth
to Inverness
Metres
0
125
250
Legend
Detailed Study Area
Wider Study Area
Existing Crossing
ABS Abstraction
DISC Discharge
MW Major Watercourse
W Minor Watercourse
P Pond
R Reservoir or Dam
Major Watercourse Crossing
Minor Watercourse Crossing
Further Information
Reference should be made to the Water Features Schedule (WFS) for detailed information on watercourses scoped-out of the assessment.
Assessed Features: White
Scoped-out Features: Grey
SCALE 1:5000
PROJECT 7 GLEN GARRY TO DALWHINNIE EIA
BASELINE PLAN
DRAWING 11.2
WATER FEATURES SURVEY
chainage 600 to 2200
DATE: 13/06/2017
PROJ: 495298
SHEET: 2 OF 7
REVISION: C01
SUITABILITY: A3

Figure WFP3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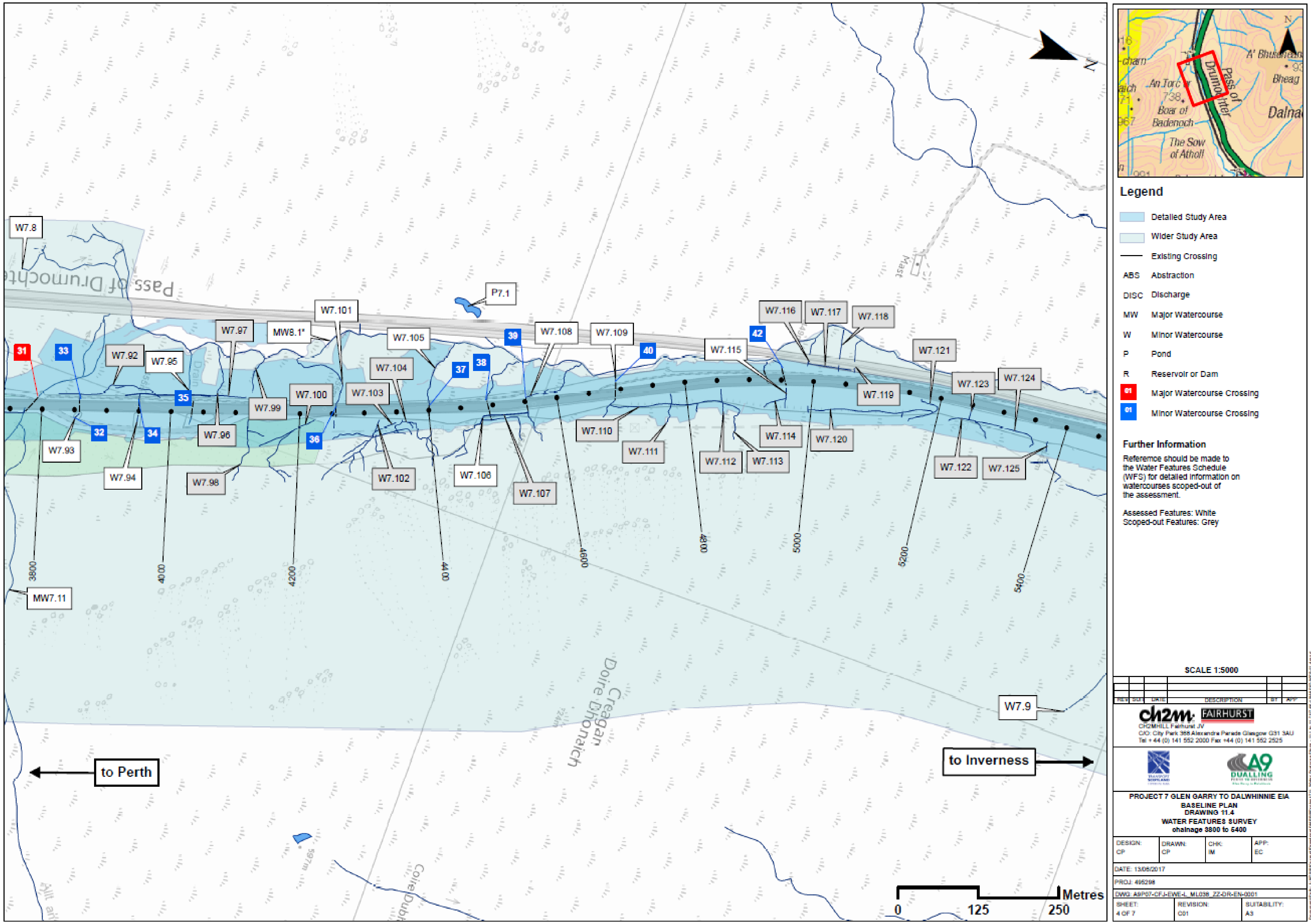
W7.7
W7.89
W7.91
W7.92
W7.93
W7.8
DISC7.6
2200
2400
2600
2800
3000
3200
3400
3600
3800
to Perth
to Inverness
0
125
250
Metres
Legend
Detailed Study Area
Wider Study Area
Existing Crossing
ABS Abstraction
DISC Discharge
MW Major Watercourse
W Minor Watercourse
P Pond
R Reservoir or Dam
Major Watercourse Crossing
Minor Watercourse Crossing
Further Information
Reference should be made to the Water Features Schedule (WFS) for detailed information on watercourses scoped-out of the assessment.
Assessed Features: White
Scoped-out Features: Grey
SCALE 1:5000
REV SUIT DATE DESCRIPTION BY APP
CH2MHILL Fairhurst JV
C/O: City Park 368 Alexandra Parade Glasgow G31 3AU
Tel + 44 (0) 141 552 2000 Fax +44 (0) 141 552 2525
PROJECT 7 GLEN GARRY TO DALWHINNIE EIA
BASELINE PLAN
DRAWING 11.3
WATER FEATURES SURVEY
chainage 2200 to 3800
DESIGN: CP
DRAWN: CP
CHK: IM
APP: EC
DATE: 13/06/2017
PROJ: 495298
DWG: A9P07-CFJ-EWE-L_ML022_ZZ-DR-EN-0001
SHEET: 3 OF 7
REVISION: C01
SUITABILITY: A3

Figure WFP4


Legend
Detailed Study Area
Wider Study Area
Existing Crossing
ABS Abstraction
DISC Discharge
MW Major Watercourse
W Minor Watercourse
P Pond
R Reservoir or Dam
Major Watercourse Crossing
Minor Watercourse Crossing
Further Information
Reference should be made to the Water Features Schedule (WFS) for detailed information on watercourses scoped-out of the assessment.
Assessed Features: White
Scoped-out Features: Grey
SCALE 1:5000
PROJECT 7 GLEN GARRY TO DALWHINNIE EIA
BASELINE PLAN
DRAWING 11.4
WATER FEATURES SURVEY
chainage 3800 to 5400
to Perth
to Inverness
Metres
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125
250
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W7.9
MW7.11
P7.1
MW8.1*
W7.92
W7.93
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W7.125
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4600
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5000
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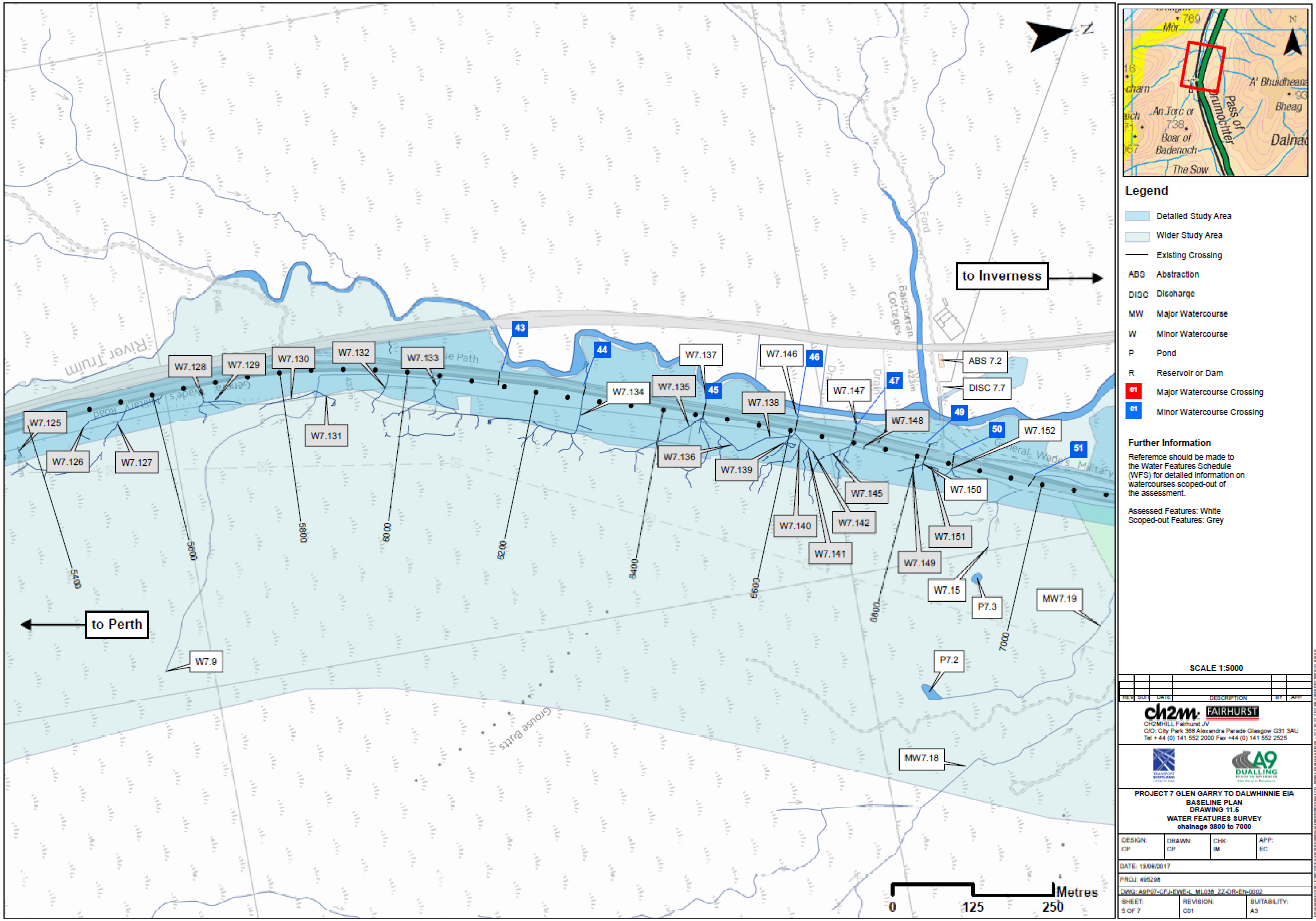
5400

Figure WFP5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to Perth
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W7.152
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W7.9
P7.2
P7.3
MW7.18
MW7.19
ABS 7.2
DISC 7.7
43
44
45
46
47
49
50
51
River Truim
Metres
0
125
250
Legend
Detailed Study Area
Wider Study Area
Existing Crossing
ABS Abstraction
DISC Discharge
MW Major Watercourse
W Minor Watercourse
P Pond
R Reservoir or Dam
Major Watercourse Crossing
Minor Watercourse Crossing
Further Information
Reference should be made to the Water Features Schedule (WFS) for detailed information on watercourses scoped-out of the assessment.
Assessed Features: White
Scoped-out Features: Grey
SCALE 1:5000
PROJECT 7 GLEN GARRY TO DALWHINNIE EIA
BASELINE PLAN
DRAWING 11.6
WATER FEATURES SURVEY
chainage 3800 to 7000
DATE: 13/06/2017
PROJ: 495298
SHEET: 5 OF 7
REVISION: C01
SUITABILITY: A3

Figure WFP6

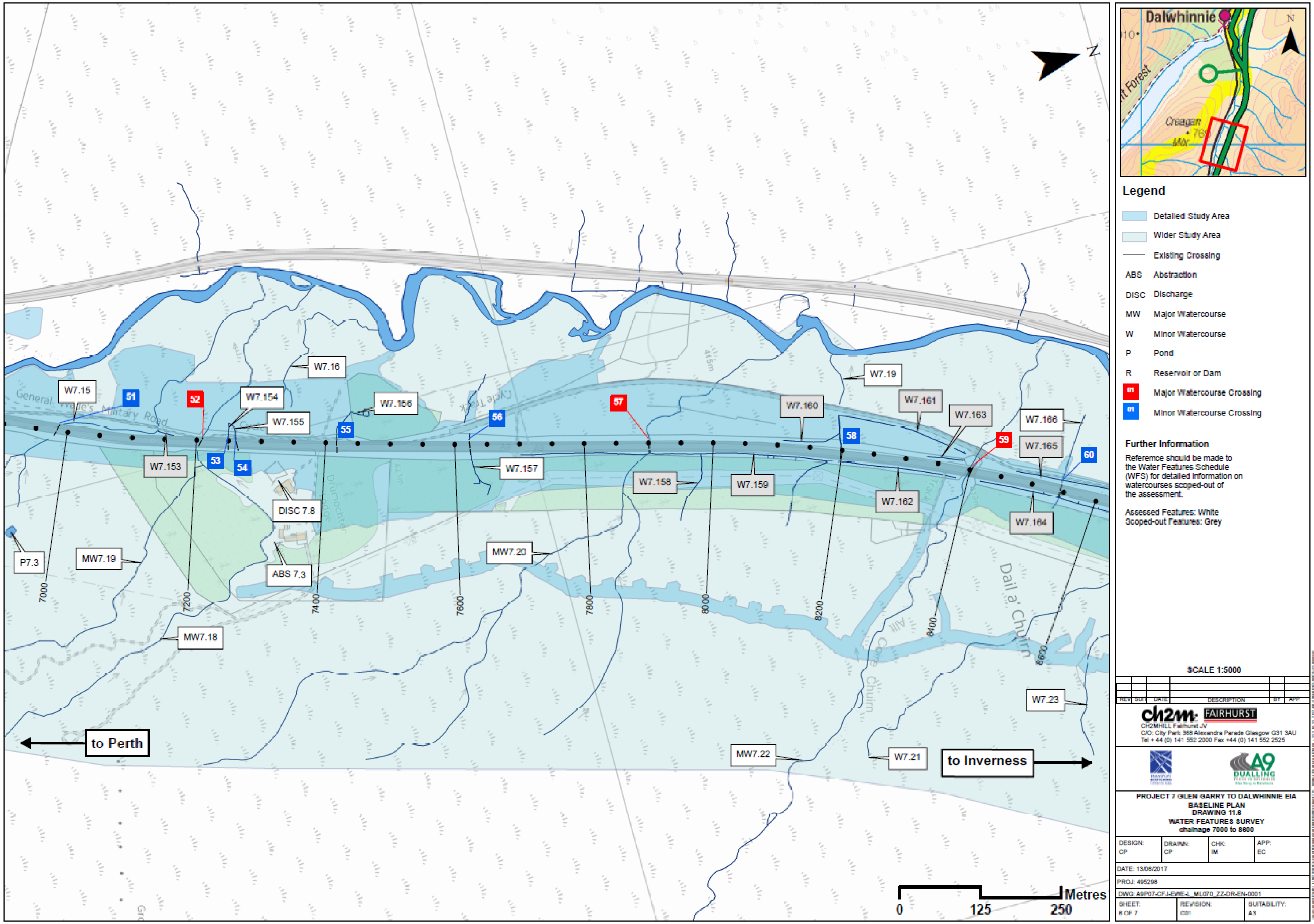
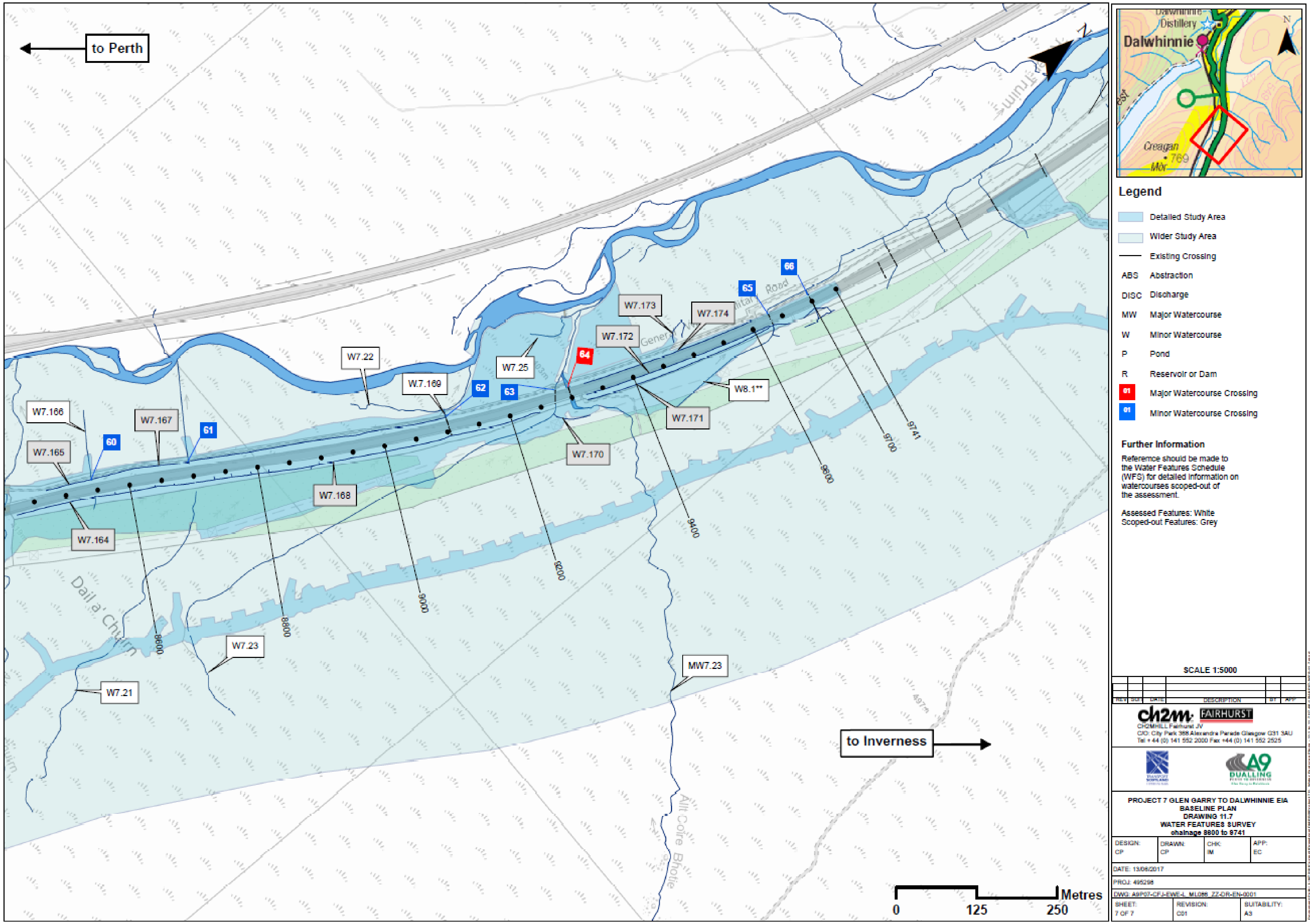
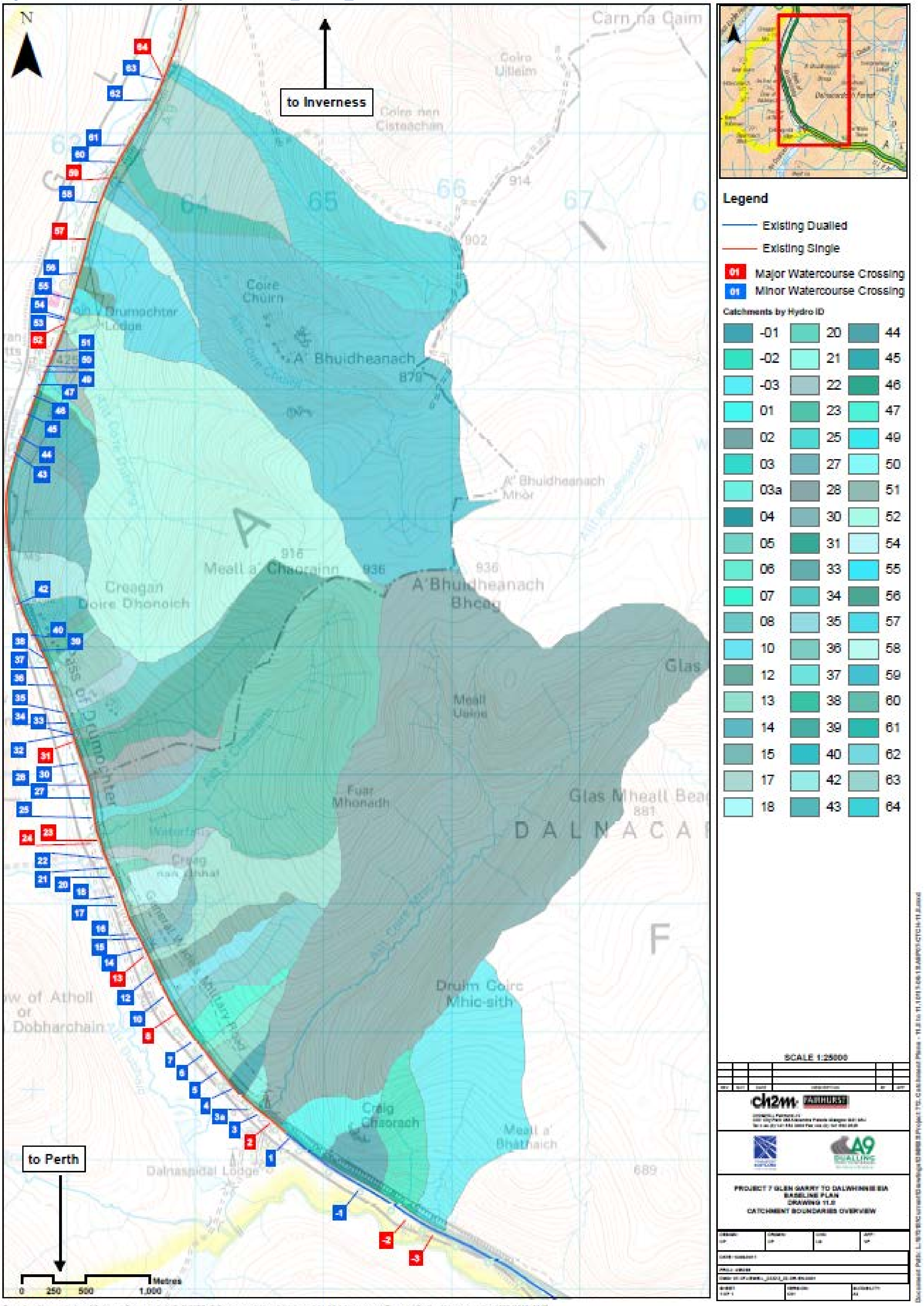

N
Dalwhinnie
Legend
Detailed Study Area
Wider Study Area
Existing Crossing
ABS Abstraction
DISC Discharge
MW Major Watercourse
W Minor Watercourse
P Pond
R Reservoir or Dam
Major Watercourse Crossing
Minor Watercourse Crossing
Further Information
Reference should be made to the Water Features Schedule (WFS) for detailed information on watercourses scoped-out of the assessment.
Assessed Features: White
Scoped-out Features: Grey
SCALE 1:5000
PROJECT 7 GLEN GARRY TO DALWHINNIE EIA
BASELINE PLAN
DRAWING 11.8
WATER FEATURES SURVEY
chainage 7000 to 8600
DATE: 13/06/2017
SHEET: 6 OF 7
REVISION: C01
SUITABILITY: A3
W7.15
W7.16
W7.154
W7.155
W7.156
W7.153
W7.157
W7.158
W7.159
W7.160
W7.161
W7.162
W7.163
W7.164
W7.165
W7.166
W7.19
W7.21
W7.23
MW7.18
MW7.19
MW7.20
MW7.22
P7.3
DISC 7.8
ABS 7.3
51
52
53
54
55
56
57
58
59
60
7000
7200
7400
7600
7800
8000
8200
8400
8600
to Perth
to Inverness
Metres
0
125
250

Figure WFP7


to Perth
to Inverness
W7.166
W7.165
W7.164
W7.167
W7.168
W7.169
W7.22
W7.25
W7.170
W7.171
W7.172
W7.173
W7.174
W8.1**
W7.23
W7.21
MW7.23
60
61
62
63
64
65
66
8600
8800
9000
9200
9400
9600
9700
9741
Allt Coire Bhotie
Dalwhinnie
Distillery
Creagan Mòr
769
Legend
Detailed Study Area
Wider Study Area
Existing Crossing
ABS Abstraction
DISC Discharge
MW Major Watercourse
W Minor Watercourse
P Pond
R Reservoir or Dam
Major Watercourse Crossing
Minor Watercourse Crossing
Further Information
Reference should be made to the Water Features Schedule (WFS) for detailed information on watercourses scoped-out of the assessment.
Assessed Features: White
Scoped-out Features: Grey
SCALE 1:5000
Metres
0
125
250
PROJECT 7 GLEN GARRY TO DALWHINNIE EIA
BASELINE PLAN
DRAWING 11.7
WATER FEATURES SURVEY
chainage 8600 to 9741
DATE: 13/06/2017
PROJ: 495298
SHEET: 7 OF 7
REVISION: C01
SUITABILITY: A3

Catchment Plan

Figure CTP1 – EIA Drawing 07-CFJ-EWE-L_ZZZZZ_ZZ-DR-EN-0001 version C01



Flood Extents Pre-development showing 4th Iteration Design Freeze (as modelled)

Figure FEX1

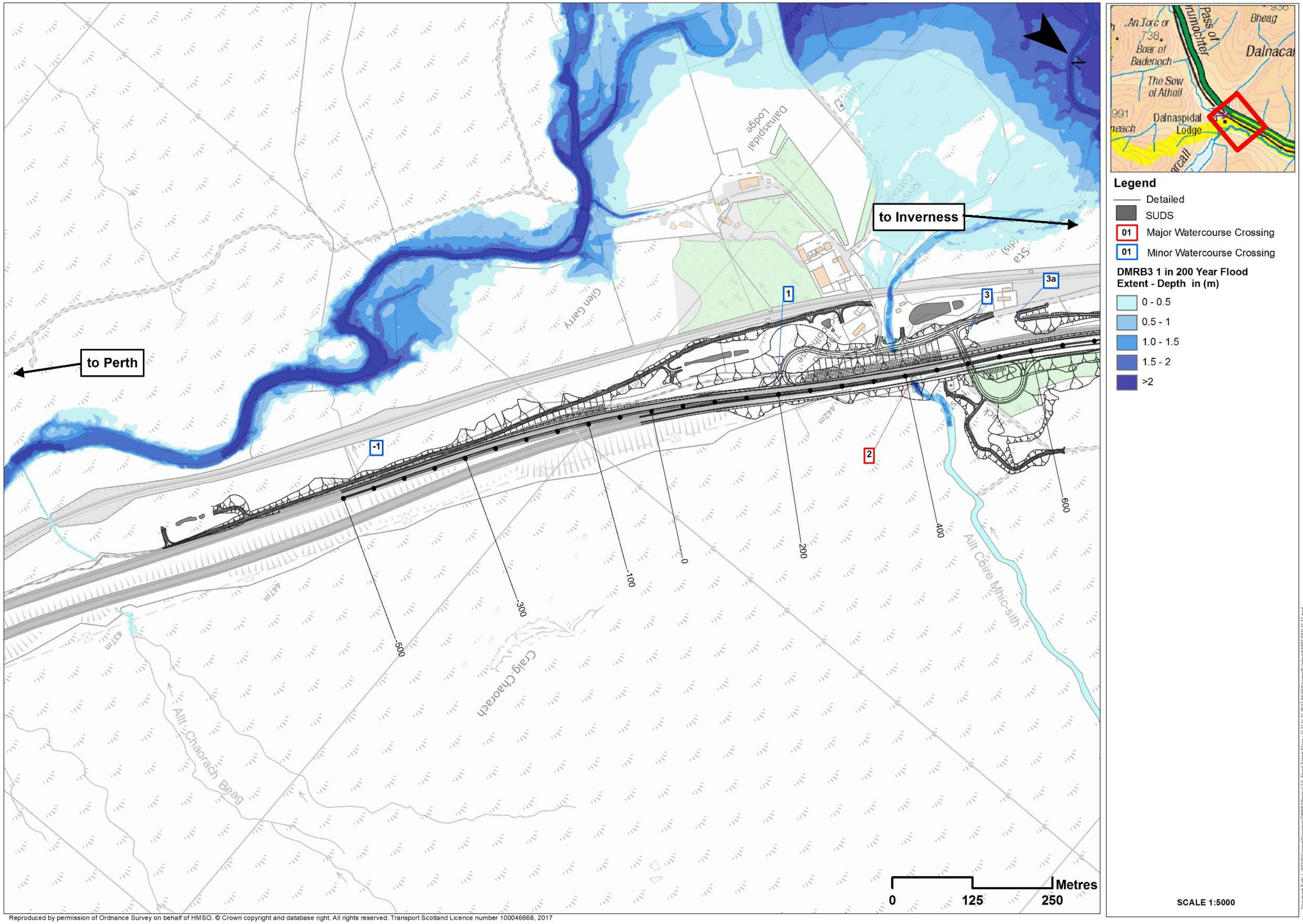
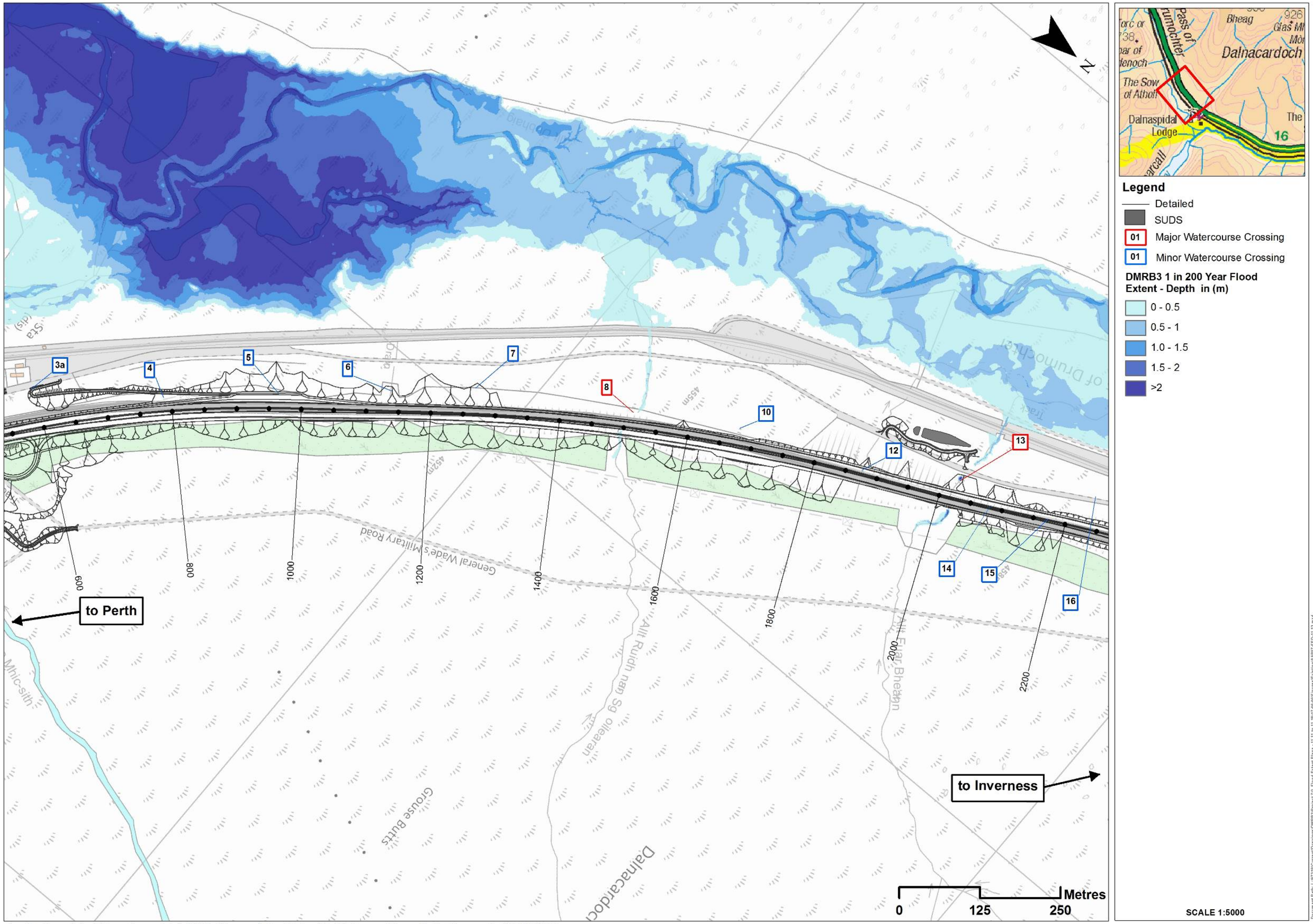
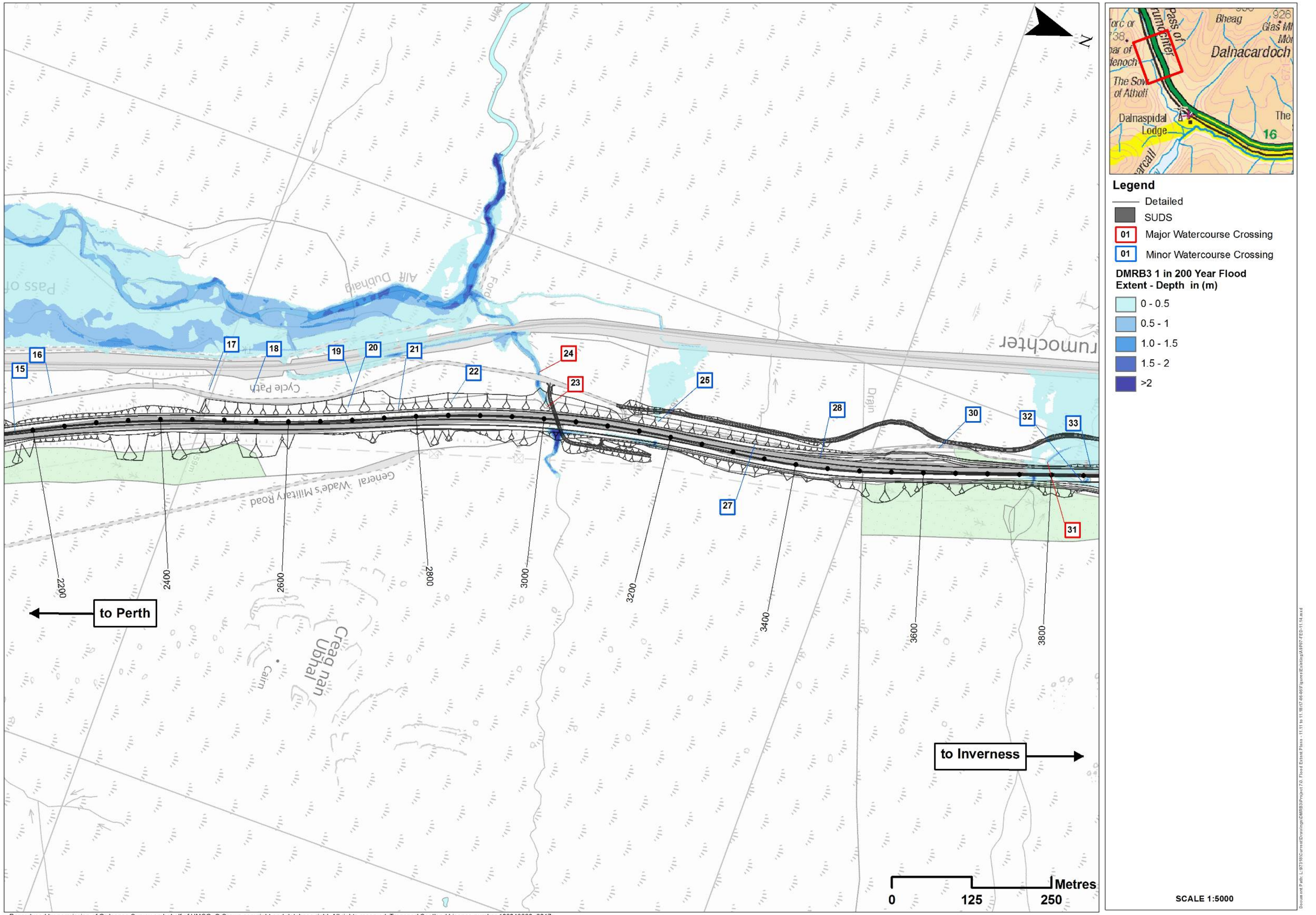


Figure FEX2



Legend
Detailed
SUDS
01 Major Watercourse Crossing
01 Minor Watercourse Crossing
DMRB3 1 in 200 Year Flood Extent - Depth in (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
SCALE 1:5000
to Perth
to Inverness
General Wade's Military Road
Allt Ruidh nan Sg oilearan
Grouse Butts
Metres
0
125
250
Dalnacardoch
Dalnaspidal Lodge
The Sow of Atholl

Figure FEX3



to Perth
to Inverness
Legend
Detailed
SUDS
01 Major Watercourse Crossing
01 Minor Watercourse Crossing
DMRB3 1 in 200 Year Flood Extent - Depth in (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
0 125 250 Metres
SCALE 1:5000
Dalnacardoch
Dalnaspidal Lodge
Creag nan Ubhal
Cycle Path
General Wade's Military Road
Allt Dubhaig

Figure FEX4

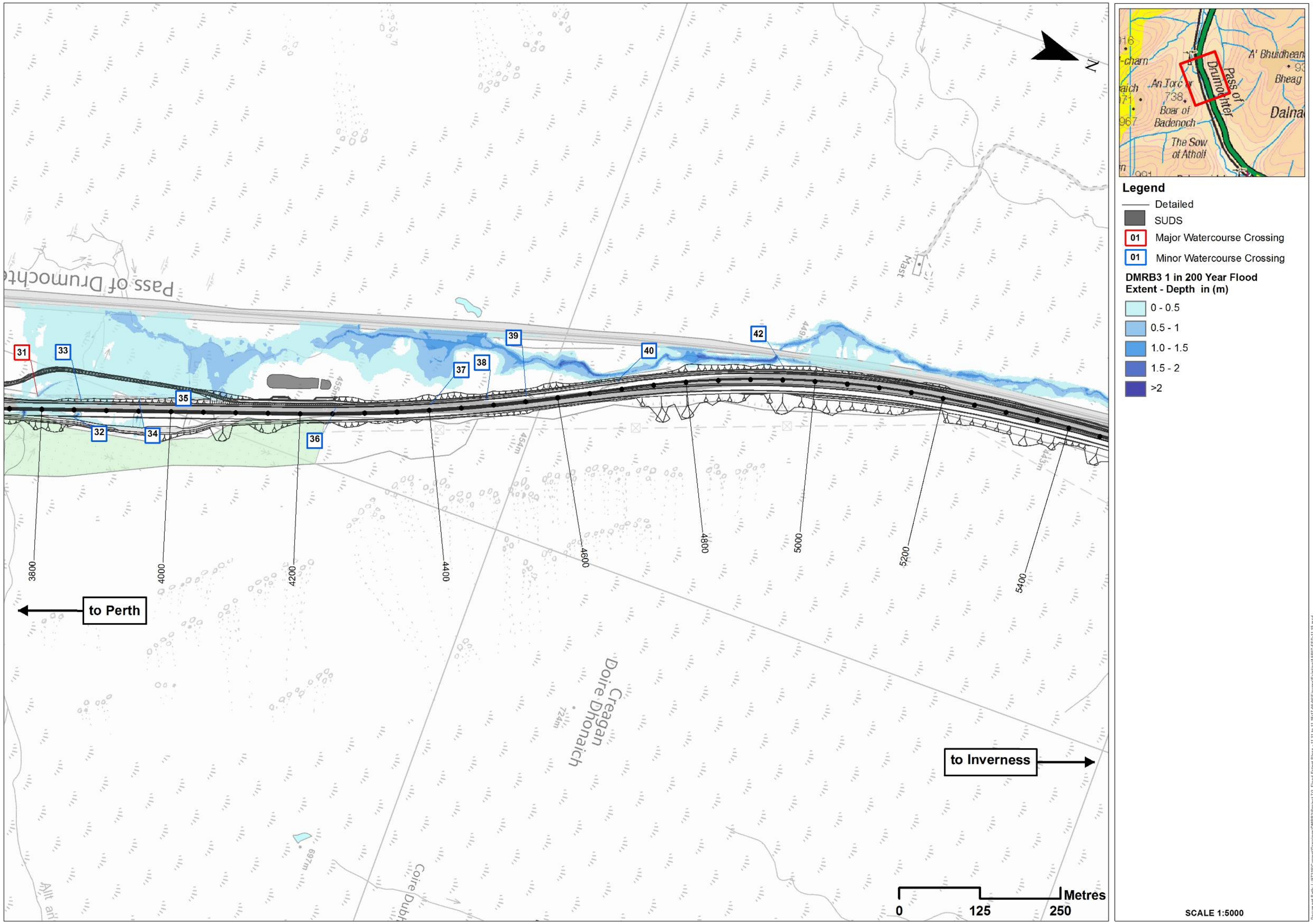
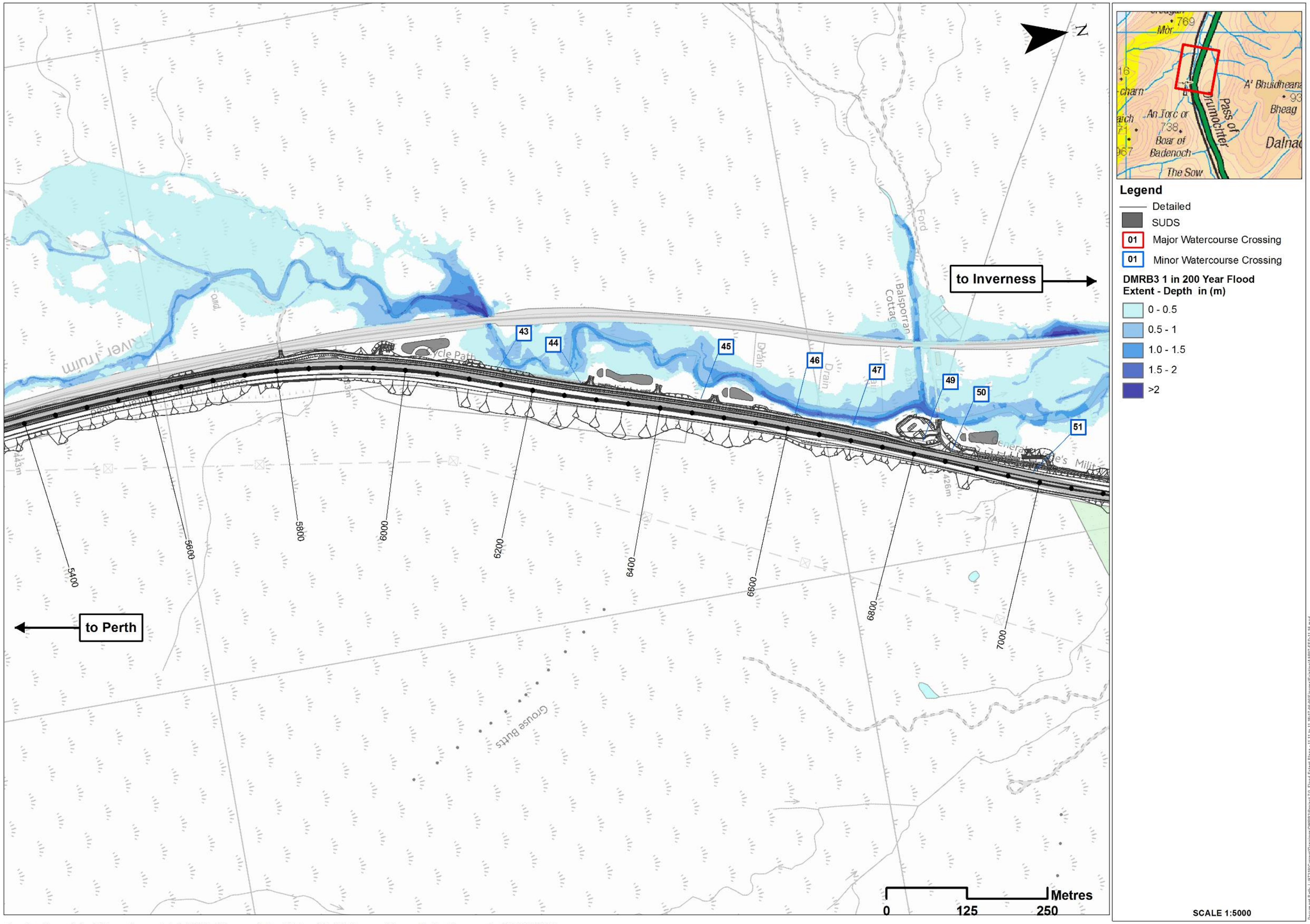

Pass of Drumochter
to Perth
to Inverness
31
32
33
34
35
36
37
38
39
40
42
3800
4000
4200
4400
4600
4800
5000
5200
5400
Creagan Doire Dhonaich
Mast
N
Legend
Detailed
SUDS
01 Major Watercourse Crossing
01 Minor Watercourse Crossing
DMRB3 1 in 200 Year Flood Extent - Depth in (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
Metres
0
125
250
SCALE 1:5000

Figure FEX5



to Inverness
to Perth
43
44
45
46
47
49
50
51
5400
5600
5800
6000
6200
6400
6600
6800
7000
Grouse Butts
Metres
0
125
250
Legend
Detailed
SUDS
Major Watercourse Crossing
Minor Watercourse Crossing
DMRB3 1 in 200 Year Flood Extent - Depth in (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
SCALE 1:5000

Figure FEX6

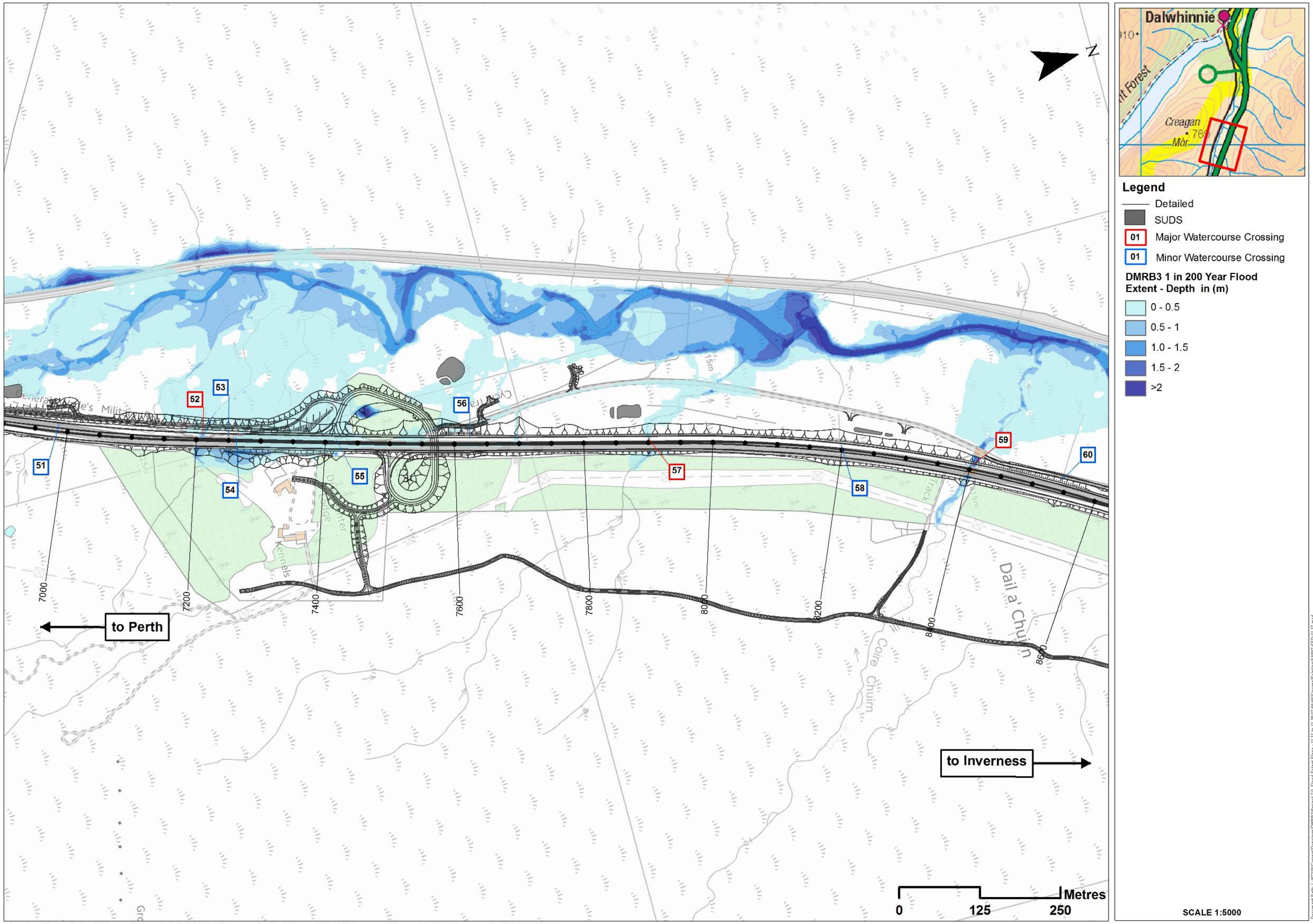
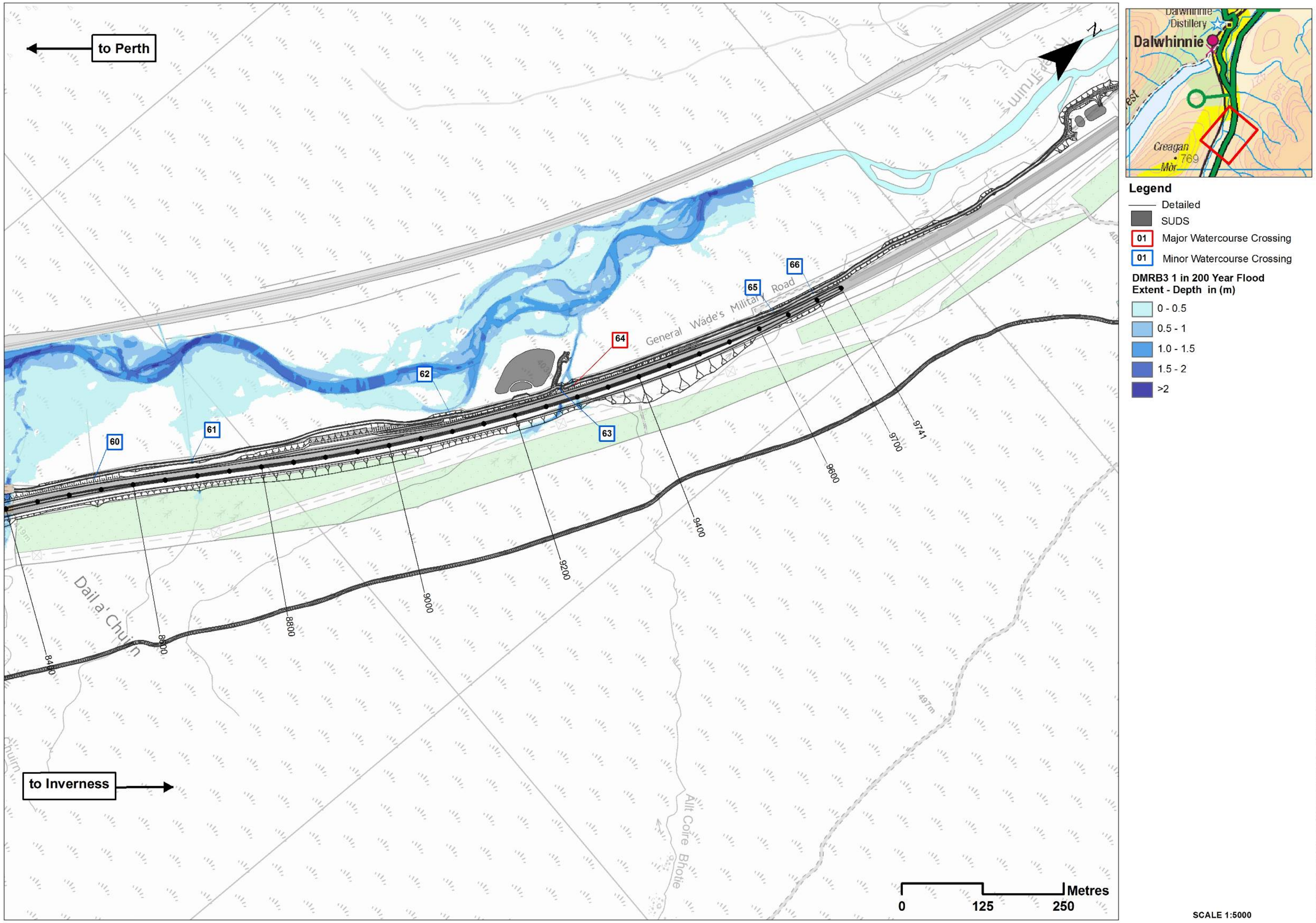

N
Dalwhinnie
Creagan Mòr
Legend
Detailed
SUDS
01 Major Watercourse Crossing
01 Minor Watercourse Crossing
DMRB3 1 in 200 Year Flood Extent - Depth in (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
51
52
53
54
55
56
57
58
59
60
7000
7200
7400
7600
7800
8000
8200
8400
8600
to Perth
to Inverness
Dail a' Chuirn
Coire Chuirn
Kennels
0
125
250
Metres
SCALE 1:5000

Figure FEX7


to Perth
to Inverness
Dalwhinnie
Dalwhinnie Distillery
Creagan Mòr
769
Legend
Detailed
SUDS
01 Major Watercourse Crossing
01 Minor Watercourse Crossing
DMRB3 1 in 200 Year Flood Extent - Depth in (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
General Wade's Military Road
Dail a' Chuirn
Allt Coire Bhotie
60
61
62
63
64
65
66
8400
8600
8800
9000
9200
9400
9600
9700
9741
0
125
250
Metres
SCALE 1:5000

Flood Extents Post-development showing 4th Iteration Design Freeze (as modelled)

Figure FPO1

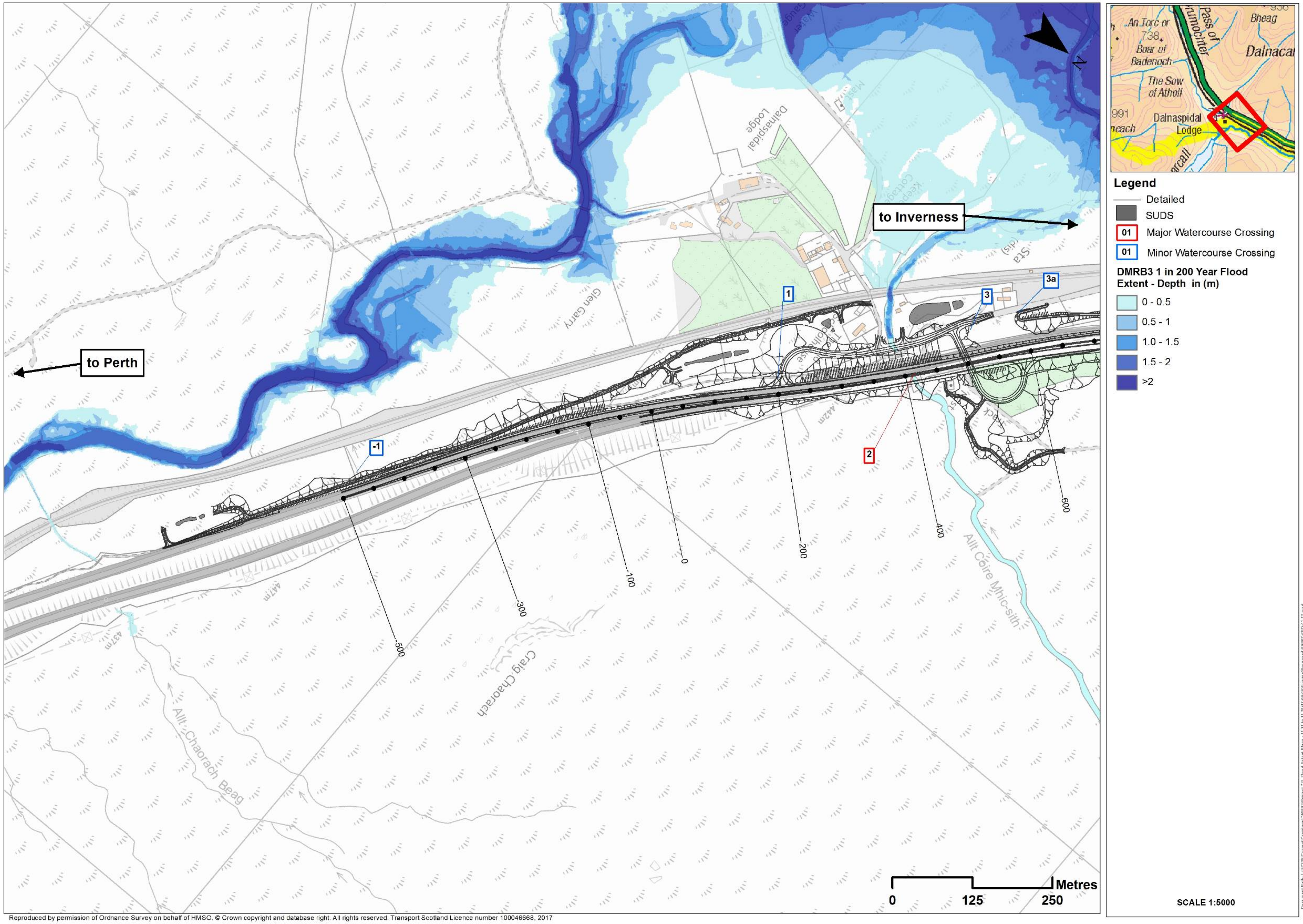
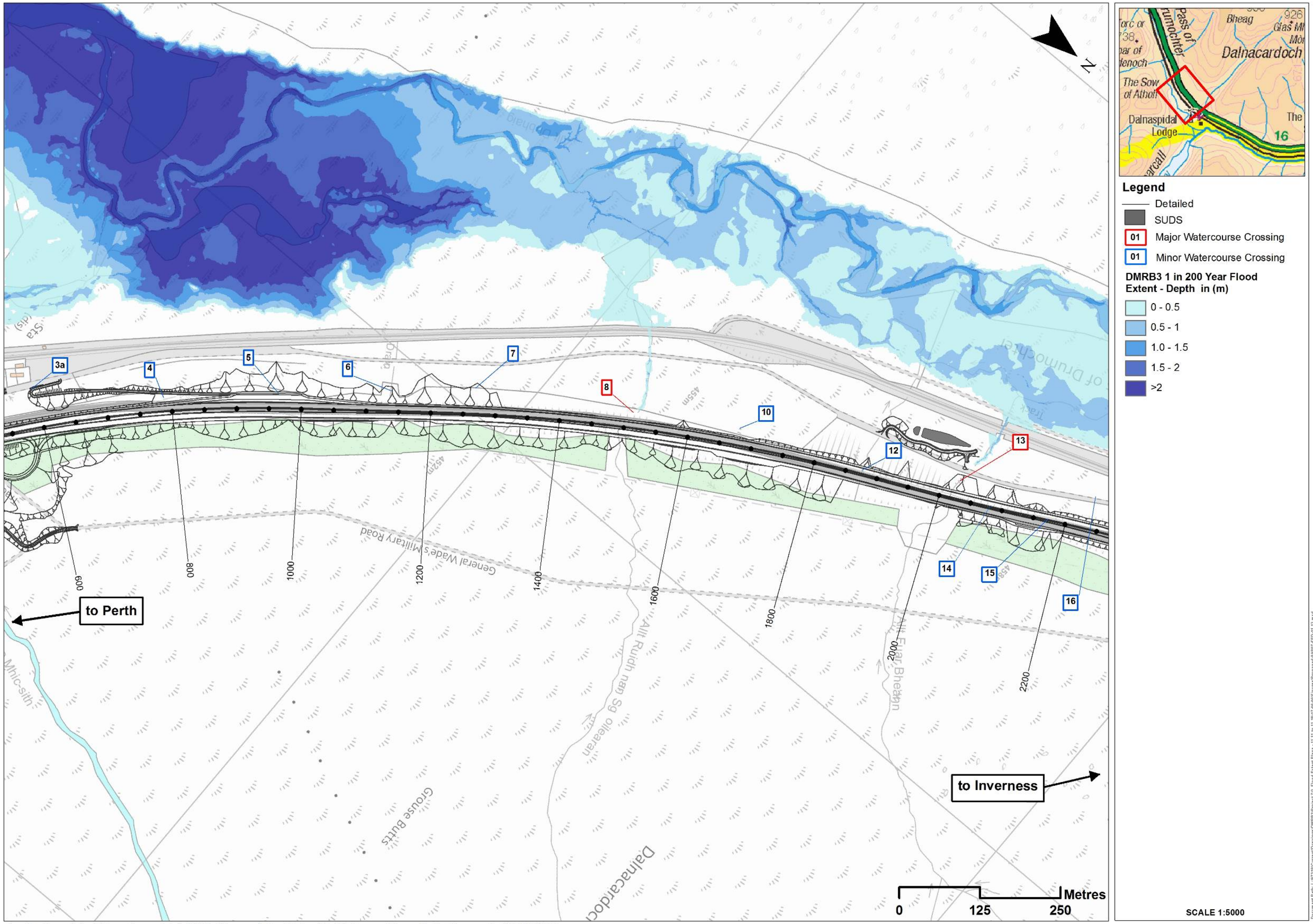
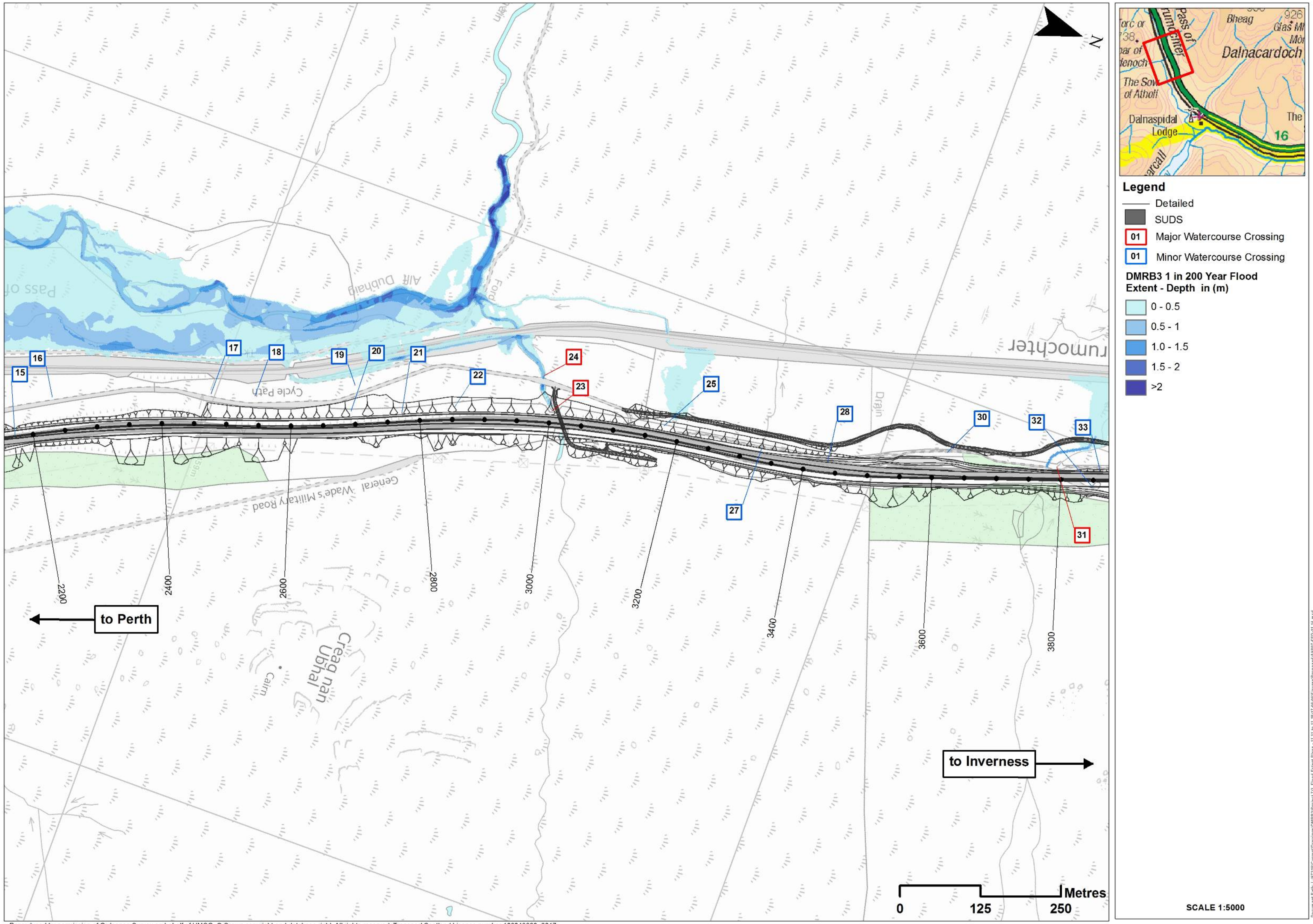


Figure FPO2



N
to Perth
to Inverness
3a
4
5
6
7
8
10
12
13
14
15
16
600
800
1000
1200
1400
1600
1800
2000
2200
General Wade's Military Road
Allt Ruidh nan Sg oilearan
Grouse Butts
Dalnacardoch
Metres
0
125
250
Dalnacardoch
Pass of Drumochter
The Sow of Atholl
Dalnaspidal Lodge
16
Legend
Detailed
SUDS
Major Watercourse Crossing
Minor Watercourse Crossing
DMRB3 1 in 200 Year Flood Extent - Depth in (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
SCALE 1:5000

Figure FPO3



Legend
Detailed
SUDS
01 Major Watercourse Crossing
01 Minor Watercourse Crossing
DMRB3 1 in 200 Year Flood Extent - Depth in (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
to Perth
to Inverness
Dalnacardoch
Dalnaspidal Lodge
Cycle Path
General Wade's Military Road
Creag nan Ubhal
Cairn
2200
2400
2600
2800
3000
3200
3400
3600
3800
0
125
250
Metres
SCALE 1:5000

Figure FPO4

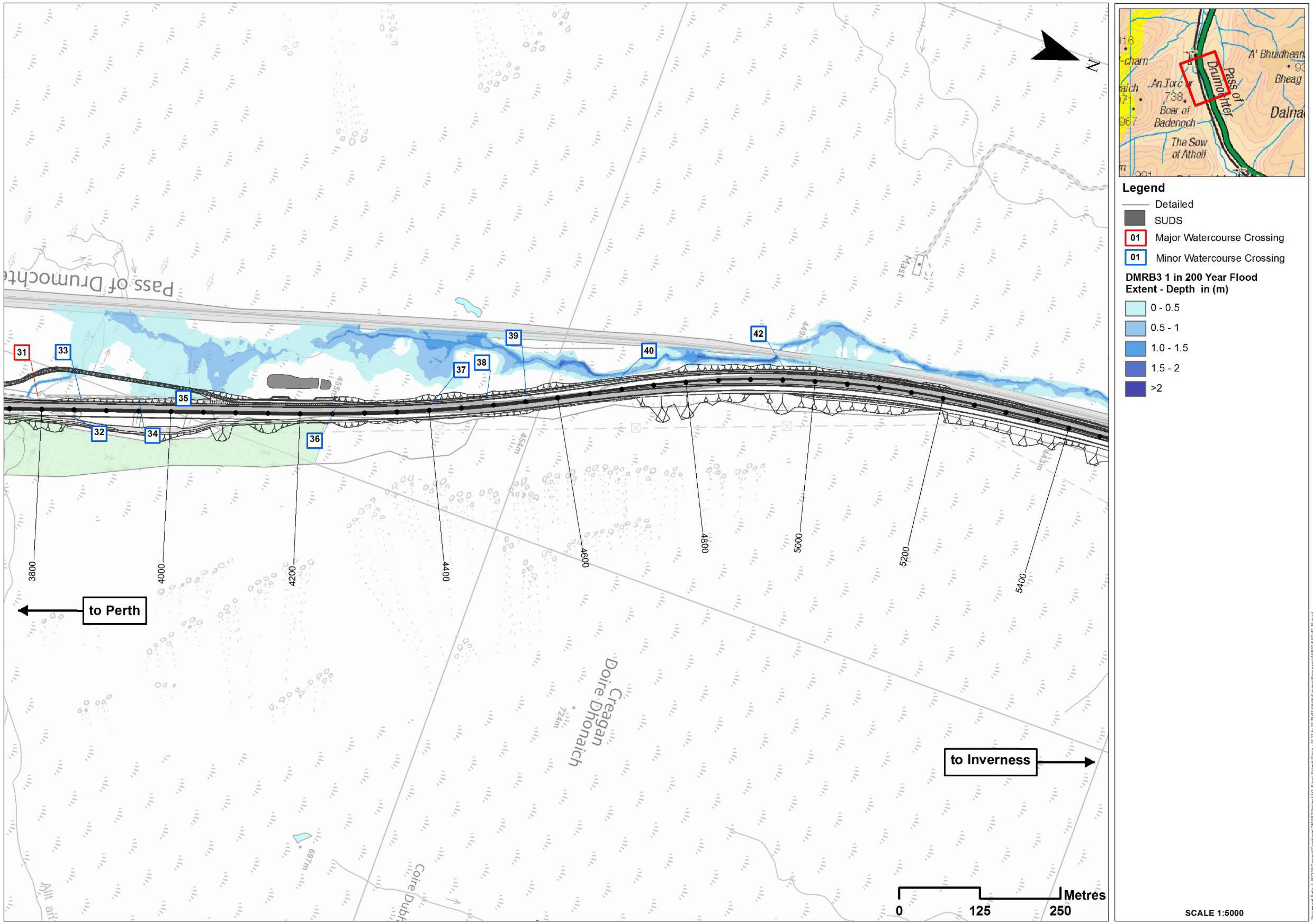

Pass of Drumochter
31
32
33
34
35
36
37
38
39
40
42
3800
4000
4200
4400
4600
4800
5000
5200
5400
to Perth
to Inverness
Creagan Doire Dhonaich
Mast
N
0
125
250
Metres
Legend
Detailed
SUDS
01 Major Watercourse Crossing
01 Minor Watercourse Crossing
DMRB3 1 in 200 Year Flood Extent - Depth in (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
SCALE 1:5000

Figure FPO5

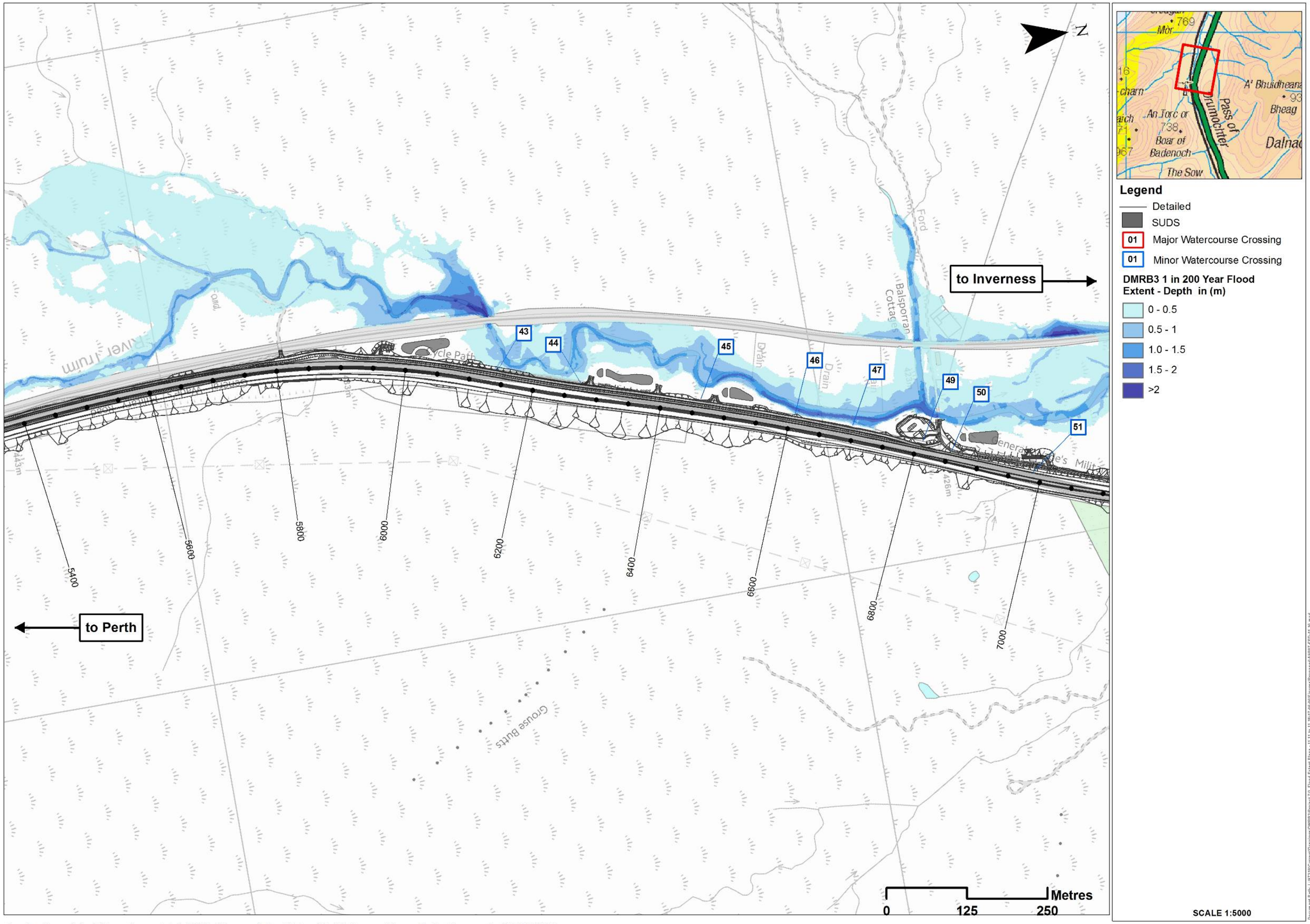

to Inverness
to Perth
Legend
Detailed
SUDS
Major Watercourse Crossing
Minor Watercourse Crossing
DMRB3 1 in 200 Year Flood Extent - Depth in (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
SCALE 1:5000
Metres
0
125
250
43
44
45
46
47
49
50
51
5400
5600
5800
6000
6200
6400
6600
6800
7000
Grouse Butts
River Truim
Balsporran Cottages
Pass of Drumochter
A' Bhuidheanach Bheag
An Torc or Boar of Badenoch
The Sow

Figure FPO6

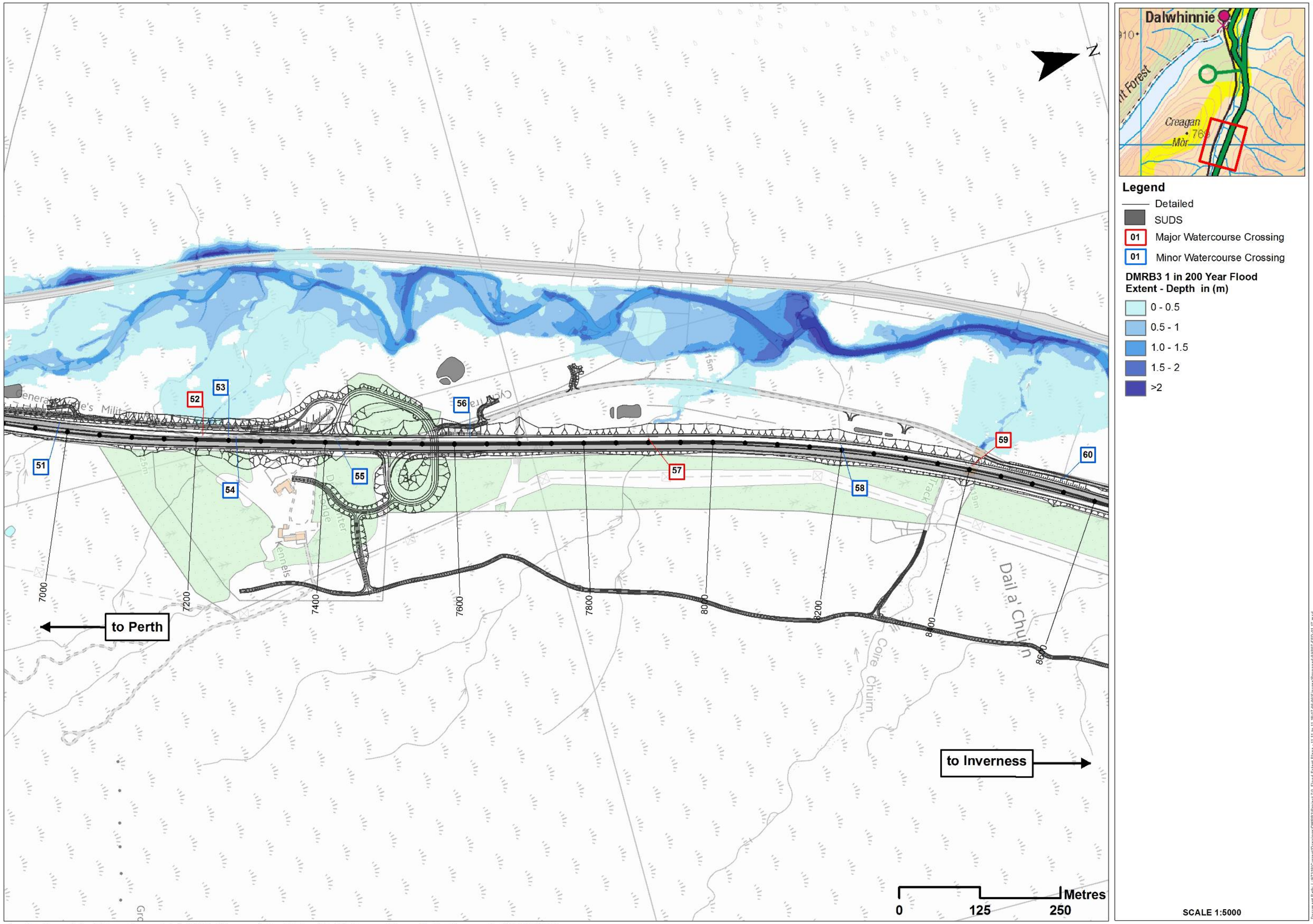
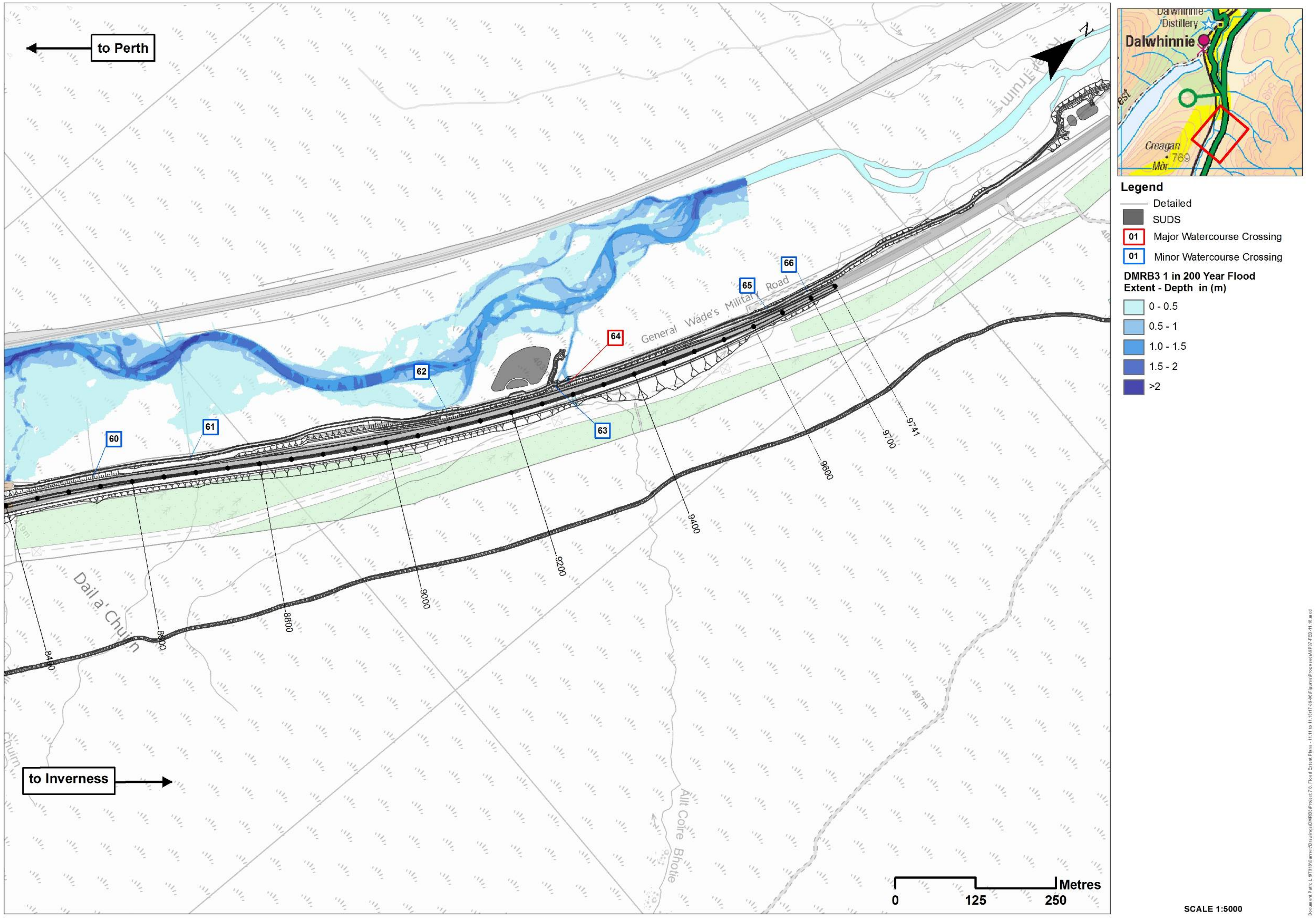

Dalwhinnie
Creagan
Mòr
Legend
Detailed
SUDS
01 Major Watercourse Crossing
01 Minor Watercourse Crossing
DMRB3 1 in 200 Year Flood Extent - Depth in (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
SCALE 1:5000
N
to Perth
to Inverness
51
52
53
54
55
56
57
58
59
60
7000
7200
7400
7600
7800
8000
8200
8400
8600
Dail a' Chuirn
Coire Chuirn
Kennels
0
125
250
Metres

Figure FPO7


to Perth
to Inverness
Dalwhinnie
Distillery
Creagan
Mòr
769
General Wade's Military Road
Dail a' Chuirn
Allt Coire Bhotie
60
61
62
63
64
65
66
8400
8600
8800
9000
9200
9400
9600
9700
9741
0
125
250
Metres
Legend
Detailed
SUDS
Major Watercourse Crossing
Minor Watercourse Crossing
DMRB3 1 in 200 Year Flood Extent - Depth in (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
SCALE 1:5000

Potential Flood Risk Receptors

Annex Table 11: Location of potential flood risk receptors identified on Figures PFR-1 to PFR-7

LABEL	TYPE	DESCRIPTION
D-001	Residential Properties	Marked as 'Dalnaspidal Lodge' on OS mapping; Proposed Scheme ch. 00,200
D-002	Residential Properties	Proposed Scheme ch. 00,300
D-003	Residential Properties	Proposed Scheme ch. 00,350
D-004	Residential Properties	Proposed Scheme ch. 00,350
D-005	Residential Properties	Proposed Scheme ch. 00,600
D-006	Residential Properties	Proposed Scheme ch. 00,600
D-007	Residential Properties	Proposed Scheme ch. 00,600
D-008	Residential Properties	Proposed Scheme ch. 00,600
D-009	Residential Properties	Marked as 'Balsporran Cottages' on OS mapping; Proposed Scheme ch. 06,800
D-010	Residential Properties	Marked as 'Drumochter Lodge' on OS mapping; Proposed Scheme ch. 07,350
D-011	Residential Properties	Marked as 'Kennels' on OS mapping; Proposed Scheme ch. 07,350
NRes-000	Non-Residential Properties	Marked as 'Mast' on OS mapping; Proposed Scheme ch. 00,450
NRes-001	Non-Residential Properties	Proposed Scheme ch. 00,300
NRes-002	Non-Residential Properties	Marked as 'Mast' on OS mapping; Proposed Scheme ch. 00,350
NRes-003	Non-Residential Properties	Proposed Scheme ch. 00,400
NRes-004	Non-Residential Properties	Marked as 'Mast' on OS mapping; Proposed Scheme ch. 05,150
HML-001	HML railway	Proposed Scheme ch. 02,700 – ch. 02,950
HML-002	HML railway	Proposed Scheme ch. 04,950 – ch. 05,100
HML-003	HML railway	Proposed Scheme ch. 06,750 – ch. 06,850
HML-004	HML railway	Proposed Scheme ch. 07,050 – ch. 07,150
HML-005	HML railway	Proposed Scheme ch. 07,300 – ch. 07,400
A9-001	OS Roads [A9]	A9 mainline and lay-by; Proposed Scheme ch. 03,750 – ch. 03,950
A9-002	OS Roads [A9]	A9 mainline and lay-by; Proposed Scheme ch. 07,250 – ch. 07,700

Figure PFR-1

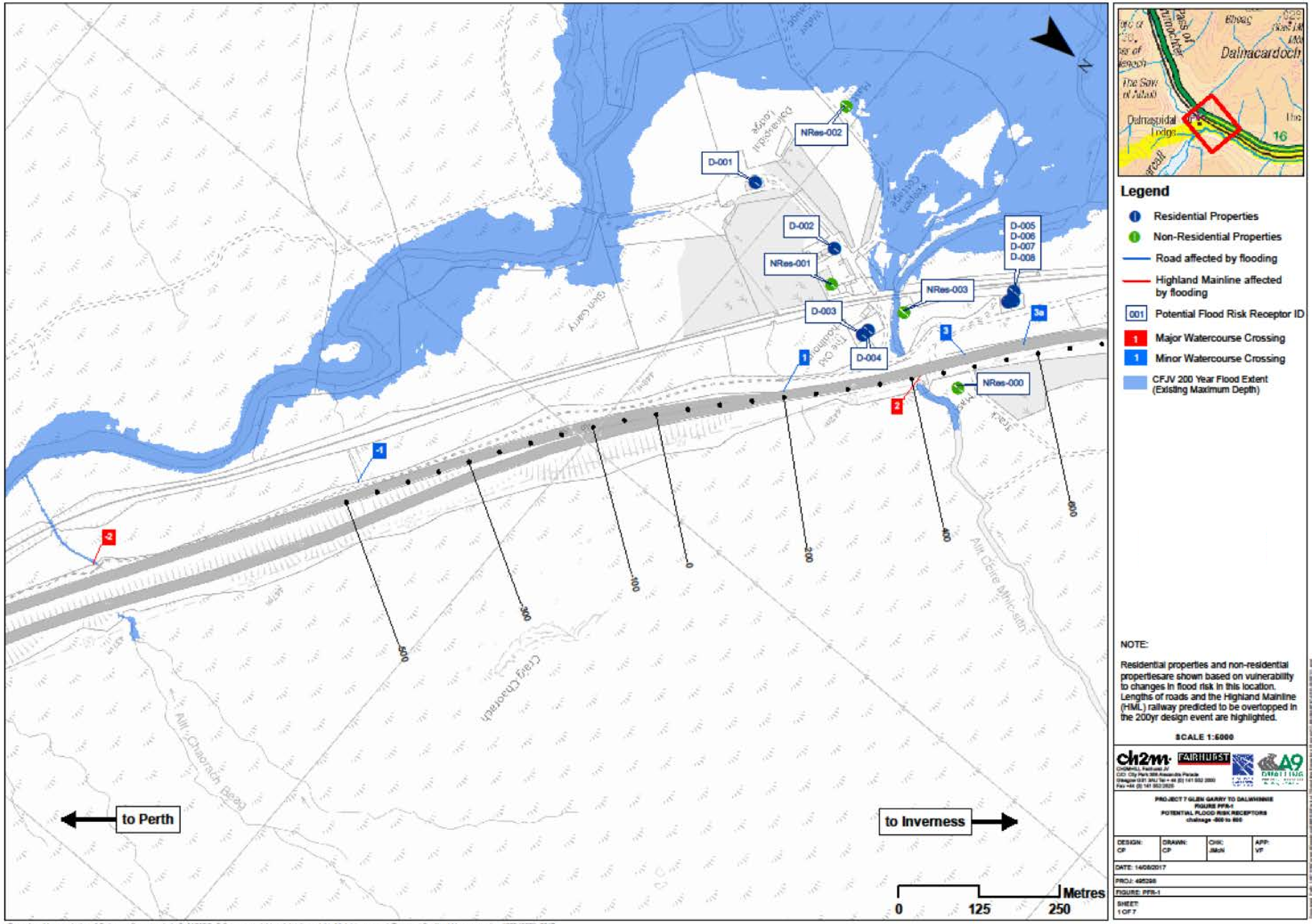

Dalnacardoch
Dalnaspidal Lodge
Legend
Residential Properties
Non-Residential Properties
Road affected by flooding
Highland Mainline affected by flooding
Potential Flood Risk Receptor ID
Major Watercourse Crossing
Minor Watercourse Crossing
CFJV 200 Year Flood Extent (Existing Maximum Depth)
NRes-002
D-001
D-002
D-005
D-006
D-007
D-008
NRes-001
NRes-003
D-003
D-004
NRes-000
to Perth
to Inverness
0
125
250
Metres
NOTE:
Residential properties and non-residential propertiesare shown based on vulnerability to changes in flood risk in this location. Lengths of roads and the Highland Mainline (HML) railway predicted to be overtopped in the 200yr design event are highlighted.
SCALE 1:6000
DESIGN: CP
DRAWN: CP
CHK: JMcN
APP: VF
DATE: 14/08/2017
FIGURE: PFR-1
SHEET 1 OF 7

Figure PFR-2

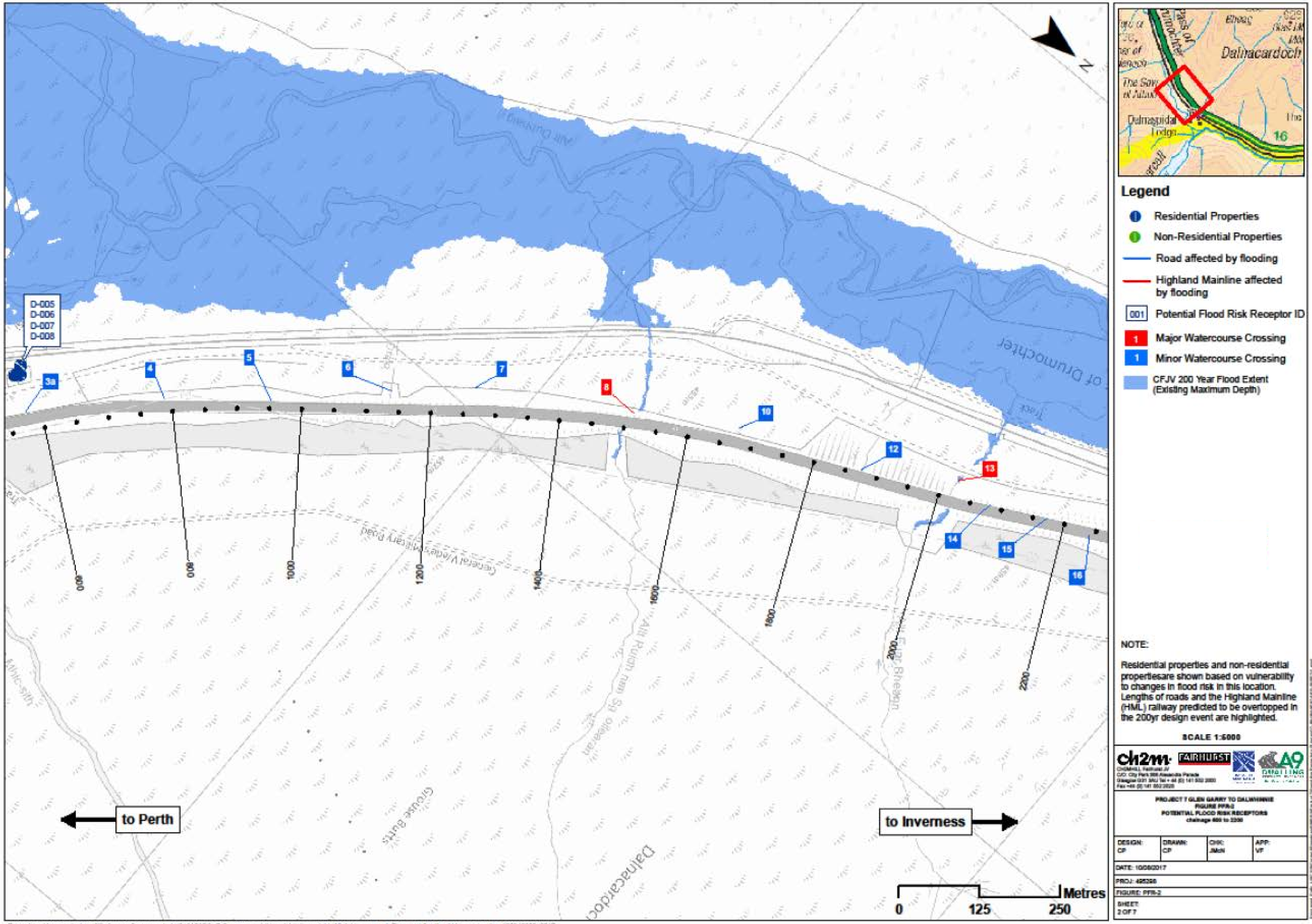

D-005
D-006
D-007
D-008
3a
4
5
6
7
8
10
12
13
14
15
16
800
900
1000
1200
1400
1600
1800
2000
2200
to Perth
to Inverness
Metres
0
125
250
Legend
Residential Properties
Non-Residential Properties
Road affected by flooding
Highland Mainline affected by flooding
001
Potential Flood Risk Receptor ID
Major Watercourse Crossing
Minor Watercourse Crossing
CFJV 200 Year Flood Extent (Existing Maximum Depth)
NOTE:
Residential properties and non-residential propertiesare shown based on vulnerability to changes in flood risk in this location. Lengths of roads and the Highland Mainline (HML) railway predicted to be overtopped in the 200yr design event are highlighted.
SCALE 1:5000
DESIGN: CP
DRAWN: CP
CHK: JMcN
APP: VF
DATE: 10/08/2017
FIGURE: PFR-2
SHEET: 2 OF 7

Figure PFR-3

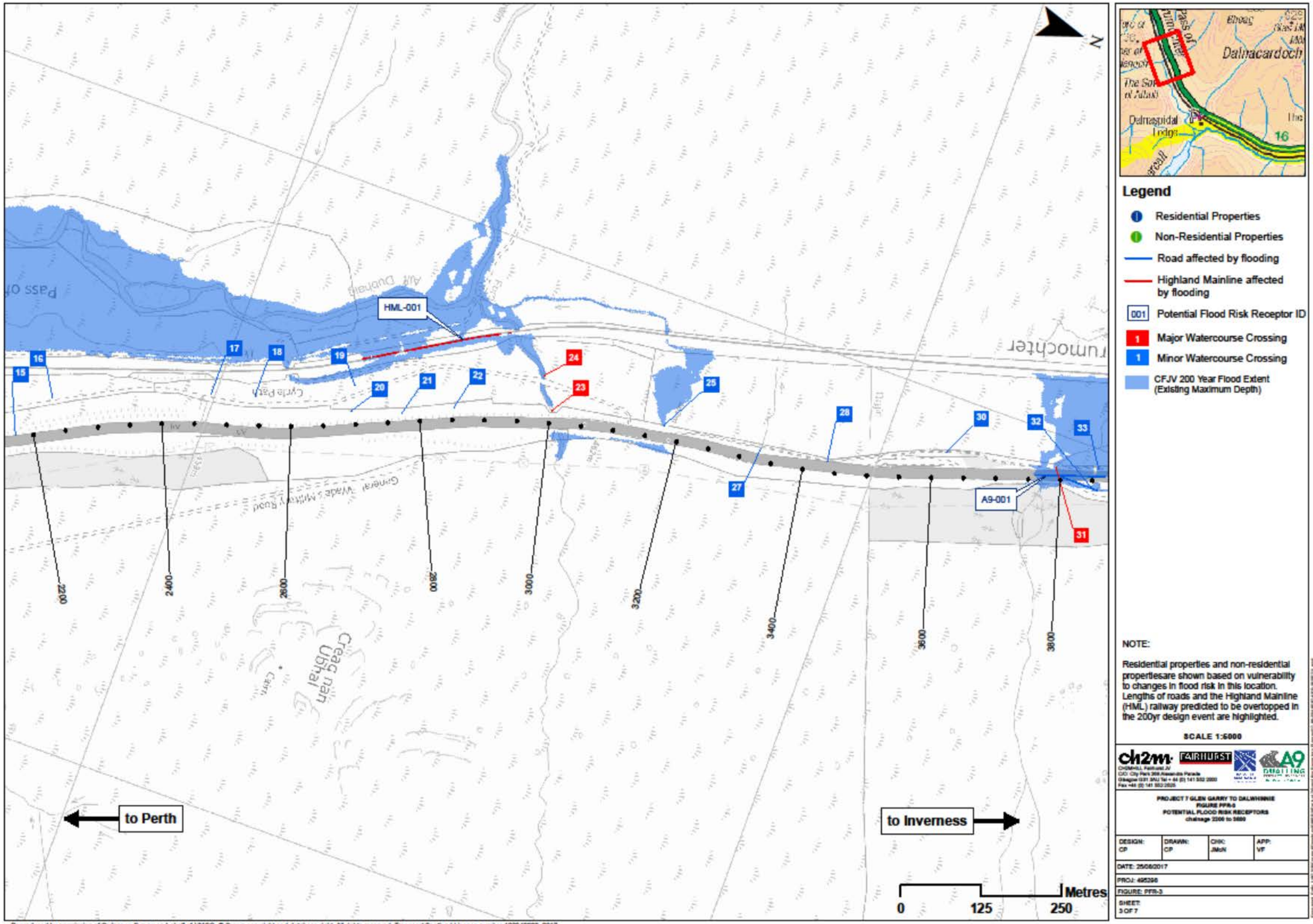

N
Legend
Residential Properties
Non-Residential Properties
Road affected by flooding
Highland Mainline affected by flooding
001 Potential Flood Risk Receptor ID
Major Watercourse Crossing
Minor Watercourse Crossing
CFJV 200 Year Flood Extent (Existing Maximum Depth)
HML-001
A9-001
15
16
17
18
19
20
21
22
23
24
25
27
28
30
31
32
33
2200
2400
2600
2800
3000
3200
3400
3600
3800
Creag nan Ubhal
to Perth
to Inverness
0
125
250
Metres
NOTE:
Residential properties and non-residential propertiesare shown based on vulnerability to changes in flood risk in this location. Lengths of roads and the Highland Mainline (HML) railway predicted to be overtopped in the 200yr design event are highlighted.
SCALE 1:6000
DESIGN: CP
DRAWN: CP
CHK: JMcN
APP: VF
FIGURE: PFR-3
SHEET: 3 OF 7

Figure PFR-4

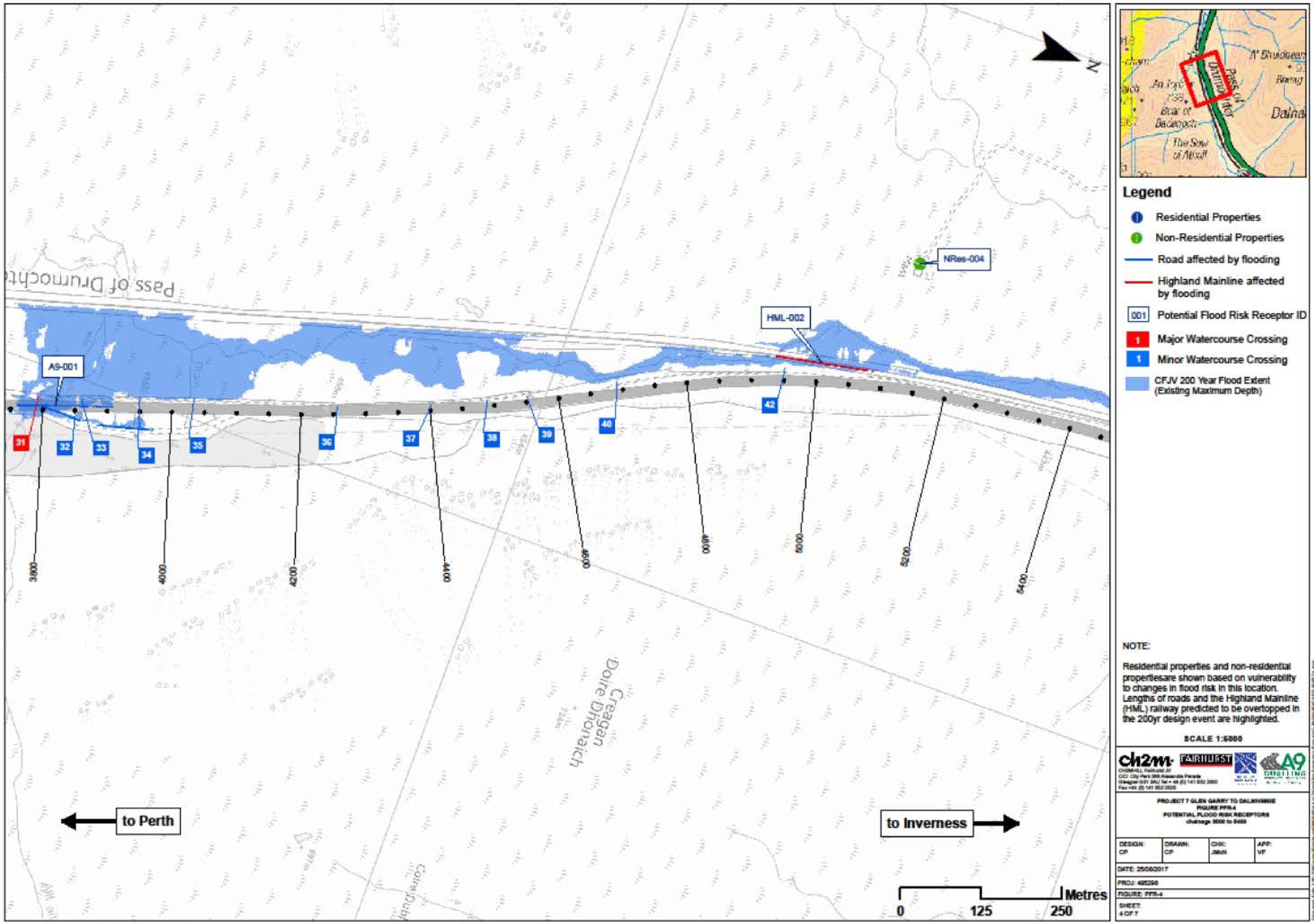

Pass of Drumochter
NRes-004
HML-002
A9-001
31
32
33
34
35
36
37
38
39
40
42
3800
4000
4200
4400
4600
4800
5000
5200
5400
Doire Creagan Dhonaich
to Perth
to Inverness
Metres
0
125
250
Legend
Residential Properties
Non-Residential Properties
Road affected by flooding
Highland Mainline affected by flooding
Potential Flood Risk Receptor ID
Major Watercourse Crossing
Minor Watercourse Crossing
CFJV 200 Year Flood Extent (Existing Maximum Depth)
NOTE:
Residential properties and non-residential propertiesare shown based on vulnerability to changes in flood risk in this location. Lengths of roads and the Highland Mainline (HML) railway predicted to be overtopped in the 200yr design event are highlighted.
SCALE 1:5000

Figure PFR-5

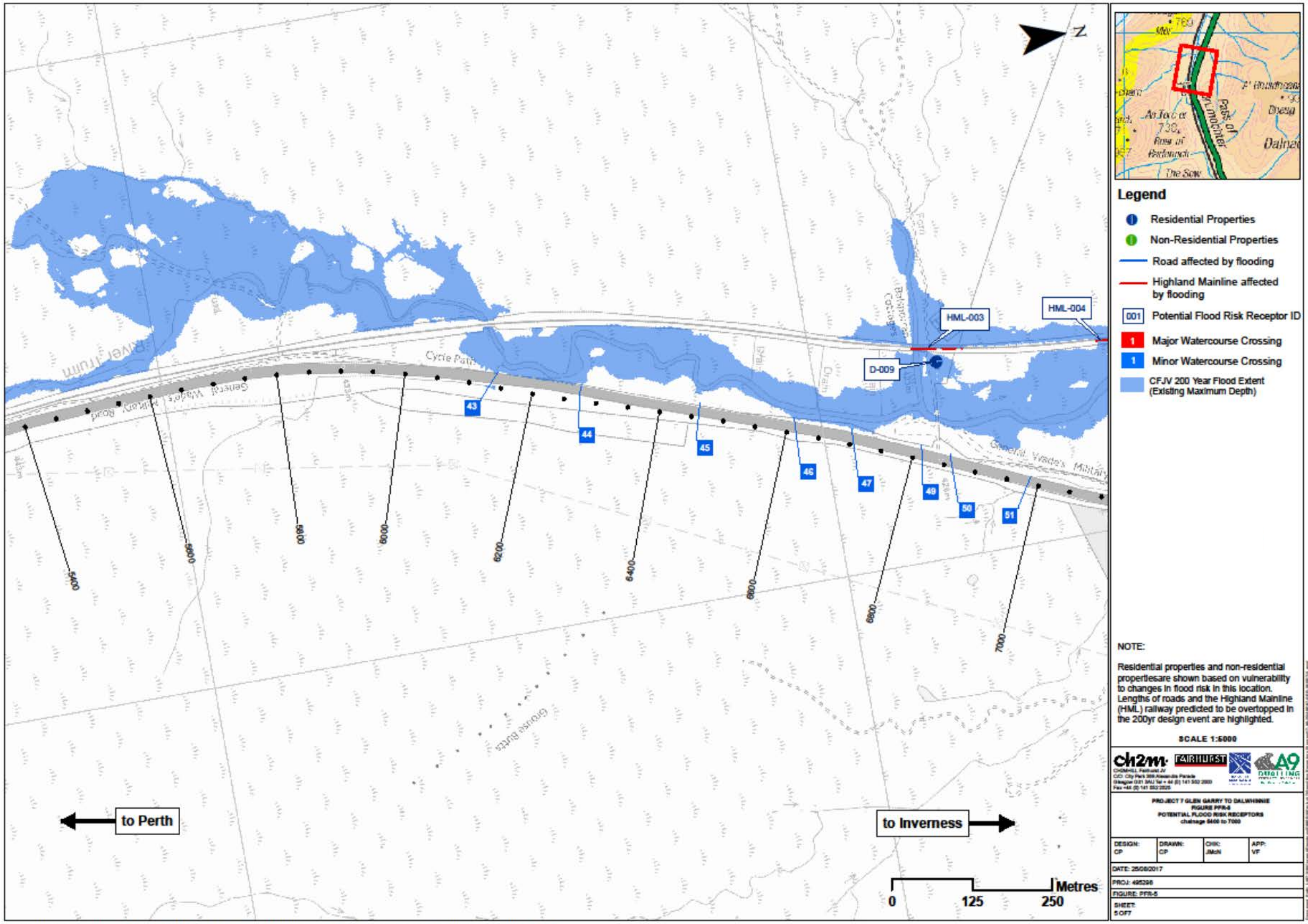

HML-003
HML-004
D-009
43
44
45
46
47
49
50
51
5400
5600
5800
6000
6200
6400
6600
6800
7000
to Perth
to Inverness
0
125
250
Metres
Legend
Residential Properties
Non-Residential Properties
Road affected by flooding
Highland Mainline affected by flooding
001 Potential Flood Risk Receptor ID
Major Watercourse Crossing
Minor Watercourse Crossing
CFJV 200 Year Flood Extent (Existing Maximum Depth)
NOTE:
Residential properties and non-residential propertiesare shown based on vulnerability to changes in flood risk in this location. Lengths of roads and the Highland Mainline (HML) railway predicted to be overtopped in the 200yr design event are highlighted.
SCALE 1:5000
PROJECT 7 GLEN GARRY TO DALWHINNIE
FIGURE PFR-5
POTENTIAL FLOOD RISK RECEPTORS
chainage 5400 to 7000
DESIGN: CP
DRAWN: CP
CHK: JMcN
APP: VF
DATE: 25/08/2017
FIGURE: PFR-5
SHEET: 5 OF 7

Figure PFR-6

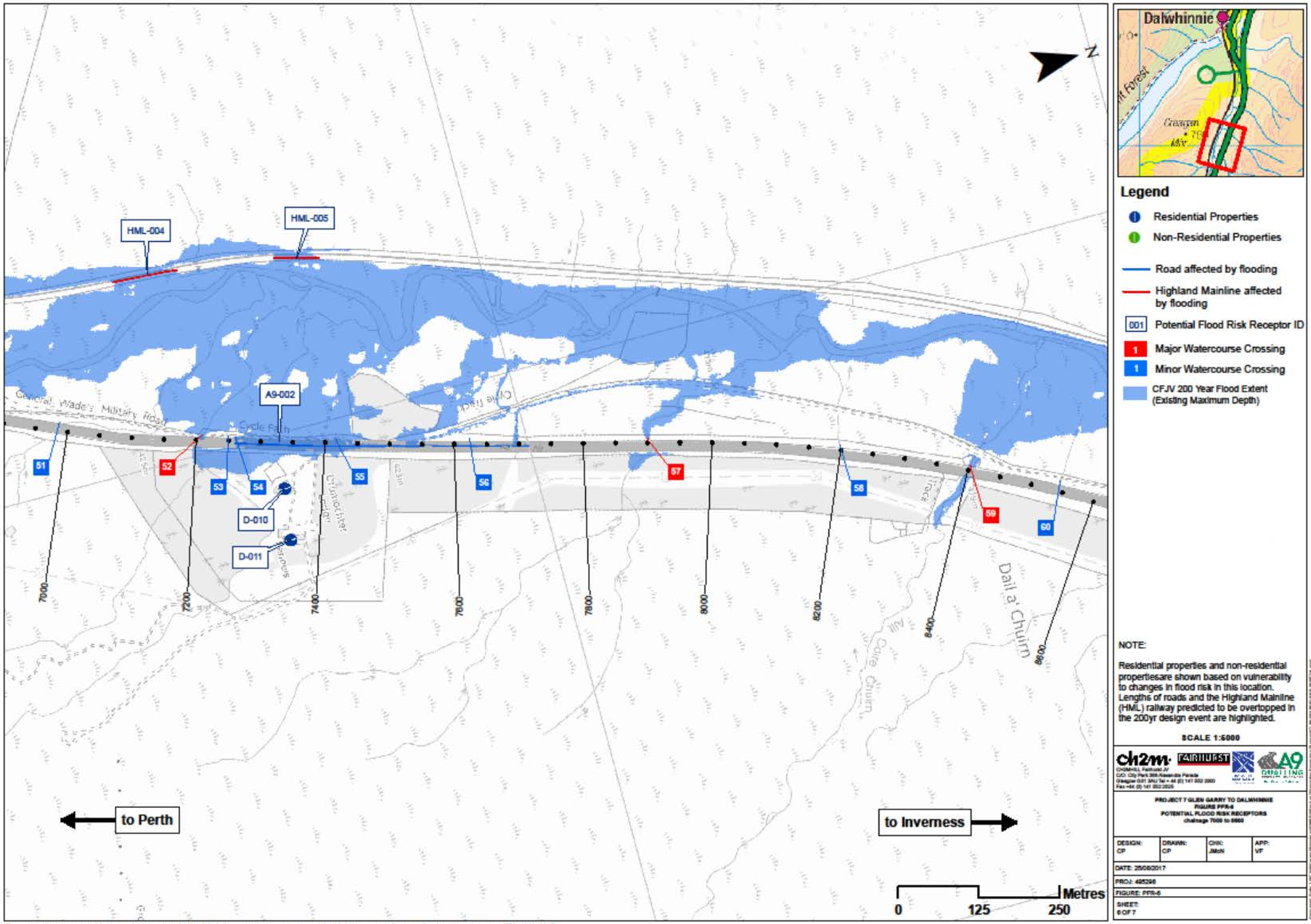
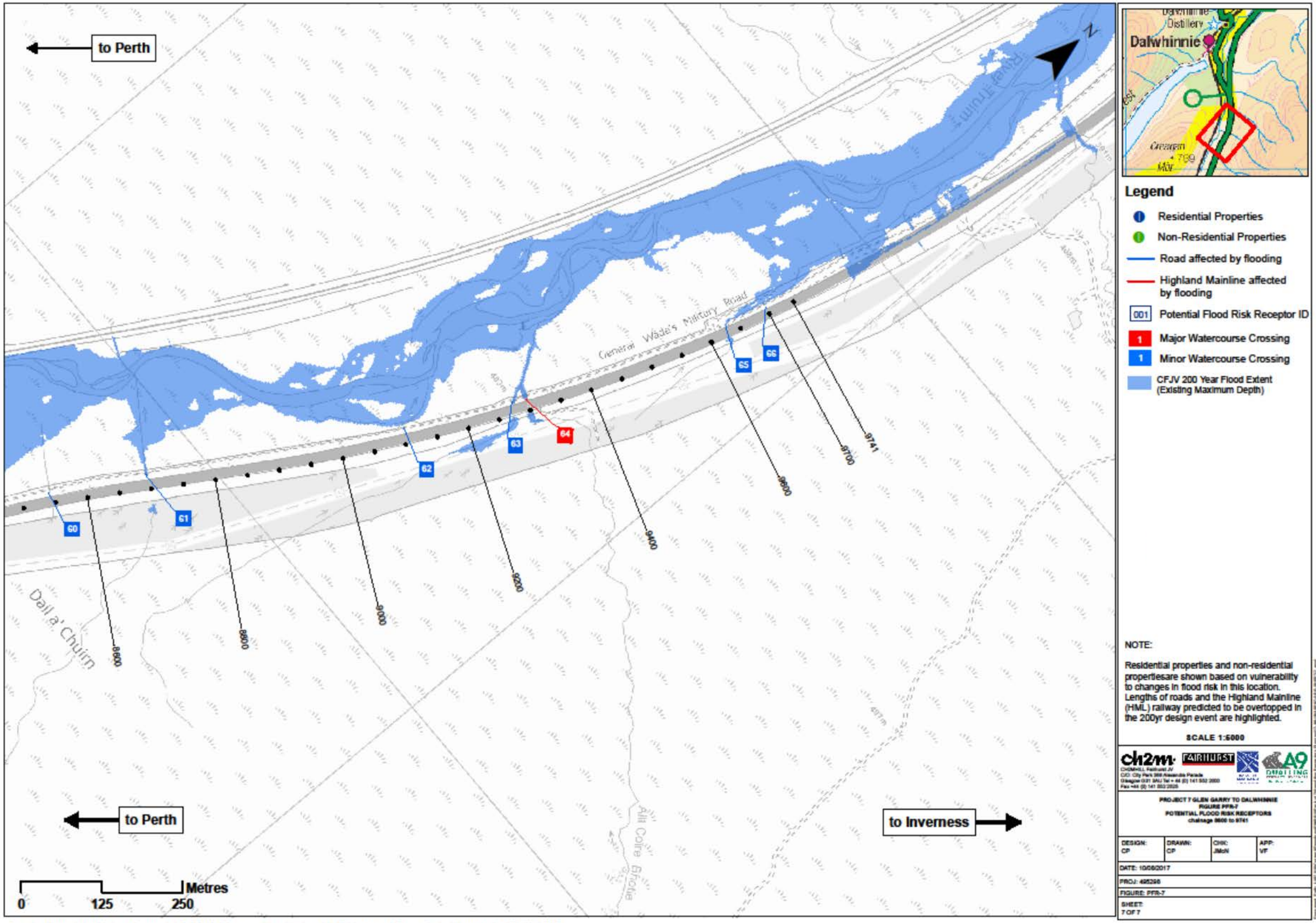

Dalwhinnie
HML-004
HML-005
A9-002
D-010
D-011
51
52
53
54
55
56
57
58
59
60
7000
7200
7400
7600
7800
8000
8200
8400
8600
to Perth
to Inverness
Legend
Residential Properties
Non-Residential Properties
Road affected by flooding
Highland Mainline affected by flooding
001 Potential Flood Risk Receptor ID
Major Watercourse Crossing
Minor Watercourse Crossing
CFJV 200 Year Flood Extent (Existing Maximum Depth)
NOTE:
Residential properties and non-residential propertiesare shown based on vulnerability to changes in flood risk in this location. Lengths of roads and the Highland Mainline (HML) railway predicted to be overtopped in the 200yr design event are highlighted.
SCALE 1:5000
Metres
0
125
250
DESIGN: CP
DRAWN: CP
CHK: JMcN
APP: VF
SHEET: 6 OF 7

Figure PFR-7


to Perth
to Perth
to Inverness
General Wade's Military Road
Dail a' Chuirn
Allt Coire Bhathaich
60
61
62
63
64
65
66
8600
8800
9000
9200
9400
9600
9700
9741
Metres
0
125
250
Dalwhinnie
Legend
Residential Properties
Non-Residential Properties
Road affected by flooding
Highland Mainline affected by flooding
001 Potential Flood Risk Receptor ID
Major Watercourse Crossing
Minor Watercourse Crossing
CFJV 200 Year Flood Extent (Existing Maximum Depth)
NOTE:
Residential properties and non-residential propertiesare shown based on vulnerability to changes in flood risk in this location. Lengths of roads and the Highland Mainline (HML) railway predicted to be overtopped in the 200yr design event are highlighted.
SCALE 1:5000
ch2m FAIRHURST
DESIGN: CP
DRAWN: CP
CHK: JMcN
APP: VF
DATE: 10/08/2017
FIGURE: PFR-7
SHEET: 7 OF 7

Compensatory Storage Areas

Figure CS-1

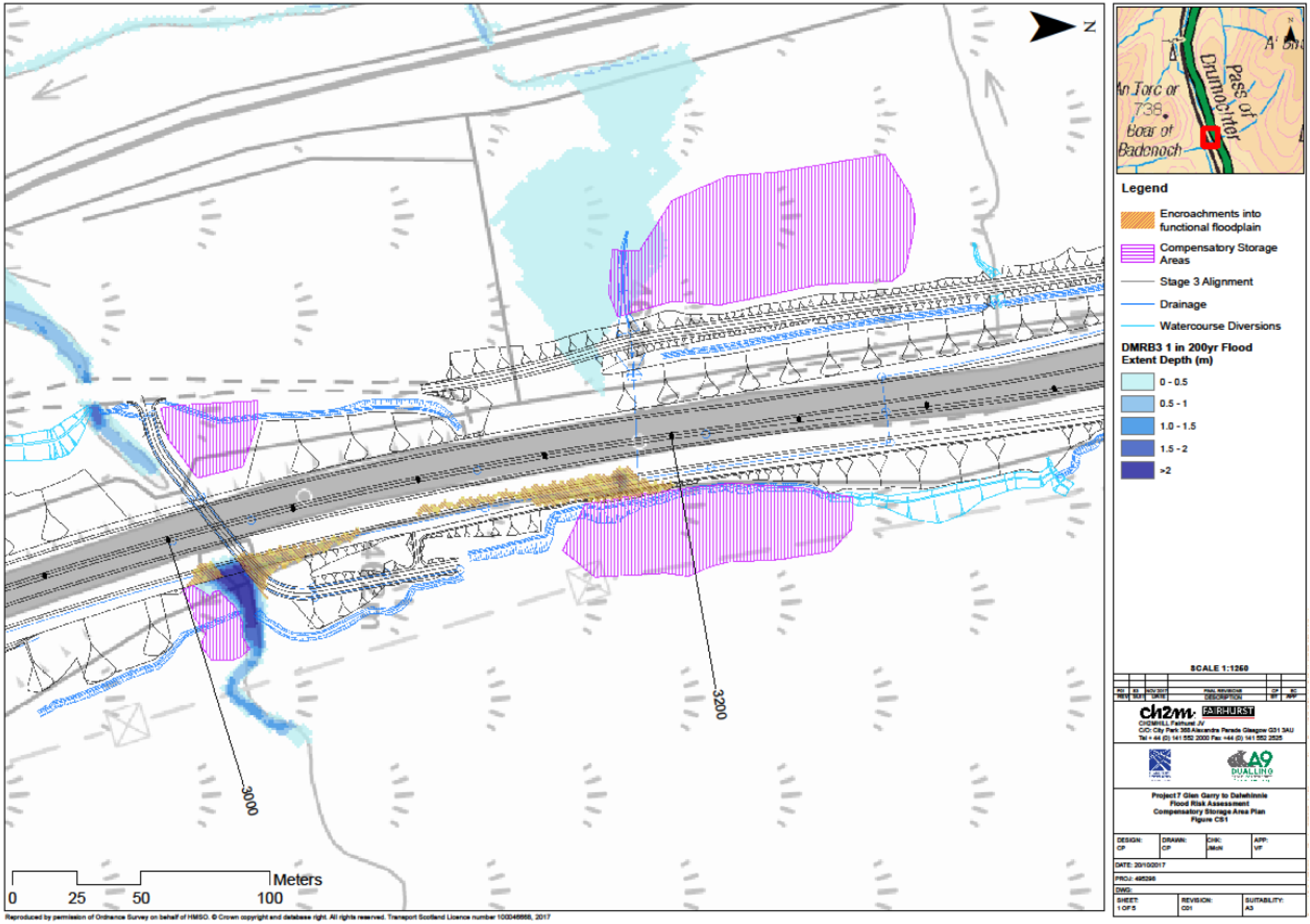


Figure CS-2

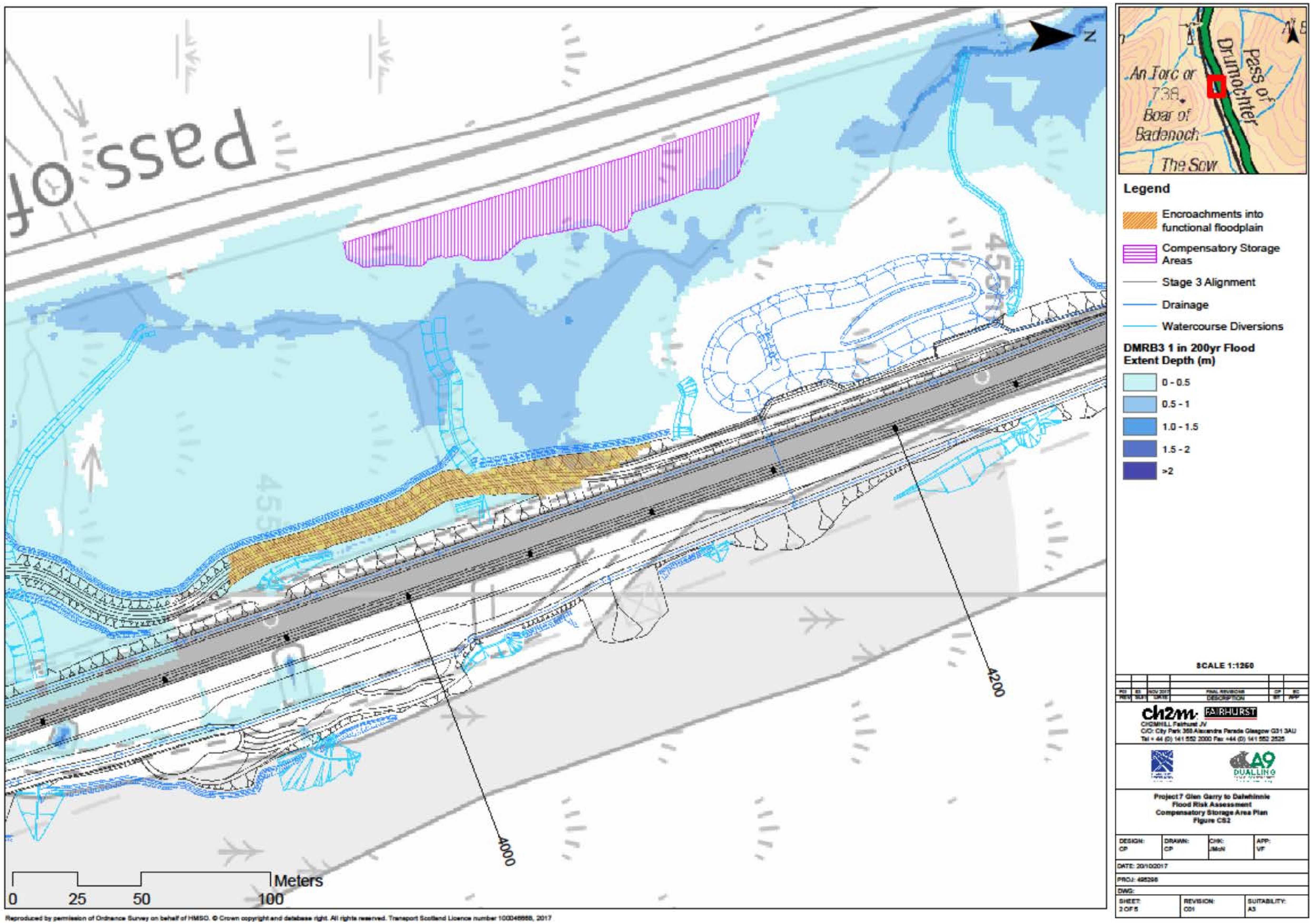

Pass of
Drumochter
Pass of
An Torc or
738
Boar of
Badenoch
The Sow
Legend
Encroachments into functional floodplain
Compensatory Storage Areas
Stage 3 Alignment
Drainage
Watercourse Diversions
DMRB3 1 in 200yr Flood Extent Depth (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
4000
4200
0
25
50
100
Meters
SCALE 1:1250
CH2MHILL Fairhurst JV
C/O: City Park 368 Alexandra Parade Glasgow G31 3AU
Project 7 Glen Garry to Dalwhinnie
Flood Risk Assessment
Compensatory Storage Area Plan
Figure CS2
DESIGN: CP
DRAWN: CP
CHK: JMcN
APP: VF
DATE: 20/10/2017
PROJ: 495298
DWG:
SHEET: 2 OF 5
REVISION: C01
SUITABILITY: A3

Figure CS-3

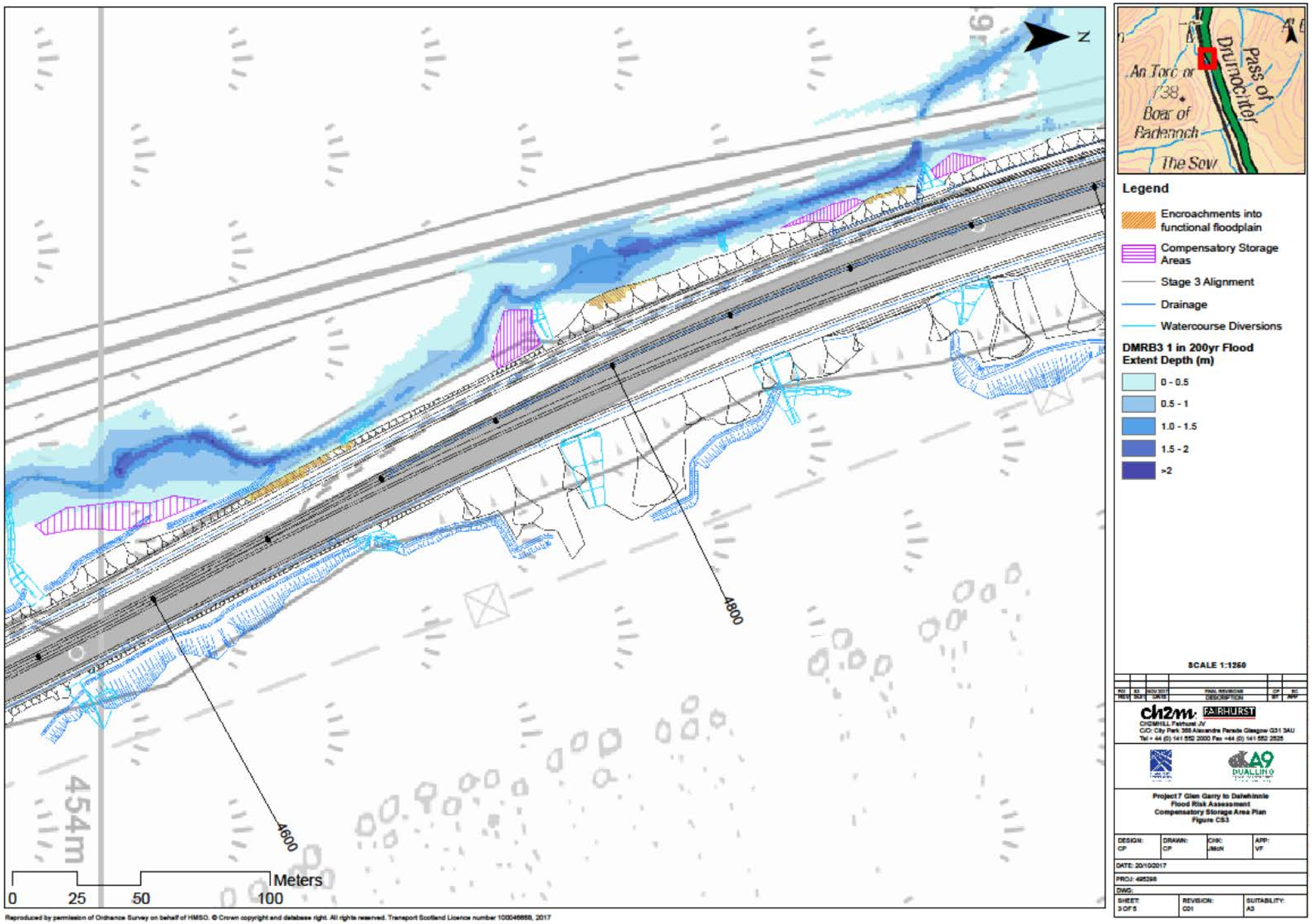

N
4600
4800
454m
0
25
50
100
Meters
An Torc or
738
Boar of
Badenoch
The Sow
Pass of
Drumochter
Legend
Encroachments into functional floodplain
Compensatory Storage Areas
Stage 3 Alignment
Drainage
Watercourse Diversions
DMRB3 1 in 200yr Flood Extent Depth (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
SCALE 1:1250
CH2MHILL Fairhurst JV
C/O: City Park 368 Alexandra Parade Glasgow G31 3AU
Tel + 44 (0) 141 552 2000 Fax +44 (0) 141 552 2525
DUALLING
Project 7 Glen Garry to Dalwhinnie
Flood Risk Assessment
Compensatory Storage Area Plan
Figure CS3
DESIGN: CP
DRAWN: CP
CHK: JMcN
APP: VF
DATE: 20/10/2017
PROJ: 495298
DWG:
SHEET: 3 OF 5
REVISION: C01
SUITABILITY: A3

Figure CS-4 [ignore black outline for SuDS ponds – SuDS considered in Assessment Design shown in blue.]

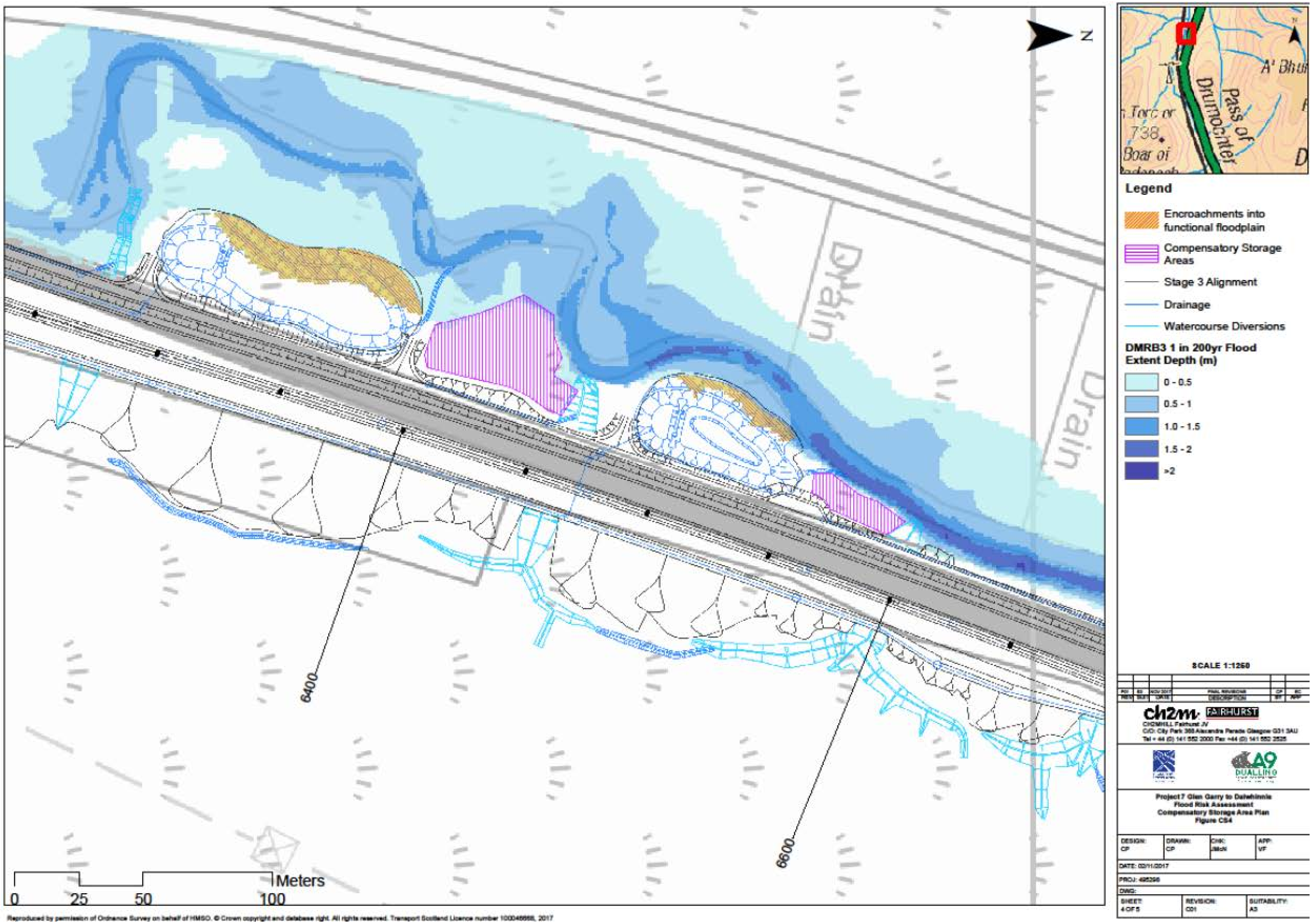


Figure CS-5

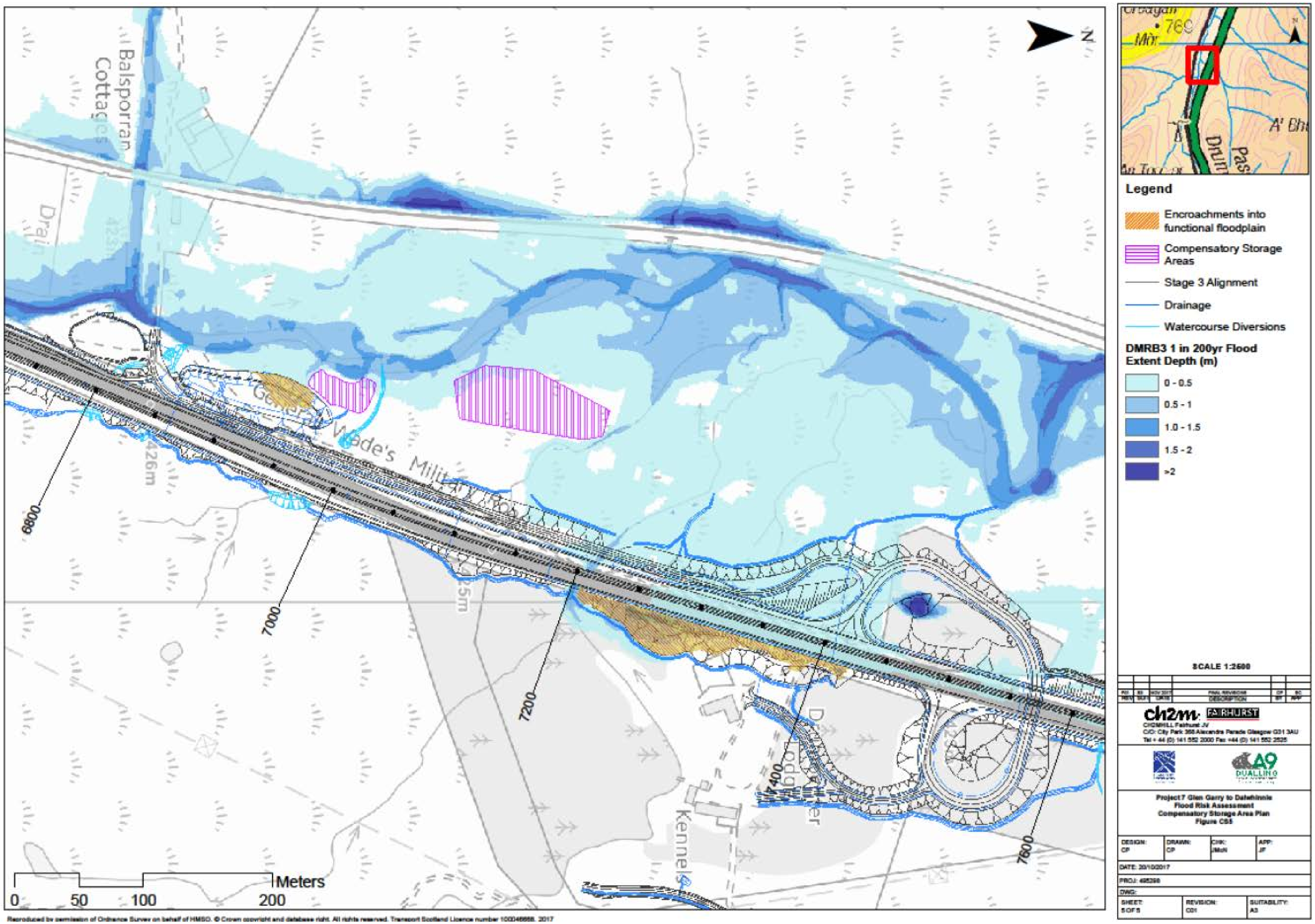

N
Balsporran Cottages
Wade's Military Road
Kennels
Legend
Encroachments into functional floodplain
Compensatory Storage Areas
Stage 3 Alignment
Drainage
Watercourse Diversions
DMRB3 1 in 200yr Flood Extent Depth (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
SCALE 1:2500
6800
7000
7200
7400
7600
0
50
100
200
Meters
ch2m FAIRHURST
A9 DUALLING
Project 7 Glen Garry to Dalwhinnie
Flood Risk Assessment
Compensatory Storage Area Plan
Figure CS5

Figure CS-6

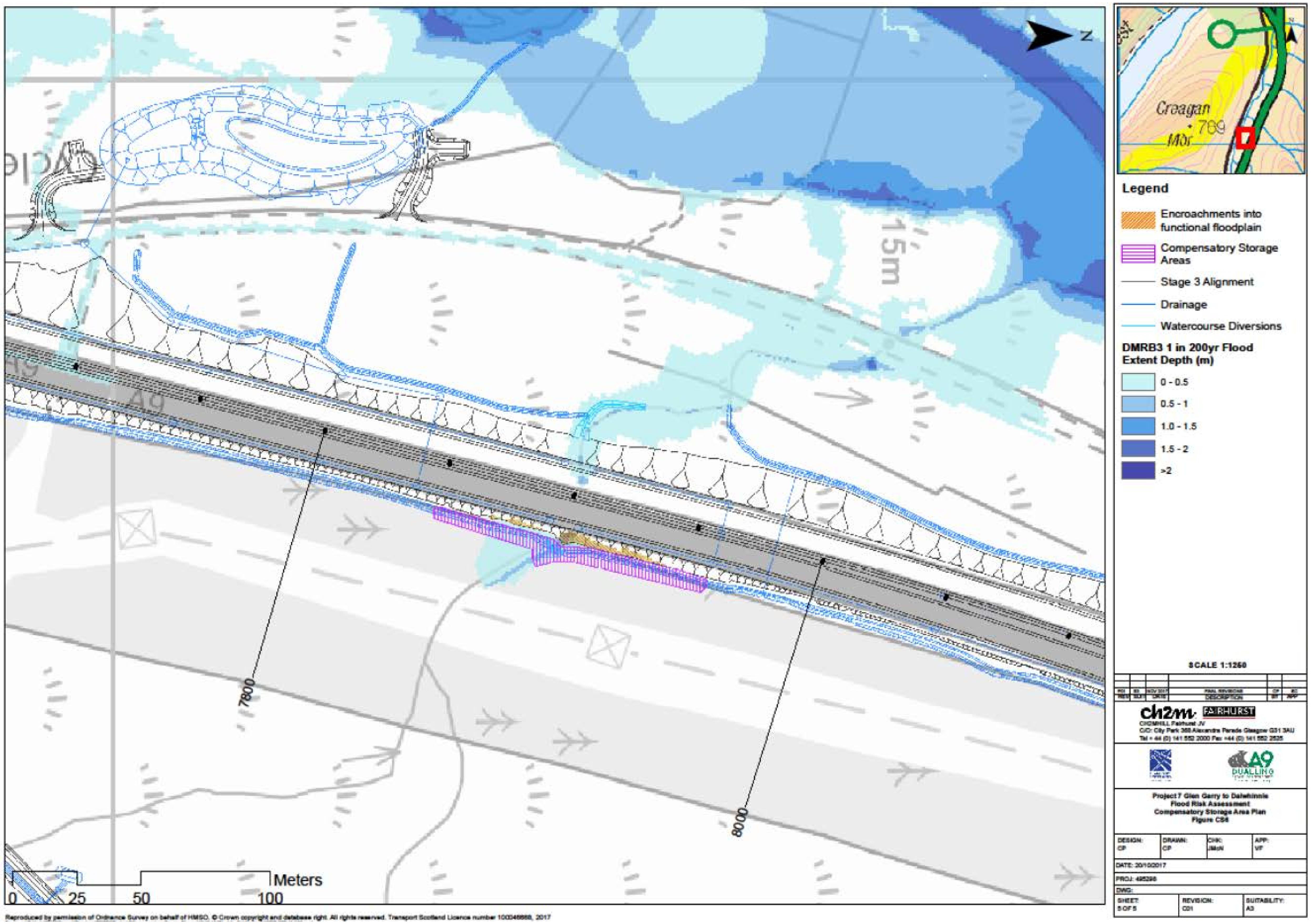
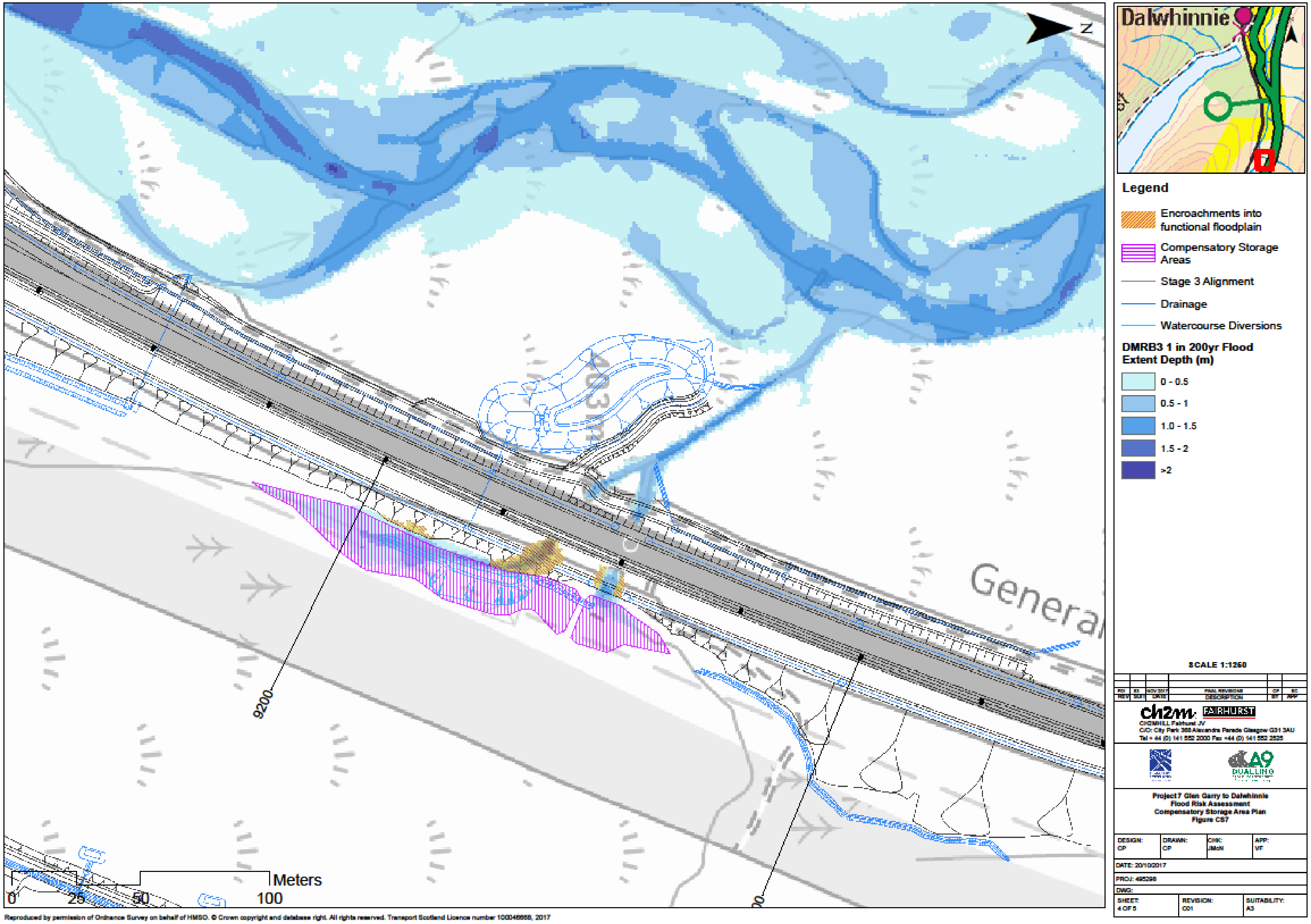

N
Creagan Mòr
789
15m
A9
7800
8000
0
25
50
100
Meters
Legend
Encroachments into functional floodplain
Compensatory Storage Areas
Stage 3 Alignment
Drainage
Watercourse Diversions
DMRB3 1 in 200yr Flood Extent Depth (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
SCALE 1:1250
ch2m FAIRHURST
A9 DUALLING
Project 7 Glen Garry to Dalwhinnie
Flood Risk Assessment
Compensatory Storage Area Plan
Figure CS6
DESIGN: CP
DRAWN: CP
CHK: JMcN
APP: VF
DATE: 20/10/2017
DWG:
SHEET: 5 OF 5
REVISION: C01
SUITABILITY: A3

Figure CS-7


Dalwhinnie
N
General
9200
Meters
0
25
50
100
Legend
Encroachments into functional floodplain
Compensatory Storage Areas
Stage 3 Alignment
Drainage
Watercourse Diversions
DMRB3 1 in 200yr Flood Extent Depth (m)
0 - 0.5
0.5 - 1
1.0 - 1.5
1.5 - 2
>2
SCALE 1:1250
REV
DATE
DESCRIPTION
APP
NOV 2017
FINAL REVISIONS
CP
CH2MHILL Fairhurst JV
C/O: City Park 368 Alexandra Parade Glasgow G31 3AU
Tel + 44 (0) 141 552 2000 Fax +44 (0) 141 552 2525
A9
DUALLING
Project 7 Glen Garry to Dalwhinnie
Flood Risk Assessment
Compensatory Storage Area Plan
Figure CS7
DESIGN:
CP
DRAWN:
CP
CHK:
JMcN
APP:
VF
DATE: 20/10/2017
PROJ: 495298
DWG:
SHEET:
4 OF 5
REVISION:
C01
SUITABILITY:
A3