Appendix A19.3: Watercourse Crossings Report

1.1 Introduction

1.1.1 This Appendix provides additional information relating to watercourse crossings to be constructed or modified as part of the A9 dualling between Pass of Birnam to Tay Crossing (Project 02), also referred to as the 'proposed scheme'.

- Section 2 provides a general description of the outline design approach being adopted.
- Section 3 considers each watercourse crossing in turn identifying the preferred approach that has been adopted at this stage in the proposed scheme development, as well as providing a summary of the hydromorphological baseline of each watercourse (see Annex 19.3A for further details on purpose of hydromorphology, assessment methodology and detailed baseline descriptions).
- Section 4 provides photographs of the existing watercourse crossings.
- Section 5 provides a schematic plan and long section for each proposed watercourse crossing.

1.1.2 This report considers the watercourse crossings associated with the proposed scheme and is to be read in conjunction with the relevant sections of the Environmental Statement and in particular Chapter 19 (Road Drainage and the Water Environment).

1.2 Outline Design Approach

1.2.1 At each proposed watercourse crossing, consideration has been given to the nature and size of the crossing, and environmental requirements. These crossings range in style including simply supported beam bridges, arch bridges and box/circular culverts.

1.2.2 In support of statutory requirements to protect biodiversity, fluvial hydromorphology also contributes to the understanding of habitat requirements, their sustainable management, and mitigation of impacts resulting from development works.

1.2.3 A collaborative hydromorphology and river engineering approach has been adopted. This approach can provide success in developing sustainable hydraulic structures and watercourse crossing designs that aim to reduce the risk of channel instability and culvert blockages which can threaten infrastructure and utilities, improve channel morphology and functioning.

1.2.4 Hydromorphology assessments may lead to the identification of areas where a river is not currently functioning effectively or is at risk. This allows the opportunity to provide morphological and environmental improvements with reference to relevant legislation and best practice guidelines. In some instances, this may contribute to, or lead to an improvement in WFD status.

1.2.5 At each watercourse crossing, consideration has been given to the 'opening size' of the bridge/culvert required to pass the design fluvial event incorporating appropriate freeboard. This also includes consideration of the impact of the proposed watercourse crossing on flood risk, associated with the design flood event. This is reported in greater detail in Appendix A19.2 (Flood Risk Assessment).

1.2.6 The outline design approach adopted for each of the watercourse crossings is provided below. In addition, reference is to be made to the outline design approach adopted to develop the larger bridge crossings i.e. non culvert crossings (4 of which exist within the proposed scheme) as identified in Section 3 of this Appendix.

Culvert Watercourse Crossings

1.2.7 The majority of watercourses crossed by the existing A9 are conveyed by means of a culvert. The proposed scheme retains the same general approach to these watercourse crossings by following the design process defined below.

1.2.8 The decision-making hierarchy adopted with regards to the general approach adopted at each watercourse crossing is presented below in order of preference:

- retain the existing watercourse crossing infrastructure unchanged;
- retain the existing watercourse crossing infrastructure but extended to accommodate the proposed scheme; and
- replace the existing watercourse crossing infrastructure with new infrastructure.

1.2.9 In terms of flood risk, all proposed watercourse crossings have been assessed against the design fluvial flood event i.e. 0.5% AEP (1 in 200 chance of occurring in any given year) plus an allowance for long term sustainability and resilience such that the proposed scheme remains operational and safe for users during times of flood and flood risk is not compromised elsewhere, as reported in Appendix A19.2 (Flood Risk Assessment). The allowance for long term sustainability and resilience includes an additional 53% uplift to the peak river flow on major watercourse and 39% uplift for minor watercourses. This is in alignment with current SEPA guidance (SEPA, 2024) for climate change allowances. A minimum of 600mm freeboard to proposed road level has also been considered in accordance with Technical Flood Risk Guidance for Stakeholders (SEPA, 2022).

1.2.10 All new culvert crossings have been designed in accordance with DMRB CD 529 (Highways England et al., 2021) which states, "*The guidance on the hydraulic design of culverts, as given in Chapter 12 of CIRIA C786 [Ref 1.N], shall be used in the design of culverts*". As such, all hydraulic assessment and design of culverts will be as per CIRIA C786 'Culvert, screen and outfall manual' guidance (CIRIA, 2019).

1.2.11 Additionally, and where existing flood risk is not compromised, all new replacement watercourse crossings (i.e. where it is proposed that an existing culvert is fully removed and replaced with a new culvert) have been sized as a minimum to freely pass the peak flow associated with the predicted 0.5% AEP (1 in 200 chance of occurring in any given year) plus an allowance for climate change, with appropriate freeboard within the culvert barrel. Culvert freeboard requirements are outlined by CIRIA 786 and are as follows:

- for culverts between 0.45m and 1.2m barrel diameter/height, a minimum freeboard of D/4 shall be provided, where D is the culvert internal diameter or culvert height for a box culvert;

- for culverts between 1.2m to 1.8m barrel diameter/height, a minimum freeboard of D/6 shall be provided, where D is the culvert internal diameter or culvert height for a box culvert; and
- for culverts of over 1.8m barrel diameter/height, 0.3m to 0.6m freeboard shall be provided.

1.2.12 For retained and extended and replaced culverts longer than 90 metres, a manhole will be provided to facilitate access for maintenance.

Cascades

1.2.13 There are a number of locations where the proposed scheme will result in an earthwork 'cut' into the adjacent hillside or the invert of the new watercourse crossing will be lowered to pass beneath the proposed road drainage system. This will result in a steepened watercourse requiring a 'cascade' to safely convey the design flood event without compromising the integrity of the hillside and/or operation of the proposed scheme.

1.2.14 From a hydraulic perspective, the flow of water within a cascade is complex and characterised by two different flow types – 'nappe flow' and 'skimming flow'. 'Nappe flow' is characterised by a succession of free-falling drops at each step with water depth recovering before the next step. 'Skimming flow' occurs when each step is submerged, typically occurring during larger magnitude discharges and/or longer cascades and requiring a stilling basin at the toe of the cascade to dissipate energy and allow water depth recovery. Both flow types are acceptable, as long as the proposed cascade geometry safely contains the flow of water.

1.2.15 The design approach was to design a hydraulic cascade to typically follow the proposed hillside topography, without significant additional excavation to form the cascade steps, which typically will have a head drop no greater than 0.5m, subject to further development at both specimen and detail design stage. This 0.5m would represent the height above the pool surface and not the depth of any pool associated with the cascade.

1.2.16 Where a cascade is considered necessary this is identified in Section 3 and also shown schematically on the drawings. The nature of the cascade dependent upon a number of factors but in general may take one of the following forms:

- bedrock channel cascade;
- natural cascade with natural gravel, cobbles and rock forming individual steps; and
- concrete cascade with stone pitching.

1.2.17 The geometry and form of each cascade will be considered on a case-by-case basis at specimen design stage taking into account hydraulic requirements, topography, fluvial morphology and nature of the underlying strata and its susceptibility to fluvial erosion (if known). Principal cascade features required to retain stable morphological functioning are as follows:

- For proposed channel bed gradients between 2% and 10%, step-pool cascades will be reinstated where the geometry and boulder sizing are based on the method presented by Chin et al. (2009) and reference reach data where available;

- For proposed channel bed gradients >10% a boulder cascade will be reinstated comprising a series of two or more steps and a pool forming cascade sequences;
- Where required from a fish migration perspective, the minimum pool depth at the base of the step will be 0.3m to allow for passage of Trout and 0.45m for passage of Salmon in line with guidance (Scottish Executive, 2012); and,
- Where a two-stage channel is required, it will be appropriately sized to safely convey the design flood event and may include adopting the methodology presented in 'The hydraulic design of stepped spillways' (CIRIA, 1978).

As such, the geometry of the proposed cascades provided in this report and associated drawings is indicative and will be subject to further development at both specimen and detail design stage.

Scour Protection Measures

1.2.18 Fluvial scour of highway structure foundations is a major cause of failure; hence attention should be given to the design of new watercourse crossings to prevent failure due to fluvial scour.

1.2.19 For each proposed watercourse crossing an assessment has been made regarding the need to offer energy dissipation/scour protection measures, in particular at bridge abutments, bridge piers, culvert entrances and/or any other river training works required as part of the proposed scheme.

1.2.20 Where structures are founded directly onto sound bedrock and/or the watercourse local to the structure of formed by a bedrock channel with little or no alluvium mantling the risk of scour is considered to be 'low' and hence no additional scour protection measures are likely.

1.2.21 Where structures are not founded directly onto sound bedrock and/or the channel local to the structure is not formed of bedrock, consideration has been given to estimating the maximum depth of scour such that structure foundations are set below this level and/or scour protection measures are provided to offer protection against scour and possible undermining of the structure foundations.

1.2.22 The zone of scour influence for each watercourse is provided in Section 3 and shown on the associated drawings. The need for and (if required) the nature of any scour protection measures and/or energy dissipation features will be determined at specimen design stage, taking into account the vulnerability of the protected asset, hydraulic requirements, channel morphology and nature of the underlying strata (if known).

1.2.23 The design of any scour protection measure and/or energy dissipation feature will be in accordance with the relevant provision of the DMRB CS 469 (National Highways, 2024).

Environmental Design

1.2.24 In so far as practicable, all river engineering works associated with the scheme will be in accordance with Scottish Environmental Protection Agency (SEPA) good practice guidance, particularly with respect to river crossings (SEPA, 2010a), sediment management (SEPA, 2010b) and bank protection (SEPA, 2008). Where this is not possible further justification will be provided at specimen design stage.

1.2.25 Particular consideration has been given in this report to the provision of mammal and fish passage and burying the culvert invert with natural riparian river deposits.

Mammal Passage

1.2.26 The provision of mammal passage within new watercourse crossings has been considered alongside geometric constraints, hydraulic performance requirements and other aspects of scheme design in developing the watercourse crossing proposals outlined in this report.

1.2.27 Where existing watercourse crossings are being replaced with a new culvert, consideration has been given to provide integral mammal passage where an ecological need has been identified. Mammal ledges have been designed in accordance with DMRB LD 118 (Highways England et al. 2020).

1.2.28 Where an existing watercourse crossing culvert has been confirmed to provide a mammal corridor but is being retained and extended to accommodate the proposed scheme, it is proposed to provide an adjacent dry mammal underpass to maintain and/or improve habitat connectivity.

1.2.29 The provision of alternative mammal passage, by means of dry mammal underpass rather than provision of mammal ledges within an enlarged watercourse culvert, has been selected to avoid the need to significantly enlarge the culvert cross-section in order to meet DMRB requirements. Locations of dry mammal underpasses are detailed in Appendix 19.3.1a.

1.2.30 Consequently, the use of dry mammal underpasses in such a situation reduces the need to increase clearance between the proposed scheme road level and the watercourse river bed level. Raising the proposed scheme road level may have significant impacts in terms of increasing the footprint of the road, drainage design, visual impact and increased capital cost; whereas the alternative option of lowering the watercourse potentially requires significant engineering intervention in the river channel, with possible further ecological and geomorphological impacts. Avoiding, or minimising an increase in culvert size also has the benefit of minimising the impact on the existing hydraulic regime and flood risk.

1.2.31 Where required details relating to the provision of mammal passage within culvert structures are provided in Section 3 (Watercourse Crossing Information) and are also shown on the drawings. Dry mammal underpasses are not detailed within this report, but their presence is noted in Section 3 (Watercourse Crossing Information) where the dry mammal underpass is associated with an adjacent watercourse.

1.2.32 No provision is made for mammal passage through culverts proposed as part of the proposed scheme to accommodate access tracks, non-motorised user tracks and other crossings away from the proposed scheme mainline. Due to the (infrequent, low speed and/or non-motorised user) nature of the traffic using such minor crossings the risk to mammals crossing overland in times of high river flow within the culvert barrel is not considered to be significant.

Fish Passage

1.2.33 The current accessibility of each watercourse for migratory fish is provided in Appendix A19.1 (Baseline Conditions), where data is available.

1.2.34 In line with good practice guidance (SEPA, 2010a), measures to provide fish passage will be developed for each watercourse crossing, as determined where necessary through consultation with SEPA and the Tay District Salmon Fisheries Board, at both the specimen and detailed design stage for applications made under The Water Environment (Controlled Activities) (Scotland) Regulations 2011.

1.2.35 Details of the provision and design of low-flow channels to facilitate fish passage will be determined at specimen and detailed design stages.

Buried Culvert Invert

1.2.36 Where possible consideration has been given to burying the culvert invert below the natural river bed level to allow for a naturalised culvert bed. This approach has been taken where a new culvert is proposed of moderate gradient and generally where the natural river bed level and bed slope is maintained through the culvert. River bed material placement and grading reinstated in proposed culverts is dependent on the channel/culvert gradient and stream type local to the proposed crossing as illustrated by the geomorphology criteria presented below:

- For proposed replacement culvert gradients >1 in 67 a sediment retention system (such as baffles) is required where the adjacent alluvial channel shows evidence of active coarse sediment supply and transport;
- For proposed replacement box culverts with diameter >1.8m install a low flow channel if practicable where the adjacent alluvial channel shows evidence of active coarse sediment supply and transport;
- For replacement culverts reinstate existing river bed material size distribution if the proposed culvert gradient is similar to the adjacent watercourse gradient. If the proposed culvert gradient differs from the upstream gradient by 1% or more, calculations to determine bed material sizing will be undertaken at specimen and detailed design.

1.2.37 Where this is not the case, in particular where the channel upstream is relatively steep and the natural retention of sediment is not expected, where the design incorporates a hydraulic feature such as a cascade formed by either a concrete channel or natural bedrock channel and/or where the existing culvert is being retained and extended, culvert embedment may not be appropriate or sustainable. The requirement for providing a buried culvert invert will be considered at each culvert location and where necessary developed further at specimen and detailed design.

1.2.38 The depth of natural river bed material above the culvert invert will vary depending on the size of culvert and respective hydraulic requirements. Natural sediment requirements for new culverts (CIRIA, 2019) are as follows:

- For culverts between 0.45m and 1.2m barrel diameter/height, the culvert invert shall be buried at least D/4 below natural bed level;
- For culverts between 1.2m to 1.8m barrel diameter/height, the invert shall be buried at least D/6 below natural bed level; and
- For culverts of over 1.8m barrel diameter/height, the invert shall be buried at least 0.3-0.6m below natural bed level.

1.2.39 These criteria are more onerous than the guidelines suggested in SEPA guidance, (SEPA, 2010a) and thus these requirements will also be met. Where necessary baffles and step pools may be included to aid retention of river bed deposits. In addition, and where possible, all new proposed scheme culverts should maintain the existing natural channel width.

1.2.40 The proposed depth of embedment at each watercourse crossing is provided in Section 3 and shown on the associated drawings in Section 6. This may be subject to change at Specimen Design stage, due to further geomorphological assessment of the sustainability of culvert embedment.

1.3 Watercourse Crossing Information

1.3.1 Table 1 provides information for each watercourse crossing which may be affected by the proposed scheme. This includes identification of the waterbody affected (together with predicted flood flows at the point of interest), details of the proposed works and broad justification for the proposed engineering solution.

1.3.2 Cross-reference shall be made between Table A19.3-1 and Section 4 (Watercourse Crossing Information) and Section 5 (Drawings), which provide photographs of the existing watercourse crossing and outline drawing of the proposed scheme watercourse crossing respectively.

Table A19.3-1: Watercourse Crossings additional information

Waterbody	Culvert number & Location	Construction detail	Baseline and proposed scheme
WF01 Approximate channel bed width at mainline culvert inlet: 2.4m Flow data: 50% AEP: 0.70m3/s 3.33% AEP: 1.504m3/s 0.5% AEP + CC: 3.74m3/s	1/A9	Upstream extension of existing A9 Culvert Local regrading of channel upstream of the culvert inlet Existing diameter = 1.8m Existing length = 63.2m Proposed diameter = 1.8m Proposed extension = 5.95m Proposed embedment = 0m	**Watercourse Crossing Baseline** Watercourse WF01 is culverted beneath the existing A9 via a 1.8m diameter concrete culvert. The existing culvert inlet is set back from the carriageway, several metres below both the existing and proposed A9 road levels. The outlet of the culvert ties into a curved (in plan alignment) concrete step cascade approximately 15.5m long which ties into a channel with stone masonry walls forming the banks. The proposed scheme will result in the A9 footprint at this location being widened on the upstream side. The widening of the A9 footprint impacts the location of the existing culvert inlet, on the upstream side (northbound). **Hydromorphology baseline** Within the study area, WF01 displays a low sinuosity planform and exhibits realignments through culverts below the Highland Main Line railway and existing A9 carriageway. Upstream of the A9, boulder step-pools with additional plane-bed and plane-riffle characteristics make up channel morphology leading to rapid flow types. Downstream of the A9 the channel is constrained by an engineered cascade structure. Therefore, WF01 has been assigned a **medium** importance classification. **Proposed Scheme** To accommodate the proposed scheme, a number of alternative watercourse crossing options have been considered, as follows: ▪ Retain the existing culvert unchanged: The existing culvert is not long enough to accommodate the proposed scheme. ▪ Extension of the existing culvert: The existing culvert could be extended upstream to accommodate the footprint of the proposed scheme. This would accommodate the proposed scheme with no significant associated impacts. This is the preferred option. ▪ Replace the existing culvert: The culvert could be replaced to the same alignment and gradient, with associated upstream channel modifications, to accommodate the proposed scheme. An extension has been demonstrated to be adequate, therefore a full replacement is not required. The preferred solution for this crossing, taking account of engineering and environmental design criteria, is to extend the existing culvert to accommodate the proposed scheme. The extension will be short at 5.95m. The extension will be constructed upstream at the same internal diameter, alignment and gradient as the existing culvert. In addition, the watercourse channel immediately upstream of the culvert entrance will require localised realignment and regrading over a length of approximately 13.9m to tie the existing channel into the new culvert inlet. The existing culvert outlet and existing downstream concrete step cascade will be retained unchanged. **Hydromorphology assessment summary** Construction activities would likely increase quantities of fine sediment along the channel, smothering bed substrate. In-channel and bankside working would also lead to potential losses in riparian vegetation, disturb and destabilise bank material as well as potentially damage and/or alter bedforms. The culvert extension, during operation, would replace channel features including a steep step-pool as well as removing riparian vegetation. The reduced channel gradient along the culvert would likely lead to deposition along the culvert invert. This, and the potential requirement to regrade the upstream channel, would lead to changes in flow and sediment transport dynamics. Further changes in sediment transport dynamics could also arise from bank protection if it is considered necessary at Specimen Design Stage. Impacts would be of slight significance reducing further to neutral following the implementation of mitigation. Further details on site specific impacts, mitigation and residual impacts are provided in Appendix A19.5 (Impact Assessment). **Ecological justifications** Ecological assessment has identified this watercourse as a potential mammal corridor. The existing culvert has an informal mammal ledge which does not appear to have been designed in accordance with DMRB LD 118. It is proposed the existing bespoke ledge will be extended through the culvert extension and tied into the newly formed bank upstream to retain mammal passage.

			Ecological assessment has not identified this watercourse as having suitable fish habitat; hence the provision for fish passage is not required. The proposal is for an extension of the existing alignment and as such, no embedment is required. **Flood Risk Justifications** The existing culvert arrangement freely passes the design flood event, with 0.3m culvert freeboard during the design flood event i.e. 0.5% AEP (200-year) plus a 39% allowance for climate change. The existing A9 is therefore not considered to be at flood risk during the design flood event, with 6.72m existing freeboard to the road level available. The new culvert arrangement will also freely pass the design flood event with 0.41m culvert freeboard. The head water level at the culvert entrance is predicted to increase by 0.086m as a result of lengthening of the culvert. The available flood freeboard between head water level and the proposed A9 road level is 5.89m, hence the proposed scheme is not considered to be at flood risk during design flood event. The head water level is out of bank in the upstream channel; however, as there are no sensitive receptors in the upstream reach no further mitigation measures are considered necessary. The new culvert arrangement freely passes the design flood event of 3.33% AEP (1 in 30 chance of occurring in any year). The water level at the culvert inlet during the event is predicted to provide an available freeboard of 0.99m, allowing sufficient space for the mammal ledge to be extended through the proposed culvert extension. The top of the mammal ledge is predicted to be 0.39m above the water level during a 3.33%AEP, where it will be 170mm thick. Downstream flood risk associated with the design flood event is not impacted by the proposed scheme.
WF02 Approximate channel bed width at mainline culvert inlet: 1.52m Flow data: 50% AEP: 0.19m3/s 0.5% AEP + CC: 0.95m3/s	2/A9	No changes are proposed to the existing A9 mainline culvert Existing diameter = 0.72m Existing length = 40.55m	**Watercourse Crossing Baseline** Watercourse WF02 is culverted beneath the existing A9 via a 0.72m diameter concrete culvert. The existing culvert inlet is set back from the carriageway, several metres below the existing and proposed A9 road levels. The downstream end of the culvert ties into a concrete stepped cascade approximately 9.1m long. The proposed scheme will result in the A9 footprint at this location being widened on the upstream side. The widening of the A9 footprint does not impact the location of the existing culvert inlet, on the upstream side (northbound) or the outlet on the downstream side (southbound). **Hydromorphology Baseline** Within the study area, WF02 displays a low sinuosity planform and exhibits realignments through culverts below access tracks and the existing A9 carriageway. Generally, WF02 comprises plane-bed, plane-riffle and step-pool morphology. The channel is constrained and poorly defined downstream of the existing A9 by an engineered cascade structure. In downstream reaches the channel exhibits a narrow, overwide and over deep cross-section, with the formation of alternate berms suggesting localised recovery of sinuosity. Therefore, WF2 has been assigned a **medium** importance classification. **Proposed Scheme** The proposed scheme will not result in a change in the A9 footprint at this location, hence the existing culvert is considered adequate to accommodate the proposed scheme at this location. **Hydromorphology Assessment Summary** Construction activities adjacent to WF02 from earthworks could increase fine sediment input to the watercourse. Where the channel is poorly defined, the tracking of plant material could lead to accidental loss of the channel. However, with no operational changes to the A9 watercourse crossing along WF02, there is no anticipated operational impacts on hydromorphology. Impacts would be of slight significance reducing further to neutral following the implementation of mitigation. Further details on site specific impacts, mitigation and residual impacts are provided in Appendix A19.5 (Impact Assessment). **Ecological Justifications** No change to the existing culvert and local watercourse is proposed. There will be no embedment required as there are no changes proposed to the culvert. **Flood risk Justifications** The existing culvert is surcharged during the design flood event i.e. 0.5% AEP (200-year) plus a 39% allowance for climate change. The water level at the culvert inlet is predicted to surcharge the culvert soffit by 0.47m and is predicted to be out of bank. The available flood freeboard between headwater level and the existing A9 road level is 3.31m. Consequently, the existing road and proposed scheme road are not considered to be at flood risk during the design flood event.

			No change to existing flood risk is anticipated.
WF05 Approximate channel bed width at mainline culvert inlet: n/a Flow data: 50% AEP: 0.24m3/s 0.5% AEP + CC: 1.21m3/s	5/A9	Upstream extension of existing A9 CulverUpstream regrading of ground to create a localised low point at the culvert inlet. Existing diameter = 0.6m Existing length = 49.77m Proposed diameter = 0.6m Proposed extension = 34.7m Proposed embedment = 0m	**Watercourse Crossing Baseline** Watercourse WF05 is culverted beneath the existing A9 via a 0.6m diameter concrete culvert. The existing culvert inlet is set back from the carriageway, at the toe of the road embankment, several metres below the existing and proposed A9 road levels. The watercourse upstream of the existing channel is currently ephemeral and has no formalised channel. Within the study area, WF05 displays a low sinuosity planform with steep step-pool flow types within the upper reaches. The watercourse dissipates within a wetland area prior to reaching the existing A9. Onsite observations confirm the channels competence and capability to transport coarse sediment under existing conditions. As such WF05 is stable under existing hydrophysiographic conditions and displays a **medium** importance classification. **Proposed Scheme** The proposed scheme will result in the A9 footprint at this location being widened on the upstream side to accommodate the scheme. The widening of the A9 footprint impacts the location of the existing culvert inlet, on the upstream side (northbound). To accommodate the proposed scheme, a number of alternative watercourse crossing options have been considered, as follows: ▪ Retain the existing culvert unchanged: The existing culvert is not long enough to accommodate the proposed scheme. ▪ Extension of the existing culvert: The existing culvert could be extended upstream to accommodate the footprint of the proposed scheme. This would accommodate the proposed scheme with no significant associated impacts. A SuDS pond is proposed at a distance of 12m from the upstream end of the culvert which would restrict flow entering the culvert inlet. As such, the area at the upstream end of the culvert will need to be altered so that a bowl-like structure which extends to the north and south will be in place at the upstream section by the embankment to better receive overland flows into the culvert. ▪ Replace the existing culvert: The culvert could be replaced on a similar alignment and gradient, with upstream channel modifications accommodating the proposed scheme. An extension has been demonstrated to be adequate, therefore a full replacement is not required. The preferred solution for this crossing, taking account of engineering and environmental design criteria, is to extend the existing culvert to accommodate the proposed scheme. The alignment and gradient shall remain the same as the existing culvert. In addition, due to the lack of a formal channel upstream of the existing crossing, localised ground reprofiling will be required to direct runoff into a local low point upstream of the new culvert inlet. A bowl-like structure will need to be put in place at the culvert inlet to attract overland flow into the culvert inlet. **Hydromorphological Assessment Summary** Construction could lead to increases in fine sediment input, whilst the culvert extension could lead to changes in flow and sediment transport dynamics and a loss of natural bed and bank material. However, at the site of the proposed culvert extension, the channel is poorly defined with an ephemeral flow regime. Therefore, regarding could be beneficial by maintaining flow conveyance along a defined channel. Impacts would be of slight significance reducing further to neutral following the implementation of mitigation. Further details on site specific impacts, mitigation and residual impacts are provided in Appendix A19.5 (Impact Assessment). **Ecological Justification** Ecological assessment has not identified this watercourse as a potential mammal corridor; hence the provision for mammal passage is not required. Ecological assessment has not identified this watercourse as having suitable fish habitat; hence the provision for fish passage is not required. No embedment is required as the new alignment is an extension of the existing culvert. **Flood Risk Justification** The existing culvert is surcharged during the design flood event i.e. 0.5% AEP (200-year) plus a 39% allowance for climate change. The water level at the existing culvert inlet is predicted to surcharge the culvert soffit by 2.31m and is predicted to be out of bank. However, the watercourse is well below the existing road level and there are no other sensitive receptors upstream of the crossing. The existing A9 is therefore not considered to be at flood risk during the design flood event, with 5.03m existing freeboard available.

			The new culvert arrangement will also be surcharged during the design flood event. The water level at the inlet is predicted to surcharge the culvert soffit by 2.19m. The head water depth at the culvert entrance is predicted to increase by 0.12m as a result of lengthening of the culvert. The available flood freeboard between headwater level and the proposed A9 road level is predicted to be 5.30m, hence the proposed scheme is not considered to be at flood risk during design flood event. The head water level is out of bank in the upstream channel however, as there are no sensitive receptors in the upstream reach no further mitigation measures are considered necessary. The adjacent proposed SuDS pond is approximately 3m higher than the head water level so there are no concerns regarding this. Downstream flood risk associated with the design flood event is not impacted by the proposed scheme.
WF05A Approximate channel bed width at mainline culvert inlet: n/a Flow data: 50% AEP: 0.32m3/s 0.5% AEP + CC: 1.58m3/s	5A/A9	Upstream and downstream extension of existing A9 Culvert New channel to be formed between culvert 5A and culvert 5b. New channel to be formed between the culvert 5A outlet to access track. Existing diameter = 1.0m Existing length = 53.98m Proposed diameter = 1.0m Proposed U/S extension = 25.81m Proposed D/S extension = 26.52m Proposed embedment = 0m	**Watercourse Crossing Baseline** Watercourse WF05A is culverted beneath the existing A9 via a 1.0m diameter concrete culvert. The existing culvert inlet is set back from the carriageway, at the toe of the road embankment, several metres the below existing and proposed A9 road levels. The existing outlet is within an area of standing water (formerly a disused curling pond) north-east of the existing A9 which then flows east towards the Tay via an outlet structure followed by a series of pipes. There is currently no formal channel upstream of this crossing with the watercourse described as ephemeral, and no formal channel downstream of the crossing where the channel is culverted to the Tay under an existing access track. **Hydromorphology baseline** Within the study area, WF05A is an intermittent channel subject to ephemeral flow regimes displaying step-pool flow types upstream of the existing A9 crossing**.** Pressures on this water feature include realignment through culverts below the B867 road and existing A9 carriageway. Downstream of the A9 the channel flows into a ponded area with evidence of extensive fine sediment and organic material deposition/ accumulation. Due to ephemeral flow conditions the watercourse cannot be classed as stable under the existing hydrophysiographic regime. Therefore, WF05A has been assigned a **low** importance classification. **Proposed Scheme** The proposed scheme will result in the A9 footprint at this location being widened on both the upstream and downstream sides of the crossing to accommodate the scheme. The widening of the A9 footprint impacts the location of the existing culvert inlet, on the upstream side (northbound) and the outlet on the downstream (southbound) side. To accommodate the proposed scheme, a number of alternative watercourse crossing options have been considered, as follows: ▪ Retain the existing culvert unchanged: The existing culvert is not long enough to accommodate the proposed scheme. ▪ Extension of the existing culvert: The existing culvert can be extended both upstream and downstream to accommodate the footprint of the proposed scheme. A new section of formal channel is required connecting crossings 5A and 5B. Removal of the existing pipe downstream and replacement with an open channel will also be required downstream. This is the preferred option. ▪ Replace the existing culvert: The culvert could be replaced on a similar alignment and gradient, with the construction of a formal channel upstream of the new crossing and downstream channel modifications to tie into the new outlet. An extension has been demonstrated to be adequate, therefore a full replacement is not required. The preferred solution for this crossing, taking account of engineering and environmental design criteria, is to extend the existing culvert to accommodate the proposed scheme. The extension will be constructed upstream and downstream at a similar internal diameter, alignment and gradient as the existing culvert. As the total length of the proposed culvert is in excess of 90m, a manhole is required and will be suitably located at the verge of the Northbound carriageway in the upstream extension to allow safe working access. In addition, due to the lack of a formal channel upstream of the existing watercourse, a new channel will be formed between the existing outlet of Culvert 5B and the new inlet of Culvert 5A. The existing pond outlet structure and pipe will be removed and replaced with a new section of open channel between the culvert outlet and the existing access track culvert inlet. The existing pond will be drained and infilled as part of the road embankment construction. **Hydromorphology Assessment Summary**

			Construction activities could alter sediment transport dynamics and availability due to the release of fine sediment during earthworks, and both bankside and in-channel working. Furthermore, in-channel and bankside works could further alter sediment transport dynamics through bed compaction and bank destabilisation. During operation, the proposed scheme has the potential to alter fluvial processes and even lead to loss of the channel, with the extension of the culvert. Removal of the ponds could lead to disconnection between the watercourse and its floodplain. Impacts would be of slight significance reducing further to neutral following the implementation of mitigation. Further details on site specific impacts, mitigation and residual impacts are provided in Appendix A19.5 (Impact Assessment). **Ecological Justifications** Ecological assessment has not identified this watercourse as a potential mammal corridor; hence the provision for mammal passage is not required. Ecological assessment has not identified this watercourse as having suitable fish habitat; hence the provision for fish passage is not required. No embedment is required for the culvert as it is an extension of the existing alignment. **Flood Risk Justifications** The existing culvert is surcharged during the design flood event i.e. 0.5% AEP (200-year) plus a 39% allowance for climate change. The water level at the culvert inlet is predicted to surcharge the culvert soffit by 0.55m and be out of bank (due to the lack of formal channel); however, the watercourse is well below the existing road level and there are no other sensitive receptors upstream of the crossing. The existing A9 is therefore not considered to be at flood risk during the design flood event, with 8.37m predicted freeboard available. The new culvert arrangement will also be surcharged during the design flood event. The water level at the inlet is predicted to surcharge the culvert soffit by 0.25m. The head water depth at the culvert entrance is not predicted to increase as a result of lengthening of the culvert. The available flood freeboard between headwater level and the proposed A9 road level is 9.26m, hence the proposed scheme is not considered to be at flood risk during design flood event. Downstream flood risk is impacted by the proposed scheme as the removal of the pond outlet structure no longer throttles the design flow. However, the increase in peak flow at the access track downstream of WF05A is considered negligible compared to peak flow in the River Tay located immediately downstream, as such, no mitigation measures are considered necessary.
	5B/B867/Railway	A small downstream extension is required to the existing rail and side road culvert Existing diameter = 1.0m Existing length = 65.56m Proposed Diameter = 1.0m Proposed Length = 70.67m	**Watercourse Crossing Baseline** The watercourse is culverted beneath the railway and the B867 side road. The proposed scheme will affect the outlet of the culvert, the footprint of the embankment is slightly extended. **Hydromorphology Baseline** See description provided for culvert number & location 5A/A9. **Proposed Scheme** The existing culvert is adequate to accommodate the proposed scheme at this location. However a small extension downstream of 5.1m is recommended to relocate the outlet clear of any proposed side road and drainage works. A new channel will be formed downstream of the culvert outlet to tie into the proposed culvert 5A inlet. **Hydromorphological Assessment Summary** Construction activities could alter sediment transport dynamics and availability due the release of fine sediment during earthworks, and both bankside and in-channel working. Furthermore, in-channel and bankside works could further alter sediment transport dynamics through bed compaction and bank destabilisation. Realignments could alter gradient but have a beneficial impact by potentially improving sediment transportation along the current poorly defined channel. Any potential bank protection could shift fluvial processes causing erosion and bank retreat along unreinforced reaches downstream, whilst the outfalling SuDS Basin B1 could alter flow dynamics. **Ecological Justifications** As per the mainline culvert 5A there is no requirement for fish or mammal passage in this location and no change to the existing culvert or local watercourse (upstream) is proposed. No embedment is required as there are no changes proposed. **Flood Risk Justifications**

			The existing culvert is surcharged during the design flood event i.e. 0.5% AEP (200-year) plus a 39% allowance for climate change. The water level at the existing culvert inlet is predicted to surcharge the culvert soffit by 0.24m and be out of bank; however, the watercourse is well below the existing railway level and there are no other sensitive receptors nearby. The available flood freeboard between headwater level and the existing railway level is 9.87m. Consequently, the existing railway and the B867 side road are not considered to be at flood risk during the design flood event. No change to existing flood risk is anticipated.
	5A/DS/Access Track	New channel to be formed between new culvert 5A outlet and access track. Existing access track culvert to be retained. Existing Diameter = 0.6m Existing length = 15.96m	**Watercourse Crossing Baseline** The watercourse is currently culverted from the curling pond outlet structure to a drop chamber via a 0.25m diameter pipe culvert, then beneath the existing access track to the east of the A9, via a 0.6m diameter pipe culvert. **Hydromorphology Baseline** See description provided for culvert number & location 5A/A9. **Proposed Scheme** The proposed scheme will result in minor changes to the access track footprint with the proposed scheme tying into the existing track adjacent to the existing culvert. Additionally, as stated, the construction of the A9 embankment will require the removal of the existing curling pond and its outfall. A section of open channel is required to between culvert 5A and the access track crossing as part of the realignment works for culvert 5A. **Hydromorphological Assessment Summary** Construction activities could alter sediment transport dynamics and availability due the release of fine sediment during earthworks, and both bankside and in-channel working. Furthermore, in-channel and bankside works could further alter sediment transport dynamics through bed compaction and bank destabilisation. Realignments could alter gradient but have a beneficial impact by potentially improving sediment transport along the current poorly defined channel. Any potential bank protection could shift fluvial processes causing erosion and bank retreat along unreinforced reaches downstream. **Ecological Justifications** As per the mainline culvert 5A there is no requirement for fish or mammal passage in this location and no change to the existing culvert is proposed. **Flood Risk Justifications** The increase in peak flow at the access track downstream of WF05A is considered negligible, and is also negligible compared to peak flow in the River Tay located immediately downstream, as such, no mitigation measures are considered necessary.
WF06 (River Tay) Approximate channel bed width at mainline culvert inlet: 81.1m Flow data: 50% AEP: 789.4 m3/s 0.5% AEP + CC: 3243 m3/s	6/A9	Existing bridge retained, with a new bridge of similar construction and arrangement constructed immediately adjacent. Existing width (span) = 225.8m Existing deck height = approx. 10.06m above water level. Proposed width (span) = 305m Proposed deck height = approx. 10.06m above water level.	**Watercourse Crossing Baseline** The River Tay Crossing bridge carries the existing A9 carriageway over the River Tay and Highland Main Line railway. The bridge was constructed circa 1977 and is a three-span structure with the superstructure comprising a single steel box girder. The deck girder is composite with a reinforced concrete deck slab. The intermediate supports are footed on end bearing piles and the end supports comprise reinforced concrete bank seat abutments on end bearing piles. There are no piers or other bridge elements within the main watercourse channel. **Hydromorphology Baseline** Within the study area, WF06 is classified as achieving 'Good' overall status under WFD and achieves an overall 'High' morphology status. The watercourse has specific targets to improve barrier to fish migration by 2027. Therefore, WF06 has been assigned a **very high** importance classification. Key characteristics are detailed below: ▪ Has a meandering single-thread planform with a confined floodplains throughout the study area, and a fragmentary vegetated riparian corridor. ▪ Comprises numerous pebble and cobble deposits including point and mid-channel bars and riffles. ▪ Banks comprise non-cohesive sand/gravel/cobble, whilst bedrock and boulders represent hard points along the bank toe. ▪ Other bedforms include pools (as part of pool-riffle sequences) and plane-bed. ▪ Pressures within the study area include a three-span bridge, seven-span bridge and bank reinforcement. **Proposed Scheme** The proposed scheme will result in the A9 footprint at this location being widened on the downstream side (southbound carriageway) to accommodate the proposed scheme. The widening of the A9 footprint impacts the location of the existing downstream face of the bridge.

			To accommodate the proposed scheme, a number of alternative watercourse crossing options have been considered, as follows: ▪ Retain the existing bridge unchanged: The existing bridge is not long enough to accommodate the proposed scheme. ▪ Replace the existing bridge: The number of options for structure replacement would have significant visual impacts and buildability issues. ▪ Construct a new bridge alongside the existing bridge: A number of different structural arrangements have been rejected on aesthetic or buildability grounds. The proposed option is a three-span structure with the superstructure comprising twin continuous steel box girders of uniform depth supporting a composite reinforced concrete deck slab. This is the preferred option. The preferred solution for this crossing, taking account of engineering and environmental design criteria, is to retain the existing three span bridge to carry the new northbound carriageway and construct a new bridge structure alongside to carry the southbound carriageway, to accommodate the proposed scheme. To stay outwith the River Tay Special Area of Conservation (SAC), the proposed new structure will have spans of 85m, 135m and 85m. This means that the new bridge is not symmetrically positioned in relation to the existing structure. The proposed scheme will maintain the existing bed gradient, with support foundations set outwith the main channel and below the level of potential scour at this location. **Hydromorphological assessment summary** Construction activities on the floodplain and adjoining tributaries could introduce additional fine sediment into the channel which could smother bed substrate and bedforms. Bankside and in-channel works could disturb bank material and lead to channel instability. Removal of riparian vegetation during enabling works could further exacerbate this effect. Installation of a pipe for SuDS Pond I could disturb an existing lateral bar during potential excavation. Operational impacts include the proposed abutments leading to removed riparian vegetation and an increased potential for scour, as well as localised changes to flow dynamics leading to changes in sediment transport dynamics. If required, scour protection could permanently alter fluvial processes locally and lead to channel adjustment. Increased rates of erosion as a result of the access track due to permanent removal of riparian vegetation. The four outfalls would also lead to permanent loss of bed and bank material leading to localised changes in flow dynamics and sediment transport dynamics. Both construction and operation impacts would lead to significant effects on WF06 (very large and large respectively), therefore specific mitigation, as summarised in Appendix 19.7 is required. With this mitigation in place, effects would likely reduce to large and moderate respectively. **Ecological Justifications** Ecological assessment has identified this watercourse as a potential mammal corridor; natural banks will be retained to maintain mammal passage. Ecological assessment has identified this watercourse as having important fish habitat as part of the SAC. The new bridge cross-section will not alter the natural river bed deposits which will allow continuity of gradient and bed material to be retained. **Flood Risk Justifications** The existing bridge is free flowing during the design flood event i.e. 0.5% AEP (200-year) plus a 53% allowance for climate change. The water level at the bridge is predicted to have 0.63m freeboard to the bridge soffit. There is existing out of bank flooding upstream and downstream of the existing structure during the design flood event. The available flood freeboard between headwater level and the existing A9 road level is 10.06m. Consequently, the existing A9 and proposed scheme road are not considered to be at flood risk during the design flood event. Negligible change to existing flood risk is anticipated. Downstream flood risk is not impacted by the proposed scheme.
WF07 Approximate channel bed width at mainline culvert inlet: n/a Flow data:	7/A9	Existing height = 2.69m Existing width = 2.75m Existing length = 17.2m Proposed Diameter = 1.8m	**Watercourse crossing Baseline** The watercourse is culverted beneath the existing A9 and Perth Road in Birnam. Note that there is an existing large 2.4m x 2.4m box culvert under-rail crossing through which WF07 passes before entering culvert beneath the existing A9. It is the A9 road culvert which is explored here as it is judged at this stage that the railway culvert will freely pass the design flow. **Hydromorphology Baseline** Within the study area, WF07 is an intermittent channel subject to ephemeral flow conditions and does not exhibit any clear hydrological connection to the existing A9. The channel does display step-pool features upstream with plain bed sections on shallower gradients. Due to the ephemeral nature of

50% AEP: 0.41m3/s 0.5% AEP + CC: 2.32m3/s		Proposed length = 152.55m Embedment = 0.3m	the channel, it cannot be considered to be stable under hydrophysiographic conditions. Therefore, WF07 has been assigned a **low** importance classification. **Proposed Scheme** The proposed scheme will result in the A9 footprint at this location being widened on the upstream side to accommodate the scheme. To accommodate the proposed scheme, a number of alternative watercourse crossing options have been considered, as follows: ▪ Retain the existing culvert unchanged: This option cannot be recommended due to lack of information. The existing culvert is unlikely to be long enough to accommodate the proposed scheme. ▪ Extend and upsize existing culvert: This option cannot be recommended due to lack of information. The existing culvert could be extended to accommodate the footprint of the proposed scheme, however we cannot confirm that this would resolve the conflicts between culvert infrastructure and proposed scheme road and drainage levels. Resolving these conflicts would likely require elevating the proposed scheme road surface and drainage levels to accommodate the existing culvert infrastructure. This would have a significant impact in terms of increasing the footprint of the road, drainage design, visual impact and also contribute to increased capital cost. ▪ Provide a new culvert: This option must be recommended due to lack of information. This option would see a new culvert underneath the existing A9 and Perth Road then transitioning to open channel across the agricultural field to the confluence with River Tay via a natural cascade. The assumed solution for this crossing, taking account of engineering and environmental design criteria, is to replace the existing culvert with a new culvert. The new proposed culvert inlet will be located between the existing railway and A9 road, where it will extend out approximately 37m East of Perth Road and 12m East of the Perth Road stub. The culvert will consist of three manholes, with the first manhole stretching out approximately 10m North-East of the culvert inlet. The second manhole will be located approximately 15m East of the proposed A9 road and 55m West of Perth Road. The third manhole will stretch out approximately 104m North-East of the culvert inlet, lying approximately 1.5m West of Perth Road. After the culvert outlet, the water will then flow into an open channel, which will then pass water into the River Tay. The downstream channel is approximately 173m long. **Hydromorphological assessment summary** A full hydromorphological assessment is not possible due to the lack of survey on the existing watercourse. The new downstream channel has been designed to be of similar alignment and similar character to the watercourse upstream. **Ecological justifications** No ecological survey available and therefore, no assessment is able to be made. No provision for mammal passage has been provided due to the long length of new culvert introduced. This will potentially negatively affect the ecological potential of the watercourse, however a comparison to existing is not available to confirm this watercourse as a potential mammal corridor. No provision for fish passage has been provided due to the long length of new culvert introduced. This will potentially negatively affect the ecological potential of the watercourse, however a comparison to existing is not available to confirm this watercourse as having suitable fish habitat. **Flood risk justifications** The new culvert arrangement will freely pass the design flood event with 0.49m culvert freeboard. The available flood freeboard between head water level and the proposed A9 road level is 5.7m, hence the proposed scheme is not considered to be at flood risk during design flood event.
WF08 (Inchewan Burn) Approximate channel bed width at mainline bridge inlet: 4.9m Flow data:	8/A9	Replacement of existing A9 bridge with new bridge. Existing length = 12.8m Existing width (span) = 28.9m Existing deck height = approx. 7.0m above water level.	**Watercourse Crossing Baseline** Watercourse WF08 passes beneath the existing A9 via a reinforced concrete bridge spanning 28.9m over the watercourse. **Hydromorphology Baseline** Within the study area, WF08 is not classified under WFD and does have anthropogenic modifications over part of its length. However, the overall length of modification in respect to the overall length of the channel is low and outwith modified reaches, the channel is in a near state of equilibrium exhibiting a diverse range of morphological features. Such features include plane-riffle and step-pool sequences upstream of the existing A9, as well as bank erosion and bars downstream of the existing A9. Flows types largely exhibit a uniform structure of rapid and tumbling flows reflecting channel morphology. Therefore, WF08 has been assigned a **high** importance classification.

50% AEP: 2.97m3/s 0.5% AEP + CC: 15.56 m3/s		Proposed length = 28m Proposed width (span) = 25m Deck height = approx. 6.3m above water level.	**Proposed Scheme** The proposed scheme will result in the A9 footprint at this location being widened on the upstream side (northbound carriageway) to accommodate the proposed scheme. The widening of the A9 footprint impacts the location of the existing upstream face of the bridge. To accommodate the proposed scheme, a number of alternative watercourse crossing options have been considered, as follows: ▪ Retain the existing bridge unchanged: The existing bridge is not long enough to accommodate the proposed scheme. ▪ Extension of the existing bridge: The existing bridge cannot be extended to accommodate the footprint of the proposed scheme, as this would reduce the headroom above the Birnam Glen Road below the minimum allowable. Resolving this conflict would require an alternative access road to be provided on the other side of the railway. This would have a significant impact in terms of increasing the footprint of the road, impact on the railway structure, visual impact and also contribute to increased capital cost. ▪ Replace the existing bridge: A number of structural arrangements have been investigated to be constructed to replace the existing crossing. The new bridge is proposed as a two-span configuration, with one span over Inchewan Burn and one span over the adjacent access road (Birnam Glen Road). This is the preferred option. The preferred solution for this crossing, taking account of engineering and environmental design criteria, is to demolish the existing bridge and replace it with a two-span bridge over the Inchewan Burn and Birnam Glen Road. The proposed scheme will maintain the existing bed gradient. The works associated with the structure will also not alter the existing bank protection/river training works, and as such there are no additional requirements for scour protection in this location. **Hydromorphological Assessment Summary** Construction activities including in-channel and bankside working could lead to fine sediment input smothering bed substrate and resulting in a homogenous bed structure. Also, the removal of riparian vegetation and construction of outfalls could destabilise channel banks and lead to scour. However, with both standard and specific mitigation in place, as detailed in Appendix A19.5 (Impact Assessment), effects would be slight. **Ecological Justifications** Ecological assessment has identified this watercourse as a potential mammal corridor. The proposed structure will not impact the watercourse and thus natural banks will be retained to maintain mammal passage. Ecological assessment has identified this watercourse as having potential suitable fish habitat, the works associated with the proposed scheme do not impact he channel and will maintain existing natural bed material. The new bridge cross-section will not alter the natural river bed deposits which will allow continuity of gradient and bed material to be retained. **Flood Risk Justifications** The existing bridge is free flowing during the design flood event i.e. 0.5% AEP (200-year) plus a 53% allowance for climate change. The water level at the bridge is predicted to have 4.21m freeboard to the bridge soffit. The available flood freeboard between headwater level and the existing A9 road level is 7m. Consequently, the existing A9 and proposed scheme road are not considered to be at flood risk during the design flood event. No change to existing flood risk is anticipated. Downstream flood risk is not impacted by the proposed scheme.
WF09 Approximate channel bed width at mainline culvert inlet: 1.45m Flow data: 50% AEP: 0.51m3/s	9/A9-U/S & 9/A9-D/S	Removal of existing A9 Culvert, to be replaced with open channel section. New culvert upstream of proposed open channel section. And extension of the existing downstream culvert (as a result of newly proposed roundabout at this location).	**Watercourse crossing baseline** Watercourse WF09 is culverted beneath the existing A9 via a 0.6m diameter concrete culvert. The existing culvert inlet and outlet are set back from the carriageway, close to the existing and proposed A9 road levels. **Hydromorphology baseline** Within the study area, WF09 has a low sinuosity planform with evidence of artificial straightening and realignment downstream of the existing A9 crossing and is extensively culverted below the A822 and the existing A9, downstream of which the channel is confined and realigned to follow field and property boundaries. Alternate bar formation upstream and step-pool formation downstream of realignments suggests an attempt to recover natural sinuosity and planform where not artificially confined. Therefore, WF09 has been assigned a **low** importance classification. **Proposed scheme**

0.5% AEP + CC: 2.55m3/s		Realignment of channel upstream of the culvert inlet Realignment of channel downstream of the culvert outlet and infill of low spot on right bank. Existing diameter = 0.6m Existing length = 51.8m Existing embedment = 0m Existing Upstream Culvert Replacement: Proposed diameter = 1.8m Proposed Length = 18.1m Proposed embedment = 0m Proposed Downstream Culvert Extension: Existing Length = 23.24m Existing Diameter = 0.6m Existing embedment = 0m Proposed extension length = 32.1m Proposed extension diameter = 0.6m Proposed extension embedment = 0m	The proposed scheme will result in the A9 being realigned and a roundabout being constructed at this location widening the footprint of the road considerably upstream and downstream. The widening of the A9 footprint impacts the location of the existing culvert inlet, on the upstream side (northbound) and the outlet on the downstream (southbound) side. To accommodate the proposed scheme, a number of alternative watercourse crossing options have been considered, as follows: ▪ Retain the existing culvert unchanged: The existing A9 is being realigned in this location with a roundabout widening the footprint upstream and downstream, the existing culvert is not long enough to accommodate the proposed scheme. ▪ Extension of the existing culvert: The existing culvert could be extended to accommodate the footprint of the proposed scheme; however, this would not resolve the conflicts between culvert infrastructure and proposed scheme road and drainage levels. Resolving these conflicts would require elevating the proposed scheme road surface and drainage levels to accommodate the existing culvert infrastructure. This would have a significant impact in terms of increasing the footprint of the road, drainage design, visual impact and also contribute to increased capital cost. ▪ Replace the existing culvert: The existing culvert be replaced on a new plan alignment on the northbound arm of the roundabout, with new upstream and downstream channel to accommodate the proposed scheme. ▪ Replace the existing culvert and extend the existing downstream culvert to pass either side of the roundabout A new culvert will be proposed upstream, located South-East of the roundabout and will pass flow from the upstream channel section to an open channel in the middle of the roundabout. The existing culvert downstream of the roundabout will be retained with an extension further upstream into the proposed open channel section within the middle of the roundabout. The culvert will pass flow downstream to the existing downstream channel, which leads to the River Braan approx. 200m downstream. A flood relief culvert will also be put in place, with its inlet formed as part of the proposed culvert extension inlet headwall. This option is recommended as it will avoid remove the need to upsize the existing culvert, which would clash with the adjacent side road, and reduces the risk of flooding downstream of the proposed roundabout. The preferred solution for this crossing, taking account of engineering and environmental design criteria, is to resize the existing upstream culvert and extend the existing downstream culvert. A flood relief culvert is also proposed downstream of the roundabout, with its inlet being located next to the proposed downstream A9 culvert inlet. The inlet of the proposed upstream culvert will lie approximately 1.5m South-East of the proposed roundabout. The outlet will be located inside of the South-East Section of the roundabout, passing flow into the open channel section through the middle of the proposed roundabout. The open channel will convey flow to the North-West connection to the proposed culvert extension inlet. The culvert will then pass flow through the extended existing culvert and then to the existing downstream channel leading to the River Braan. **Hydromorphology assessment summary** In-channel and bankside working would only cause minimal impacts to the watercourse due to its heavily modified nature and a lack of morphological features. Floodplain working however, could require the removal of riparian vegetation and the subsequent destabilisation of natural bank material, potentially affecting reaches downstream of the existing realignment. Furthermore, fine sediment input could smother bed substrate material. During operation, the new culvert would likely replace natural bed and bank material, potentially replacing any morphological features associated with channel adjustment noted along the watercourse. Lateral connectivity with bank sediment will likely be impeded by the culvert, whilst riparian vegetation will be lost. Channel straightening along the culvert could increase channel gradient along the culvert, potentially effecting flow and sediment transport processes downstream of the A9. Similarly, the proposed channel realignment will likely alter sediment transport processes due to changes in sinuosity and gradient. **Ecological justifications** Ecological assessment has not identified this watercourse as a mammal corridor; hence the provision for mammal passage is not required. Ecological assessment has not identified this watercourse as having suitable fish habitat; hence the provision for fish passage is not required. Further, the invert of the new culvert will not be buried in natural sediment as the existing watercourse has no competency to pass course sediment. The upstream existing culvert is being realigned and resized and the proposed downstream culvert is to be of a large diameter. As such, both culverts require embedment to be installed.

			Flood Risk Justifications The existing culvert is surcharged during the design flood event i.e. 0.5% AEP (200-year) plus a 39% allowance for climate change. This surcharging results in flooding of the areas to the west between WF9 and the River Braan which includes the A822, a property and a builder's yard. The water level at existing culvert inlet is predicted to surcharge the culvert soffit by 8.74m and is out of bank. The water level at the culvert inlet is predicted to overtop the existing A9 road level by 3.9m, therefore, the existing A9 is at risk of flooding. The newly proposed upstream culvert, on the South side of the roundabout, is free flowing during the design flood event. Freeboard to the proposed A9 road level is 3m. The available freeboard within the proposed pipe itself between headwater level and the Inlet Soffit level, upstream of the roundabout, is 1.11m. Consequently, the Southern section of the roundabout should remain free from flood risk. The extended downstream culvert would be surcharged during the design flood event, therefore the flood relief culvert is proposed to take excess flows and prevent an increase to flood risk in these locations. The head water depth at the extended downstream culvert inlet is not predicted to increase as a result of lengthening of the culvert, however the inlet is predicted to surcharge the culvert soffit by 0.72m. The freeboard to the proposed A9 road level is 4.31m due to the increased proposed road levels. The flood relief culvert takes all excess flows that surcharge the downstream culvert. Consequently, for the channel downstream of the roundabout, flood risk will remain the same as in baseline conditions. No flood risk to sensitive receptors is impacted by the proposed scheme.
	9/A9-D/S-FRC	Proposed flood relief culvert length = 226m Proposed flood relief culvert Height = 1m Proposed flood relief culvert width = 1.5m	**Watercourse Crossing Baseline** See description provided for culvert number & location 9/A9-U/S & 9/A9-D/S. **Hydromorphology Baseline** See description provided for culvert number & location 9/A9-U/S & 9/A9-D/S. **Proposed Scheme** The proposed scheme will result in the A9 being realigned and a roundabout being constructed at this location widening the footprint of the road considerably upstream and downstream. The widening of the A9 footprint impacts the location of the existing culvert inlet, on the upstream side (northbound) and the outlet on the downstream (southbound) side. The preferred solution for this crossing, taking account of engineering and environmental design criteria, is to resize the existing upstream culvert and extend the existing downstream culvert. A flood relief culvert will also be situated downstream of the roundabout, with its inlet being situated by a headwall, next to the headwall of the proposed culvert inlet. The flood relief culvert will lie West of the downstream culvert arrangement, passing beneath an existing footpath North of the existing A9 road parallel to the Southbound carriageway to connect to a new outfall into the River Braan. The flood relief culvert will include 4 manholes, with the first manhole located approximately 7.3m, at an angle of 60°, North-West of the proposed culvert inlet. The culvert will then facilitate a turn of approximately 45° and then extend out by 38m beyond the North-West section of the roundabout, where the second manhole will be located. The culvert will then take a sharp turn, at approximately 70° after the second manhole and extend out West by a length of approximately 67.5m towards the third manhole. After the third manhole, the culvert will then facilitate a turn of approximately 10° towards the North-West and extend by another 40m towards the fourth manhole. After the fourth manhole, the culvert will then facilitate a final turn of approximately 10° towards the North-West, where it will extend out another 63m towards the River Braan and will outfall on the right bank of the river. **Hydromorphological Assessment Summary** See description provided for culvert number & location 9/A9-U/S & 9/A9-D/S. **Ecological Justifications** As per the mainline culverts for 9 there is no requirement for fish or mammal passage in this location and no change to the existing culvert is proposed. **Flood Risk Justifications** The newly proposed flood relief culvert will be free flowing during the design flood event. Freeboard to the proposed A9 road level is 4.31m. The available freeboard within the proposed box culvert itself, between headwater level and the Inlet Soffit level, is 0.68m. Consequently, the Northern section of the roundabout should remain free from flood risk and no flood risk to sensitive receptors will be impacted by the proposed scheme.
WF11 (River Braan)	11/A9	Replacement of existing A9 bridge with new bridge.	**Watercourse Crossing Baseline** Watercourse WF11 passes beneath the existing A9 via a reinforced concrete bridge spanning 28.9m over the watercourse.

Approximate channel bed width at mainline culvert inlet: 17.6m Flow data: 50% AEP: 122 m3/s 0.5% AEP + CC: 613 m3/s		Existing length = 13.6m Existing width (span) = 28.9m Existing deck height = approx. 5.6m above water level. Proposed length = 35.5m Proposed width (span) = 51.8m Proposed deck height = approx. 6.8m above water level.	**Hydromorphology Baseline** Within the study area, WF11 is classified as achieving a 'High' morphology status. Therefore, WF11 has been assigned a **very high** importance classification. Key characteristics include: ▪ Single thread channel exhibiting pool-riffle and uniform/rapid flow types. ▪ Bedforms comprise pool-riffle and plane-riffles. **Proposed Scheme** The proposed scheme will result in the A9 footprint at this location being widened on the upstream side (northbound carriageway) to accommodate the proposed scheme. The widening of the A9 footprint impacts the location of the existing upstream face of the bridge. To accommodate the proposed scheme, a number of alternative watercourse crossing options have been considered, as follows: ▪ Retain the existing bridge unchanged: The existing bridge is not long enough to accommodate the proposed scheme. ▪ Extension of the existing bridge: The existing bridge could be extended to accommodate the footprint of the proposed scheme; however, the existing structure does not have sufficient freeboard from flood flows and any extension would increase the flood risk. Resolving this conflict would require extensive works to increase capacity of the channel beneath the bridge. This would have a significant impact in terms of increasing the footprint of the road, visual impact, contribute to increased capital cost and also impact the River Tay Special Area of Conservation (SAC). ▪ Replace the existing bridge: A number of structural arrangements have been investigated to be constructed to replace the existing crossing. The new bridge is proposed as a single span on plate girders. This is the preferred option. The preferred solution for this crossing, taking account of engineering and environmental design criteria, is to demolish the existing bridge and with a new bridge to accommodate the proposed scheme. The proposed new bridge will have a greater span over a longer length, following a new plan alignment from the existing bridge. The proposed scheme will maintain the existing bed gradient, with scour protection as required beneath natural river bed deposits to maintain bed level). The requirements of the scour protection will be determined at the specimen design stage. **Hydromorphology Assessment Summary** Bankside and floodplain working could lead to increased input of fine sediment which could smother bed substrate material and depositional features. Works within the vicinity of the channel could disturb or remove natural bed and bank material. Operational impacts could lead to throttled flows increasing erosion both upstream and downstream of the River Braan crossing. Potential scour protection could require permanent riparian vegetation removal and alter local flow and channel form. Proposed outfalls would also alter local flow dynamics and sediment transport dynamics, all of which could alter channel characteristics and physical in-channel habitat features. **Ecological Justifications** Ecological assessment has identified this watercourse as a potential mammal corridor; natural banks will be retained to maintain mammal passage Ecological assessment has identified this watercourse as having potential suitable fish habitat, the works associated with the proposed scheme do not impact he channel and will maintain existing natural bed material. The new bridge cross-section will not alter the natural river bed deposits which will allow continuity of gradient and bed material to be retained. **Flood Risk Justifications** The existing bridge is free flowing during the design flood event i.e. 0.5% AEP (200-year) plus a 53% allowance for climate change. The water level at the bridge is predicted to have 1.05m freeboard to the bridge soffit. Consequently, the existing bridge is not at risk of flooding during the design flood event. The available flood freeboard between headwater level and the existing A9 road level is 5.6m. Consequently, the existing A9 and proposed scheme road are not considered to be at flood risk during the design flood event. There is significant out of bank flooding upstream of the existing bridge during the design event. A beneficial impact to existing flood risk is anticipated upstream of the replacement structure. Downstream flood risk is not impacted by the proposed scheme. The new structure is also not at risk of flooding in the design event with a freeboard to soffit of 1.117m.

			Max water level of 53.159mAD which is above the previous bridge design soffit of 53.1mAD but the bridge has been redesigned for DF7A and will have a new soffit of 54.276mAD Road level is 56.8mD thus giving freeboard to road of 3.641m.
WF12 (Mill Lade) Approximate channel bed width at mainline culvert inlet: Flow data: 50% AEP: 20.45m^3/s 0.5% AEP + CC: 21.19m^3/s	12/A9	2m extension of the existing box culvert. New outlet headwall structure as part of A9 mainline retaining wall Existing height = 2.0m Existing width = 3.5m Existing length = 40.5m Proposed length = 42.5m Proposed embedment = 0.20m	**Watercourse Crossing Baseline** Watercourse WF12 is culverted beneath the existing A9 via a 2.00m high by 3.50m wide concrete box culvert. **Hydromorphology Baseline** Within the study area, WF12 is an engineered channel and displays a straight planform with engineered bends and no natural morphological features or signs of recovery. Therefore, WF12 has been assigned a **low** importance classification. **Proposed Scheme** The proposed scheme will result in the A9 footprint at this location being widened on both the upstream and downstream sides (southbound and northbound carriageways) to accommodate the proposed scheme including new adjacent side roads. The widening of the A9 footprint impacts the location of the existing culvert outlet. To accommodate the proposed scheme, a number of alternative watercourse crossing options have been considered, as follows: ▪ Retain the existing culvert unchanged: The existing culvert is not long enough to accommodate the proposed scheme. ▪ Retain the existing culvert with a cantilevered retaining wall to be constructed at the outlet: The existing culvert is not long enough to accommodate the proposed scheme; however, with the addition of a reinforced concrete retaining wall at the outlet of the culvert, the proposed scheme can be accommodated. This is the preferred option. ▪ Extension of the existing culvert: The existing culvert will be extended both downstream to accommodate the proposed scheme. This option impacts flood levels and encroaches on the River Tay SAC ▪ Replace the existing culvert: The existing culvert could be replaced however this has been considered unnecessary in view of the suitability of the cantilevered retaining wall option. The preferred solution for this crossing taking account of engineering and environmental design criteria is to retain the existing culvert without extending it, which requires large and lengthy retaining walls to be constructed at the outlet end to support the new carriageway embankment. These walls will incorporate large overhang cantilevers to carry the excess width of the new alignment that would otherwise need an extension to the culvert length. The proposal not to extend the culvert is driven by environmental and flood risk considerations. The proposed scheme will maintain the existing bed gradient, with scour protection as required beneath natural river bed deposits to maintain bed level). The requirements of the scour protection will be determined at the specimen design stage. **Hydromorphology Assessment Summary** During construction, in-channel works could lead to losses of some natural bank material, whilst bankside working could lead to bank destabilisation and scour. Fine sediment input as a result of construction could lead to diffuse impacts on the River Tay, if there is a pathway to the receptor via WF12. During operation, flow regimes could change due to increased impervious surfaces adjacent to the channel, whilst fluvial processes could alter following the culvert extension. Outfalls would likely lead to a permanent loss of natural bank material. **Ecological Justifications** The existing culvert has an informal mammal ledge which does not appear to have been designed in accordance with DMRB LD 118, specifically it is located below the flood level suggested in guidance. The existing culvert cross-section cannot accommodate mammal ledges compliant with DMRB LD 118 geometry, therefore, it is proposed the existing ledge will be retained and tied into the newly formed bank at the retaining wall downstream to retain mammal passage. Ecological assessment has not identified this watercourse as having suitable fish habitat; hence the provision for fish passage is not required. The culvert invert is specified to be embedded through the proposed culvert extension to maintain continuity of the culvert invert gradient and natural bed material. **Flood Risk Justifications**

			The existing culvert is surcharged during the design flood event i.e. 0.5% AEP (200-year) plus a 53% allowance for climate change. The water level at the existing culvert inlet is predicted to surcharge the culvert soffit by 3.28m and there is significant out of bank flooding upstream of the existing bridge during the design event. The available flood freeboard between headwater level and the existing A9 road level is 2.73m. Consequently, the existing A9 is not considered to be at flood risk during the design flood event. As there are no changes proposed to the culvert there is no new anticipated flood risk to the scheme. The new road level will be raised to 56.37mAD giving 3.151m of freeboard to peak water level of 53.219mAD. Consequently, the proposed A9 is not considered to be at flood risk during the design flood event. Further, no impact to existing flood risk is anticipated.
WF12A Approximate channel bed width at mainline culvert inlet: 0.4m Flow data: 50% AEP: 0.28m3/s 0.5% AEP + CC: 1.41m3/s	12A/A9	No changes are proposed to the existing A9/Railway Culvert Existing diameter = 1.05m Existing length = 99.1m	**Watercourse Crossing Baseline** The watercourse is culverted beneath the railway and the existing A9 road. **Hydromorphology Baseline** Within the study area, WF12A has a low sinuosity planform and steep gradient with realignment through culverts below the existing A9 and Highland Main Line railway. Upstream of the existing A9 WF12A displays limited natural morphological features including steps and pools. Downstream of the A9, WF12A is largely channelised before discharging into the River Tay. Therefore, WF12A has been assigned a **low** importance classification. **Proposed scheme** The proposed scheme will not widen the road footprint beyond the existing culvert inlet, nor will the proposed scheme infrastructure conflict with the existing culvert, as such the existing crossing will be retained unchanged. The existing culvert is adequate to accommodate the proposed scheme at this location. **Hydromorphological Assessment Summary** During construction, in-channel and bankside working could remove riparian vegetation and disturb bed and bank material leading to changes in flow and sediment transport dynamics, whereby scour and deposition could result. Other works could release additional fine sediment into WF13, altering sediment transport dynamics and smothering the bed substrate. During operation, the extended culvert would likely replace natural bed and bank material, potentially replacing any step-pool sequences identified along the channel. Lateral connectivity with bank sediment will likely be impeded by the culvert extension, whilst riparian vegetation will be lost. Channel straightening along the culvert could increase channel gradient along the culvert, potentially affecting flow and sediment transport processes downstream of the A. Based on the alignment of the culvert extension, channel realignments, upstream and downstream of the A9 are a likely requirement. Therefore, impacting flow and sediment transport processes along the watercourse. **Ecological Justifications** No change to the existing culvert and local watercourse is proposed. As such, no embedment is required. **Flood risk Justifications** The existing culvert is surcharged during the design flood event i.e. 0.5% AEP (200-year) plus a 39% allowance for climate change. The water level surcharges the culvert soffit at the inlet by 0.05m. The available flood freeboard between headwater level and the existing A9 road level is 8.26m. Consequently, the existing railway and A9 road are not considered to be at flood risk during the design flood event. The available flood freeboard between the headwater level and the proposed A9 road level is predicted to be 9.92m. Consequently, the proposed road is not considered to be at flood risk during the design flood event. No change to existing flood risk is anticipated.
WF12B Approximate channel bed width at mainline culvert inlet: Flow data:	12B/A9	Existing diameter = 1.2m Existing length = 90m Proposed Diameter = 1.8m Proposed Length = 132.3m Proposed Embedment = 0.3m	**Watercourse Crossing Baseline** Watercourse WF12B is culverted underneath the existing A9 and railway. The newly proposed culvert alignment will be underneath the new section of carriageway and embankments. **Hydromorphology baseline** Within the study area, WF12B has a low sinuosity and pool defined channel upstream of the existing A9. The channel exhibits realignment through a culvert below the existing A9 and Highland Main Line railway. WF12B cannot be assessed as “stable” under hydrophysiographic conditions, in that it has

50% AEP: 0.31m3/s 0.5% AEP + CC: 1.54m3/s			been so heavily modified and subjected ephemeral flow conditions that natural channel morphology criteria cannot be applied. Therefore, WF12B has been assigned a **low** importance classification. **Proposed scheme** To accommodate the proposed scheme, a number of alternative water crossing options have been considered as follows: ▪ Retain the existing culvert unchanged: The existing culvert is not long enough to accommodate the proposed scheme. ▪ Extend the existing culvert. The existing culvert can be extended to accommodate the footprint of the proposed scheme, however this will not resolve the conflicts between culvert infrastructure and proposed scheme road and drainage levels. Resolving these conflicts will require elevating the proposed scheme road surface and drainage levels to accommodate existing culvert infrastructure. This would have a significant impact in terms of increasing the footprint of the road, drainage design, visual impact and also contribute to increased capital cost. ▪ Replace the existing culvert. This is the preferred option: that the culvert will be replaced with a new pipe culvert on a new plan and vertical alignment, straight through its whole course from inlet to outlet, with a manhole approximately halfway. This option appears to be the most feasible, with the inlet of the culvert aligned to the channel upstream of the proposed road footprint and the outlet at the same location and level as the existing culvert outlet. A straight alignment will minimise energy losses in comparison to a culvert where a bend takes place in the alignment. The preferred solution for this crossing taking account of engineering and environmental design criteria is to replace the existing culvert at a revised alignment to accommodate the proposed scheme. The proposed scheme will require an earthwork 'cut' into the adjacent hillside to win space to accommodate the new northbound carriageway and the new adjacent side road. A new culvert inlet is proposed at the edge of the upstream earthworks, this will involve realigning the approaching channel upstream of the existing A9 Road over approximately 4.0m. **Hydromorphology Assessment Summary** During construction, in-channel works could disturb or remove natural bed and bank material and increase sediment mobilisation causing changes in sediment transport dynamics and lead to the smothering bed substrate material. During operation, replacement of 40m of channel by the proposed side road and culvert extension could lead to changes to flow and sediment transport dynamics, which could potentially impact WF12. **Ecological Justifications** The culvert invert is specified to be embedded through the proposed culvert to maintain continuity of the culvert invert gradient and natural bed material. Ecological assessment has not identified this watercourse as a mammal corridor; hence the provision for mammal passage is not required. Ecological assessment has not identified this watercourse as having suitable fish habitat; hence the provision for fish passage is not required. **Flood Risk Justifications** The existing culvert is surcharged during the design flood event i.e. 0.5% AEP (200-year) plus a 39% allowance for climate change. The water level at the culvert inlet is predicted to surcharge the culvert soffit by 0.20m and is predicted to be in bank. However, the watercourse is well below the existing road level and there are no other sensitive receptors upstream of the crossing. The existing A9 is therefore not considered to be at flood risk during the design flood event, with 1.5m existing freeboard available. However, in order to accommodate the new proposed A9 Scheme, a realignment is considered necessary as is a new culvert. The existing culvert is not long enough to accommodate the proposed scheme. The proposed culvert arrangement will freely pass the design flood event of 0.5% AEP (200-year) design flood event plus a 39% allowance for climate change, with 0.71m culvert freeboard during the design flood event. The head water depth at the culvert entrance is predicted to be 0.61m less than the existing culvert as a result of upsizing the culvert to allow for free flow under design flood event. The proposed culvert arrangement provides greater freeboard than the existing culvert for both the culvert inlet and the A9 proposed road level. The available flood freeboard between headwater level and the proposed A9 road level is 2.06m, hence the proposed scheme is not considered to be at flood risk during design flood event. As the head water level is contained within the upstream channel, no further mitigation measures are considered necessary.

			Downstream flood risk is not impacted by the proposed scheme.
WF13 Approximate channel bed width at mainline culvert inlet: 1.55m Flow data: 50% AEP: 0.72m3/s 0.5% AEP + CC: 4.01m3/s	13/A9	Replacement of existing A9 culvert with new box culvert on new alignment. Realignment of channel upstream of the mainline culvert inlet. Realignment of channel downstream of the mainline culvert outlet. Existing diameter = 1.0m Existing length = 45.0m Proposed height = 1.8m Proposed width = 2.7m Proposed length = 174.4m Proposed embedment = 0.3m	**Watercourse Crossing Baseline** Watercourse WF13 is culverted beneath the existing A9 via a 1.0m diameter concrete culvert. The existing culvert inlet is set back from the carriageway, close to the existing and proposed A9 road levels. **Hydromorphology Baseline** Within the study area, WF13 exhibits a wide range of morphological features including steps and pools, and plane riffle bed forms and is achieving near state equilibrium for most of its length with exception of a small length of reach upstream of the existing A9 crossing where incision was observed. Therefore, WF13 has been assigned a high importance classification. **Proposed Scheme** The proposed scheme will result in the new Dalguise Junction being constructed in the location of the existing crossing, including northbound and southbound side roads and an underpass beneath the proposed A9 road. The widening of the A9 footprint impacts the location of the existing culvert inlet, on the upstream side (northbound) and the outlet on the downstream (southbound) side. To accommodate the proposed scheme, a number of alternative watercourse crossing options have been considered, as follows: ▪ Retain The Existing Culvert Unchanged: The existing culvert is not long enough to accommodate the proposed scheme. ▪ Extend The Existing Culvert: The existing culvert could be extended to accommodate the footprint of the proposed scheme, however this would not resolve the conflicts between culvert infrastructure and proposed scheme road and drainage levels, as well as the road and drainage levels of the proposed Dalguise junction underpass. Resolving these conflicts would require elevating the proposed scheme road surface and drainage levels to accommodate the existing culvert infrastructure. This would have a significant impact in terms of increasing the footprint of the road, drainage design, visual impact and also contribute to increased capital cost. ▪ Replace Existing Culvert On New Alignment: The culvert can be replaced on a new alignment with multiple sections and manhole to accommodate the proposed scheme. Upstream and downstream channel realignments are required to tie into the existing watercourse. This is the only viable option for this watercourse due to the construction of the Dalguise Junction. The preferred solution for this crossing, taking account of engineering and environmental design criteria, is to replace the existing culvert with a new box culvert to accommodate the proposed scheme. Due to the widened road footprint and the presence of the side roads the proposed culvert will be significantly longer than the existing with the inlet starting approximately 7m West of the proposed northbound side road and 35m South of the existing watercourse. The culvert will extend approximately 80m East towards the proposed underpass, then extending 50m North-East towards the Non-Motorised User (NMU) Path. The culvert will then extend approximately 40m North to connect back into the existing watercourse alignment immediately upstream of the existing railway crossing. To avoid clashes with proposed A9 road designs and drainage, the culvert design will include three manholes, with the first located between the upstream side road and the northbound carriageway. The second manhole will be located between the southbound carriageway and the proposed underpass, where the manhole will facilitate a turn of approximately 40° towards the third manhole. The third manhole will be located between the proposed underpass and the proposed SUDS access track. The third manhole will facilitate a turn of approximately 40° towards the culvert outlet. The 2 bends at 40° are considered necessary as they will both avoid clashes with the proposed underpass and A9 Road, whilst also simultaneously preventing the need to accommodate a larger bend which would risk blockage debris and head loss within the culvert. At specimen design, a curved alignment between the two manholes will be explored to navigate the 80^{o} bend in a continuous curve. This will be achievable either using angles between box culvert sections of use of special sections. **Hydromorphological Assessment Summary** During construction, in-channel and bankside working could remove riparian vegetation and disturb bed and bank material leading to changes in flow and sediment transport dynamics, whereby scour and deposition could result. Other works could release additional fine sediment into WF13, altering sediment transport dynamics and smothering the bed substrate.

			During operation, culverting would replace natural bed and bank material leading to a loss in morphological features observed along the channel and fragment both longitudinal and lateral connectivity of the watercourse, as well as leading to a permanent loss in riparian vegetation. Changes in channel gradient could also change flow dynamics resulting in change sin sediment transport dynamics. Channel realignments could lead to changes in flow and sediment transport dynamics along the channel, as well as any bank protection. The latter could shift erosional processes to downstream reaches, whilst fragmenting lateral connectivity between the channel and bank face sediments. **Ecological Justifications** Ecological assessment has not identified this watercourse as a mammal corridor; hence the provision for mammal passage is not required. Ecological assessment has not identified this watercourse as a suitable fish passage, hence the provision for fish passage is not required. The culvert invert is specified to be embedded through the proposed culvert to maintain continuity of the culvert invert gradient and natural bed material. **Flood Risk Justifications** The existing culvert is surcharged during the design flood event i.e. 0.5% AEP (200-year) plus a 39% allowance for climate change. The water level at the culvert inlet is predicted to surcharge the culvert soffit by 1.95m and is predicted to be out of bank. However, the watercourse is well below the existing road level and there are no other sensitive receptors upstream of the crossing. The existing A9 is therefore not considered to be at flood risk during the design flood event, with 2.59m existing freeboard available. The new culvert arrangement will freely pass the design flood event, with 0.365m culvert freeboard during the design flood event. The head water depth at the culvert entrance is predicted to be 1.52m less than the existing culvert as a result of upsizing the culvert to allow for free flow under design flood event. Additionally, head loss values at the 80° bend have been taken into account, with a resultant 0.133m head loss contributing to the headwater level at the inlet. The available flood freeboard between headwater level and the proposed A9 road level is 1.9m, hence the proposed scheme is not considered to be at flood risk during design flood event. As the head water level is contained within the upstream channel, no further mitigation measures are considered necessary. Downstream flood risk is impacted by the proposed scheme, as the increased capacity of the culvert will result in increased flow downstream of the A9. There is a single sensitive flood receptor downstream of the crossing, the Highland Mainline Railway. The increase in flows downstream is small in comparison to the receiving watercourse (River Tay) and any exceedance will result in shallow depths of flooding within the existing floodplain, at far lower depths than occurs during even a 3.33% (30-year) event on the River Tay, therefore the increase in flood risk is considered negligible.
WF14 Approximate channel bed width at mainline culvert inlet: 1.1m Flow data: 50% AEP: 0.43m3/s 0.5% AEP + CC: 2.23m3/s	14/B898	Upstream extension of existing A9 Culvert Local regrading of channel upstream of the culvert inlet Existing diameter = 1.2m Existing length = 24.3m Proposed diameter = 1.2m Proposed upstream extension = 3.1m	**Watercourse Crossing Baseline** Watercourse WF14 is culverted beneath the existing B898 side road via a 1.2m diameter concrete culvert. The existing culvert inlet is set back from the carriageway, close to the existing and proposed B898 road level. **Hydromorphology Baseline** Within the study area, WF14 displays a low sinuosity planform and steep gradient with realignments through culverts below the existing A9, farm access tracks and local access roads. Upstream of the A9 WF14 displays natural morphological features including steps and pools indicating an attempt to recover to a natural equilibrium. Therefore, WF14 has been assigned a **moderate** importance classification. **Proposed Scheme** The proposed scheme will result in the B898 footprint at this location being widened on the upstream side to accommodate the scheme impacting the location of the existing culvert inlet. To accommodate the proposed scheme, a number of alternative watercourse crossing options have been considered, as follows: ▪ Retain the existing culvert unchanged: The existing culvert is not long enough to accommodate the proposed scheme. ▪ Extend the existing culvert: As the existing culvert plan and vertical alignment does not conflict with the proposed scheme road and drainage levels, this is considered to be the preferred option. The existing culvert will be extended upstream to accommodate the proposed scheme. ▪ Replace the existing culvert: The existing culvert could be replaced however this has been considered unnecessary in view of the suitability of the extension option.

			The preferred solution for this crossing, taking account of engineering and environmental design criteria, is to extend the existing culvert to accommodate the proposed scheme. The new culvert section will have an identical internal diameter, alignment and gradient as the existing culvert. To accommodate the proposed culvert invert levels, it is proposed to regrade a short section of upstream watercourse from the culvert inlet to tie-in with the existing upstream channel bed levels. **Hydromorphological assessment summary** During construction, In-channel works would disturb bed and bank material, as well as observed bedforms, leading to potential channel instability. Bankside working would likely lead to removal of riparian vegetation and disturbance to bank material potentially resulting in bank instability. Other works would likely lead to an influx of fine sediment which could alter sediment transport dynamics and smother bed substrate material. During operation, culvert extension would lead to a permanent loss of riparian vegetation and natural bed and bank material potentially leading to channel adjustment. Culvert extensions and replacement would alter channel gradient, also potentially leading to channel adjustment. Bank protection could also lead to changes in flow dynamics and therefore sediment transport dynamics, whilst channel realignment could lead to localised benefits. **Ecological Justifications** Ecological assessment has not identified this watercourse as a mammal corridor; hence the provision for mammal passage is not required. Due to the infrequent nature of the traffic using the side road the risk to mammals crossing overland in times of high river flow within the culvert barrel is not considered to be significant. Hence no provision of mammal ledges etc. within the new culvert section is proposed. Ecological assessment has identified this watercourse as having potential suitable fish habitat; however, this is mostly limited to the section of the watercourse downstream of the railway crossing, which is likely acting as a barrier to fish due to gradient. As the new alignment is a small extension of the existing culvert, no embedment is required. **Flood Risk Justifications** The existing culvert is surcharged during the 0.5% AEP (200-year) plus a 39% allowance for climate change. The water level surcharges the existing culvert inlet by 0.24m. The water level at the culvert inlet is out of bank of the upstream channel; however, there are no sensitive receptors upstream of the culvert. The existing B898 is therefore not considered to be at flood risk during the design flood event, with 1.04m predicted freeboard available. The proposed extended culvert is surcharged during the design flood. The head water level is predicted to surcharge the culvert extension by 0.09m. The head water depth at the culvert entrance is predicted to increase by 1.66m as a result of lengthening of the culvert. The available flood freeboard between headwater level and the proposed A9 road level is 1.8m, hence the proposed scheme is not considered to be at flood risk during design flood event. The head water level is out of bank in the upstream channel; however, as there are no sensitive receptors in the upstream reach no further mitigation measures are considered necessary. Downstream flood risk associated with the design flood event is not impacted by the proposed scheme.
WF16 Approximate channel bed width at mainline culvert inlet: 1.3m Flow data: 50% AEP: 0.57m3/s 0.5% AEP + CC: 1.30m3/s	16/A9	Replacement of existing A9 culvert with new culvert. New cascade feature to lower upstream watercourse to new culvert entrance invert level and local realigning of the channel downstream of the culvert outlet. Existing diameter = 1.1m Existing length = 43.8m Proposed diameter = 1.35m Proposed length = 40.89m	**Watercourse Crossing Baseline** Watercourse WF16 is culverted beneath the existing A9 via a 1.1m diameter concrete culvert. The existing culvert inlet is set back from the carriageway close to existing and proposed A9 road levels. **Hydromorphology Baseline** Within the study area, WF16 has a low sinuosity planform and steep gradient with realignments through culverts below the existing A9, farm access tracks and local access roads. Upstream of the A9, WF16 displays limited natural morphological features and displays an ephemeral flow regime. Therefore, WF16 has been assigned a **medium** importance classification. **Proposed Scheme** The proposed scheme will result in the A9 footprint at this location being widened on both the upstream and downstream sides to accommodate the scheme. The proposed widening on the downstream side (northbound carriageway) is included within the Tay Crossing to Ballinluig scheme, whereas the upstream (southbound carriageway) widening is included within the Dunkeld to Tay Crossing Scheme. Additionally, a new road drainage treatment basin on the downstream side clashes with the location of the existing culvert outlet. To accommodate the proposed scheme, a number of alternative watercourse crossing options have been considered, as follows: ▪ Retain the existing culvert unchanged: The existing culvert is not long enough to accommodate the proposed scheme.

		Proposed embedment = 0.225m	▪ Extension of the existing culvert: The existing culvert could be extended to accommodate the footprint of the proposed scheme; however, this would not resolve the conflicts between the culvert infrastructure and proposed scheme road and drainage levels. Resolving the level conflicts would require elevating the proposed scheme road and drainage level to accommodate the existing culvert infrastructure and moving the drainage pond. This would have a significant impact in terms of increasing the footprint of the road, drainage design, visual impact, and also contribute to increased capital cost. ▪ Replace the existing culvert: This is the preferred option that the culvert will be replaced to a new alignment and lower gradient to accommodate the proposed scheme. The preferred solution for this crossing, taking account of engineering and environmental design criteria, is to replace the existing culvert with a new culvert to accommodate the proposed scheme. The new culvert replaces the existing culvert on a new plan alignment with a new culvert inlet location at a lower level than the existing. This will require the culvert invert level at its inlet to be set at a lower level than the present channel bed level at this location. In addition, the channel gradient immediately upstream of the culvert entrance will be steeper; hence a new cascade feature will be required to convey the flow of water to the culvert entrance. A new culvert exit is proposed to the north of the new drainage basin. The proposed new culvert will have a larger internal diameter to convey flow beneath the proposed scheme infrastructure to the outlet location. Realignment of the upstream channel is required locally at the top of the earthwork 'cut' to meet the cascade entrance. Downstream, channel realignment is required to tie into the existing watercourse upstream of the access track crossing downstream. **Hydromorphological Assessment Summary** During construction, in-channel works would disturb bed and bank material, as well as observed bedforms, leading to potential channel instability. Bankside working would likely lead to removal of riparian vegetation and disturbance to bank material potentially resulting in bank instability. Other works would likely lead to an influx of fine sediment which could alter sediment transport dynamics and smother bed substrate material. During operation, culvert extension would lead to a permanent loss of riparian vegetation and natural bed and bank material potentially leading to channel adjustment. Culvert extensions and replacement would alter channel gradient, also potentially leading to channel adjustment. Bank protection could also lead to changes in flow dynamics and therefore sediment transport dynamics, whilst channel realignment could lead to localised benefits. **Ecological Justifications** Ecological assessment has not identified this watercourse as a mammal corridor; hence the provision for mammal passage is not required. Ecological assessment has not identified this watercourse as having potential suitable fish habitat, additionally as the proposed cascade feature is likely to be a barrier to sediment transport the invert of the new culvert will not be buried. **Flood Risk Justifications** The existing culvert freely passes the peak flow associated with the design flood event i.e. 0.5 % AEP (200-year) plus a 39% allowance for climate change, however peak water levels upstream are predicted to be out of bank under the design flood event. Freeboard to the existing A9 road level is 0.6m, consequently the existing A9 is not considered to be at flood risk during the design flood event. The new culvert arrangement will also freely pass the design flood event, with 0.29m culvert freeboard during the design flood event. The head water depth at the culvert entrance is predicted to decrease by 0.108m as a result of upsizing the culvert to allow for free flow under design flood event. The available flood freeboard between headwater level and the proposed A9 road level is 3.53m, hence the proposed scheme is not considered to be at flood risk during design flood event. The head water level is out of bank in the upstream channel however, as there are no sensitive receptors in the upstream reach no further mitigation measures are considered necessary. Downstream flood risk associated with the design flood event is not impacted by the proposed scheme.
WF18 Approximate channel bed width at mainline culvert inlet: 1.8m Flow data: 50% AEP: 0.55m3/s	18/A9	Replace existing A9 culvert with new box culvert. New cascade feature to lower upstream watercourse to new culvert entrance invert level. Existing diameter = 0.77m	**Watercourse Crossing Baseline** Watercourse WF18 is culverted beneath the existing A9 via a 0.77m diameter concrete culvert. The existing culvert inlet is set back from the carriageway at the top of an existing embankment. The embankment is set at a steeper gradient than a straight alignment between the inlet and outlet meaning the gradient of the culvert must change at an unknown location. **Hydromorphology Baseline** Within the study area, WF18 displays a low sinuosity planform and steep gradient with realignments through culverts below the existing A9, and local access roads. Upstream of the A9 WF18 displays natural morphological features including boulder steps and pools indicating an attempt to recover to a natural equilibrium. Therefore, WF18 has been assigned a **medium** importance classification.

0.5% AEP + CC: 1.21m3/s		Existing length = 75.5m Proposed height = 1.5m Proposed width = 1.8m Proposed length = 42.9m Proposed embedment = 0.25m	**Proposed Scheme** The proposed scheme will result in the A9 footprint at this location being widened on the upstream side (southbound carriageway) to accommodate the scheme and new adjacent side road. To accommodate the proposed scheme, a number of alternative watercourse crossing options have been considered, as follows: ▪ Retain the existing culvert unchanged: The existing culvert is long enough to accommodate the proposed scheme, however, the existing culvert infrastructure conflicts with proposed road and drainage levels and proposed re-profiling of the existing embankment. ▪ Extension of the existing culvert: The existing culvert is long enough to accommodate the footprint of the proposed scheme; however, this would not resolve the conflicts between culvert infrastructure and proposed scheme levels and excavation. Resolving these conflicts would require elevating the proposed scheme road and drainage levels to accommodate the existing culvert infrastructure. This would have a significant impact in terms of increasing the footprint of the road, drainage design, visual impact, and also contribute to increased capital cost. ▪ Replace the existing culvert: This is the preferred option: that the culvert will be replaced to a new alignment and lower gradient to accommodate the proposed scheme. The preferred solution for this crossing, taking account of engineering and environmental design criteria, is to replace the existing culvert at a revised alignment to accommodate the proposed scheme. The new box culvert replaces the existing culvert on the same plan alignment with the culvert outlet location being retained, at a lower invert level than the present river bed level. The proposed scheme will require an earthwork 'cut' into the adjacent hillside to win space to accommodate the new southbound carriageway. A new culvert inlet is proposed at the edge of the upstream road verge thereby reducing the length of culvert required. This will require the culvert invert level at its inlet to be set at a lower level than the present channel bed level at this location. In addition, the channel gradient immediately upstream of the culvert entrance will be steeper; hence a new cascade feature will be required to convey the flow of water to the culvert entrance. Realignment of the upstream channel is required locally at the top of the earthwork 'cut' to meet the cascade entrance. Downstream, channel regrading is required to tie into the existing watercourse. **Hydromorphological Assessment Summary** During construction, In-channel works would disturb bed and bank material, as well as observed bedforms, leading to potential channel instability. Bankside working would likely lead to removal of riparian vegetation and disturbance to bank material potentially resulting in bank instability. Other works would likely lead to an influx of fine sediment which could alter sediment transport dynamics and smother bed substrate material. Culvert extensions would lead to a loss of natural bed material, whilst as with bank protection would lead to losses of natural bank material, lateral connectivity and riparian vegetation. Both would also shift sediment transport dynamics leading to potential erosion and/or deposition upstream and/or downstream. Channel realignments would likely alter flow and sediment transport dynamics, but this may present an opportunity to benefit the watercourse. **Ecological Justifications** Ecological assessment has identified this watercourse as being an active mammal corridor and consequently there is a requirement to provide mammal passage. To facilitate this, a box culvert is proposed, with mammal ledges set at the appropriate level. The invert of the new culvert will be buried to maintain continuity of the culvert invert gradient and natural bed material. The culvert invert is specified to be embedded through the proposed culvert to maintain continuity of the culvert invert gradient and natural bed material. **Flood Risk Justifications** The existing culvert is surcharged during the design flood event i.e. 0.5% AEP (200-year) plus a 39% allowance for climate change. The water level at the culvert inlet is predicted to surcharge the culvert soffit by 0.42m, although peak water level is predicted to be contained within the riverbanks of the upstream channel. The existing A9 is therefore not considered to be at flood risk during the design flood event, with 2.64m predicted freeboard available. The new culvert arrangement will freely pass the design flood event, with 0.54m culvert freeboard during the design flood event. The head water depth at the culvert entrance is predicted to decrease by 0.35m as a result of upsizing of the culvert to allow for mammal passage.

			The available freeboard between headwater level and the proposed A9 road level is 3.07m, hence the proposed scheme is not considered to be at flood risk during design flood event. As the head water level is contained within the upstream channel, no further mitigation measures are considered necessary. Downstream flood risk is impacted by the proposed scheme, as the larger culvert barrel no longer throttles the design flow upstream. However, the increase in peak flow at WF18 is considered negligible compared to peak flow in the River Tay located immediately downstream, as such, no mitigation measures are considered necessary.

1.4 Photographs

1.4.1 Photographs of each of the culverts and watercourses are provided in Table A19.3-2. Typically, where available, both upstream and downstream photographs are provided to illustrate smaller structures. Larger structures, e.g. bridges, are provided with a single representative view.

Table A19.3-2: Watercourse photographs

	
Photograph 1: WF1 Existing A9 culvert outlet and downstream cascade	**Photograph 2: WF1 Existing A9 culvert inlet and upstream channel**

	
Photograph 3: WF2 Existing A9 culvert outlet and downstream channel	**Photograph 4: WF2 Existing A9 culvert inlet and upstream channel**

Photograph 5: WF05 Existing A9 culvert outlet and downstream channel

Photograph 6: WF05 where upstream channel sinks upstream of the Existing A9

Photograph 7: WF05A Existing Railway culvert outlet and downstream channel	Photograph 8: WF05A Existing Railway culvert inlet and upstream channel

	
Photograph 9: WF05A Existing A9 outlet and downstream channel	**Photograph 10: WF05A Existing A9 culvert inlet and upstream channel**

Photograph 11: WF05A Existing Access Track culvert outlet and downstream channel

Photograph 12: WF05A Existing Access Track culvert inlet and upstream channel

Photograph 13: WF07 Lack of visible outlet downstream of rail structure	Photograph 14: WF07 Approximate location of existing inlet and channel upstream of rail crossing

Photograph 15: WF08 (Inchewan Burn) Existing A9 bridge looking upstream

Photograph 16: WF09 Existing A9 culvert outlet and downstream channel

Photograph 17: WF09 Existing A9 culvert inlet and upstream channel

Photograph 18: WF09 Existing access track culvert outlet and downstream channel	Photograph 19: WF09 Existing access track culvert outlet and upstream channel

Photograph 20: WF11 (River Braan) Existing A9 bridge

Photograph 21: WF12 (Mill Lade) Existing A9 Culvert outlet and downstream channel

Photograph 22: WF12 (Mill Lade) Existing A9 Culvert inlet and upstream channel

Photograph 23: WF12A Existing A9 culvert outlet and downstream channel	Photograph 24: WF12A Existing A9 culvert inlet and upstream channel
	
Photograph 25: WF12B Existing A9 culvert outlet and downstream channel	**Photograph 26: WF12B Existing A9 culvert manhole, inlet not found and upstream channel ephemeral**

Photograph 27: WF13 Existing A9 culvert outlet and downstream channel

Photograph 28: WF13 Existing A9 culvert inlet and upstream channel

Photograph 29: WF14 Existing Side Road culvert outlet and downstream channel	Photograph 30: WF14 Existing Side Road culvert inlet and upstream channel

Photograph 31: WF06 (River Tay) Existing A9 bridge

Photograph 32: WF16 Existing A9 culvert outlet and downstream channel

Photograph 33: WF16 Existing A9 culvert inlet and upstream channel

Photograph 34: WF18 Existing A9 culvert outlet and downstream channel	Photograph 35: WF18 Existing A9 culvert inlet and upstream channel

1.5 Drawings

1.5.1 Engineering sketches (and where available, drawings) are provided for each watercourse crossing. Sketches outlining the proposed arrangements are provided for the numerous smaller watercourse crossings which are proposed to be replaced or extended to accommodate the widened A9 footprint. General Arrangement drawings of the larger structures are provided, which present a greater level of detail for these structures.

1.6 References

Regulations

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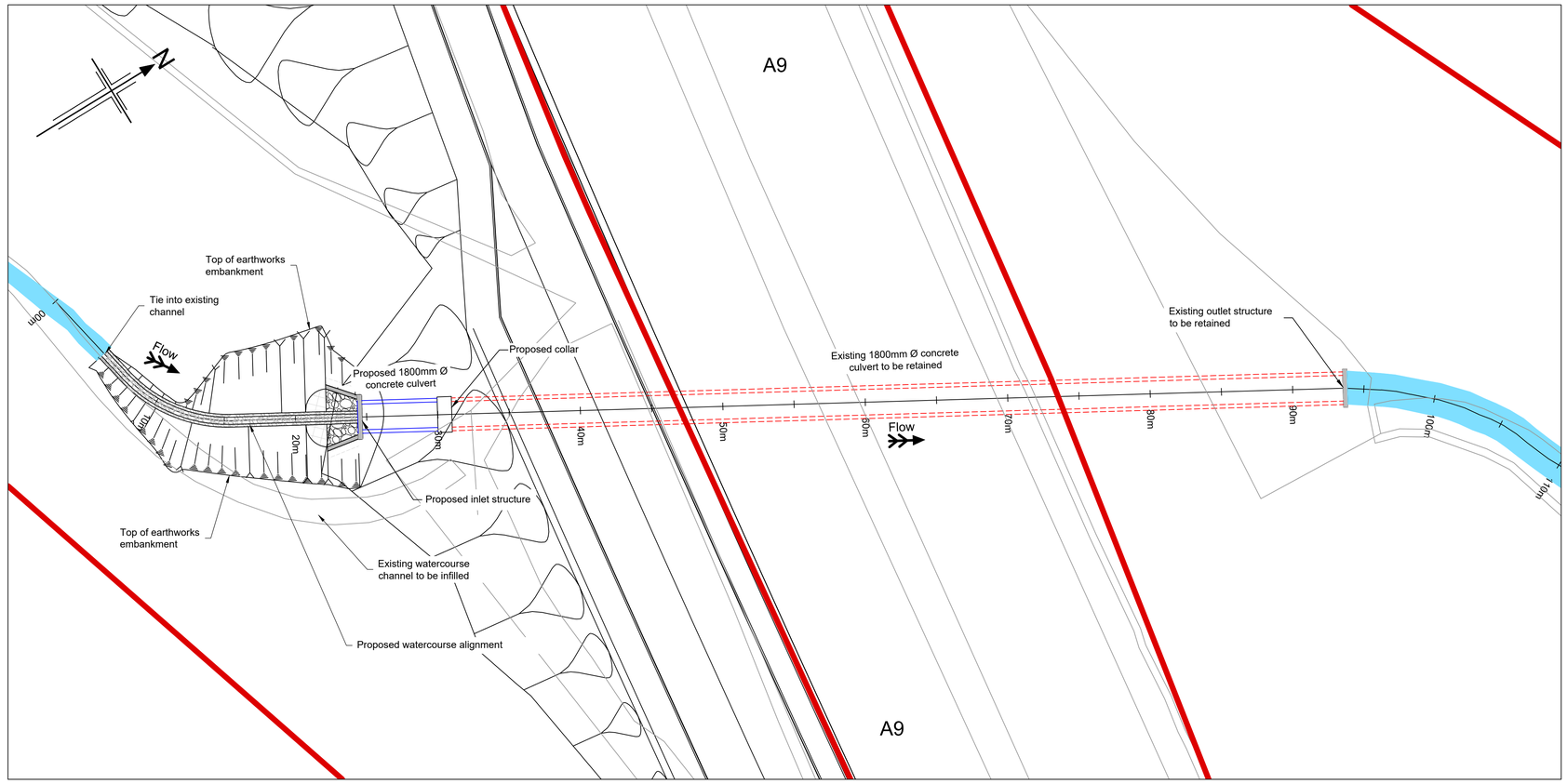

WF01 - PLAN

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SCALE 1:400 (A3)
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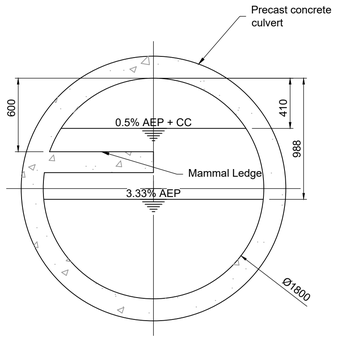

TYPICAL SECTION THROUGH CULVERT
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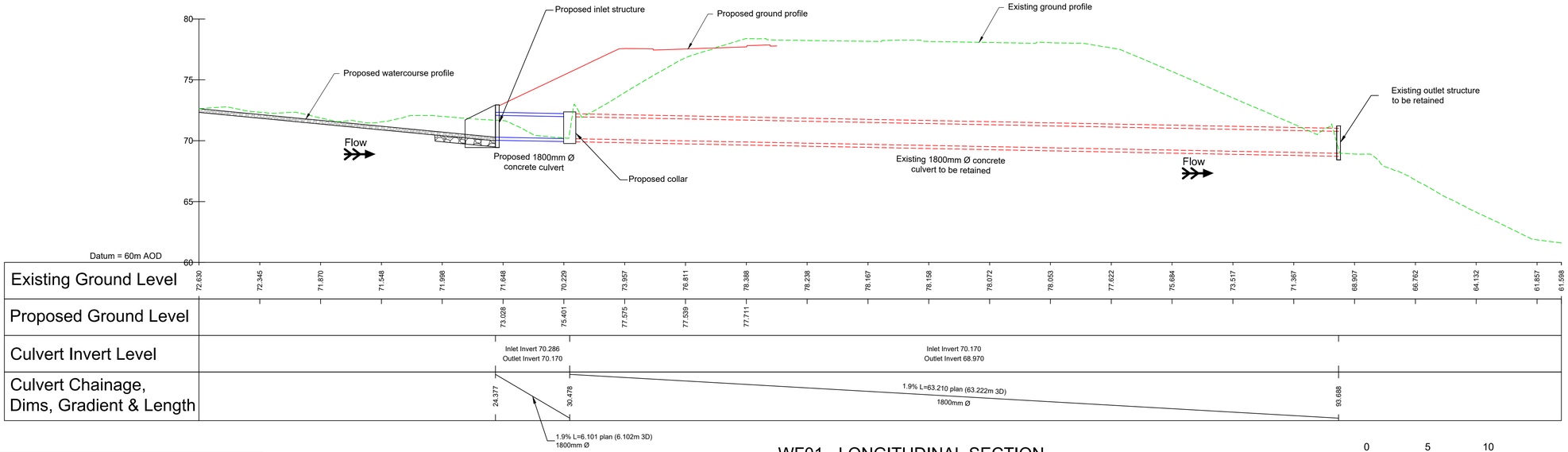

WF01 - LONGITUDINAL SECTION

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SCALE 1:400 (A3)
METRES

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All chainages are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum unless noted otherwise.
4. Do not scale from this drawing.
5. All details shown on this drawing are indicative only and subject to further development at *Specimen Design* stage.
6. This drawing shall be read in conjunction with Appendix A19.3: Watercourse Crossing report and not in isolation.

Key:

- Existing Ground Profile
- Proposed Ground Profile
- Existing Culvert
- Proposed Culvert
- Existing Watercourse
- Riverine Material
- Rip-Rap
- Rip-Rap (buried)
- CPO Boundary

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer: Jacobs
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Client: TRANSPORT SCOTLAND / CÒMHDHAIL ALBA

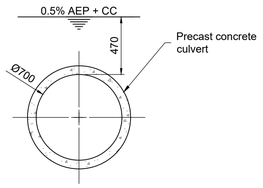
Project: A9 DUALLING PASS OF BIRNAM TO TAY CROSSING

Drawing title: BIRNAM TO TAY CROSSING PROPOSED MODIFICATIONS TO CULVERT ON WATERCOURSE WF01

Drawing status: ISSUED FOR INFORMATION

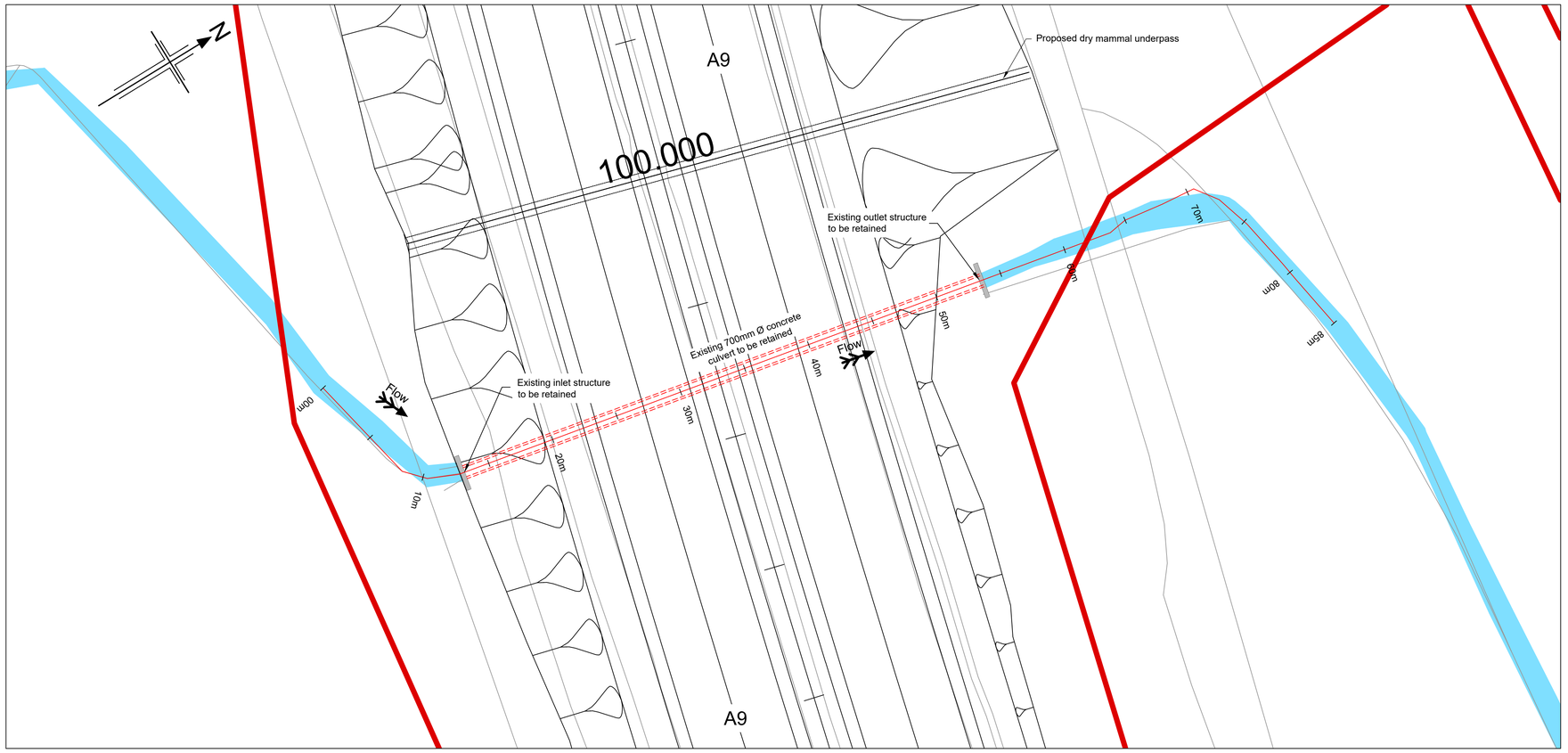
State		DO NOT SCALE
Scale	AS SHOWN	
Jacobs No.	B2140002	Rev 0
Client no.	TS/MTRIPS/SER/2013/03	

Drawing number: PIN A9P02 - Originator JAC - Volume EAC - Location X_ZZ000_ZZ - Type DR - Role ZZ - Number 0001



TYPICAL SECTION THROUGH CULVERT

SCALE 1:25



WF02 - PLAN

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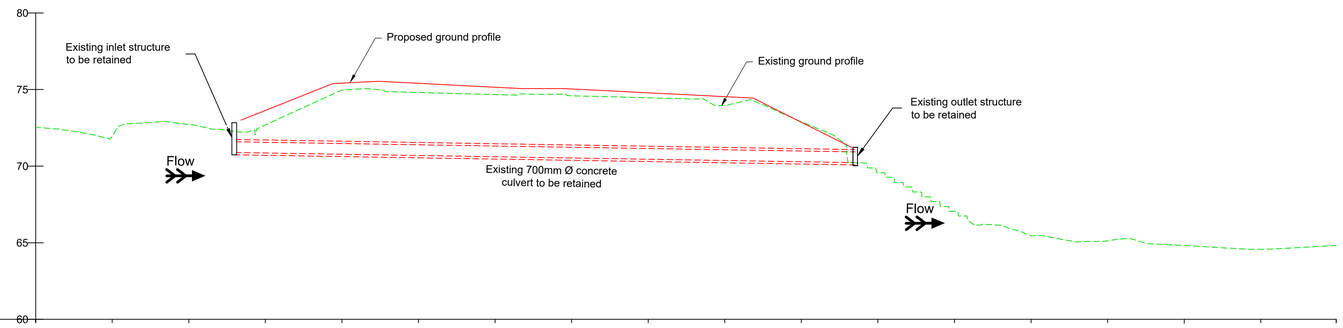
METRES



Datum = 60m AOD

Existing Ground Level	72.535	71.957	72.724	72.690	74.962	74.867	74.669	74.599	74.463	73.975	72.895	69.573	67.052	65.455	65.127	64.821	64.577	64.820
Proposed Ground Level				73.637	75.416	75.404	75.152	75.039	74.787	74.535	72.868							
Culvert Invert Level				Inlet Invert 70.890 Outlet Invert 70.230														
Culvert Chainage, Dims, Gradient & Length				12.963	1.6% L=40.548 plan (40.554m 3D) 700mm Ø							53.511						

WF02 - LONGITUDINAL SECTION

0 5 10 20

SCALE 1:200 (A1)
SCALE 1:400 (A3)

METRES

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All chainages are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum unless noted otherwise.
4. Do not scale from this drawing.
5. All details shown on this drawing are indicative only and subject to further development at *Specimen Design* stage.
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Key:

- Existing Ground Profile
- Proposed Ground Profile
- Existing Culvert
- Proposed Culvert
- Existing Watercourse
- Riverine Material
- Rip-Rap
- Rip-Rap (buried)
- CPO Boundary

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

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Client: TRANSPORT SCOTLAND / CÒMHDHAIL ALBA

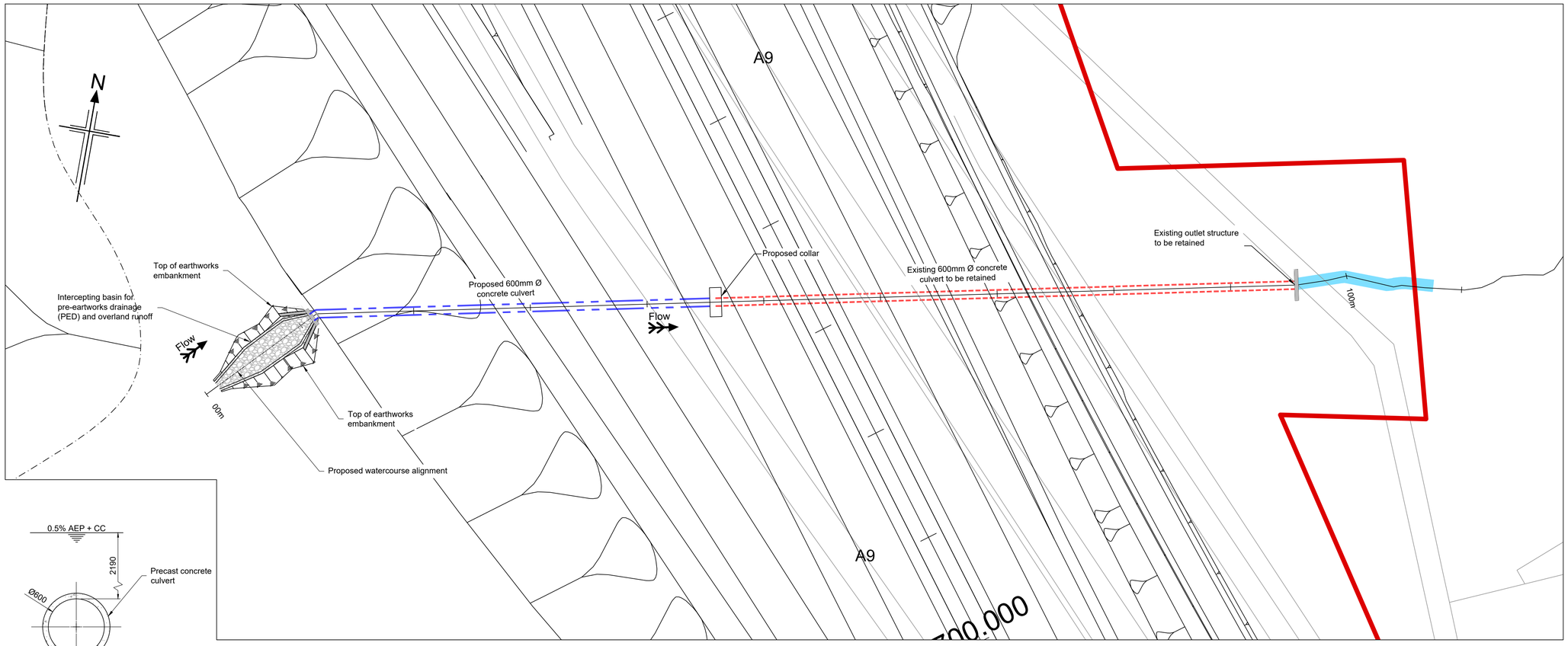
Project: A9 DUALLING – PASS OF BIRNAM TO TAY CROSSING

Drawing title: BIRNAM TO TAY CROSSING PROPOSED MODIFICATIONS TO CULVERT ON WATERCOURSE WF02

Drawing status: ISSUED FOR INFORMATION

State		DO NOT SCALE
Scale	AS SHOWN	
Jacobs No.	B2140002	Rev 0
Client no.	TS/MTRIPS/SER/2013/03	

Drawing number: PIN | Originator | Volume
A9P02 - JAC - EAC-
Location | Type | Role | Number
X_ZZ001_ZZ - DR- ZZ- 0001

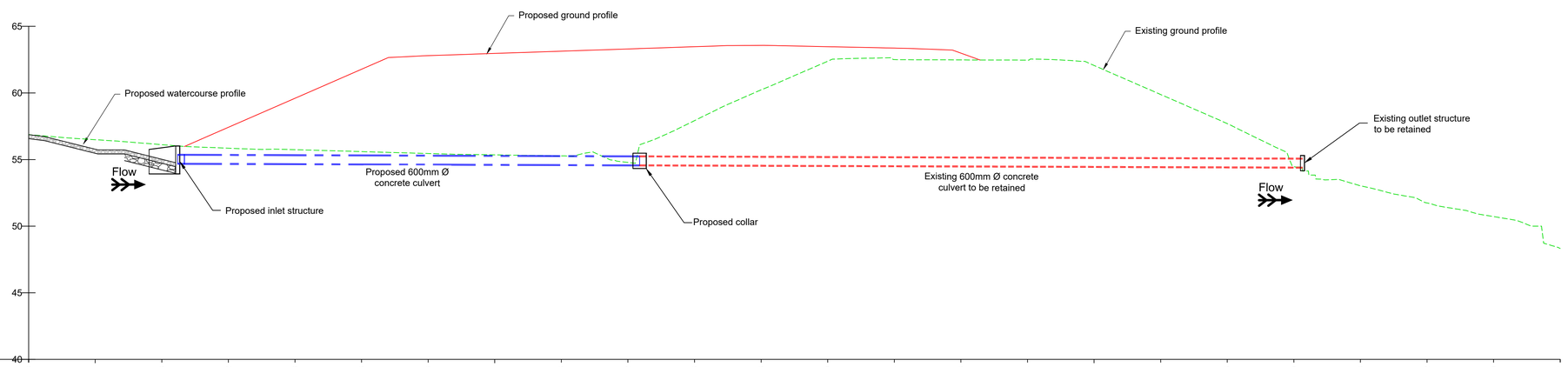


WF05 - PLAN

0 5 10 20
METRES
SCALE 1:200 (A1)
SCALE 1:400 (A3)

TYPICAL SECTION THROUGH CULVERT

SCALE 1:25



Datum = 40m AOD

Existing Ground Level	56.868	56.491	56.118	55.852	55.738	55.596	55.453	55.351	55.276	54.782	57.923	60.233	62.379	62.504	62.478	62.464	62.061	59.884	57.696	54.470	53.028	51.742	50.720	48.327
Proposed Ground Level	56.868	56.489	56.110	57.421	59.598	61.776	62.797	62.965	63.133	63.301	63.469	63.588	63.470	63.361	62.987	62.429	62.071	59.888	57.678	54.475	53.028	51.740	50.720	48.316
Culvert Invert Level			Inlet Invert 54.722 Outlet Invert 54.719				Inlet Invert 54.719 Outlet Invert 54.600										Inlet Invert 54.600 Outlet Invert 54.430							
Culvert Chainage, Dims, Gradient & Length			11.197	0.3% L=34.183 plan (34.183m 3D) 600mm Ø						45.880	0.3% L=49.766 plan (49.767m 3D) 600mm Ø										95.646			

WF05 - LONGITUDINAL SECTION

0 5 10 20
METRES
SCALE 1:200 (A1)
SCALE 1:400 (A3)

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All chainages are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum unless noted otherwise.
4. Do not scale from this drawing.
5. All details shown on this drawing are indicative only and subject to further development at *Specimen Design* stage.
6. This drawing shall be read in conjunction with Appendix A19.3: Watercourse Crossing report and not in isolation.

Key:

- Existing Ground Profile
- Proposed Ground Profile
- Existing Culvert
- Proposed Culvert
- Existing Watercourse
- Riverine Material
- Rip-Rap
- Rip-Rap (buried)
- CPO Boundary

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer: Jacobs
95 Bothwell St, Glasgow, G2 7HX
Tel +44(0)141 243 8000 Fax +44(0)141 226 3109
www.jacobs.com

Client: TRANSPORT SCOTLAND / CÒMHDHAIL ALBA

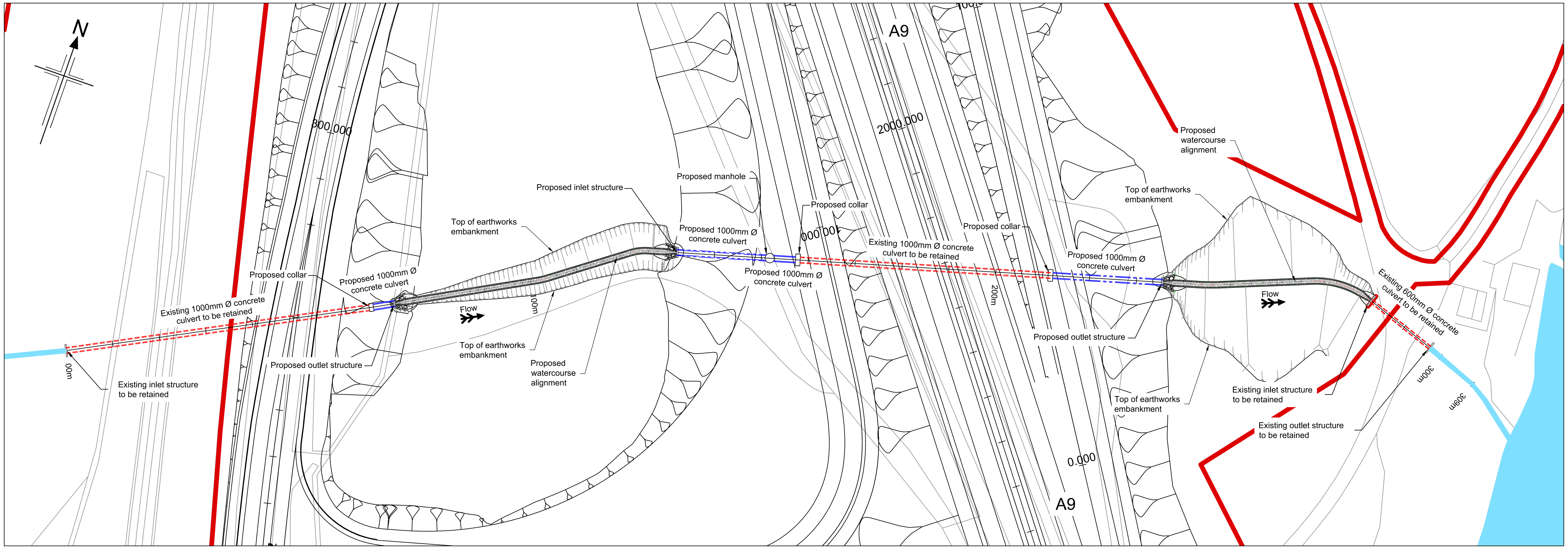
Project: A9 DUALLING PASS OF BIRNAM TO TAY CROSSING

Drawing title: BIRNAM TO TAY CROSSING PROPOSED MODIFICATIONS TO CULVERT ON WATERCOURSE WF05

Drawing status: ISSUED FOR INFORMATION

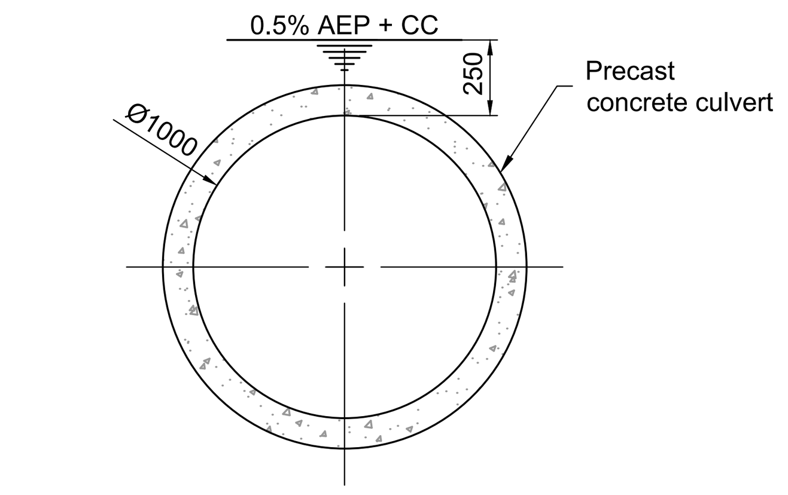
State		DO NOT SCALE	
Scale	AS SHOWN		
Jacobs No.	B2140002	Rev	0
Client no.	TS/MTRIPS/SER/2013/03		

Drawing number: PIN | Originator | Volume
A9P02 - JAC - EAC-
Location | Type | Role | Number
X_ZZ017_ZZ -DR- ZZ- 0001



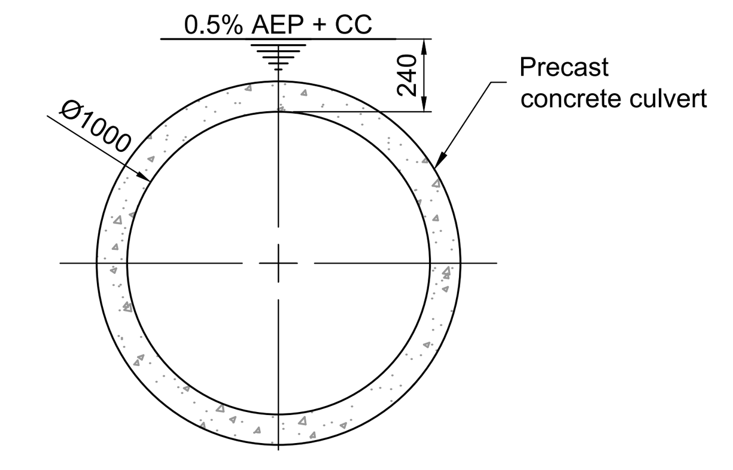
WF05A & WF05B - PLAN

0 10 20 30 40 50 METRES
SCALE 1:500 (A1)
SCALE 1:1,000 (A3)



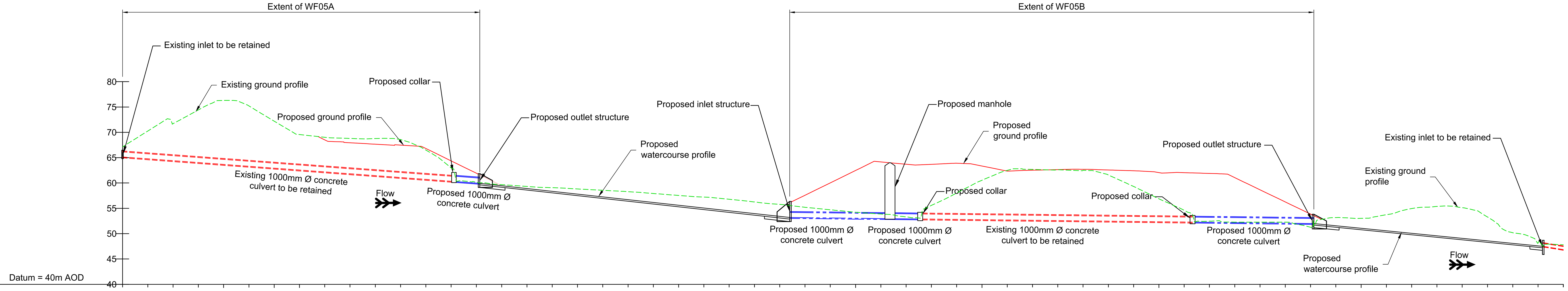
TYPICAL SECTION THROUGH CULVERT WF5A

SCALE 1:25



TYPICAL SECTION THROUGH CULVERT WF5B

SCALE 1:25



Existing Ground Level	Proposed Ground Level
67.128	67.183
70.255	70.279
71.703	71.694
74.423	74.328
76.301	76.221
75.214	75.217
72.211	72.228
69.561	69.557
69.025	68.520
68.796	67.941
68.775	67.655
68.578	67.472
66.505	66.817
62.993	64.371
60.137	61.924
59.663	59.662
59.316	59.316
59.076	59.038
58.822	58.821
58.558	58.550
58.287	58.278
57.928	57.947
57.540	57.594
57.216	57.242
56.788	56.777
56.256	56.278
55.779	55.779
55.206	57.564
54.707	60.019
54.231	62.474
53.872	64.159
53.309	63.703
55.582	63.685
58.026	63.903
60.541	63.340
62.487	62.343
62.678	62.506
62.604	62.638
62.497	62.702
61.585	62.571
59.306	62.402
56.871	62.050
54.603	62.038
52.462	61.871
52.276	61.062
52.267	58.660
52.262	56.257
51.255	53.855
53.179	53.166
53.021	53.015
53.734	53.710
54.954	54.919
55.373	55.375
55.122	55.145
53.287	53.280
50.178	50.188
48.165	48.165
47.809	47.826

Culvert Invert Level

- Inlet Invert 65.140, Outlet Invert 60.300
- Inlet Invert 60.300, Outlet Invert 59.923
- Inlet Invert 53.187, Outlet Invert 52.959
- Inlet Invert 52.959, Outlet Invert 52.890
- Inlet Invert 52.890, Outlet Invert 52.270
- Inlet Invert 52.270, Outlet Invert 51.993
- Inlet Invert 47.490, Outlet Invert 44.940

Culvert Chainage, Dims, Gradient & Length

- 7.4% L=65.561 plan (65.739m 3D), 1000mm Ø — 65.561
- 7.4% L=5.105 plan (5.118m 3D), 1000mm Ø — 70.665
- 1.2% L=19.826 plan (19.827m 3D), 1000mm Ø — 131.974
- 1.2% L=5.985 plan (5.986m 3D), 1000mm Ø — 151.800
- 1.2% L=53.833 plan (53.837m 3D), 1000mm Ø — 157.785
- 1.2% L=24.023 plan (24.025m 3D), 1000mm Ø — 211.656
- 235.641
- 16.0% L=15.963 plan (16.165m 3D), 600mm Ø — 281.024

WF05A & WF05B - LONGITUDINAL SECTION

0 10 20 30 40 50 METRES
SCALE 1:500 (A1)
SCALE 1:1,000 (A3)

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All chainages are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum unless noted otherwise.
4. Do not scale from this drawing.
5. All details shown on this drawing are indicative only and subject to further development at *Specimen Design* stage.
6. This drawing shall be read in conjunction with Appendix A19.3: Watercourse Crossing report and not in isolation.

Key:

- Existing Ground Profile
- Proposed Ground Profile
- Existing Culvert
- Proposed Culvert
- Existing Watercourse
- Riverine Material
- Rip-Rap
- Rip-Rap (buried)
- CPO Boundary

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer: Jacobs

95 Bothwell St, Glasgow, G2 7HX
Tel:+44(0)141 243 8000 Fax:+44(0)141 226 3109
www.jacobs.com

Client: TRANSPORT SCOTLAND CÒMHDHAIL ALBA

Project: A9 DUALLING PASS OF BIRNAM TO TAY CROSSING

Drawing title
BIRNAM TO TAY CROSSING PROPOSED MODIFICATIONS TO CULVERT ON WATERCOURSE WF05A & WF05B

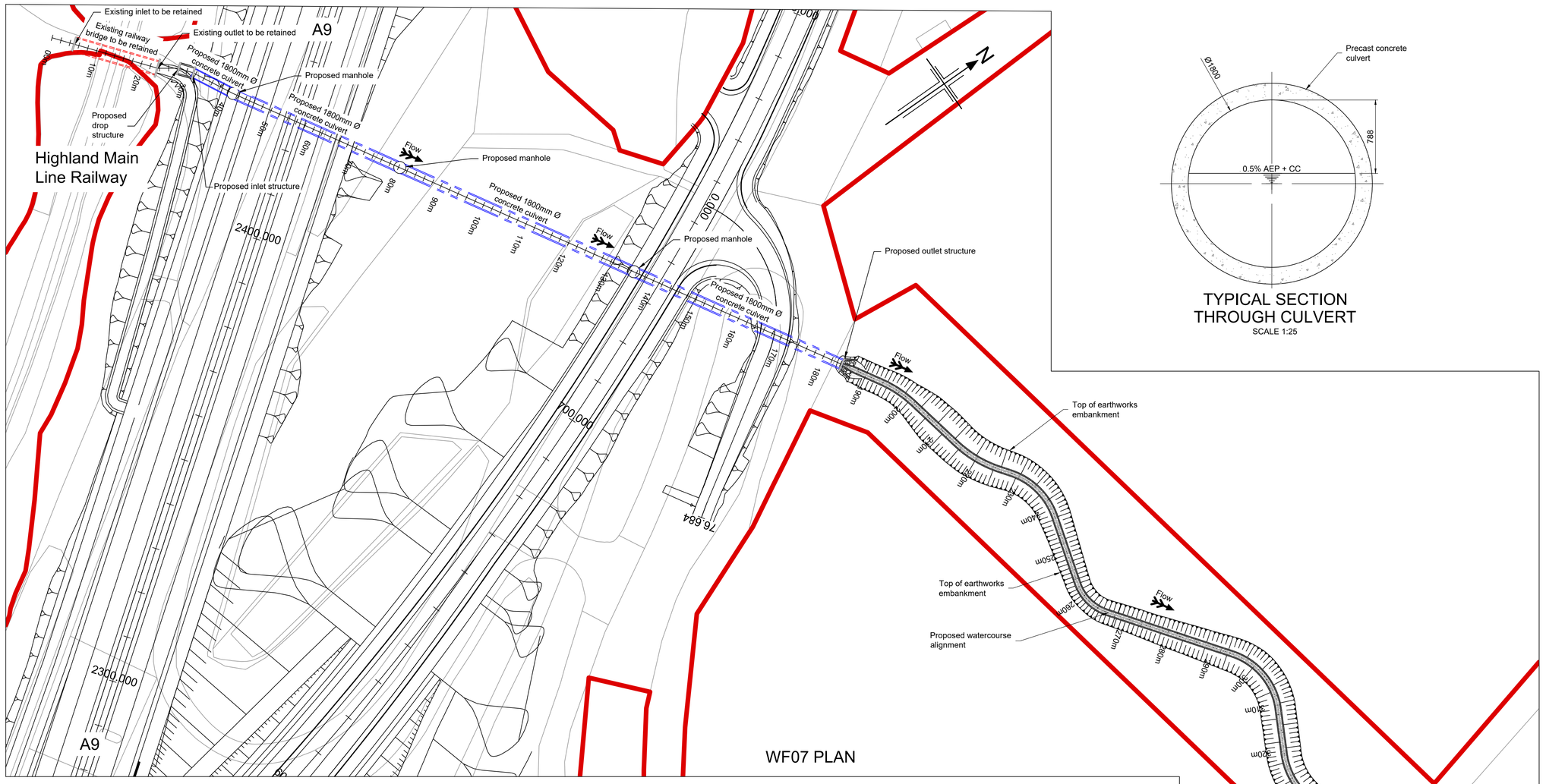
Drawing status
ISSUED FOR INFORMATION

State	
Scale	AS SHOWN
Jacobs No.	B2140002
Client no.	TS/MTRIPS/SER/2013/03

DO NOT SCALE

Rev 0

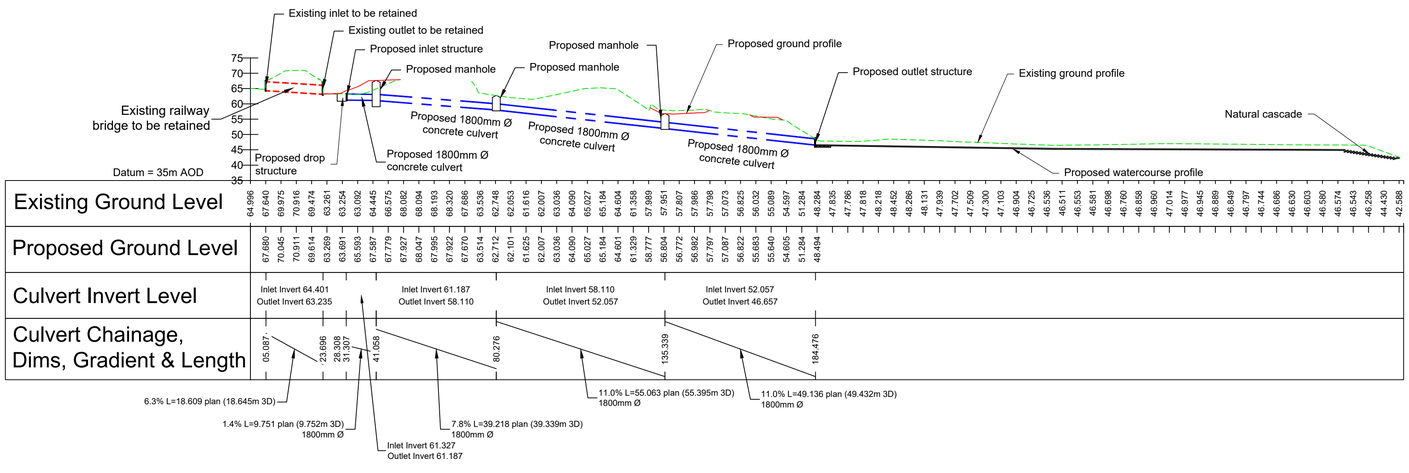
Drawing number
PIN | Originator | Volume | Location | Type | Role | Number
A9P02 - JAC - EAC- X_ZZ020_ZZ - DR- ZZ- 0001



WF07 PLAN

TYPICAL SECTION THROUGH CULVERT

SCALE 1:25



WF07 - LONGITUDINAL SECTION

0 10 20 30 40 50 60 70 80 90 100

SCALE 1:1,000 (A1)
SCALE 1:2,000 (A3)

METRES

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All chainages are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum unless noted otherwise.
4. Do not scale from this drawing.
5. All details shown on this drawing are indicative only and subject to further development at *Specimen Design* stage.
6. This drawing shall be read in conjunction with Appendix A19.3: Watercourse Crossing report and not in isolation.

Key:

- Existing Ground Profile
- Proposed Ground Profile
- Existing Culvert
- Proposed Culvert
- Existing Watercourse
- Riverine Material
- Rip-Rap
- Rip-Rap (buried)
- CPO Boundary

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer: Jacobs

Client: Transport Scotland / Còmhdhail Alba

Project: A9 Dualling – Pass of Birnam to Tay Crossing

Drawing title

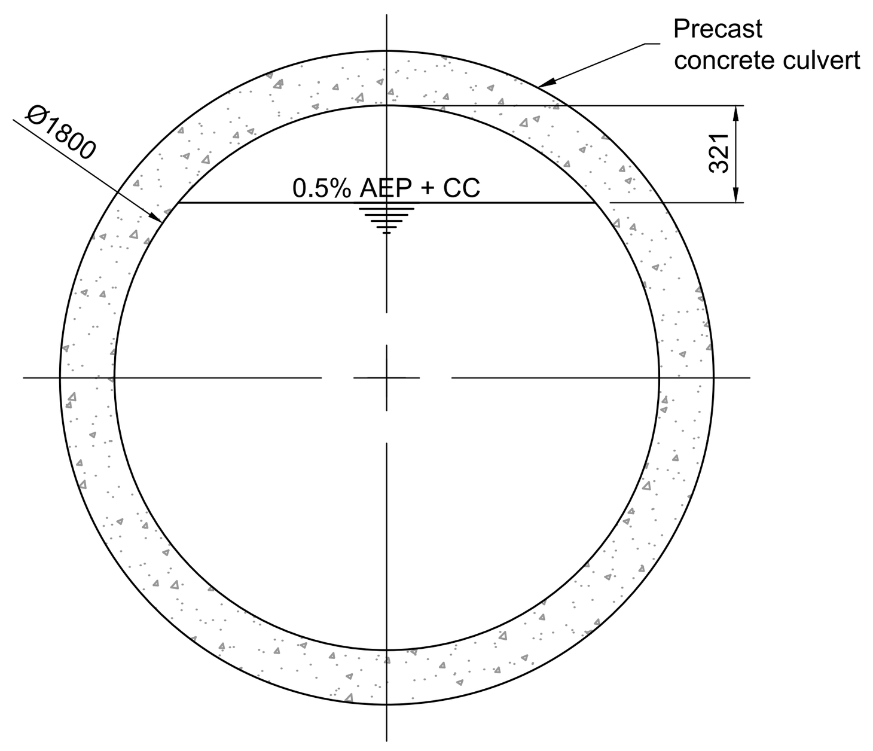
BIRNAM TO TAY CROSSING PROPOSED MODIFICATIONS TO CULVERT ON WATERCOURSE WF07

Drawing status: ISSUED FOR INFORMATION

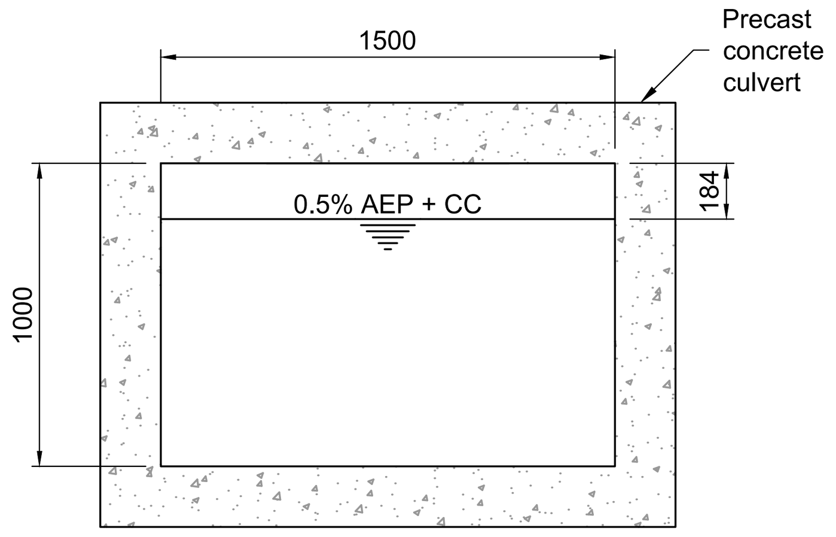
State		DO NOT SCALE
Scale	AS SHOWN	
Jacobs No.	B2140002	Rev 0
Client no.	TS/MTRIPS/SER/2013/03	

Drawing number: A9P02 - JAC - EAC- X_ZZ024_ZZ - DR- ZZ- 0001

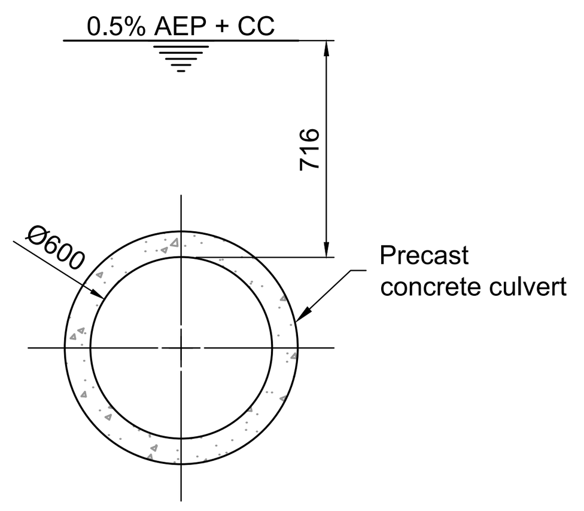
(PIN | Originator | Volume | Location | Type | Role | Number)



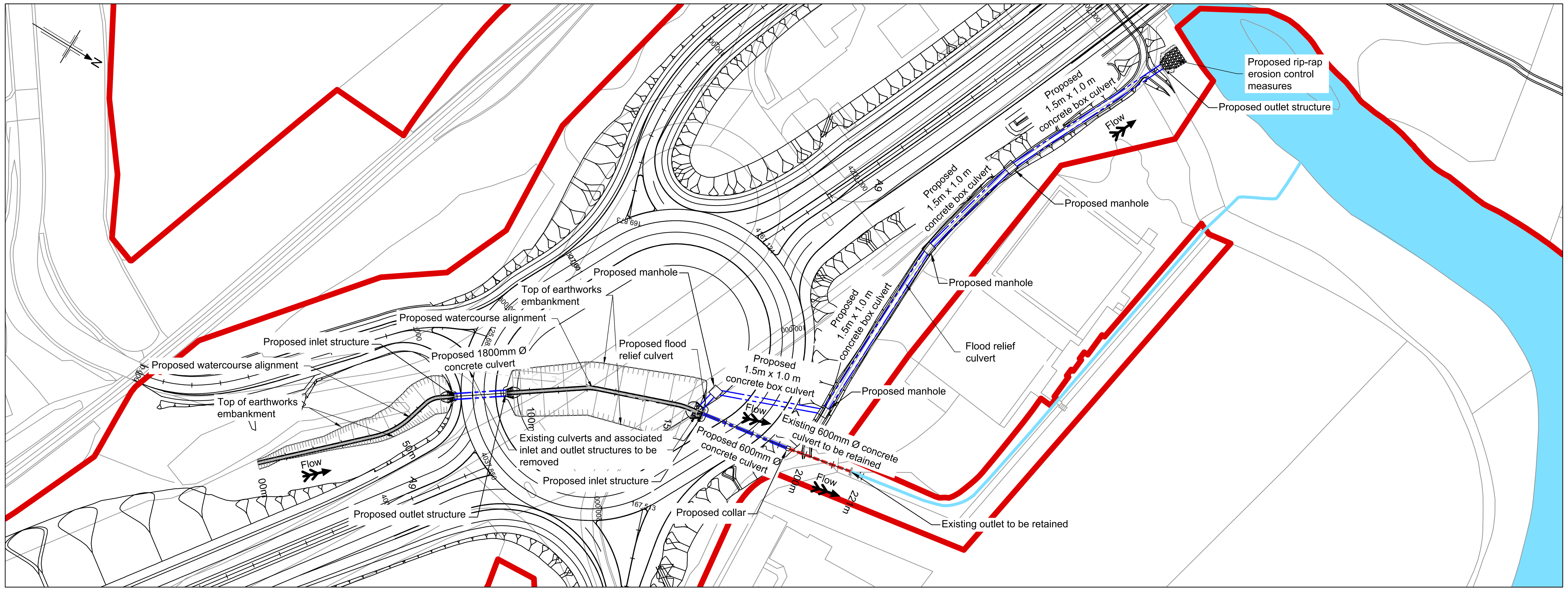
TYPICAL SECTION THROUGH 1800 Ø CULVERT
SCALE 1:25



TYPICAL SECTION THROUGH FLOOD RELIEF CULVERT 1000 x 1500
SCALE 1:25



TYPICAL SECTION THROUGH 600 Ø CULVERT
SCALE 1:25



WF09 - PLAN

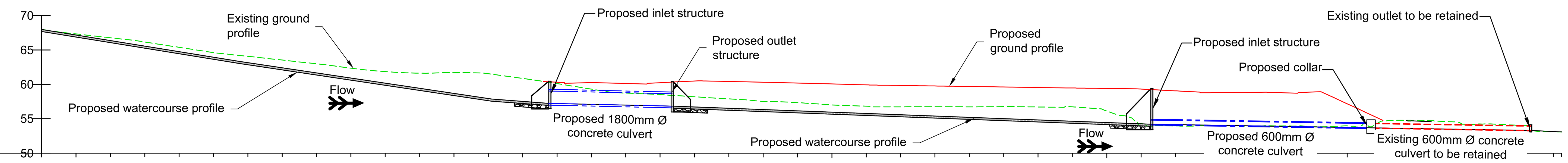
0 10 20 30 40 50 60 70 80 90 100
SCALE 1:1,000 (A1)
SCALE 1:2,000 (A3)
METRES

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All chainages are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum unless noted otherwise.
4. Do not scale from this drawing.
5. All details shown on this drawing are indicative only and subject to further development at *Specimen Design* stage.
6. This drawing shall be read in conjunction with Appendix A19.3: Watercourse Crossing report and not in isolation.

Key:

- Existing Ground Profile
- Proposed Ground Profile
- Existing Culvert
- Proposed Culvert
- Existing Watercourse
- Riverine Material
- Rip-Rap
- Rip-Rap (buried)
- CPO Boundary



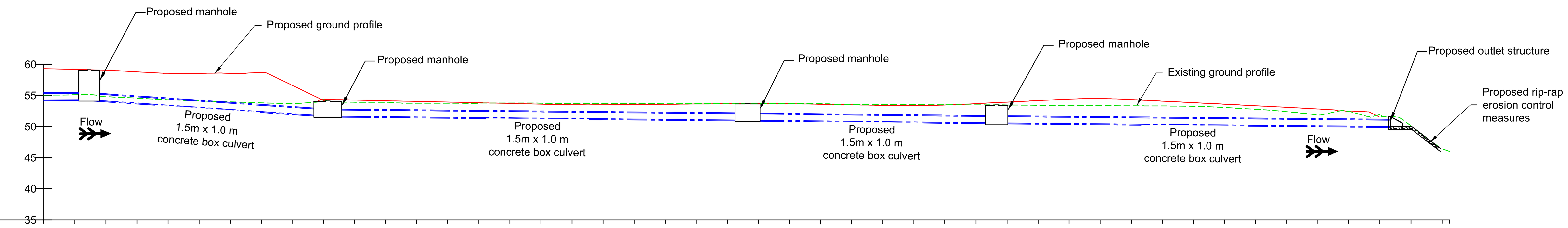
Datum = 50m AOD

Existing Ground Level	Proposed Ground Level
67.972	67.972
67.322	67.322
66.769	66.768
66.153	66.153
65.379	65.379
64.608	64.608
64.069	64.069
63.527	63.529
62.985	62.989
62.344	62.358
61.848	61.882
61.624	61.639
61.733	61.733
61.537	61.520
60.862	60.849
60.103	60.297
59.300	60.246
58.724	60.124
58.520	60.234
58.192	60.482
57.878	60.413
57.500	60.302
57.337	60.174
57.001	60.045
56.823	59.923
56.726	59.845
56.737	59.766
56.728	59.688
56.758	59.613
56.704	59.540
56.729	59.466
56.111	59.399
54.290	59.307
53.945	59.049
53.976	58.778
53.927	58.822
53.951	58.793
53.810	58.885
53.947	57.168
54.648	54.845
54.760	54.659
54.564	54.564
54.235	54.240
54.052	54.052
[illegible] 53.075	53.108 53.075

Culvert Invert Level:
- Inlet Invert 57.230 / Outlet Invert 56.827
- Inlet Invert 54.204 / Outlet Invert 53.680
- Inlet Invert 53.680 / Outlet Invert 53.300

Culvert Chainage, Dims, Gradient & Length:
- 73.810 – 91.743: 2.2% L=17.934 plan (17.938m 3D) 1800mm Ø
- 161.416 – 193.472: 1.6% L=32.025 plan (32.030m 3D) 600mm Ø
- 193.472 – 216.712: 1.6% L=23.240 plan (23.243m 3D) 600mm Ø

WF09 - LONGITUDINAL SECTION



Datum = 35m AOD

Existing Ground Level	Proposed Ground Level
55.039	59.303
55.120	59.188
54.801	59.074
54.566	58.804
54.314	58.481
54.131	58.553
53.967	58.551
53.806	58.684
53.719	56.627
54.316	54.372
53.915	54.267
53.898	54.151
53.764	54.040
53.756	53.932
53.753	53.828
53.769	53.727
53.747	53.626
53.723	53.525
53.719	53.514
53.723	53.545
53.725	53.585
53.718	53.625
53.728	53.666
53.719	53.695
53.692	53.674
53.661	53.585
53.561	53.500
53.544	53.416
53.524	53.381
53.503	53.532
53.482	53.745
53.467	53.959
53.425	54.174
53.388	54.412
53.364	54.486
53.333	54.291
53.307	54.062
53.261	53.833
53.058	53.594
52.774	53.345
52.388	53.090
51.886	52.822
52.455	52.487
51.940	51.653
50.113	50.060
[illegible] 45.998	46.409 45.998

Culvert Invert Level:
- Inlet Invert 54.289 / Outlet Invert 54.304
- Inlet Invert 54.304 / Outlet Invert 51.680
- Inlet Invert 51.680 / Outlet Invert 51.036
- Inlet Invert 51.036 / Outlet Invert 50.596
- Inlet Invert 50.596 / Outlet Invert 50.029

Culvert Chainage, Dims, Gradient & Length:
- to 07.303: -0.2% L=7.303 plan (7.303m 3D) 1500x1000mm (WxH)
- 07.303 – 45.699: 6.8% L=38.396 plan (38.485m 3D) 1500x1000mm (WxH)
- 45.699 – 113.242: 1.0% L=67.543 plan (67.546m 3D) 1500x1000mm (WxH)
- 113.242 – 153.335: 1.1% L=40.094 plan (40.096m 3D) 1500x1000mm (WxH)
- 153.335 – 216.543: 0.9% L=63.208 plan (63.210m 3D) 1500x1000mm (WxH)

WF09 - FLOOD RELIEF CULVERT LONGITUDINAL SECTION

0 10 20 30 40 50
SCALE 1:500 (A1)
SCALE 1:1,000 (A3)
METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer: Jacobs
95 Bothwell St, Glasgow, G2 7HX
Tel:+44(0)141 243 8000 Fax:+44(0)141 226 3109
www.jacobs.com

Client: TRANSPORT SCOTLAND CÒMHDHAIL ALBA

Project: A9 DUALLING PASS OF BIRNAM TO TAY CROSSING

Drawing title
BIRNAM TO TAY CROSSING PROPOSED MODIFICATIONS TO CULVERT ON WATERCOURSE WF09

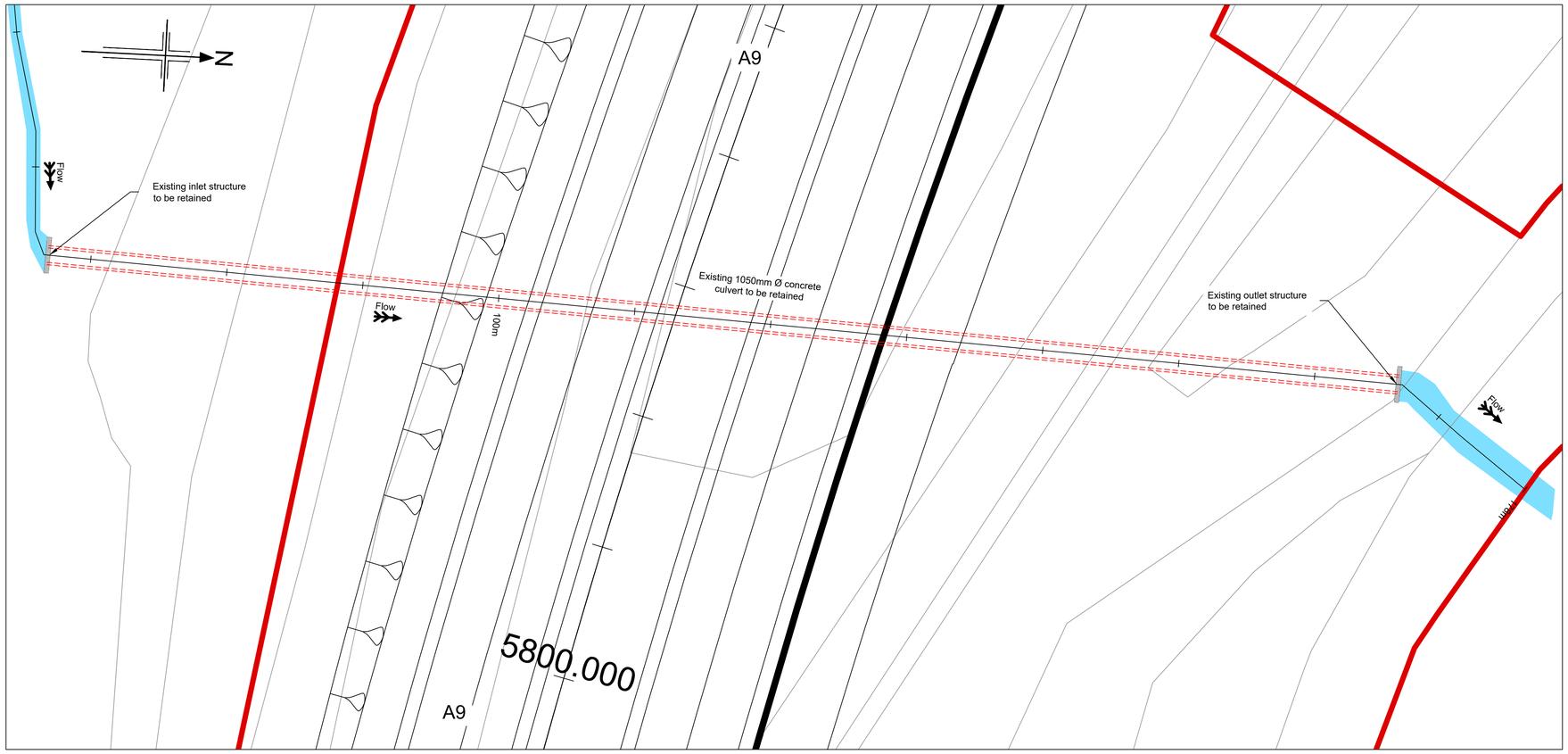
Drawing status: ISSUED FOR INFORMATION

State	
Scale	AS SHOWN
Jacobs No.	B2140002
Client no.	TS/MTRIPS/SER/2013/03

DO NOT SCALE

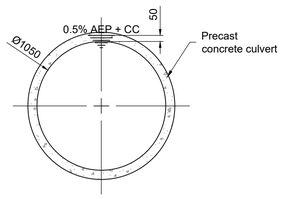
Rev 0

Drawing number: PIN A9P02 - Originator JAC - Volume EAC- Location X_ZZ041_ZZ - Type DR- Role ZZ- Number 0001

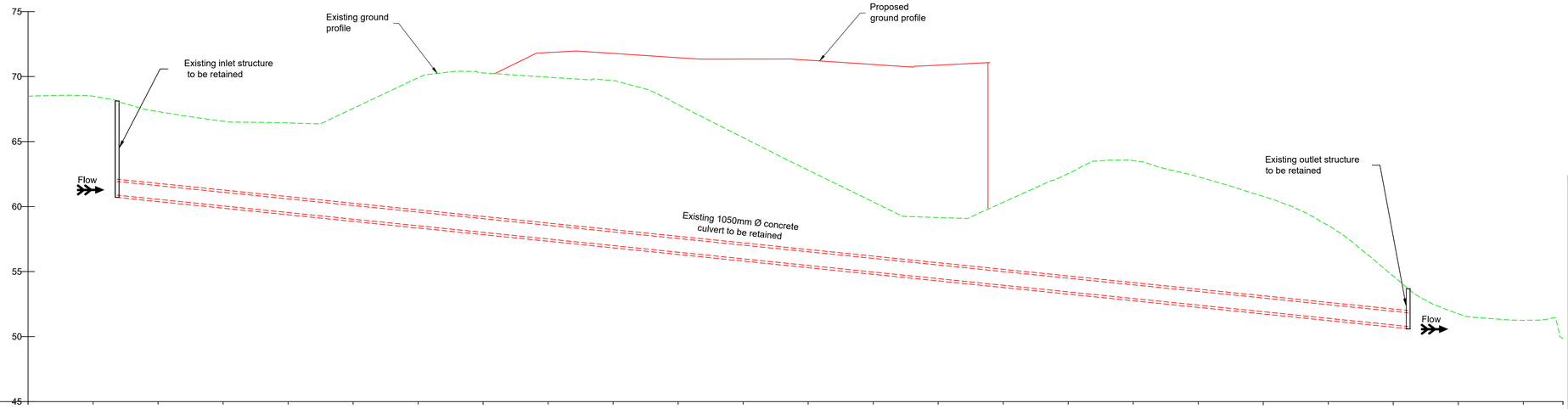


WF12A - PLAN

0 5 10 20
SCALE 1:200 (A1)
SCALE 1:400 (A3)
METRES



TYPICAL SECTION
THROUGH CULVERT
SCALE 1:25



Existing Ground Level	68.496	68.490	67.309	66.560	66.435	67.553	69.906	70.282	69.953	69.690	67.842	65.306	62.803	60.358	59.157	60.326	62.539	63.538	62.295	60.781	58.558	54.651	51.761	51.254	49.840
Proposed Ground Level									71.854	71.762	71.452	71.347	71.260	70.932	70.878										
Culvert Invert Level	Inlet Invert 60.880 Outlet Invert 50.780																								
Culvert Chainage, Dims, Gradient & Length	66.846	10.2% L=99.300 plan (99.812m 3D) 1050mm Ø																				166.146			

WF12A - LONGITUDINAL SECTION

0 5 10 20
SCALE 1:200 (A1)
SCALE 1:400 (A3)
METRES

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All chainages are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum unless noted otherwise.
4. Do not scale from this drawing.
5. All details shown on this drawing are indicative only and subject to further development at *Specimen Design* stage.
6. This drawing shall be read in conjunction with Appendix A19.3: Watercourse Crossing report and not in isolation.

Key:

- Existing Ground Profile
- Proposed Ground Profile
- Existing Culvert
- Proposed Culvert
- Existing Watercourse
- Riverine Material
- Rip-Rap
- Rip-Rap (buried)
- CPO Boundary

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer: Jacobs
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Tel +44(0)141 243 8000 Fax +44(0)141 226 3109
www.jacobs.com

Client: TRANSPORT SCOTLAND / CÒMHDHAIL ALBA

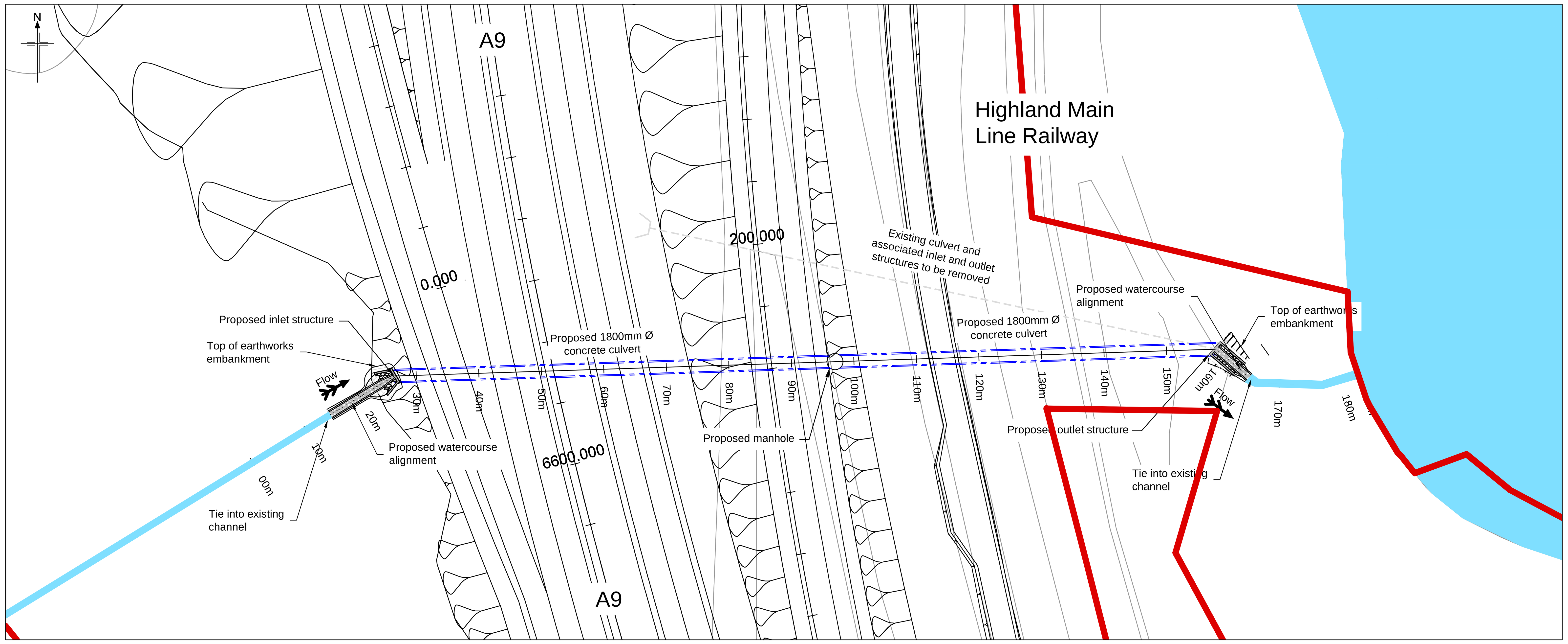
Project: A9 DUALLING
PASS OF BIRNAM
TO TAY CROSSING

Drawing title
BIRNAM TO TAY CROSSING
PROPOSED MODIFICATIONS
TO CULVERT ON
WATERCOURSE WF12A

Drawing status
ISSUED FOR INFORMATION

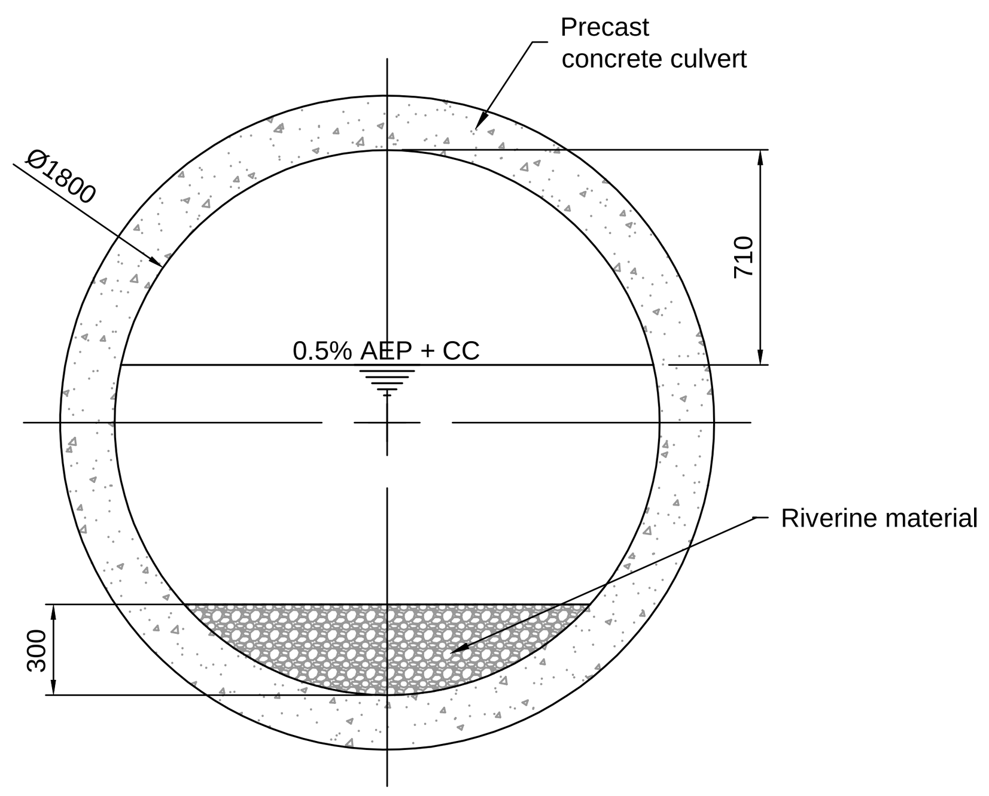
State		DO NOT SCALE	
Scale	AS SHOWN		
Jacobs No.	B2140002	Rev	0
Client no.	TS/MTRIPS/SER/2013/03		

Drawing number
PIN | Originator | Volume
A9P02 - JAC - EAC-
Location | Type | Role | Number
X_ZZ058_ZZ - DR - ZZ - 0001

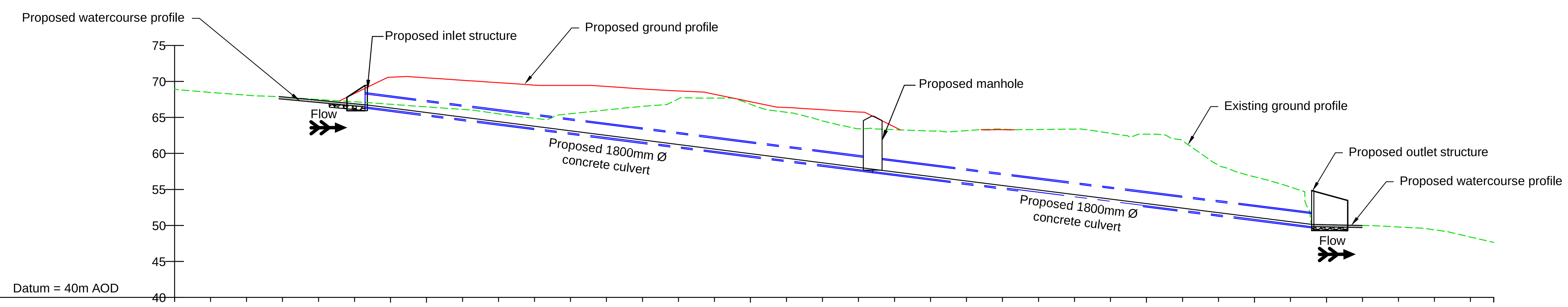


WF12B - PLAN

0 10 20 30 40 50 METRES
SCALE 1:500 (A1)
SCALE 1:1,000 (A3)



TYPICAL SECTION
THROUGH 1800 Ø CULVERT
SCALE 1:25



Existing Ground Level	Proposed Ground Level
68.912	
68.478	
68.094	
67.860	67.863
67.493	67.519
67.177	68.326
66.831	70.590
66.471	70.504
66.114	70.165
65.507	69.827
64.886	69.488
65.515	69.445
66.038	69.304
66.534	68.978
67.588	68.680
67.697	68.228
66.841	67.190
65.714	66.360
64.522	66.065
63.423	65.770
63.305	63.805
63.125	63.126
63.170	63.171
63.370	63.298
63.326	63.331
63.380	63.381
62.795	62.804
62.671	62.695
61.762	61.764
58.338	58.323
56.751	56.758
55.326	55.329
50.101	50.102
50.005	
49.788	
49.390	
48.392	
47.641	

Culvert Invert Level	Culvert Chainage, Dims, Gradient & Length
Inlet Invert 66.467, Outlet Invert 57.501	26.473 – 96.966: 12.7% L=70.493 plan (71.061m 3D), 1800mm Ø
Inlet Invert 57.501, Outlet Invert 49.840	96.966 – 157.945: 12.6% L=60.979 plan (61.458m 3D), 1800mm Ø

WF12B - LONGITUDINAL SECTION

0 10 20 30 40 50 METRES
SCALE 1:500 (A1)
SCALE 1:1,000 (A3)

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All chainages are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum unless noted otherwise.
4. Do not scale from this drawing.
5. All details shown on this drawing are indicative only and subject to further development at *Specimen Design* stage.
6. This drawing shall be read in conjunction with Appendix A19.3: Watercourse Crossing report and not in isolation.

Key:

- Existing Ground Profile
- Proposed Ground Profile
- Existing Culvert
- Proposed Culvert
- Existing Watercourse
- Riverine Material
- Rip-Rap
- Rip-Rap (buried)
- CPO Boundary

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer: Jacobs

Client: TRANSPORT SCOTLAND CÒMHDHAIL ALBA

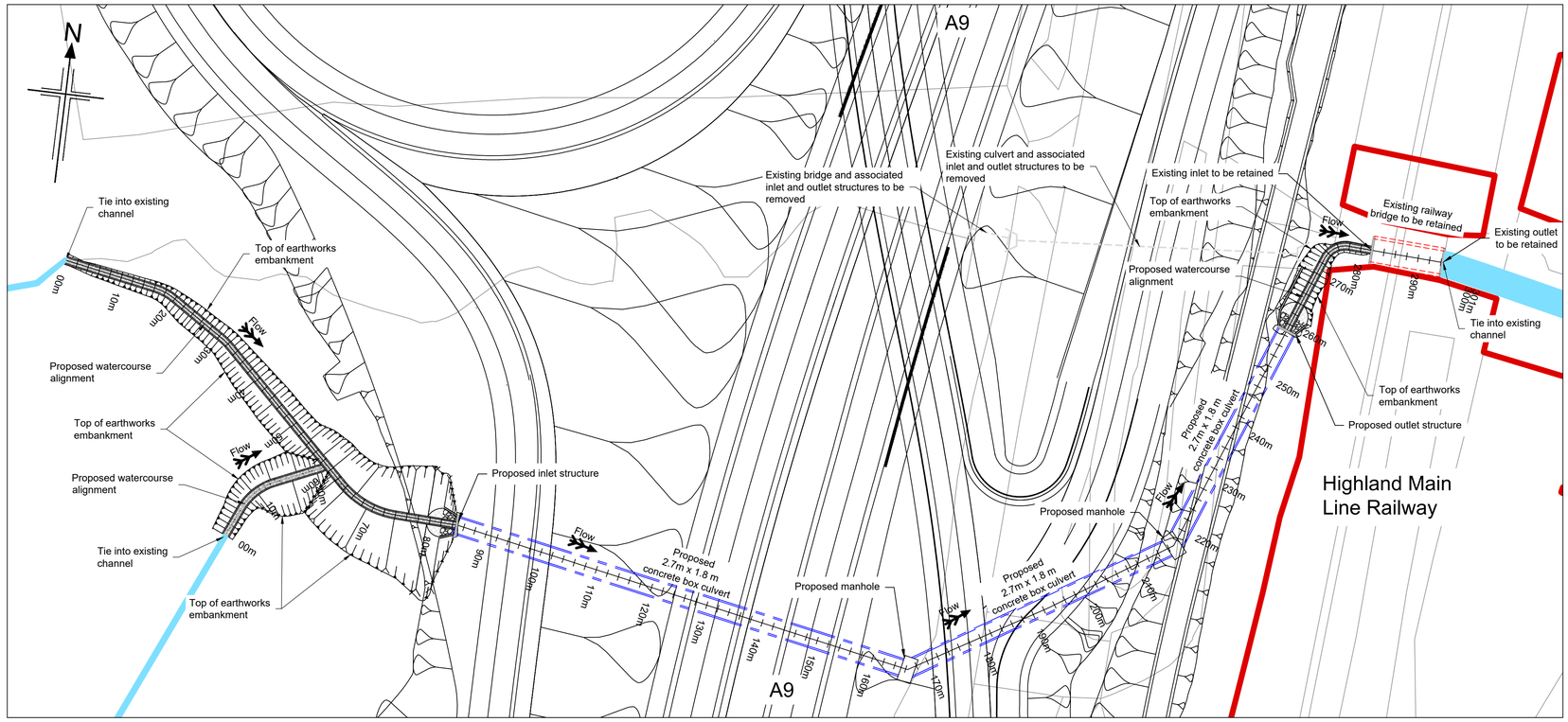
Project: A9 DUALLING PASS OF BIRNAM TO TAY CROSSING

Drawing title
BIRNAM TO TAY CROSSING
PROPOSED MODIFICATIONS
TO CULVERT ON
WATERCOURSE WF12B

Drawing status
S2 - ISSUED FOR INFORMATION

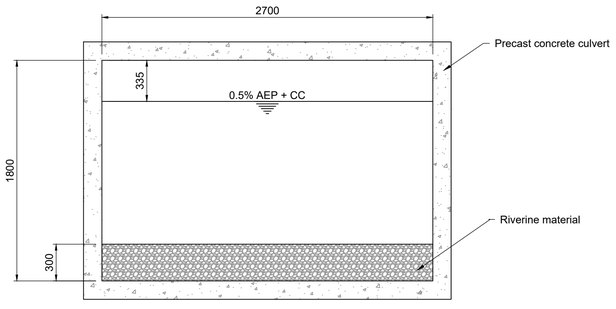
State		DO NOT SCALE
Scale	AS SHOWN	
Jacobs No.	B2140002	Rev P01.1
Client no.	TS/MTRIPS/SER/2013/03	

Drawing number
PIN A9P02 - Originator JAC - Volume EAC- Location X_ZZ066_ZZ - Type DR - Role ZZ - Number 0001

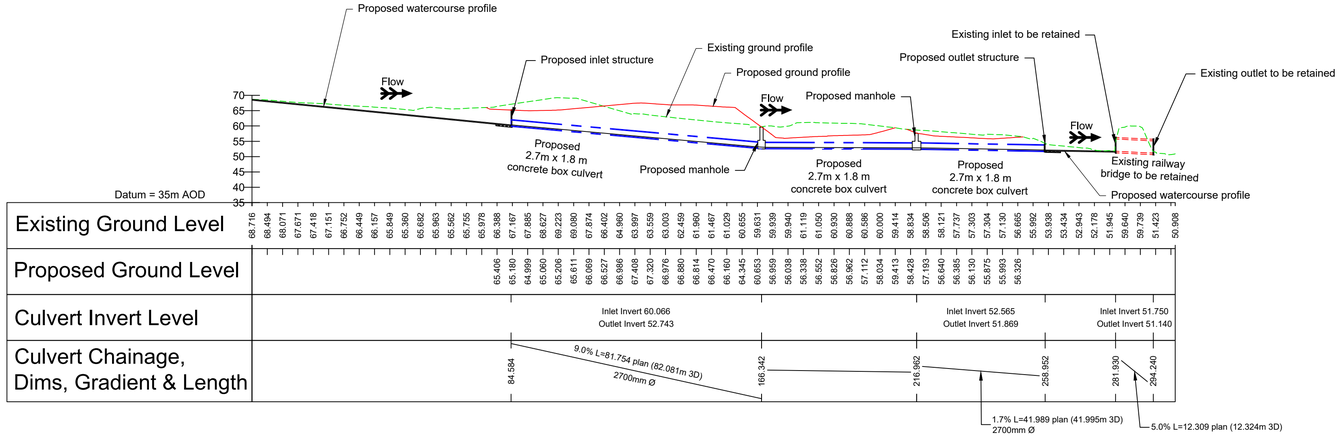


WF13 - PLAN

SCALE 1:500 (A1)
SCALE 1:1,000 (A3)
0 10 20 30 40 50 METRES



TYPICAL SECTION THROUGH CULVERT
SCALE 1:25



WF13 - LONGITUDINAL SECTION

SCALE 1:1,000 (A1)
SCALE 1:2,000 (A3)
0 10 20 30 40 50 60 70 80 90 100 METRES

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All chainages are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum unless noted otherwise.
4. Do not scale from this drawing.
5. All details shown on this drawing are indicative only and subject to further development at *Specimen Design* stage.
6. This drawing shall be read in conjunction with Appendix A19.3: Watercourse Crossing report and not in isolation.

Key:

- Existing Ground Profile
- Proposed Ground Profile
- Existing Culvert
- Proposed Culvert
- Existing Watercourse
- Riverine Material
- Rip-Rap
- Rip-Rap (buried)
- CPO Boundary

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer: Jacobs
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www.jacobs.com

Client: TRANSPORT SCOTLAND / CÒMHDHAIL ALBA

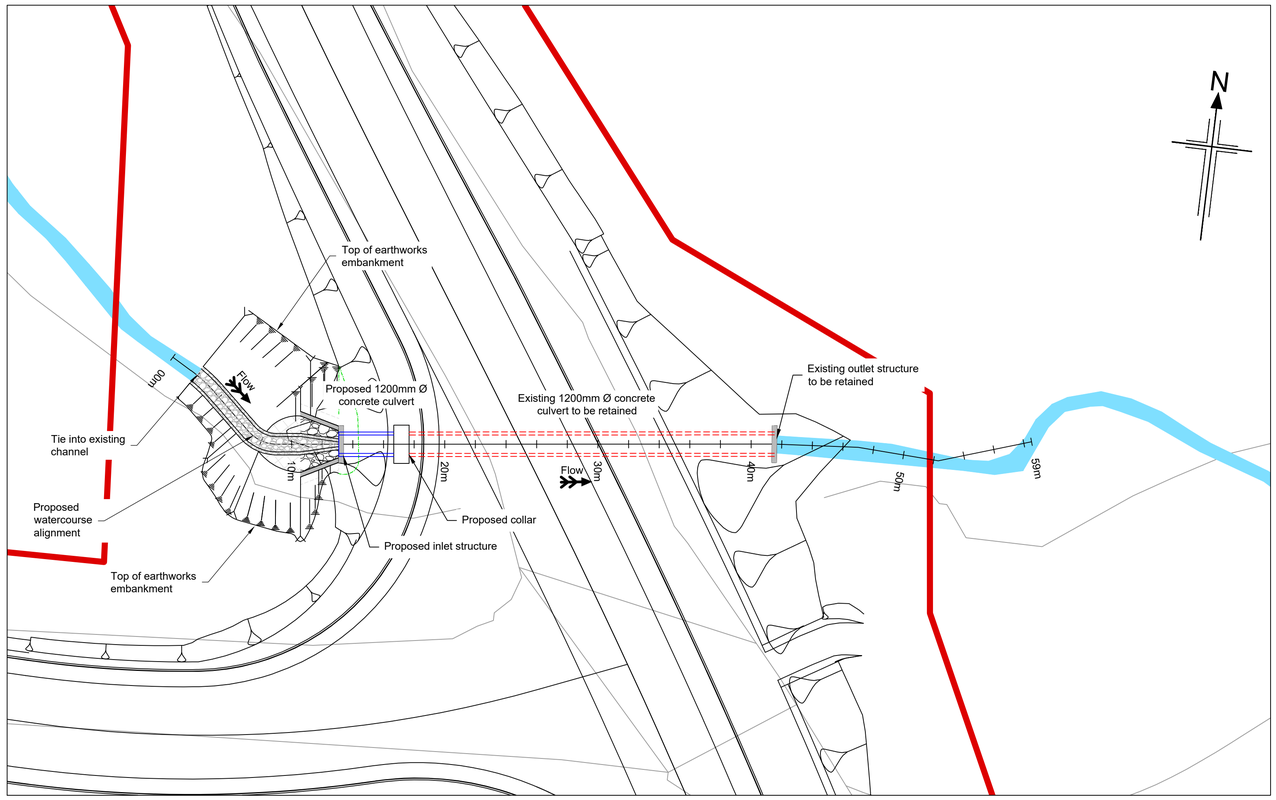
Project: A9 DUALLING PASS OF BIRNAM TO TAY CROSSING

Drawing title
BIRNAM TO TAY CROSSING PROPOSED MODIFICATIONS TO CULVERT ON WATERCOURSE WF13

Drawing status: ISSUED FOR INFORMATION

State		DO NOT SCALE
Scale	AS SHOWN	
Jacobs No.	B2140002	Rev 0
Client no.	TS/MTRIPS/SER/2013/03	

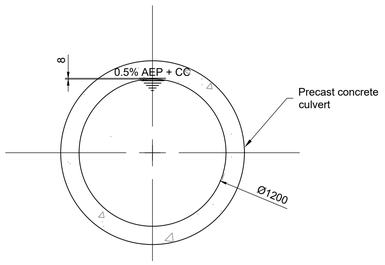
Drawing number
PIN - Originator - Volume
A9P02 - JAC - EAC-
Location - Type - Role - Number
X_ZZ069_ZZ - DR - ZZ - 0001



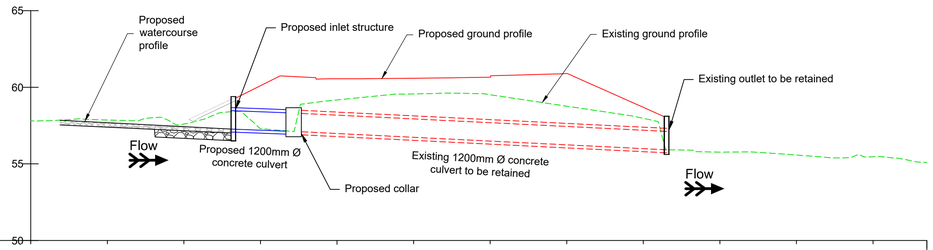
WF14 - PLAN

0 5 10 20

SCALE 1:200 (A1)
SCALE 1:400 (A3)
METRES



TYPICAL SECTION THROUGH CULVERT
SCALE 1:25



Datum = 50m AOD

Existing Ground Level	57.867	57.862	57.603	57.304	59.171	59.563	59.512	58.765	57.972	55.769	55.579	55.467
Proposed Ground Level				60.103	60.558	60.589	60.654	60.897	58.690	56.494		
Culvert Invert Level				Inlet Invert 57.272 Outlet Invert 57.120			Inlet Invert 57.120 Outlet Invert 55.920					
Culvert Chainage, Dims, Gradient & Length				13.081	17.168	4.9% L=24.354 plan (24.383m 3D) 1200mm Ø			41.521			

3.7% L=4.087 plan (4.090m 3D) 1200mm Ø

WF14 - LONGITUDINAL SECTION

0 5 10 20

SCALE 1:200 (A1)
SCALE 1:400 (A3)
METRES

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All chainages are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum unless noted otherwise.
4. Do not scale from this drawing.
5. All details shown on this drawing are indicative only and subject to further development at *Specimen Design* stage.
6. This drawing shall be read in conjunction with Appendix A19.3: Watercourse Crossing report and not in isolation.

Key:

- Existing Ground Profile
- Proposed Ground Profile
- Existing Culvert
- Proposed Culvert
- Existing Watercourse
- Riverine Material
- Rip-Rap
- Rip-Rap (buried)
- CPO Boundary

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer: Jacobs
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Tel +44(0)141 243 8000 Fax +44(0)141 226 3109

Client: TRANSPORT SCOTLAND / CÒMHDHAIL ALBA

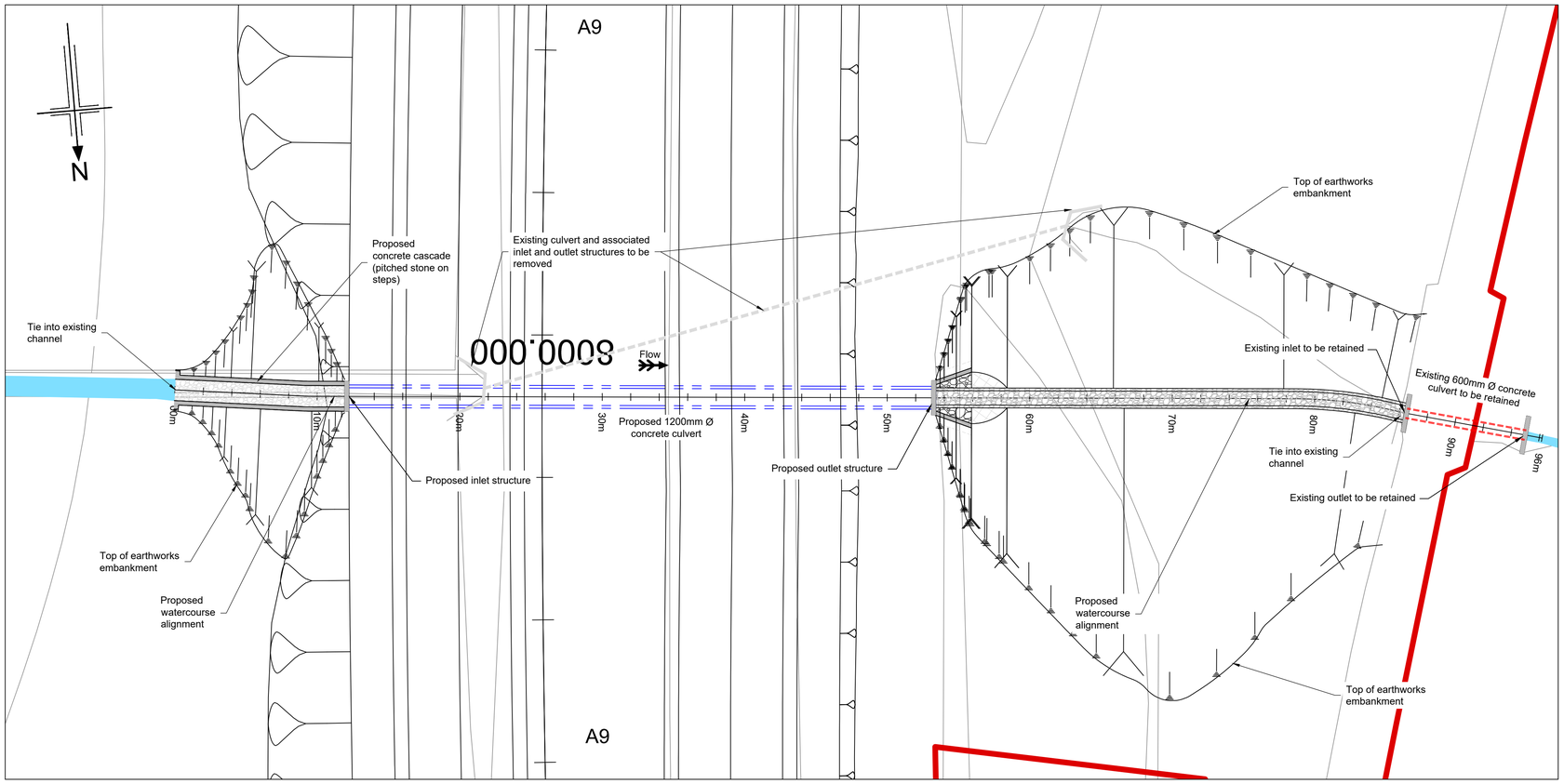
Project: A9 DUALLING PASS OF BIRNAM TO TAY CROSSING

Drawing title: BIRNAM TO TAY CROSSING PROPOSED MODIFICATIONS TO CULVERT ON WATERCOURSE WF14

Drawing status: ISSUED FOR INFORMATION

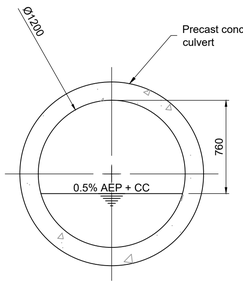
State		DO NOT SCALE
Scale	AS SHOWN	
Jacobs No.	B2140002	Rev 0
Client no.	TS/MTRIPS/SER/2013/03	

Drawing number
PIN A9P02 - Originator JAC - Volume EAC-
Location X_ZZ075_ZZ - Type DR- Role ZZ- Number 0001

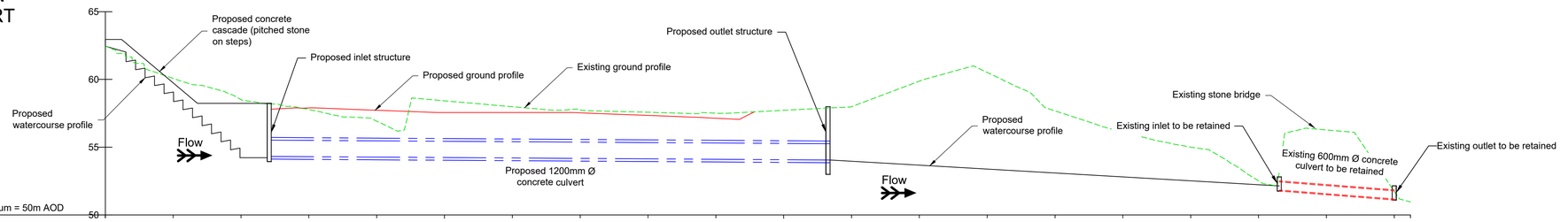


WF16 - PLAN

0 5 10 20
SCALE 1:200 (A1)
SCALE 1:400 (A3)
METRES



TYPICAL SECTION THROUGH CULVERT
SCALE 1:25



Existing Ground Level	62.450	60.075	58.513	57.784	56.923	58.421	57.985	57.778	57.576	57.502	57.721	57.989	59.870	60.515	57.678	56.123	55.000	52.516	56.270	51.749	50.955
Proposed Ground Level				57.895	57.725	57.553	57.553	57.531	57.341	57.136											
Culvert Invert Level				Inlet Invert 54.317 Outlet Invert 54.053														Inlet Invert 51.836 Outlet Invert 51.174			
Culvert Chainage, Dims, Gradient & Length				12.229	0.6% L=41.188 plan (41.189m 3D) 1200mm Ø						53.417							86.527	7.6% L=8.473 plan (8.498m 3D) 600mm Ø		95.000

WF16 - LONGITUDINAL SECTION

0 5 10 20
SCALE 1:200 (A1)
SCALE 1:400 (A3)
METRES

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All chainages are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum unless noted otherwise.
4. Do not scale from this drawing.
5. All details shown on this drawing are indicative only and subject to further development at *Specimen Design* stage.
6. This drawing shall be read in conjunction with Appendix A19.3: Watercourse Crossing report and not in isolation.

Key:

- Existing Ground Profile
- Proposed Ground Profile
- Existing Culvert
- Proposed Culvert
- Existing Watercourse
- Riverine Material
- Rip-Rap
- Rip-Rap (buried)
- CPO Boundary

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer: Jacobs
95 Bothwell St, Glasgow, G2 7HX
Tel +44(0)141 243 8000 Fax +44(0)141 226 3109
www.jacobs.com

Client: TRANSPORT SCOTLAND / CÒMHDHAIL ALBA

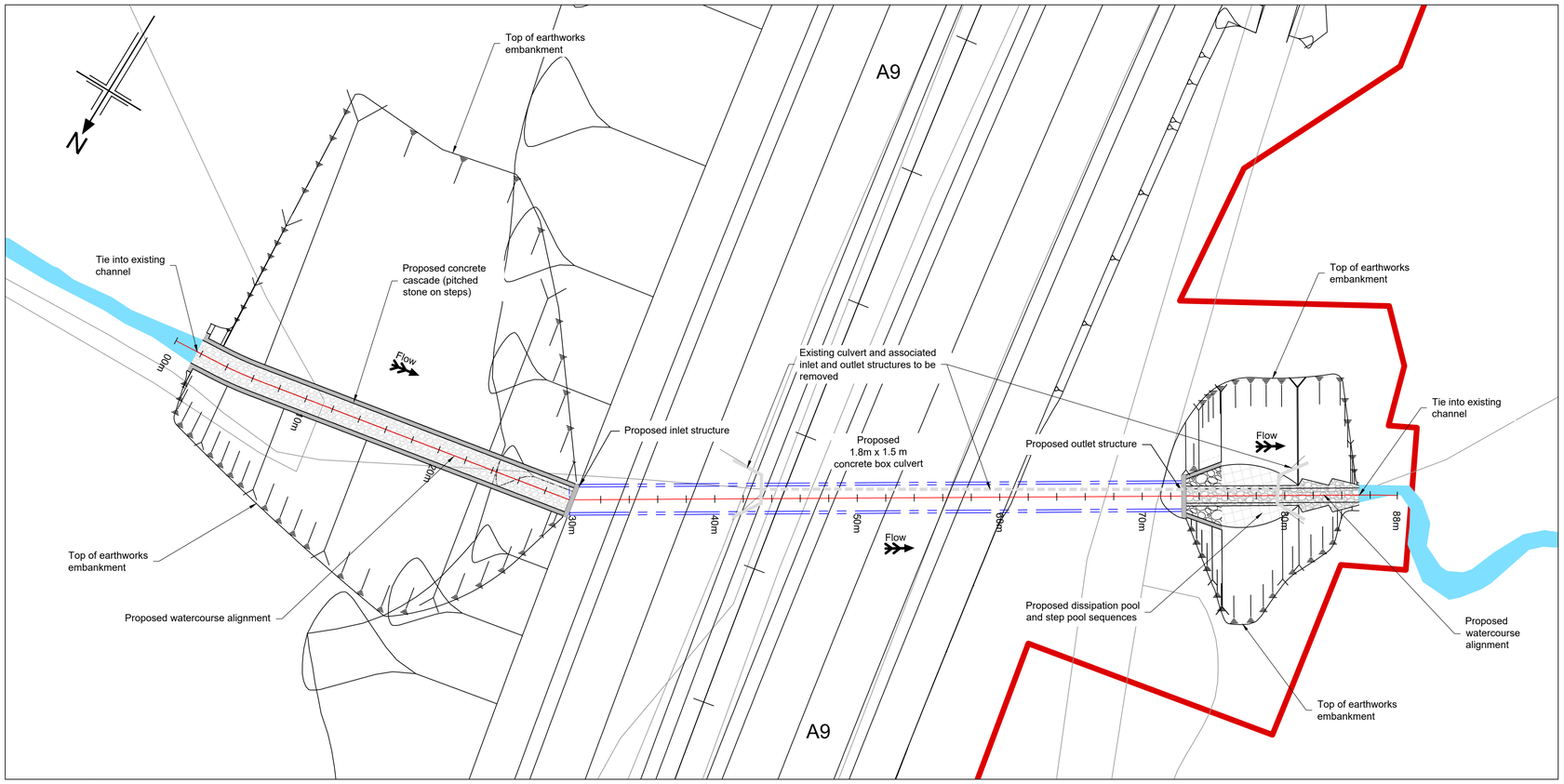
Project: A9 DUALLING PASS OF BIRNAM TO TAY CROSSING

Drawing title
BIRNAM TO TAY CROSSING PROPOSED MODIFICATIONS TO CULVERT ON WATERCOURSE WF16

Drawing status
ISSUED FOR INFORMATION

State		DO NOT SCALE	
Scale	AS SHOWN		
Jacobs No.	B2140002	Rev	0
Client no.	TS/MTRIPS/SER/2013/03		

Drawing number
PIN | Originator | Volume
A9P02 - JAC - EAC-
Location | Type | Role | Number
X_ZZ080_ZZ -DR- ZZ- 0001

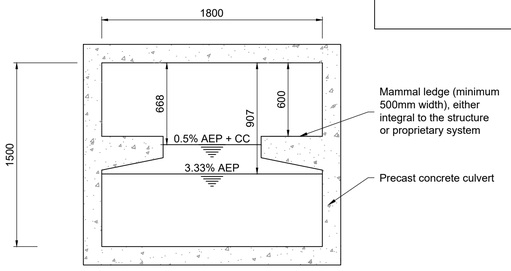


WF18 - PLAN

0 5 10 20

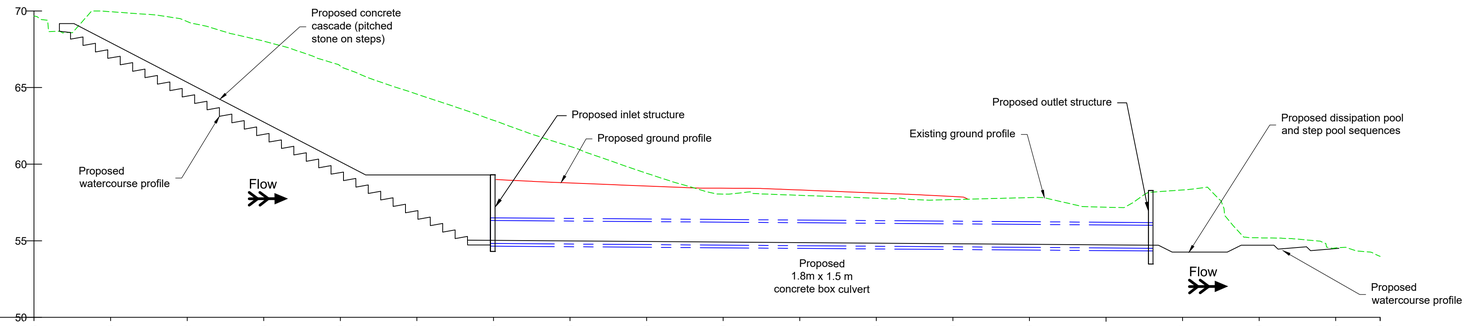
SCALE 1:200 (A1)
SCALE 1:400 (A3)

METRES



TYPICAL SECTION THROUGH CULVERT

SCALE 1:25



Datum = 50m AOD

Existing Ground Level	69.665	69.953	69.312	68.033	66.400	64.572	62.868	61.158	59.408	58.049	57.967	57.768	57.689	57.820	57.191	58.317	55.199	54.535	53.979
Proposed Ground Level						64.101	59.114	58.772	58.572	58.431	58.315	58.117	57.889						
Culvert Invert Level	Inlet Invert 54.825 Outlet Invert 54.510																		
Culvert Chainage, Dims, Gradient & Length	29.803	0.7% L=43.268 plan (43.269m 3D) 1800mm Ø														73.071			

WF18 - LONGITUDINAL SECTION

0 5 10 20

SCALE 1:200 (A1)
SCALE 1:400 (A3)

METRES

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All chainages are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum unless noted otherwise.
4. Do not scale from this drawing.
5. All details shown on this drawing are indicative only and subject to further development at *Specimen Design* stage.
6. This drawing shall be read in conjunction with Appendix A19.3: Watercourse Crossing report and not in isolation.

Key:

- Existing Ground Profile
- Proposed Ground Profile
- Existing Culvert
- Proposed Culvert
- Existing Watercourse
- Riverine Material
- Rip-Rap
- Rip-Rap (buried)
- CPO Boundary

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer: Jacobs
95 Bothwell St, Glasgow, G2 7HX
Tel +44(0)141 243 8000 Fax+44(0)141 226 3109
www.jacobs.com

Client: TRANSPORT SCOTLAND / CÒMHDHAIL ALBA

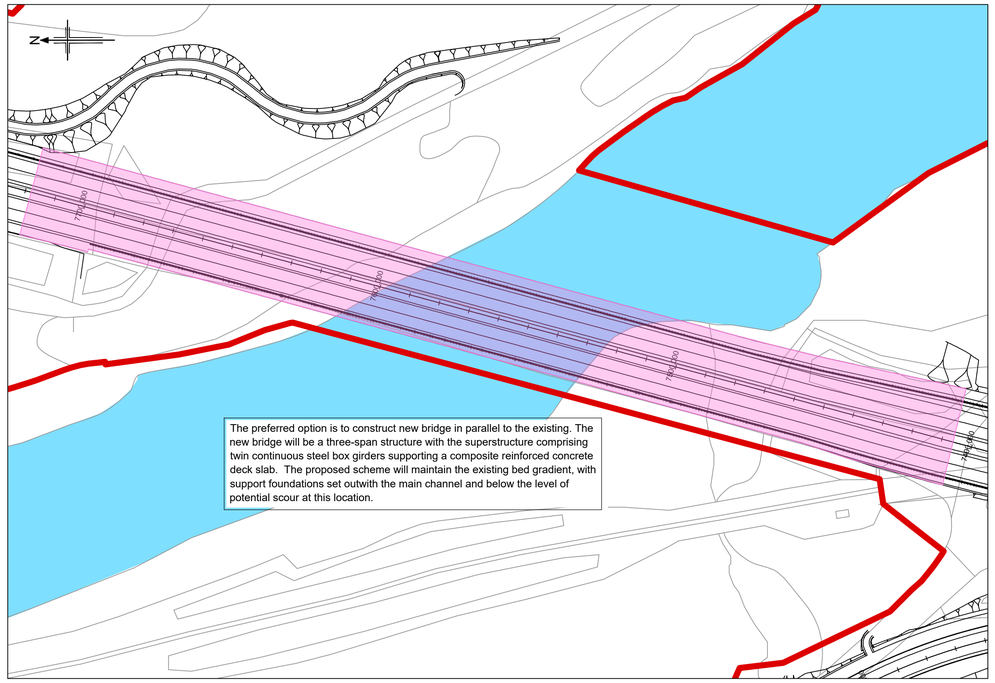
Project: A9 DUALLING PASS OF BIRNAM TO TAY CROSSING

Drawing title: BIRNAM TO TAY CROSSING PROPOSED MODIFICATIONS TO CULVERT ON WATERCOURSE WF18

Drawing status: ISSUED FOR INFORMATION

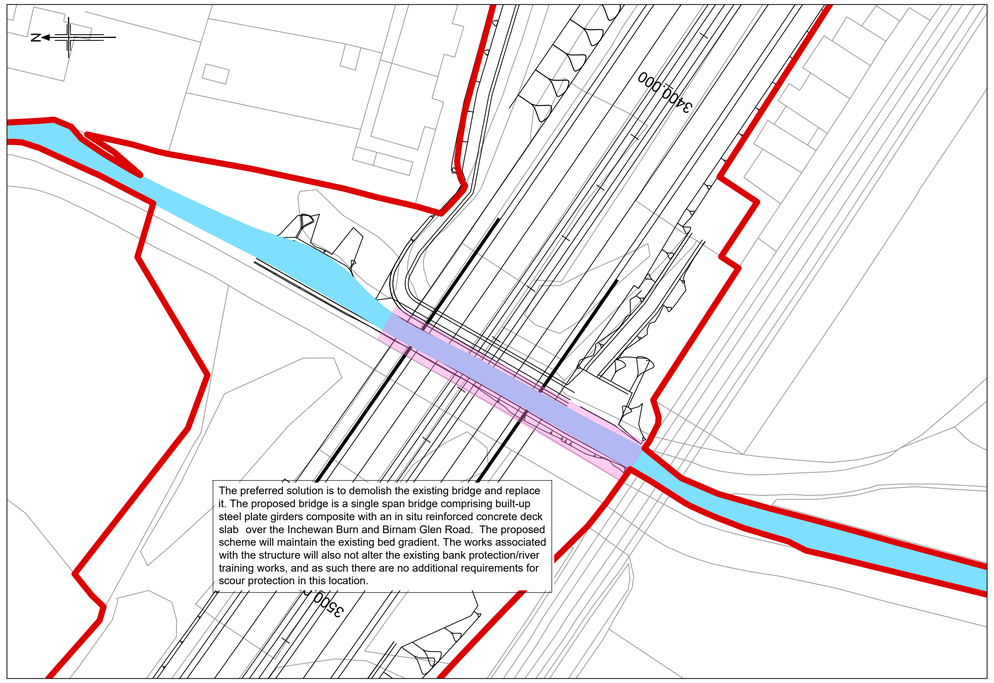
State		DO NOT SCALE	
Scale	AS SHOWN		
Jacobs No.	B2140002	Rev	0
Client no.	TS/MTRIPS/SER/2013/03		

Drawing number: PIN A9P02 - Originator JAC - Volume EAC - Location X_ZZ083_ZZ - Type DR - Role ZZ - Number 0001



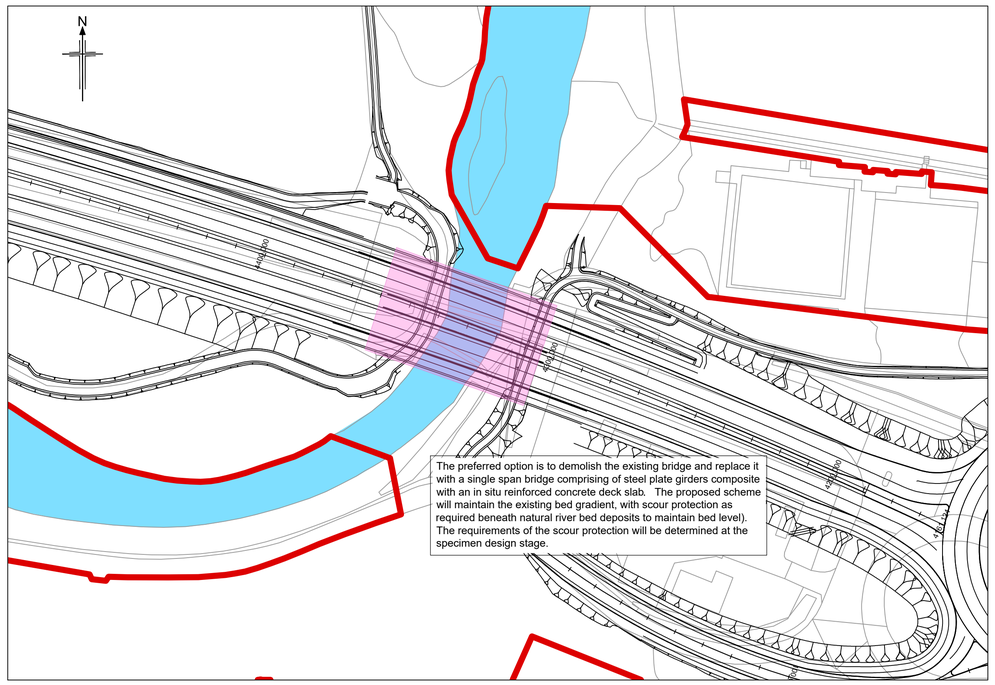
WF6 RIVER TAY
PLAN

0 10 20 30 40 50 60 70 80 90 100
METRES
SCALE 1:1,000 (A1)
SCALE 1:2,000 (A3)



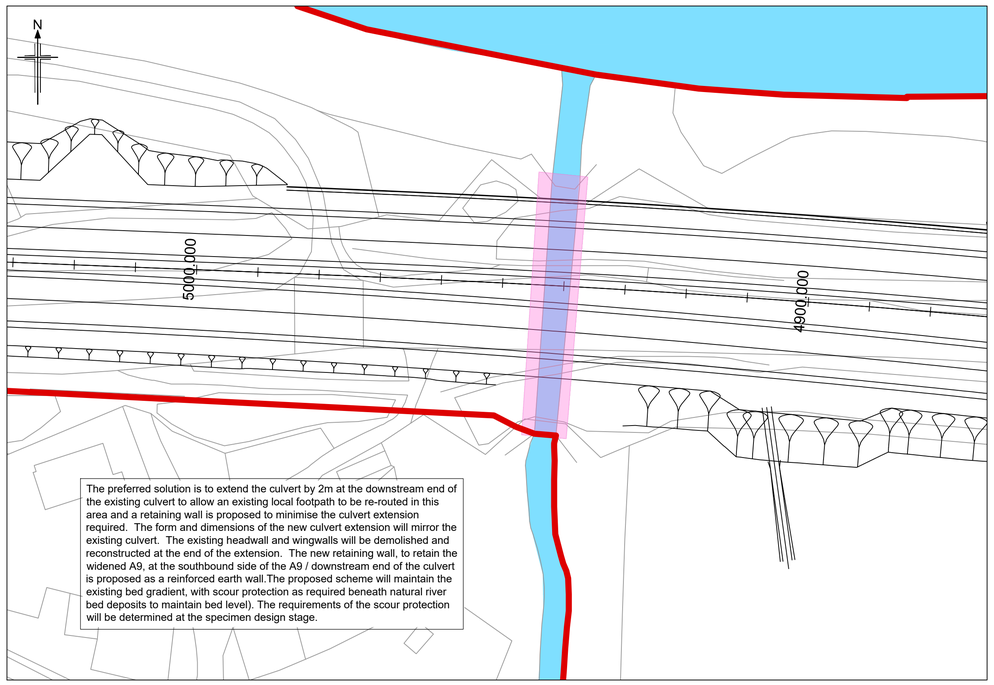
WF8 INCHEWAN BURN
PLAN

0 10 20 30 40 50
METRES
SCALE 1:500 (A1)
SCALE 1:1,000 (A3)



WF11 RIVER BRAAN
PLAN

0 10 20 30 40 50 60 70 80 90 100
METRES
SCALE 1:1,000 (A1)
SCALE 1:2,000 (A3)



WF12 MILL LADE
PLAN

0 10 20 30 40 50
METRES
SCALE 1:500 (A1)
SCALE 1:1,000 (A3)

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All chainages are in metres unless noted otherwise.
3. All levels are in metres above Ordnance Datum unless noted otherwise.
4. Do not scale from this drawing.
5. All details shown on this drawing are indicative only and subject to further development at *Specimen Design* stage.
6. This drawing shall be read in conjunction with Appendix A19.3: Watercourse Crossing report and not in isolation.

Key:

Existing Watercourse

Extent of Crossing

CPO Boundary

Major Water Crossing Salient Notes

WF06 - River Tay

- Existing bridge retained, with a new bridge of similar construction and arrangement constructed immediately adjacent
- Existing width (span) = 225.8m
- Existing deck height = approx. 10.06m above water level
- Proposed width (span) = 305m
- Proposed deck height = approx. 10.06m above water level

WF8 - Inchewan Burn

- Replacement of existing A9 bridge with new bridge.
- Existing length = 12.8m
- Existing width (span) = 28.9m
- Existing deck height = approx. 7.0m above water level.
- Proposed length = 26.26m
- Proposed width (span) = 25m
- Existing deck height = approx. 6.3m above water level

WF11 - River Braan

- Replacement of existing A9 bridge with new bridge
- Existing length = 13.6m
- Existing width (span) = 28.9m
- Existing deck height = approx. 5.6m above water level
- Proposed length = 35.5m
- Proposed width (span) = 51.8m
- Proposed deck height = approx. 6.8m above water level

WF12 - Mill Lade

- Extension of the existing box culvert. New outlet headwall structure as part of A9 mainline retaining wall
- Existing height = 2.0m
- Existing width = 3.5m
- Existing length = 40.5m
- Proposed length = 42.5m
- Proposed embedment = 0.20m

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer:
Jacobs
95 Bothwell St, Glasgow, G2 7HX
Tel +44(0)141 248 6800, Fax +44(0)141 226 3109

Client: TRANSPORT SCOTLAND / CÒMHDHAIL ALBA

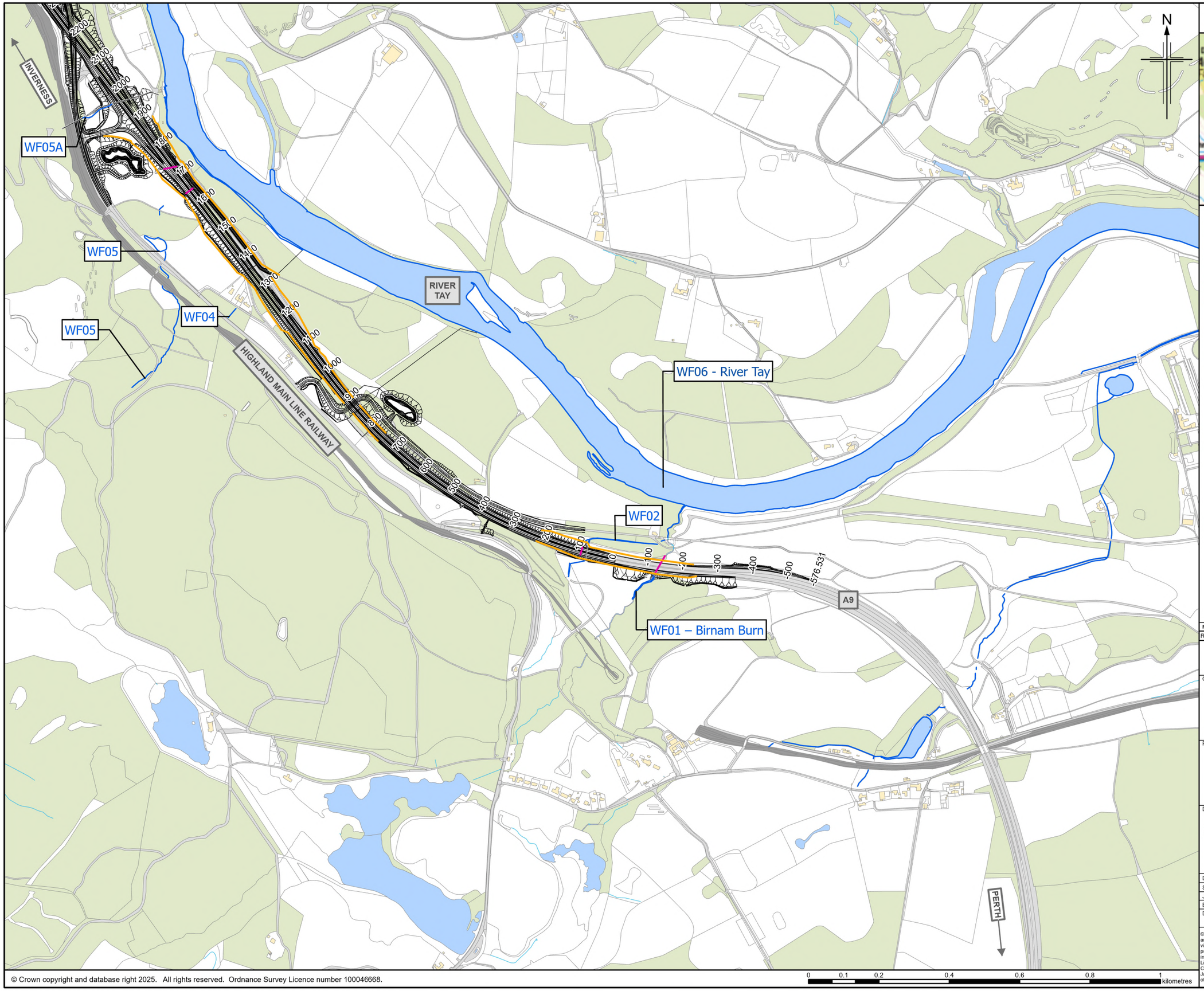
Project: A9 DUALLING
PASS OF BIRNAM
TO TAY CROSSING

Drawing title
BIRNAM TO TAY CROSSING
PROPOSED MODIFICATIONS
MAJOR WATERCOURSE
CROSSING LOCATIONS

Drawing status
ISSUED FOR INFORMATION

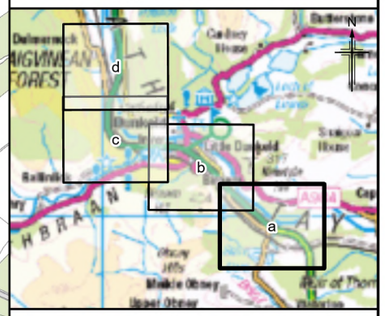
State		DO NOT SCALE
Scale	AS SHOWN	
Jacobs No.	B2140002	Rev 0
Client no.	TS/MTRIPS/SER/2013/03	

Drawing number
PIN | Originator | Volume
A9P02 - JAC - EAC-
Location | Type | Role | Number
X_ZZZZZ_ZZ - DR - ZZ - 0001



0 0.1 0.2 0.4 0.6 0.8 1 kilometres

Appendix 19.3.1a



Legend

- Proposed scheme (DMRB Stage 3)
- SuDS
- Watercourses
- Proposed Mammal Ledges and Dry Mammal Underpass
- Proposed Mammal Fencing

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
P03	MAY 2025	For Stage Approval	PM	AP	GK	EM

Jacobs
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Client: TRANSPORT SCOTLAND / CÒMHDHAIL ALBA

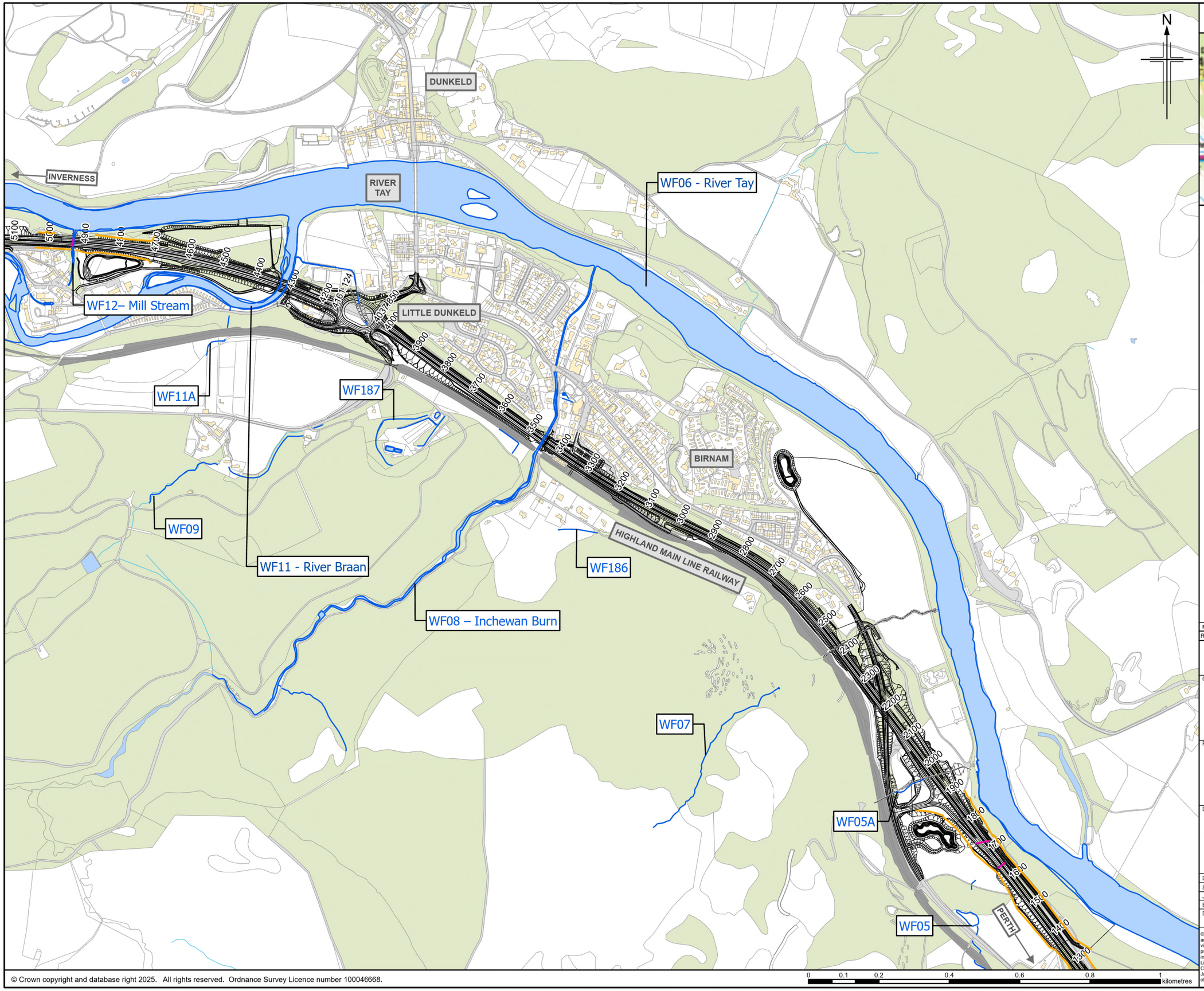
Project: A9 DUALLING – PASS OF BIRNAM TO TAY CROSSING

Drawing title

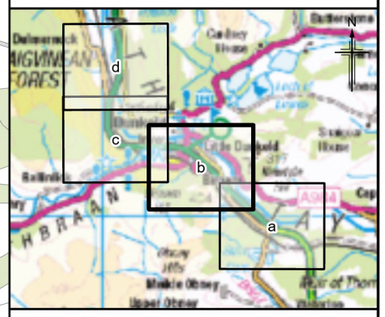
Environmental Impact Assessment Report
Dry mammal underpass locations

Sheet 1 of 4

Drawing Status	S4 – For Stage Approval	
Scale	1:10,000 @ A3	DO NOT SCALE
Jacobs No.	B2140002	
BIM No.	A9P02-JAC-EWE-D_ZZZZZ_ZZ-FG-EN-0003	
Drawing number	Appendix 19.3.1a	Rev P03



Appendix 19.3.1b



Legend

- Proposed scheme (DMRB Stage 3)
- SuDS
- Watercourses
- Proposed Mammal Ledges and Dry Mammal Underpass
- Proposed Mammal Fencing

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
P03	MAY 2025	For Stage Approval	PM	AP	GK	EM

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Client: TRANSPORT SCOTLAND / CÒMHDHAIL ALBA

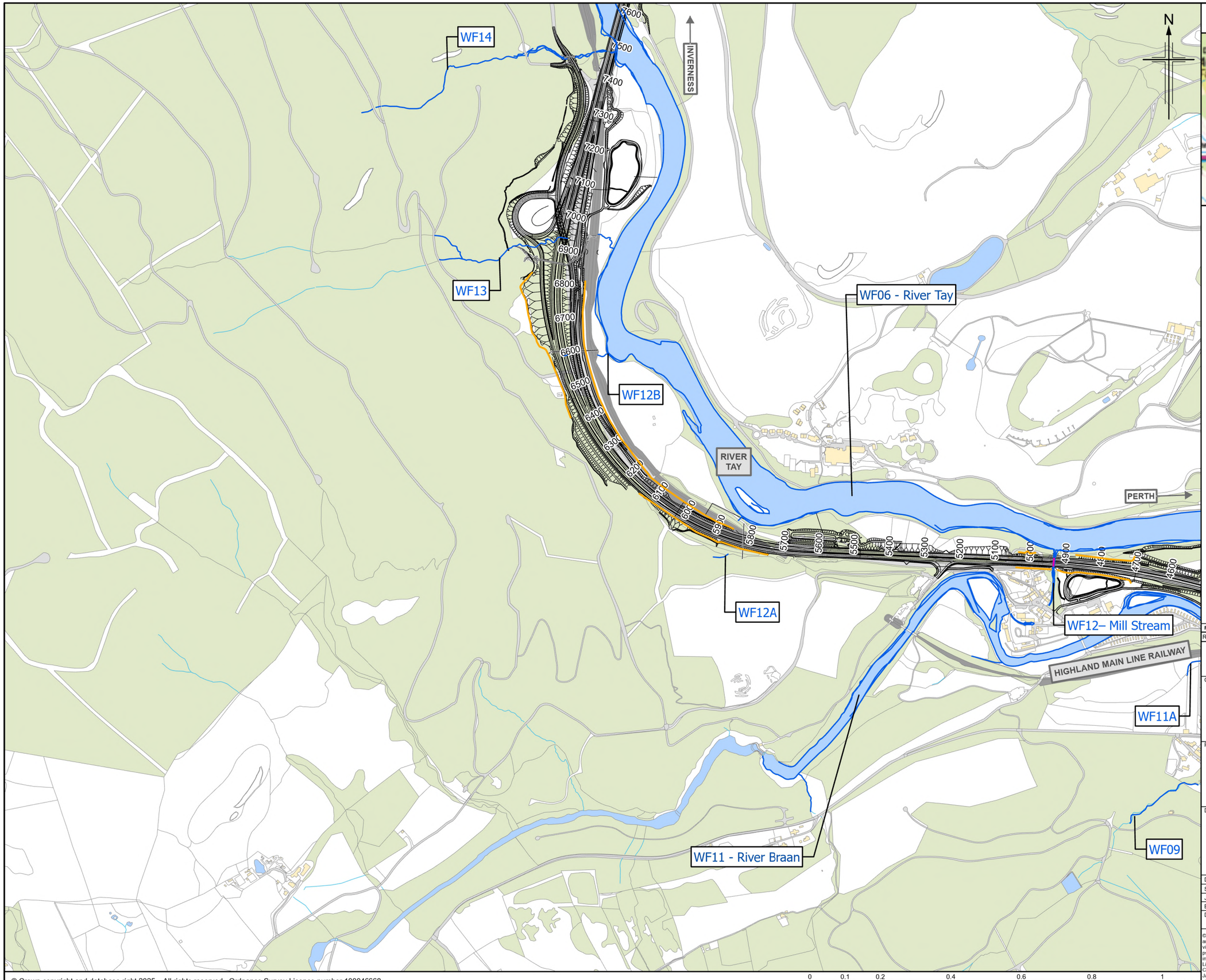
Project: A9 DUALLING – PASS OF BIRNAM TO TAY CROSSING

Drawing title

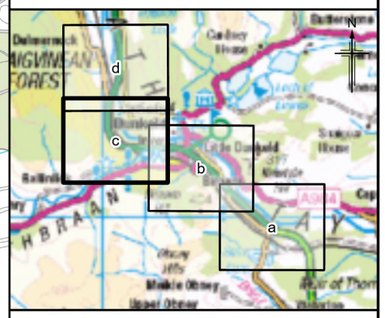
Environmental Impact Assessment Report
Dry mammal underpass locations

Sheet 2 of 4

Drawing Status	S4 – For Stage Approval
Scale	1:10,000 @ A3 — DO NOT SCALE
Jacobs No.	B2140002
BIM No.	A9P02-JAC-EWE-D_ZZZZZ_ZZ-FG-EN-0003
Drawing number	Appendix 19.3.1b
Rev	P03



Appendix 19.3.1c



Legend

- Proposed scheme (DMRB Stage 3)
- SuDS
- Watercourses
- Proposed Mammal Ledges and Dry Mammal Underpass
- Proposed Mammal Fencing

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
P03	MAY 2025	For Stage Approval	PM	AP	GK	EM

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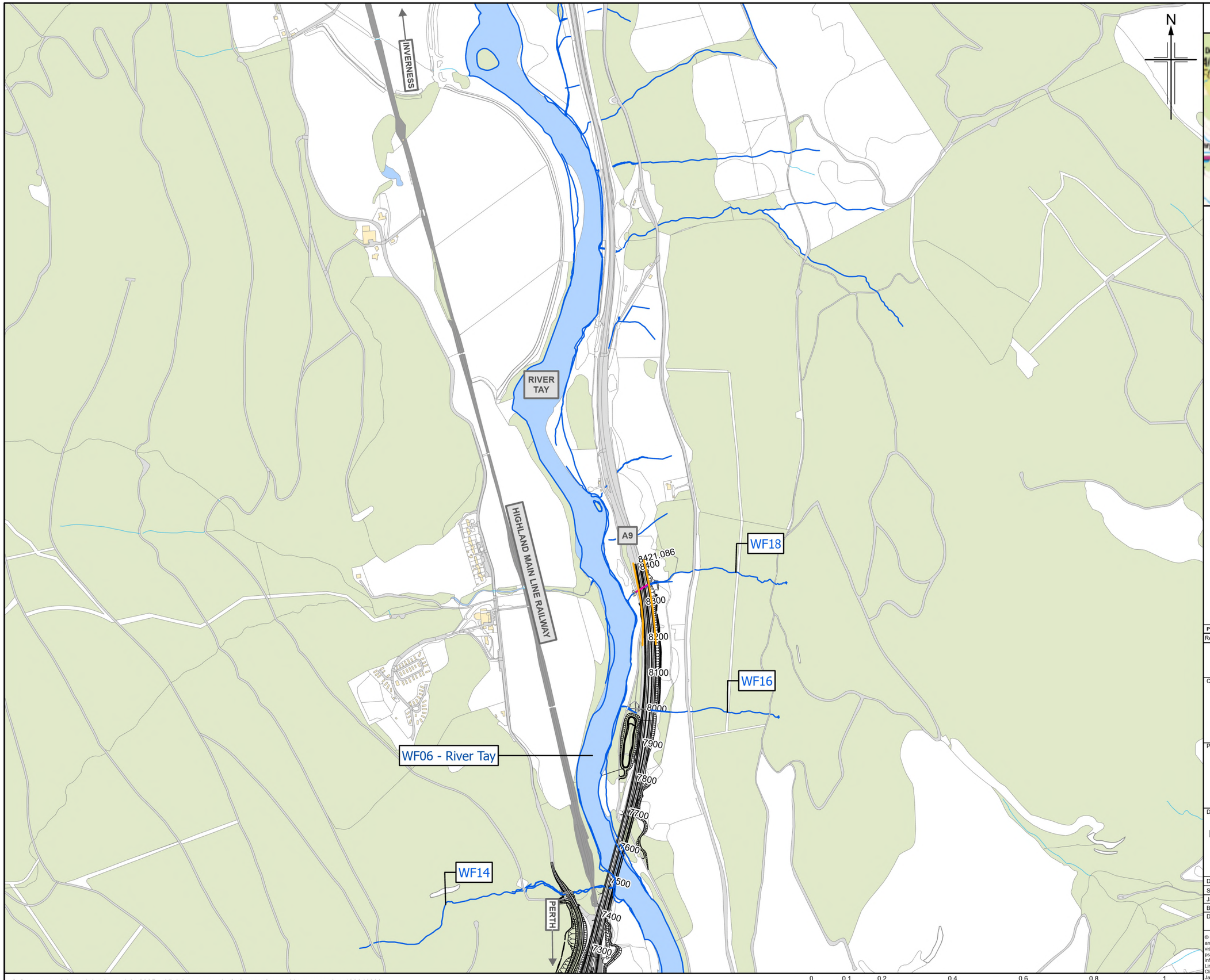
Project: A9 DUALLING – PASS OF BIRNAM TO TAY CROSSING

Drawing title

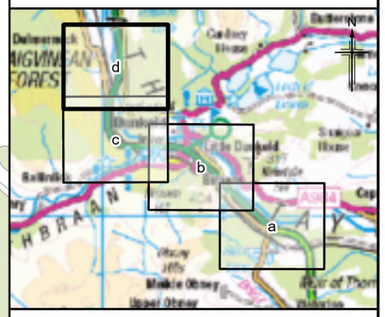
Environmental Impact Assessment Report
Dry mammal underpass locations

Sheet 3 of 4

Drawing Status	S4 – For Stage Approval	
Scale	1:10,000 @ A3	DO NOT SCALE
Jacobs No.	B2140002	
BIM No.	A9P02-JAC-EWE-D_ZZZZZ_ZZ-FG-EN-0003	
Drawing number	Appendix 19.3.1c	Rev P03



Appendix 19.3.1d



Legend

- Proposed scheme (DMRB Stage 3)
- SuDS
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Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
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Sheet 4 of 4

Drawing Status	S4 – For Stage Approval	
Scale	1:10,000 @ A3	DO NOT SCALE
Jacobs No.	B2140002	
BIM No.	A9P02-JAC-EWE-D_ZZZZZ_ZZ-FG-EN-0003	
Drawing number	Appendix 19.3.1d	Rev P03