Appendix A19.4: SuDS and Water Quality

1.1 Introduction

Scope

1.1.1 This appendix presents the assessment of water quality impacts to surface waters due to discharges of road runoff from the proposed scheme during its operation as well as impacts from accidental spillage. These assessments have been undertaken in accordance with the Design Manual for Roads and Bridges (DMRB) LA 113 (Highways England et al., 2020) and SEPA Regulatory Method (WAT-RM-08) Sustainable Urban Drainage Systems (SUDS or SUD Systems) (SEPA, 2019). This document forms an appendix to Chapter 19 Road Drainage and the Water Environment.

1.1.2 This appendix provides the following additional information on the operational Sustainable Drainage Systems (from herein referred to as SuDS) associated with the proposed scheme:

- description of existing drainage conditions;
- A9 Dualling SuDS design principles, and project specific departures from these principles;
- proposed SuDS components (outfall locations, discharges rates and management trains), and justification for their adoption; and
- proposed attenuation and restricted discharge rates.

1.1.3 Temporary SuDS measures to be adopted during the construction of the proposed scheme are discussed within Appendix A5.1 (Construction Information). The impact assessment, informed by the results of the water quality assessments covered in this appendix, is presented in Appendix A19.5 (Impact Assessment).

Background

1.1.4 The primary purpose of SuDS is to provide a drainage solution which mimics natural run-off processes through interception, attenuation and conveyance prior to eventual discharge into the ground or to a surface watercourse. SuDS are a legal requirement for discharges from road schemes under the Water Environment and Water Services (Scotland) Act 2003 and the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended).

1.1.5 The four overarching pillars of SuDS design, of which any proposed SuDS scheme should aim to provide benefits to, are:

- water quality;
- water quantity;
- biodiversity; and
- amenity.

1.1.6 This appendix specifically considers the water quality aspects embedded within the proposed SuDS design. Amenity and biodiversity aspects have been considered and are discussed within Appendix A10.6 (SuDS Design Principles).

1.2 Existing Conditions

Site Description

1.2.1 The study area for the proposed scheme is characterised by the topography of the narrow River Tay floodplain and the adjacent steep hillsides of the lower Grampian Mountains. The proposed scheme drains entirely into the WF06 (River Tay) catchment via tributaries including WF08 (Inchewan Burn), WF11 (River Braan) and numerous other minor tributaries which are crossed by the proposed scheme. The sub-catchments in which the proposed scheme is located are predominantly rural with the existing A9, the towns of Dunkeld and Birnam representing the main urban influences on catchment hydrology.

1.2.2 The hydrogeology of the study site is characterised by highly permeable alluvium and river terrace deposits underlying the River Tay floodplain, and low permeability glacial till and metamorphic bedrock on the adjacent hillsides. Ground Investigation (GI) data, including groundwater monitoring, indicates that groundwater levels are typically near surface (<3m below ground level) across the River Tay floodplain.

1.2.3 Further information on the baseline conditions of the study area is provided within Appendix A19.1 (Baseline).

Existing Drainage

1.2.4 The existing A9 is predominantly drained via a network of kerbs and gullies which discharge untreated and un-attenuated runoff into each minor watercourse crossed by the road. There are sections of filter drains which are understood to have been installed as part of maintenance or localised upgrading works. No drawings or schematics of the existing drainage networks have been identified, therefore assumptions made on the existing drainage are based on site surveys and topography.

1.3 Proposed Scheme

1.3.1 The mainline carriageway of the proposed scheme will consist of eleven drainage catchments and associated outfalls (labelled A to I). The majority of proposed side roads within the proposed scheme will be encapsulated within the mainline drainage catchments, and have two levels of SuDS treatment (Table A19.4.2). There will be some side roads, mostly access and maintenance tracks, which cannot be incorporated to mainline catchments and will incorporate a single level SuDS treatment (filter drains/ swales on either side of the carriageway), with outfalls to minor watercourses crossed by the scheme.

1.3.2 The locations of the proposed mainline SuDS components and drainage catchments are shown on Figure 19.4. Further details on the SuDS design and components are discussed in Appendix A10.6 (SuDS Design Principles).

SuDS Design Principles

1.3.3 The following specific SuDS Design Principles, relevant to water quality and water quantity aspects, have been agreed amongst relevant stakeholders (including SEPA, local authorities and NatureScot) for the A9 Dualling Programme:

- SuDS should not be developed within the functional floodplain. Where this is unavoidable, SuDS should be protected from inundation during the 3.33% AEP (30-year) event and compensatory flood storage should be provided for any loss of floodplain storage during the 0.5% AEP (200-year) event.
- Two levels of SuDS treatment should be provided for all mainline drainage catchments (it is noted that proprietary SuDS may only be considered as a level of treatment in constrained sites).
- Surface water discharges should not result in any deterioration of water quality or hydromorphological effects in the receiving watercourses.
- Cuttings should avoid intercepting groundwater where this may result in the dewatering of groundwater or watercourses.

1.3.4 Standards for attenuation have not implicitly been agreed, nonetheless it has generally been accepted that the 0.5% AEP (200-year) plus a 39% allowance climate change (CC) flood event should be attenuated where possible in line with the flood risk design standards.

Additional drainage design information

1.3.5 Drainage catchment H, in the vicinity of the proposed Dalguise Junction, requires a pumping station due to design constraints preventing the use of a gravity-fed drainage solution for its full extent. Surface run-off from the northbound loop and the realigned B898, would be conveyed to the main drainage network within the proposed A9 dual carriageway via a pumping station. From there, a gravity-fed solution would be maintained to convey the run-off through a SuDS detention basin prior to the WF06 (River Tay) outfall. The pumping station would be positioned in a lay-by on the realigned B898, approximately 40m north of the junction between the B898 and the northbound loop. Due to the existing topography and gradient of the proposed B898, the pumping station would be of considerable depth, approximately 5 to 7m below the proposed carriageway level.

Project Specific SuDS Departures

1.3.6 As described in Appendix A19.2 (Flood Risk Assessment), the proposed scheme is largely located near, and partly within, the functional floodplain of the River Tay. For drainage catchments F and H, this has required a departure from the SuDS Design Principles to locate SuDS outwith the functional floodplain. In addition, the impact of siting SuDS within the functional floodplain has required a departure from the SuDS Design Principles to protect SuDS from inundation during the 3.33% AEP (30-year) event.

1.3.7 The proposed scheme is located in close proximity to residential and commercial property in the town of Birnam. This has constrained the adoption of a second level of SuDS treatment, on drainage catchment C1.

1.3.8 Diagram A19.4-1 details the decision process which has been followed in determining the preferred SuDS options to be adopted within these constrained catchments. The specific departures from the SuDS Design Principles (from herein referred to as 'SuDS Departures') are discussed in more detail below.

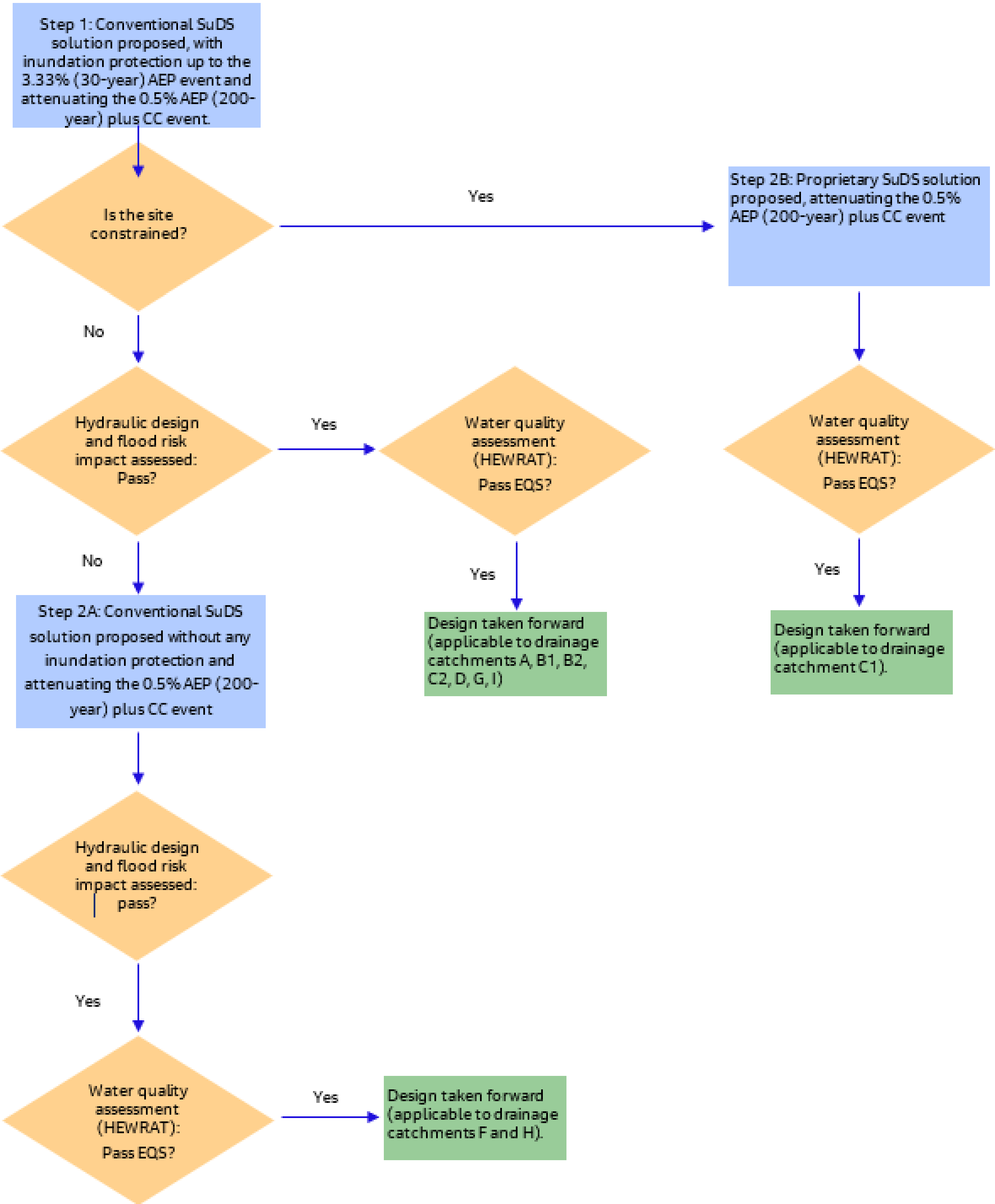

Diagram A19.4-1: Decision flow diagram for assessing options for second levels of SuDS for the proposed scheme.

SuDS Departure 1: SuDS within the Functional Floodplain without Inundation Protection

1.3.9 Where drainage catchments have been constrained by flood extents and levels, as detailed in Appendix A19.2 (Flood Risk Assessment), the adoption of conventional SuDS components without inundation protection (i.e. SuDS constructed below existing ground levels) has been considered. This departure prevents the loss of floodplain storage and associated flood risk impacts. For drainage catchments F and H, this departure allowed the adoption of conventional SuDS as a secondary level of treatment.

SuDS Departure 2: Adoption of Proprietary SuDS

1.3.10 SEPA Regulatory Method (WAT-RM-08) Sustainable Urban Drainage Systems (SUDS or SUD Systems) (SEPA, 2019) notes 'Proprietary SuDS' will only be considered by SEPA to provide a level of treatment for constrained sites provided they treat runoff, allow infiltration and attenuate flows.

1.3.11 Drainage catchment C1 is constrained to the south by Dunkeld & Birnam Station and the Highland Main Line railway and is further constrained to the north by residential and commercial property in the town of Dunkeld and Birnam such that there is insufficient space either adjacent to, or at reasonable distance from, the proposed scheme to accommodate conventional SuDS treatments for this catchment.

1.3.12 'Proprietary SuDS', in the form of hydrodynamic vortex separators (HVS) (to treat runoff) followed by geocellular attenuation tanks (to attenuate flows), have been assessed as the only viable option to provide a second level of treatment for the C1 catchment. The proposed proprietary SuDS features will provide attenuation of runoff volumes associated with the 0.5% AEP (200-year) plus a 39% allowance climate change event.

1.3.13 Further detail on these features is provided in Appendix A10.6 (SuDS Design Principles).

SuDS Departure 3: Discharging to Minor Watercourses

1.3.14 The options for discharging to nearby watercourses for drainage catchment B1 have been constrained by both hydrogeology and the desire to minimise impacts to the River Tay Special Area of Conservation (SAC). Discharging to ground has been discounted due to the presence of raised groundwater levels in the study area and hence the risk of operational failure. Preliminary options considered the construction of outfalls on the banks of WF06 (River Tay), however these would require the construction of significant lengths of pipeline at significant depth (with subsequent safety and maintenance issues). This would have also required construction within the river, resulting in bed and bank disturbance impacts to the WF06 (River Tay).

1.3.15 A solution to minimise any direct impacts on WF06 (River Tay) (and its designated status) was to discharge to the minor watercourse, WF05A. This feature drains towards the WF06 (River Tay) via surface and subsurface mechanisms, which is dependent on inflows and groundwater levels, as inferred from hydrology, GI data, topography and flood modelling results. Therefore, discharging into this water feature has been assessed as the preferred option, due to the requirement to minimise the construction and operational impacts on the River Tay SAC, as well as reduce safety risks and maintenance burdens.

Mainline SuDS

1.3.16 The SuDS management trains for the mainline carriageway of the proposed scheme, outfall locations (per drainage catchment) and a cross reference to the justification for their selection where departures are proposed, are provided in Table A19.4-1. It should be noted that Drainage Catchment E is proposed to tie into the existing drainage network.

Table A19.4-1: Proposed mainline SuDS

Drainage Catchment	NGR of Outfall Location		Receiving Water Feature	Water Feature Description	Proposed Management Train (MT)	Justification for Proposed SuDS Design
	Easting	Northing				
A	305139	740151	WF06 (River Tay)	Major watercourse	MT1: ▪ Filter Drain ▪ Detention Basin	Meets SuDS Design Principles
B1	304086	740753	WF05A	Drainage channel	MT2: ▪ Filter Drain ▪ Detention Basin with Wet Pond (Retention Pond)	Refer to SuDS Departure 3
B2	303927	741704	WF06 (River Tay)	Major watercourse	MT1: ▪ Filter Drain ▪ Detention Basin	Meets SuDS Design Principles
C1	303053	741744	WF08 (Inchewan Burn)	Medium watercourse	MT3: ▪ Filter Drain ▪ Geocellular Storage ▪ Hydrodynamic Vortex Separator	Refer to SuDS Departure 2
C2	303053	741744	WF08 (Inchewan Burn)	Medium watercourse	MT4: ▪ Filter Drain ▪ Dry Swale	Meets SuDS Design Principles
D	302296	742148	WF11 (River Braan)	Major watercourse	MT1: ▪ Filter Drain ▪ Detention Basin	Meets SuDS Design Principles

Drainage Catchment	NGR of Outfall Location		Receiving Water Feature	Water Feature Description	Proposed Management Train (MT)	Justification for Proposed SuDS Design
	Easting	Northing				
E	302681	742202	Existing drainage network	Existing drainage network	MT4: ▪ Filter Drain ▪ Dry Swale	Meets SuDS Design Principles
F	301705	742235	WF12 (Mill Stream)	Minor (artificial) watercourse	MT1: ▪ Filter Drain ▪ Detention Basin	Refer to SuDS Departure 1
G	301050	742445	WF06 (River Tay)	Major watercourse	MT5: ▪ Combined Kerb Drain ▪ Filter Drain ▪ Conveyance Swale ▪ Detention Basin	Meets SuDS Design Principles
H	300444	743296	WF06 (River Tay)	Major watercourse	MT1: ▪ Filter Drain ▪ Detention Basin	Refer to SuDS Departure 1
I	300448	744141	WF06 (River Tay)	Major watercourse	MT6: ▪ Filter Drain ▪ Wetland	Meets SuDS Design Principles

Side Road SuDS

1.3.17 Side roads encapsulated into mainline drainage catchments will be treated by two levels of SuDS treatment, detailed in Table A19.4-2. Where side roads cannot be incorporated into mainline drainage, the proposed side road drainage will incorporate a single level of SuDS treatment, which will generally comprise filter drains on either side of the carriageway, designed to allow for infiltration. There are some sections where conditions (topography and verge width within the earthworks) will also allow the adoption of swales instead of filter drains. The side roads will outfall to minor watercourses that are crossed by the scheme. It is anticipated that the outfall structure, where discharging into a minor watercourse, can be embedded within the culvert design or can be located directly adjacent to the crossing structure.

Table A19.4-2: SuDS for Side Roads incorporated into Mainline Drainage Catchments

Mainline Drainage Catchment	Incorporated Side Roads	Receiving Water Feature	Proposed Management Train (MT)
B1	B867	WF05A	MT2: ▪ Filter Drain ▪ Detention Basin with Wet Pond (Retention Pond)
B2	B867/ Perth Road Realignment	WF06 (River Tay)	MT1: ▪ Filter Drain ▪ Detention Basin
D	A822 (arm of roundabout) and Undefined Road to Inver (arm of Roundabout)	WF11 (River Braan)	MT1: ▪ Filter Drain ▪ Detention Basin
H	Dalguise junction B898	WF06 (River Tay)	MT1: ▪ Filter Drain ▪ Detention Basin

Access Tracks

1.3.18 Access tracks are proposed to provide access to agricultural premises, residential properties and operational access (to SuDS features and railway maintenance). These tracks will generally be unsurfaced and feature vehicle movements lower than surfaced side roads. All private access tracks will have a minimum single level of SuDS treatment, which will generally comprise a grass ditch situated at either edge of the track designed to allow for infiltration. The ditch shall discharge into the adjacent minor watercourse where practicable. Where there is no receiving watercourse available, any runoff from the track will be collected by the ditch and allowed to infiltrate the ground (i.e., act as a soakaway) where appropriate. In the case of the Railway Maintenance access road the edge of road treatment in the form of filter drains will be directed to the Dunkeld & Birnam Station car park. The car park drainage will be served by permeable pavement connected to geocellular storage which will then discharge to WF08 (Inchewan Burn).

1.4 Water Quality Assessment

Methodology

1.4.1 Water quality assessments for the proposed scheme have been undertaken in accordance with DMRB LA 113 (Highways England et al., 2020) using the Highways England Water Risk Assessment Tool (HEWRAT). The assessments cover the potential for likely significant effects on receiving watercourses from routine runoff, and the potential for likely significant effects from the accidental spillage of pollutants.

1.4.2 In addition, an assessment of the impact from de-icing activities, and specifically chloride (Cl^-), has been undertaken using a simple mass balance approach. The suitability of the proposed side road SuDS has also been assessed using the Simple Index Approach (SIA), in-line with SEPA's Regulatory Guidance (WAT-RM-08) Sustainable Urban Drainage Systems (SUDS or SuD Systems) (SEPA, 2019) and as detailed within the SuDS Manual (CIRIA, 2015).

HEWRAT: Routine Runoff Assessment

1.4.3 The HEWRAT assessment uses statistically based models for predicting the quality of road runoff in terms of specific soluble and sediment-bound pollutants. The models use traffic density, climatic region and event rainfall characteristics to predict runoff quality in terms of "event mean concentrations".

1.4.4 The tool then predicts the impact of the road runoff on receiving watercourses. For soluble pollutants, the assessment comprises a simple mass balance calculation accounting for river flows and hence dilution of pollutants. For sediment bound pollutants, the model considers both the likelihood and extent of sediment accumulation.

1.4.5 Dissolved copper (Cu) and dissolved zinc (Zn) are used as indicators of the level of impact from soluble pollutants, as they are known to result in acute toxic effects to aquatic ecology at certain threshold concentrations. The assessment results detail whether the SuDS discharge would 'pass' or 'fail' in terms of the frequency that pollutant thresholds are exceeded. For sensitive sites such as those within the study area, the toxicity thresholds may only be exceeded once per year in any given 24-hour period or 0.5 times per year in any given 6-hour period.

1.4.6 HEWRAT also estimates in-river annual average concentrations for dissolved Cu and dissolved Zn that can be compared to adopted Environmental Quality Standards (EQS) as detailed in The Scotland River Basin District (Standards) Directions 2014 (Scottish Government, 2014), which are 1µg/l and 10.9µg/l for dissolved copper (bioavailable) and dissolved zinc (bioavailable) respectively.

1.4.7 Chronic impacts associated with sediment-bound pollutants are also identified by assessing concentrations of total copper, zinc, cadmium, pyrene, fluoranthene, anthracene, phenanthrene and total PAH (Polycyclic Aromatic Hydrocarbons). These concentrations are similarly assessed against ecological-based thresholds to determine the toxicity risk. A 'pass' or 'fail' result is also given, however an 'alert' is given for outfalls that would otherwise pass the assessment for sediment-bound pollutants, were it not for the following features being present downstream:

- a protected site within 1km of the point of discharge; and
- a structure, lake or pond within 100m of the point of discharge.

1.4.8 The efficiency of the proposed SuDS components in treating pollutants (treatment efficiencies) has been obtained using data provided in Table 8.3.2N1 of DMRB CG 501 (Highways England et al., 2022). Further details of the treatment efficiencies used in the assessments are provided in Annex A.

1.4.9 The HEWRAT routine runoff assessment uses a three-step approach to assess the impacts of both soluble and sediment-bound pollutants. The three-step approach is as follows:

- Step 1: estimates pollutant concentrations in the undiluted road runoff;
- Step 2: estimates pollutant concentrations after dilution within the receiving watercourse; and
- Step 3: estimates pollutant concentrations after mitigation (i.e. the treatment provided by the proposed SuDS) and dilution within the receiving watercourse.

1.4.10 Only Step 2 and Step 3 results are presented within this appendix. These results translate into the pre-mitigation (Step 2) and post-mitigation or residual (Step 3) impact magnitudes, as presented within Appendix A19.5 (Impact Assessment) and Chapter 19 (Road Drainage and Water Environment).

1.4.11 The input data and associated sources used within the routine runoff assessments are presented in Table A19.4-3. Annex A of this document provides the full list of input data specific to each drainage catchment.

Table A19.4-3: Routine Runoff Assessment standard input data and data sources

Parameter	Value Used	Notes/Data Sources
Annual Average Daily Traffic (AADT)	>10,000 and <50,000	Design year 2051 Source: Jacobs' traffic modelling team.
Climatic Region	Colder Wet	Source: HEWRAT Help v2.0
Rainfall Site	Ardtalnaig (SAAR 1343.9mm)	Source: HEWRAT Help v2.0
Hardness	Low = <50mg $CaCO_3$/l	Worst-case scenario. SEPA water quality monitoring data for River Tay at Pitnacree used as donor information.
95%ile River Flow (m^3/s) – value of flow which is exceeded 95% of the time	Specific to each outfall location	Source: Jacobs' hydrologists
Baseflow Index (BFI)	Specific to each outfall location	Source: Flood Estimation Handbook (FEH) Web Service and Jacobs' hydrologists
Impermeable and permeable area draining to outfall (ha)	Specific to each drainage catchment	Source: proposed scheme information
Receiving watercourse dimensions (estimated river width at Q_{95}, bed width, side slope and long slope)	Specific to each outfall location	Source: site information and desk study
Receiving watercourse Manning's n	Specific to each outfall location	Source: site information and with reference to (Chow, 1959)
Existing treatment of solubles and sediment (%)	0	Only partial treatment on the existing A9. Precautionary approach to assume no existing treatment.
Proposed treatment of solubles and sediments (%)	Specific to each drainage catchment	Sources: DMRB CG 501 (Highways England, 2022) Table 8.3.2N1 – Pollution and flow control measures options
Proposed attenuation – restricted discharge rate (l/s) to Q_{BAR}	Specific to each drainage catchment	Source: proposed scheme information

HEWRAT: Spillage Risk Assessment

1.4.12 The spillage risk assessment within DMRB LA 113 (Highways England et al., 2020) has been designed to calculate spillage risk during the operation of the proposed scheme and the associated probability of a serious pollution incident. The risk is calculated assuming that an accident involving spillage of pollutants onto the carriageway would occur at an assumed frequency (expressed as annual probabilities) based on calculated traffic volumes; the percentage of that traffic volume that is considered a Heavy Goods Vehicle (HGV); and the type of road/junction within each drainage catchment.

1.4.13 The probability that a spillage will cause a pollution incident (P_{INC}) is calculated as:

$P_{INC} = P_{SPL} \times P_{POL}$; where:

- P_{SPL} = probability of a serious accidental spillage in one year over a given road length, which is calculated using the road length, risk factors associated with the specific road type, and AADT and % Heavy Good Vehicles in the design year (2051 for the proposed scheme); and
- P_{POL} = the risk reduction factor, dependent upon emergency services response times, which determines the probability of a serious spillage leading to a serious pollution incident of surface waters (factor of 0.6 is applied for the proposed scheme as it is a rural trunk road with a response time of >20minutes and <1 hour).

1.4.14 In line with DMRB LA 113, where spillage risk is calculated as less than the 0.5% AEP (200-year), the spillage risk falls within acceptable limits even when road runoff discharges within close proximity (i.e. within 1km) to a designated conservation site (i.e. the River Tay SAC).

Impacts from De-icing Activities

1.4.15 In the absence of an existing method, a simple and conservative risk-based model has been developed to assess the impacts of de-icing activities, and specifically salt spreading and associated chloride (Cl^-) concentrations, within road runoff and receiving watercourses.

1.4.16 The method uses guidance (UK Roads Liaison Group, 2016) on the maximum application rate of road salt, combined with information of the ratio of road salt to brine in pre-wetted salt application; to estimate the mass (kg) of salt applied per square meter of road and subsequently per section of road draining to each outfall. The assumed maximum spreading rate of road salt application to the road surface is detailed in Table A19.4-4.

1.4.17 The second stage of the assessment considers the dilution available within the receiving watercourse, which because of the winter conditions at the time of application, is calculated from the estimated mean flow in each watercourse. The volume of salt entering the watercourse is assumed based on a 5mm depth rainfall event, which relates to the first flush rainfall depths used in the 'The SuDS Manual' (CIRIA, 2015).

1.4.18 In the absence of a UK short-term EQS for Cl^-, the subsequent concentration of Cl^- in the receiving watercourse is therefore assessed against a guidance concentration threshold of 640mg/l as reported by the Canadian Council of Ministers to the Environment (2011) for short-term exposure. The Canadian guidance is based on Cl^- toxicity tests which included a mussel species with similar biology and ecology to the freshwater pearl mussel native to the UK. Freshwater mussels are noted in the Canadian guidance document as being the most sensitive taxonomic group to Cl^-.

1.4.19 Although Scotland specific short-term thresholds are not available to assess against, some guidance on long term / chronic thresholds are available. SEPA's guidance document, Supporting Guidance (WAT-SG-53) Environmental Quality Standards and Standards for Discharge to Surface Waters (SEPA, 2020), states annual average concentrations of Cl^- should not exceed 250mg/l in freshwater environments. Assessments undertaken have referenced this standard to better contextualise calculated results.

1.4.20 The standard input parameters used within the Cl^- assessments are provided in Table A19.4-4.

Table A19.4-4: Standard input parameters to assessment of Cl^-

Parameter	Value Used	Source
Max application of salt per m^2	40g/m^2	UK Roads Liaison Group (2016)
Rainfall depth	5mm	Value adopted relates to the first flush rainfall depths used in the 'The SuDS Manual' (CIRIA, 2015).
Ratio of dry salt to brine	70:30	UK Roads Liaison Group (2016).
Runoff Coefficient	1	Coefficient as used in the HEWRAT.
Canadian Water Quality Guideline for Short-term exposure (WQG-S) to Cl^- concentrations for freshwater	640mg/l	Canadian Council of Ministers to the Environment (2011)
SEPA EQS value for long term/ chronic impacts for Cl^- concentrations in freshwater	250mg/l	Supporting Guidance (WAT-SG-53) Environmental Quality Standards and Standards for Discharge to Surface Waters (SEPA, 2020)

1.4.21 It is noted the results of the Cl^- assessment have not been included within the overall impact assessment for the proposed scheme due to the following reasons: the lack of a UK short-term EQS for Cl^- concentrations, published data on SuDS treatment efficiencies in removing Cl^- concentrations, and a defined methodology for assessing the impacts of Cl^- concentrations in line with the DMRB.

Simple Index Approach for Side Roads

1.4.22 The Simple Index Approach has been used to determine the suitability of the SuDS proposed for side road drainage in-line with SEPA's Regulatory Guidance (WAT-RM-08) Sustainable Urban Drainage Systems (SUDS or SUD Systems) (SEPA, 2019). The Simple Index Approach, as detailed within 'The SuDS Manual' (CIRIA, 2015), comprises two key components:

- Pollution Hazard Indices (PHI) of between 0 and 1, based on the pollutant levels likely for different land-use types, where higher values indicate higher pollutant levels; and
- Pollution Mitigation Indices (PMI) of between 0 and 1, based on the ability of SuDS components or groundwater protection measures to treat pollutants, where higher values indicate higher treatment efficiency.

1.4.23 PHI and PMI values are given for three broad pollutant categories: Total suspended solids (TSS), Metals, and Hydrocarbons. Where PHI is assessed to be less than PMI, mitigation or proposed SuDS is considered sufficient to treat runoff from the pollution source.

1.4.24 It is noted that side roads are generally surfaced, minor roads that will experience traffic flows (AADT) in the region of 60 to 350 vehicles per day (VPD). Traffic volumes for 'low traffic roads' are defined as <300 traffic movements per day (CIRIA, 2015); therefore, this category is deemed to be the most representative for the proposed side roads.

Limitations

1.4.25 The following key limitations to the water quality assessments undertaken are noted:

- The routine runoff assessment is noted as having a limited ability for assessing impacts on watercourses which are intermittent or ephemeral, with guidance within DMRB LA 113 stating that the impacts on groundwater should be considered in such instances.
- The data that has informed the HEWRAT tool is derived from several English motorways, which is noted as causing some notable differences when applied in Scotland. For example, on the A9 Dualling projects, the accidental spillage risk assessment results have been observed to be far below the acceptable limits even without mitigation, which is presumed to be due to the comparatively low traffic and HGV volumes.
- The rainfall data used within the tool is taken from the nearest rainfall station (Ardtalnaig). This station is approximately 30km west from the proposed scheme, therefore there may be some differences in the rainfall events that occur within the study area.
- The quoted SuDS treatment efficiencies taken from DMRB CG 501 (Highways England et al., 2022) are derived from limited studies, and do not account for the length or size of certain SuDS components.
- There is no published data on the treatment of Cl^- from SuDS, limiting the assessment of impacts from de-icing activities. No allowance for background salt concentrations is currently included in the assessment.

- Existing water quality within receiving watercourses is not directly taken into consideration in the HEWRAT routine runoff model; however, it is taken into consideration when assigning importance (Chapter 19: Road Drainage and the Water Environment and Appendix A19.1: Baseline Conditions) and thus determining the impact significance (Appendix A19.5: Impact Assessment and Chapter 19: Road Drainage and the Water Environment).

Results

1.4.26 This section presents the results of the water quality assessments undertaken for the proposed scheme. Annex A provides a summary of the input data used within the assessments.

<u>HEWRAT: Routine Runoff Assessment</u>

1.4.27 The results of the Step 2 Tier 1 assessment (i.e. no mitigation) has been undertaken based on the details of the proposed scheme. The results of the assessment are summarised in Table A19.4-5. Locations of the outfalls are provided in Figure 19.4. Table A19.4-6 presents the results from the Step 3 HEWRAT assessments for the proposed scheme including embedded mitigation.

1.4.28 It should be noted that no HEWRAT assessment was carried out for drainage catchment E. This catchment will discharge into the existing road drainage network and as such, HEWRAT is not applicable in this scenario.

Table A19.4-5: Mainline water quality assessment results (pre-mitigation)

Drainage Catchment	Receiving Watercourse	HEWRAT Routine Runoff Assessment				
		Dissolved Cu	Dissolved Zn	Cu EQS Compliance (µg/l)	Zn EQS Compliance (µg/l)	Sediment Bound Pollutants
Pre - Mitigation (Step 2)						
A	WF06 (River Tay)	0.00	0.00	0.00	0.00	Alert
B1	WF05A	3.20	3.70	1.16	3.59	Alert
B2	WF06 (River Tay)	0.00	0.00	0.00	0.00	Alert
C1	WF08 (Inchewan Burn)	0.00	0.00	0.05	0.16	Alert
C2	WF08 (Inchewan Burn)	0.00	0.00	0.01	0.02	Alert
D	WF11 (River Braan)	0.00	0.00	0.00	0.01	Alert
E	Existing Drainage Network	n/a	n/a	n/a	n/a	n/a
F	WF12 (Mill Stream)	0.80	1.60	0.50	1.54	Fail
G	WF06 (River Tay)	0.00	0.00	0.00	0.00	Alert
H	WF06 (River Tay)	0.00	0.00	0.00	0.00	Alert
I	WF06 (River Tay)	0.00	0.00	0.00	0.00	Alert

Table A19.4-6: Mainline water quality assessment results (post-mitigation)

Drainage Catchment	Receiving Watercourse	HEWRAT Routine Runoff Assessment				
		Dissolved Cu	Dissolved Zn	Cu EQS Compliance (µg/l)	Zn EQS Compliance (µg/l)	Sediment Bound Pollutants
Post - Mitigation (Step 3)						
A	WF06 (River Tay)	0.00	0.00	0.00	0.00	Alert
B1	WF05A	0.60	1.00	0.70	1.69	Alert
B2	WF06 (River Tay)	0.00	0.00	0.00	0.00	Alert
C1	WF08 (Inchewan Burn)	0.00	0.00	0.05	0.08	Alert
C2	WF08 (Inchewan Burn)	0.00	0.00	0.00	0.01	Alert
D	WF11 (River Braan)	0.00	0.00	0.00	0.01	Alert
E	Existing Drainage Network	n/a	n/a	n/a	n/a	n/a
F	WF12 (Mill Stream)	0.80	0.40	0.50	0.85	Alert
G	WF06 (River Tay)	0.00	0.00	0.00	0.00	Alert
H	WF06 (River Tay)	0.00	0.00	0.00	0.00	Alert
I	WF06 (River Tay)	0.00	0.00	0.00	0.00	Alert

Table A19.4.7: Cumulative mainline water quality assessment results

Drainage Catchment	Receiving Watercourse	HEWRAT Routine Runoff Assessment				
		Dissolved Cu	Dissolved Zn	Cu EQS Compliance (µg/l)	Zn EQS Compliance (µg/l)	Sediment Bound Pollutants
Pre - Mitigation (Step 2)						
C1 to C2	WF08 (Inchewan Burn)	0.00	0.00	0.06	0.18	Alert
I to H	WF06 (River Tay)	0.00	0.00	0.00	0.00	n/a
Post - Mitigation (Step 3)						
C1 to C2	WF08 (Inchewan Burn)	0.00	0.00	0.05	0.09	Alert
I to H	WF06 (River Tay)	0.00	0.00	0.00	0.00	n/a

1.4.29 The cumulative assessments for drainage Run C (C1 and C2) result in a pass for soluble pollutant impacts and no exceedances of the EQS for dissolved Cu or Zn, these results are provided in Table A19.4-7. Drainage Catchment I and H pass for soluble pollutant impacts and are not assessed for sediment accumulation as the outfalls are greater than 100m apart. No cumulative assessment was undertaken for the other drainage catchments outfalling to WF06 (River Tay) (A, B2, G and H) as all outfalls are located greater than 1km distance from each other.

1.4.30 Regardless of the magnitude of the result, if an outfall is within 1km of a protected site, HEWRAT will report an 'Alert' result for sediment bound pollutants. All drainage runs have an 'Alert' for sediment bound pollutants associated with them during Step 2 (Pre-mitigation) and Step 3 (Post-mitigation) due to their proximity (<1km) to the River Tay SAC. The one exception is a 'Fail' result on sediment bound pollutants at Step 2 for drainage Run F, however this result is reported as a 'Pass' with the inclusion of mitigation and therefore no further interventions are required.

1.4.31 The only failure of the HEWRAT routine runoff assessments, after the adoption of mitigation, is associated with WF05A (Drainage Catchment B1) which is ephemeral in nature with a very low Q_{95} flow ($0.0019m^3/s$). It is acknowledged within DMRB LA 113 that the HEWRAT tool has limited ability in assessing impacts on ephemeral watercourses, as increasing the mitigation will still not enable a 'Pass' result if Q_{95} flows are sufficiently low due to insufficient dilution. As discussed in SuDS Departure 3 (paragraphs 1.3.14 and 1.3.15), discharging to this drainage channel has been assessed as the preferred option, regardless of the HEWRAT results, when considering the local hydrogeology and the desire to minimise impacts on the River Tay SAC.

1.4.32 In addition, once the importance of the watercourse has been taken into consideration, no watercourse is reported as having a significant impact ('Moderate adverse' or above) within Chapter 19 (Road Drainage and Water Environment). Therefore, no redesign or adoption of further mitigation is required in this instance.

<u>HEWRAT: Spillage Risk Assessment</u>

1.4.33 The annual probability of a serious pollution incident occurring within each highway catchment draining to an individual outfall has been estimated to be far below the 0.5% AEP (200-year) guidance quoted in DMRB LA 113 for sensitive areas. Likewise, the summed annual probability of a serious pollution incident occurring across the cumulative drainage catchments (C1 and C2 to WF08 (Inchewan Burn), and A, B2, G, H and I to WF06 (River Tay)) is observed to also be far below the 0.5% AEP (200-year) threshold. The results of the single and cumulative assessments for spillage risk are provided in Table A19.4-8.

1.4.34 Although the risk of a spillage event has been assessed as low, spillage control valves will form part of the SuDS outlet designs for attenuation features (swales, wetlands, geocellular storage tanks and detention basins) to contain any pollutants in the event of a spillage.

Table A19.4-9: Mainline spillage risk assessment results

Drainage Catchment	Receiving Watercourse	Post - Mitigation (Step 3)	
		HEWRAT Spillage Risk Assessment	
		Return Period (years)	Within Acceptable Limits? (i.e., < 200 years and therefore Not Significant)
Single outfalls			
A	WF06 (River Tay)	4503	Yes
B1	WF05A	3044	Yes
B2	WF06 (River Tay)	5032	Yes
C1	WF08 (Inchewan Burn)	6192	Yes
C2	WF08 (Inchewan Burn)	51395	Yes
D	WF11 (River Braan)	1110	Yes
E	Existing Drainage	20024	Yes
F	WF12 (Mill Stream)	3454	Yes
G	WF06 (River Tay)	6103	Yes
H	WF06 (River Tay)	3040	Yes
I	WF06 (River Tay)	5439	Yes
Cumulative outfalls			
C1 to C2	WF08 (Inchewan Burn)	5526	Yes
A, B2, G, H and I	WF06 (River Tay)	911	Yes

<u>Impacts from De-icing Activities</u>

1.4.35 The results of the salt assessment are presented in Table A19.4-9 and are compared to the Cl- concentrations for short-term (640mg/l standard adopted from Canadian Water Quality guidelines) and long-term (250mg/l as outlined by SEPA in WAT-SG-53 guidance) threshold values. The results of the salt assessment show Cl- concentrations exceed the short-term and the EQS long-term values at two water features (WF05A and WF12). These water features are of a low and medium importance, respectively, and they are generally unsuitable for fish species (presently and are likely to continue to be unsuitable in the future) and no protected aquatic ecological species have been identified within them.

1.4.36 Concentrations of Cl^- within WF05A and WF12 will become further diluted when they discharge into WF06 (River Tay), which is the nearest location where protected species could be impacted by Cl^-. The assessment shows that the significant dilution would occur within the WF06 (River Tay) and would reduce Cl^- concentrations levels to below both the Canadian short-term guideline value and long-term value taken from SEPA guidance. Impacts from de-icing activities and salt assessment are for information only and do not form part of DMRB LA 113 guidance, therefore impacts are not assessed further in terms of magnitude and significance.

Table A19.4-9: Specific Input Parameters and Results of Salt Assessment

Drainage Catchment	Receiving Watercourse	Catchment Area (km^2)	Impermeable Area Draining to Outfall (m^2)	Mean flow (m3/s)	Maximum Discharge Rate (l/s)	Outflow Concentration of NaCl (mg/l)	Outflow Concentration of Cl- (mg/l)	Comparison to Canadian WQG-S (short-term /acute) (640mgCl-/l)	Comparison to EQS (long-term / chronic) (250mgCl-/l)
A	WF06 (River Tay)	3198	24190	141	12.5	100	61	Pass	Pass
B1	WF05A	0.432	41190	0.0096	26.9	2567	1557	Fail	Fail
B2	WF06 (River Tay)	3195	14700	141	14	100	61	Pass	Pass
C1	WF08 (Inchewan Burn)	5.77	13770	0.13	7.4	283	172	Pass	Pass
C2	WF08 (Inchewan Burn)	5.77	1890	0.13	5	226	137	Pass	Pass
D	WF11 (River Braan)	211	27360	7.02	18.2	109	66	Pass	Pass
E	Existing Drainage Network	n/a	2560	n/a	n/a	n/a	n/a	n/a	n/a
F	WF12 (Mill Stream)	0.024	26450	0.001	17.7	3269	1982	Fail	Fail

Drainage Catchment	Receiving Watercourse	Catchment Area (km^2)	Impermeable Area Draining to Outfall (m^2)	Mean flow (m3/s)	Maximum Discharge Rate (l/s)	Outflow Concentration of NaCl (mg/l)	Outflow Concentration of Cl- (mg/l)	Comparison to Canadian WQG-S (short-term /acute) (640mgCl-/l)	Comparison to EQS (long-term / chronic) (250mgCl-/l)
G	WF06 (River Tay)	2971	16810	133	6.9	100	61	Pass	Pass
H	WF06 (River Tay)	2969	50120	133	42	101	61	Pass	Pass
I	WF06 (River Tay)	2967	22600	133	13	100	61	Pass	Pass

Simple Index Approach for Side Roads and Access Tracks

1.4.37 The results from the Simple Index Approach for side road drainage are presented in Table A19.4-10 below. The results indicate that swales would be the preferred level of treatment for side road drainage, with additional Total Suspended Solids (TSS) mitigation recommended when only filter drains / infiltration trenches are proposed. The results from the Simple Index Approach for access tracks are presented in Table A19.4-11.

1.4.38 However, the Simple Index Approach does not consider the length of filter drains, and for the proposed scheme, filter drains will be constructed on both sides of the side road where reasonably practicable thereby enhancing their length and treatment relative to the impermeable area. Therefore, this is considered likely to provide sufficient enhancement to the treatment of TSS where swales cannot be accommodated.

Table A19.4.10: Side road water quality assessment results

Parameter	Category	TSS	Metals	Hydrocarbons
PHI	Low traffic roads (e.g. residential roads and general access roads, < 300 traffic movements/day)	0.5	0.4	0.4
Option 1:				
PMI SuDS 1	Filter Drain (where the trench is not designed as in infiltration component)	0.4	0.4	0.4
PMI SuDS 2	Swale	0.5	0.6	0.6
Combined Pollution Mitigation Indices for the Runoff Area		0.65	0.7	0.7
Sufficiency of Pollutant Mitigation Indices (PHI≤PMI)		Sufficient	Sufficient	Sufficient
Option 2:				
PMI SuDS 1	Filter Drain (where the trench is not designed as in infiltration component)	0.4	0.4	0.4
PMI SuDS 2	Detention Basin	0.5	0.5	0.6
Combined Pollution Mitigation Indices for the Runoff Area		0.65	0.65	0.7
Sufficiency of Pollutant Mitigation Indices (PHI≤PMI)		Sufficient	Sufficient	Sufficient

Table A19.4.11: Access track water quality assessment results

Parameter	Category	TSS	Metals	Hydrocarbons
PHI	Low traffic roads (e.g. residential roads and general access roads, < 300 traffic movements/day)	0.5	0.4	0.4
Option 1:				
PMI SuDS	Filter Strip	0.4	0.4	0.5
PMI Groundwater Protection	Infiltration trench with suitable depth of filtration material underlain by 300 mm minimum depth of soils with good contamination attenuation potential	0.4	0.4	0.4
Combined Pollution Mitigation Indices for the Runoff Area		0.6	0.6	0.7
Sufficiency of Pollutant Mitigation Indices (PHI≤PMI)		Sufficient	Sufficient	Sufficient
Option 2:				
PMI SuDS	Swale	0.5	0.6	0.6
PMI Groundwater Protection	None	0	0	0
Combined Pollution Mitigation Indices for the Runoff Area		0.5	0.6	0.6
Sufficiency of Pollutant Mitigation Indices (PHI≤PMI)		Sufficient	Sufficient	Sufficient
Option 3 (Dunkeld & Birnam Station and Railway Maintenance Access):				
PMI SuDS 1	Filter Drain	0.4	0.4	0.4
PMI SuDS 2	Permeable Paving	0.7	0.6	0.7
PMI SuDS 3	Geocelluar Storage	Indices not provided as these are specific to the product		
Combined Pollution Mitigation Indices for the Runoff Area (excluding PMI SuDS 3)		0.75	0.7	0.75
Sufficiency of Pollutant Mitigation Indices (PHI≤PMI)		Sufficient	Sufficient	Sufficient

1.5 Summary

1.5.1 In summary, after the adoption of mitigation only Drainage Catchment B1 (discharging to WF05A) fails components of the HEWRAT routine runoff assessment. The fail recorded at this location, post-mitigation, is due to the exceedance of acceptable soluble zinc (Zn) events for RST24. All of the relevant outfalls pass the cumulative routine runoff assessments.

1.5.2 All individual and applicable cumulative catchment assessments related to Spillage Risk have been calculated to be below the defined significance threshold of 0.5% AEP (200-year). Therefore, the overall impact of Spillage Risk on the proposed scheme is not significant.

1.5.3 Departures from the SuDS Design Principles include: adopting SuDS within the functional floodplain but without inundation protection; adopting proprietary SuDS components as a second level of treatment; and discharging to minor watercourses.

1.5.4 These departures have enabled the impacts on the River Tay SAC to be minimised, by removing direct discharges into the SAC. Therefore, these can be considered to have increased the biodiversity benefits provided by the SuDS design. The departures have also minimised flood risk impacts by minimising the loss of floodplain storage, thereby increasing the water quantity benefits provided by the SuDS design.

1.5.5 The water quality impact from de-icing activities on surrounding watercourse receptors, sourced from the proposed scheme, is not expected to result in significant environmental significant effects on sensitive aquatic receptors within the River Tay SAC. It is also noted that the salt assessment is for information only and does not form part of DMRB LA 113 guidance, therefore impacts are not quantified further in terms of magnitude and significance.

1.5.6 The Simple Index Approach was used for assessing impacts on water quality on drainage runoff from side road and access tracks. For side roads, results show where filter drains and detention basins are proposed, sufficient treatment is provided by indication of indicative Pollution Mitigation Indices (PMI) being greater than indicative Pollution Hazard Indices (PHI). For access tracks, the provision of a filter strip with outlined infiltration trench will be sufficient to mitigate against indicative PHIs. The treatment measures proposed for the Dunkeld & Birnam Station and Railway Maintenance Access are also sufficient against indicative PHIs. The overall impact of drainage from side roads and access tracks is considered to be non-significant.

1.5.7 Water quality assessment results have been undertaken which indicate once the importance of the receiving water features has been taken into consideration (Appendix A19.5: Impact Assessment), no significant impacts on water quality are found from the proposed operational discharges. The River Tay SAC catchment will benefit from the adoption of SuDS treatment in conjunction with the A9 Dualling Programme, as there is generally no such treatment associated with the existing A9.

1.6 References

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Annex A: Water Quality Assessment Input Data

Treatment Efficiencies of SuDS Management Trains

1.6.1 The treatment efficiency calculation and overall treatment efficiencies of the four management train components in combination are shown below. Treatment efficiencies are derived from Table 8.3.2N1 of DMRB CG 501 (Highways England et al., 2022). 'The SuDS Manual' (CIRIA, 2015) guidance advises that a factor of 0.5 is applied to the treatment efficiency of a secondary treatment component, as the treatment performance of secondary or tertiary levels of treatment is reduced due to already reduced pollutant concentrations in the inflow, this is reflected in the calculations where required. Percentage (%) of Pollutant Remaining = 100% x (1 – SC1) x (1 – SC2)

1.6.2 Where:

- SC1 = Treatment efficiency of SuDS Component 1
- SC2 = 0.5 x treatment efficiency of SuDS Component 2
- Total System Treatment Efficiency (%) = 100 - % of Pollutant Remaining

Table A19.4-12: Management Train 1 to 7 – summary of pollutant removal efficiencies

Drainage System	Treatment Efficiencies (%)		
	Dissolved Cu	Dissolved Zn	TSS
MT1			
SC1: Filter Drain	0	45	60
SC2: Detention Basin	0	0	50
Total system	**0**	**45**	**70**
MT2			
SC1: Filter Drain	0	45	60
SC2: Retention Pond	40	30	60
Total system	**40***	**53**	**72**
MT3			
SC1: Filter Drain	0	45	60
SC2: Geocellular Storage	0	0	0
SC3: Hydrodynamic Vortex Separator	0	15	40
Total system	**0**	**49**	**68**
MT4			
SC1: Filter Drain	0	45	60

Drainage System	Treatment Efficiencies (%)		
	Dissolved Cu	Dissolved Zn	TSS
SC2: Dry Swale	50	50	80
Total system	**50***	**58**	**76**
MT5			
SC1: Combined Kerb Drain	0	0	0
SC2: Filter Drain	0	45	60
SC3: Conveyance Swale	50	50	80
SC4: Detention Basin	0	0	50
Total system	**50***	**58***	**72***
MT6			
SC1: Filter Drain	0	45	60
SC3: Detention Basin	0	0	50
Total system	**0**	**45**	**70**
MT7			
SC1: Filter Drain	0	45	60
SC2: Wetland	30	50	60
Total system	**30***	**58**	**72**

*SC1 does not provide treatment, therefore treatment efficiency of SC2 not multiplied by 0.5.

HEWRAT Routine Runoff and Spillage Risk Assessments Input Data

1.6.3 Table A19.4-13, Table A19.4-14 and Table A19.4-15 summarise the input data used in the HEWRAT Routine Runoff and Spillage Risk calculations.

Table A19.4-13: HEWRAT and Spillage Risk Input Data (1)

Drainage Catchment	Receiving Watercourse	Easting	Northing	AADT	Climatic Region / Rainfall Site	Q_{95} Flow (m3/s)	Mean Annual Flow (m3/s)	Proposed Impermeable Area (ha)	Proposed Permeable Area (ha)
A	WF06 (River Tay)	305139	740151	>10,000 and <50,000	Cold Wet / Ardtalnaig	36.100	141.1	2.419	1.236
B1	WF05A	304086	740753	>10,000 and <50,000	Cold Wet / Ardtalnaig	0.0019	0.0096	4.119	3.57
B2	WF06 (River Tay)	303927	741704	>10,000 and <50,000	Cold Wet / Ardtalnaig	36.060	141.0	1.47	2.664
C1	WF08 (Inchewan Burn)	303053	741744	>10,000 and <50,000	Cold Wet / Ardtalnaig	0.0260	0.128	1.377	0.663
C2	WF08 (Inchewan Burn)	303053	741744	>10,000 and <50,000	Cold Wet / Ardtalnaig	0.0260	0.128	0.189	0.094
D	WF11 (River Braan)	302296	742148	>10,000 and <50,000	Cold Wet / Ardtalnaig	0.6160	7.02	2.736	2.184
E	Existing Drainage Network	N/A	N/A	>10,000 and <50,000	Cold Wet / Ardtalnaig		N/A	0.256	0.090
F	WF12 (Mill Stream)	301705	742235	>10,000 and <50,000	Cold Wet / Ardtalnaig	0.004	0.001	2.645	1.400

Drainage Catchment	Receiving Watercourse	Easting	Northing	AADT	Climatic Region / Rainfall Site	Q_{95} Flow (m3/s)	Mean Annual Flow (m3/s)	Proposed Impermeable Area (ha)	Proposed Permeable Area (ha)
G	WF06 (River Tay)	301050	742445	>10,000 and <50,000	Cold Wet / Ardtalnaig	35.270	133.36	1.681	0.381
H	WF06 (River Tay)	300444	743296	>10,000 and <50,000	Cold Wet / Ardtalnaig	35.250	133.25	5.012	5.991
I	WF06 (River Tay)	300448	743141	>10,000 and <50,000	Cold Wet / Ardtalnaig	35.220	133.17	2.260	1.163

Table A19.4.14: HEWRAT and Spillage Risk Input Data (2)

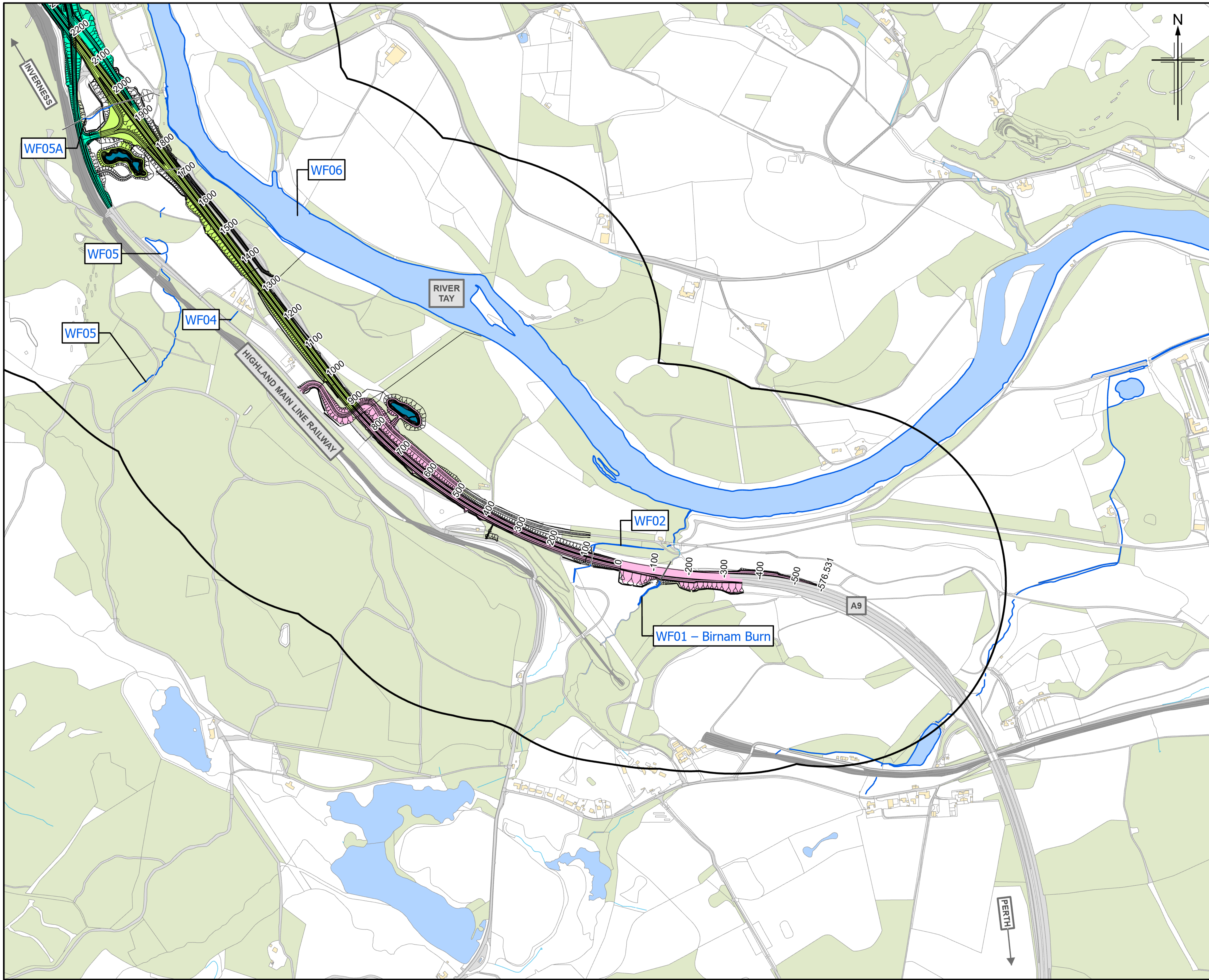
Drainage Catchment	BFI Index	Is the Discharge within 1km of Protected Site?	Water Hardness	Downstream Structure Reducing Velocity?	Estimated River Width (m)	Manning's n	Side Slope (m/m)	Long Slope (m/m)
A	0.436	Yes	Low <50mg CaCO3/l	No	151	N/A	N/A	N/A
B1	0.639	Yes	Low <50mg CaCO3/l	Yes	0.27	N/A	N/A	N/A
B2	0.436	Yes	Low <50mg CaCO3/l	No	77.3	N/A	N/A	N/A
C1	0.508	Yes	Low <50mg CaCO3/l	No	4.36	N/A	N/A	N/A
C2	0.508	Yes	Low <50mg CaCO3/l	No	4.36	N/A	N/A	N/A

Drainage Catchment	BFI Index	Is the Discharge within 1km of Protected Site?	Water Hardness	Downstream Structure Reducing Velocity?	Estimated River Width (m)	Manning's n	Side Slope (m/m)	Long Slope (m/m)
D	0.438	Yes	Low <50mg CaCO3/l	Yes	17.27	N/A	N/A	N/A
E	N/A	N/A	Low <50mg CaCO3/l	N/A	N/A	N/A	N/A	N/A
F	0.639	Yes	Low <50mg CaCO3/l	Yes	3.94	N/A	N/A	0.021
G	0.435	Yes	Low <50mg CaCO3/l	No	70.73	N/A	N/A	N/A
H	0.435	Yes	Low <50mg CaCO3/l	No	57.38	N/A	N/A	N/A
I	0.435	Yes	Low <50mg CaCO3/l	No	74	N/A	N/A	N/A

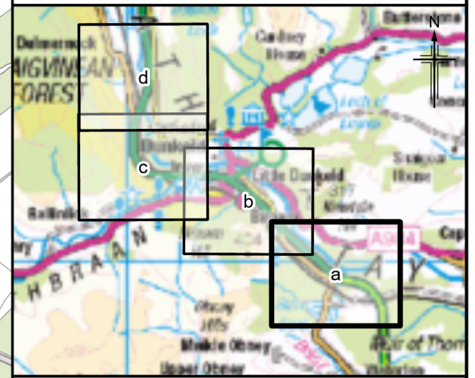
Table A19.4-15: HEWRAT and Spillage Risk Input Data (3)

Drainage Catchment	Proposed SuDS Treatment Train	Proposed treatment of Cu (%)	Proposed treatment of Zn (%)	Proposed settlement of sediments (%)	Restricted Discharge Rate from SuDS Outfall (l/s)	SuDS Volume (m3)	Breakdown of Road Lengths Draining to Outfall (m)
A	MT1: ▪ Filter Drain ▪ Detention Basin	0	45	70	12.5	4352.4	2430
B1	MT2: ▪ Filter Drain ▪ Detention Basin with Wet Pond (Retention Pond)	40	53	72	26.9	6194.2	3760
B2	MT1: ▪ Filter Drain ▪ Detention Basin	0	45	70	14.0	3956	2440
C1	MT3: ▪ Filter Drain ▪ Geocellular Storage ▪ Hydrodynamic Vortex Separator	0	49	68	7.4	1695	1400
C2	MT4: ▪ Filter Drain ▪ Dry Swale	50	58	76	5.0	N/A	220
D	MT1: ▪ Filter Drain ▪ Detention Basin	0	45	70	18.2	3933	2395
E	MT4: ▪ Filter Drain ▪ Dry Swale	50	58	76	TBC	N/A	430

Drainage Catchment	Proposed SuDS Treatment Train	Proposed treatment of Cu (%)	Proposed treatment of Zn (%)	Proposed settlement of sediments (%)	Restricted Discharge Rate from SuDS Outfall (l/s)	SuDS Volume (m3)	Breakdown of Road Lengths Draining to Outfall (m)
F	MT1: ▪ Filter Drain ▪ Detention Basin	0	45	70	17.7	6027.1	2570
G	MT5: ▪ Combined Kerb Drain ▪ Filter Drain ▪ Conveyance Swale ▪ Detention Basin	50	58	72	6.9	1917.7	1620
H	MT6: ▪ Filter Drain ▪ Detention Basin	0	45	70	42.0	12128	5780
I	MT7: ▪ Filter Drain ▪ Wetland	30	58	72	13.0	3462	1946



Appendix 19.4.1a



Legend

- Proposed scheme (DMRB Stage 3)
- SuDS
- 500m Study Area
- Watercourses

Drainage Catchment

- A
- B1
- B2
- C1
- C2
- D
- E
- F
- G
- H
- I
- Dunkeld & Birnam Station and Railway Maintenance Access Track
- Indicative Attenuation Pond

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

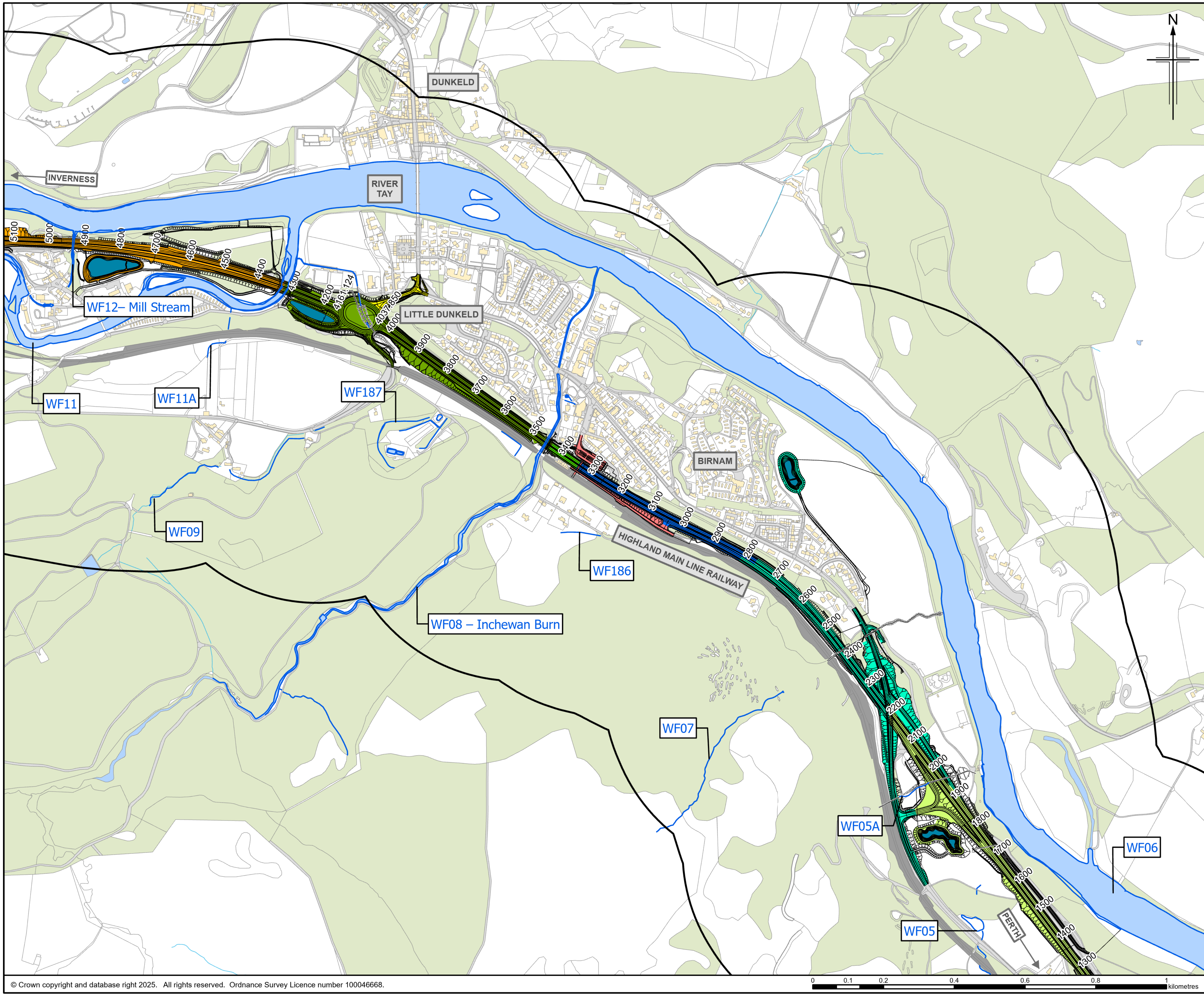
Drawing title

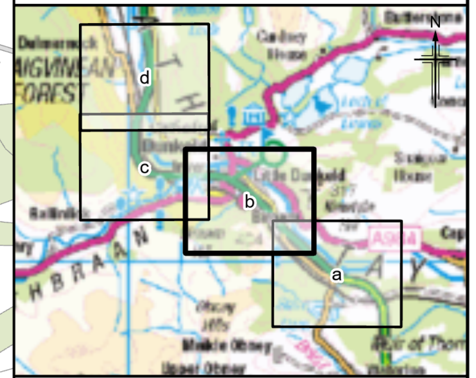
Environmental Impact Assessment Report
Drainage Catchments

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-0004	
Drawing number	Appendix 19.4.1a	Rev P03

Appendix 19.4.1b





Legend

- Proposed scheme (DMRB Stage 3)
- SuDS
- 500m Study Area
- Watercourses

Drainage Catchment

- A
- B1
- B2
- C1
- C2
- D
- E
- F
- G
- H
- I
- Dunkeld & Birnam Station and Railway Maintenance Access Track
- Indicative Attenuation Pond

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

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95 Bothwell Street, Glasgow, G2 7HX, UK.
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Client
TRANSPORT SCOTLAND
CÒMHDHAIL ALBA

Project
A9 DUALLING
PASS OF BIRNAM TO TAY CROSSING

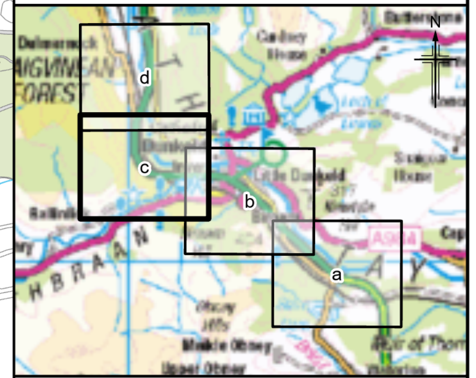
Drawing title

Environmental Impact Assessment Report
Drainage Catchments

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-0004	
Drawing number	Appendix 19.4.1b	Rev P03

Appendix 19.4.1c



Legend

- Proposed scheme (DMRB Stage 3)
- SuDS
- 500m Study Area
- Watercourses

Drainage Catchment

- A
- B1
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- C1
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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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A9 DUALLING
PASS OF BIRNAM TO TAY CROSSING

Drawing title
Environmental Impact Assessment Report Drainage Catchments

Sheet 3 of 4

Drawing Status	S4 – For Stage Approval	
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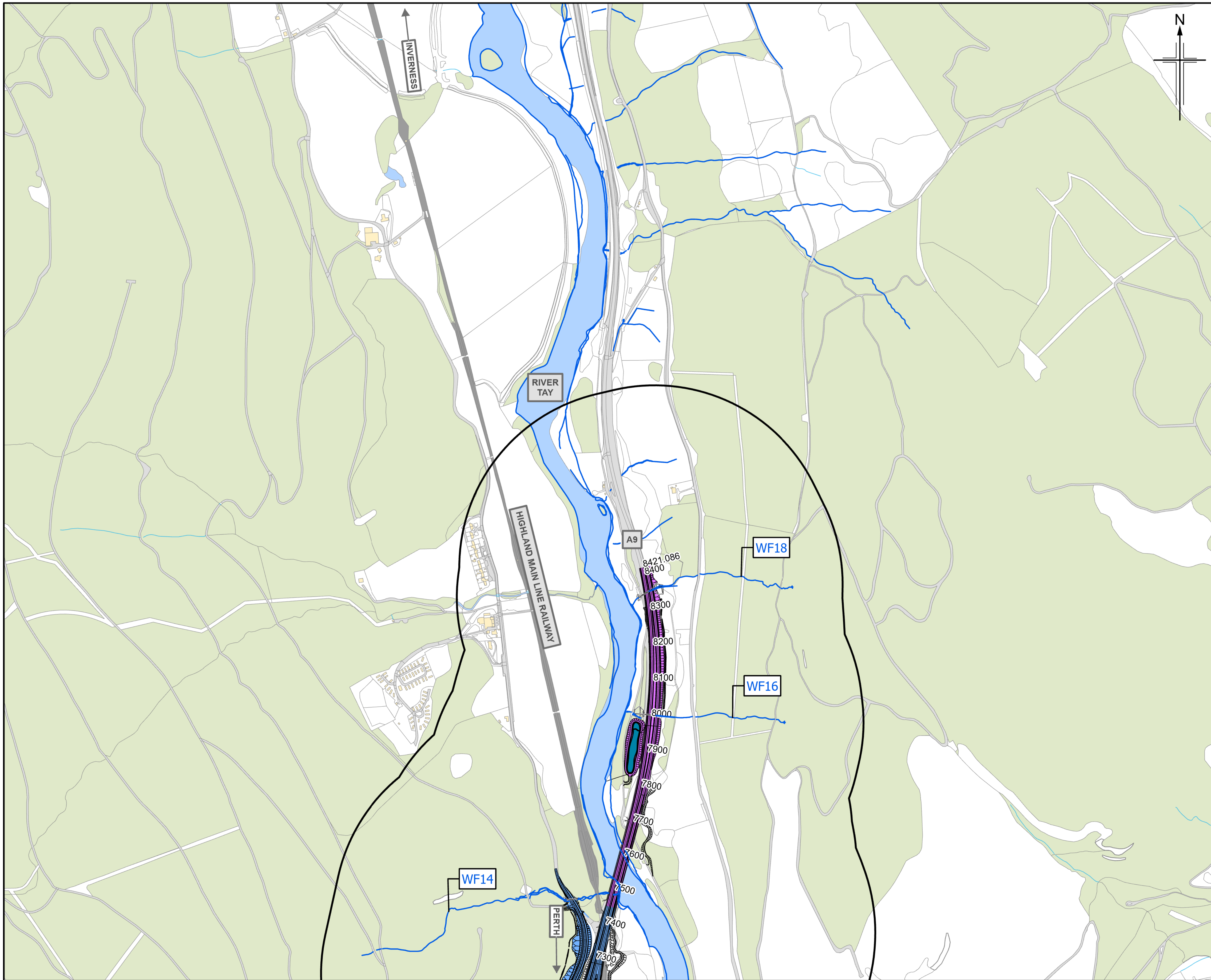
BIM No.	A9P02-JAC-EWE-D_ZZZZZ_ZZ-FG-EN-0004	
Drawing number	Appendix 19.4.1c	Rev P03



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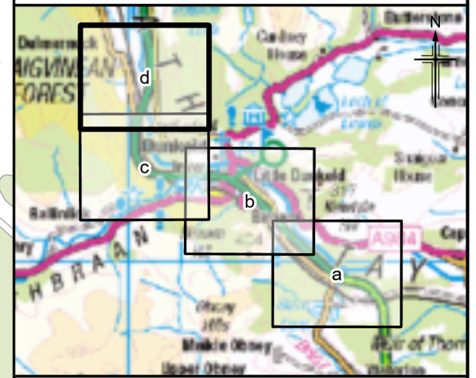
Appendix 19.4.1d



Legend

- Proposed scheme (DMRB Stage 3)
- SuDS
- 500m Study Area
- Watercourses

Drainage Catchment

- A
- B1
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- C1
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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 Drainage Catchments

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-0004
Drawing number	Appendix 19.4.1d
Rev	P03