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# 1 INTRODUCTION

## 1.1 Overview

1.1.1 The Highways Agency submitted an application[1] ("Application") for development consent to improve the M4 motorway ("M4") to a smart motorway between junction 12 (Theale), which is near Reading, and junction 3 (Hayes), in west London (the "Scheme") as shown on Figure 1 below.

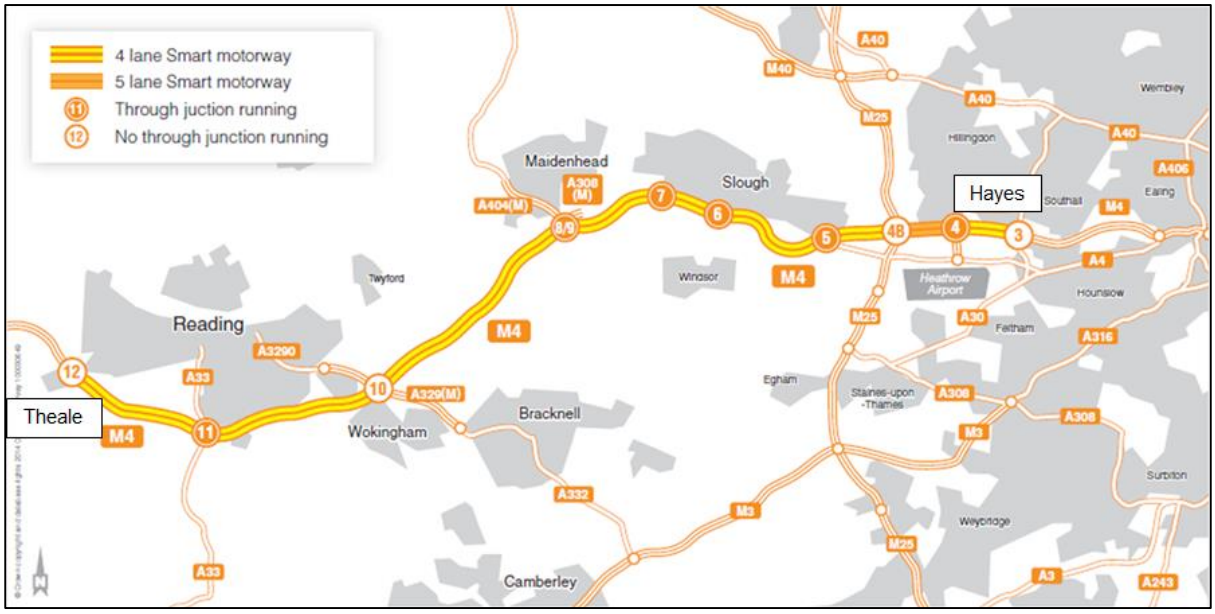


**Figure 1: Scheme location plan**

## 1.2 Drainage strategy concept

1.2.1 A Drainage Strategy was submitted as part of the Application. This document is an updated Drainage Strategy Report (the "Strategy"), which is provided to address items raised during the Examination of the Application regarding the drainage proposals relating to the Scheme. In particular, it addresses matters raised by the London Borough of Hillingdon, Buckinghamshire County Council and the Environment Agency.

1.2.2 The Strategy has been developed to guide the design of the drainage elements which will manage surface water runoff generated by the Scheme. The Strategy outlines suitable mitigation measures to manage additional runoff when:

[1] The application was made on 31 March 2015 and was submitted by the then Highways Agency. The powers and duties of the agency now reside with Highways England, which is the statutory successor to the Highways Agency.

a) impermeable areas are increased as a result of widening of the carriageway and creation of emergency refuge areas (“ERAs”) and;

b) the catchment area of the existing drainage systems change (i.e. where the existing hard shoulder slopes in the opposite direction to the carriageway camber and this is amended as part of the proposed Scheme to slope towards the carriageway).

1.2.3 The Strategy has been prepared in accordance with the best practice documents listed below:

a) Agency Interim Advice Note (“IAN”) 161/13. "Managed Motorways, All Lane Running”, which sets out the design parameters and the associated infrastructure and technology requirements for the scheme;

b) Design Manual for Roads and Bridges (“DMRB”) Volume 4 (Section 2) Part 3 (HD33/06 Surface and Sub-surface Drainage Systems for Highways) (Highways Agency, 2006) and in accordance with government policy on the use of Sustainable Drainage Systems (“SuDS”);

c) the National Networks National Policy Statement ("NN NPS"), provides guidance for promoters of nationally significant infrastructure projects on the road and rail networks, and the basis for the examination by the Examining Authority and decisions by the Secretary of State. In line with the strategic objectives set out in the NN NPS, one of the Scheme’s objectives is to deliver environmental improvements and mitigation where appropriate and required; and

d) The Water Framework Directive (“WFD”) that was given effect in England by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 SI 2003/2901. This report has been compiled to promote the fundamental principle of the WFD to protect water resources and to promote sustainable water use.

1.2.4 The criteria set out below were used in preparing the Strategy:

a) design edge of pavement pipe size to contain a 1:1 year storm without the pipe crown being surcharged;

b) design drainage systems serving additional paved areas to only allow surcharge within the drainage system, avoiding flooding the carriageway of the motorway, during a 1:5 year return period storm

event (inclusive of 20% increase in peak rainstorm intensity to take account of climate change);

c) ensure that the road cross section will normally contain storm water in the event of a 1:100 year event (6 hour storm) without spilling onto adjacent land. Hydraulic calculations are based upon the Flood Estimation Handbook method, published by the Centre for Ecology and Hydrology (CEH, 1999). Standard road cross sections are as depicted in Highways England Construction Drawings – B Series drawings;

d) appropriate spillage control measures will be included in the ERA design. Guidance is set out in HD33/06;

e) no net additional discharge from the Scheme. In other words, existing outfalls will continue to discharge water at existing, established rates. This is limited by the diameter of the existing outfall pipe and therefore represents no change to the current situation. Where necessary, the Scheme will introduce additional positive drainage within the existing system for the purpose of carrying additional water generated from the additional impermeable areas. Flow attenuation measures in the form of oversized pipes, chambers and soakaways (which all represent forms of SuDS) will also be incorporated to ensure discharge rates and volumes at existing outfalls are not worsened (i.e. increased) relative to the existing situation. It is considered that currently there is no need for any additional outfalls;

f) Where minor pavement area increases are required, for example, by creating the ERAs and the additional paved area associated with the central reservation, attenuation is required to ensure existing discharge rates and volumes are not increased. The design will be in accordance with the National Planning Policy Framework.

## 1.3 Scheme and associated drainage details

### Scheme details

1.3.1 The M4 is the main strategic route between London and the West of England and Wales, connecting with the M25 and Heathrow Airport. Major towns and cities along the M4 include London, Reading, Swindon, Bristol, Newport, Cardiff and Swansea.

1.3.2 The Scheme is approximately 51km (32 miles) in length from junction 12 (Theale) to junction 3 (Hayes).

1.3.3 The M4 between junctions 12 and 3 carries over 130,000 vehicles per day, and more in places. At peak times, traffic flows on many links are close to or exceed the total flow that the link is designed to handle and traffic on the M4 therefore suffers from heavy congestion, which leads to unpredictable journey times. Traffic flows are forecast to increase to an average of 160,000 vehicles per day over the next 20 years, which will result in more severe congestion without road improvements.

1.3.4 The Scheme will help relieve congestion by permanently converting the hard shoulder to a running lane and using technology to vary speed limits and manage traffic. Signs and signals will be used to inform drivers of conditions on the highway network, when and where variable speed limits are in place, and when lanes are closed.

1.3.5 The current design is for 33 ERAs up to 2.5km apart and measuring 100m long and a minimum of 4.6m wide as indicated in 5.36 of IAN 161/13. These ERAs would be built within the highway boundary.

1.3.6 Operation of the Smart Motorway will be controlled via gantry mounted Light-Emitting Diode (“LED”) signs.

1.3.7 New drainage systems will be required in the central reserve and the verges where appropriate. Drainage in the central reserve will largely be replaced with linear drains in sloped/cambered sections of carriageway.

1.3.8 In the verge, it is proposed to replace the existing kerb and gully system with linear drains and combined kerb and gully systems where appropriate. Verges are typically 1.5-2m wide. On that basis, it is likely that there will be a requirement to provide a bound surface above filter drains to prevent stone scatter. Therefore, an alternative surface water collection system (i.e. surface water channel or slot drain) will be required. These slot drains provide additional storage capacity compared to the existing kerb and gully system and therefore provide greater attenuation for runoff compared to the existing drainage infrastructure.

1.3.9 Non-coplanar lengths of hard shoulder (areas of existing hard shoulder that currently slopes in the opposite direction to the carriageway) will be changed to slope in the same direction as carriageway camber. In these areas modelling of the existing drainage system will be undertaken to confirm the extent of any upgrade requirements.

1.3.10 At ERAs, discharge rates will be restricted by flow controls and spillage control devices will also be provided. The additional volumes of runoff generated from new paved areas are to discharge, by soil infiltration, into underlying soils or additional attenuation provided in the form of oversized kerb units; pipes and/or manhole chambers, all of which represent SuDS techniques that are suitable for Smart motorway Schemes. Attenuation will discharge at 2 litres per second per hectare, during a 6 hour storm event (in accordance with Section 3-7 of the CIRIA (Construction Industry Research and Information Association) C697 SuDS (Sustainable Drainage System) Manual). These mitigation measures minimise the impact of flood risk following development of the Scheme.

1.3.11 Using available design information shown on the General Arrangement drawings (see Annex F1 of the Engineering Design Report, in Document Reference 7.4), Google Maps and LiDAR data of the existing carriageway, the total increase in impermeable area as a result of widening, creation of ERAs and construction of the Reinforced Concrete Barrier ("RCB") is estimated to be 12.8ha. This represents approximately 2.34% of the estimated total Scheme area of 547ha (excluding the central reserve area between chainage 14460 to 15790 where the motorway splits).

**Level of design**

1.3.12 Between junctions 12 and 3, indicative drainage layouts were developed at least as far as an indicative design, without completing gradient analysis or pipe network modelling or drainage schedules.

1.3.13 Between junctions 12 and 8, a more comprehensive drainage design has been undertaken by calculating gradients for linear drains, pipe network modelling and producing drainage schedules using data from the Highways Agency Drainage Data Management System ("HADDMS") which continue to be maintained by Highways England.

**Water quality**

1.3.14 Spillage risk following the Scheme will be confirmed during the detailed design phase of the Scheme, as it is not appropriate to carry out an assessment of spillage risk before the design has been finalised. However, a worst case scenario appraisal has been carried out and where the more detailed spillage risk appraisal indicates that a significant modification of the drainage system is required, a further Highways Agency Water Risk Assessment Tool ("HAWRAT") assessment will be undertaken for all outfalls within the Scheme boundary.

1.3.15 When considering mitigation of potential impacts to surface waters using the HAWRAT, particular attention will be paid to paragraphs A.19 to A.21 of HAWRAT regarding the interpretation of required treatment, dilution (flow attenuation) and sediment removal.

1.3.16 The Scheme is to include additional pollution control measures to augment existing systems within the Scheme Order limits, providing enhancements within the Scheme. Pollution control enhancement measures will be tailored to site specific soil and topographical conditions and in accordance with the space available within the Order limits. The measures could be either active or passive in operation, and may include:

a) active systems (which require intervention by operators): penstocks, valves, notched weirs; downstream defenders, and

b) passive systems such as silt traps, filter drains, soakaways and oil separators.

**Maintenance**

1.3.17 Between junctions 12 and 4b, regular maintenance of the existing and proposed drainage system will be undertaken, by the Asset Support Contract (“ASC”), using the outcome based approach to maintenance based on Asset Maintenance and Operational Requirements ("AMOR") and the Technology Maintenance Management Manual ("TMMM"). Between junctions 4b and 3, regular maintenance is undertaken, by the Design Build Finance Operate (“DBFO”) contract, in accordance with the Network Management Manual (“NMM”) and Routine and Winter Service Code (“RWSC”). The maintenance regime will need to take into account the nature of the proposed linear drains and combined kerb drainage systems within the Scheme. The maintenance regime may be changed from time to time, but the Scheme can be anticipated to be maintained in accordance with standards applicable to special road and motorways.

1.3.18 Highways England will also ensure that the enhancement or remediation measures, identified by CCTV surveys of the existing drainage system during the detailed design phase, and secured as part of the Scheme (including replacement or relocation of carrier drains and chambers and provision of pollution control measures) and which are required to ensure the existing drainage system functions correctly during storm events, will be completed during the construction phase of the Scheme.

**Ditches**

1.3.19 Existing ditches that are affected by the widening works comprised within the Scheme are to be re-aligned or hydraulically connected to upstream and downstream ditches using pipe culverts where required.

1.3.20 The Scheme's proposed works will not culvert, divert or re-align Frog's Ditch (see Sheet 59 of the General Arrangement drawings, Annex F1 of the Engineering Design Report, in Document Reference 7.4), which is crossed by the M4 motorway near to Junction 3. Engineering options are currently being explored by Highways England. Options include a possible cantilever slab over part of the ditch or the construction of a gabion type retaining wall (approximately 1m in height) or similar solution. During the detailed design phase of the Scheme the final solution will be designed and approval sought pursuant to the requirements attached to the Development Consent Order .

**Runoff volumes**

1.3.21 NN NPS paragraph 5.113 states: *"The surface water drainage arrangements for any project should be such that the volumes and peak flow rates of surface water leaving the site are no greater than the rates prior to the proposed project, unless specific off-site arrangements are made and result in the same net effect"*.

1.3.22 The Scheme is expected to increase the volume of surface water runoff entering the drainage system, due to an increase in road pavement area (as indicated in 1.3.10 above), if not mitigated. Mitigation will therefore be incorporated within the Scheme's drainage system, by designing attenuation to largely mimic/replicate the surface water runoff response of the existing highway drainage catchment area to ensure no net additional discharge flow or volume increase in the existing surface water runoff from the Scheme.

1.3.23 Using a sample drainage system, the hydraulic assessment, as discussed in section 3.4 of this report, shows how additional volumes generated by additional paved areas would be managed within the Scheme.

**Outfalls**

1.3.24 The outfalls provided in the new drainage systems designed for the Scheme will include:

a) the connection point where ERAs drainage systems connect into an existing drainage system's carrier pipe;

b) a new soakaway; or

c) the existing drainage systems' outfall to a watercourse or soakaway

1.3.25 No existing outfalls have been identified which would require relocation as a result of the Scheme.

## 1.4 Consultation and impacts of the Scheme on the water environment

1.4.1 Consultation undertaken has included relevant consultee groups between junction 12 and junction 3. In particular, this includes consultation with the EA and the Lead Local Flood Authorities whose jurisdiction is crossed by the Scheme to discuss the approach to be taken to the assessment of flood risk and the management of routine rainfall runoff and spillage risk. A scoping opinion was requested from the EA and Lead Local Authorities. These have formed part of the wider consultations for the Scheme proposals as set out in the Consultation Report (Document Reference 5.1).

1.4.2 An Environmental Information Workshop was held in January 2015 to give stakeholders further opportunity to familiarise themselves with the Preliminary Environmental impact (“PEI”) Report, the findings of the environmental assessments, and to discuss the Statements of Common Ground and the Development Consent Order ("DCO") process.

1.4.3 Further consultation with the EA and Lead Local Flood Authorities relating to road drainage and the impact of the Scheme on the water environment is to be undertaken before the final design is approved.

1.4.4 The assessment of impacts of the Scheme on the water environment has been undertaken and is reported in the chapter 15 of the Environmental Statement (Document Reference 6.1).

# 2 EXISTING HIGHWAY DRAINAGE

## 2.1 Existing highway drainage between junction 12 and 8/9

2.1.1 Somewhat greater information about junctions 12 to 8/9 exists in the form of as-built drawings. Nevertheless, a similar approach has been, and will be, undertaken.

2.1.2 The existing highway drainage along the M4 between junctions 12 and 8/9 is mainly kerb and gullies and a positive drainage system located in the verge. The central reserve drainage consists mainly of a filter drain system. The majority of highway runoff is discharged via outfalls to watercourses. However, in some areas there are also soakaways which facilitate some drainage to groundwater. For the purposes of the assessment of the Scheme, it has been assumed that the existing drainage system is sufficient for the existing motorway or can be made to perform as such by an enhanced maintenance scheme or repairs. The condition of the existing drainage system has not been confirmed, but for the purposes of assessment is assumed to be properly maintained and operational, on the above basis.

2.1.3 Existing drainage network drawings were created in CAD format using information provided by:

a) HADDMS for the existing pipe network;

b) as-built drawings from 1972 – Drawing 3953/C6/ Sheets 35 to 54; and

c) as built drawings undertaken by Carnell survey in 2009 (as built drawings 7120_SU_HD_003 Sheet 1 to 18).

2.1.4 Where there are no as-built drawings for recent drainage works additional drainage asset surveys are to be completed during the detailed design stage of the Scheme.

2.1.5 Analysis of the as-built drawings and HADDMS shows that the majority (approx. 60%) of the central reserve is unpaved and the current surface water run-off is collected by a combined filter drain and carrier pipe system. A carrier/filter drain runs along the entire length of central reserve, including areas of balanced carriageway (where the road camber slopes equally away from the central reserve).

2.1.6 Existing drainage layout drawings for junctions 12 and 8/9 are provided at Annex A.

## 2.2 Existing highway drainage between Junction 8/9 to Junction 3

2.2.1 The existing highway drainage along the M4 between junctions 8/9 and 3 is mainly kerb and gullies and a positive drainage system with some over the edge systems is located in the verge. The central reserve drainage mainly consists of a filter drain system. The majority of highway runoff is discharged via outfalls to watercourses. However, in some areas there are also soakaways which facilitate some drainage to groundwater. For the purposes of the assessment, it has been assumed that the existing drainage system is sufficient for the existing motorway or can be made to perform as such by an enhanced maintenance scheme or repairs. The condition of the existing drainage system has not been confirmed, but for the purposes of assessment is assumed to be properly maintained and operational on the above basis.

2.2.2 Base drainage network drawings were created in CAD format between junction 8 to junction 3 of the M4 using the following data sources:

a) HADDMS for the existing pipe network; and

b) Mksurveys Closed Circuit Television ("CCTV") drainage drawings for the drainage between junction 5 to junction 1 of the M4, dated July 2013.

2.2.3 Where there are no as-built drawings for recent drainage works, additional drainage asset surveys are to be completed during the detailed design stage of the Scheme.

2.2.4 Existing drainage layout drawings for junctions 8/9 to 3 are provided at Annex B.

## 2.3 Category B pollution risk drainage outfalls

2.3.1 An assessment of outfalls was undertaken using data extracted from HADDMS to determine outfalls with a pollution risk classed as Category B. The HADDMS outfalls register indicates only one outfall is classed as a Category B outfall within the Scheme.

2.3.2 The outfall discharges into The Cut watercourse at chainage 36155 between junctions 10 and 8/9, and has a drainage catchment area of approximately 470m$^2$ on the eastbound carriageway and 7200m$^2$ on the westbound carriageway.

# 3 PROPOSED HIGHWAY DRAINAGE DESIGNS

## 3.1 Drainage design principles to be used for detail designs

### Climate change

3.1.1 NN NPS 5.90 notes: *"Climate change over the next few decades is likely to mean milder wetter winters and hotter drier summers in the UK, while sea levels will continue to rise. Within the lifetime of nationally significant infrastructure projects, these factors will lead to increased flood risks in areas susceptible to flooding, and to an increased risk of flooding in some areas which are not currently thought of as being at risk. The applicant, the Examining Authority and the Secretary of State (in taking decisions) should take account of the policy on climate change adaptation in paragraphs 4.36 to 4.47"*.

3.1.2 NN NPS 4.41 also states that *"Where transport infrastructure has safety-critical elements and the design life of the asset is 60 years or greater, the applicant should apply the UK Climate Projections 2009 (UKCP09) high emissions scenario (high impact, low likelihood) against the 2080 projections at the 50% probability level"*.

3.1.3 Interpolation of figures from the UK Climate Projections: Briefing report, dated December 2010, indicates that a climate change allowance of between 10 to 30% can be used to predict winter storm impacts on the M4 between junctions 12 to 3.

3.1.4 A 20% allowance for climate change has been applied in accordance with HD33/06. The climate change allowance has been applied to runoff calculations for all additional paved areas, but not to runoff from existing paved areas within the Scheme that are unchanged, as this is not considered "development".

3.1.5 Additional paved areas are those impermeable areas created by carriageway widening, the construction of ERAs, or existing paved areas within the Scheme that are not currently captured by an existing drainage pipe system but will be following development.

### SuDS

Within the Scheme, whilst space availability severely restricts the feasibility of using above ground SuDS features, such as ponds, reed beds and swales, the drainage strategy for the Scheme includes soakaways, oversized pipes and chambers, all of which qualify as SuDS features.

3.1.6 Sites have been put forward by Buckinghamshire County Council and the London Borough of Hillingdon for use in accommodating above ground SuDS features. Of the seven sites offered four of these, at Cranford Park, Watery Lane, Moat Cottage and in the vicinity of Junction 4 Heathrow Spur, are located beyond the Order limits.

3.1.7 At present, Highways England does not have powers over the offered land at these four sites, nor has use of the land for this purpose been assessed as part of the Scheme's Environmental Impact Assessment. Moreover, there are no agreements in place with local authorities in respect of the land, no Section 253 agreements or acquisition by private treaty to enable the land to be used outside the Scheme.

3.1.8 Further, the use of such land for above ground SuDS drainage solutions could prevent other uses coming forward and as the land is outside the confines of both the Scheme, and land under Highways England's control, creates issues surrounding securing the future management and maintenance of the SuDS systems.

3.1.9 For these reasons it is concluded that it is not appropriate or feasible to use land outside of the Order limits to accommodate above ground SuDS such as swales, reed beds and ponds.

3.1.10 The remaining sites, located at Junction 4b and at Junction 7 of the M4 and Lake End Road are located within the Order limits and use of these sites to accommodate above ground SuDS has been subject to an initial feasibility assessment.

3.1.11 Areas of land located centrally within Junction 4b are illustrated in Figure 2. The scheme does not include any proposals to undertake carriageway widening or drainage works within the vicinity of Junction 4b. If the areas suggested were to be used for above ground SUDS to provide attenuation for the additional paved areas only (in accordance with the drainage strategy), runoff from the nearest areas of widening would have to be conveyed over significant distances (approximately 400m from the widening at Old Slade Lane and 1400m from the nearest ERAs), significantly increasing scheme costs. Further, the transportation of surface water over such distances is unlikely to be feasible as the topography of the land in this location is relatively flat.

3.1.12 There are no watercourses within the footprint of Junction 4b therefore the outfalls of any SUDS would also have to be culverted underneath the existing interchange links to connect into adjacent watercourses

(Highways England's records indicate that areas within Junction 4b may be subject to ground water flooding and therefore use of soakaways in this location is not considered to be a viable option). This would significantly increase scheme costs.

3.1.13 It would be necessary to provide maintenance access to all SUDS installed as part of the scheme. As these areas are located between high speed interchange links, such as at Junction 4b, there would be significant safety risks to maintenance operative associated with leaving and joining the interchange links to undertake maintenance works. It is therefore likely that significant works would be required to ensure safe maintenance access could be provided, potentially requiring additional bridges and maintenance access routes outside of the Order Limits.

3.1.14 Further, the land currently has a dense tree/vegetation cover so extensive clearance work would be required to provide space for and allow maintenance access to any SuDS system. This work has the potential to adversely impact on other environmental receptors and has not been assessed as part of the schemes environmental impact assessment.

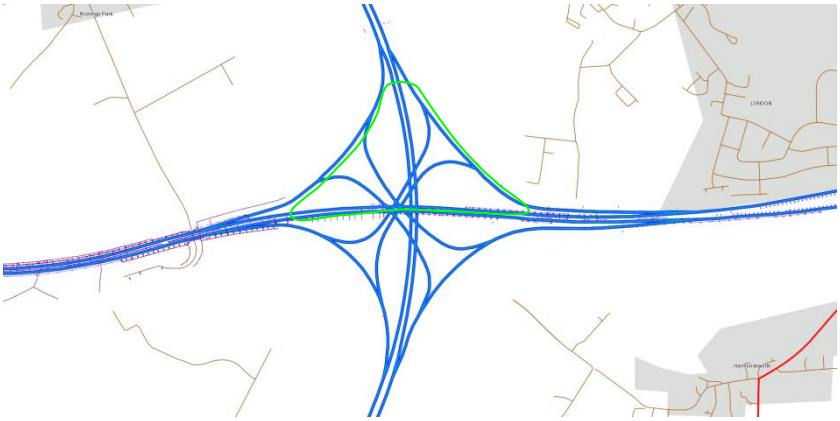

**Figure 2: Junction 4b**

3.1.15 Land at Junction 7 and Lake End Road is illustrated in Figure 3. The suggested areas of land within the footprint of the junction to both the north and south of the M4 mainline are generally significantly higher than the mainline (due to tying in to the adjacent slip roads which link in to the Junction 7 overbridge). Therefore, construction of above ground SUDS would require deep excavations, potentially requiring additional retaining walls. This would involve a significant additional construction cost and ongoing maintenance costs and therefore the use of these areas is not considered to be feasible.

3.1.16 The suggested area to the south of the Junction 7 loop is located within the Order Limits. However, this land is required only temporarily for access and working space for the realigned Junction 7 alignment. The permanent use of such land for above ground SuDS would create issues relating to securing the future management and maintenance of the SuDS systems (and access for maintenance). Therefore, excavation of a SuDS in this location is not considered to be an appropriate or viable option.

3.1.17 The areas located to the south of the Junction 7 are proposed to accommodate construction compound 6, which rules out use of this land to accommodate above ground SuDS features. Highways England's records indicate that areas located to the north of junction 7 may be subject to ground water flooding. Excavating a SuDS in this location may therefore not be a viable option for this additional reason. SUDS north of the junction may also have the potential to adversely impact on other environmental receptors and as such would need to be subject to additional environmental assessments.

3.1.18 Highways England only has temporary land ownership rights for the area highlighted on the eastern side of Lake End Road, so creating permanent SuDS in this area would need to be secured under a separate agreement to the DCO. The implementation of SuDS at the western side of the existing Lake End Road alignment is not possible as Lake End Road is to be re-aligned. Above ground SUDS at junction 7 and Lake End Road may also create maintenance issues, which would be an additional burden on the public purse and that would not be in the public interest given the existence of other acceptable drainage options which would not carry such an additional burden.

3.1.19 At Lake End Road, the suggested area to the west of the road is not feasible for construction of above ground SUDS as this land is required to accommodate the realignment of Lake End Road.

3.1.20 The suggested area to the east of Lake End Road is located within the Order Limits. However, this land is required only temporarily for access and working space for the new Lake End Road bridge. The permanent use of such land for above ground SuDS would create issues relating to securing the future management and maintenance of the SuDS systems (and access for maintenance).

**Figure 3: Junction 7 and Lake End Road**

3.1.21 Initial reviews therefore conclude that lands offered/proposed within the Order limits are subject to a significant number of constraints with regard to implementing above ground SuDS. It is also considered that use of these lands is not necessary to deliver a drainage design that mitigates all impacts of the proposed Scheme on drainage and associated flood risk in accordance with planning policy requirements.

**Discharge**

3.1.22 The principle that there should be no net increase in discharge as a result of the Scheme has been applied to drainage design within the Scheme. This means that the existing discharge is to be maintained at current rates and volumes (refer to paragraphs 3.1.21, 3.1.22 and section 3.4) to mimic the response of the existing highway drainage catchment area.

3.1.23 So far as practicable, discharge rates will be restricted to less than 5 l/s by flow control devices. To reduce the risk of blockages within the system, flows will not be restricted at small drainage system outfalls.

3.1.24 Where proposed impermeable areas increase the surface area compared to the existing impermeable areas, oversized pipes or manhole chambers are to be used to provide attenuation when flows are restricted, to ensure, so far as practical, that existing discharge at outfalls is not exceeded.

3.1.25 Attenuation and surface water runoff flow restrictions to existing discharge rates at outfalls, where additional impermeable areas are collected by the

existing drainage system, would minimise the impact of flood risk from the Scheme to surrounding sites.

3.1.26 Within the Scheme, an outfall from a drainage system could be where a new drainage pipe system connects with an existing downstream drainage pipe system, a watercourse or a soakaway. Alternatively is could be where an existing drainage pipe system, that has new paved areas, connects with an existing downstream pipe system that has an unchanged paved catchment area, a watercourse or a soakaway.

**Runoff volumes**

3.1.27 The drainage system is to be designed in accordance with NPS 5.113 principle that: *"The surface water drainage arrangements for any project should be such that the volumes and peak flow rates of surface water leaving the site are no greater than the rates prior to the proposed project, unless specific off-site arrangements are made and result in the same net effect"*.

3.1.28 Additional volumes of surface water runoff generated from additional paved areas are to be mitigated by increased attenuation and use of overflow outfalls to systems such as soakaways as detailed in section 3.4.

**Existing system**

3.1.29 For this drainage strategy it has reasonably been assumed that the existing pipework is sufficient for the existing motorway. Where surface water flooding is reported to have occurred from blocked drainage, it can also be assumed that maintenance/repair or localised substitution/replacement of the systems is capable of providing a satisfactorily functioning system as stated in paragraph 1.3.18.

3.1.30 The London Borough of Hillingdon identified residential properties located adjacent to the existing Junction 4b eastbound on-slip, illustrated in Figure 4, which it says have experienced flooding on a number of occasions. The London Borough of Hillingdon has stated that flooding occurred before any floodwater overtopped the banks of the local watercourse, indicating that a combination of sources contribute to the flooding issues experienced at these properties. Highways England will investigate the outfall connection from their drainage system to the nearest watercourse and ensure the system is fit for purpose, implementing any mitigation measures that may be required in accordance with paragraph 1.3.18 above..

**Figure 4: Junction 4b Eastbound on-slip**

3.1.31 The London Borough of Hillingdon also raised the issue of how the existing M4 drainage system connects with the nearest watercourse in the vicinity of Moat Cottage. Highways England will confirm the position and will implement any remedial measures that may be required to ensure the drainage system is fit for purpose, in accordance with paragraph 1.3.18.

**Water quality**

3.1.32 The drainage design is based on the principle of not polluting the water environment, to ensure that existing water quality is maintained by augmenting or replacing the existing drainage system in the motorway where required. Further details of assessment methods and measures are discussed in Chapter 16 of the Scheme's Environment Statement.

**Mainline and central reserve**

3.1.33 On embankments, at grade situations or where a kerb has been provided, a linear slot drain is proposed in the verges.

3.1.34 Maximum drainage length for slot drains ("Lp") between outfall connections has been calculated using Manning Resistance equation, given in HA 113/05, using the 315mm x 410mm oval linear slot drain.

3.1.35 In accordance with DMRB, at 0% pipe or carriageway gradient, the formulae from the HA 113/05 (Clauses 7.1 and 7.2) are not suitable to calculate the Lp value.

3.1.36 Therefore, Micro Drainage software, based on the Rational Modified Method, is to be used to simulate the water flow within the pipe. This method is recognised by the Highways Agency Standard HD33/06 as a part of the Wallingford Procedure, the most commonly used procedure in the UK for drainage analysis.

3.1.37 The results of Micro Drainage modelling, carried out on the basis of a 375mm circular pipe, show that the capacity of that pipe in 0% or very close to 0% gradient in situations necessitates the provision of downstream outfalls at approximately 80m spacing.

3.1.38 This length is understood to be the maximum length of the 375mm pipe that is able to contain the design run-off without surcharging. Considering the fairly irregular character of the existing longitudinal gradient and anticipated pipe siltation, which is very likely to occur where carriageway gradients are low, the maximum spacing between outfalls in these sections (0% or very close to 0%), has been taken as 40m.

**ERAs**

3.1.39 When ERA drainage is independent of an existing drainage system and there are ditches or existing pipe network in the vicinity of the ERA, then the discharge is restricted by an orifice plate with a minimum diameter of 100mm. Due to increased risks of blockages and possible higher maintenance requirements, smaller diameter orifice plates are not considered appropriate.

3.1.40 If an ERA is to be part of an augmentation of the existing drainage network, then the proposed ERA drainage system is to be modelled in Micro Drainage using existing carriageway plus ERA catchment areas for 1 in 5 year and 1 in 1 year return period rainfall events with runoff released at existing discharge rates.

3.1.41 Run-off from an ERA catchment is to be collected and attenuated by Combined Kerb Drainage Units ("KDUs") before discharging into a drainage ditch or existing pipe network.

**Junctions**

3.1.42 At junctions where existing drainage catchments increase the existing drainage systems capacity will be checked using DMRB to ensure that surface water runoff during 1 in 5 year storm events (plus climate change allowance in accordance with paragraph 3.1.4), will not increase flood risk from surface water flooding. Where required, attenuation will be provided within the drainage system to maintain the current rate and volume of discharge at the outfall. It is considered that the pollution risk is unchanged as a result of the changes to the junctions, and therefore no additional pollution control measures are currently proposed as part of the design.

**Underbridges**

3.1.43 For underbridges, a 1 in 5 year return period rainfall event and 20% increase in rainfall intensity (HD 33/06) allowance for climate change design criteria has been assessed for new paved areas only.

## 3.2 Proposed highway drainage designs - junction 12 to junction 8/9

3.2.1 The drainage design assessment undertaken for this section of the Scheme was completed using Highways England's guidance and HADDMS data using the design principles stated in Section 3.1

3.2.2 The drainage details include the drainage system proposed within the central reserve and verges along the Scheme. This includes drawings with drainage schedules.

3.2.3 Between Junctions 11 and 10 (Ch.52,075 to 53,000), a RCB and a new surface water collection system have recently been constructed. The details of the new surface water collection system, constructed in 2012, are attached in Annex H.

3.2.4 Verge drainage design drawings for proposed highway drainage designs between junctions 12 and 8/9 are provided at Annex C.

3.2.5 Central reserve drainage design drawings for proposed highway drainage designs between junctions 12 and 8/9 are provided at Annex D.

3.2.6 Junction drainage design drawings for proposed highway drainage designs between junctions 12 and 8/9 are provided at Annex E.

3.2.7 ERA drainage design drawings for proposed highway drainage designs between junctions 12 and 8/9 are provided at Annex F.

## 3.3 Proposed highway drainage designs - junction 8/9 to junction 3

3.3.1 A preliminary drainage assessment was undertaken between Junction 8/9 to Junction 3 to provide an initial appraisal, in order to indicate possible drainage system types and the extent that they may be required for the Scheme.

3.3.2 Linear slot drains are proposed where the current hard shoulder is being turned into a running lane, widening and in the central reserve. These provide additional storage capacity compared to the existing kerb and gully system and therefore provide greater attenuation for runoff compared to the existing drainage infrastructure. Linear slot drains are generally not required on slip roads unless slip lanes are widened within the Scheme.

3.3.3 Filter drains may need to be replaced by linear slot drains if it is considered that they pose a safety risk to vehicles. This will be the case where filter stone on the surface is within 3.2m of the carriageway.

3.3.4 Linear drain locations have been located at the low side of the carriageway using flow arrows produced from Lidar. Where the position of outfalls in the current drainage system is known, linear drainage outfalls have been located to coincide with existing outfalls, however where no existing drainage information exists, the outfall locations have been assumed (these will be verified on site during construction). They have not been used where there is an ERA or an underbridge as alternative collector systems such as beany blocks or bridge deck drainage units are to be used.

3.3.5 Linear slot drain outfalls ("LDOs") have been indicated approximately every 30m as a conservative approach. This is less than the calculated minimum spacing distance for LDOs on a flat gradient of 80m and the recommended 40m. Using Lidar-generated contours, high and low points have been identified. At high points in a linear drain run, a linear slot drain access point ("LDA") has been shown.

3.3.6 The assumed outfall connections for linear slot drains will be confirmed and any necessary adjustments made following detailed drainage asset surveys.

3.3.7 Combined bridge and kerb drains have been placed on underbridges on either the verge or central reserve – depending on whether the carriageway is in super elevation or if it is balanced.

3.3.8 Kerb Drains have been placed around ERAs based on the design principle of all ERAs sloping towards the verge.

3.3.9 Outfalls and access points for kerb drains and bridge drains ("KDOs/KDAs" and "BDAs/BDOs") were assessed using the same principles as used for linear slot drains. Indicative outfalls have been located where current outfalls are available.

3.3.10 Based on interpolation of existing carriageway drainage records and Lidar data showing existing carriageway surface levels, drainage outfalls from three ERAs may need to cross the carriageway to connect with existing drainage, as there is no available verge drainage system to connect to the ERA drainage. This design solution is subject to confirmatory soakaway testing and detailed drainage surveys at the following locations:

a) ch 15050 – ch 15150 (EB);

b) ch 15065 – ch 15135 (WB); and

c) ch 24400 – ch 24500 (EB).

3.3.11 In sections of slips roads where contours are missing or not available, the flow direction of the drainage network is interpolated from contours slopes within those sections/parts of upstream or downstream slip road where contours are available.

3.3.12 Indicative drainage drawings for proposed highway drainage designs between junction 8/9 to junction 3 are provided at Annex G.

## 3.4 New paved area surface water volumes

3.4.1 A sample drainage pipe work system within the Scheme near to junction 8/9 was assessed using Micro Drainage 2014 software. The CIRIA (Construction Industry Research and Information Association) C697 SuDS Manual (Sustainable Drainage System Manual) "rule of thumb" storm duration of 360 minutes was selected to assess the long-term storage volume discharging from the system during a 1 in 5 year storm event. This storm event was chosen for the assessment as highway drainage carrier pipes are designed to capture runoff from a 1 in 5 year event (HD33/06 design guidance). The results of the modelling are show in Table 1 below.

3.4.2 Hydraulic modelling of the sample pipe work (see Annex I & J) was completed for the following scenarios, namely:

a) EXISTING DRAINAGE: Modelling existing pipes and existing impermeable catchments areas;

b) ADDITIONAL PAVED AREAS: Additional paved areas are new areas created when the carriageway

is widened or paved areas that are not currently captured by the existing drainage pipe system but will be captured following development i.e. changing existing hard shoulders slopes to match carriageway camber. Additional paved areas were modelled to show the volume of water that will be generated from these areas only; and

c) PROPOSED DRAINAGE: Modelling a modified pipe system with existing and additional paved catchment areas using attenuation and restricted flows to existing outfall discharge rates and volumes. Modelling results showed that attenuation is required to ensure surface water volumes discharged at outfalls do not increase when additional areas of impermeable area are captured by an existing drainage system. An allowance for climate change was applied by increasing additional paved impermeable areas by 20%.

| Table 1 MICRO DRAINAGE 1 in 5 YEAR PROBABILTY 360 MINUTE DURATION STORM EVENT | | |
|---|---|---|
| **Modelling** | **Maximum Flow at Outfall pipe (l/s)** | **Maximum Discharge Volume at outfall ($m^3$)** |
| EXISTING DRAINAGE | 34.8 | 230 |
| ADDITIONAL PAVED AREAS. | 5.2 | 33.7 |
| PROPOSED DRAINAGE | 29.7 | 236 |

**Table 1: Micro drainage 1 in 5 year probability 360 minute duration storm event**

3.4.3 As shown in the table above, the maximum discharge rate at the existing outfall will be reduced from the existing 34.8 l/s to 29.7 l/s with the maximum volume discharge increasing slightly from 230$m^3$ to 236$m^3$ during a 1 in 5 year 360 minute duration storm event. The slight increase

in volume shown in the hydraulic modelling results can be mitigated by the relative decrease in flow rates. This restriction of flows and volumes to best mimic existing outfall discharge conditions was achieved by providing an overflow pipe upstream of the outfall pipe that discharges into a soakaway.

3.4.4 The additional paved areas model was created by using the existing drainage pipe system and only inputting the increase impermeable area following development of the Scheme. The modelling results show the discharge rate and volume that is generated by the additional paved areas and indicates attenuation requirements to best mimic existing outfall discharge.

3.4.5 The table demonstrates that when additional paved areas discharge into, or are augmented with, an existing system that through increased attenuation and using overflow pipes to SuDS outfalls such as a soakaway, flows can be restricted to best mimic the existing response of the catchment area, and thereby lessen flood risk in comparison to the existing flood risk.

# 4 CONCLUSIONS

4.1.1 The Drainage Strategy has been produced to ensure that suitable mitigation measures are used to manage additional runoff where impermeable areas are increased as a result of the Scheme. It will be secured by a requirement attached to the Development Consent Order that authorises construction of the Scheme. That in turn will ensure that the detailed drainage design secures the necessary mitigation.

4.1.2 Drainage mitigation measures are to be implemented in accordance with design principles set out in IAN161/13, DMRB HD33/06, and the requirements of the NN NPS and the WFD.

4.1.3 The fundamental principle of the Strategy is that the Scheme will not produce additional discharge in flow rate or volume at existing outfalls.

4.1.4 All new drainage system designs will use the size of pipes required to contain a 1 in 1 year storm without pipe crown surcharging and to provide conveyance of 1 in 5 year surface water flows with surcharge but no flooding during a 1 in 5 year storm event.

4.1.5 A climate change allowance of 20% has been applied to the assessment of additional paved areas when designing new or augmenting existing drainage systems affected by increased impermeable as a result of the Scheme.

4.1.6 Using the principles within this drainage strategy it is considered that suitable mitigation measures can be implemented within and are secured for the Scheme's drainage system to manage surface water runoff from the Scheme.

# REFERENCES

IAN 161/13 – Managed Motorways All Lane Running.

DMRB Vol 4 Section 2 Part 6 – HA 113/05 – Combined Channel and Pipe System for Surface Water Drainage.

DMRB Vol 4 Section 2 Part 3 – HA 33/06 – Surface and Sub-surface Drainage Systems for Highways.

MCHW Volume 1 - Specification for Highways Works – Series 500 – Drainage and Service Ducts.

MCHW Volume 2 – Notes for Guidance – Series NG 500 – Drainage and Service Ducts.

MCHW Volume 4 – Bills of Quantities for Highway Works (Sections 1, 2 and 3).

Linear slotted drain Manufacturers Details (Britpave).

# ABBREVIATIONS

| Term | Meaning |
|---|---|
| ALR | All Lane Running |
| BDA | Bridge Deck unit Access |
| BDO | Bridge Deck unit Outlet |
| CCTV | Closed Circuit Television |
| DMRB | Design Manual for Roads and Bridges |
| EA | Environment Agency |
| EAR | Environmental Assessment Report |
| EB | East Bound Carriageway |
| ERA | Emergency Refuge Area |
| ES | Environmental Statement |
| FRA | Flood Risk Assessment |
| HA | Highways Agency |
| HADDMS | Highways Agency Drainage Data Management |
| IAN | Interim Advice Note |
| J | Junction |
| KDA | Combined Kerb and Drainage unit Access point |
| KDU | Combined Kerb and Drainage Unit |
| KDO | Combined Kerb and Drainage unit Outlet |
| LDA | Linear Drain Access |
| LDO | Linear Drain Outlet |
| LED | Light-Emitting Diode |
| Lp | Drainage length for slot drains |
| OS | Ordnance Survey |
| PPGs | Pollution Preventions Guidelines |

| Term | Meaning |
|---|---|
| RCB | Rigid Concrete Barrier |
| WB | West Bound Carriageway |

# GLOSSARY

| Term | Meaning |
|---|---|
| Associated Development | Development which is associated with a NSIP. The IPC decides whether development is associated development. This can include development in England and in water adjacent to England. |
| CEMP | Construction environmental Management Plan. A site specific plan developed to ensure that appropriate environmental management practices are followed during the construction phase of a project. |
| EAR | An Environmental Assessment Report documents the findings of an Environmental Assessment. |
| EIA | The assessment of the impacts on the environment of a development project. |
| Flood Zone Three | This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year. |
| Flood Zone Two | This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year. |
| Mitigation | Measures including any process, activity, or design to avoid, reduce, remedy or compensate for negative environmental impacts or effects of a development |
| NSIP | Nationally significant infrastructure projects are large scale developments such as certain new harbours, power generating stations (including wind farms), highways developments and electricity transmission lines, which require a type of consent known as ‘development consent’ under procedures governed by the Planning Act 2008 (and amended by the Localism Act 2011). |
| non/coplanar | Coplanar surfaces are surfaces that are in alignment with each other i.e. surfaces in hard shoulder areas slope in the same direction as the main carriageway. Non-coplanar surfaces are where hard shoulder areas are slope in the opposite direction to the main carriageway. |

# ANNEX A: J12 – J8/9 EXISTING DRAINAGE DRAWINGS

| Drawing Number | Drawing title |
|---|---|
| 537806-MUH-00-S3-DR-DR-500000 | EXISTING DRAINAGE J12 to J8/9 KEY AND INDEX OF DRAWINGS |
| 537806-MUH-00-S3-DR-DR-500001 | EXISTING DRAINAGE J12 to J8/9 SHEET 1 OF 33 CH 62300 - 62900 |
| 537806-MUH-00-S3-DR-DR-500002 | EXISTING DRAINAGE J12 to J8/9 SHEET 2 OF 33 CH 61400 - 62300 |
| 537806-MUH-00-S3-DR-DR-500003 | EXISTING DRAINAGE J12 to J8/9 SHEET 3 OF 33 CH 60500 - 61400 |
| 537806-MUH-00-S3-DR-DR-500004 | EXISTING DRAINAGE J12 to J8/9 SHEET 4 OF 33 CH 59600 - 60500 |
| 537806-MUH-00-S3-DR-DR-500005 | EXISTING DRAINAGE J12 to J8/9 SHEET 5 OF 33 CH 57800 - 59600 |
| 537806-MUH-00-S3-DR-DR-500006 | EXISTING DRAINAGE J12 to J8/9 SHEET 6 OF 33 CH 57800 - 57800 |
| 537806-MUH-00-S3-DR-DR-500007 | EXISTING DRAINAGE J12 to J8/9 SHEET 7 OF 33 CH 56900 - 57800 |
| 537806-MUH-00-S3-DR-DR-500008 | EXISTING DRAINAGE J12 to J8/9 SHEET 8 OF 33 CH 56000 - 56900 |
| 537806-MUH-00-S3-DR-DR-500009 | EXISTING DRAINAGE J12 to J8/9 SHEET 9 OF 33 CH 55100 - 56000 |
| 537806-MUH-00-S3-DR-DR-500010 | EXISTING DRAINAGE J12 to J8/9 SHEET 10 OF 33 CH 54200 - 55100 |
| 537806-MUH-00-S3-DR-DR-500011 | EXISTING DRAINAGE J12 to J8/9 SHEET 11 OF 33 CH 53300 - 54200 |
| 537806-MUH-00-S3-DR-DR-500012 | EXISTING DRAINAGE J12 to J8/9 SHEET 12 OF 33 CH 52400 - 53300 |
| 537806-MUH-00-S3-DR-DR-500013 | EXISTING DRAINAGE J12 to J8/9 SHEET 13 OF 33 CH 51500- 52400 |
| 537806-MUH-00-S3-DR-DR-500014 | EXISTING DRAINAGE J12 to J8/9 SHEET 14 OF 33 CH 50600 - 51500 |
| 537806-MUH-00-S3-DR-DR-500015 | EXISTING DRAINAGE J12 to J8/9 SHEET 15 OF 33 CH 49700 - 50600 |
| 537806-MUH-00-S3-DR-DR-500016 | EXISTING DRAINAGE J12 to J8/9 SHEET 16 OF 33 CH 48800 - 49700 |
| 537806-MUH-00-S3-DR-DR-500017 | EXISTING DRAINAGE J12 to J8/9 SHEET 17 OF 33 CH 47900 - 48800 |
| 537806-MUH-00-S3-DR-DR-500018 | EXISTING DRAINAGE J12 to J8/9 SHEET 18 OF 33 CH 47000 - 47900 |
| 537806-MUH-00-S3-DR-DR-500019 | EXISTING DRAINAGE J12 to J8/9 SHEET 19 OF 33 CH 46100 - 47000 |
| 537806-MUH-00-S3-DR-DR-500020 | EXISTING DRAINAGE J12 to J8/9 SHEET 20 OF 33 CH 45200 - 46100 |
| 537806-MUH-00-S3-DR-DR-500021 | EXISTING DRAINAGE J12 to J8/9 SHEET 21 OF 33 CH 44300 - 45200 |
| 537806-MUH-00-S3-DR-DR-500022 | EXISTING DRAINAGE J12 to J8/9 SHEET 22 OF 33 CH 43400 - 44300 |
| 537806-MUH-00-S3-DR-DR-500023 | EXISTING DRAINAGE J12 to J8/9 SHEET 23 OF 33 CH 42500- 43400 |
| 537806-MUH-00-S3-DR-DR-500024 | EXISTING DRAINAGE J12 to J8/9 SHEET 24 OF 33 CH 41600 - 42500 |
| 537806-MUH-00-S3-DR-DR-500025 | EXISTING DRAINAGE J12 to J8/9 SHEET 25 OF 33 CH 40700 - 41600 |
| 537806-MUH-00-S3-DR-DR-500026 | EXISTING DRAINAGE J12 to J8/9 SHEET 26 OF 33 CH 39800 - 40700 |
| 537806-MUH-00-S3-DR-DR-500027 | EXISTING DRAINAGE J12 to J8/9 SHEET 27 OF 33 CH 38900 - 39800 |
| 537806-MUH-00-S3-DR-DR-500028 | EXISTING DRAINAGE J12 to J8/9 SHEET 28 OF 33 CH 38000 - 38900 |
| 537806-MUH-00-S3-DR-DR-500029 | EXISTING DRAINAGE J12 to J8/9 SHEET 29 OF 33 CH 37100 - 38000 |

| Drawing Number | Drawing title |
|---|---|
| 537806-MUH-00-S3-DR-DR-500030 | EXISTING DRAINAGE J12 to J8/9 SHEET 30 OF 33 CH 36200 - 37100 |
| 537806-MUH-00-S3-DR-DR-500031 | EXISTING DRAINAGE J12 to J8/9 SHEET 31 OF 33 CH 35300 - 36200 |
| 537806-MUH-00-S3-DR-DR-500032 | EXISTING DRAINAGE J12 to J8/9 SHEET 32 OF 33 CH 34400 - 35300 |
| 537806-MUH-00-S3-DR-DR-500033 | EXISTING DRAINAGE J12 to J8/9 SHEET 33 OF 33 CH 33500 - 34400 |

# ANNEX B: J8/9 – J3 EXISTING DRAINAGE DRAWINGS

| Drawing Number | Drawing title |
|---|---|
| 537806-MUH-00-S3-DR-DR-300121 | EXISTING DRAINAGE J8/9 to J3 KEY AND INDEX SHEET |
| 537806-MUH-00-S3-DR-DR-300122 | EXISTING DRAINAGE J8/9 to J3 SHEET 1 OF 27 |
| 537806-MUH-00-S3-DR-DR-300123 | EXISTING DRAINAGE J8/9 to J3 SHEET 2 OF 27 |
| 537806-MUH-00-S3-DR-DR-300124 | EXISTING DRAINAGE J8/9 to J3 SHEET 3 OF 27 |
| 537806-MUH-00-S3-DR-DR-300125 | EXISTING DRAINAGE J8/9 to J3 SHEET 4 OF 27 |
| 537806-MUH-00-S3-DR-DR-300126 | EXISTING DRAINAGE J8/9 to J3 SHEET 5 OF 27 |
| 537806-MUH-00-S3-DR-DR-300127 | EXISTING DRAINAGE J8/9 to J3 SHEET 6 OF 27 |
| 537806-MUH-00-S3-DR-DR-300128 | EXISTING DRAINAGE J8/9 to J3 SHEET 7 OF 27 |
| 537806-MUH-00-S3-DR-DR-300129 | EXISTING DRAINAGE J8/9 to J3 SHEET 8 OF 27 |
| 537806-MUH-00-S3-DR-DR-300130 | EXISTING DRAINAGE J8/9 to J3 SHEET 9 OF 27 |
| 537806-MUH-00-S3-DR-DR-300131 | EXISTING DRAINAGE J8/9 to J3 SHEET 10 OF 27 |
| 537806-MUH-00-S3-DR-DR-300132 | EXISTING DRAINAGE J8/9 to J3 SHEET 11 OF 27 |
| 537806-MUH-00-S3-DR-DR-300133 | EXISTING DRAINAGE J8/9 to J3 SHEET 12 OF 27 |
| 537806-MUH-00-S3-DR-DR-300134 | EXISTING DRAINAGE J8/9 to J3 SHEET 13 OF 27 |
| 537806-MUH-00-S3-DR-DR-300135 | EXISTING DRAINAGE J8/9 to J3 SHEET 14 OF 27 |
| 537806-MUH-00-S3-DR-DR-300136 | EXISTING DRAINAGE J8/9 to J3 SHEET 15 OF 27 |
| 537806-MUH-00-S3-DR-DR-300137 | EXISTING DRAINAGE J8/9 to J3 SHEET 16 OF 27 |
| 537806-MUH-00-S3-DR-DR-300138 | EXISTING DRAINAGE J8/9 to J3 SHEET 17 OF 27 |
| 537806-MUH-00-S3-DR-DR-3001390 | EXISTING DRAINAGE J8/9 to J3 SHEET 18 OF 27 |
| 537806-MUH-00-S3-DR-DR-300140 | EXISTING DRAINAGE J8/9 to J3 SHEET 19 OF 27 |
| 537806-MUH-00-S3-DR-DR-300141 | EXISTING DRAINAGE J8/9 to J3 SHEET 20 OF 27 |
| 537806-MUH-00-S3-DR-DR-300142 | EXISTING DRAINAGE J8/9 to J3 SHEET 21 OF 27 |
| 537806-MUH-00-S3-DR-DR-300143 | EXISTING DRAINAGE J8/9 to J3 SHEET 22 OF 27 |
| 537806-MUH-00-S3-DR-DR-300144 | EXISTING DRAINAGE J8/9 to J3 SHEET 23 OF 27 |
| 537806-MUH-00-S3-DR-DR-300145 | EXISTING DRAINAGE J8/9 to J3 SHEET 24 OF 27 |
| 537806-MUH-00-S3-DR-DR-300146 | EXISTING DRAINAGE J8/9 to J3 SHEET 25 OF 27 |
| 537806-MUH-00-S3-DR-DR-300147 | EXISTING DRAINAGE J8/9 to J3 SHEET 26 OF 27 |
| 537806-MUH-00-S3-DR-DR-300148 | EXISTING DRAINAGE J8/9 to J3 SHEET 27 OF 27 |

# ANNEX C: J12 – J8/9 VERGE DRAINAGE DRAWINGS

| Drawing Number | Drawing title |
|---|---|
| 537806-MUH-VR-00-S3-DR-DR-500000 | PROPOSED DRAINAGE J12 - J8/9 KEY AND INDEX OF DRAWINGS |
| 537806-MUH-VR-00-S3-DR-DR-500001 | PROPOSED DRAINAGE J12 - J8/9 VERGE SHEET 1 OF 32 CH 62300 – 62900 |
| 537806-MUH-VR-00-S3-DR-DR-500002 | PROPOSED DRAINAGE J12 - J8/9 SHEET 2 OF 32 CH 61400 – 62300 |
| 537806-MUH-VR-00-S3-DR-DR-500003 | PROPOSED DRAINAGE J12 - J8/9 SHEET 3 OF 32 CH 60500 – 61400 |
| 537806-MUH-VR-00-S3-DR-DR-500004 | PROPOSED DRAINAGE J12 - J8/9 SHEET 4 OF 32 CH 59600 – 60500 |
| 537806-MUH-VR-00-S3-DR-DR-500005 | PROPOSED DRAINAGE J12 - J8/9 SHEET 5 OF 32 CH 57800 – 59600 |
| 537806-MUH-VR-00-S3-DR-DR-500006 | PROPOSED DRAINAGE J12 - J8/9 SHEET 6 OF 32 CH 57800 – 57800 |
| 537806-MUH-VR-00-S3-DR-DR-500007 | PROPOSED DRAINAGE J12 - J8/9 SHEET 7 OF 32 CH 56900 – 57800 |
| 537806-MUH-VR-00-S3-DR-DR-500008 | PROPOSED DRAINAGE J12 - J8/9 SHEET 8 OF 32 CH 56000 – 56900 |
| 537806-MUH-VR-00-S3-DR-DR-500009 | PROPOSED DRAINAGE J12 - J8/9 SHEET 9 OF 32 CH 55100 – 56000 |
| 537806-MUH-VR-00-S3-DR-DR-500010 | PROPOSED DRAINAGE J12 - J8/9 SHEET 10 OF 32 CH 54200 – 55100 |
| 537806-MUH-VR-00-S3-DR-DR-500011 | PROPOSED DRAINAGE J12 - J8/9 SHEET 11 OF 32 CH 53300 – 54200 |
| 537806-MUH-VR-00-S3-DR-DR-500012 | PROPOSED DRAINAGE J12 - J8/9 SHEET 12 OF 32 CH 52400 – 53300 |
| 537806-MUH-VR-00-S3-DR-DR-500013 | PROPOSED DRAINAGE J12 - J8/9 SHEET 13 OF 32 CH 51500-52400 |
| 537806-MUH-VR-00-S3-DR-DR-500014 | PROPOSED DRAINAGE J12 - J8/9 SHEET 14 OF 32 CH 50600 – 51500 |
| 537806-MUH-VR-00-S3-DR-DR-500015 | PROPOSED DRAINAGE J12 - J8/9 SHEET 15 OF 32 CH 49700 – 50600 |
| 537806-MUH-VR-00-S3-DR-DR-500016 | PROPOSED DRAINAGE J12 - J8/9 SHEET 16 OF 32 CH 48800 – 49700 |
| 537806-MUH-VR-00-S3-DR-DR-500017 | PROPOSED DRAINAGE J12 - J8/9 SHEET 17 OF 32 CH 47900 – 48800 |
| 537806-MUH-VR-00-S3-DR-DR-500018 | PROPOSED DRAINAGE J12 - J8/9 SHEET 18 OF 32 CH 47000 – 47900 |
| 537806-MUH-VR-00-S3-DR-DR-500019 | PROPOSED DRAINAGE J12 - J8/9 SHEET 19 OF 32 CH 46100 – 47000 |
| 537806-MUH-VR-00-S3-DR-DR-500020 | PROPOSED DRAINAGE J12 - J8/9 SHEET 20 OF 32 CH 45200 – 46100 |
| 537806-MUH-VR-00-S3-DR-DR-500021 | PROPOSED DRAINAGE J12 - J8/9 SHEET 21 OF 32 CH 44300 – 45200 |
| 537806-MUH-VR-00-S3-DR-DR-500022 | PROPOSED DRAINAGE J12 - J8/9 SHEET 22 OF 32 CH 43400 – 44300 |
| 537806-MUH-VR-00-S3-DR-DR-500023 | PROPOSED DRAINAGE J12 - J8/9 SHEET 23 OF 32 CH 42500-43400 |
| 537806-MUH-VR-00-S3-DR-DR-500024 | PROPOSED DRAINAGE J12 - J8/9 SHEET 24 OF 32 CH 41600 – 42500 |
| 537806-MUH-VR-00-S3-DR-DR-500025 | PROPOSED DRAINAGE J12 - J8/9 SHEET 25 OF 32 CH 40700 – 41600 |

| Drawing Number | Drawing title |
|---|---|
| 537806-MUH-VR-00-S3-DR-DR-500026 | PROPOSED DRAINAGE J12 - J8/9 SHEET 26 OF 32 CH 39800 – 40700 |
| 537806-MUH-VR-00-S3-DR-DR-500027 | PROPOSED DRAINAGE J12 - J8/9 SHEET 27 OF 32 CH 38900 – 39800 |
| 537806-MUH-VR-00-S3-DR-DR-500028 | PROPOSED DRAINAGE J12 - J8/9 SHEET 28 OF 32 CH 38000 – 38900 |
| 537806-MUH-VR-00-S3-DR-DR-500029 | PROPOSED DRAINAGE J12 - J8/9 SHEET 29 OF 32 CH 37100 – 38000 |
| 537806-MUH-VR-00-S3-DR-DR-500030 | PROPOSED DRAINAGE J12 - J8/9 SHEET 30 OF 32 CH 36200 – 37100 |
| 537806-MUH-VR-00-S3-DR-DR-500031 | PROPOSED DRAINAGE J12 - J8/9 SHEET 31 OF 32 CH 35300 – 36200 |
| 537806-MUH-VR-00-S3-DR-DR-500032 | PROPOSED DRAINAGE J12 - J8/9 SHEET 32 OF 32 CH 34400 – 35300 |

# ANNEX D: J12 – J8/9 CENTRAL RESERVE DRAINAGE DRAWINGS

| Drawing Number | Drawing title |
|---|---|
| 537806-MUH-CR-S3-DR-DR-500000 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE KEY AND INDEX OF DRAWINGS |
| 537806-MUH-CR-S3-DR-DR-500001 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 1 OF 32 CH 62300 – 62900 |
| 537806-MUH-CR-S3-DR-DR-500002 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 2 OF 32 CH 61400 – 62300 |
| 537806-MUH-CR-S3-DR-DR-500003 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 3 OF 32 CH 60500 – 61400 |
| 537806-MUH-CR-S3-DR-DR-500004 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 4 OF 32 CH 59600 – 60500 |
| 537806-MUH-CR-S3-DR-DR-500005 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 5 OF 32 CH 57800 – 59600 |
| 537806-MUH-CR-S3-DR-DR-500006 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 6 OF 32 CH 57800 – 57800 |
| 537806-MUH-CR-S3-DR-DR-500007 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 7 OF 32 CH 56900 – 57800 |
| 537806-MUH-CR-S3-DR-DR-500008 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 8 OF 32 CH 56000 – 56900 |
| 537806-MUH-CR-S3-DR-DR-500009 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 9 OF 32 CH 55100 – 56000 |
| 537806-MUH-CR-S3-DR-DR-500010 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 10 OF 32 CH 54200 – 55100 |
| 537806-MUH-CR-S3-DR-DR-500011 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 11 OF 32 CH 53300 – 54200 |
| 537806-MUH-CR-S3-DR-DR-500012 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 12 OF 32 CH 52400 – 53300 |
| 537806-MUH-CR-S3-DR-DR-500013 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 13 OF 32 CH 51500-52400 |
| 537806-MUH-CR-S3-DR-DR-500014 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 14 OF 32 CH 50600 – 51500 |
| 537806-MUH-CR-S3-DR-DR-500015 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 15 OF 32 CH 49700 – 50600 |
| 537806-MUH-CR-S3-DR-DR-500016 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 16 OF 32 CH 48800 – 49700 |
| 537806-MUH-CR-S3-DR-DR-500017 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER |

| Drawing Number | Drawing title |
|---|---|
| | COLLECTION CENTRAL RESERVE SHEET 17 OF 32 CH 47900 – 48800 |
| 537806-MUH-CR-S3-DR-DR-500018 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 18 OF 32 CH 47000 – 47900 |
| 537806-MUH-CR-S3-DR-DR-500019 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 19 OF 32 CH 46100 – 47000 |
| 537806-MUH-CR-S3-DR-DR-500020 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 20 OF 32 CH 45200 – 46100 |
| 537806-MUH-CR-S3-DR-DR-500021 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 21 OF 32 CH 44300 – 45200 |
| 537806-MUH-CR-S3-DR-DR-500022 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 22 OF 32 CH 43400 – 44300 |
| 537806-MUH-CR-S3-DR-DR-500023 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 23 OF 32 CH 42500- 43400 |
| 537806-MUH-CR-S3-DR-DR-500024 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 24 OF 32 CH 41600 – 42500 |
| 537806-MUH-CR-S3-DR-DR-500025 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 25 OF 32 CH 40700 – 41600 |
| 537806-MUH-CR-S3-DR-DR-500026 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 26 OF 32 CH 39800 – 40700 |
| 537806-MUH-CR-S3-DR-DR-500027 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 27 OF 32 CH 38900 – 39800 |
| 537806-MUH-CR-S3-DR-DR-500028 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 28 OF 32 CH 38000 – 38900 |
| 537806-MUH-CR-S3-DR-DR-500029 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 29 OF 32 CH 37100 – 38000 |
| 537806-MUH-CR-S3-DR-DR-500030 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 30 OF 32 CH 36200 – 37100 |
| 537806-MUH-CR-S3-DR-DR-500031 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 31 OF 32 CH 35300 – 36200 |
| 537806-MUH-CR-S3-DR-DR-500032 | PROPOSED DRAINAGE J12 – J8/9 SURFACE WATER COLLECTION CENTRAL RESERVE SHEET 32 OF 32 CH 34400 – 35300 |

# ANNEX E: J12 –J8/9 JUNCTION DRAINAGE DRAWINGS

| Drawing Number | Drawing title |
|---|---|
| 537806-MUH-VR-S3-DR-DR-500150 | PROPOSED DRAINAGE J12- J8/9 SURFACE WATER COLLECTIONS JUNCTIONS KEY AND INDEX OF DRAWINGS |
| 537806-MUH-VR-S3-DR-DR-500151 | PROPOSED DRAINAGE J12- J8/9 SURFACE WATER COLLECTIONS JUNCTION 12 SHEET 1 OF 6 CH 6259 – 61589 |
| 537806-MUH-VR-S3-DR-DR-500152 | PROPOSED DRAINAGE J12- J8/9 SURFACE WATER COLLECTIONS READING MSA JUNCTION SHEET 2 OF 6 CH 59725 - 58720 |
| 537806-MUH-VR-S3-DR-DR-500153 | PROPOSED DRAINAGE J12- J8/9 SURFACE WATER COLLECTIONS JUNCTION 11 SHEET 3 OF 6 CH 55340 - 54324 |
| 537806-MUH-VR-S3-DR-DR-500154 | PROPOSED DRAINAGE J12- J8/9 SURFACE WATER COLLECTIONS JUNCTION 10 SHEET 4 OF 6 CH 46905 - 45901 |
| 537806-MUH-VR-S3-DR-DR-500155 | PROPOSED DRAINAGE J12- J8/9 SURFACE WATER COLLECTIONS JUNCTION 10 SHEET 5 OF 6 CH 46002 - 44995 |
| 537806-MUH-VR-S3-DR-DR-500156 | PROPOSED DRAINAGE J12- J8/9 SURFACE WATER COLLECTIONS JUNCTION 8 SHEET 6 OF 6 CH 34819 - 33800 |

# ANNEX F: J12 – J8 ERA DRAINAGE DRAWINGS

| Drawing Number | Drawing title |
|---|---|
| 537806-MUH-VR-S3-DR-DR-500101 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 1 OF 19 CH36078 – 35878 ERA E7 – A1 |
| 537806-MUH-VR-S3-DR-DR-500102 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 2 OF 19 CH36817 – 36425 ERA E7 – B1 |
| 537806-MUH-VR-S3-DR-DR-500103 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 3 OF 19 CH38392 – 38191 ERA E7 – A2 |
| 537806-MUH-VR-S3-DR-DR-500104 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 4 OF 19 CH38884 – 38684 ERA E7 – B2 |
| 537806-MUH-VR-S3-DR-DR-500105 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 5 OF 19 CH 40791 – 40591 ERA E7 – A3 |
| 537806-MUH-VR-S3-DR-DR-500106 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 6 OF 19 CH41340 – 41140 ERA E7 – B3 |
| 537806-MUH-VR-S3-DR-DR-500107 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 7 OF 19 CH43184 – 42984 ERA E7 – A4 |
| 537806-MUH-VR-S3-DR-DR-500108 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 8 OF 19 CH 43401 – 43201 ERA E7 – B4 |
| 537806-MUH-VR-S3-DR-DR-500109 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 9 OF 19 CH 48223 – 48023 ERA E8 – A1 |
| 537806-MUH-VR-S3-DR-DR-500110 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 10 OF 19 CH 49083 – 48698 ERA E8 – B1 |
| 537806-MUH-VR-S3-DR-DR-500111 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 11 OF 19 CH 50649 – 50449 ERA E8 – A2 |
| 537806-MUH-VR-S3-DR-DR-500112 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 12 OF 19 CH 50950 – 50750 ERA E8 – B2 |
| 537806-MUH-VR-S3-DR-DR-500113 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 13 OF 19 CH 52681 – 52481 ERA E8 – A3 |
| 537806-MUH-VR-S3-DR-DR-500114 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 14 OF 19 CH 52901 – 52701 ERA E8 – B3 |
| 537806-MUH-VR-S3-DR-DR-500115 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 15 OF 19 CH 56329 – 56129 ERA E9 – A1 |

| Drawing Number | Drawing title |
|---|---|
| 537806-MUH-VR-S3-DR-DR-500116 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 16 OF 19 CH 57150 – 56950 ERA E9 – A1 |
| 537806-MUH-VR-S3-DR-DR-500117 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 17 OF 19 CH 58099 – 57899 ERA E9 – A2 |
| 537806-MUH-VR-S3-DR-DR-500118 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 18 OF 19 CH 60462 – 60262 ERA E9 – B3 |
| 537806-MUH-VR-S3-DR-DR-500119 | PROPOSED DRAINAGE SURFACE WATER COLLECTION EMERGENCY REFUGE AREAS SHEET 19 OF 19 CH 60462 – 60262 ERA E9 – A3 |

# ANNEX G: J8/9 – J3 INDICATIVE DRAINAGE

| Drawing Number | Drawing title |
|---|---|
| 514451-MUH-00-ZZ-DR-DR-300149 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION KEY AND INDEX SHEET |
| 514451-MUH-00-ZZ-DR-DR-300150 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 1 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300151 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 2 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300152 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 3 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300153 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 4 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300154 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 5 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300155 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 6 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300156 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 7 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300157 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 8 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300158 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 9 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300159 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 10 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300160 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 11 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300161 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 12 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300162 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 13 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300163 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 14 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300164 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 15 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300165 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 16 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300166 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 17 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300167 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 18 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300168 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 19 of 27 |

| Drawing Number | Drawing title |
|---|---|
| 514451-MUH-00-ZZ-DR-DR-300169 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 20 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300170 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 21 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300171 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 22 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300172 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 23 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300173 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 24 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300174 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 25 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300175 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 26 of 27 |
| 514451-MUH-00-ZZ-DR-DR-300176 | INDICATIVE DRAINAGE J8/9 – J3 SURFACE WATER COLLECTION SHEET 27 of 27 |

# ANNEX H: M4 Junction 10 -11 Drainage Layout As Built Drawings

# ANNEX I: MICRO DRAINAGE MODELLING PLAN

# ANNEX J: MICRO DRAINAGE MODELLING DETAILS

## EXISTING DRAINAGE SYSTEM

## ADDITIONAL PAVED AREAS ONLY

## PROPOSED DRAINAGE SYSTEM