12. Geology, Soils and Groundwater

12.1. Introduction

12.1.1. This Chapter presents the Design Manual for Roads and Bridges (DMRB) Stage 3 assessment of the potential impacts of the Proposed Scheme in relation to the impacts on soils (peat only) and groundwater. Construction and operational impacts from both the improvements to the Old Military Road (OMR) and long-term solution (LTS), as described in Chapter 4: The Proposed Scheme, are discussed. For this assessment, construction impacts are generally considered to be short-term impacts which occur during the construction phase only. Operational impacts are considered long-term or permanent impacts affecting receptors after the construction phase is complete. Operational impacts will hence be referred to as permanent impacts throughout this chapter. It is recognised that many operational impacts are initiated by construction activities e.g. excavation of cuttings, however, the full effect of the impact may only manifest itself in the long term. The following potential impacts were considered:

- peat or carbon-rich soils
- groundwater pollution from routine runoff in the operational phase
- direct loss or changes to groundwater aquifers and groundwater-dependent features
- groundwater pollution resulting from construction activities
- groundwater pollution from accidental spillages (i.e., vehicles/plant spills or leakages of fuels, oils, lubricants, coolants etc.)
- increased turbidity caused by excavation works
- loss or changes to Groundwater Dependent Terrestrial Ecosystems (GWDTE) and
- potential for increased groundwater flood risk.

12.1.2. Consequential impacts on sites designated for their conservation value, groundwater-dependent habitats and associated fauna have been discussed in Chapter 11: Biodiversity. Pollution impacts on surface waters and flooding,

including groundwater flooding have been discussed in Chapter 19: Road Drainage and the Water Environment.

12.2. Sources of Information

12.2.1. The following sources of information have been used as part of this assessment:

- British Geological Survey (BGS) 1:50,000 and 1:10,000 scale superficial and bedrock geology mapping (British Geological Survey (2020). BGS Geoindex Onshore.)
- Aquifer Productivity Mapping (Brighid E O Dochartaigh et al., (2011). Aquifer Productivity (Scotland) GIS Datasets. Version 2.)
- Aquifer Vulnerability Mapping (Brighid E O Dochartaigh et al., (2011). User guide: Groundwater Vulnerability (Scotland) GIS Dataset. Version 2.)
- WFD Groundwater Body Classifications (Scottish Environmental Protection Agency (2015). Water Classification Hub)
- Scotland's Environment Web Map - Aquifer Classifications (Scottish Government, 2024) p
- National Soil Map of Scotland (Scottish Government, 2024)
- UK Soil Observatory (Esri UK, 2024)
- Carbon and Peatland Map 2016 (Scottish Government, 2016)
- Land Capability for Agricultural in Scotland (Scottish Government, 2017)
- BGS Groundwater Vulnerability Map of Scotland 1:100,000 scale (BGS, 2015)
- Coal Authority online interactive map data (2024)
- BGS 'Directory of Mines and Quarries': (Cameron, D.G., Idoine, N.E., Brown, T.J., Patton, M.A.G., McGinn, C. and Mankelow, J.M., (2020). Directory of mines and quarries. British geological survey)
- Google Earth (Google, 2024)
- Defra's MAGIC Map (DEFRA, 2024)
- Ordnance Survey (OS) raster mapping on 1:25,000 scale (2024)
- OS Terrain 50 Mapping (2024)
- LA 113 Guidance (Highways England et al. (2020). LA 113 Road Drainage and the Water Environment

- LA109 Guidance (Highways England et al. (2019). LA 109 Geology and Soils and
- CIRIA report C750 Groundwater Control: Design and Practice (CIRIA (2016). C750 Groundwater Control: Design and Practice).

12.2.2. In relation to GWDTE, UKHab and National Vegetation Classification (NVC) mapping has been carried out as detailed within Chapter 11: Biodiversity and Volume 4, Appendix 11.4: Designated Sites and Terrestrial Habitat Report.

12.3. Approach and Methods

12.3.1. The proposed methodology for the geology and ground conditions impact assessment follows the guidance set out in LA 109 Geology and Soils and DMRB LA 113 Road Drainage and the Water Environment. This applies to all potential impacts outlined in Section 12.1.1, apart from peat which is discussed in 12.3.9. The approach and methods have been informed by legislation, policy and guidance. The legislation and methodology are found in Volume 4, Appendix 12.1 - Geology, Soils and Groundwater Legislation Policy and Guidance and Volume 4, Appendix 12.2 - Geology, Soils and Groundwater Methodology, respectively.

Study Area

12.3.2. The assessment study area includes the footprint of the Proposed Scheme (excluding the Biodiversity Net Gain (BNG) and Natural Capital (NC) enhancement areas) and a buffer of 250m. The footprint of the Proposed Scheme can be seen in Volume 3, Figure 4.1 Scheme Layout Overview.

12.3.3. It is recognised that the impacts of the Proposed Scheme on groundwater receptors may extend some distance away from the Proposed Scheme footprint; however, 250m is considered a conservative estimate of the extent of the impacts. This assessment therefore covers both the direct and indirect impacts of groundwater receptors.

12.3.4. The assessment study area for GWDTE includes the footprint of the Proposed Scheme and a buffer of 250m for a NVC survey, this is in recognition that the potential impacts on these receptors may extend some distance from the Proposed Scheme. For the purposes of reviewing potential GWDTE direct and

indirect losses, the study area has been defined based on the Proposed Scheme footprint and this 250m buffer. Details of the NVC survey are provided in Volume 4, Appendix 11.4: Designated Sites and Terrestrial Habitat Report.

12.3.5. The assessment study area for peat, and subsequently the Peat Management Plan (PMP), applies only where peat is located. Since the footprint of the Proposed Scheme is underlain by peat or peaty soils (as shown in Volume 3, Figure 12.4), therefore, the assessment study area includes the Proposed Scheme footprint and a 250m buffer.

Method of Baseline Collection

12.3.6. The collection of data informing the impact of the Proposed Scheme includes:

- Preliminary Sources Study Report (PSSR) (Jacobs Aecom (2022). Access to Argyll and Bute (A83) Preliminary Sources Study Report.)
- 2022 and 2023 ground investigations
- survey data collection (including peat depths) and
- desk-study data collection (data sources outlined in Section 12.2).

Consultation

12.3.7. Consultation was undertaken throughout the DMRB Stage 2 and DMRB Stage 3 process through the A83 Environmental Steering Group (ESG) which comprised, in relation to geology, soils and groundwater, of the Loch Lomond and The Trossachs National Park Authority (LLTNPA), Argyll and Bute Council, SEPA and NatureScot.

12.3.8. Public consultation was undertaken between 26th May and 7th July 2023 which included four days of public exhibitions in Arrochar and Lochgilphead in June 2023 and the virtual exhibition online. Further public consultation was undertaken between 18 March and 10 May 2024 both online and at public exhibitions.

Assessment Criteria

12.3.9. In accordance with DMRB LA 109 and LA 113 Standard Guidance, the assessment has considered the sensitivity of the receptors, the magnitude of impact of The Proposed Scheme upon it and resulted in a determination of the significance of effect of The Proposed Scheme on the resource. The

methodology can be found in Volume 4, Appendix 12.2 Geology, Soils and Groundwater Methodology.

Peat

12.3.10. The assessment of peat is not outlined within DMRB LA 109 and therefore, the assessment of the significance of impacts in relation to peat has been based on guidance in the National Planning Framework 4 (NPF4) Policy 5 which provides significant protection for peatland and carbon-rich soils. Informing meticulous project design, this assessment ensures alignment with relevant guidance and the mitigation hierarchy. Its primary goal is to proactively avoid adverse impacts and subsequently minimise them through best practices. To validate adherence to this approach, an Outline PMP has been developed. Further information has been provided in Volume 4, Appendix 12.4 Outline Peat Management Plan.

12.3.11. The following data collection has been completed:

- a peat depth survey showing colour-coded peat depths around Loch Restil
- a peat depth survey showing interpolated peat depths
- peatland condition assessment/mapping and
- NVC habitat mapping (as part of Chapter 11: Biodiversity).

12.3.12. Areas of peat, carbon-rich soils and priority peatland have been identified through comparison and collation of data from the BGS superficial geology mapping, Scotland soil carbon and peat maps, and data from national vegetation class mapping.

Limitations of the Assessment

12.3.13. This assessment has relied upon the accuracy and level of detail of the documented data sources listed within Section 12.2.

12.3.14. This chapter has been prepared with data collected as outlined in 12.3.6. including data from preliminary 2022 and 2023 ground investigations. Data from the current Ground Investigation (GI) which commenced in November 2024 is not yet available, and as such is a limitation of this assessment.

12.3.15. Due to the presence of peat within the study area and historic landslides, a Peat Stability and Landslide Hazard Risk Assessment (to be developed as part of the

reporting following further GI and ground investigation report (GIR)) should be undertaken. A limitation of this Chapter is that this Assessment has not yet been completed. This assessment will use peat probing depth data in combination with slope information to initially determine the risk of peat instability, based primarily on the factor of safety slope stability calculations in combination with consequence (receptor) evaluation. Specific areas are identified at an initial stage, and those areas with an initial risk level greater than low are then evaluated further, using geotechnical information and interpretation of aerial photography to refine the initial desktop assessment for each location. The additional information enables the evaluation of the potential extent and the identification of appropriate mitigation measures to reduce the revised risk level.

12.3.16. The scale of various mapping datasets, such as groundwater vulnerability and soils mapping, is such that only broad characterisation of these attributes and high-level assessment of potential impacts has been possible at this stage. Both the aquifer productivity and groundwater vulnerability data only provide a guide to aquifer conditions at a 1:100,000 scale.

12.3.17. Given low likelihood of groundwater dependency upon potential GWDTE in the context of the local topographic and hydrological setting and multiple water sources, a proportionate approach has been adopted, with focus on specific habitats with higher potential for dependency from field survey and desktop review.

Sub-Topics Scoped Out of the Assessment

Peat or carbon-rich soils

12.3.18. There is no requirement to excavate extensive areas of peat, based on soil mapping data, hence the potential operational (permanent) impacts have been scoped out of the assessment.

Groundwater pollution from routine runoff in the operational phase

12.3.19. The potential groundwater pollution impact from routine runoff has been scoped out as a potential construction impact as the activities are only operational (permanent) related.

Groundwater pollution resulting from construction activities:

12.3.20. The potential for groundwater pollution from accidental spillages (i.e., vehicles/plant spills or leakages of fuels, oils, lubricants, coolants etc.) and increased turbidity caused by excavation works, has been scoped out as a potential operational (permanent) impact as the activities are only construction related.

Potential for increased groundwater flood risk.

12.3.21. The potential for increased groundwater flood risk has been discussed in Chapter 19: Road Drainage and the Water Environment, hence scoped out of the assessment in this Chapter.

Agricultural Soils

12.3.22. As part of the EIA scoping exercise conducted with the A83 ESG, agricultural soils and geology have been scoped out of this assessment. This was due to a lack of identified receptors.

Contaminated Land

12.3.23. Contaminated land has also been scoped out at this stage due to a lack of identified sources of contamination. However, a contaminated land risk assessment will be carried out as part of the proposed GI works and will be assessed within the ground investigation report.

BNG and NC enhancement areas

12.3.24. The BNG and NC enhancement areas have been scoped out of the area considered to be impacted by the Proposed Schene. This is because the works planned here, which are mainly planting of trees and shrubs, are not considered to have any potential impact on the geology, soils or groundwater receptors.

12.4. Baseline Conditions

12.4.1. Baseline conditions for the Proposed Scheme are included within Volume 4, Appendix 12.3 – Geology, Soils and Groundwater Baseline.

12.4.2. Sections covered within Volume 4, Appendix 12.3 Geology, Soils and Groundwater Baseline include the topography of the region, the superficial and bedrock geology, soils and peat. A section on groundwater describes the

hydrogeology of the area, including observed levels, vulnerability and quality of groundwater. There is also information regarding water supplies and GWDTE.

12.5. Embedded Mitigation

12.5.1. The Proposed Scheme has been designed, as far as possible, to avoid and minimise impacts and effects on the geology and soil environment through the process of design development.

12.5.2. An iterative design process was conducted and consultations with SEPA provided advice to improve the designs. For example, an interim design included a swale feature, however, this was subsequently removed due to potential impact to peat and other sensitive receptors within Beinn an Lochain Site of Special Scientific Interest (SSSI), further details can be found in Chapter 4: The Proposed Scheme.

12.5.3. Peat Probing has been undertaken around Loch Restil, which was recorded to be within an area of Class 2 Peatland. Design changes have since taken place to avoid this area, meeting the first hierarchy in NPF4, Policy 5 - Soils. Volume 4, Appendix 12.6 Outline Peat Management Plan has been updated to confirm this information.

Improvements to the OMR

12.5.4. Mitigation measures embedded into the design of the OMR Improvements are outlined in Table 12.1 below.

Table 12.1 - OMR Embedded Mitigation Measures

Embedded Mitigation Reference	Embedded Mitigation Measures
GSG-Embed1	The footprint of the existing OMR has been utilised as much as possible, which minimises both the land take required and cuttings into the hillside, hence reducing the potential impact on soils (including carbon rich soils such as peat) and groundwater receptors.

Embedded Mitigation Reference	Embedded Mitigation Measures
GSG-Embed2	Between CH160 to CH1090 and CH2480 to CH3836, it is proposed to retain the existing ditches, which would provide a Surface Water Pollution Mitigation Index of SS 0.5, M 0.6, and H 0.6. This suggests only 0.2 below the target Suspended Solids (SS) score, and satisfactory treatment for Metals (M) and Hydrocarbons (H) in comparison to the OMR Road Pollution Hazard Indices. Although these mitigation indices fall below compliance with the Simple Index Approach (SIA), they do provide treatment and existing features look in good condition. The proposal to retain was agreed in principle with SEPA during the A83 ESG January 2024 consultation meeting, to minimise engineering interventions as a proportionate approach for the OMR to be used as a temporary route.
GSG-Embed3	Between CH1090 to CH2480, filter drains are proposed along most of the extents to drain the road as well as draining the earthworks and verges. These filter drains would provide a Surface Water Pollution Mitigation Index of SS 0.4, M 0.4 and H 0.4. Although these mitigation indices fall below compliance with the Simple Index Approach (SIA), they do provide treatment and existing features look in good condition. The proposal to retain was agreed in principle with SEPA during the A83 ESG January 2024 consultation meeting, to minimise engineering interventions as a proportionate approach for the OMR to be used as a temporary route.

Long-Term Solution

12.5.5. Mitigation measures embedded into the LTS design are outlined below in Table 12.2 below.

Table 12.2 - LTS Embedded Mitigation Measures

Embedded Mitigation Reference	Embedded Mitigation Measures
GSG-Embed4	The LTS follows the footprint of the existing A83 corridor, which minimises both the land take required and cuttings into the hillside, hence reducing the potential impact on geology, soils and groundwater receptors.

Embedded Mitigation Reference	Embedded Mitigation Measures
GSG-Embed5	The following has been included within the drainage design: • Sustainable drainage system (SuDS) in Network 1, is a detention basin, allowing storage of runoff, attenuation and treatment, before discharging to the Croe Water. The basin's height above ground level varies from 0.21m to 1.26m agl (above ground level). The maximum groundwater level at the basin is recorded as 0.15m bgl (below ground level) (AAB-BH1049), hence the base of the feature is designed to be ~0.35m above the maximum groundwater level to mitigate the risk of groundwater contamination. • The detention basin will be vegetated, with the soil layer absorbing a proportion of the runoff, in addition to sediment and pollutant removal. • Carrier drains, aligned throughout most of the LTS area, comprise unperforated pipes, without infiltration (due to slope stability concern). • Carrier drains close to the basin are proposed to either be concrete material or with a concrete surround bedding to counteract the potential flotation of pipes due to high groundwater levels. • Filter drains carrying road runoff as part of the SuDS for Networks 2 and 3 will be lined with an impermeable material, to prevent infiltration increasing risk of slope instability and will protect groundwater from any contaminants. • Crest drains that intercept overland flow are expected to also be lined, particularly in upper sections, preventing infiltration of water onto unstable slopes. • Ditches designed to receive overland flow with no road runoff input

12.6. Potential Impacts - Improvements to the OMR

12.6.1. The potential impacts of improvements to the OMR are discussed below, they have been subdivided into construction and permanent impacts but account for the implementation of the embedded mitigation as set out in Section 12.5.

12.6.2. Each impact is assessed using the methods outlined in Section 12.3 and criteria detailed in Volume 4, Appendix 12.2 Geology, Soils and Groundwater Methodology. The potential impacts are assessed before mitigation, with potential mitigation detailed following this assessment and a summary including residual impact.

Construction Impacts (Improvements to the OMR)

Loss or change to peat or carbon-rich soils (OMR Improvements)

12.6.3. The construction of the OMR Improvements require the excavation of peaty soils to allow for the widening and realignment of the OMR. Due to the nature of the peat on site, the load-bearing capacity in the peat is likely too low for this construction. Therefore, it is required that the peat is excavated to ensure that a safe structure can be implemented. It is important to note the potential impacts on peat quality during construction relate to the removal of superficial deposits during the creation of cuttings and potential excavation close to or below the groundwater table. These impacts are temporary but may result in long-term changes to peat quality. Further information on the construction impacts on peat and carbon-rich soils for the OMR are included in the PMP (Volume 4, Appendix 12.4 Outline Peat Management Plan).

12.6.4. Further GI is to be undertaken to confirm the location, type and depth of peat deposits within the Proposed Scheme. Based on information collated to date the peat deposits would be classed as either Class 3 or Class 5 (see Volume 4, Appendix 12.4 Outline Peat Management Plan). Given the topography and site notes from the MTS GI, focussed on the OMR, we do not anticipate there to be substantial undisturbed peat deposits. The draft factual report is not yet available but initial reports from the site works indicate there are isolated buried peat deposits associated with landslide debris; however, these will not be disturbed during road widening. The topsoil is mixed in with peaty soils and gravel/boulders. As neither of these classifications are nationally significant the

environmental sensitivity is considered Medium. Since the potential impacts to the peat would be temporary, the magnitude of impact on peatland is Minor, resulting in an overall significance of Slight Adverse.

Direct loss or changes to groundwater aquifers and groundwater dependant features (OMR Improvements)

12.6.5. Impacts to groundwater mainly take place where road cuttings are located across the Proposed Scheme. Where a large cut intercepts the groundwater table, it may cause drawdown of the surrounding groundwater table and dewatering to nearby receptors. A cuttings assessment has been undertaken (Volume 4, Appendix 12.4 Cuttings Assessment), which estimated the likely drawdown created by road cuttings across the Proposed Scheme. All groundwater-associated features that fall within this area of drawdown (i.e. radius of influence) were then identified as those features likely to be impacted by the proposed works.

12.6.6. The Improvements to the OMR includes 34 proposed cuttings (areas of material excavation). The results of the assessment showed that 17 of these cuttings are likely to intercept groundwater. The remaining 17 cuttings were considered to have no impact on groundwater flows and have been screened out of the assessment. Results of the cuttings assessment, including the estimated drawdowns, calculated radius of influence and assessment of impact, are shown in Volume 4, Appendix 12.4 Cuttings Assessment.

12.6.7. Overall, the magnitude of impacts on the superficial or bedrock aquifer across the 17 cuttings is anticipated to be Negligible. Therefore, the subsequent significance is Slight Adverse.

Groundwater pollution from construction (OMR Improvements construction impact)

12.6.8. Groundwater pollution during construction can allow pollutants to migrate through the unsaturated zone to shallow aquifers. Excavation of the overlying material, particularly where cuttings are proposed in areas of permeable drift deposits with shallow groundwater, could increase the vulnerability of localised aquifers to contaminants. Pollutants could arise from vehicle/plant spills or

leakages of fuels, oils, lubricants and coolants. Also, increased turbidity could be caused by excavation works.

12.6.9. The potential impacts from accidental spillages have mainly been assessed as operational impacts and have been evaluated using the methodology outlined within Appendix D of the LA 113 Standard and the results are presented in Volume 4, Appendix 12.5 Spillage and Runoff Assessments.

12.6.10. It is important to note the potential impacts on groundwater quality during construction. These relate to the removal of surface cover, including soils and superficial deposits, during the creation of cuttings and potential excavation close to or below the groundwater table. Spillages in these areas could introduce pollutants directly into the groundwater aquifers resulting in changes to water quality. These events are temporary in nature but may result in long-term changes to water quality.

12.6.11. With the embedded mitigation measures in place, it is anticipated that the magnitude of impact on the associated aquifers will be Minor, resulting in a significance of Slight Adverse.

Groundwater Dependent Terrestrial Ecosystems (GWDTE) (OMR Improvements Impact)

12.6.12. GWDTE within the study area may be impacted through direct loss of habitat under the footprint of the Proposed Scheme, through severance of habitat and through changes to the groundwater regime supporting the habitat. This could result in altered vegetation in corridors close to infrastructure, known as indirect loss. Supporting information on GWDTE, including M10 NVC habitat discussion in this setting, is provided in Volume 4, Appendix 12.3: Baseline and Volume 4, Appendix 12.4: Cuttings Assessment.

12.6.13. The existing linear features of the OMR and upslope A83 are already likely to act as barriers to shallow groundwater flows on this slope. The improvements to the OMR involve limited engineering activities, with a short section of carriageway widening, plus associated minor geotechnical and drainage upgrades to improve slope stability and transfer of flow. Baseline groundwater conditions are expected to be re-established close to excavations. Any change close to the M10

community would be of very limited horizontal and vertical extent, with no change to water inputs at the base of Glen Croe or to the wider Croe Water system.

12.6.14. Direct losses associated with the OMR Improvements are very small, with indirect losses potentially more extensive (upslope and downslope). However, as the groundwater drawdown effect would reduce with distance from the Proposed Scheme, it is anticipated that the overall changes to GWDTE would also be restricted, with radii of influence values from excavations (Table 12.7) indicating a maximum distance of 2m. Figure 12.7: Groundwater Dependent Terrestrial Ecosystems displays these locations. None of these OMR excavation radii of influence overlap with M10 NVC habitat.

12.6.15. Little direct or indirect effects on GWDTE are predicted to occur as a result of the OMR Improvements. The magnitude of change to GWDTE is considered to be Negligible, with a Slight Adverse effect.

Operational (Permanent) Impacts (OMR)

Loss or changes to Groundwater Dependant Terrestrial Ecosystems (GWDTE) (OMR Improvements)

12.6.16. GWDTE information previously noted for construction impact is also valid for the operational phase, with little indirect or direct effect on M10 GWDTE due to the Proposed Scheme being limited to the existing OMR corridor and very limited radii of influence values on groundwater from excavations.

12.6.17. For the OMR operational phase, as for construction, the magnitude of change to GWDTE is considered to be Negligible, with a Slight Adverse effect.

Direct loss or changes to groundwater aquifers and groundwater dependant features (OMR Improvements)

12.6.18. Under the Controlled Activities Regulations 2011, the abstraction of water from the dewatering of road cuttings is regulated during the construction phase. Once an operational final passive drainage system is in place the activity no longer requires authorisation. However, road cuttings excavated to below the groundwater table, and associated drainage, have the potential to permanently lower localised groundwater levels in the aquifer adjacent to the cutting and alter

groundwater flow paths. This could also affect nearby groundwater-dependent receptors, such as wetlands, surface water bodies or groundwater abstractions.

12.6.19. Therefore, the assessment conducted for construction impact is also valid for the operational phase. Hence, the operational (permanent) impact significance is Slight Adverse.

Groundwater pollution from accidental spillage (OMR Improvements)

12.6.20. Pollution of groundwater aquifers and private and public water supplies may occur during operation from accidental spillages with pollutants migrating through the unsaturated zone of an aquifer to the saturated part of the aquifer below. The embedded mitigation measures detailed in the road design (vehicle restraint system and drainage system) are designed to minimise the impact of accidental spillages and reduce potential pollution risks.

12.6.21. The sensitivity of groundwater aquifers has been evaluated through a review of BGS superficial and bedrock geology, aquifer productivity, aquifer vulnerability and review of the WFD groundwater body status as detailed in Volume 4, Appendix 12.3 – Geology, Soils and Groundwater Baseline.

12.6.22. The groundwater outfalls relating to the OMR Improvements have been assessed for accidental spillage using the methodology outlined in Appendix D of the LA 113 guidance. The drainage networks assessed comprise:

- MTS OMR Existing 2-Way Extents, CH160 to CH1090 (eight networks)
- MTS OMR Existing 1-Way Extents, CH2480 to CH3836 (13 networks)
- MTS OMR Proposed Phase 3, CH1090 to CH2480 (19 networks)
- Sharp Bend 1 drainage network
- Sharp Bend 2 drainage network and
- Sharp Bend 3 drainage network.

12.6.23. The overall spillage risk assessment is presented in Volume 4, Appendix 12.5 Spillage and Runoff Assessments.

12.6.24. The result of the calculations relating to operational accidental spillage demonstrates that, whilst applying conservatively high traffic data for the Proposed Scheme, the three network discharges to groundwater will meet the

minimum DMRB standard of a 1 in 200 year return period, with the worst calculated annual probability being 1 in 365,206 years. This outcome indicates that no further mitigation would be required.

12.6.25. As the predicted outcomes also reflect the existing baseline status for the OMR in the event of an accidental spillage, it has accordingly been concluded that the magnitude of impact of the Proposed Scheme on the receiving groundwaters (High sensitivity) would be of No Change magnitude, with the associated significance being Neutral.

Groundwater pollution from routine runoff (OMR Improvements)

12.6.26. A broad range of potential pollutants, such as hydrocarbons i.e. fuel and lubricants, fuel additives, metal from corrosion of vehicles, de-icer, and gritting material can accumulate on road surfaces. These can subsequently be washed off the road during rainfall events, polluting the receiving water bodies.

12.6.27. Drainage networks with groundwater discharges are specified for the Proposed Scheme as shown on Volume 3, Figure 12.9 Proposed Drainage Networks as outlined in 12.6.22.

12.6.28. Information on each of the drainage networks is provided in Chapter 4: The Proposed Scheme.

12.6.29. DMRB Method C calculations have been carried out to assess the potential impact on groundwater.

12.6.30. The assessment of routine runoff impacts on groundwater occurs at the locations shown in Volume 4, Appendix 12.5 Spillage and Runoff Assessments.

12.6.31. The groundwater assessment results for the drainage networks have all been identified as a Medium Risk, primarily due to the shallow groundwater levels and lithology. However, it is considered that the assessment is likely to be overestimating the risk to groundwater, due to a number of factors. These include traffic volumes predicted at the lower end of the Low Risk parameter class and that all the drainage networks are designed to discharge to surface water, hence only a small proportion of the runoff may inadvertently discharge to groundwater.

12.6.32. As the predicted outcomes also reflect the existing baseline status for the OMR for routine runoff discharge, with recognition that the assessment values overestimate the potential for any groundwater discharge (as system is designed for surface discharge), the impact of routine runoff on the superficial and bedrock aquifers (high sensitivity) is anticipated to be of No Change Magnitude, with a Significance of Neutral.

12.7. Potential Impacts from the Long-Term Solution (LTS)

12.7.1. The potential impacts for the Proposed Scheme LTS are discussed below, they have been subdivided into construction and operational impacts but account for the implementation of the embedded mitigation as set out in Section 12.5.

12.7.2. Each impact is assessed using the methods outlined in Section 12.3. The potential impacts are assessed before mitigation, with potential mitigation detailed following this assessment (refer to Section 12.8) and a summary including residual impact (refer to Section 12.9).

Construction Impacts (LTS)

Loss or change to peat or carbon-rich soils (LTS)

12.7.3. As part of the LTS construction, there is a need to excavate areas of peat adjacent to the existing A83 to allow for the construction of the debris flow shelter and to allow for slight realignments for the A83. Due to the nature of the peat on site, it is likely that the load-bearing capacity in the peat is too low for this construction. Therefore, it is required that the peat is excavated to ensure a safe structure can be implemented. It is important to note the potential impacts on peat quality during construction relate to the removal of superficial deposits during the creation of cuttings and potential excavation close to or below the groundwater table. These impacts are temporary but may result in long-term changes to peat quality. Further information on the construction impacts on peat and carbon-rich soils are outlined in the PMP (Volume 4, Appendix 12.4 Outline Peat Management Plan).

12.7.4. Further GI is to be undertaken to confirm the location, type and depth of peat deposits within the Proposed Scheme. The A83 mainline and OMR (all within the LTS) is mainly Class 5 with small pockets of Class 3 mapped. Overall, within the

Class 3 and 5 areas only very limited deposits of undisturbed peat are expected, due to the topography and presence of mass movement deposits, with few locations likely to record depths greater than 0.5m. Disturbance to these areas shall be minimised and limited to the immediate area of the A83 and OMR corridors, again, in accordance with NPF4 Policy 5.

12.7.5. As neither Class 3 or Class 5 classifications are nationally significant the environmental sensitivity is considered Medium. Since the potential impacts to the peat would be temporary, the magnitude of impact on peatland is Minor, resulting in an overall significance of Slight Adverse.

Direct loss or changes to groundwater aquifers and groundwater dependant features (LTS)

12.7.6. Impacts to groundwater mainly take place where road cuttings are located across the Proposed Scheme. Where a large cut intercepts the groundwater table, it may cause drawdown of the surrounding groundwater table and dewatering to nearby receptors. A cuttings assessment has been undertaken (Volume 4, Appendix 12.4 Cuttings Assessment), which estimated the likely drawdown created by road cuttings across the Proposed Scheme. All groundwater associated features that fall within this area of drawdown (i.e. radius of influence) were then identified as those features likely to be impacted by the proposed works.

12.7.7. Groundwater aquifers and groundwater dependant features comprise the superficial and bedrock aquifers underlying the Proposed Scheme. There are no public or private water supplies within 250m of the Scheme.

12.7.8. The LTS includes 73 proposed cuttings (areas of material excavation). The results of the assessment showed that 39 of these cuttings are likely to intercept groundwater. The remaining 34 cuttings were considered to have no impact on groundwater flows and have been screened out of the assessment. Results of the cuttings assessment, including the estimated drawdowns, calculated radius of influence and assessment of impact, are shown in Volume 4, Appendix 12.4 Cuttings Assessment.

12.7.9. Overall, the magnitude of impacts on the superficial or bedrock aquifer is anticipated to be Negligible/Minor. Therefore, the subsequent significance is Slight/Moderate.

12.7.10. However, given that there are no nearby groundwater receptors other than the aquifers, the use of conservative groundwater level values in most cuttings, and the generally very low flow discharge rates, the magnitude of impact can be reduced to Negligible with significance of Slight Adverse.

Groundwater pollution from construction (LTS)

12.7.11. Groundwater pollution during construction has the potential to allow pollutants to migrate through the unsaturated zone to shallow aquifers. Excavation of the overlying material, particularly where cuttings are proposed in areas of permeable drift deposits with shallow groundwater, could increase the vulnerability of localised aquifers to contaminants. Pollutants could arise from vehicles/plant spills or leakages of fuels, oils, lubricants and coolants. Also, increased turbidity could be caused by excavation works.

12.7.12. The potential impacts from accidental spillages have mainly been assessed as operational impacts and have been evaluated using the methodology outlined within Appendix D of the LA 113 Standard, and the results are presented in Volume 3, Appendix 12.5 Spillage and Runoff Assessments.

12.7.13. It is important to note the potential impacts on groundwater quality during construction. These relate to the removal of surface cover, including soils and superficial deposits, during the creation of cuttings and potential excavation close to or below the groundwater table. Spillages in these areas could introduce pollutants directly into the groundwater aquifers resulting in changes to water quality. These impacts are temporary in nature but may result in long-term changes to water quality.

12.7.14. With the embedded mitigation measures in place, it is anticipated that the magnitude of impact on the associated aquifers will be Minor, resulting in a significance of Slight Adverse.

Groundwater Dependent Terrestrial Ecosystems (GWDTE) (LTS)

12.7.15. The development of extended and deepened catch pits and associated excavation of the A83 debris flow shelter structure is anticipated to intercept additional groundwater, alongside overland flow and surface water, which shall be discharged via culverts to the slope below the debris flow shelter. The interception of water from slope above and subsequent transfer below the debris flow shelter is a critical function of the design to ensure safe operation. Due to potential for scour and inducing instability to highly mobile slopes below the A83, above the OMR, infiltration back to groundwater is not planned mid-slope. The excavations planned for the LTS are over 1m depth, therefore SEPA LUPS 31 Guidance suggests effects are considered against a 250m GWDTE buffer.

12.7.16. Little direct effect on GWDTE is predicted to occur as a result of the LTS construction, with focus on the M10 NVC habitat of greater concern in terms of potential groundwater dependency. In comparison with the OMR Improvements, there is greater potential for indirect effects adjacent to (particularly downslope) of expanded A83 excavations on localised groundwater conditions as evidenced from the larger radii of influence zones (Table 12.10, Volume 4, Appendix 12.4 – Cuttings Assessment). However, these radii of influence values remain substantially less than the SEPA LUPS 31 Guidance's 250m guidance definition, with all values less than 50 m and the majority being less than 10m. None of these zones overlap with M10 habitat. Volume 3, Figure 12.7: Groundwater Dependent Terrestrial Ecosystems displays these locations.

12.7.17. The Proposed Development may alter sub-surface flow patterns mid-slope, immediately below the A83, but any change would be of limited distance and depth, given baseline conditions, with no change to any water inputs at the base of Glen Croe or to the overall Croe Water catchment.

12.7.18. The magnitude of change to GWDTE is considered to be Minor, with a Slight Adverse effect.

Operation Impacts (LTS)

Loss or changes to Groundwater Dependant Terrestrial Ecosystems (GWDTE) (LTS)

12.7.19. GWDTE information previously noted for LTS construction impact is also valid for the operational phase, with an elevated concern downslope in terms of indirect effects due to expanded excavations and larger radii of influence on the A83 corridor.

12.7.20. For the LTS operational phase, as for the construction phase, the magnitude of change to GWDTE is considered to be Minor, with a Slight Adverse effect.

Direct loss or changes to groundwater aquifers and groundwater dependant features (LTS)

12.7.21. Under the Water Environment (Controlled Activities) (Scotland) Regulations 2011, (as amended) the abstraction of water from the dewatering of road cuttings is regulated during the construction phase. Once an operational final passive drainage system is in place the activity no longer requires authorisation. However, road cuttings excavated to below the groundwater table, and associated drainage, have the potential to permanently lower groundwater levels in the aquifer adjacent to the cutting and alter groundwater flow paths. This could also affect nearby groundwater-dependent receptors, such as wetlands, surface water bodies or groundwater abstractions.

12.7.22. Therefore, the assessment conducted for construction impact is also valid for the operational phase. Hence, the operational (permanent) impact significance is Slight Adverse.

Groundwater pollution from accidental spillage (LTS)

12.7.23. Pollution of groundwater aquifers and private and public water supplies may occur during operation from accidental spillages with pollutants migrating through the unsaturated zone of an aquifer to the saturated part of the aquifer below. The embedded mitigation measures detailed in the road design (vehicle restraint system and drainage system) are designed to minimise the impact of accidental spillages and reduce potential pollution risks.

12.7.24. The sensitivity of groundwater aquifers has been evaluated through review of BGS superficial and bedrock geology, aquifer productivity, aquifer vulnerability and review of the WFD groundwater body status as detailed in Volume 4, Appendix 12.3 – Geology, Soils and Groundwater Baseline.

12.7.25. The drainage design discharges to surface water receptors. However, a number of these, in Networks 2 and 3 shall discharge into channels with relatively low flows and where groundwater infiltration may occur during low precipitation periods. Therefore, a groundwater assessment has been undertaken alongside surface water assessment to ensure a robust assessment process.

12.7.26. The proposed mainline groundwater outfalls have been assessed for accidental spillage using the methodology outlined in Appendix D of the LA 113 guidance.

12.7.27. The overall spillage risk assessment is presented in Volume 4, Appendix 12.5 Spillage and Runoff Assessments.

12.7.28. The result of the calculations relating to operational accidental spillage demonstrate that, whilst applying conservatively high traffic data for the Proposed Scheme, the network discharges to groundwater via will meet the minimum DMRB standard of a 1 in 200 year return period, with the worst calculated annual probability being 1 in 51,261 years. This outcome indicates that no further mitigation would be required.

12.7.29. It is also considered that operation of the Proposed Scheme would result in attenuation of surface runoff from the carriageway and provide treatment via SuDS (embedded mitigation) prior to the discharge of surface runoff back to the water environment and groundwater aquifers. Compared with the existing scenario, where there is no formal capture and treatment of surface runoff, the Proposed Scheme would represent a betterment with a beneficial effect on accidental spillages.

12.7.30. It has accordingly been concluded that the magnitude of impact of the Proposed Scheme on the receiving groundwaters (High sensitivity) would be of Negligible magnitude, with the associated significance being Slight Beneficial.

Groundwater pollution from routine runoff (LTS)

12.7.31. A broad range of potential pollutants, such as hydrocarbons i.e. fuel and lubricants, fuel additives, metal from corrosion of vehicles, de-icer, and gritting material, can accumulate on road surfaces. These can subsequently be washed off the road during rainfall events, polluting the receiving water bodies.

12.7.32. Thirteen networks with groundwater discharges are proposed for the Proposed Scheme, all of which feature filter drains and carrier drains. An infiltration basin is proposed at the southern extent of the Scheme, just north of the outfall for Network 1. However, note that the superficial groundwater level is believed to the near the ground surface at this location.

12.7.33. DMRB Method C calculations have been carried out to assess the potential impact on groundwater.

12.7.34. The assessment of routine runoff impacts on groundwater occurs at the locations shown in Volume 4, Appendix 12.5 Spillage and Runoff Assessments.

12.7.35. The groundwater assessment results for the drainage networks have all been identified as a Medium Risk, primarily due to the shallow groundwater levels and lithology. However, it is considered that the assessment is likely to be overestimating the risk to groundwaters, due to several reasons. The traffic volumes are at the lower end of the Low Risk parameter class. All the networks predominantly discharge to surface water, hence only a small proportion of the runoff will discharge to groundwater.

12.7.36. It is also considered that operation of the Proposed Scheme would result in attenuation of surface runoff from the carriageway and provide treatment via SuDS (embedded mitigation) prior to the discharge of surface runoff back to the water environment and groundwater aquifers. Compared with the existing scenario, where there is no formal capture and treatment of surface runoff, the Proposed Scheme would represent a betterment with a beneficial effect on routine runoff.

12.7.37. In light of the embedded mitigation measures included in the drainage design, and the assessment that the scores overestimate the groundwater discharge, the residual impact of routine runoff on the superficial and bedrock aquifers (High

sensitivity) is of Minor Beneficial magnitude, with a significance of Slight Beneficial.

12.8. Mitigation

12.8.1. Additional mitigation for the Proposed Scheme are provided in Table 12.3 below.

Table 12.3 - Mitigation Measures

Mitigation Reference	Mitigation Measures
GSG1	• Creation and implementation of a Soil and Materials Management Plan (SMMP) which will detail the appropriate way to segregate and store materials on site such as the storage of stockpiles away from watercourses in designated locations, segregation of material and storage of any contaminated arisings in a lined skip/on an impermeable membrane, keeping storage periods as short as possible; when stripping, stockpiling or placing soil, do so in the driest condition possible and use tracked equipment where possible to reduce compaction, and soil re-use criteria and placement techniques. The risks posed by any soil contamination can be reduced by ensuring that made ground materials are maintained under hardstanding or, if appropriate, placed under a clean layer of subsoil and topsoil. This will be managed during construction under the Standards for Highways Works Series 600 2024 and the Sustainable reuse of soils BS ISO 18504 published in 2017 or BS ISO 15176: 2019. • Creation and implementation of a Surface Water Management Plan (SWMP) detailing control and treatment measures for excavation and surface water runoff. • Implementation of a Dewatering Management Plan (DMP) would be required for any dewatering activities being carried out. This document would outline how to remove excess water from the construction site and minimise environmental impacts, enabling groundwater recharge whilst taking account of local slope stability. Any dewatering activities will be compliant with industry standards and best practice and the PMP. Working areas are to be kept to a minimum for construction of the project to reduce habitat loss. • Review and verification of private water supply information to ensure source types, locations and related assets are confirmed pre- construction.
GSG2	Further ground investigations and groundwater monitoring to refine the estimation of groundwater drawdown and radii of influence. This data will also be required to assess the groundwater volumes seeping into the cuttings, including the LTS catch pit, which will inform the cutting drainage design. Due to potential slope instability, it is envisaged that any groundwater collected shall be transferred to the surface water drainage system. If further GI data suggests groundwater seepage into the cuttings is likely to be substantial then groundwater cut-off walls may be required. The road drainage and cut-off drainage elements will discharge to watercourses.
GSG2	Linked with GSG2, data with relevance to M10 habitats shall be reviewed against previous findings to verify the assessment outcome. On the basis that uncertainty remains, groundwater level and water quality monitoring shall be undertaken in accordance with SEPA LUPS- GU31 guidance, including locations both upslope and downslope of the Proposed Scheme covering the period preceding construction until post-construction, across a number of seasons. Ecological monitoring would be undertaken in parallel for any change to community in comparison to baseline. This data shall be used to update and refine the M10 habitat assessment. Should outcomes emerge that indicate these habitats are subject to a residual effect greater than current assessment, proportionate design measures shall be considered in latter design stages. These could include sub-surface cross-drains, to enable shallow groundwater pathways to continue supply to downslope habitats. This approach will ensure any effect upon GWDTE, based on emerging information, does not exceed slight adverse significance. SEPA shall be consulted at all above stages.

12.9. Residual Effects

12.9.1. Table 12.4, Table 12.5, Table 12.6 and Table 12.7 present the impact assessment and residual effects of the OMR improvements and the LTS during both the construction and operational (permanent) periods.

12.9.2. The assessment undertaken has demonstrated that with the implementation of embedded and additional mitigation that effects can be mitigated to non-significant levels during both the construction and operation of the Proposed Scheme.

Table 12.4 - Construction phase impact assessment (OMR Improvements)

Impact	Pre-Mitigation Effect Magnitude	Pre-Mitigation Effect Significance	Mitigation Measures	Post-Mitigation Effect Magnitude	Post-Mitigation Effect Significance
Peat and soils	Minor	Slight Adverse	GSG1, GSG2 Further GI will reduce uncertainties in the presence of peat and will help to inform the CEMP, PMP, SMMP and any dewatering activities, and will help design the scheme to meet the mitigation hierarchy in relation peat soils.	Minor	Slight Adverse

Impact	Pre-Mitigation Effect Magnitude	Pre-Mitigation Effect Significance	Mitigation Measures	Post-Mitigation Effect Magnitude	Post-Mitigation Effect Significance
Loss or changes to GWDTE	Negligible	Slight Adverse	GSG3 Review of GI groundwater data, potentially GWDTE monitoring or sub-surface drainage measures.	Negligible	Slight Adverse
Direct loss or changes to groundwater aquifers and groundwater dependant features	Negligible	Slight Adverse	GSG1, GSG2, GSG3 Additional GI will inform groundwater conditions and the CEMP will provide methods of work to protect groundwater and GWDTE.	Negligible	Slight Adverse

Impact	Pre-Mitigation Effect Magnitude	Pre-Mitigation Effect Significance	Mitigation Measures	Post-Mitigation Effect Magnitude	Post-Mitigation Effect Significance
Groundwater pollution from construction	Minor	Slight Adverse	GSG1 CEMP, SMMP, SWMP and DWP will provide methods of work to protect groundwater and GWDTE from potential pollution during the construction phase.	Minor	Slight Adverse

Table 12.5 - Operational phase impact assessment (OMR Improvements)

Impact	Pre-Mitigation Effect Magnitude	Pre-Mitigation Effect Significance	Mitigation Measures	Post-Mitigation Effect Magnitude	Post-Mitigation Effect Significance
Loss or changes to GWDTE	Negligible	Slight Adverse	GSG3 Review of GI groundwater data, potentially GWDTE monitoring or sub-surface drainage measures.	Negligible	Slight Adverse
Direct loss or changes to groundwater aquifers and groundwater dependant features	Negligible	Slight Adverse	Embedded mitigation in design to prevent direct loss or changes to groundwater, no additional mitigation measures required.	Negligible	Slight Adverse
Groundwater pollution from accidental spillages	No Change	Neutral	Embedded mitigation in design to prevent groundwater pollution, no additional mitigation measures required.	No Change	Neutral

Impact	Pre-Mitigation Effect Magnitude	Pre-Mitigation Effect Significance	Mitigation Measures	Post-Mitigation Effect Magnitude	Post-Mitigation Effect Significance
Groundwater pollution from routine runoff	No Change	Neutral	Embedded mitigation in design to prevent groundwater pollution, no additional mitigation measures required.	No Change	Neutral

Table 12.6 - Construction phase impact assessment (LTS)

Impact	Pre-Mitigation Effect Magnitude	Pre-Mitigation Effect Significance	Mitigation Measures	Post-Mitigation Effect Magnitude	Post-Mitigation Effect Significance
Peat and soils	Minor	Slight Adverse	GSG1, GSG2 Further GI will reduce uncertainties in the presence of peat and will help to inform the CEMP, PMP, SMMP and any dewatering activities, and will help design the scheme to meet the mitigation hierarchy in relation peat soils.	Minor	Slight Adverse
Loss or changes to GWDTE	Minor	Slight Adverse	GSG3 Review of GI groundwater data, potentially GWDTE monitoring or sub-surface drainage measures.	Minor	Slight Adverse

Impact	Pre-Mitigation Effect Magnitude	Pre-Mitigation Effect Significance	Mitigation Measures	Post-Mitigation Effect Magnitude	Post-Mitigation Effect Significance
Direct loss or changes to groundwater aquifers and groundwater dependant features	Negligible	Slight Adverse	GSG1, GSG2, GSG3 Additional GI will inform groundwater conditions and the CEMP will provide methods of work to protect groundwater and GWDTE.	Negligible	Slight Adverse
Groundwater pollution from construction	Minor	Slight Adverse	GSG1 CEMP, SMMP, SWMP and DWP will provide methods of work to protect groundwater and GWDTE from potential pollution during the construction phase.	Minor	Slight Adverse

Table 12.7 - Operational phase impact assessment (LTS)

Impact	Pre-Mitigation Effect Magnitude	Pre-Mitigation Effect Significance	Mitigation Measures	Post-Mitigation Effect Magnitude	Post-Mitigation Effect Significance
Loss or changes to GWDTE	Minor	Slight Adverse	GSG3 Review of GI groundwater data, potentially GWDTE monitoring or sub-surface drainage measures.	Minor	Slight Adverse
Direct loss or changes to groundwater aquifers and groundwater dependant features	Negligible	Slight Adverse	Embedded mitigation in design to prevent direct loss or changes to groundwater, no additional mitigation measures required.	Negligible	Slight Adverse

Impact	Pre-Mitigation Effect Magnitude	Pre-Mitigation Effect Significance	Mitigation Measures	Post-Mitigation Effect Magnitude	Post-Mitigation Effect Significance
Groundwater pollution from accidental spillages	Negligible	Slight Beneficial	Embedded mitigation in design to prevent groundwater pollution, no additional mitigation measures required.	Negligible	Slight Beneficial
Groundwater pollution from routine runoff	Minor	Slight Beneficial	Embedded mitigation in design to prevent groundwater pollution, no additional mitigation measures required.	Minor	Slight Beneficial

Compliance with Planning Policy

12.9.3. The assessment is considered to be in compliance with National Planning Framework 4, specifically in relation to Policy 5 (Soils, including peat) and Policy 22 (Flood Risk and Water Management).This is also considered to comply with SEPA's Groundwater Protection Policy for Scotland, applying a proportionate and risk-based approach to assess and protect GWDTE.