6 LAND USE, GEOLOGY AND SOILS IN THE EXISTING ENVIRONMENT

This Chapter of the EIAR presents available information on the land, soils and geology of the Study Area along and in the vicinity of the proposed Drainage Scheme.

This Chapter provides a baseline for land, soils and geology in the Study Area and assesses how the proposed Scheme may impact on the existing soil and geological environment and land during the construction and operation phase of the Scheme. The River Deel (Crossmolina) Drainage Scheme has an indefinite operational duration, therefore it is not considered necessary to assess the impacts of decommissioning.

The residual effects of the proposed development on land, soil and geology following mitigation are assessed and presented in this Chapter along with the relevant mitigation measures.

6.1 METHODOLOGY AND LIMITATIONS

This Chapter has been compiled in accordance with the following:

- The European Commission 'Guidance on the Preparation of the Environmental Impact Assessment Report (2017),
- The EPA Guidelines on the information to be contained in Environmental Impact Assessment Reports' (DRAFT August 2017)
- The EPA 'Advice Notes on Current Practice in the preparation of Environmental Impact Statements'
- The Institute of Geologists of Ireland 'Geology in Environmental Impact Statement – A Guide'.
- The Department of Housing's 'Guidelines for Planning Authorities and An Bord Pleanála on Carrying out Environmental Impact Assessment' (August 2018)
- National Road Authority (Now TII) 'Guideline on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes'

A desktop study was carried out in order to ascertain a comprehensive baseline for the Study Area and give a description of the existing environment. This information was then used to assess the potential impacts and significant effects that the proposed Drainage Scheme will have on land, geology and soils within the Study Area in accordance with the description of impacts set out in Chapter 1. It was then possible to propose practicable mitigation measures to ensure that any potential impacts identified will not have a significant effect on the environment during the construction and operational phase.

No significant difficulties were encountered in the compilation of this Chapter.

6.1.1 Published Material

The baseline study of the existing land, soil and geological environment throughout the proposed Study Area was prepared using the Geological Survey of Ireland's (GSI) online database and the GSI publication; 'Geology of North Mayo' (1992), along with additional source material. A comprehensive list is included below;

- The Geology of North Mayo (Long, MacDermot, Morris, Sleeman & Titezsch-Tyler, GSI, 1992)
- The GSI online database
- Mayo County Development Plan (2014-2020)

- Concrete Products Directory (Irish Concrete Federation)
- Aerial Photography
- General Soil Map of Ireland
- Explanatory Bulletin to Soil Map of Ireland 1980
- The Trophic Status of Lough Conn, An Investigation into the Causes of Recent Accelerated Eutrophication (Mayo County Council, 1993)
- ENVision Mines Site, the EPA's online Historic Mines Inventory
- General Soil Map of Ireland
- Explanatory Bulletin to Soil Map of Ireland 1980

A ground investigation contract was carried out which consisted of boreholes, rotary open hole drilling, rotary coring and trial pits spread throughout the Study Area. The recorded data was used to confirm and verify information obtained from the above sources.

6.1.2 Definitions

Land is introduced into the Environmental Impact Assessment Report as per the 2014 Directive as a prescribed factor addressing the issues of land take.

Environmental and agricultural scientists generally understand the word 'soil' to refer to the fertile, organic rich layer which occurs on the surface of the Earth and the underlying layers which interact with it in terms of nutrient, ion, water and heat exchange. Using this definition, the depth of the soil layer is typically 0.3m to 1.0m thick. Geologists and engineers, on the other hand, generally understand the word 'soil' to refer to all unconsolidated (non-lithified) organic and inorganic deposits which occur above bedrock.

For the purpose of this EIAR, the term 'soil' refers to the unconsolidated, organic rich material closest to the Earth's surface ('topsoil), while the term 'subsoil' (Quaternary Geology) is used to refer to all other unconsolidated (non-lithified) materials which occur above bedrock.

The Study Area referred to in this Chapter relates to the area within the Scheme temporary works boundary, as identified in Chapter 3, Figure 3.1.

6.2 'DO-NOTHING' SCENARIO

If the proposed Scheme were not to proceed, the land, soils and geology within the Study Area would be left as it is, and no changes would be made to the existing land use practices.

In implementing the 'Do nothing' alternative, the opportunity to mitigate against flooding up to the 1% AEP flood event would be lost and, during flood conditions, land within and in the vicinity of Crossmolina Town would continue to flood.

6.3 LAND

The assessment of land use generally considers land take or acquisition and changes in baseline land use. The CORINE (Co-ordinated Information on the Environment) data series was established by the European Community (EC) as a means of compiling geo-spatial environmental information in a standardised and comparable manner across the European continent. The land in the Study Area is classified as follows:

- Land spanning from the River Deel in Mullenmore to Lough Conn - Agricultural areas or Pastures principally occupied by agriculture. The footprint of the proposed diversion channel and washlands traverses agricultural lands of 22 landowners.

6.3.1 Agricultural Land

The national agricultural land area is 4,883,600 ha including commonage and rough grazing, including 4,088,000 ha of grassland, 280,400 ha of cereals and 71,100 ha of other crops, fruit and horticulture (Central Statistics Office, 2018). There are 137,500 farms in Ireland with an average farm size of 32.4 ha.

The total agricultural area of Co. Mayo is 278,997 ha and when commonage and rough grazing are excluded there is 235,505 ha grassland, 360 ha cereals and 231 ha of other crops, fruit and horticulture (Central Statistics Office, 2012). There are 12,458 farms with an average farm size of 22.4 ha.

6.3.1.1 Impact on Agricultural land

Permanent Slight Negative Impact

There will be a total permanent loss of approximately 8.58 ha of agricultural lands as a result of the proposed diversion channel. During flood conditions, an additional area of up to 23.7 ha of agricultural land will be flooded as a result of the new washlands created downstream of the diversion channel, dependent on levels in Lough Conn at the time of an overflow event. The agricultural land affected by the washlands will not be permanent land loss but temporarily unusable during a flood event. During the construction phase there will be an additional temporary loss of 6.74 ha of agricultural land to facilitate the temporary works areas as shown in Chapter 3, Figure 3.1.

22 landowners will lose a portion of their land as a result of the proposed diversion channel, washlands or both. 16 landowners will be directly affected by permanent land lost as a result of the diversion channel construction. 5 landowners will be affected by the new washlands created downstream of the Scheme and 1 landowner will be affected by both permanent land lost as a result of the diversion channel construction and the new washlands created downstream of the Scheme. A table showing the land lost for each landowner can be found in Appendix 6D.

Impacts on land use have been assessed in Chapter 11 (Material Assets). Where possible, impacts on agricultural land use during the construction and operational phases of the Scheme have been mitigated in the design of the Scheme. The route of the diversion channel has been chosen with regard to several factors including the goal to minimise the division of existing fields and land holdings where possible.

The Scheme when constructed will mitigate flood risk to Crossmolina Town, and as a consequence the agricultural lands along the river bank downstream will benefit from reduced flood risk as a result of the Scheme construction. Access to these lands via Crossmolina Town and other local access routes, which are presently cut off during flood events, will also improve as a result.

Based on this assessment, the impact of the proposed Scheme on land is imperceptible on a national and county level, however it constitutes a permanent slight negative impact on agricultural land in the Study Area due to the permanent loss of 8.58 ha of agricultural land during the operation phase of the Scheme.

6.4 GEOLOGY

6.4.1 Geomorphology

The topography, and spectacular scenery of North Mayo owes much to its geological structure. Metamorphic rocks date from 2 billion to 400 million years ago. Overlying sedimentary rocks were deposited 400 – 290 millions years ago. Igneous rocks intruded from 2 billion to 50 millions years ago. The quaternary sediments overlying these formations are mainly of glacial origin, varying in age from 1.6 million year to the present day. The catchment of the River Deel is bound to the South and Southwest by the ancient resistant Quartzites, Clasts, and Schists of the Nephin Beg range. To the West lie the dinantian limestones from the Downpatrick formation. The topography drops into the pure bedded limestones of the Ballina formation, and it is here where the karst features of the Deel catchment can be found.

At the peak of the last glaciation, 15,000 years ago, when much of Europe was covered in ice, sea levels fell to approximately 130m lower than present day. As a result, the rivers eroded down to the new base level cutting new steep sided gorges in places. When temperatures subsequently improved the ice sheets receded, sea levels rose and the gorges rapidly became infilled with fluvioglacial sand and gravels as the rivers responded again to the changing base level. The River Deel itself may originally have pursued more direct course to Lough Conn, in comparison to the long meandering course that it follows today through Crossmolina Town, Knockadangan, and Deel Castle, before joining the Lake at Wherrew. Potential historic routes are now partly obscured by glacial deposits. Glacial deposits between the River and the Lake in the townlands of Mullenmore are known to lie up to 20m thick in places.

6.4.2 Bedrock Geology

The River Deel raises at the foot of Birreencorragh Mountain in the Nephin Beg mountain range. The river flows northwards through the valley between the Birreencorragh and Bullaunmore mountains. It continues northwards until it intersects the R312 at which point the river turns eastwards. The river continues eastwards until it enters the Study Area at Moneymore and gradually turns northward to flow though Crossmolina town. Downstream of Crossmolina, the River Deel loops around to the East and South to discharge into Lough Conn just north of Wherrew. Its total length is approximately 63 km.

The Geology of North Mayo (Long, MacDermot, Morris, Sleeman & Titezsch-Tyler, GSI, 1992) and the 'Geological Survey of Ireland Online Database' (shown in Appendix 6A of this document) indicates that the Study Area is underlain by Limestone with Calcareous Shale. Marine Shelf facies present in the bedrock indicate oceanic influence during formation. The upper reaches of the River Deel are underlain by Carboniferous Slate Series, Calciferous Sandston Series and Lower Avonian Shales and Sandstones.

Limestone bedrock was encountered during the site investigation, which was carried out as part of the River Deel (Crossmolina) Drainage Scheme. Rockhead was encountered at depths ranging from 1.2m to 19.8m with varying numbers of voids encountered in the Study Area. The bedrock was typically highly weathered and fractured at upper levels becoming more competent with depth.

The area is also rich in old karst features such as dolines, caves, swallow holes, for example at Lough Agawna, and the various swallow holes along the River Deel itself, some of which can be seen in the vertical walls of the above mentioned gorges. Karst springs, the largest of which are located at Mullenmore, can also be found at Tobermore and Tobernagawna.

6.4.3 Geological Heritage

Geological heritage encompasses the earth science component of nature conservation including both bedrock and unconsolidated (soil) deposits close to the surface and processes (past and present) that shaped the land surface. The identification of geological heritage is achieved by finding sites or areas that best demonstrate particular types of geology, processes or phenomena that rank as noteworthy. A site selection process is currently being undertaken by the Geological Survey of Ireland (GSI), through the Irish Geological Heritage (IGH) Programme.

The IGH programme is a partnership between GSI and the National Parks and Wildlife Service (NPWS) and aims to identify, document the wealth of geological heritage, and protect and conserve it against threats through local authority planning and promote its value with landowners and the public. The primary national site designation for geological heritage (and nature conservation in general) is the Natural Heritage Area (NHA) designation. Designation of national sites is the responsibility of the National Parks and Wildlife Service (NPWS), working in partnership with the IGH programme. The second tier designation is that of County Geological Site (CGS). While a County Geological Site is not statutorily protected, the designation is intended to provide recognition for the site and protection through inclusion within the County/ City Development Plan Policy and Objectives.

The Mayo County Development Plan (2014-2020) states that "It is an objective of the Council to protect, enhance and conserve candidate Special Areas of Conservation, Special Protection Areas, Natural Heritage Areas and proposed National Heritage Areas, Statutory Nature Reserves, Ramsar Sites and Biogenetic Reserves, including those listed in the Environmental Report documenting the Strategic Environmental Assessment of this plan and any modifications or any additional areas that may be so designated during the lifetime of the plan".

The County Development Plan identifies 15 National Heritage Areas (NHAs) and 48 proposed Natural Heritage Areas (pNHAs). No sites that have been identified for Geological Heritage are located within or in proximity to the study area.

As noted above, the study area is rich in karst features, many of which have gone undocumented prior to the commissioning of the hydrogeological assessment associated with this Scheme.

6.4.4 Economic Geology

The term 'economic geology' refers to commercial activities involving soil and bedrock. The activities involved principally comprise aggregate extraction (sand and gravel pits and quarries) and mining. A number of sources were examined for information on such commercial activities within the Study Area, including:

- Mayo County Council Planning Department (Application for Registration of Quarries under Section 261, Planning and Development Act 2000)
- Mayo County Development Plan (2014-2020)
- Concrete Products Directory (Irish Concrete Federation)
- Aerial Photographs (2005)
- ENVision Mines Site, the EPA's online Historic Mines Inventory

The sources consulted above indicate that there are no active quarries within the Study Area. The nearest active quarries are presented in Table 6.1:

Location	Status	Operators
Coolturk, Crossmolina. 8km outside Study Area	Active	Coolturk Quarries
Mullafarry, Killlala. 13 km outside Study Area	Active	Mullafarry Quarry LTD

Table 6.1 Quarries in the vicinity of the Study Area

The locations of these quarries are shown on Drawing SG001 in Appendix 6B.

As the abovementioned quarries are outside the Study Area, it is not envisaged that there will be any direct impact on these facilities from the proposed Drainage Scheme.

Excavated material will be reused on site where possible classified as a construction by-product in the context of Article 27 of the European Communities (Waste Directive) Regulations. Surplus excavated material will be transported off site by a licensed haulier to an authorised disposal or recovery facility and in compliance with all the mitigation measures within the EIAR. Where feasible, material will be removed from site and transported to the closest suitably licenced facility to be processed and used on other construction projects in the vicinity. Any contaminated material will be transported to an approved waste facility for treatment and safe disposal.

Potential quarries for disposal and as sources of material are discussed below.

Coolturk quarry has been identified as a potential disposal site for excavated material from the proposed channel (subject to approval). Both Coolturk and Mullafarry quarries are potential sources for imported granular material during the construction contract.

6.4.5 Geohazards

Upon consultation with the National Landslide Database for Ireland (Landslides Working Group) and Mayo County Council it was found that the closest recorded landslides is 9.9km from the Study Area. A summary of the recorded landslide events in the vicinity of the proposed Scheme are provided in table 6.2. There are no known geohazards within the Study Area.

Location	Event Name	Event Date	Distance to Proposed Scheme
Cuilmullagh Near Bofeenaun, Near Lough Conn, Mayo. Outside Study Area	Cuilmullagh	-	~9.9 km
Shanettra, Ballycastle, Ballina. Outside Study Area.	Shanettra_2000	2000	~13.76 km
Cluddaun, Ballycastle, Ballina. Outside Study Area	Cluddaun	-	~13.90 km
Cludage, Ballycastle, Ballina. Outside Study Area	Cludagh	-	~14.71 km
Briska – Largan, Co. Mayo. (Closure of N59). Outside Study Area	-	12th July 1997	~23.9 km

Table 6.2 Landslide events in the vicinity of the Study Area

6.4.6 Quaternary Geology (Subsoil)

The Quaternary Period extended from the beginning of the Ice Age to the present day and is the final one of geological time scale. Almost all surface deposits were deposited during the Quaternary Period either directly by glacier ice or by glacial meltwater. As the ice flowed over the underlying rock surface, pieces of protruding and loose rock became attached to its base. As these were carried along they both abraded the underlying rock and were ground down themselves. The rock that was picked up by the ice and partly ground down was later deposited either directly from the base or margin of the ice, or by meltwater flowing from the ice. In the former case it became Till and in the latter case it was separated out and deposited as gravel, sand, silt or clay. The composition of these sediments reflects the type of rock or substrate over which the ice flowed. Ice movements in North Mayo are one of the most complex in Ireland.

Subsoils deposited since the end of the last glaciation are typically referred to as 'recent deposits'. The most widespread recent deposits in Ireland is peat, which occurs both as upland blanket peat and lowland raised bog.

The 'Geological Survey of Ireland Online Database; (Extract from GSI Database presented in Appendix 6C) and the site investigation indicate that the Study Area comprises the following subsoils

- Made ground
- Peat
- Fluovioglacial deposits
- Alluvium
- Glacial Till
- Glaciofluvial Sands and Gravels

6.4.6.1 Made Ground

Made Ground is defined as material, including soil, which has been deposited on land and/or altered by anthropogenic (human) activity. Available data suggests that Made Ground is found throughout the Study Area and in many cases is typically brownish grey sandy gravelly clay with low to medium cobble content. The route of the diversion channels is largely made up natural soils but made ground was encountered during the site investigation in areas where the proposed diversion channel crosses the R315, Lake Road and access roads south of the Lake Road.

The key risk associated with made ground is its uncertain age and potential to harbour contamination. However, no evidence of historical activities which could potentially have contributed to soil contamination were identified along or in the vicinity of the proposed Scheme.

6.4.6.2 Peat

Peat is defined as soil with more than 50% organic carbon (calculated from the loss on ignition). The site investigation indicates that localised deposits of Peat are present in the Study Area, encountered at depths of up to 5 metres. It is likely therefore that the proposed Scheme may impact on Peat in the area.

6.4.6.3 Fluvioglacial Deposits

The site investigation indicates that Fluvioglacial deposits, typically medium dense sands and gravels with localised pockets of firm sandy gravelly clays interspersed throughout are present in the Study Area. It is likely therefore that the proposed Scheme may impact on Fluvioglacial Deposits in the area.

6.4.6.4 Alluvium

Alluvium is a young sediment that was recently eroded and carried off the hill side by a surface watercourse. It is ground into finer and finer grains each time it moves downstream, a process that can take thousands of years.

Alluvium soils are typically found at or in the vicinity of a surface watercourse and as such, a large stretch of the River Deel downstream of Crossmolina Town is situated within Alluvium subsoils. As these subsoils were not encountered as part of the site investigation, it is unlikely that the proposed Scheme will have any impact on Alluvium in the area.

6.4.6.5 Glacial Till

Glacial till is a generic term which applies to glacially derived and/or transported soil which is deposited beneath or on the margins of a glacier or ice sheet. The Teagasc subsoil map, as presented on the Geological Survey of Ireland Online Database. The Glacial Till encountered in the Study Area during the Site Investigation was described as gravelly clay and silt, occasionally with organic components, frequently with low to high cobble and boulder content.

It is likely certain that the proposed Scheme may impact on Glacial Till in the area.

6.4.6.6 Glaciofluvial Sands and Gravels

According to the Teagasc Subsoil Mapping there is an area of Sands and Gravels to the west of Crossmolina Town, spanning north and south of the River Deel. These Sands and Gravels are interpreted to be of glaciofluvial origin, deposited by glacial meltwater at the end of the last glaciation as the ice sheets retreated and formed outwash kame and terrace landforms. The site investigation confirms the presence of sands and gravels within the Study Area.

As Glaciofluvial Sands and Gravels are located in the immediate vicinity of the proposed Scheme it is certain that the proposed works will have an impact on Glaciofluvial Sands and Gravels.

6.4.7 Potential Impacts on Geology

The key significant effects associated with the construction phase of the River Deel (Crossmolina) flood Relief Scheme are the excavation, handling, storage, processing and transport of earthworks materials. The estimated volume of excavation anticipated during the construction phase is presented on Table 6.3.

Origin of Excavation	Volume of Material
Diversion channel, bridge and retaining wall foundations energy dissipation structure and intake structure	166,400 m^3

Table 6.3 Volumes of Excavated Material

There are a number of potentially negative environmental impacts associated with the handling of excavated materials. These impacts can arise directly as a result of on-site excavation and construction activities or indirectly, due to placement of excess unsuitable materials at off-site locations.

Limited geotechnical ground truthing comprising minor site investigation works and archaeological test trenches will be carried out on commencement of the construction stage of the Scheme, the effect of which is predicted to be imperceptible and as such has not been assessed below.

6.4.7.1 Loss of Bedrock

Potential Permanent Not Significant Negative Impact

The vast majority of the Study Area, and the entire area covered by the proposed works, are underlain by Limestone with Calcareous Shale, as described above in Section 6.4.2. The majority of excavation required will comprise excavating for the diversion channel. Although this excavated material will be reused where possible, a significant volume of excavated material will be removed from the proposed Scheme. Based on the available geotechnical data, it is considered unlikely that significant quantities of bedrock will be encountered, even at the excavation depths envisaged.

As the type of bedrock that will be excavated is abundant throughout the Study Area the portion to be removed will not be significant in comparison to the volumes retained and as such will not have a significant effect on the bedrock of the Study Area. There will be no additional impact during the operation phase of the Scheme.

Mitigation Measures

Where it is necessary to remove bedrock to facilitate construction of the proposed Scheme, suitable material will be reused elsewhere where possible. Material removed from site will be transported to the closest suitably licensed facility to be processed and used on other construction projects in the vicinity, where possible.

Residual Effect – Permanent Imperceptible Negative Impact

With the mitigation in place, the loss of bedrock as a result of the Scheme will be minimised, this impact will constitute a Permanent Imperceptible Negative Impact.

6.4.7.2 Loss of Geological Heritage

Potential Neutral Impact

There are no sites in the vicinity of the proposed works of sufficient geological or geomorphological importance on a national or county scale to merit consideration for designation as a Natural Heritage Area (NHA). Due to possible exposure of bedrock as a result of proposed excavation works it is just as likely that the effect will be positive as negative.

As noted above, the study area is rich in karst features, many of which have gone undocumented prior to the commissioning of the hydrogeological assessment associated with this Scheme. An assessment of the extent of karstification and the location of karst features was carried out and is presented in Appendix 7A. Based on the geotechnical information available, it is unlikely that karstified bedrock will be encountered during the construction of the Scheme. Should there be exposure of new geological surfaces, especially in bedrock, it may serve to facilitate greater understanding and appreciation of local geological heritage and earth science. There will be no additional impact during the operation phase of the Scheme.

6.4.7.3 Loss of Quaternary Geology

Potential Permanent Slight Negative Impact

As described in Section 6.4.6, the Study Area is predominantly underlain by fluvioglacial deposits, glacial till, made ground, and peat. The effect of the removal of excavated material from the proposed works will be minimal as these subsoils are in abundance throughout the Study Area, and the county as a whole.

A small portion of the proposed flood defence measures are underlain by made ground and therefore there is a risk that contaminated material may be encountered. No evidence of historic activities which could potentially have contributed to soil contamination were identified in the immediate vicinity of the proposed Scheme. Although the key risk with Made Ground is its uncertain origin and potential to contain contaminated material, on the basis of available evidence and taking into consideration the small volume of made ground to be excavated, the potential effect is regarded as being slight negative. There will be no additional impact during the operation phase of the Scheme.

Mitigation Measures

Excavated subsoils will be reused as fill where possible. Any remaining volumes of surplus materials will be transported to the closest suitably licensed facility to be processed and reused in other construction projects in the vicinity, where possible. Where reuse is not possible, material will be transported to an approved waste facility for safe disposal.

Residual Impact – Permanent Imperceptible Negative Impact

With the mitigation in place, the loss of quaternary geology will be minimised. This impact will constitute a residual Permanent Imperceptible Negative Impact.

6.5 SOILS

Soil is the top layer of the earth's crust. It is formed by mineral particles, organic matter, water, air and living organisms. It is an extremely complex, variable and living medium and its characteristics are a function of parent subsoil or bedrock materials, climate, relief and the actions of living organisms over time.

Soil can take thousands of years to evolve and is essentially a non-renewable resource. Soil performs many vital functions. It supports food and other biomass production (for example forestry and biofuels) by providing anchorage for vegetation and storing water and nutrients long enough for plant to absorb them. Soil also stores, filters and transforms other substances including carbon and nitrogen. It has a role supporting habitats and serves as a platform for human activity, landscape and archaeology.

6.5.1 Soil Formation

There are three principal soil formation processes that take place in Ireland, leaching, gleisation and calcification.

Through the *leaching* process, soluble constituents are carried down through the soil profile, the soil becomes progressively more acidic until relatively insoluble constitutes such as iron, aluminium and humus are washed deeper into the soil. Organic matter may accumulate on the surface and an iron pan may be formed at a lower level in the soil. At this point the leaching process may be referred to as podzolisation.

Gleisation is the soil-forming process resulting from the water-logging, possibly due to high water tables, or the impermeable nature of the soil itself. The movement of water through the soil is highly restricted and as a result leaching is very limited. Due to anaerobic conditions many soil constituents are converted by chemical processes into reduced forms. The soil usually takes a grey or blue colour as a result of the reoxidation processes.

Calcification is a process resulting in the redistribution of calcium carbonate in the soil profile without complete removal of it. Regions where rainfall is typically 750mm or less are affected by this process. Since the rainfall is low, the percolation of water through the profile is not sufficient to completely remove the calcium carbonate that existed in the parent material or that was produced by reaction between carbonic acid and the calcium hydrolysed from silicate minerals. Accumulation of carbonates at some point in the profile is typical of calcification. Calcium also tends to keep fine clay in a granular condition resulting in very little downward clay movement.

Due to the climate in Ireland, Leaching and Gleisation are the two most common soil formation processes.

6.5.2 Soil Associations

The General Soil Map of Ireland classifies the Study Area as flat to undulating lowland. These lands generally have a slope of less than 3° and have an elevation below 100m. The Study Area comprises principally Degraded Grey Brown Podzolics (50%). Associated soil classifications are defined as Peat (15%), Brown Earth (5%), Gleys (10%) and Podzols (10%). These soils are mainly derived from Limestone glacial till. Made Ground from the surface was recorded in a number of locations as part of the site investigation studies.

Grey Brown Podzolic soils have been formed from a calcareous patent material, which counteracts the effects of leaching. The lighter textured Grey Brown Podzolicas are good all-purpose soils. Heavier textured Grey Brown Podzolicas are highly suited to pasture production.

Peat is classified as having a high organic matter (>30%) and a minimum depth of 30cm. Two different types occur in Ireland; blanket and basin peat. Blanket peat occurs under conditions of high rainfall and high humidity while basin peats are formed in river valleys, lake basins, hollows or in areas where the subsoil is sufficiently impermeable resulting in a high watertable.

Brown Earths are relatively mature, well drained, mineral soil with a relatively uniform profile. These soils have not been extensively leached with the result that there are no obvious signs of removal and deposition of iron oxides, humus or clays. In many cases a certain degree of leaching has taken place resulting in the translocation of soluble constituents, notably calcium and magnesium. The majority of Brown Earths result from lime deficient parent minerals and are therefore acidic in nature. The desirable structure and drainage characteristics results in these soils being the most extensively cultivated soils, making up for a relatively low nutrient status by responding well to manorial amendments.

Gleys are soils in which the effects of poor drainage dominate and which have developed under the influence of waterlogging, characterised by the Gleisation process described above. Most gleys have poor physical conditions which make them unsuitable for cultivation or for intensive grassland farming. Their productive capacity is also affected by restricted growth in spring and autumn.

Podzols are acidic and have been depleted of nutrients due to leaching. Podzols are generally poor soils and have high fertiliser and lime requirements. They are generally formed in mountain areas where means of reclamation and cultivation are not feasible.

6.5.3 Potential Impacts on Soil

6.5.3.1 Loss of Soil

Potential Permanent Not Significant Negative Impact

As the proposed Scheme traverses agricultural land, and soil was encountered in the site investigation, it is likely that the Scheme will have an effect on the soil in the area.

Any loss of soil, or other potential impacts will be during the construction phase and likely to be associated with excavation, handling, storage, processing and transport of earthworks materials associated with the diversion channel. Where soils are disturbed, excavated and/or stored for re-use during construction, they are prone to erosion by surface water run-off. In-situ soils may be compacted by construction machinery, reducing their ability to store water, which in turn may lead to increased run-off and soil erosion. Soil erosion has the potential to decrease soil fertility, while also leading to an increase in sediment in surface water bodies.

As any soils underlying the proposed works are abundant on a local and regional scale, they are of relatively low environmental and/or ecological value. The volume of soils encountered throughout the construction phase will be also be relatively small in comparison to the volume of excavated material generated. This constitutes a potential permanent not significant negative impact. There will be no additional impact during the operation phase of the Scheme.

Mitigation Measures

Any excavated topsoil will be stored on site and used to reinstate the channel. All storage will be undertaken within the identified temporary works area. The temporary works area is shown in Chapter 3, Figure 3.1. The amount stored at any time will be minimised by completing the channel on a sectional basis with each section being completed before proceeding to the next as set out in Chapter 3, Section 3.4. Topsoil storage areas will be defined and fenced off with silt fencing to prevent run off. In order to control the potential loss of soils as a result of erosion due to surface water run-off, a surface water management system will be put in place. As well as minimising soil erosion, a surface water management system will also minimise the volume of suspended solids transported by surface water run-off and discharged into local watercourses. The following measures will form part of the surface water management system and the contractor will be obliged to implement them during the construction phase:

- Vegetation and soil will be left in place for as long as possible prior to excavation and stockpiling of soil to be minimised during wet weather periods.
- Soil stockpiles will be shaped so as to shed water.
- Surface water run-off from exposed soil surface will be intercepted and redirected to the silt management areas as shown on the Construction Sequence Drawings (Appendix 3B).
- Granular materials will be placed over bare soil, particularly in the vicinity of watercourses, to prevent erosion of fines and/or rutting by construction machinery.

Residual Impact – Neutral Impact

Taking into account that any excavated topsoil will be used to reinstate the diversion channel, in conjunction with the mitigation measures as outlined above, soil loss will be mitigated and the residual effect of the proposed Scheme on soil will be insignificant. This impact will constitute a Neutral Impact.

6.5.3.2 Contaminated Land

Potential Short Term Moderate Negative Impact

Potential effects may result from the improper management, storage and handling of fuels and lubricants for plant and machinery and of non-hazardous or hazardous liquid and solid wastes during the construction phase of the proposed Scheme. Localised contamination of soils could result from an accident, spill or leak.

The site investigation carried out to date indicates the presence of made ground, which may contain construction debris. It is possible that hazardous materials may be encountered during construction works at this location or during excavation of the R315, L1105 or Lake Road for example.

In addition, three strands of Japanese Knotweed *Fallopia japonica* have been identified in the footprint of the proposed Scheme as discussed in Chapter 5, Section 5.4. Failure to implement appropriate management of soil contaminated with Japanese Knotweed during the construction phase of the Scheme could result in the spread and regrowth of the species in other areas.

There will be no additional impact during the operation phase of the Scheme.

Mitigation Measures

In order to reduce the risk of soil contamination as a result of accidents spill or leaks, and water contamination from on site soil and material storage, the following measures will be implemented;

- Fuels, chemicals, liquids and solid wastes will be stored on impermeable surfaces. Fuels stored on site will be minimised. Plant refuelling shall be undertaken using a jeep mounted bowser to minimise storage of fuel on site. Small quantities of chemicals and petrol required for tools shall be stored with drip trays in a vented fuel store in the temporary works compound
- Plant refuelling shall be undertaken on impermeable surfaces within a suitably constructed bund in accordance with best practice guidelines. No refuelling will be permitted in or near soil or rock cuttings. Only designated trained operatives will be authorised to refuel plant on-site
- Plant shall be inspected regularly for any leaks
- Storage of fuel and oil will be regularly inspected for leaks or signs of damage
- A lock system will be fitted on all taps, nozzles or valves associated with refuelling equipment
- All hydrocarbons and other potential contaminants will be stored within suitably constructed bunds in accordance with best practice guidelines. The bunds will be sized to hold 110% of the volume of the stored contaminants in order to contain a spill should it occur. The base and walls of the bund shall be impermeable to water and oil
- Spill kits will be provided at refuelling areas and at high risk/sensitive sites
- Large volumes of excavated material will not be allowed to accumulate within the temporary working areas. Any stockpiling of soils will be greater than 10 metres away from any surface waters, and runoff will be prevented by the use of a silt fence
- There will be no storage of materials, machinery or soil in areas that are susceptible to flooding

- Where contaminated soil is encountered, the ECoW will assess the extent of contamination and will supervise any operations involving contaminated soil. Any contaminated soil will be transported to an approved waste facility for treatment and safe disposal.
- An emergency response plan to deal with accidental spillages is contained within the Outline Construction Environmental Management Plan (Appendix 3C). This will include providing toolbox talks regarding the appropriate use of spill kits and best practice for the management of accidental spills.

All Japanese Knotweed within and surrounding the site of the proposed works will be subject to the Invasive Species Management Plan (Chapter 5, Section 5.5.6.5). The following measures will be implemented in order to mitigate against the risk of moving soil contaminated with Japanese Knotweed;

- A pre-construction invasive species survey will be undertaken at the site of the proposed Scheme
- In advance of any works being carried out on the site of the proposed Drainage Scheme, any invasive species that occur within the identified works area will be subject to treatment with a non-persistent glyphosate herbicide. This will be undertaken at the end of the growing season (late August – September) and the method of application and chemical formulation will be agreed with all relevant stakeholders prior to application and treatment. Some of the stands are currently being treated in advance of any works. It is intended that these advance works will weaken the plant in advance of the construction works
- Treatment will be undertaken from hand held sprayers and will avoid the potential for spray drift into other areas.
- In all areas where Japanese Knotweed has been identified within the footprint of the proposed works (including areas within 7 metres of recorded stems) will be fenced off and included within the Knotweed Management Plan.
- Knotweed and contaminated soil will be excavated from its current location and removed to a containment bund within the works area for ongoing treatment. The location of this bund is shown in Chapter 5, Figure 5.8.
- The loading of each truck will be undertaken on a surface that can be easily cleaned (such as a radon barrier) and will be inspected by a suitably qualified ecologist and if necessary, brushed down before departure to ensure that there is no knotweed present on the outside of it.
- The excavation will be overseen by a suitably qualified ecologist and will involve the excavation of the Knotweed and associated rhizomes. The ecologist will inspect the excavated area following removal and will determine whether all rhizomes have been removed. Once satisfied, the sites will be declared free from Knotweed.
- All excavation machinery will be thoroughly cleaned and disinfected prior to leaving the section of the proposed works that is subject to the Knotweed Management Plan.
- Following completion of the construction and reinstatement, the site will be sown with grass seed mix and allowed to quickly re-vegetate.
- Follow up surveys will be undertaken for at least three years following the construction to ensure that these small stands are completely eradicated.

Residual Impact –Short Term Slight Negative Impact

The implementation of the above measures will mitigate the risk of contamination as a result of fuels and chemicals associated with construction. The residual impact of contaminated land as a result of the proposed Scheme is considered to be a Short Term Slight Negative Impact.

6.6 CUMULATIVE AND IN-COMBINATION IMPACT ASSESSMENT

6.6.1 Cumulative Impact Assessment

All elements of the proposed Scheme were assessed in order to identify any cumulative effects.

The movement and removal of soils, overburden and rock during the construction phase of the proposed Scheme has the potential to give rise to impact on water quality. The excavation of the diversion channel, roads and other works areas has the potential to intercept larger volumes of drainage water that will require management. The EIAR chapters and the Outline Construction Environmental Management Plan provide robust information on how to avoid such effects.

The movement and removal of soils, overburden and rock during the construction phase has the potential to give rise to noise and dust impacts. However, these effects and the measures that are in place to avoid any cumulative or interactive effects are fully described in this EIAR.

Based on the assessment of all elements of the proposed Scheme, no significant cumulative effects are anticipated.

It is considered that the design of the proposed River Deel (Crossmolina) Drainage Scheme, the scale of the works and the implementation of effective mitigation and best practice will ensure that the proposed Scheme, when considered on its own, will minimise as much as possible significant effects on land, soils and geology. Overall, the reduced risk of flooding will have a positive effect on land in the Crossmolina area.

6.6.2 In-Combination Impact Assessment

A search in relation to plans and projects that may have the potential to result in a cumulative in-combination effects on the environment was carried out as part of the EIAR. The proposed Scheme has been considered, in combination with plans and the projects set out in Chapter 2, Sections 2.8 of the EIAR. In addition, the following data sources were assessed:

- Mayo County Council Development Plan 2014-2020
- Relevant Local Area Plans
- Western River Basin Management Plan
- An Bord Pleanála Website (Planning Searches)
- Myplan.ie
- Web search for major infrastructure projects in North Mayo

Mayo County Development plan 2014-2020 was consulted to identify developments which could cause cumulative impacts with the proposed project.

Bord Na Mona peat extraction in the Shanvolahan sub-catchment ceased in 2003 and a bog rehabilitation plan has been implemented to significantly reduce suspended sediment loss since its establishment. With mitigation measure in place, the proposed Scheme in combination with the bog rehabilitation plan will not result in significant cumulative effects on lands, soils and geology.

There is Coillte owned coniferous forestry in the upstream catchments of the Deel River. This area belongs to the Coillte Business Area Unit (BAU) 1NorthWest. Forests in the upstream catchments are:

- Tristia, 1,442 hectares
- Shannettra, 3,140 hectares

Forest operations are required to be conducted in line with the Forest Service's Code of Best Forest Practice which includes a series of Requirements, Guidelines and Notes. The Service aims to maintain and appropriately enhance the protective functions of forest management (including soil). Forest practice is designed in ensure it is associated with a healthy environment and the need for improved water and soil quality. With mitigation measure in place, the proposed Scheme in combination with the forest operations will not result in significant cumulative effects on lands, soils and geology.

Following a detailed assessment of the receiving environment, the potential for any further impact when considered in combination with any or all of the above plans and projects, was found to have no potential for significant in-combination cumulative effects on land, soils and geology.