4 ENGINEERING ASSESSMENT

4.1 Engineering Standards – Proposed Departures and Relaxations

4.1.1 Mainline Standards

The design of the new mainline route is based around Category 6 criteria as outlined in 'Highway Link Design' (DMRB Volume 6, Section 1, TD 9/93) which is essentially a rural D2AP with grade separated junctions and no gaps in the central reserve. The proposed geometry can be achieved within the standards set out in this document for a Design Speed of 120kph (Band B).

The geometric design criteria to achieve desirable minimum standards for the mainline is as follows (one step below desirable minimum is shown in brackets):

Design Speed	:	120B kph (100B kph)
Stopping Sight Distance	:	295m (215m)
Desirable Minimum Radius (5% superelevation)	:	1020m (720m)
Desirable Minimum Crest K	:	182 (100)
Absolute Minimum Sag K	:	37
Desirable Maximum Gradient	:	4%
Absolute Maximum Gradient	:	8%
Minimum Gradient	:	0.5%
Carriageway Provision	:	Dual 2 Lane All Purpose (D2AP) with 1.0m hard strips
Central Reserve	:	4.5m (including 1.0m hardstrips) widened as necessary for visibility purposes
Verge Width	:	2.5m widened as necessary for visibility purposes

4.1.2 Junction Standards

Three of the four junctions are designed to the geometric standards set out in 'Layout of Compact Grade Separated Junctions' (DMRB, Volume 6, Section 1, TD 40/94) with the other designed to 'Geometric Design of Major/Minor Priority Junctions' (DMRB, Volume 6, Section 1 TD 42/95). The tie-ins to the Castledawson and Creagh Roundabouts are designed in accordance with "Geometric Design of Roundabouts" (DMRB, Volume 6, Section 2, TD 16/93).

4.1.3 Side Roads Standards

The side roads for the scheme are designed using the standards set out in 'Highway Link Design' (DMRB, Volume 6, Section 1 TD 9/93) and, where the side road designs incorporate junctions with other roads, 'Geometric Design of Major/Minor Priority Junctions' (DMRB, Volume 6, Section 1, TD 42/95).

4.1.4 Other Standards

The standards set out in 'Cross-Sections and Headrooms' (DMRB, Volume 6, Section 1, TD 27/05) have also been used for the design of the mainline, connector roads and side roads.

4.1.5 Mainline Horizontal Alignment

The desirable minimum horizontal radius for a 120kph design speed is 1020m. There are two 720m horizontal radii used in the scheme. This radius is one step below desirable and is necessary for the tie-in to the existing Toome Bypass. The first 720m radius is located from Chainage 0 to Chainage 95 approximately and is necessary for the tie-in to Castledawson Roundabout. The second curve is located from Chainage 6,280 to Chainage 6,550 approximately. Verge and central reserve widening are required through several sections, to achieve the necessary Stopping Sight Distance (SSD). These areas are outlined below:

Chainage	**Central Reserve Widening**
0 – 490	The central reserve is widened to 9.25m from 2.5m (excluding hardstrips) over the length of the 1020m radii to achieve a SSD of 295m for traffic travelling west.
2150 –3700	The central reserve is widened to 10.75m from 2.5m (excluding hardstrips) over this length to achieve a desirable minimum SSD of 295m for traffic travelling both east and west.
3900 –5150	The central reserve is widened to 8.45m from 2.5m (excluding hardstrips) over the length of the 1020m radii to achieve a SSD of 295m for traffic travelling east.
5250 –5450	The central reserve is widened to 3.0m from 2.5m (excluding hardstrips) over the length of the 2040m radii to achieve a SSD of 295m for traffic travelling west.
5600 –6100	The central reserve is widened to 4.25m from 2.5m (excluding hardstrips) over the length of the1740m radii to achieve a SSD of 295m for traffic travelling east.
6100 –6740	The central reserve is widened to 12.75m from 2.5m (excluding hardstrips) over the length of the 720m radii to achieve a SSD of 295m for traffic travelling west.

Table 4.1 – Locations Where Central Reserve Widening is necessary to maintain the required SSD

Chainage	**Verge Widening**
80 – 400	The verge is widened to 4.8m (maximum) from 2.5m over the length of the 1020m radii to achieve a SSD of 295m for traffic travelling east
2590 –3100	The verge is widened to 6.2m (maximum) from 2.5m over the length of the 1020m radii to achieve a SSD of 295m for traffic travelling east
3110 –3630	The verge is widened to 7.3m (maximum) from 2.5m over the length of the 1020m radii to achieve a SSD of 295m for traffic travelling west
3950 –5130	The verge is widened to 8.5m (maximum) from 2.5m over the length of the 1020m radii to achieve a SSD of 295m for traffic travelling west
5200 –5470	The verge is widened to 2.8m (maximum) from 2.5m over the length of the 2040m radii to achieve a SSD of 295m for traffic travelling east
5590 –6060	The verge is widened to 3.5m (maximum) from 2.5m over the length of the 1740m radii to achieve a SSD of 295m for traffic travelling west
6050 –6740	The verge is widened to 11.0m (maximum) from 2.5m over the length of the 720m radii to achieve a SSD of 295m for traffic travelling east

Table 4.2 – Locations where Verge Widening is necessary to maintain the required SSD

4.1.6 Mainline Vertical Alignment

The vertical alignment is influenced by the existing topography of the drumlin landscape, the tie-in positions at either end of the scheme and the side road and river crossings. The alignment has been developed in accordance with the required criteria for vertical curvature and gradients specified in 'Highway Link Design' (DMRB, Volume 6, Section 1, TD 9/93).

The maximum gradient used is 1.572%, which is below the desirable maximum of 4% for dual carriageways. The minimum gradient is 0.05%, which is below the minimum gradient of 0.5% advised for effective drainage on kerbed roads. Shallow gradients have been used on the scheme to follow the existing flat topography, and 'over-edge' drainage will be incorporated into the design to ensure surface water drains correctly. The minimum sag curve used on the scheme has a K value of 37, which is the absolute minimum for a 120kph design speed. The minimum crest K is 182, which is the desirable minimum required.

The minimum clearance used at structures is 5.3m between the back of verge and the underside of bridge deck, in accordance with 'Cross Sections and Headrooms' (DMRB, Volume 6, Section 1, TD 27/05).

4.1.7 <u>Departures from Standard and Relaxations</u>

A major objective in the scheme development is to achieve a high standard of design and therefore aim for a mainline free of Departures from Standards, which has been accomplished with one exception. The topography of the site is relatively flat, therefore the mainline incorporates a number of sections with a gradient less than 0.5%, which is the minimum recommended for kerbed roads in 'Highway Link Design' (DMRB, Volume 6, Section 1, TD 9/93). As a result this has been included as a Departure from Standard.

The major junctions and some side roads in the scheme require Departures from Standard and Relaxations at various locations based on the design speed determined by Roads Service. A summary of these Departures and Relaxations can be found in Appendix B.

4.2 Climate, Topography and Land Use

4.2.1 <u>Climate</u>

On the whole, Northern Ireland is cloudier than the rest of the United Kingdom, because of the hilly nature of the terrain and the proximity to the Atlantic. Even so, the coastal strip of County Down has an annual average total of over 1,400 hours of sunshine. The dullest parts of Northern Ireland are the more mountainous areas, with annual average totals of less than 1,100 hours. Mean daily sunshine figures reach a maximum in May or June, and are at their lowest in December. The key factor is, of course, the variation in day length through the year, but wind and cloud are major controlling factors as well. Based on 1961 – 1990 annual mean sunshine duration (hours) statistics, the area between Toome and Castledawson would typically experience between 1,251 – 1,300 hours of sunshine per annum.

Rainfall in Northern Ireland varies widely, with the highest average annual totals being recorded in the Sperrin, Antrim and Mourne Mountains, where the annual precipitation is approximately 1,600 mm. Proximity to the Atlantic Ocean and the prevailing southwesterly low pressure systems, are the cause of the comparatively high rainfall figures experienced in the Province. Based on 1961 – 1990 annual mean rainfall (mm) statistics, the area between Toome and Castledawson would typically experience between 861 – 1,040 mm of rainfall per annum. Seasonal variation in Northern Ireland is not large, but the wettest months are between August and January. This is partly a reflection of the relatively low frequency of thunderstorms in the Province.

Throughout Northern Ireland, mean annual temperature varies little at low altitudes, averaging between 8.5°C to 9.5°C, with the higher mean values occurring nearer to the coasts. As would be expected, the lowest mean annual temperatures are recorded with increasing height, therefore, Slieve Donard (Northern Ireland's highest Mountain) would have an mean annual temperature of about 4.5°C. Due to the influences of the surrounding sea, Northern Ireland's winter temperatures are relatively mild, therefore inland areas like that between Toome and Castledawson, generally experience colder temperatures than the coast, with the opposite being the case in the summer months. On average the area between Toome and Castledawson can expect a mean annual temperature of 8.5°C to 9.0°C (based on 1961 – 1990 statistics). Inland, generally January or February are the coldest months of the year and July is the warmest month, with the mean annual maximum temperatures between Toome and Castledawson being 18.4°C to 19.4°C (based on 1961 – 1990 statistics).

In general, wind speed increases with height, with the strongest winds being observed over the summits of hills and mountains. The coastal fringes of County Antrim and Down have about fifteen gales per year, while the number of days decreases inland to five days or fewer. These are associated with the passage of deep depressions across or close to the British Isles and most frequently occurring in the winter months. In comparison with the rest of the British Isles, the frequency of gales experienced in Northern Ireland is relatively low, due to the shielding effect that the rest of Ireland and some parts of Scotland has on decreasing wind speed.

4.2.2 <u>Topography and Land Use</u>

The study area is situated within a lowland, glacial landscape, comprising a broad, relatively flat plain with open pastures and straight drainage channels extending into Lough Beg to the north, closed by the Long Mountain Ridge and Creagh drumlins to the east and west. In this landscape, all elements and distant landforms are highly visible, such as the new bridge over the Lower Bann, industrial buildings and the Elk Inn.

West of the Creagh Roundabout, the area comprises a landform of shallow, steep-sided, flat-topped drumlins, elevated between the expansive Lower Bann floodplain, the narrow tree-lined escarpment–constrained Moyola River floodplain, and the gently rising lower slopes of Leitrim Hill in the north. Further west, a regular field landscape characterises the area, either side of the Moyola River.

Bounding the Castledawson Bypass, a gently rolling farmed landscape dominates, generally rising to the west, drumlins with steep slopes to the east and south, and short views between them, and the Castledawson settlement to the north.

In general this landscape is representative of a mix of anthropogenic activities that are under significant development pressure. It is a relatively flat landscape which is important not only for its scenic quality, but also for its wetland habitat, nature conservation and archaeological interests.

4.3 Ground Conditions, Geology and Geomorhology

The area is generally underlain by extrusive igneous rocks, mainly flood basalts of Tertiary age, from the Lower Basalt Formation. The basalts are mostly medium-grained, olivine-rich and often porphyritic. They are also commonly affected by wide columnar jointing and fracturing, making them susceptible to deep weathering.

Drift deposits include glacial till (boulder clay) with some drumlin fields forming over them, particularly to the west near Castledawson. There are also recent lacustrine deposits, particularly to the east near Toome. Topsoil overlies much of these Quaternary deposits, forming farmland, playing fields, and gardens.

There is also 'Made Ground', most obviously in the former Toome to Magherafelt railbed, disused airfield, existing road construction and in backfilled excavations, such as former sand and gravel pits.

There are a range of soil types in the area, all of which have their own individual drainage and nutrient characteristics.

4.4 Contaminated Land

4.4.1 Introduction

A site investigation was undertaken along the proposed route between Toome and Castledawson. The site investigation was required to obtain information on ground conditions, which would assist in the design of the scheme and these were undertaken in the summer of 2006. The site investigation was based on information obtained during the preparation of desk studies and environmental impact assessments for the road scheme.

This report assesses the results of chemical analysis undertaken on samples obtained during the above site investigation in relation to risks to human health, controlled waters and to the road scheme.

4.4.2 Analysis results

Samples of soil materials were tested for total and leachable concentrations of determinands. Water samples were also tested where groundwater was encountered in sampling locations. The majority of samples tested indicated low concentrations of the determinands in the testing schedule.

The analysis schedule for the soil samples was as follows:

boron (water soluble), arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, sulphate (water soluble), sulphide (total), chloride (soluble), phenols monohydric, cyanide (total), asbestos, pH, Total Organic Matter, TPH - CWG (C5-35) Aliphatic / Aromatic Split (with CWG banding), BTEX, GRO, PAH (16 USEPA), VOCs, SVOCs, PCBs.

The analysis schedule for the leachate samples were as follows:

arsenic, boron, cadmium, chromium, copper, iron, lead, nickel, selenium, zinc, mercury, chemical oxygen demand (COD), electrical conductivity, chloride, nitrite, nitrate, sulphide, sulphate, phenols monohydric, cyanide (total), cyanide (free), pH, TPH - CWG (C5-35) Aliphatic / Aromatic Split (with CWG banding), BTEX, GRO, PAH (16 USEPA), VOCs, SVOCs, PCBs.

The analysis schedule for the groundwater samples were as follows:

arsenic, boron, cadmium, chromium, chromium hexavalent, copper, iron, lead, nickel, selenium, zinc, mercury, chemical oxygen demand (COD), electrical conductivity, alkalinity (total), chloride, nitrite, nitrate, sulphide, ammonium (total), sulphate, phenols monohydric, thiocyanate, cyanide (total), cyanide (free), pH, TPH - CWG (C5-35) Aliphatic / Aromatic Split (with CWG banding), BTEX, GRO, PAH 16 USEPA (GC/MS), VOCs, SVOCs (GC/MS), PCBs, organochlorine and organophosphate pesticides, triazine herbicides.

The following soil samples underwent chemical analysis for the soil and leachate analysis schedules:

024T (0.8m bgl)	107B (2.5m bgl)	107B (5.5m bgl)	501/2B (1.5m bgl)	501/2B (5.6m bgl)
510T (0.8m bgl)	510T (1.7m bgl)	301T (1.0m bgl)	303T (1.0m bgl)	203T (0.6m bgl)
303RT (1.0m bgl)	303RT (2.0m bgl)	303T (1.5m bgl)	411T (1.2m bgl)	412T (0.5m bgl)
416T (1.3m bgl)	421T (1.4m bgl)	513T (0.2m bgl)	514T (0.6m bgl)	518T (1.0m bgl)
608T (0.8m bgl)	610T (1.5m bgl)	216T (0.4m bgl)	218T (0.4m bgl)	

The following water samples underwent chemical analysis:

001W	002W	013/2B	103B	104B
204/1B LONG	204/1B SHORT	301W	302W	401W
405B	501W			

The chemical analysis results have been reviewed and the analysis results of note have been identified and are summarised in the following paragraphs.

Total PAH concentrations were detected in sample 301T (0.584 mg/kg), 303T (1.31 mg/kg) and 303RT 1.0m bgl (18.8 mg/kg). Three of the key PAHs are Benzo(a)pyrene which was recorded at a concentration of 0.027 mg/kg in 301T, 0.069 mg/kg in TP303T and 2.1 mg/kg in TP303RT 1.0m bgl; Naphthalene which was recorded at a concentration of 0.121 mg/kg in 301T, 0.349 mg/kg in 303T and 0.242 mg/kg in 303RT; dibenzo(a,h)anthracene which was recorded at a concentration of 0.009 mg/kg in 301T, 0.017 mg/kg in 303T and 0.305 mg/kg in 303RT. All other samples recorded concentrations of Total PAH that were significantly lower than the above results

Total petroleum hydrocarbon concentrations of 1.46 mg/kg (sample 301T), 119.58 mg/kg (sample 303T) and 92.8 mg/kg (sample 303RT 1.0m bgl) were recorded in the soil samples. These TPH concentrations coincide with the higher PAH concentrations encountered along the route of the road scheme. This is not unexpected as PAH and TPH analyses do overlap. All other samples recorded concentrations of Total Petroleum Hydrocarbons that were significantly lower than the above results.

No significant concentrations of Volatile Organic Compounds or Semi-Volatile Organic Compounds were recorded in any of the samples tested. PCBs were not detected in any of the samples tested. Two samples (TP203T 0.6m bgl and TP303RT 2.0m bgl) tested for organochlorine and organophosphate pesticides did not record any concentrations above the respective detection limits.

High total organic matter concentrations, indicative of naturally organic-rich or peaty soils, were recorded in 7 soil samples as follows:

Sample	Concentration TOM %
406B	52.01
525T	48.35
607T	68.51
608T	40.03
609T	44.21 – 52.05
612/1T	44.32
612T	62.41
613T	48.6

The chemical analysis results indicate that no significant concentration of metal determinands have been detected in soil samples. However, it should be noted that the majority (79 out of 103) of the samples tested were analysed for pH, total organic matter, water-soluble sulphate and/or soluble chloride, only.

Sample 303RT was obtained from a location that the trial pit log indicates contained waste materials and peat. A hydrocarbon odour was also noted at this location.

A leachate sample (218T) was recorded with a concentration of thiocyanate of 15 mg/kg. A leachate sample (216T) was recorded with a concentration of nitrate of 2402 mg/kg. Analysis of leachate from sample 303T recorded a lead concentration of 4 μg/l; a zinc concentration of 198 μg/l and a COD of 52 mg/l. Leachate from sample TP203T recorded a concentration of copper of 4 μg/l, zinc of 9 μg/l and COD of 15 mg/l. Leachate from sample TP303RT recorded copper concentrations of 4 μg/l and 7 μg/l and COD of 11 mg/l and 40 mg/l. Leachate from sample 301T recorded a COD of 22 mg/l. Leachate from samples TP301T and 303T recorded concentrations of Total PAH of 1.3 μg/l and 0.6 μg/l, respectively. Recorded values of naphthalene, fluoranthene and anthracene were 0.607 μg/l, 0.082 μg/l and 0.057 μg/l, respectively, in leachate sample 301T and 0.257 μg/l, 0.09 μg/l and 0.013 μg/l, respectively, in sample 303T.

Of the water samples tested: two were found to contain high concentrations of nitrate; samples 103B (64.9 mg/l) and 104B (64.3 mg/l). Three samples recorded high concentrations of ammonia; samples 204/1B LONG (1.5 mg/l), 302B (21 mg/l) and 501W (2.6 mg/l). A concentration of 28 μg/l of Total Aliphatics was recorded in sample 013/2B. A concentration of 274 μg/l of Total Aliphatics and 43 μg/l of Total Aromatics were recorded in sample 501W. Sample 501W recorded a concentration of total PAH of 614 ng/l. The following individual PAHs were detected in sample 501W: naphthalene, acenaphthalene, fluorene, phenanthrene, anthracene, fluoranthene, and pyrene.

4.4.3 Assessment of Risks

The samples containing determinands at concentrations of note were further assessed against published Soil Guideline Values (SGV) for soil samples and Environmental Quality Standards (EQS) and drinking water standards for leachate and water samples. Where published generic SGV values were not available generic SGV were calculated using CLEA UK MODEL 2005 version 1.0.

Human Health Assessment

The chemical analysis results have been compared with SGVs for an industrial / commercial land use scenario. This land use scenario is considered to be most similar to that of a road scheme, as the majority of the land will be overlain by hardstanding or used as landscaped areas. Therefore, direct human contact with any potential soil contaminants would be limited. The soil organic matter and pH values used in the calculations were 1% and pH7.

Although of note, the concentration of Total PAHs encountered in three samples of soil materials were below the SGV using the Generic Assessment Criteria of the CLEA UK MODEL 2005 version 1.0 of 31 mg/kg for benzo(a)pyrene and 290 mg/kg for naphthalene based on an industrial/commercial end use scenario. The generic SGV for benzo(a)pyrene of 1.15 mg/kg based on a residential with plant uptake scenario was exceeded in sample 303RT (2.1 mg/kg) only. The generic SGV for naphthalene of 3.39 mg/kg based on a residential with plant uptake scenario was not exceeded in any of the samples. The generic SGV for dibenzo(a,h)anthracene of 1.25 mg/kg was not exceeded in any of the samples. However, as mentioned previously the scenario of greatest relevance to the road scheme is the industrial/commercial land use scenario. Therefore, the PAH concentrations encountered during the site investigation are not expected to have an impact on human heath, the wider environment or on the construction of the road scheme.

The Total Petroleum Hydrocarbon concentrations (Total Aliphatic and Total Aromatic components) identified as being of note in the previous section were compared against SGVs derived by the Generic Assessment Criteria for industrial/commercial and residential with plant uptake land use scenarios. The SGVs for the Aliphatic components of the Total Petroleum

Hydrocarbons under both industrial/commercial and residential with plant uptake land use scenarios were not exceeded in any sample tested.

The SGVs derived by the Generic Assessment Criteria for the Aromatic components of the Total Petroleum Hydrocarbons under both industrial/commercial and residential with plant uptake land use scenarios were not exceeded in any sample tested. Therefore the Total Petroleum hydrocarbon concentrations encountered during the site investigation are not expected to have an impact on human health, the wider environment or on the construction of the road scheme.

The high concentrations of total organic matter appear to be associated with peat materials in the majority of samples. In those samples in which peat or peaty materials are not identified in the sample descriptions there are no indications from the organic chemical analysis results to suggest a contaminative source for the high organic matter concentrations.

Controlled Waters Assessment

As mentioned in section 2 a thiocyanate concentration of 15 mg/kg was noted in sample location 218T at 0.4m bgl. There is no Soil Guideline Value or Environmental Quality Standard for thiocyanates. However, thiocyanates are described in CLR 8 (DEFRA, 2002) as the least toxic of the cyanide species, although prolonged exposure can cause skin irritation and other non-acute symptoms. This sampling point was located in an area, which will be beneath an embankment. Therefore, human contact with this material would be negligible once site works had been completed and infiltration of rainwater will be minimised by the slope of the embankment.

As mentioned previously a nitrate concentration of 2402 mg/kg was encountered in leachate prepared from a sample taken from sampling point 216T at 0.4m bgl. There is no indication from the trial pit logs to indicate what could be the source of this elevated concentration of nitrate. A potential source for the nitrate could well be agriculture through the addition of inorganic or organic fertilisers. The sampling point is within fields in agricultural use. Although elevated this concentration appears to be an isolated case in the data available and is therefore considered unlikely to cause significant harm to controlled waters. This sampling point is located within an area of cutting. These materials may be removed completely from the site or may be reused elsewhere onsite. However, if these materials are to be reused they should not be placed near to a watercourse or water body.

The concentration of PAHs encountered in the leachate samples 301T and 303T were compared with the Environmental Quality Standards for naphthalene, anthracene and fluoranthene. The EQS for naphthalene is 10 μg/l, anthracene is 0.1 μg/l and fluoranthene is 0.1 μg/l. The concentrations of the three PAHs recorded in the leachate of the samples 301T and 303T did not exceed the Environmental Quality Standards for the PAHs. These concentrations of PAHs, therefore, would not cause significant harm to controlled waters.

Zinc (198 µg/l 303T and 9 µg/l TP203T), copper (4 µg/l TP203T and 7 µg/l TP303RT) and lead (4 µg/l 303T) concentrations were noted in leachate samples. The average value for total alkalinity recorded across the whole site for water samples was 231 mg/l. The EQS' for zinc, copper and lead at a water hardness of 200 to 250 mg/l are as follows: 300 µg/l, 40 µg/l and 20 µg/l, respectively. This indicates that none of the recorded metal concentrations would cause significant harm to controlled waters.

The measure of Chemical Oxygen Demand noted in samples TP203T, 301T, 303T and TP303RT may be as a result of the peat materials that are present along the route of the road scheme. The organic chemical analysis results do not indicate other potential sources of the Chemical Oxygen Demand concentrations.

4.4.4 Conclusion

The chemical analysis data obtained during the site investigation undertaken in the summer of 2006 has been reviewed. Initially samples containing concentrations of note of various determinands were identified. The determinand concentrations of these samples were then compared to generic Soil Guideline values or Environmental Quality Standards. Where no published Soil Guideline Value was available the Generic Assessment Criteria of the CLEA UK MODEL 2005 v1.0 was used to derive Soil Guideline Values (aliphatic and aromatic Total Petroleum Hydrocarbon fractions, benzo(a)pyrene and naphthalene (PAHs)).

The human health risk assessment based on a commercial/industrial land use scenario has not indicated the presence of contamination that would cause significant harm to human health. The assessment of risk to controlled waters based on the comparison of leachate and water chemical analysis results with the relevant Environmental Quality Standard has not indicated the presence of contamination that would cause significant harm to controlled waters.

One location along the route of the road at TP303RT did encounter made ground which contained brick, concrete, wire, metal straps, and plastic containers. Peat materials overlaid these waste materials, indicating that the peaty materials themselves were made ground. A hydrocarbon odour was also noted within this sampling location. However, the chemical analysis results did not indicate that there was a contamination issue at this sampling location. It should be noted that these materials may not be suitable due to geotechnical considerations.

The material sampled at location 216T, which contained elevated concentration of leachable nitrate, at a shallow depth is within an area of proposed cutting. This material can be reused elsewhere on site, if geotechnically acceptable, but should not be placed close to surface watercourses or other water features.

The materials that were initially highlighted as being of concern are more likely to be unsuitable for use in the road scheme for other reasons due to the presence of peat and/or landfilled materials rather than for environmental considerations. On the basis of the chemical analysis results seen to date any materials requiring disposal would in the worst cases be classified as hazardous non-reactive.

4.5 Drainage, Hydrology and Hydrogeology

4.5.1 Existing Conditions

The area is predominantly underlain by Tertiary basalts of low to moderate permeability. Some groundwater flow may occur in shallow cracks and fissures opened up by weathering, or in other discontinuities, and form locally important aquifers. North of the Hillhead Road junction however, there is an area underlain by glacial outwash, consisting of sands and clays, and glacial sands and gravels forming locally important aquifers, which are vulnerable to pollution.

The groundwater between Toome and just west of the Moyola River consists predominantly of minor aquifers, which are moderately permeable and the underlying soils are considered to have a poor ability to attenuate diffuse contaminants, and in which non-adsorbed diffuse contaminants and liquid discharges will leach rapidly.

From west of the Moyola River to a point west of the Annaghmore Road, the underlying soils are considered to have a low leaching potential. Within these soils, contaminants are unlikely to penetrate the soil layer because water and contaminant movement is largely horizontal or they have little ability to attenuate diffuse contaminants. Generally these are peat or soils of high clay content, characterised as surface water gleys.

Between just west of the Annaghmore Road and Castledawson Roundabout, the soils have a moderate ability to attenuate diffuse contaminants, which include most brown earths and some gleyed brown earths.

In total the proposed scheme will traverse approximately seven watercourses, all of which are potential outfalls for the road drainage system.

4.5.2 Drainage Strategy

Whilst acknowledging that the scheme will be subject to detailed design development, the procedures utilised in the development of the outline drainage design are consistent with the principles / requirements defined in the Design Manual for Roads and Bridges, the Sustainable Urban Drainage Design Manual for Scotland and Northern Ireland (SUDS Manual) and current Regulations, Orders and European Directives.

Based on the foregoing, the outline design has been developed in such a manner as to:

- Address road safety issues pertaining to the accumulation of surface water as defined in the DMRB;
- Provide an efficient system, using normally available and readily maintained components for conveying surface water arisings from the new road to the receiving watercourse;
- Incorporate facilities to permit treatment of run-off, principally to remove sediments and hydrocarbons, prior to discharge to the receiving watercourse;
- Incorporate facilities to permit attenuation of flows such that the risk of flooding within existing watercourses is not enhanced by the proposed road drainage system; and

- Provide facilities to isolated the drainage system from the receiving watercourses in the event of spillages of contaminants of risk to aquatic flora and fauna.

4.5.3 Outline Drainage Design

The outline design for the carriageway was based on the assumption that conveyance from the carriageway surface to the drainage system shall generally be via an 'over the edge' drainage system where kerbs are not required. At locations where kerbs are necessary (junctions / roundabouts incorporated within the works), gullies will be used to convey surface water run-off to the drainage system.

The drainage system shall incorporate adequate provision to ensure that the formation and, where a capping layer is provided, the sub formation level is maintained free of water and ground water levels are controlled below the carriageway in accordance with the DMRB.

Where kerbs are to be installed as part of the works, the carriageway surface will be drained via a gully system, with a flow width maintained within the hard strip, where available, and within 0.5 metres of the channel where hardstrips are not incorporated in the design.

The drainage strategy for the proposed works was developed based on the establishment of the critical nodes on the drainage networks that comprise: -

- High points and low points where drainage gradients are critical;
- Adjacent to structures and culverts where drain depth and location are critical;
- Outfalls where invert levels are critical relative to existing watercourse invert levels;
- Changes in gradient to permit the development of a representative model; and
- Elsewhere to allow modelling of appropriate pipe sizes.

The outline drainage design was modelled using the WinDes package produced by MicroDrainage. The network was analysed using the Storm module within the software package, which is based on the Wallingford Procedures for assessing run-off from paved areas.

For the purpose of the development of the strategy, the networks were designed using a 1 in 2 year storm event of maximum intensity of 50 mm per hour.

A minimum depth from soffit to road channel level (or cover depth) of 1.2 metres was assumed based on the worst case that full capping is required, thus allowing for a minimum depth to soffit below capping of 150 mm.

This approach was considered appropriate to provide the required resolution, when considering the vertical geometry of the road, taking into account required clearances over watercourse structures, and the design of outfalls from the drainage system.

4.5.4 Attenuation and Treatment

The outline design of the drainage system takes into account the requirement to treat and attenuate run-off from the carriageway. In general, the approach adopted was to achieve a neutral impact on the receiving watercourses.

In terms of water quality, this is achieved through the provision of two phases of treatment. The first phase occurs within the edge of carriageway filter drains, and the second phase is achieved by providing detention basins prior to the outfalls to existing watercourses.

Such an arrangement provides high efficiencies in the removal of sediments, suspended solids, hydrocarbons and other pollutants. In addition, the provision of a detention basin allows outflow control to be achieved such that:

- discharges are constrained to enhance retention periods for improved water treatment; and
- the outfall can be closed in the event of spillage to minimise the risk of pollutants reaching the receiving watercourse.

Through outflow control, the detention basins will provide a dual role of treatment and attenuation. Allowance has been made in the outline design for:

- flows arising from a normal storm event to be released over a period of 24 hours in accordance with the guidance provided within the SUDS Manual; and
- flows arising from the 1 in 100 year critical duration storm to be attenuated and released at flows not exceeding the 1 in 2 year run-off from the existing catchment.

In determining inflows and attenuation requirements, the 1 in 100 year critical storm event was derived using the MicroDrainage WinDes Source Treatment module. Existing flows arising from the 1 in 2 year event were estimated using the Institute of Hydrology Report 124 method for small ungauged catchments.

4.5.5 Description of Drainage

The preliminary outline drainage design is detailed on the Preliminary Drainage drawings contained in Appendix C. The drainage design is described in the paragraphs below.

Outfalll 1, Chainage 0 – 2030, Castledawson Roundabout to Moyola River Bridge

With the exception of the carriageway in proximity to the staggered junction at Bellshill Road, the drainage between Castle Dawson Roundabout and Moyola Bridge will be via an over the edge filter drain system. The carriageway from the extents of the junction splay at Bellshill Road will be kerbed and will be drained via a system of gullies or kerb offlets. A section of deeper drainage (approximately 2.5 m deep) between the lowpoint at Chainage 1150 and the high point to the east at Chainage 1250 will be required.

Final treatment and storage will be provided via and detention basis or similar SUDS system located within the LMA to the south west of the existing bridge structure.

Outfall 2,Chainage 2030 – 3000, Moyola River Bridge to Hillhead Road Junction

In this section the carriageway will generally fall towards the low point at Chainage 2500. The verge detail will be an over-the-edge drainage system with kerbing provided on the approach to the Moyola River Bridge.

Run-off from the bridge structure will be taken into the carriageway drainage network. An outfall to a swale/ditch adjacent and to the south of the carriageway is proposed at the low point at Chainage 2500. The swale/ditch will convey flows to a detention basin or similar SUDS system located to the south east of the existing Moyola River Bridge structure.

Outfall 3, Chainage 3000 - 5850, Hillhead Road Junction to Creagh Junction

This section of the carriageway will fall at gradients generally greater than 0.5%. For the purpose of the outline drainage design, it has been assumed that a minimum acceptable drainage pipe gradient of 1 in 200 should be adopted. Therefore it is proposed that this section be drained via an over-the-edge drainage system with frequent outfalls to an edge of carriageway swale or ditch. In this manner, drains can be maintained at minimum depths.

An outfall to the existing natural drainage system will be provide to the north east of Deerpark Road Junction, with sufficient wayleaves provided to allow regrading of the existing watercourse to achieve the required outfall levels.

Outfall 4, Chainage 5850 to 6700, Creagh Junction to Toome Bypass

As per Outfall 3, the road gradients in this section are less than the minimum acceptable pipe gradient of 1 in 200. It is therefore proposed that drainage be via the use of over-the-edge drainage system with frequent outfalls to an edge of carriageway swale or ditch.

At the tie in to the existing Toome Bypass drainage system, allowance has been made for the construction of detention basins or similar to link in to the currently operational series of SUDS facilities.

4.6 Public Utilities

Consultations with the statutory undertakers and relevant bodies took place during all stages of the route development, to determine their interests within the vicinity of the proposed alignment. Information from the existing major utility providers was collated and used to assess the impact that their apparatus has upon the route and alternative option proposals were prepared for consideration.

Information regarding existing services was received from the following:

- Northern Ireland Electricity Plc;
- British Telecom NI; and
- Department for Regional Development - Water Service.

Existing services and remedial proposals are shown on the drawings contained in Appendix D.

Communications also took place with NTL Communications, Cable & Wireless, Phoenix Natural Gas and Eircom NI. All confirmed that they have no existing plant in the vicinity of the route.

4.6.1 Northern Ireland Electricity

Information relating to the electricity distribution and supply networks in the area between Toome and Castledawson was received from Northern Ireland Electricity Plc. Within the footprint of the route, the electricity supply network has a range of line capacities from 275kV high voltage to low voltage domestic supply lines. Drawing No.s. BD03093D\2002A, 2005A – 2007A and Table 4.6.1 below indicate the nature, number and locations of potential conflict. The majority of crossings occur on the 11kV local distribution lines. However there is also a single crossing of the 275kV lines, two crossings of 110kV lines and four crossings of 33kV lines.

Mainline Chainage (m)	Location Number	Type of service	Level of finished road above existing ground level
0 – 60	37	MV UG	Mainline in cutting / embankment
370 - 385	36	HV 11 Kv OH	Route at grade to slight embankment
850	35	MV OH	Realigned Annaghmore Road on embankment
815 – 845	34	HV 11 kV OH	Route in cutting
890 – 950	33	HV 11 Kv OH Transformer	Realigned Annaghmore Road on embankment
985	32	MV UG	Slight cutting/at grade
1420 – 1490	31	HV 33 kV OH	Route in cutting
1550 – 1700	30	HV 33 kV OH	Route in cutting. Bells Hill Rd (south) on embankment
2325	29	HV 11 kV OH MV OH Transformer	Route at grade to slight embankment.
2900 – 3100	28	2 x HV 33 kV UG	Mainline in cutting, realigned Hillhead Rd on embankment to at grade.

Mainline Chainage (m)	Location Number	Type of service	Level of finished road above existing ground level
		HV 33 kV OH	
2915 – 2990	27	2 x HV 33 kV UG MV OH	Realigned Hillhead Rd on embankment
3520	26	Proposed HV 11 kV OH	Route on embankment
3520	25	HV 11 kV OH	Route on embankment
3685 – 3710	24	Proposed HV 33 kV	Route on embankment
3710 – 3730	23	Proposed HV 33 kV	Route on embankment
4500	22	HV 11 kV OH	Realigned Deerpark Rd on embankment
4600	21	MV OH	Access at grade. No conflict
4460 – 4530	20	HV 11 kV OH	Mainline & link Rd to Deerpark Road on embankment.
4970	19	HV 11 kV OH	Route on embankment
5490 - 5530	18	HV 33 kV OH	Route on embankment
5565 – 5700	17	HV 110 kV OH	Route on embankment, accommodation overbridge
5900	16	HV 11 kV OH	Route on embankment
5950	15	HV 11 kV OH Transformer MV UG	Link from Boilas Rd to Creagh Junction on embankment
6000	14	HV 110 kV OH	Link from Boilas Rd to Creagh Junction on embankment
6000	13	HV 11 kV OH	Link from Creagh Roundabout on embankment
6115 – 6160	12	HV 11 kV UG	Realigned Hillhead Rd on embankment
End of mainline	11	HV 275 kV OH	Realigned Hillhead Rd in slight cutting

Table 4.6.1 – Northern Ireland Electricity apparatus affected by the Preferred Route

4.6.2 <u>British Telecom</u>

British Telecom confirmed the presence of telecom apparatus within the area of the route.

An extensive network of British Telecom overhead distribution wires and underground ducts is in place throughout the area surrounding the route. British Telecom indicated that ducting containing up to three main fibres and possibly some local fibres running from Toome to Castledawson, along the existing A6 Hillhead Road, is considered a trunk line. Similarly the ducting which is present around Castledawson Roundabout and contains up to four main fibres is of high importance. British Telecom also provided a preliminary cost estimate of £225,000 for alterations to BT plant and apparatus in the scheme area. Drawing No.s. BD003094D\2008A, 2011A – 2013A and Table 4.6.2 provide details of the location of BT cables and outline the impact on the existing telecommunication network.

Mainline Chainage (m)	Location Number	Type of service	Impact on Preferred Route	Level of finished road above existing ground level
0 – 10	24	Duct	Major duct running from Castledawson to Magherafelt in eastern verge of Castledawson Roundabout contains at least 4 fibres. Manhole located on northern side of Roundabout.	Mainline joins existing roundabout at grade with majority of widening on southern side.
930 – 1000	23	Duct/OH	OH & duct parallel to existing Annaghmore Rd. Duct in previously realigned junction with existing A6	Mainline at grade. Realigned Annaghmore Rd on embankment / overbridge with some cutting north of mainline. Links off realigned Annaghmore Rd on embankment to at grade.
1460 – 1500	22	Duct	Duct in northern verge of existing A6. Duct running along existing Bells Hill Rd crosses existing A6 to private access south of mainline.	Mainline in cutting. Bells Hill Rd (north) in cutting. Bells Hill Rd (south) on embankment. Accommodation access overbridge.
1500 – 1600	21	Duct	Duct in northern verge of existing A6 crosses southwards to Bells Hill Road	Route at grade to slight embankment
2400 – 2470	20	Duct/OH	OH lines along Brough Rd. Ducted lines under existing A6.	Route at grade
3000 – 3200	19	Duct	Duct in existing junction between Hillhead Rd and Castledawson Bypass is empty. Buried cables in Creagh Rd with duct crossing existing A6.	Realigned Hillhead Rd at grade.
2950 – 3000	18	Duct/OH	Duct parallel to Hillhead Rd with up to 3 main fibres & local fibres. OH line along Hillhead Rd	Realigned Hillhead Rd on embankment to at grade
2950 – 3100	17	Duct	Duct along Hillhead Rd with up to 3 main fibres & local fibres.	Mainline in cutting. Realigned Hillhead Rd on overbridge / embankment.
4300 – 4500	16	OH	OH parallel to Deerpark Road	Mainline on embankment, realigned Deerpark Rd overbridge, embankment to at grade
4400 – 4600	15	Duct/OH	Duct in existing Creagh Hill Rd to Deerpark Rd, joins OH along Deerpark Road	Creagh Hill Rd at grade to embankment. Deerpark Rd at grade, northwards to embankment
6000 – 6100	14a	Duct	Possible duct with up to 3 fibres parallel to existing Hillhead Road towards Castledawson	New link road from Creagh Roundabout to Creagh junction on embankment

Mainline Chainage (m)	Location Number	Type of service	Impact on Preferred Route	Level of finished road above existing ground level
5940 – 6000	14	OH	OH along Boilas Road from Hillhead Rd	Mainline on embankment, link roads at Creagh Junction on embankment.
6500 – 6740	13	Duct	Duct with up to 3 fibres parallel to existing Hillhead Road towards Castledawson	Mainline on at grade to embankment. Realigned Hillhead Road at grade on northern side, embankment on southern side
End of mainline. 0 – 200 Realigned Hillhead Rd	12	Duct	Duct with up to 3 fibres parallel to existing Hillhead Road. Empty duct in southern verge of Toome Bypass to joint box	Realigned Hillhead Road at grade northern side to embankment on southern side.

Table 4.6.2 – British Telecom apparatus affected by the Preferred Route

4.6.3 Watermains

Records of the location of various items of water distribution related plant was received from the Department for Regional Development - Water Service. There are a significant number of 3-inch to 250mm diameter local distribution water mains of varying material specification within and across the area of the route. The majority of watermain conflicts are associated with the crossing of local roads. The largest mains crossed are those present in the existing A6 Hillhead Road.

Table 4.6.3 summarises the mains that are affected by the route. Drawing No.s. BD03094D\2014A, 2017A – 2019A show the existing supply network and indicate the proposed diversionary or other remedial measures which have been presented to Water Service to maintain the existing watermain system. Based on an economic model provided by DRD Water Service, the cost for diversionary works to watermains is estimated at £420,796.77.

Chainage (m)	Pipe ø	Impact on Preferred Route	Proposed solution	Diversion length (m)
920 - 1000	200mm	Watermain crosses mainline	Watermain diverted to verge of realigned Annaghmore Rd south of mainline & ducted under mainline. Spurs north & south of mainline to maintain domestic supply.	568
1465 - 1480	3”/4”	Watermain crosses mainline	Watermain ducted under mainline	88
2420 - 2435	125mm	Watermain crosses mainline	Watermain ducted under mainline	70
2925 - 3080	4”	Watermain crosses mainline	North of route, watermain diverted to verge of realigned Hillhead Road & accommodation access track & ducted under mainline. Spur provided on western side of realigned Hillhead Rd to maintain domestic supply.	370

Chainage (m)	Pipe ø	Impact on Preferred Route	Proposed solution	Diversion length (m)
4300 - 4560	3"	Watermain crosses realigned Deerpark Rd	Watermain diverted to verge of Creagh Hill & Deerpark Rd's and bridged over mainline	684
5940 - 5960	125mm	Watermain crosses mainline	Watermain diverted to toe of embankment & ducted under mainline	190
6590 - End	4"	Watermain crosses / runs parallel to mainline	Watermain diverted to southern verge of mainline, then crosses to northern verge	342
6590 - End	250mm	Watermain crosses / runs parallel to mainline	Watermain diverted to southern verge of mainline, then crosses to northern verge	310
6590 – End	250mm	Watermain crosses / runs parallel to mainline	Watermain diverted to northern verge of realigned Hillhead Rd, crossing to southern verge of mainline	192

Table 4.6.3 – Watermains apparatus affected by the Preferred Route

4.6.4 Sewerage

Records of the location of various items of sewer related plant were received from the Department for Regional Development - Water Service. There are a significant number of foul and combined sewers, both pumped and gravity, of varying material specification ranging in size from 63 to 450mm, within and across the area of the route.

Between Toome and Castledawson there are a number of areas of conflict with both foul and combined sewers requiring significant diversions. These include pumping mains at the tie in with the existing Toome Bypass, a foul pumping main Hillhead Road junction and foul and combined sewers at Annaghmore Road. Based on an economic model provided by DRD Water Service, the cost for diversionary works to sewer related plant is estimated at £368,533.91. Existing sewerage plant and proposed mitigation measures are shown on Drawing Nos. BD03094\2014A, 2017A – 2019A.

Chainage (m)	Pipe ø	Impact on Preferred Route	Proposed solution	Diversion length (m)
750 - 2030	450mm	Sewer outfall crosses mainline & runs parallel in northern verge	Sewer ducted under mainline	55
750 - 1480	250mm	Proposed pumped foul sewer to run in southern verge of A6, cross mainline to Bells Hill Rd North	Divert to southern verge of mainline & provide ducted crossing	740
960 -1030	150mm	Pumped combined sewer running in Annaghmore Road & crossing mainline	Sewer ducted under mainline, diverted to toe of embankment & ducted under Annaghmore Road	173

Chainage (m)	Pipe ø	Impact on Preferred Route	Proposed solution	Diversion length (m)
960 -1030	150mm	Foul sewer running in Annaghmore Road & crossing mainline	Sewer ducted under mainline & diverted to toe of embankment	212
2420 - 2435	150mm	Foul sewer crosses mainline	Foul sewer ducted under mainline	40
2925 - 3080	63mm	Pumped foul sewer crosses mainline	Pumped foul sewer ducted under mainline & brought along accommodation access track to rejoin existing sewer on Hillhead Rd	270
3050 - 3071	150mm	Foul sewer crosses realigned Hillhead Rd south of mainline	Sewer crosses existing A6 & old Creagh Road, possibly through existing duct – to be determined	
4375 - 4520	150mm	Proposed foul sewer crossing realigned Deerpark Road	Sewer realigned to toe of Creagh Hill embankment & ducted under realigned Deerpark Road	158
6425 - End	180mm	Pumped foul sewer (not in service) crosses & runs parallel to mainline	Sewer diverted to southern verge of mainline, ducted across existing A6 mainline to northern verge rejoining existing pipe	320
6425 - End	400mm	Pumped foul sewer (not in service) crosses & runs parallel to mainline	Sewer diverted to southern verge of mainline, ducted across existing A6 mainline to northern verge to rejoin existing pipe	325

Table 4.6.4 – Sewerage apparatus

4.7 Structures

The scheme will require the construction of sixteen major bridge structures for which suitable designs were investigated and developed. The basic features considered when choosing the most appropriate form for each structure were:-

- structural type;
- type of foundation;
- span arrangements;
- number and type of supports; and
- choice of materials.

It is common for several possible solutions to present themselves at each structure, and a balance needs to be achieved between all these items when selecting the most suitable option. The preferred solution for each structure was influenced largely by the following factors:

- appearance and environmental impact;
- desire to maintain the appearance of a "family" of structures within the scheme;
- safety and ease of construction;
- foundation conditions;
- road geometry;
- future maintenance; and
- cost.

The final design for each structure was also influenced by aesthetic appeal, whole-life cost, safety and the need to limit disruption during construction.

Using this process, preliminary designs were developed for each of the ten major structures, and these are presented in Appendix E. The structures can be divided into four generic groups, comprising the following:

- three overbridges carrying side roads and accommodation access roads over the new mainline A6, constructed on the line of the existing A6;
- five overbridges carrying side roads and accommodation accesses over the new A6 mainline off-line from the existing A6;
- an underbridge carrying the A6 mainline over the Moyola River and an accommodation access track; and
- an underpass structure accommodating an access track beneath the eastbound slip road at Hillhead Road Junction.

The design philosophy adopted for each group of bridges is discussed briefly in the following sections, as are many features peculiar to individual structures.

4.7.1 Precast Prestressed Beam Overbridges Constructed On-Line - Annaghmore Road Bridge, McMillin Accommodation Bridge and Galway Accommodation Bridge.

A precast prestressed concrete beam solution was selected for the structural form of the on-line overbridges on the basis of their suitability for construction over the existing live A6 with the minimum disruption possible. Carraigeways beneath the new spans would require to be closed whilst beams are placed on the new supports but thereafter the remainder of the superstructure can be constructed over live traffic.

Back spans with bankseat supports are preferred to adoption of full height abutments; the resulting open aspect is considered much more aestetically pleasing continuing the lines of the mainline approach earthworks.

The aesthetic appeal of this structural form will be maintained by designing to avoid the need for a soffit downstand over intermediate supports thus achieving a continuous soffit line over the full stucture length; this desirable feature, which will also maintain the "family" link with any similar structures with insitu concrete decks, will however probably dictate the need for temporary support to beam ends whilst the insitu diaphragms are constructed. The most aesthetically pleasing intermediate supports are considered to be multi-faceted, nominally circular, individual columns.

All three bridges are of such an overall length that integral construction, i.e. no bearings or movements, is mandatory. Preliminary ground investigations indicate that Annaghmore Road Bridge will require piled foundations whilst the other two will have spread footings.

The horizontal road alignment over McMillin and Galway accommodation Bridges is straight. The curved alignment over Annaghmore Road Bridge will be accommodated by slightly kinking the beam alignment at each intermediate support and varying the length of the insitu edge cantilevers to maintain a constant verge width on both sides.

4.7.2 Insitu Reinforced Concrete Overbridges Constructed Off-Line - Hillhead Road Junction Bridge, Deerpark Road Junction Bridge, Nugents Accommodation Bridge, McGrogan Accommodation Bridge and Creagh Accommodation Bridge.

Having no traffic management constraints imposed on their construction, it is considered likely that insitu concrete will be the most economic form for these bridges which will produce results similar aesthetically to the on-line precast beam bridges; however it may be that economy of scale and speed of construction advantages would finally dictate that the family of overbridges all be of precast form.

Again an open aspect is preferred with bankseat end supports whilst the intermediate supports would comprise individual 'circular' columns.

Whilst having no effect on the outward appearance, the precise detail of the various spans would vary to maximise economy. The longer spans on Hillhead and Deerpark Road Junction Bridges would be voided and, in the latter case, possibly post-tensioned too.

Integral construction is preferred to minimise ongoing maintenance associated with bearings and movement joints. However in the case of the two longest, Deerpark Road Junction and Creagh Junction Bridges, this is impractical and and bearings at supports and movement joints with inspection galleries will be required.

Available geotechnical data suggests that all but McGrogan Accommodation Bridge will require piled foundations.

4.7.3 Moyola River Bridge

A simple three span structure is proposed in this location with spans proportioned such that there are no supports within the main channel of the river and pedestrian access is possible beneath both side spans. To avoid unnecessary risk of pollution it is proposed to adopt a precast beam superstructure which will minimise the construction activities taking place over the river itself whilst it is unprotected.

The modest overall length dictates an integral solution and, based on current knowledge of ground conditions, foundation piling is likely to be required.

4.7.4 Hillhead Road Junction Underpass

A simple reinforced concrete box structure is proposed in this instance with short wingwalls splayed at 45deg which minimises the their overall size and also gives the most pleasing appearance. A pattern profile finish will be provided to the exposed faces of the wingwalls.

4.8 Construction Sequence

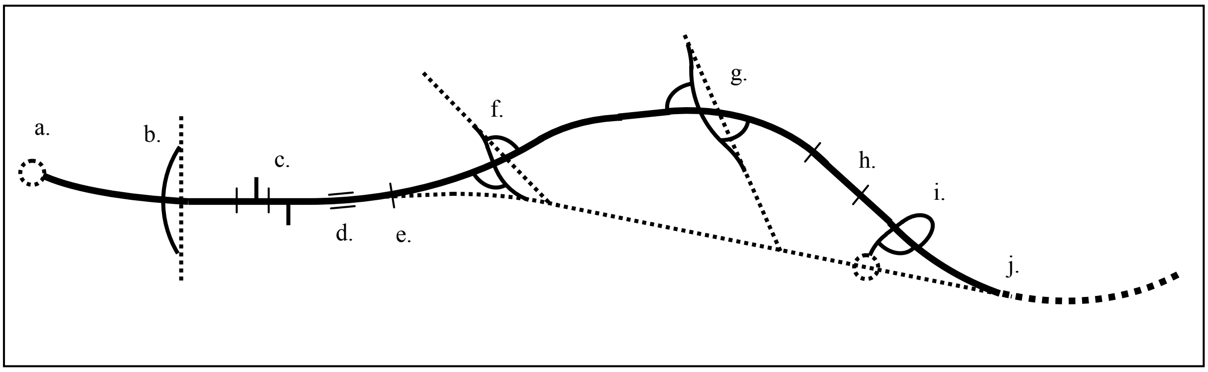
The scheme was examined to demonstrate that the proposed works can be built while keeping the existing route operational. A series of construction sequences and traffic management measures was considered which will facilitate this. The necessary traffic measures will include:

- temporary speed restrictions;
- narrow running lanes;
- two-way contraflow working;
- alternate one-way (shuttle) working under traffic signals; and
- traffic diversion routes.

There will be some disruption to traffic, although this will be minimised to acceptable levels. Whilst it will be essential to maintain two-way traffic flow on the A6 at peak periods, it may be acceptable to use one-way traffic signal controlled operation at off-peak periods.

4.8.1 Specific Construction Elements

Much of the route is off-line and will not have buildability complexities. The locations considered in detail where the route interfaces with the existing A6 and other roads are shown below.



Location

a. Castledawson Roundabout Tie-in
b. Annaghmore Road
c. Bellshill Road Junction
d. Moyola River Crossing
e. Brough Road
f. Hillhead Road Junction
g. Deerpark Junction
h. McGrogan Overbridge
i. Creagh Junction
j. Toome Bypass tie-in

a. Castledawson Roundabout Tie-in

The eastbound carriageway of the new dual carriageway A6 follows the route of the existing single carriageway, with the westbound carriageway off-line to the south. As a result the westbound carriageway can be built with little impact on the existing A6 traffic flows. Once the westbound carriageway has been completed, traffic could be switched to use this section of road, maintaining two-way traffic flow under contra-flow conditions. Speed restrictions could be applied through the works.

b. Annaghmore Road

This section the westbound carriageway of the new A6, which lies off-line, could be constructed with traffic continuing to use the existing single carriageway A6 as normal. As the westbound carriageway is being built, the south abutment for the overbridge structure could also be constructed. On completion of the westbound carriageway and south abutment, traffic could be switched on to the new carriageway, allowing the existing A6 to be upgraded to the required standard. The north abutment for the overbridge could then be constructed. Upon completion of both carriageways, Lane 1 on each could be closed, with traffic running in Lane 2 under contra-flow conditions with speed restrictions. This would maintain a safety zone while the pier in the central reserve is built. A nighttime closure may be required to lift the precast bridge deck into position. The use of permanent deck formwork would enable work on the deck to continue above live traffic, however erection and dismantling of falsework over the road would require to be done under closures.

The priority junction at Annaghmore could be stopped up immediately with traffic diverted to the nearby junction at Bellshill Road.

c. Bellshill Road

The Bellshill Road priority junction follows the existing geometry and access could be maintained during construction. Some traffic signal controlled shuttle-working may be required. As the Annaghmore priority junction is stopped-up the number of vehicles using this junction is likely to increase, which should be considered during construction.

d. Moyola River Crossing

The existing A6 crosses the Moyola River on a structure. The existing single carriageway will form the eastbound carriageway of the new dual carriageway, with a new separate structure being constructed to carry the westbound carriageway. As this structure is independent of the existing structure there should be no major traffic management issues during the construction phase.

e. Brough Road

There is a priority junction on the existing A6 at Brough Road which will be stopped-up as part of the scheme. To the north of the new A6, this road will be stopped-up almost immediately with a diversion put in place directing traffic to Hillhead Road. To the south of the A6, a road is proposed to link the Brough Road to the existing A6. While this road is under construction there is adequate space to provide a temporary road to accommodate traffic. However, some traffic signal controlled shuttle working may be required to allow pavement tie-in work.

f. Hillhead Junction

At the location of the proposed Hillhead Junction the mainline is off-line and the compact connector loops in the northeast and southeast quadrants can be constructed with no major traffic management issues. However, the junction requires Hillhead Road to be realigned west and passed over the mainline on an overbridge. The overbridge could be constructed and the existing Hillhead Road should remain open giving access to the existing A6. Some traffic signal controlled contra-flow may be necessary during construction of the north and south tie-ins. Upon completion of the new overbridge, the existing Hillhead Road will be stopped-up. The existing A6 then adjoins the new Hillhead Road at a priority junction to the south. Some traffic signal controlled contra-flow may be required.

Temporary roads may be required to allow access to properties while a permanent pavement is under construction.

g. Deerpark Junction

Deerpark Road Junction makes use of a new overbridge off-line of the existing Deerpark Road. As the overbridge is off-line it can be constructed with little impact on the existing road, which can remain open. To complete the tie-in between the new Deerpark Road and the existing, traffic signal controlled shuttle-working may be necessary. Once the new overbridge is complete, traffic can be moved onto this road and the existing Deerpark Road stopped-up and used only as an access road to properties. Temporary access roads may need to be constructed while the permanent pavement is formed. The connector in the southeast quadrant can only be constructed once the overbridge is complete, as it crosses the existing Deerpark Road. The connector in the northwest quadrant is off-line, so presents no traffic management issues. The Creagh Hill road adjoins Deerpark Road, this access could be temporarily re-aligned to allow construction and pavement laying of the new tie-in and would be subject to speed limits. This would be subject to approval from the relevant landowner. Alternatively, traffic may be diverted west along the Creagh Hill Road onto the existing A6 where access will be maintained to Deerpark Road.

h. McGrogan Overbridge

The proposed overbridge at McGrogan Road will be low usage, as it only serves to provide access for a landowner to land severed by the mainline. As a result, a temporary road off-line of the existing could be formed and used while the overbridge is being constructed. This would require approval from the landowner. Since the road is low usage, traffic signals and shuttle working will not be required.

i. Creagh Junction

The connectors in the northeast and southeast quadrants are off-line and so can be constructed with no traffic management issues. Boyle’s Lane must remain open throughout construction to serve properties on this road and allow them access to the existing A6. The earthworks for the new overbridge for Creagh junction encroach upon Boyle’s Lane, therefore a temporary diversion of this road may be required, subject to landowner approval. Where the new road ties in to Boyle’s Lane to the north, some traffic signal controlled shuttle-working may be necessary. At the tie-in to the Creagh Roundabout, lane 2 of the roundabout could be closed to allow surfacing work to be completed at the tie-in. This could be done at off-peak times to minimise traffic disruption. Speed limits will be in force on the roundabout approaches during construction. Once the junction is complete Boyle’s Lane will be stopped-up and the mainline constructed through the junction.

j. Toome Bypass tie-in

The westbound carriageway of the existing bypass is to be used as a single carriageway road that will adjoin Hillhead Road. Only 400m of this new road is on-line so the majority of the off-line construction can be completed without any impact on traffic. The Hillhead Road junction could remain open throughout construction so the tie-in to the east cannot be completed at this stage. Once the off-line section is complete, traffic could be diverted onto it from the Toome Bypass, allowing the mainline tie-in to the Toome Bypass to be constructed. During construction the existing dual carriageway at this section will be restricted to single carriageway which may cause queuing and delays. To complete re-surfacing work on the existing westbound carriageway of the bypass, traffic could be switched to the eastbound carriageway. Once the mainline tie-in is complete, traffic can follow the new road. Hillhead Road junction can then be stopped-up and the tie-in to Hillhead Road completed. Traffic signal controlled shuttle working may be necessary to allow pavement tie-in at this location.