Údarás
Náisiúnta Iompair
National **Transport** Authority

SANDYMOUNT / MERRION TO BLACKROCK CORRIDOR STUDY

FEASIBILITY STUDY AND OPTIONS ASSESSMENT REPORT

Part D: Appendices

D1 - Preliminary Tree Survey Report
D2 - Grade Separation of Merrion Gates Feasibility Study Report

AECOM ROD
ROUGHAN & O DONOVAN

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D1 - Preliminary Tree Survey Report

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Sandymount to Blackrock Corridor Study
Preliminary Tree Survey Report

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Issue for Feasibility Report

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For and on behalf of Brady Shipman Martin

Contents

1.0 Introduction

The National Transport Authority is investigating possible improvements to transport infrastructure along key routes in Dublin; this report has been prepared to feed into a feasibility study that is being carried out to examine various road and cycle lane options between Sandymount and Blackrock.

2.0 Report Limitations

- The inspection has been carried out from ground level using visual observation methods only.
- This report is based on a preliminary assessment of the trees lining the survey route and is intended to provide an overview of the extent and quality of the tree cover present; it is not a detailed health and condition survey of all of the trees along the route.
- The field survey involved inspecting areas open to the public only; no private gardens, business or school premises were accessed during the data collection.
- Trees are living organisms whose health and condition can change rapidly. Trees should be checked on a regular basis, preferably once a year. The conclusions and recommendations of this report are valid for one year.
- The fruiting bodies of some important species of decay fungi only emerge at certain times of the year and may not have been visible during this inspection.
- There is no such thing as a 100% safe tree in all conditions, since even perfectly healthy trees may fall or suffer branch break.
- Climbing plants such as Ivy can obscure structural defects and some symptoms of disease, where such plants prevent a thorough examination it is recommended that the climber be cut at ground level and the tree re-inspected when it has died back.

3.0 Methodology

The site was surveyed on foot and the trees were then assessed using Visual Tree Assessment (VTA) techniques; summary notes regarding tree species, age class, size and condition along the route were taken where appropriate.

4.0 Survey Key

4.1 Tree Number
No trees were tagged or plotted as part of this preliminary survey.

4.2 Species
Refers to the specific tree species in both common and botanical names.

4.3 Age
Tree age classes were recorded as:

Y: Young tree – yet to reach biological maturity
SM: Semi-mature - tree now well established and developing
EM: Early-Mature - tree not yet fully grown
M: Mature - fully mature tree up to 100% of its usual lifespan
OM: Over mature - tree now declining from natural causes
Vet: Veteran - tree of value due to old age and ecological/cultural significance

4.4 Stem Diameter, Tree Height and Crown Size Measurements

Height: Total Tree Height in metres

Dbh: Diameter (in mm) at breast height measured at 1.5m from ground level

4.5 Useful Life Expectancy (ULE)
The estimated useful lifespan is an estimate of the number of years that an individual tree *under current site conditions* may be expected to remain in reasonable physiological and structural condition.

4.4 Condition
Condition refers to both physiological condition (good, fair, poor, dead.) and structural condition e.g. collapsing, the presence of any decay and physical defect.

Good: No obvious defects visible, vigour and form of tree good.
Fair: Tree in average condition for its age and the environment.
Poor: Tree shows signs of ill health/structural defect
Bad: Tree in seriously bad health/major structural problem
Dead: Tree now completely dead

4.7 Comments
Additional description/commentary on individual trees or groups of trees where appropriate.

4.8 Recommendations
Preliminary management recommendations are noted, including remedial pruning works, further investigation of suspected defects that require more detailed assessment and potential for wildlife habitat.

4.7 Tree Retention Category (Cat)

The tree retention category system grades a tree's suitability for retention within a development:

A Indicates a tree of high quality and value. These are trees that are particularly good examples of their species, which also provide landscape value. These trees are in such a condition as to be able to make a substantial contribution. (A minimum of 40 years is suggested)

B Indicates a tree of moderate quality and value. Trees that might be included in the high category, but are downgraded because of impaired condition. These trees are in such a condition as to make a significant contribution. (A minimum of 20 years is suggested)

C Indicates a tree of low quality and value - trees with an estimated remaining life expectancy of at least 10 years, or young trees with a stem diameter of below 150mm.

U Trees that are in such a condition that they cannot realistically be retained as living trees in the context of the current land use for longer than 10 years.

Sub Categories

Tree categories may be further categorised using the following sub-categories (e.g. C1, C2 or C3) - 1 mainly Arboricultural qualities, 2 mainly landscape qualities, 3 mainly cultural values.

4.8 Root Protection Area (RPA)

The Root Protection Area **(**RPA) is the minimum area around individual trees to be protected from disturbance during construction works. The RPA is expressed as a radius in metres measured from the tree stem (RPA–R(m)), the total area in square metres (RPA-A(m2)) or as the sides of a square in metres (RPA-S(m)).

For single stem trees, the root protection area (RPA) should be calculated as an area equivalent to a circle with a radius 12 times the stem diameter.

For trees with more than one stem, one of the two calculation methods below should be used.
The calculated RPA for each tree should be capped to 707 m_2.

a) For trees with two to five stems, the combined stem diameter should be calculated as follows:
$\sqrt{}$ ((stem diameter 1)$_2$ + (stem diameter 2)$_2$ ... + (stem diameter 5)$_2$)

b) For trees with more than five stems, the combined stem diameter should be calculated as follows:
$\sqrt{}$ ((mean stem diameter)$_2$ × number of stems).

5.0 Findings

The tree survey field data was collected on the 6th of September 2015.

The route surveyed includes the road carriageway, pavement and associated curtilage along a 3km stretch of the R118; running south from the junction of Ailesbury Road to the Merrion Gates (where Merrion Road becomes the Rock Road), and then further south to the junction with Mount Merrion Avenue at the southern end of the study area. A short link between Merrion Road and the Strand Road plus part of the existing cycleway through Blackrock Park was also included.

5.1 Ailesbury Road to Nutley Lane

This section is comprised primarily of older residential housing with a mature streetscape of large mature street trees spaced out along either side of the road set within the pavement areas. The dominant street trees are mostly specimen London Plane (*Platanus x hispanica*) and Common Lime (*Tilia x europaea*) stems of good form and quality. The trees are in mostly good physiological and structural condition, with mainly full crowns and healthy looking foliage. The trees are medium to large in size; 400-700 dbh and 15-18m tall, and are very significant features in the local landscape (see image 1 below).

Image 1 View south down Merrion Road from close to the Ailesbury Road junction

The mature trees appear to be being well managed and were not noted to be requiring any serious remedial works; they are however situated within a fully paved ground surface area and have tarmac right up to the tree stems with no open soil surface at all.

There are 4 mature London Plane trees and 2 mature Limes within this section, with another 6 semi-mature or early mature Lime trees established along the eastern side of the road. There is a linear group of trees forming a landscape screen along the eastern side of the pavement at the northern end of east side of the road up to the junction with Ailesbury Road; this group is mainly mature Cherry Plum (*Prunus cerasifera* 'Pissardii') in variable condition, but it also includes a mature Sycamore (*Acer pseudoplatanus*) in fairly good condition at the northern end of the group.

There are 3 early mature Maples (*Acer platanoides*) and 2 Limes in fair condition along the west side of the street outside the shopping centre close to the junction with Nutley Lane; these are relatively small trees (150-200mm dbh) but seem well established and are of moderate value.

There are some established trees and shrubs inside the garden limits of some of the houses along this part of the road; most notably a fine pair of mature Lime trees on either side of the entrance into no.172 Merrion Road. These trees are of high value and are located close to the public pavement and would be likely to have significant root growth extending outside the private property.

5.2 Nutley Lane to Strand Road

This section of the survey route primarily concerns the eastern side of Merrion Road where the mature character of the streetscape continues all the way to the junction with Strand Road to the south. The northern section of the western side of the road is devoid of street trees with the exception of the early mature Lime trees along the verge of Nutley Lane (see image 2 below); there are 2 mature London Plane and 1 Lime at the southern end close to the junction with Strand road.

Image 2 Junction of Nutley Lane and Merrion Road; early mature Lime trees are established along the south verge of Nutley Lane and in the grass verge immediately north of the junction.

Large mature high value specimen trees of Lime (x6) and London Plane (x7) are spaced out along the eastern side of the street adding considerable landscape and amenity value to the locality (see image 2 below).These trees are in mostly good health and condition and range 450mm to 700mm dbh and 12-17m in height. There are also mature trees just outside the public realm; a mature Austrian Pine (*Pinus nigra*) and Sycamore in the grounds of the nursing home (no. 202) and a linear group of Lawson Cypress (*Chamaecyparis lawsoniana*) (200-400mm dbh) and Whitebeam (*Sorbus aria*) along the southern edge of the Church car park in the area considered for a link up through to Strand Road. A large mature Poplar (in relatively poor condition) is growing in the corner of the car park close to the DART line; 2 mature Ash trees are located just inside the grounds of the Bank of Ireland to the south (see image 4 below).

Image 3 View looking south down Merrion Road with mature specimen London Plane and Lime trees spaced along the eastern side of the street.

Image 4 showing site of proposed link between Merrion Road and Strand Road; note row of Lawson Cypress next to the car park entrance, mature Ash x2 in the grounds of the bank and large Poplar in the far corner.

There is a small cluster of Cabbage Palms (*Cordyline australis*) and 1 semi-mature Lime in the landscape verge just north of the junction with Strand Road; these trees are of relative low value (see image 5 below).

5.3 Strand Road to Booterstown Avenue

The only significant street trees in this section are located immediately south of the Strand Road junction between the pavement and DART line and are comprised of a short linear group of Lime, of which 5 are in fair condition and moderate value and 1 is dead standing. There are an additional 7 Lime trees located behind a boundary wall to the east of the pavement along the Rock Road to the south.

Image 5 showing junction of Strand Road and the R118 as it becomes the Rock Road; note mature Lime trees south of the junction and cluster of Cordyline Palms just north of the junction.

Numerous young and established trees are growing within the grounds of the nursing home to the west of the Rock Road; these trees (mostly Cherry *Prunus spp*. and Ash *Fraxinus excelsior*) are in good or fair condition and are set well back inside the grounds, away from the pavement and highway.

There has been extensive tree planting within the Elm Park development (most of which is becoming well established) and there are small clusters of trees located off the street; including 1 mature Cherry in the front grounds of the derelict unit opposite Elm Park and Sycamore/Leylandii (*Cupressocyparis x leylandii*) in poor condition growing in the garden of no. 32 Trimbleston Avenue.

The dominant tree population along this section of road is the mixed species scrub woodland growing to the east of the highway and pavement; this woodland is mostly early mature Sycamore and Elm (*Ulmus glabra*) with some Poplar (*Populus spp*.), Ash and Alder (*Alnus cordata*). The trees are mostly occupying a strip of land around 0.5km long between the boundary wall along the road and the wetland to the east; much of which is within the Booterstown Nature Reserve (which extends all the way south to the Booterstown DART station car park). The trees are mostly100-400mm dbh and in mainly fair condition; many have light branching growing out over the pavement (see image 6 below).

Image 6 section of the Rock Road looking south - with Booterstown Nature Reserve to the east and residential housing to the west

Residential housing to the west of the highway (between numbers 136-144) includes some mature gardens containing attractive mature specimen trees including Sycamore, Ash, Lime and Yew (*Taxus baccata*) in fair to good condition; these trees are located behind the long established boundary walls of the houses (see image 7 below).

Image 7 Mature trees in front gardens along the western side of the Rock Road.

5.4 Booterstown Avenue to Mount Merrion Avenue

The section of the survey route between Booterstown Avenue and Mount Merrion Avenue is a wide stretch of road with concrete pavement on either side; there are no established street trees within the pavement areas, however there are many trees along the route that are located just outside the actual street limits. The vast majority of these trees are located within the public parkland (Blackrock Park) to the east of the highway, or within the grounds of the schools/colleges and hospital situated to the western side of the road. Most of the trees within these grounds are set back from the pavement behind long established masonry walls.

Image 8 View looking north from just south of the junction of Booterstown Avenue and the Rock Road; note parkland trees overhanging the pavement to the right of the picture and mature/over mature Beech and Sycamore trees inside the old boundary wall in the centre.

There is a linear group of early mature trees growing on either side of Willow Park school entrance drive on the western side of the road; these trees include Alder, Lime, Whitebeam and Willow (*Salix spp*.) are mostly 100-200mm dbh (with a small number of 400+mm dbh), of moderate value and are growing in a landscape verge behind a row of bollards (see image 9 below).

Image 9 Roadside plantation just north of the School entrance off Rock Road.

The grounds of the Willow Park school and Blackrock College extend for around 500m along the western side of the road with trees forming a long landscape feature along the properties road frontages. The northern portion of the boundary has a masonry wall backed by mature and early mature trees (Monterey Cypress *Cupressus macrocarpa*, Sycamore, Lime, Elm, Cherry and Leylandii).

The southern portion, along Blackrock College, comprises a plinth wall and iron railing extending from the main entrance to the college to Castledawson Avenue. Behind the railing is a landscape bed which contains a series of early mature Lime, Sycamore and Cherry trees (150-300mm dbh) in fair or good condition spread out along its length, with the trees less numerous towards the southern end. Set back from the roadside tree line and behind an internal pathway, is a second line of larger mature trees (mainly Horse Chestnut) that runs parallel to the boundary fence.

Blackrock Clinic is located just south of Blackrock College and there are several mature trees including Beech (*Fagus sylvatica*), Sycamore and Horse Chestnut (Aesculus hippocastanum) established in landscape beds close to the entrance drive (see image 10 below); the late mature Beech to the north of the entrance is showing early signs of decline.

The eastern side of the road runs alongside the northern part of Blackrock Park; here mixed species trees are established along the route just inside the park limits (1-3m from the pavement edge); the species mix includes Horse Chestnut, Lime, Hornbeam (*Carpinus betulus*), Sycamore, Cherry Plum, Flowering Cherry, Birch (*Betula spp*.), Field Maple (*Acer campestre*), Hawthorn (*Crataegus monogyna*), Poplar, Holm Oak (*Quercus ilex*), Beech and Locust Tree (*Robinia pseudoacacia*). The trees are in mostly fair condition; mostly early mature in age class and 200-400mm dbh. 1 larger mature Horse Chestnut (700mm dbh) is in poor condition due to infection by Bleeding Canker. Several trees have branch growth extending out over the pavement.

The southern part of the park borders the road from Phoenix Terrace to the junction of Mount Merrion Avenue; here parkland trees are growing on the bank sloping down away from the pavement area, behind a wall separating the park from the street. The northern area is sparsely populated with Flowering Cherry trees and southern section more thickly covered with mature and early mature Sycamore, Whitebeam,

Lime, Cedar (*Cedrus spp.*) and Monterey Pine (*Pinus radiata*) of moderate to low quality/value. Mature and early mature Leylandii and Cherry form a linear group behind a large wall at the far southern end of the survey area opposite the Mount Merrion Avenue junction.

On the west side of the Rock Road there are several shrubs and small trees (including 1 early mature Maple) along the edge of the pavement outside the Sion Hill complex; more significant trees are growing inside a boundary wall to the north of the Mount Merrion Avenue junction; this is comprised mostly of mature Leylandii and Cherry (see image 11 below).

Image 10 showing entrance to Blackrock Clinic and grounds of Blackrock College to the right of the picture

Image 11 Rock Road just north of the junction with Mount Merrion Avenue; note mature Leylandii behind stone walls on both sides of the street.

5.5 Blackrock Park Cycle Track

The existing cycle route through Blackrock Park runs mostly along the eastern edge of the park; parallel with the DART line, there are few significant trees along most of its length; however the section east of the lake is lined by an avenue of early mature Elm and *Acer* in fair condition (see image 12 below). These trees are 200-400 mm dbh and are set back 3m or so from the paved cycle route.

There are 2 mature trees (500-600mm dbh) just east of the bandstand, close to the proposed new bridge; these trees (a Sycamore and an Austrian Pine) are in fair condition and are of moderate value.

Image 12 Looking south along the existing Cycle route east of the lake in Blackrock Park.

6.0 Comments/Conclusions

The northern section of the survey area contains a series of significant mature specimen trees of high landscape and amenity value. The trees are located along the 800m section of road between Ailesbury Road to the north and the Strand Road to the south. The trees are rated as being BS 5837 category A trees with considerable life expectancies (40+ years).

These trees (London Plane and Lime) are growing within the paved area of the public footpath (between the edge of the public realm and road carriageway) and are highly vulnerable to root damage should major construction works take place in close proximity to their stems and root systems.

The actual spread and extent of the root systems is difficult to gauge because root growth may be restricted or uneven in an urban environment; however based on the recommendations contained within BS 5837:2012 *Trees in relation to design, demolition and construction- Recommendations* root protection measures should extend for a distance of 12x the stem diameters from the trees; in many cases this will be 5-9m. Work can be undertaken within this area or root protection zone (RPA) but it must be properly planned and supervised or serious damage can be done to tree root systems, sometimes leading to the premature death of the tree.

The group of mature Lime trees just south of the Merrion Gates are of lesser value (category B) than the larger street trees to the north but are still worthy of retention in the landscape (with the exception of the 1 dead tree in the group which should be removed).

The proposed link between Merrion Road and the Strand Road would likely impact on the trees and hedge along the southern edge of the church car park and trees within the grounds of the Bank of Ireland; this should be a consideration when planning the works; the mature Poplar close to the DART line is in poor structural condition and should be considered for removal.

The vast majority of the other trees along the route are located on ground set back from the road and pavement; in many cases behind substantial walls that will have severely limited any root spread towards the roadside. These trees place much lesser constraints on any works that are proposed along the roadside, but will still need to be considered to some degree, especially the areas along the edge of the northern end of Blackrock Park and the trees on either side of the school entrance off the Rock Road.

The larger trees adjacent the internal park cycle trails are of mostly moderate value (category B) and should be considered suitable for retention within any new layout; and accorded sufficient protection during any planning and design work where practicable.

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FEASIBILITY STUDY AND OPTIONS ASSESSMENT REPORT

D2 - Grade Separation of Merrion Gates Feasibility Study Report

AECOM ROD
ROUGHAN & O DONOVAN

Grade Separation of Merrion Gates

Feasibility Study Report

FINAL

August 2009

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Grade Separation of Merrion Gates

Feasibility Study Report

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Grade Separation of Merrion Gates

Feasibility Study Report

TABLE OF CONTENTS

1.0 INTRODUCTION

Roughan & O'Donovan have been engaged by Iarnród Éireann to assess the feasibility of removing the level crossing at Merrion Gates. The Dart line / east coast railway crosses Strand Road at the junction with Merrion Road in Merrion in southeast Dublin.

Merrion Gates is situated along the coast on the south eastern border of Dublin City Council (DCC) administrative area with Dun Laoghaire – Rathdown Council. Merrion Gates has long been a bottleneck in the Dublin road network, and this has been exacerbated with increased frequency of Dart movements over the past decade. Strand Road is an important strategic route and in the absence of the Dublin Eastern Bypass motorway, forms a de facto eastern ring road of the city, linking to the East Link through Sandymount and the N11 via Booterstown Avenue / Mount Merrion Avenue. The route also provides access to the Port from the south city, although the recent HGV ban has diverted much of the truck traffic to the Port Tunnel (and East Link for access to the South Port).

Merrion Gates is a CCTV controlled level crossing. As such, while the gates operate on an automatic basis, train passage is controlled remotely and trains have to wait for a signal before they may proceed through. Train speeds are much reduced under these arrangements, with considerably longer road closure periods as a result. Typical closure periods last of the order of 3.5 minutes; however, these can accommodate two trains passing each other during one closure.

The site location is illustrated on **Figure 001** and the study area is shown on **Figure 002**. The existing arrangement is shown in the photo below.

View of Merrion Gates from Elm Park Development

View of Merrion Gates from Strand Road

2.0 BACKGROUND & CONTEXT

The removal of the level crossing at Merrion Gates has long been an objective of various transportation policy documents for the Dublin area, including Platform for Change, the DTO strategic vision for the Dublin transportation network to 2016 (now envisaged to be implemented by 2023). The scheme was included in former designs for the Dublin Eastern Bypass, where a new route would be constructed outside and parallel to the railway line to the approximate location of Booterstown Dart station, where it would link with the Eastern Bypass via a half interchange. This has however been omitted from more recent designs for the motorway scheme, and as such, the grade separation of Merrion Gates is now being considered as a separate standalone project. The proposed solutions will improve access by removing the Dart dominated crossing, thus reducing the vehicle static times and improving circulation for commuters travelling north and south on the eastern side of Dublin, and will play a key role in relieving congestion in the southeast city area.

Rail safety is a key consideration in assessing the medium term desirability of retaining the existing arrangements at Merrion Gates. 16 trains, with up to 1,600 passengers on each traverse the crossing during both the morning and evening peak hours. During each of these same periods, about 1,600 cars cross the railway. As such, the potential for incident is significant.

Despite the fact that the level crossing at Merrion Gates is controlled by CCTV, a system generally regarded as inherently safe, the crossing is rated the 16th most dangerous in the country by Iarnród Éireann's 'Sotera' risk assessment process. This ranking arises from the large number of vehicles crossing the railway (and the associated increased risk of incident) and the likely severity of any incident that might occur.

Iarnród Éireann is in the process of an extensive project to remove or upgrade railway level crossings with a view to enhancing safety. While Merrion Gates is already operated under CCTV control, the level of activity at the crossing, together with the strategic importance of the DART Line for the Dublin commuting population, is such that consideration of further improvement is warranted.

Several other engineering projects are in the advanced planning stages in the immediate vicinity of Merrion Gates. The principal among these are:

- Sutton to Sandycove Coastal Cycleway / Walkway scheme (S2S);
- South Dublin Bay Coastal Protection scheme.

It is anticipated that there will be a considerable degree of overlap between the above two projects, the former of which is a cross city pedestrian / cycleway project in three phases and the latter is a scheme to provide flood defence for the 50 year design horizon, prior to the construction of more ambitious measures, as envisaged in the Strategic Vision for Dublin Bay, being developed by DCC.

DCC has requested that the options for the Merrion Gates grade separation scheme take account of the objectives of the S2S scheme and associated flood defence works.

Flood Defence Measures at Merrion Gates

3.0 DATA COLLECTION

An extensive data collection exercise has been undertaken so as to establish a comprehensive understanding of the baseline conditions in the area in order to identify all constraints to the construction of the proposed level crossing removal. The following data has been collated for use in the feasibility study:

- OSi vector mapping of the area;
- County Development Plan from DCC;
- Orthographic photography of the area;
- Available topographical data for the area;
- Recent planning lists;
- Construction drawings for the Elm Park development access from Merrion Road;
- Sutton to Sandycove (S2S) Walkway and Cycleway constraints study
- Services details for the area;
- Traffic Count Data.

All of the above have been collated and used in the preparation of this Feasibility Report. Route options were developed taking into account the above information, as well as the physical, environmental and engineering obstacles, which will determine the route and design of the scheme.

4.0 CONSTRAINTS STUDY

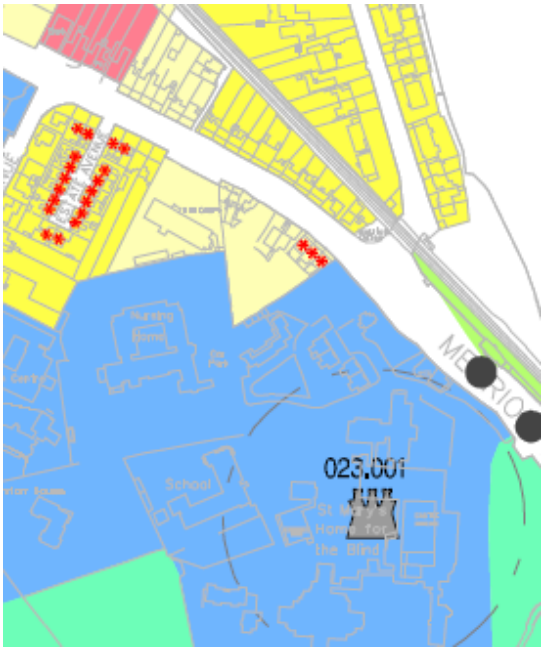
The constraints study area for the proposed level crossing removal is indicated in **Figure 002** in **Appendix A**. The area runs from Merrion Shopping Centre to Booterstown Marsh, and from Sandymount Strand to west of Merrion Road/Rock Road. However, the area of influence extends further in traffic terms, as the scheme will have an impact on traffic in the surrounding area. The study area is predominantly residential, with some commercial property including the new Elm Park Development and institutional uses including St. Vincent's Hospital and the St Mary's Complex.

Merrion Gates is located in a particularly constrained location, which has prevented the implementation of a grade separation scheme to date. However, to our knowledge, no comprehensive study has yet been undertaken assessing the options for bypassing the existing crossing. The following presents an outline of the likely key constraints to the development of alternative crossing solutions:

4.1 Archaeology, Architecture and Cultural Heritage

There are a number of isolated cultural heritage sites within the study area that the proposed scheme should seek to avoid if practicable. The Record of Monuments and Places (RMP) identifies national monuments in the area. DU023 is recorded as the site of Merrion Castle (currently the site of St Mary's Home) within this area DU023-001001 is Classified as a Castle or Tower House. In addition the site holds the RMP site of DU023-001004 Stone Head just to the south of the proposed development.

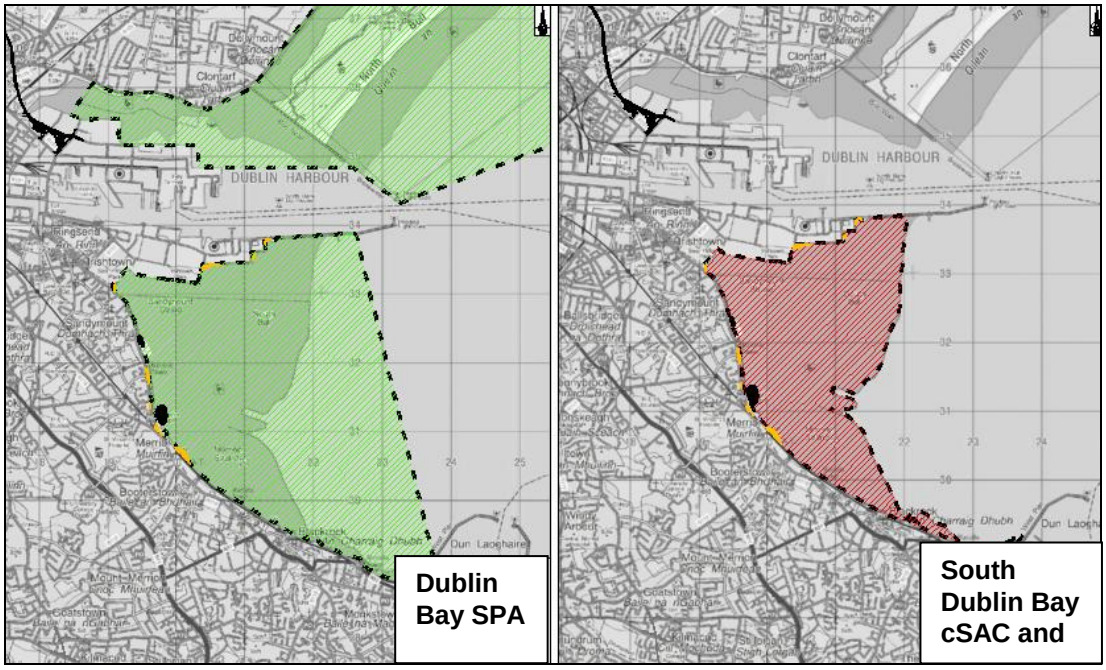
A number of structures are listed on the Register of Protected Structures of Dublin City Development Plan. Three houses are protected for architectural heritage where Merrion Road meets Strand Road. A number of houses are protected for architectural merit at Estate Avenue.



Extract from Dublin City Development Plan outlining protected monuments and structures within the study area.

4.2 Flora and Fauna

There are major ecological constraints in the Dublin Bay area. All of the inter-tidal area is designated as a candidate Special Area of Conservation (cSAC) under the EU Habitats Directive; a Special Protection Area (SPA) under the EU Birds Directive and a proposed National Heritage Area (NHA).



Designated Areas in Dublin Bay

The principal species of ornithological interest in South Dublin Bay are wintering waterfowl and roosting terns. The south bay holds 2 internationally and 8 nationally important numbers of bird species which feed and roost in the bay area. South Dublin is afforded protection because of the extensive area of priority habitats that are found there including:

- Intertidal and mudflats
- Shifting dunes along the shore line and
- Annual vegetation of Drift lines

A bed of Dwarf Eelgrass (Zostera spp.) is found on the bay, close to the shore at Merrion Gates and is one of the largest stands on the east coast. This bed is of significant importance for feeding Brent geese and also provides a habitat for a range of invertebrates.

Bed of Dwarf Eelgrass at Merrion Gates

Brent Geese Feeding on Dwarf Eelgrass Bed

Roosting at high tide is limited on the bay but the height of the sediment banks allows for some roosting birds on most tides. This is especially the case from Merrion Gates to Booterstown, which remains uncovered or else covered by shallow water allowing birds to remain. Any loss of habitat for birds feeding at Merrion Gates would pose risk to population of Brent Geese. Loss of intertidal flats near the shore line would deprive waders of high tide roosts.

Disturbance would deprive birds of feeding for the duration of the period of disturbance and afterwards until macro-invertebrate population become re-established. The Zostera bed could also be adversely affected by deposited sediments. Winter time disturbance would potentially affect the largest number of birds when feeding pressure is at its highest. If disturbance is close to the shore line then this may deter birds from roosting on exposed sands at high tide.

4.3 Landscape

The study area is largely residential in nature and the area is afforded excellent views overlooking South Dublin Bay. Protection of existing views across the Bay is an objective of the Dun-Laoghaire-Rathdown County Council Development Plan 2004-2010. Any proposed development will need to be sympathetic to the surrounding environment.

View across Dublin Bay from Elm Park Development

4.4 Utilities

Merrion Road is a key services artery into and out of Dublin City Centre. Among the more significant services running along the route below ground are:

- Principal trunk watermain (c. 600mm Ø) into Dublin City Centre;
- High voltage (110KV) ESB connection from Ringsend to Blackrock;
- 250mm high pressure Bord Gáis steel transmission main;
- 800mm x 600mm Nutley Stream culvert;
- 1000mm x 800mm trunk sewer;
- 450mm Overflow Sewer;
- NTL and Eircom ducts.

These utilities will pose a significant constraint to all of the options but in particular would complicate any subsurface proposal considered.

4.5 Traffic

Within the greater Dublin area, the primary routes for travel between the north and south is the M50 to the west, the N11 route through the centre of the city, Merrion Road and Strand Road to the east. Both Merrion Road and Strand Road form part of strategic routes in the Dublin transportation network, in the case of the former, a key radial route, linking the south eastern suburbs to the city centre, and in the case of the latter, a key orbital route, forming a de facto eastern ring road of the city. As such, both routes carry significant volumes of traffic, in particular during peak periods. It should also be noted that Strand Road and the east link form a more attractive orbital route for people living in the south eastern suburbs as the nearest interchange to the M50 is almost 4.5km away at Sandyford, which is very unappealing route to motorists at rush hour.

Traffic projections for the key roads for 2009 are shown in the table below based on survey information from 2203, the Elm Park Development EIS and NRA traffic growth factors.

Table 1: Peak Hour Traffic Flows at Merrion Gates (2009 Estimated)

Merrion Gates Level Crossing	AM Peak (08.00-09.00)		PM Peak (17.00-18.00)		Approx. AADT
	Entry Flow	Exit Flow	Entry Flow	Exit Flow	
Merrion Road	1334	1406	1767	1242	35057
Rock Road	2014	1765	1652	2382	47943
Strand Road	805	847	773	698	19163

From the table above, there is a demand flow of approximately 1,650 cars to cross the level crossing during the morning peak hour.

The traffic projections for Merrion Road and Rock Road may be slightly overstated as traffic capacity has been reduced since 2003 with the construction of a Quality Bus Corridor along the route. The demand for the Strand Road / Merrion Road route is however unlikely to have diminished due to the lack of availability of alternative modes or routes. This traffic is also likely to increase with the realisation of development aspirations for the Poolbeg Peninsula, which will exacerbate existing capacity deficits in the Ringsend area, congesting the northern section of Strand Road and Beach road.

The Eastern Bypass study predicted traffic volumes of the order of 23,000 AADT on Strand Road and 29,000 AADT on Merrion Road in 2016. Even following the construction of the motorway scheme, traffic volumes of 18,000 AADT on Strand Road and 26,000 AADT on Merrion Road are predicted. This suggests that the grade separation of Merrion Gates is a scheme that should proceed, even if the Dublin Eastern Bypass is constructed in the future.

According to current timetables from the Iarnród Éireann website, there are 8 northbound and 8 southbound trains between the hours of 0800 and 0900 and the same number between 1700 and 1800. While some of these trains coincide and pass each other during a single closure, the crossing is nonetheless still closed for approximately 50% of the peak hour. This leads to long queues and delays inbound during the morning peak hour and outbound during the evening peak hour.

4.6 Land Use and Planning

There is currently a mix of land uses in the study area, between residential, commercial and institutional uses. Strand Road is primarily residential, with 22 properties of note fronting onto Dublin Bay on the immediate approach to Merrion Gates. There is a vacant state-owned office building on the western side of Strand Road (formerly Forfás), which may provide an opportunity for a new route. This route would emerge in the grounds of Merrion Church on the opposite side of the Railway Line. There is an existing pedestrian overbridge across the railway at this approximate location.

There is a complex of institutional facilities immediately to the south of the three protected structures fronting on Merrion Road, across from Merrion Gates. There are no known development aspirations for these lands.

A significant development has recently been completed at Elm Park in the southern section of the study area. Elm Park will consist of a 5 storey hospital, 168 room hotel, 42,500 sq metres of offices, 220 residential apartments, and 101 housing units

for the elderly, as well as some amenities such as cafes and newsagents, with 1300 units of associated car parking. There is a new signalised junction on to Merrion Road 175m south of Merrion gates serving this new development. The developer has also purchased the adjacent Tara Towers Hotel and intends to redevelop that site to a higher density.

Several planning applications have been submitted for lands between the Swiftpost depot and Booterstown Marsh approximately opposite the Elm Park development on the Merrion Road. Planning permission has not however been granted due to issues of prematurity in the context of long term aspirations for the Eastern Bypass.

All further development would be expected to further exacerbate congestion on the road network centred on Merrion Gates, particularly during peak hours.

4.7 Existing Road Network

Any proposed grade separation of Merrion Gates will be constrained in as much as it will have to allow for continued connectivity to the existing road network, both in terms of through roads and local access. Strand Road is currently a two-lane single carriageway road; Merrion Road / Rock Road has two traffic lanes in each direction, as well as a bus lane each way. Initial discussion with Dublin City Council and Dun Laoghaire – Rathdown County Council have indicated that it may be acceptable to remove sections of the bus lane in the interests of improving through flow for all vehicles. This permits the possibility of lane-drop / lane-gain arrangements for options with southbound slip road connectivity only onto Merrion Road.

4.8 Design Standards

Generally speaking, new road schemes should be designed to conform to the NRA Design Manual for Roads and Bridges (DMRB). It is however acknowledged that is not always practicable in constrained urban environments. The constraints at Merrion Gates are such that a lower design standard is likely to be adopted for horizontal curvature and vertical alignment.

The DMRB specifies a maximum vertical gradient of 8% for non-national single carriageway roads. Again, depending on the solution adopted, this may not be achievable. However, there are several other key considerations in relation to vertical gradient, as follows:

- It is anticipated that there will be a proportion of truck traffic along the route, for which it is undesirable to have a gradient in excess of 6%;
- An initial consultation has been held with Dublin City Council Project Office, who have requested that a link be provided to the S2S scheme as part of the project, which would enforce additional limitations on the gradient, most likely an upper limit of 5% for the mobility impaired.

Other design standards, such as facilities for the Mobility Impaired and Disabled (MID) at junctions will be adopted in the final design of the scheme. In addition, any service diversions proposed will have to conform with the requirements of the relevant service providers.

Clearance requirements above roads and railways have been assumed for the purposes of this initial study to be:

- 4.9m vertical clearance over railway;
- 5.3m vertical clearance over roadways.

5.0 ROUTE OPTIONS

In order to fully assess the feasibility of the proposed scheme, it is necessary to identify a range of possible options and undertake an outline initial assessment of each. Initially, several broad options were considered and these are discussed in turn below. Following that, refinements to the broad options are assessed in more detail.

5.1 Broad Options

An initial overview yielded three broad corridors for a route for an alternative railway crossing, as follows:

- Crossing at the approximate location of the existing crossing, i.e. between the crossing and the petrol filling station 160m to the south along Merrion Road;
- Crossing to the north of the existing crossing, although there is limited opportunity to pass through the large number of residences and businesses;
- Crossing to the south of the Swiftpost depot on Merrion Road, approximately 250m south of the existing crossing.

5.1.1 New Crossing near the Existing Crossing

While a new crossing near the location of the existing crossing would face several challenges, including visual impact, environmental constraints, disruption during the construction stage and potentially archaeology, the cost advantages of a shorter route, together with the relative unattractiveness of and/or limited range of possibilities associated with the other broad options dictate that this option merits further study.

5.1.2 New Crossing north of the Existing Crossing

A new crossing to the north would have the obvious advantage of avoiding the designated protection and conservation areas within the Strand area, as all major associated works would be located inland. However, a quick review of aerial photography and Ordnance Survey mapping indicated little opportunity to construct a new crossing without extensive property acquisition and demolition. One potential route exists through the grounds of the old Forfás offices on Strand Road and the grounds of Merrion Church on Merrion Road. This option is considered further in later sections.

5.1.3 New Crossing south of Swiftpost Depot

A new crossing to the south of the Swiftpost depot has been mooted as a possible solution for the grade separation of Merrion Gates for quite some time. However, an analysis of the constraints has suggested that this option would prove very difficult and costly for the following reasons:

- Any new crossing at this approximate location would require considerable incursion into the designated Strand area and would, most notably, interfere with the embryonic dune formation at the mouth of Trimmleston Stream;
- There is an existing substantial three storey office building facing out onto the Strand between the petrol station and the Swiftpost depot on the east side of Merrion Road and a new route outside the railway at this point would have a severe visual impact at this location as it would have to ascend to minimise the impact on the embryonic dunes;

- The additional length involved would add significantly to the cost. The land costs would also be very high, as the landowner in question has significant development aspirations, despite the open space zoning.
- The descent to tie into Rock Road would be difficult in the short area available and the tie into the constrained and already busy Trimmlestown Avenue junction would be difficult in traffic terms.

It is therefore not considered worthwhile further investigating this option.

5.2 Option Development

Based on the foregoing discussion, two broad options have emerged for further investigation. In the case of a route north of the existing crossing, only one feasible option has been identified. Three further options have been developed for crossing in the vicinity of the existing crossing and these are assessed in turn below.

5.2.1 Route Option 1a: Online Overbridge Option

The most obvious solution is to construct an online up and over solution, with a spur to the side to service existing dwellings on Strand Road and an onward connection across Merrion Road. This solution will span across the railway lines at the current position of the Strand Road junction at a minimum vertical clearance from rail level of 4.9m and continue across Merrion Road at a minimum vertical clearance of 5.3m above the road surface.

This layout involves a lane-drop / lane gain arrangement on Merrion Road which will require the use removal of a short stretch of bus lane between the Elm Park junction and the St Mary's lands in the northbound direction. A more substantial length of bus lane will likely be removed in the southbound direction to facilitate traffic from Strand Road and Merrion Road merging. A ramp metering arrangement is not considered appropriate at this location.

The positioning of this option is such that it would have no impact on Dublin Bay and associated designated areas. The structure would follow the existing road layout at Merrion Gates closely, running just west of the existing Strand Road alignment while climbing to cross over the railway and Merrion Road (southbound lane). Based on information on the DCC Development plan, this route would have no impacts on any structures or locations of archaeological interest.

This route would however have a significant impact on the 22 houses along the shore side of Strand Road. These houses would be serviced from a new cul de sac along the existing Strand Road alignment, which would be overshadowed by the retaining structure required for the new road scheme. The interface between this cul de sac and the realigned road would be difficult.

The long-section indicates that a potential up and over solution could be achieved with a maximum gradient of 5%. An indicative route for this scheme is shown on **Figure 3** in **Appendix A**.

The main advantages and disadvantages of this option are summarised below:

<u>Advantages</u>

- No impact on South Dublin Bay;
- Relatively inexpensive;

- Limited property acquisition.
- No likely impact on sites of archaeological potential.

Disadvantages

- Severe visual impact along Strand Road and on one property on Merrion Road;
- Restriction on access from the south to houses on Strand Road;
- Potential need for acquisition and demolition of structures on western side of Strand Road;
- Potential need for acquisition and demolition of one property on eastern side of Merrion Road;
- Considerable traffic impact at construction stage;
- Removal of left-turn from Merrion Road to Strand Road.

Whilst this option would likely prove the least expensive, the impact on properties along Strand Road is such that it is considered infeasible and does not warrant further assessment.

Existing Character of Strand Road

5.2.2 Route Option 1b: Online Underpass Option

This variant solution would follow the same plan route as Option 1a, but would pass under the railway and Merrion Road. Due to the volume of traffic on the Dart line / east coast railway line, it is likely that the railway crossing would have to be constructed over the course of series of weekend possessions of the railway. The high water table and the presence of sands and gravels in the vicinity of the bridge would significantly complicate below ground construction. They would likely rule out insitu construction and precast box construction box under the railway. It is likely a contiguous piled solution would be required incorporating anchors under adjacent properties. This solution would cross underneath the railway lines at the current position of the Strand Road junction with a minimum vertical clearance of 5.3m from the road surface.

Again, this option would entail a lane-drop / lane-gain arrangement on Merrion Road. There would be considerable difficulties however in achieving forward visibility on the left turn from the underpass onto Merrion Road, where the geometry would be very constrained by the requirement for precast box construction. As in the case of Option 1a, the longsection indicates that a potential down and under solution could be achieved with a maximum gradient of 5%.

This option would require significant temporary works at construction stage, which would cause severe disruption on Strand Road and Merrion Road. In addition, very significant service diversions would be required, which would increase substantially the area of the dig. The constraints in close proximity to Merrion Gates would also require additional land area for construction of the underpass structure. The finished scheme would face flooding concerns and the positioning of the road below the water table in a tidal area would require a pumped drainage system. These systems can become inundated during severe flooding events, as recently evidenced in Belfast, when the West Link Tunnel had to be closed for several days.

The main advantages and disadvantages of this option are summarised below:

Advantages

- No impact on South Dublin Bay;
- Limited property acquisition;
- No likely impact on sites of archaeological potential.

Disadvantages

- Severance of access to lands to the east of Merrion Road;
- More expensive than Option 1a, with particular cost risk associated with major service diversions;
- Restriction on access from the south to houses on Strand Road;
- Potential need for acquisition and demolition of one property on eastern side of Merrion Road;
- Potential need for acquisition and demolition of structures on western side of Strand Road and one property on eastern side of Merrion Road;
- Considerable traffic impact at construction stage;
- Impacts on the groundwater table during the construction and operational phases;
- Removal of left-turn from Merrion Road to Strand Road;
- Limited room for temporary works area, likely need for piled construction along the alignment and through the railway leading to significant impact on railway traffic;
- The need for a pumped drainage system, the associated maintenance requirements and the associated risk of inundation.

Based on the above assessment, this option is less attractive than Option 1a, which was discarded and therefore has not been retained for further study.

5.2.3 Route Option 2: Offline Overbridge Option 1 – Loop on Strand Side

An alternative solution that would avoid any significant impact on the properties along Strand Road would be to construct a spiral ramp at the southern end of Strand Road

to cross the railway at the approximate location of the existing level crossing, with an onward connection across Merrion Road. Strand Road would be extended at its current level approximately 60m into the strand area parallel to the railway line. Beyond this point, the roadway would continue on a viaduct, swinging left on a 40m radius and ascending at a rate of about 5% before crossing over itself and the railway approximately 20m to the south of the existing crossing. This layout would again involve a lane-drop / lane gain arrangement on Merrion Road with the same layout and consequences as in the case of Option 1a.

This scheme would involve incursion into the South Dublin Bay cSAC, pNHA and SPA in close proximity to the bed of dwarf eelgrass near Merrion Gates. Suitable construction methods would have to be identified so as to avoid impacts on the eelgrass itself or on the hydraulic regime that sustains it. The viaduct could be constructed using discreet piles integral with the piers such that they could be driven as a single unit. Precast beams could then be lifted on top of the piers, once constructed. Appropriate craneage could be utilised to minimise impacts on the hydraulic regime.

Whilst this scheme has many advantages over the others considered, it would be subjected to detailed scrutiny at Appropriate Assessment stage, where it would have to be shown that no better solution exists and that there exists an overriding public interest to deliver the scheme.

An indicative route is shown on **Figures 004 & 005** in **Appendix A**.

The main advantages and disadvantages of this option are summarised below:

Advantages

- Limited impact on properties along Strand Road;
- Limited property acquisition;
- No likely impact on sites of archaeological potential;
- Limited traffic impact at construction stage.

Disadvantages

- Severe visual impact for one property on Merrion Road and one property on Strand Road;
- Potential impact on sites of ecological potential with South Dublin Bay cSAC, most notably the bed of Zostera Noltii near Merrion Gates;
- Potential need for acquisition and demolition of one property on eastern side of Merrion Road;
- Removal of left-turn from Merrion Road to Strand Road.

In spite of the concerns outlined above, it is recommended that this scheme be further investigated at preliminary design and environmental assessment stages.

Existing Environment for Option 2

5.2.4 Route Option 3a: Offline Overbridge Option 2 – Loop on Merrion Road Side

A further alternative, that would reduce the impact on the cSAC, would be to construct a ramp on viaduct from the southern end of Strand Road, climbing to a railway crossing further south (near the petrol station on Merrion Road) and to avail of open space in front of the St. Mary's complex on the western side of Merrion Road to loop back around to tie into Merrion Road. This ramp would ascend at a rate of 5% on the eastern side of the railway before crossing the railway on a skew and continuing across Merrion Road on a straight. The ramp would then descend at a rate of 5% - 6% through the grounds of St. Mary's on a 40-50m radius to meet Merrion Road at an at grade T junction.

The structure would follow the existing Bay edge parallel to the railway tracks, and would therefore only have minimal encroachment on the roosting areas and the bay itself. It is not foreseen that this option would have any significant detrimental impact on the designated bay area, as construction works would not be required in any of the more sensitive areas, nor would the works impact on any of the key hydraulic channels.

This option would offer the most flexibility in traffic terms, as all movements would be accommodated with the potential for a free flowing left movement towards the city. The scheme would however involve vehicles queuing on a gradient of 5% or more at a red light from the new link onto Merrion Road. This queuing would occur on a downhill gradient and as such would not cause as much concern as in the case of an uphill slope. As in the case of earlier options, this scheme would require some reorganisation of the lane configuration on the Merrion Road. Again, the removal or curtailment of bus priority measures could only be justified if it resulted in an improvement in through flow for all vehicles.

This option would entail substantial land acquisition at the St. Mary's complex and associated disruption to the parking, circulation and landscaping arrangements within its grounds. The structure would also have a severe visual impact for St. Mary's but the visual impact from other properties would be minor. Dublin City Council's Development Plan 2005-2011 identifies the central area of St. Mary's as a site of archaeological potential and this risk is therefore associated with Option 3a.

An indicative route for this scheme is shown on **Figure 006** in **Appendix A**.

The main advantages and disadvantages of this option are summarised below:

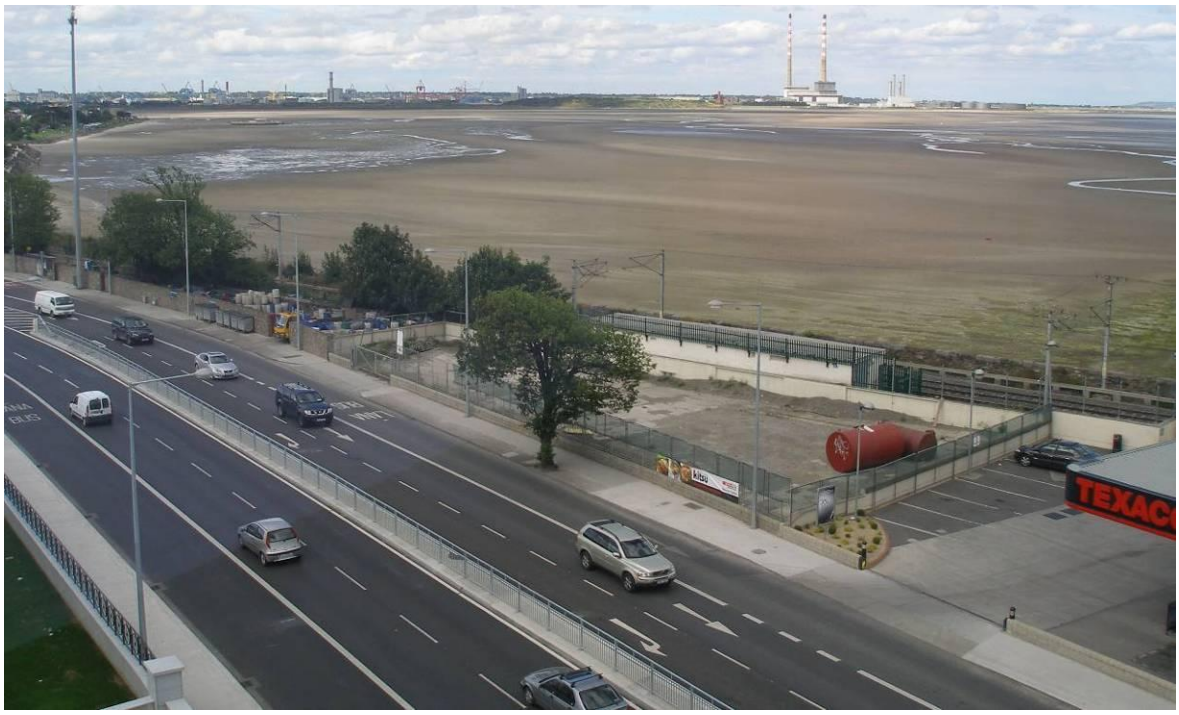
Advantages

- No impact on properties along Strand Road;
- Limited number of properties to be acquired;
- Limited traffic impact at construction stage;
- Unlikely to impact on sites of ecological importance;
- Most flexibility in terms of traffic movements accommodated.

Disadvantages

- Significant land acquisition and visual impact at St. Mary's complex and associated cost;
- Impact on site of archaeological potential at St. Mary's complex;
- Potential for contaminated land adjacent to petrol station on Merrion Road.
- Vehicles queuing on a gradient (downhill) on approach to Merrion Road.

In spite of the concerns outlined above, it is recommended that this scheme be further investigated at preliminary design and environmental assessment stages.



Existing Environment for Option 3

5.2.5 Route Option 3b: Offline Underpass – Loop on Merrion Road Side

This variant solution would follow the same plan route as Option 3a, but would pass under the railway and Merrion Road. Many of the same difficulties apply as in option 1b but more land would be available for jacking the precast underpass box under the railway. Also, the scheme would afford the same traffic flexibility as option 3a, albeit vehicles approaching the Merrion Road junction would do so on a 5% gradient or more, resulting in hill starts following a red light.

On the negative side, the extents of the excavations immediately adjacent to the railway line would pose concerns in relation to the embankment's stability and the

service concerns that applied to Option 1b would be greater in that diversion routes would be more circuitous. In all probability, all of the existing services would have to be routed around the loop within the grounds of St. Mary's, thus further extending the land requirement in the complex. The finished scheme would face the same flooding concerns as Option 1b.

The main advantages and disadvantages of this option are summarised below:

Advantages

- No impact on properties along Strand Road;
- Limited number of properties to be acquired;
- Limited traffic impact at construction stage (aside from Merrion Road crossing);
- Limited impact on sites of ecological importance;
- Most flexibility in terms of traffic movements accommodated.

Disadvantages

- More expensive than Option 3a, with particular cost risk associated with major service diversions;
- Significant land acquisition and visual impact at St. Mary's complex and associated cost;
- Impact on site of archaeological potential at St. Mary's complex;
- Potential for contaminated land adjacent to petrol station on Merrion Road;
- Impacts on the groundwater table during the construction and operational phases;
- Vehicles queuing on uphill gradient on approach to Merrion Road.

Based on the above assessment, this option is less attractive than Option 3a, however, it is the most attractive of the tunnelled solutions and should be further studied if the overbridge options are discarded.

Lands in front of St. Mary's Complex

5.2.6 Route Option 4: Crossing to North of Existing Crossing

As outlined in Section 5.1 above, one potentially viable route exists to the north of the existing level crossing. This crossing would avail of open space adjacent to the disused Forfás office complex on Strand Road and the car park of Merrion Church. This solution would span across the railway lines directly between Merrion Church and the Forfás offices at a minimum vertical clearance from rail level of 4.9m, and join Strand Road beside these offices. There are currently two vehicular accesses to the site so it would not be rendered unviable by the closure of one where the new route would tie into Strand Road.

The tie in to Strand Road would most likely take the form of a roundabout to be consistent with the other junctions along the route and having regard to the site constraints. This roundabout would not be full sized but would be a large mini-roundabout with the facility for larger vehicles to overrun the central island. This element of the works would require some encroachment into the promenade area to the east of Strand Road but would not affect the existing walkway along the seaside.

The tie in at the Merrion Road end would prove somewhat more problematic, due to the constrained road width at this point, on road parking and trees along the roadside. The junction would have to be signalised, with a less than ideal approach gradient on the new road in excess of 5%. The need for a right turn towards Strand Road would remain, thus reducing the efficiency of this solution in traffic terms. Notwithstanding, management of the lights sequence during the morning peak period, when the right turn demand would be highest, should be straightforward since the opposing outbound flow from the city centre would be relatively light.

This route would again avoid any impacts on Dublin Bay. It would also avoid archaeological impact and would entail little traffic disruption during the construction stage. This option would also entail limited (albeit potentially costly) property acquisition.

There would be overlooking of properties to the immediate north of the Forfás offices. The impact on Merrion Church would be significant and suitable alternative arrangements would have to be put in place for churchgoers. These could perhaps be accommodated in the former Forfás car park (or part thereof) if this were acquired. There is an existing pedestrian overbridge across the railway between the car park and the church grounds.

Merrion Church Car Park

An indicative route for this scheme is shown on **Figure 007**.

The main advantages and disadvantages of this option are summarised below:

Advantages

- No impact on properties along Strand Road;
- No impact on South Dublin Bay;
- Relatively inexpensive;
- Limited property acquisition;
- Limited traffic impact at construction stage;
- All traffic movements accommodated;
- No likely impact on sites of archaeological potential.

Disadvantages

- Severe visual impact at office complex, Merrion Church and nearby properties;
- Removal of a considerable portion of Merrion Church car park;
- Considerable reconfiguration of road layout on Merrion Road required, with potential requirement to reconfigure upstream and downstream junctions.
- Vehicles queuing on a gradient (downhill) on approach to Merrion Road.

It is recommended that this scheme be further investigated at preliminary design and environmental assessment stages.

Former Forfás Offices on Strand Road

5.3 Constructability of Route Options

For such a localised project, any of the schemes proposed above would require quite extensive and complicated civil engineering works in a constrained environment. It is anticipated that all bridge elements would be constructed from precast concrete beams, unless a desire emerges to construct a signature bridge at this location. It would be possible to cross Merrion Road with a single span under any of the arrangements proposed above.

The schemes will also involve considerable retaining structures adjacent to the existing carriageway of Merrion Road for construction of the merge and diverge ramps. An initial appraisal suggests that these would best be constructed using a reinforced earth solution. If a conventional retaining wall were used, the temporary works to construct the foundations would have a considerable impact on Rock Road. The multitude of services along this route would also pose difficulties. A piled solution is not favoured due to the additional expense and complex interfaces with services etc.

As noted previously, construction of Option 2 within the cSAC would entail considerable challenges, however, these merit further investigation before the option is dismissed.

5.4 Outcome of Options Assessment

Arising from this study, three options have been selected for further study. These are:

- Option 2: Spiral loop in the strand with overbridge across railway and Merrion Road close to existing crossing. This will now be referred to as **Option A**;
- Option 3a: Straight ramp from end of Strand Road with skew bridge crossing of railway and straight bridge crossing of Merrion Road with spiral loop in the grounds of St Mary's. This will now be referred to as **Option B**;
- Option 4: Crossing over railway through grounds of former Forfás premises and Merrion Church. This will now be referred to as **Option C**.

6.0 Traffic Modelling

A traffic model of the Rock Road / Merrion Road / Strand Road area has been developed to assess the performance of the three remaining options, A, B and C, from a traffic impact perspective. The model was developed using the S-Paramics modelling software, which accurately models driver behaviour in complex urban environments. A comprehensive data collection exercise was undertaken to inform the development of the model, involving the collation of the following information:

- Ordnance survey mapping;
- As constructed drawings of the Rock Road, Merrion Road and Elm Park access schemes;
- On site measurements to confirm any additional dimensions required;
- Turning count surveys at 8 junctions;
- Queue length surveys at 6 junctions;
- Journey length surveys along 6 routes.

The extent of the traffic model is shown on the diagram below:

Diagram 1: Extent of Traffic Model

The base year model was calibrated using the data assembled from the queue length and journey time surveys and produced an accurate representation of base conditions. Each of the three options was then coded into the model to assess the impacts of each. The following diagrams show the options coded into the model:

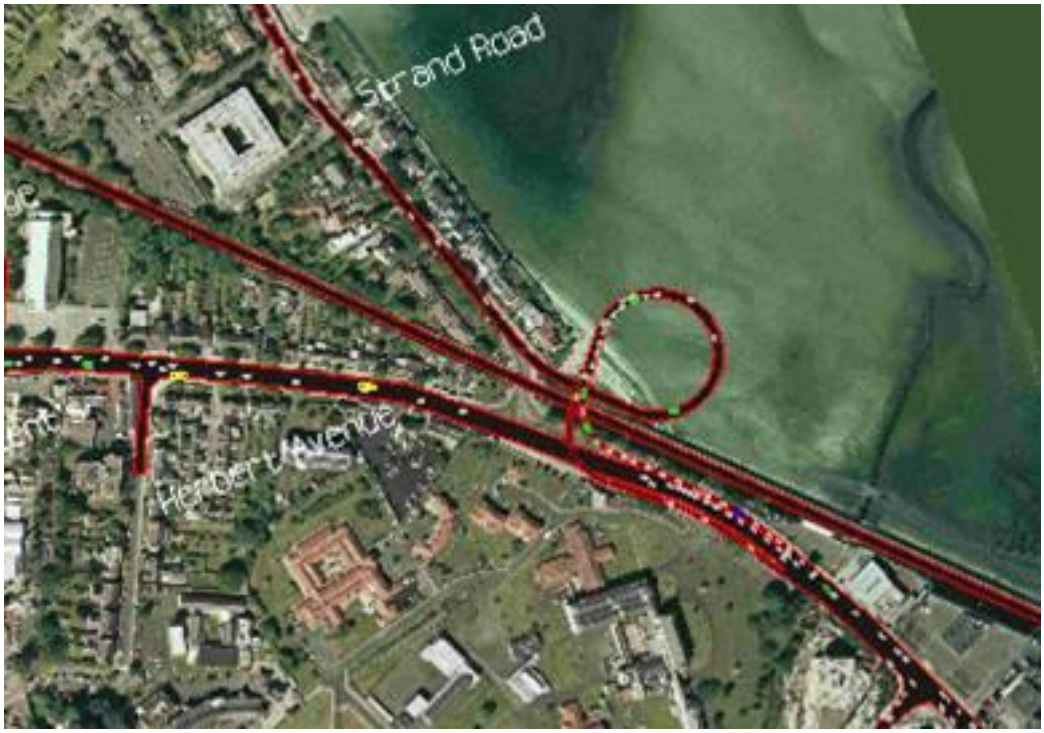


Diagram 2: Option A Traffic Model

Diagram 3: Option B Traffic Model

Diagram 4: Option C Traffic Model

The models were refined by adapting the existing road markings on Rock Road / Merrion Road and Strand Road to optimise the performance in each case. The outcome of the modelling process for each option is summarised below:

Option A

The free flow movement to Strand Road leads to a removal of inbound congestion on Rock Road during the morning peak period and congestion outbound on Strand Road in the evening peak is significantly improved. However, due to the volume of traffic outbound on Merrion Road and the proximity to the Elm Park junction, it is not possible to operate the slip road southbound on a free flow basis. As such, signals are required at the base of the southbound slip to regulate flows.

The construction of this option would require the removal of the existing bus lanes on Rock Road for between the existing level crossing and the Trimleston Avenue junction. However, this would not result in any detrimental impact on bus travel times, as congestion would be removed entirely in the northbound direction, thereby rendering the bus lane redundant, and the signals at the base of the southbound slip could be programmed to prioritise bus throughput along the Merrion Road / Rock Road axis.

Option A has been shown therefore to have significant positive impacts on travel times at this location.

Option B

The left turn from Rock Road onto the new link can operate on a free flow basis and therefore achieves the same positive effect as in the case of Option A in terms of congestion relief on Rock Road (subject to the removal of a length of the bus lane on the approach to the diverge). The design of the new at grade signalised junction on Rock Road is such that it has significant capacity for peak outbound traffic movements during the PM peak hour and results in the removal of delays for traffic

during this period. However, the volumes of traffic southbound during the evening peak are such that the scheme would require the removal of the bus lane southbound as far as the Booterstown Avenue junction.

Option B presents opportunities not presented by the other options to potentially close other crossings nearer the city centre, as all traffic movements can be accommodated at the proposed new junction. While there would be other difficulties associated with the closure of such crossings, the lack of an alternative route has been a significant consideration in the justification of their retention to date.

As in the case of Option A, the removal of bus lanes in either direction will not have an appreciable impact on bus travel times, as the overall efficiency of the network will be improved and congestion will be removed. Option B has been shown to have the most beneficial traffic impact of the three options considered.

Option C

Option C does not achieve the same benefits as Options A or B, in that it retains the conflict between inbound traffic from Rock Road / Merrion Road to Strand Road and outbound traffic along Merrion Road / Rock Road (the other options allow for grade separation of this movement). Nevertheless, the removal of the level crossing from the equation leads to an improvement in inbound traffic flows during, most notably during the morning peak hour, and outbound flows during the evening peak hour.

The traffic modelling has not allowed for a right turn from the new link onto Merrion Road North, however, this could perhaps be revisited at a later design stage. As in the case of Options A and B, the scheme requires the removal of bus lanes in either direction, in both cases, along most of the roadway between the Nutley Lane and Elm Park junctions. This will have a marginal negative impact on inbound bus travel times during the morning peak hours, as congestion will be relieved, but not entirely removed, by this option. The impact on outbound bus travel times should not be significant.

Overall, Option C shows limited congestion relief compared to Options A and B, however, this has to be balanced against the much lower cost of the scheme. It should also be noted that the model allowed for retention of on-street parking along the eastern side of Merrion Road between the new junction and the existing level crossing, which compromises southbound traffic capacity. It is noted that this parking could potentially be relocated to redundant land at the location of the existing level crossing following the construction of the new link.

Model Outputs

The following tables and graphs summarise the key outputs of the traffic model in terms of the key performance parameters, namely, number of vehicles accommodated, average journey time per vehicle, total network minutes and queue lengths:

Table 2: Total Network Vehicles

Scenario	AM Peak	% Change	PM Peak	% Change
	Vehicles		Vehicles	
Base	7838		6975	
Option A	8208	5%	7287	4%
Option B	8265	5%	7340	5%
Option C	8173	4%	7314	5%

Table 3: Average Journey Time per Vehicle

Scenario	AM Peak	% Change	PM Peak	% Change
	Ave JT / veh		Ave JT / veh	
Base	8		9	
Option A	4	-45%	5	-39%
Option B	4	-46%	5	-40%
Option C	6	-25%	6	-28%

Table 4: Total Network Minutes

Scenario	AM Peak	% Change	PM Peak	% Change
	Network Minutes		Network Minutes	
Base	62481		60327	
Option A	35695	-43%	38366	-36%
Option B	35749	-43%	37961	-37%
Option C	48991	-22%	45415	-25%

The tables above demonstrate that Option B outperforms the others marginally in terms of the total number of vehicles accommodated and is marginally better the Option A in terms of total network minutes and average journey time per vehicle. Option C caters for almost the same number of vehicles, but journey times per vehicle are up to 50% longer than in the case of the option options, resulting in an increase in total network minutes of more than 20%. Nevertheless, the improvement over the base scenario in each instance is significant.

The following charts provide a useful visual representation of the benefits accrued by the three options in terms of journey times and queuing:

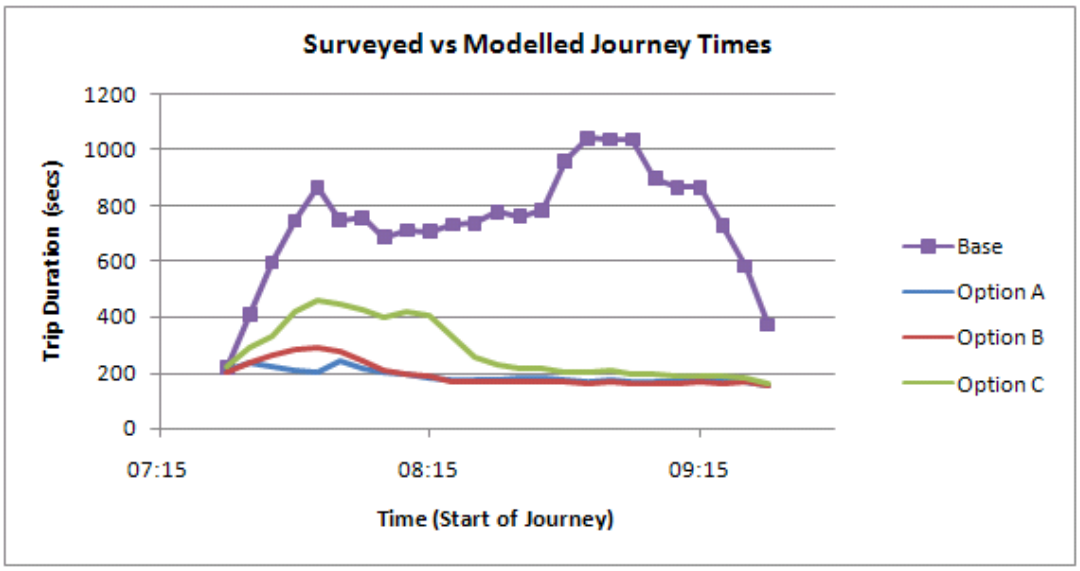


Chart 1: AM Peak Journey Times from Rock Road to Strand Road

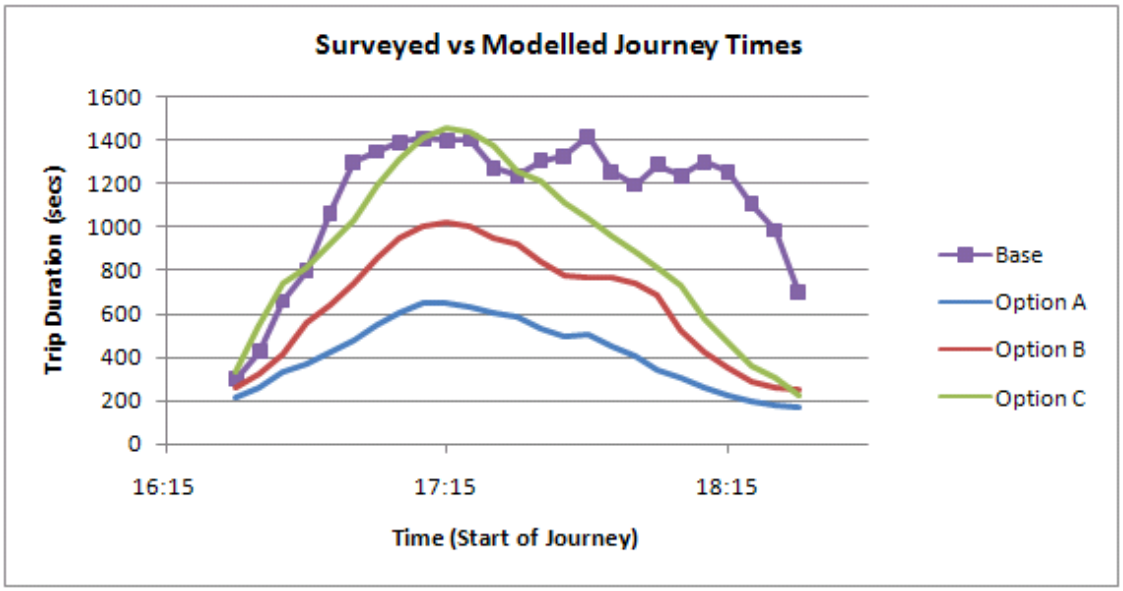


Chart 2: PM Peak Journey Times from Strand Road to Rock Road

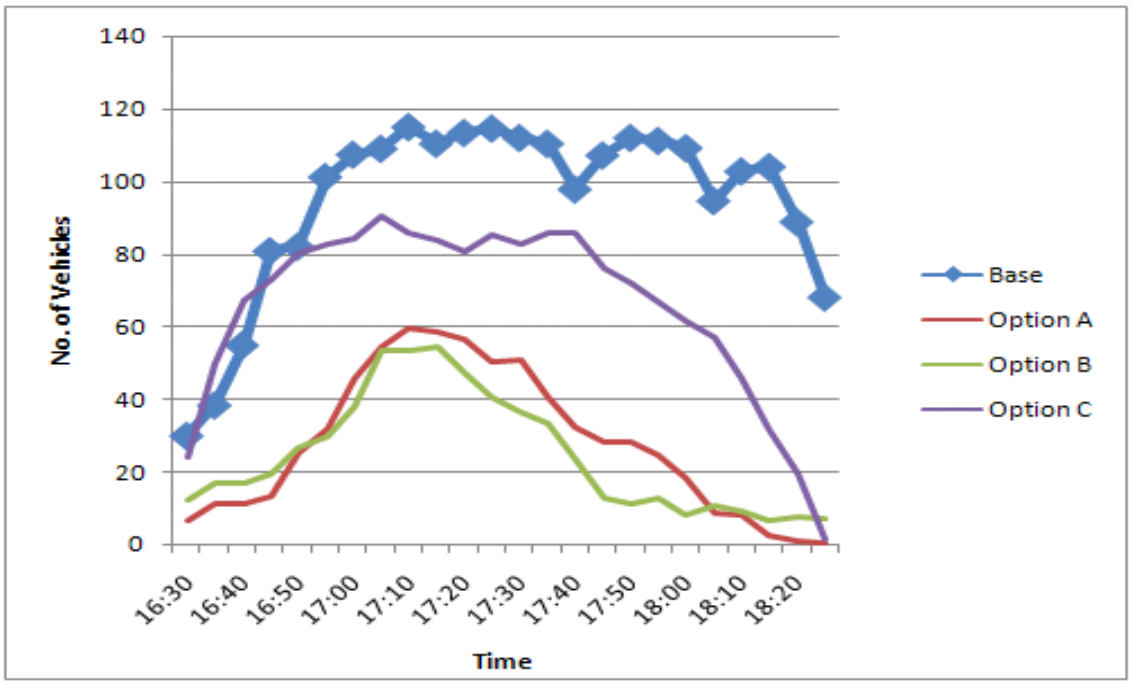


Chart 3: PM Peak Southbound Queue Length on Strand Road

The traffic modelling exercise has taken account of the impacts on the junctions at Nutley Lane, Trimleston Avenue and Booterstown Avenue. These signalised junctions have been shown to operate within capacity with any of the options in place, subject to adjustment of the lane markings as discussed and some optimisation of the signal timings.

There may be a concern about downstream impacts on junctions outside the modelled area as a result of flushing traffic through Merrion Gates. In terms of broader network impacts, the modelling work undertaken and our appraisal of general traffic conditions suggest that there will be a net benefit so long as traffic flows are managed on the surrounding network to complement the significant benefit accrued by the removal of the Merrion Gates bottleneck. No appreciable drop in level of service is anticipated, as entry flows to the traffic model area are regulated by the capacity of upstream junctions, except in the case of Strand Road arrivals. These can be addressed without the need for extensive works, as follows:

1) Strand Road to Blackrock Traffic

There is considerable capacity at the two lane entry to the Rock Road / Mount Merrion Avenue junction to permit a modest increase in southbound through flows without severe adverse effects. As the dual carriageway continues through Blackrock, the effect of the additional traffic will dissipate through the following junctions and the net impact will be almost imperceptible.

2) Strand Road to N11 Traffic

This traffic can use either Booterstown Avenue or Mount Merrion Avenue to access the N11. The right turn lane from Rock Road to Mount Merrion Avenue, while having good capacity, could become obstructed by queued ahead traffic southbound. This could be remedied by the removal of a short stretch of bus lane northbound on the Rock Road downstream of the junction and the extension of the right turn lane (this can be achieved simply by amending the road markings. This would have no detrimental impact on bus or

car travel times as traffic won't queue back that far from the Booterstown Avenue junction following the implementation of the improvement works.

A less intensive solution would be to alter the signal sequence at the Booterstown Avenue / N11 junction to permit the right turn from Booterstown Avenue before the right turn from the N11. This would clear the right turning traffic which obscures the left turning traffic at present, thereby improving the efficiency of the operation of the arm.

It is therefore anticipated that modest improvement works may be required at downstream junctions along the Strand Road to N11 route, however, these works would not be significant and would complement the level crossing removal to deliver a significant improvement in cross-city travel times.

Summary of Traffic Modelling Exercise

The traffic modelling process has shown varying degrees of positive benefit associated with the three options. Options A and B perform similarly well and result in removal of much of the congestion that currently occurs at this location. The more modest Option C provides less significant benefits but nonetheless provides a significant improvement over the existing situation at a much lower cost.

It is not anticipated that the scheme will result in significant adverse impacts on downstream junctions as a result of the release of additional traffic at Merrion Gates. Two downstream locations of possible increased congestion have been identified and simple, low-cost mitigation measures proposed to ameliorate any increase in queuing and delay that might arise.

7.0 Indicative Cost Estimate and Benefits Assessment

7.1 Cost Estimation

An outline costing exercise has been undertaken on the three options to have emerged from this Feasibility Study, A, B and C. These cost estimates have been prepared based on unit rates derived from the out-turn costs of other similar schemes and do not include for optimism bias uplift or other contingency. The three options have been costed as follows:

Table 5: Cost Estimate - Option A

Option A	Area (sqm)	Rate per sqm	Cost
At Grade	500	€200.00	€100,000.00
Bridge	3000	€3,500.00	€10,500,000.00
Total Embankment	4200	€750.00	€3,150,000.00
Junctions			€500,000.00
Subtotal (Construction)			**€14,250,000.00**
Land Area	1750	€500.00	€875,000.00
Total			**€15,125,000.00**

Table 6: Cost Estimate - Option B

Option B	Area	Rate per sqm	Construction Cost
At Grade	1350	€200.00	€270,000.00
Bridge	5050	€1,600.00	€8,080,000.00
Total Embankment	1900	€500.00	€950,000.00
Junctions			€400,000.00
Subtotal (Construction)			**€9,700,000.00**
Land Area	5750	€500.00	€2,875,000.00
Total			**€12,575,000.00**

Table 7: Cost Estimate - Option C

Option C	Area	Rate per sqm	Construction Cost
At Grade	250	€200.00	€50,000.00
Bridge	250	€1,250.00	€312,500.00
Total Embankment	3650	€750.00	€2,737,500.00
Junctions			€400,000.00
Subtotal (Construction)			**€3,500,000.00**
Land Area	3750	€500.00	€1,875,000.00
Total			**€5,375,000.00**

The rates used for each element of each option reflect the structural type and complexity of the element in question. For example, Option A requires a complex signature curved structure in an area with significant construction constraints, whereas simple beam and slab construction will suffice for the bridge in Option C. Similarly, Option B entails simple embankment construction in open space, while Options A and C require retained structures in constrained working environments.

In each case, a land value of €5,000,000 per hectare has been used. This is based on 2007 land costing studies for the Dublin Eastern Bypass, adjusted for the recent decline in property values. Should the scheme progress to preliminary design, a more detailed land costing exercise should be undertaken to refine this approximation. The effect of an increase in land costs is to broaden the cost differential between Options B and C, while a reduction in land value would have the converse effect.

7.2 Benefits Assessment

The NRA Project Appraisal Guidelines set out a detailed methodology for the assessment of the benefits associated with a new road scheme. This methodology covers, among others, travel time savings, vehicle operating cost savings and accident cost savings. For the purposes of this initial assessment, and to ensure robustness in the Benefit – Cost Ratio (BCR), travel time savings only have been considered. Based on the output of the traffic model, the following travel time savings have been identified for each option:

Table 8: Travel Time Savings

Rate per Hour: €14.00	Option A	Option B	Option C
Minutes	48,747	44,581	28,402
Hours	812.45	743.02	473.37
Saving	€11,374.30	€10,402.23	€6,627.13
Daily	€22,748.60	€20,804.47	€13,254.27
Weekly	€136,491.60	€124,826.80	€79,525.60
Annually	€7,097,563.20	€6,490,993.60	€4,135,331.20
30 years	€212,926,896.00	€194,729,808.00	€124,059,936.00

A value of time of €14.00 per hour has been used for the purposes of the above assessment, as it represents an approximation of the average of the rates for Working Time (€26.75 in 2009), Commuting Time (€8.19 in 2009) and Other Driving Time (€7.35 in 2009). These values have also been adjusted for car occupancy (1.23 for working, 1.20 for commuting and 1.85 for other). Different average values can be arrived at, depending on the flow groups constituting the traffic profile, and €14.00 represents a lower bound estimate that ensures benefits aren't overstated.

The Table above outlines the minutes time savings identified during the modelling periods (2 hours AM peak and 2 hours PM peak), which have then been converted to daily savings (multiplier of 2), and thence to annual and 30 year projections, 30 years being the normal return period for the purposes of benefit-cost analysis. On this basis, the following benefit-cost ratios have been calculated for the three options, taking account of travel time savings only:

Table 9: Benefit - Cost Ratios

Option	Cost	Annual Benefit	BCR
A	€15,125,000.00	€7,097,563.20	14.1
B	€12,575,000.00	€6,490,993.60	15.5
C	€5,375,000.00	€4,135,331.20	23.1

The table above demonstrates clearly that there is a very strong economic case for the grade separation of Merrion Gates. It further emphasises the detrimental effect of the existing arrangement on traffic flows, in demonstrating the significant time savings that could be achieved with its removal. It is noted that the benefits associated with Options A and B are far stronger than in the case of Option C, however, the much lower cost of Option C makes this option considerably more favourable from a purely economic perspective.

It is noted that there will be a significant benefit to rail users from the grade separation of Merrion Gates that is not included in the above assessment. This can be monetised, as follows:

> Should an incident occur at Merrion Gates during rush hour requiring the closure of the crossing for an hour, there would be a consequent delay to 16 trains that hour with knock-on delays for later services. Each train has a crush load of 2,000 passengers, based on 250 passengers per traincar in 8 cars. Assuming an average load of 1600 passengers per train, 25,600 people would be delayed in the peak hour and almost as many again the next hour until normal service resumes. Assuming an average delay of 1 hour for 25,600 passengers, and based on the average hourly value of time of €14.00, there would be an economic loss of over €350,000 associated with the disruption to train users, without taking account of the delays to road users.

It is noted that there has been 1 incident at Merrion Gates to date in 2009, 2 incidents each in 2007 and 2008 and an average of 3 a year for the previous 6 years and 5 incidents in 2000. In total, there have been 29 incidents over the past decade. Depending on the number of these incidents that affected rush hour flows, the potential savings from the removal of the crossing could have amounted to up to €10 million over the period.

Based on the foregoing economic assessment, it is recommended that the scheme be brought forward to planning.

8.0 Interface with Other Schemes

The potential for interface between the Merrion Gates Grade Separation and Sutton to Sandycove pedestrian / cycleway schemes (S2S) has been discussed with Dublin City Council as it is a requirement for the latter to provide connections to the existing pedestrian and cycleway network at 500m maximum intervals. The proposed scheme could provide such a connection across the railway at this difficult location.

In addition, the S2S scheme will face the same difficulties identified above continuing southward along the coastline from Merrion Gates, in particular at the embryonic dune formation at the mouth of Trimleston Stream beside Booterstown DART station. It is anticipated that the section to the south of Merrion Gates will face a lengthier planning process and staged construction of the scheme is therefore being considered. The proposed grade separation of Merrion Gates could provide a useful interim terminus point for the S2S scheme, although this would dictate a desirable maximum vertical gradient of 5% for all elements. This could be achieved with either of Option A or B, as outlined above. Option C would require a slightly steeper vertical gradient of 7% locally on the approach to Merrion Road.

Should the planning difficulties south of Merrion Gates prove insurmountable, the proposed scheme could form part of the Sutton to Sandycove route. There is sufficient space to construct a two-way cycle track in front of the existing buildings along the east side of Rock Road as far as Blackrock Park at Booterstown. Some encroachment on private properties would be involved, for example along the edge of the forecourt of the petrol station and into the landscaped strip in front of Merrion House. Further south there is space available in undeveloped lands opposite the Tara Towers Hotel, and along the top of the road embankment fronting onto the Booterstown Marsh Bird Sanctuary. Were the scheme to proceed on this basis, a short section of the overall route would be inland of the railway, which will provide easier connections to local roads and residential communities.

In the case of Option C, should the 7% gradient be considered an unacceptable standard for the S2S scheme (despite the short distance involved), a short pedestrian and cycle underpass could perhaps be constructed at the location of the existing crossing. Such an underpass would not face the same geometrical challenges as a vehicular underpass, as the headroom requirement and span would be much smaller.

Any of the Merrion Gates route options that encroach into the Strand area could incorporate flood defence measures. Whilst the measures would only be effective over a relatively short distance in the context of the larger flood defence scheme, it is not anticipated that there would be a difficulty in incorporating measures, subject to further discussions with the drainage department.

9.0 CONCLUSIONS

A desk study and site inspection identified several options for the removal of the railway level crossing at Merrion Gates. These options were assessed in turn and several dismissed on grounds such as environmental disturbance and construction complexity. Three options were deemed worthy of more detailed consideration, as follows:

- Option A: Continuation of Strand Road southward with an elevated loop through the Strand Area and southbound slip roads onto Rock Road.
- Option B: Continuation of Strand Road southward with westward loop across railway and Rock Road with connection to Rock Road through the St. Mary's complex.
- Option C: Link north of existing crossing through grounds of former Forfás premises and Merrion Church.

These options were tested using a specially developed S-Paramics model, which indicated significant benefits over the existing scenario in each case. Options A and B showed more significant benefits than Option C, however, these have been shown to be significantly more expensive through a preliminary cost estimation exercise. Nevertheless, all options considered have yielded a very strong economic case, with Benefit – Cost ratios as outlined in the following table:

Benefit - Cost Ratios

Option	Cost	Annual Benefit	BCR
A	€15,125,000.00	€7,097,563.20	14.1
B	€12,575,000.00	€6,490,993.60	15.5
C	€5,375,000.00	€4,135,331.20	23.1

The principal drawbacks associated with each of the options are as follows:

- Option A: Potential impact on designated bay area and visual impact on Merrion Road;
- Option B: Extensive land take (and associated cost) from St Mary's complex, as well as potential archaeological risk;
- Option C: Visual impact, disruption at Merrion Church and traffic management at either end.

These disadvantages should not detract from the wider benefits to traffic in Southeast Dublin of any of the above schemes by the removal of the Merrion Gates bottleneck. In addition, there would be considerable rail safety benefits from the removal of the crossing from the heavily trafficked Dart Line.

There is little to choose between Options A and B in terms of cost or traffic impact and the increased environmental sensitivity associated with Option A introduces a large planning risk that doesn't arise to the same extent with Option B. As such, Option A can be discarded on the basis of the assessment.

The study has concluded that there would be significant benefits associated with the removal of the level crossing at Merrion Gates and it is recommended that Options B

and C be retained for further study, with a view to bringing a scheme to planning and construction.

APPENDIX A

Figures

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Project Title	Merrion Gates			
Drawing Title	Location Map			
Date: July 2008	Scale: 1:100,000	CAD File: 99.175	Project No.: 99175320	
Drawn: KOD	Checked: EOC	Approved: SMG	Drawing No.: 001	Rev.: A

Legend:

A	Dwarf Eelgrass		Proposed Sutton–Sandycove Walkway/Cyclepath
B	Embryonic Dune Formation		
C	Roosting Areas		
	Elm Park Development		
	Rock Road/Merrion Road		
	Dart Line		
	Strand Road		

No.	Revision	Date	By	Chk'd	App'd
	Stage		Date		App'd
	PRELIMINARY				
	APPROVAL				
	TENDER				
	CONSTRUCTION				

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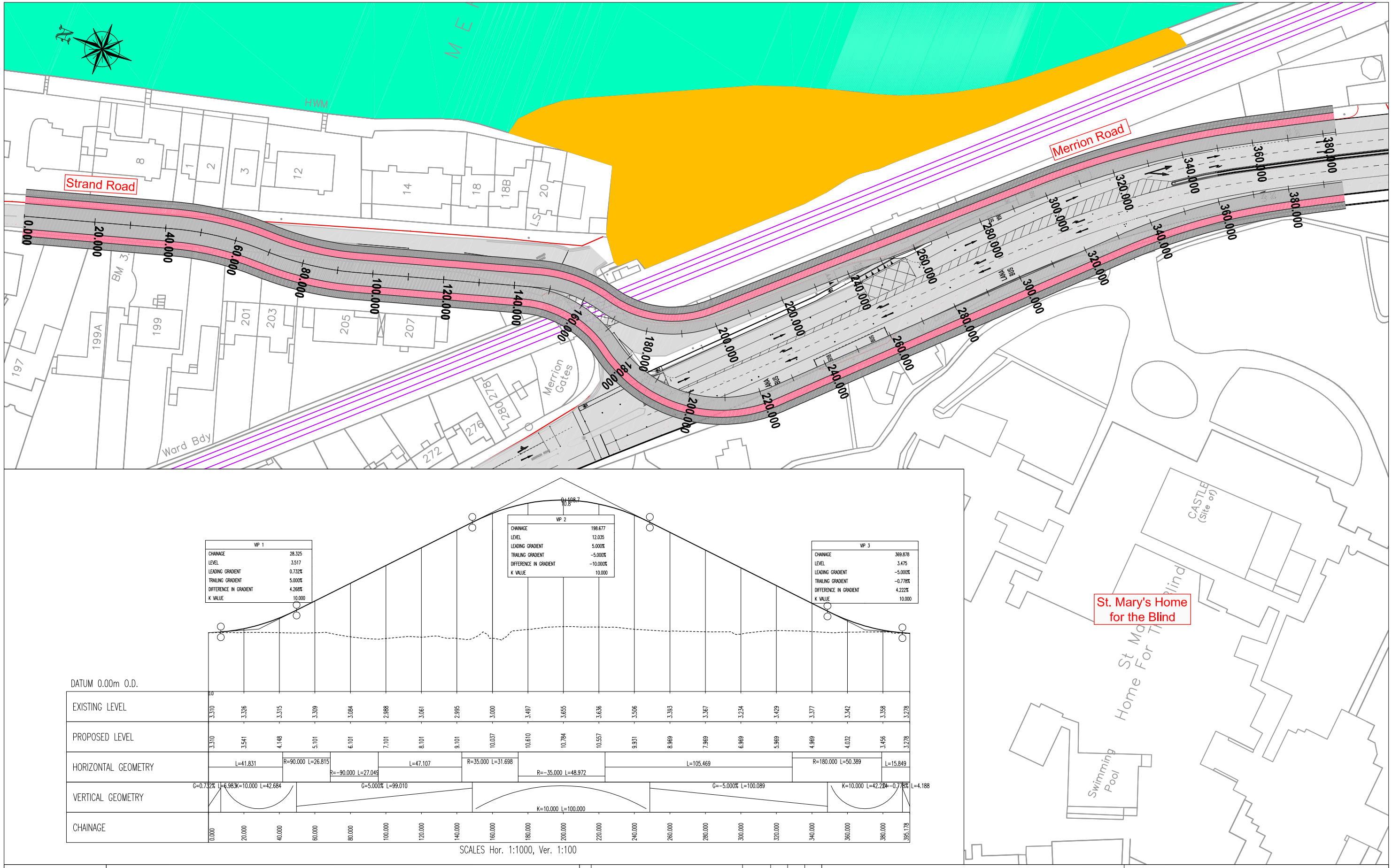
Designed:	Checked:	Approved:	Status:
FD	EOC	SMG	Feasibility

Project Title: Grade Separation of Merrion Gates Feasibility Study

Drawing Title: Study Area

Drawn:	Job No:	Drawing No:	Rev:
FD	99.175.320	002	

Scale: (A1)	Date:
1:2500	July 2008



SCALES Hor. 1:1000, Ver. 1:100

Legend

- Existing Road Edges
- Railway Tracks
- Roosting Area
- Dwarf Eelgrass

No.	Revision	Date	By	Chk'd	App'd
C	Corrections to Ramp Lengths	Aug 09	EOC	EOC	SMG
B	Tied into ARUP Markings	AUG 08	FD		
A	Road Markings added	AUG 08	FD		

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Designed: EOC | Checked: EOC | Approved: SMG | Status: Feasibility

Project Title: Grade Separation of Merrion Gates
Feasibility Study

Drawing Title: Initial Route Option 1

Drawn: FD | Job No: 99.175.320 | Drawing No: 003 | Rev: C

Scale: (A1) 1:500 | Date: AUG 2008

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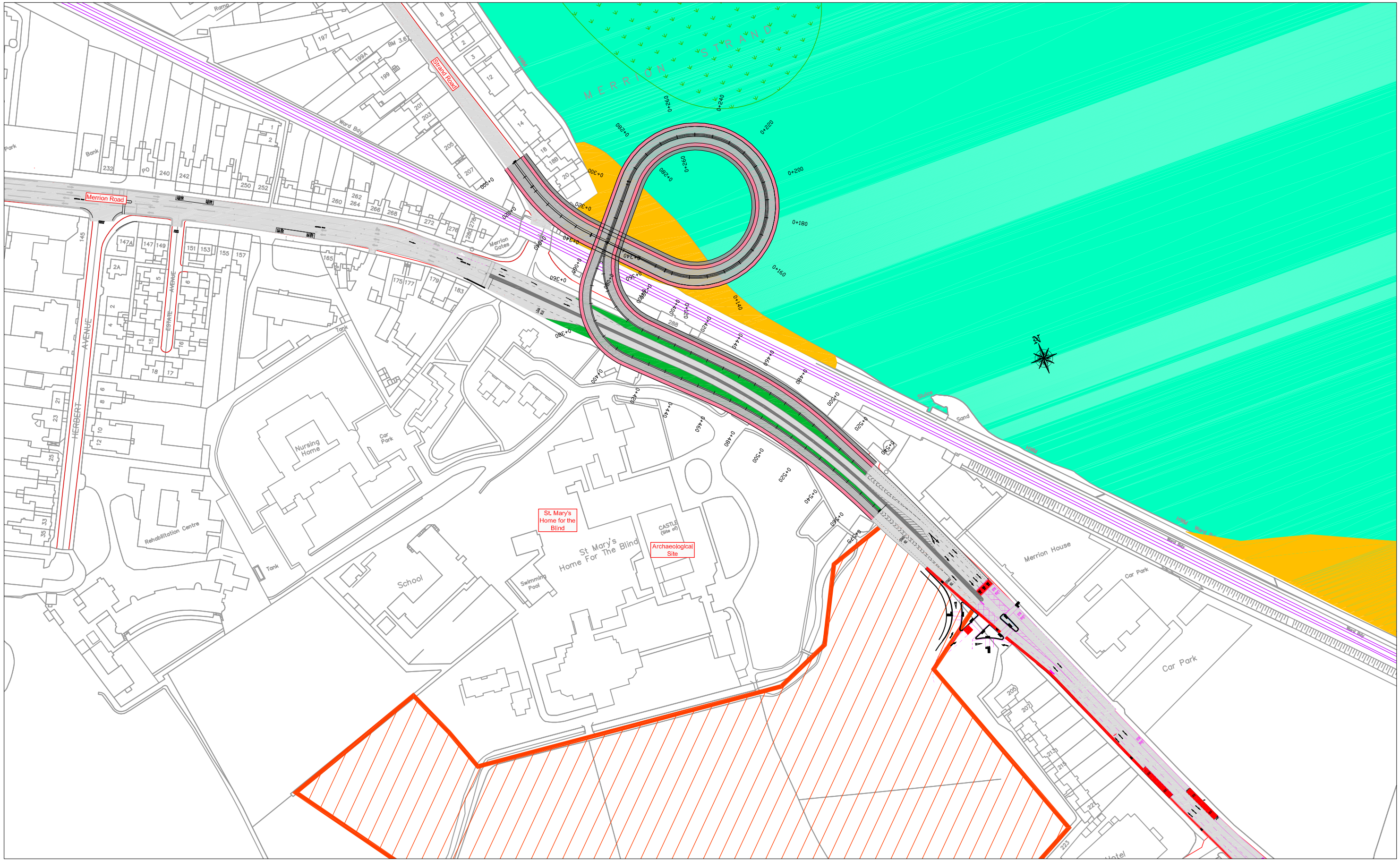

Legend

- Existing Road Edges
- Railway Tracks
- Roosting Area
- Dwarf Eelgrass

No.	Revision	Date	By	Chk'd	App'd
D	Final Issue	Aug 09	EOC	EOC	SMG
C	Minor Amendments	Feb 09	EB	EOC	SMG
C	Alignment, road markings extensively revised	12/02/09	EB	EOC	SMG
A	Tied into ARUP Markings	AUG 08	FD	EOC	SMG

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
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Project Title: Grade Separation of Merrion Gates
Feasibility Study

Drawing Title: Final Option A
(Route Option 2 in Initial Assessment)

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
EOC	EOC	SMG	Feasibility	FD	99,175,320	004	D

Scale: (A1) 1:1000 | Date: FEB 2009

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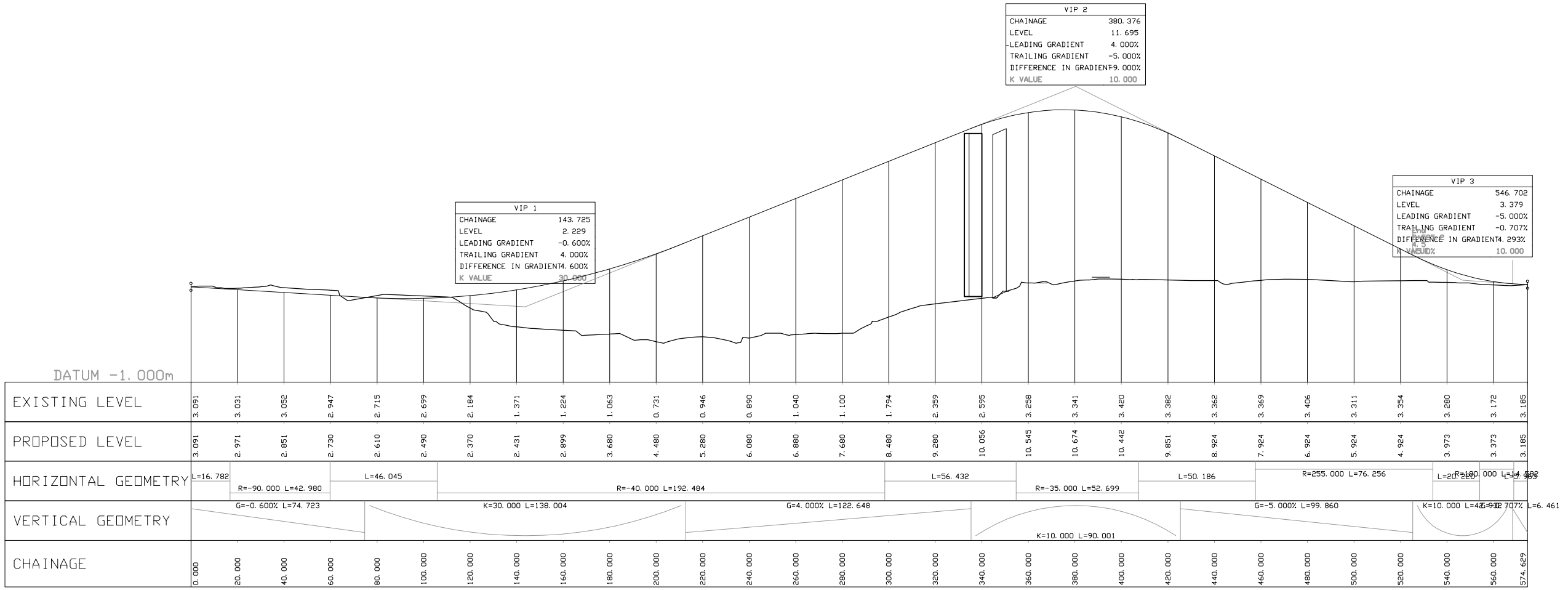
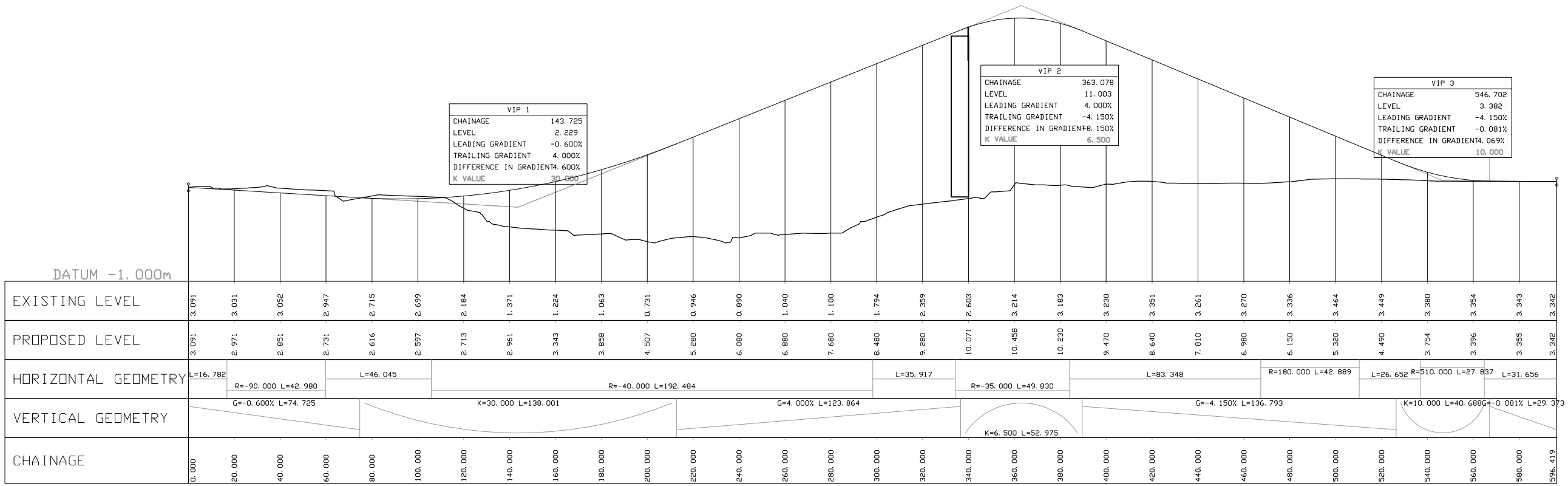


NORTHBOUND ALIGNMENT



SOUTHBOUND ALIGNMENT

No.	Revision	Date	By	Chk'd	App'd
B	Final Issue	Aug 09	EOC	EOC	SMG
A	Minor Revisions	Oct 08	FD	EOC	SMG

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Designed: EOC | Checked: EOC | Approved: SMG | Status: Feasibility

Project Title: Grade Separation of Merrion Gates
Feasibility Study

Drawing Title: Final Option A - Vertical Alignments
(Route Option 2 in Initial Assessment)

Drawn:	Job No:	Drawing No:	Rev:
FD	99.175.320	005	B

Scale: (A1) H 1:1000 V 1:100 | Date: SEPT 2008

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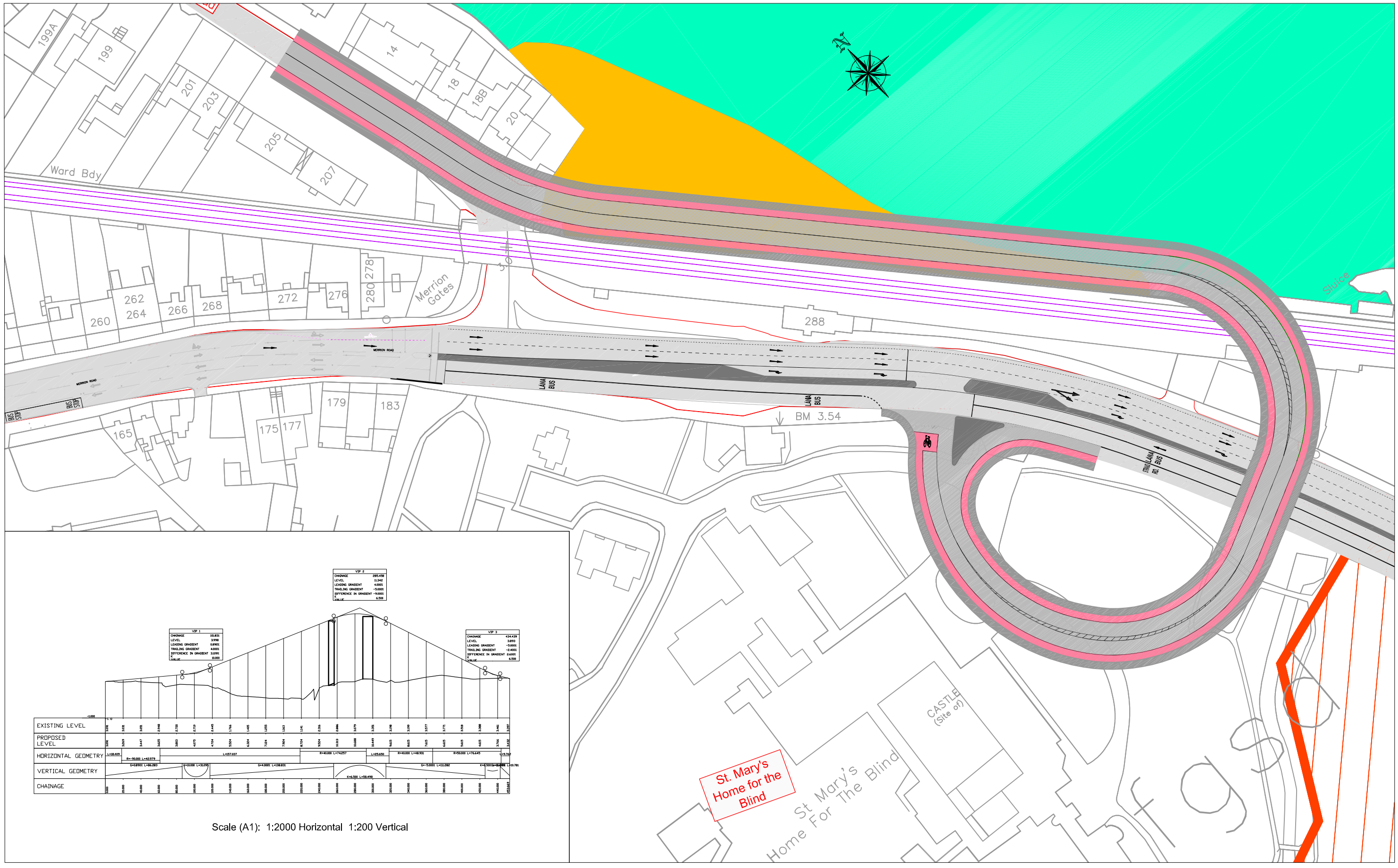

Scale (A1): 1:2000 Horizontal 1:200 Vertical

Legend

- Existing Road Edges
- Railway Tracks
- Roosting Area
- Dwarf Eelgrass
- Elm Park Development

No.	Revision	Date	By	Chk'd	App'd
D	Longsection Added	Aug 09	EOC	EOC	SMG
C	Alignment and roadmarkings extensively revised	12/02/09	EB	EOC	SMG
B	ARUP Road Markings, & Road realigned	AUG 2008	FD	EOC	SMG
A	04147 Survey Road Markings added and junction modified to suit	SEPT 2008	FD	EOC	SMG

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Designed: EOC | Checked: EOC | Approved: SMG | Status: Feasibility

Project Title: Grade Separation of Merrion Gates
Feasibility Study

Drawing Title: Final Option B
(Route Option 3 in Initial Assessment)

Drawn:	Job No:	Drawing No:	Rev:
EB	99.175.320	006	D

Scale: (A1) 1:500 | Date: FEB 2009

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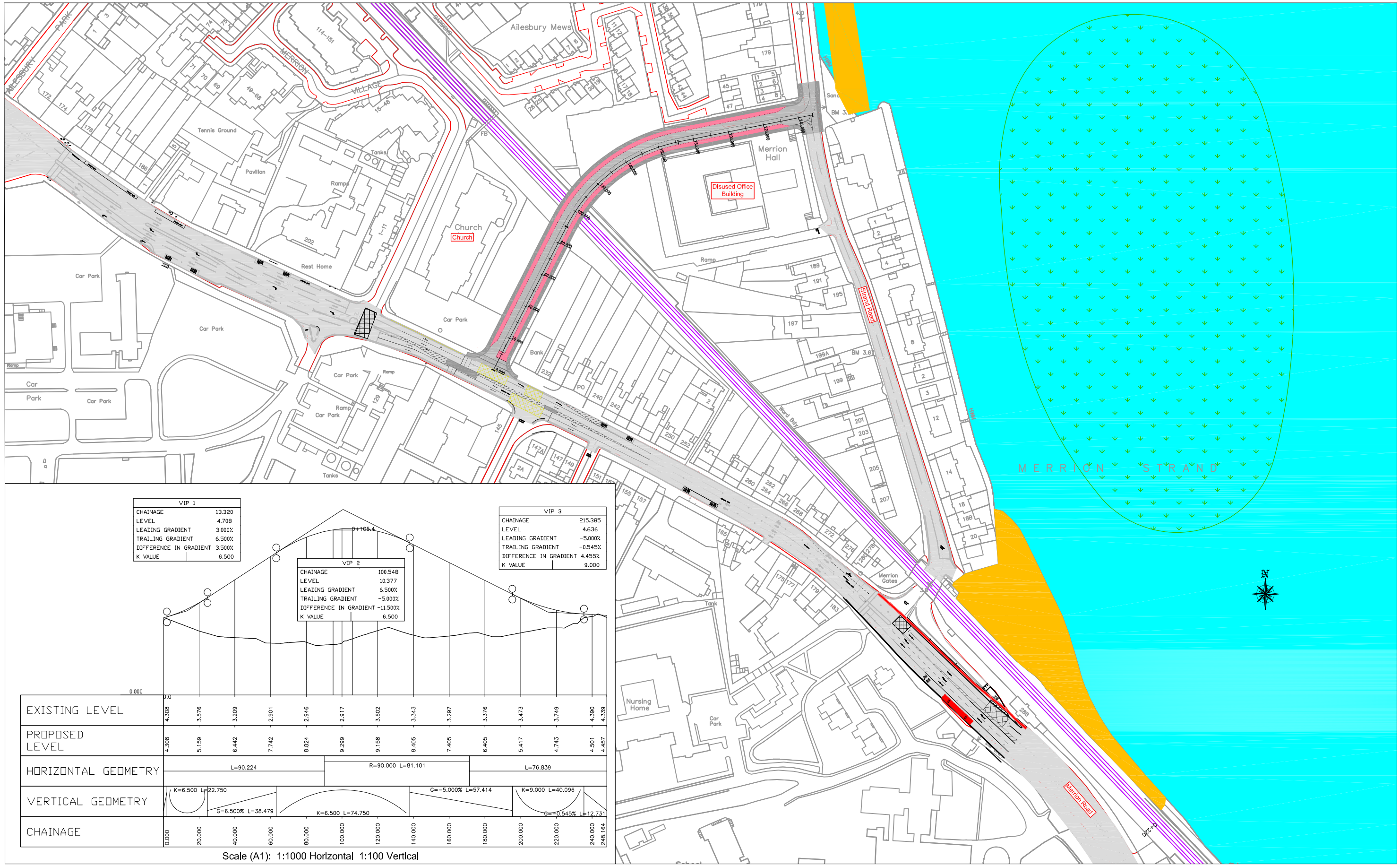

VIP 1	
CHAINAGE	13.320
LEVEL	4.708
LEADING GRADIENT	3.000%
TRAILING GRADIENT	6.500%
DIFFERENCE IN GRADIENT	3.500%
K VALUE	6.500

VIP 2	
CHAINAGE	100.548
LEVEL	10.377
LEADING GRADIENT	6.500%
TRAILING GRADIENT	-5.000%
DIFFERENCE IN GRADIENT	-11.500%
K VALUE	6.500

VIP 3	
CHAINAGE	215.385
LEVEL	4.636
LEADING GRADIENT	-5.000%
TRAILING GRADIENT	-0.545%
DIFFERENCE IN GRADIENT	4.455%
K VALUE	9.000

EXISTING LEVEL	4.308	3.576	3.209	2.901	2.946	2.917	3.602	3.343	3.297	3.376	3.473	3.749	4.390	4.339
PROPOSED LEVEL	4.308	5.159	6.442	7.742	8.824	9.299	9.158	8.405	7.405	6.405	5.417	4.743	4.501	4.457
HORIZONTAL GEOMETRY	L=90.224					R=90.000 L=81.101					L=76.839			
VERTICAL GEOMETRY	K=6.500 L=22.750		G=6.500% L=38.479		K=6.500 L=74.750			G=-5.000% L=57.414		K=9.000 L=40.096		G=-0.545% L=12.731		
CHAINAGE	0.000	20.000	40.000	60.000	80.000	100.000	120.000	140.000	160.000	180.000	200.000	220.000	240.000	248.164

Scale (A1): 1:1000 Horizontal 1:100 Vertical

Legend

- Existing Road Edges
- Railway Tracks
- Roosting Area
- Dwarf Eelgrass

No.	Revision	Date	By	Chk'd	App'd
C	Longsection Added	Aug 09	EOC	EOC	SMG
B	Roadmarkings extensively revised	12/02/09	EB	EOC	SMG
A	Tie in with ARUP Elm Park Road Markings	AUG 2008	FD	EOC	SMG

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Project Title: Grade Separation of Merrion Gates Feasibility Study

Drawing Title: Final Option C (Route Option 4 in Initial Assessment)

Designed:	Checked:	Approved:	Status:
EOC	EOC	SMG	Feasibility

Drawn:	Job No:	Drawing No:	Rev:
EB	99,175,320	007	C

Scale: (A1) 1:1000 Date: FEB 2009

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