C.A.R.S. Project
Design Report.

PRODUCED BY:	Browne, A. Kennedy, M. Dolan, N. Selman, C.
STUDENT NO:	C09365788-C09686908-D11125480-C08868352
DATE DUE:	20-April-2012
COURSE:	Dt004/3 – Civil Engineering
LECTURER:	Valerie Fenton

Table of Contents

Table of Figures

Executive Summary

As part of the Collage Awareness of Road Safety (CARS) Project the Civil Engineering Group, have re-designed a junction with the main focus being on the road safety regarding 17-24 year olds. Following extensive research into the Proposed Grangegorman Development, the group identified pedestrians and cyclists as a main priority. As stated in the Master Plan for the Grangegorman development, measures will be put in place to ensure that pedestrian and cyclist traffic is of key importance.

The selected junction is adjacent to the proposed Broadstone Gate entrance, a main pedestrian & cyclist access route. Plans to include car parking and a light rail tram system are also nearby, resulting in high volumes of traffic movements.

In order to achieve a high standard of road safety the group examined a number of options; these included a zebra crossing, a roundabout, alterations to on-street furniture, diagonal crossing and on demand signalling. Following an assessment of all the design possibilities, the group concluded, that there was two feasible design solutions. The two solutions the group decided upon were, an underpass and an overpass with preference being on pedestrian and cyclist safety.

Introduction

Purpose

For the 'Cars Project' as part of the Highways and Transportation II module, group four have decided to assess the junction known as 'Constitution Hill – Western Way'. The junction was chosen, as it is adjacent to the proposed entrance to the 'Dublin Institute of Technologies' (DIT) future campus at Grangegorman (according to the 'Grangegorman Development Agency').

It is the group's intention to assess the junction from the point of view of future students of DIT, as they will make up the majority of traffic using the junction. To comply with the average student age bracket (17-24 years), the junction will be redesigned from the point of view of pedestrians and cyclists.

Overview of Information

In order to redesign the junction for non-vehicular traffic the following was carried out.

1. The junction was assessed, researched and selected
2. A peak hour traffic survey was preformed on the junction to assess the current running capacities for both vehicular and non-vehicular traffic and the results recorded.
3. Following the survey, some desk research was preformed to estimate the number of people expected to use DIT's new campus. From this the projected future traffic on the junction was calculated.
4. 3 possible alterations to the junction were discussed and designed. A cost benefit analysis was then preformed to identify which option was most desirable.
5. Following the new design of the junction a report was produced and submitted to the relevant persons.

Research Synopsis

In order to redesign the junction to make it safe for non-vehicular traffic substantial research was required and is listed below.

Traffic Analysis Survey – The TAS gave the group important information regarding the volumes of traffic using the junction, the pedestrian desire paths as well as establishing times of peak flow and hazards.

Roadwork's Unit Rate Database – This document, produced by the National Roads Authority (NRA) allowed the group to compile a set of accurate costs relating to highway related infrastructure in Ireland.

Grangegorman Development Plan – A study into the proposed plans in relation to the proposed new DIT campus site. This document, produced by the Grangegorman Development Agency, allowed the group to establish projected traffic routes and desired paths.

Google – Using mapping databases such as 'Google Maps' & 'Google Earth' the group was able to reproduce illustrations and elevated drawings of the junction.

Road Safety Authority – The RSA website provided the group with information about recent collisions and incidents at the junction.

National Roads Authority – The Project Appraisal Guidelines document was helpful as it gave information relating to the cost of accidents.

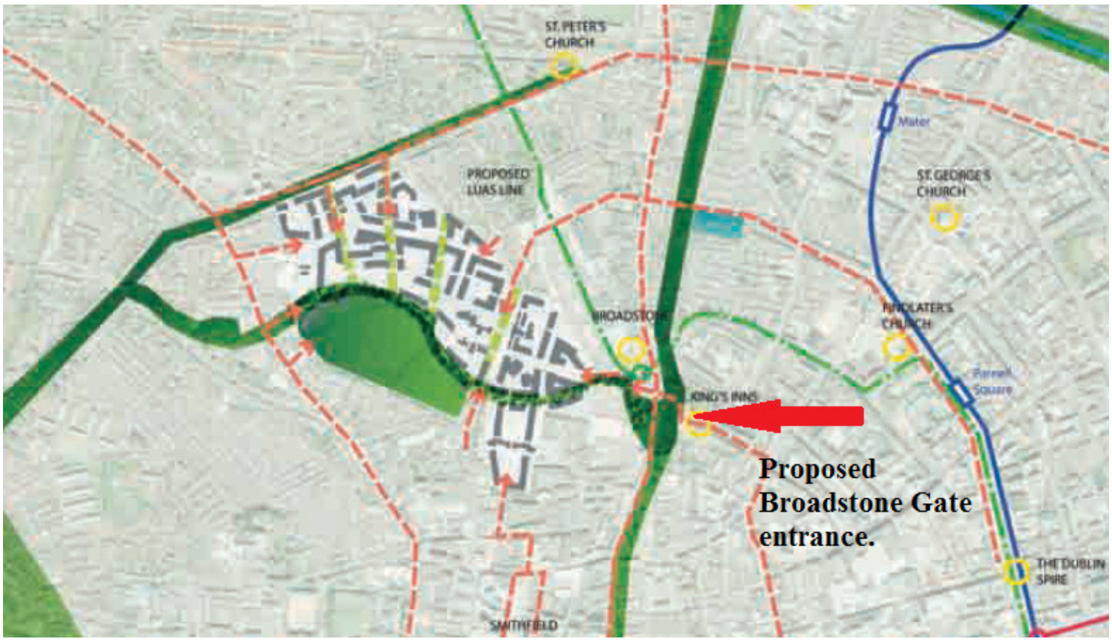
Background

In 1910 the governor of the house of Grangegorman decided to build a mental institution for mentally ill patients. The Richmond asylum was opened in 1814 and was designed by Francis Johnson. In 2006 the GGDA was set up in an attempt to modernise and consolidate all of the DIT campuses and buildings, presently located in

a number of locations throughout Dublin City. The location for this new campus was Grangegorman.

The campus will have a number of entrances; the major ones being on Constitution Hill – Western Way, and other on the North Circular Road. These entrances are expected to deal with the traffic associated with the 30,000 staff and students occupying the Grangegorman Campus. (Grangegorman Development Plan 2012)

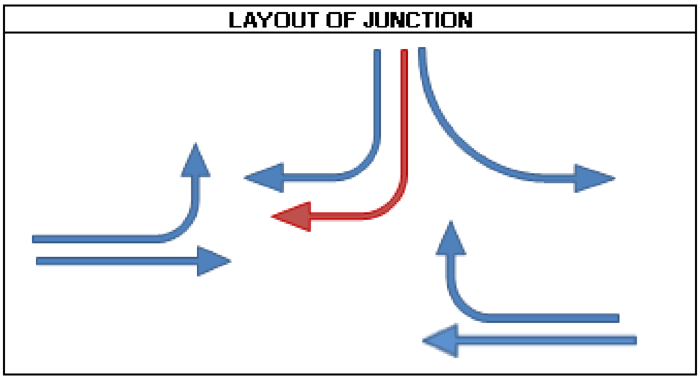
The focus of this report will be the Constitution Hill – Western Way junction, which will see high volumes of traffic and pedestrians upon completion of the project.



Traffic Survey

A survey was taken on a representative day (mid-week, not school holiday) of existing traffic flows between 7am and 10am to establish peak traffic flows and total traffic flows in all directions.

Vehicular Traffic



	Time Period	Flow 1							Flow 2							Flow 3						
		Car	Bus	HV	4x4	Mcyc	Cyc	Total	Car	Bus	HV	4x4	Mcyc	Cyc	Total	Car	Bus	HV	4x4	Mcyc	Cyc	Total
1	0700 - 0715	145	2	1		2	4	**154**	74	3	1			7	**84**	15	1				2	**18**
2	0715 - 0730	154	1	2			9	**162**	73	8	8	10	1	4	**124**	20	2				0	**25**
3	0730 - 0745	155	2				11	**160**	97	3	7	18	2	6	**141**	39	3	1			1	**49**
4	0745 - 0800	178	4	1		1	14	**191**	124	4	6	30		13	**179**	50	2				2	**55**
5	0800 - 0815	146	3	2		1	7	**159**	129	1	3	5		4	**144**	36	3	1			3	**46**
6	0815 - 0830	138	2	1	2		10	**148**	93	3	4	9		10	**120**	37	1				4	**40**
7	0830 - 0845	150	2	2			18	**160**	125	0	5	5		11	**143**	44	2	1			4	**52**
8	0845 - 0900	134	1			3	19	**138**	133	2	6	8	2	9	**162**	41	4		1		3	**52**
9	0900 - 0915	123	3	1	1		12	**134**	101	1	4	6	1	7	**120**	37	3			1	3	**45**
10	0915 - 0930	117	2			1	9	**123**	100	3	3	2		7	**117**	33	3	1			0	**43**
11	0930 - 0945	121	3			1	8	**129**	103	2	1	8	1	4	**119**	27	1		2		2	**32**
12	0945 - 1000	104	2	1	1		5	**113**	96	2	1	4		5	**108**	28	2				1	**33**

	Time Period	Flow 4							Flow 5							Flow 6						
		Car	Bus	HV	4x4	Mcyc	Cyc	Total	Car	Bus	HV	4x4	Mcyc	Cyc	Total	Car	Bus	HV	4x4	Mcyc	Cyc	Total
1	0700 - 0715	15	3	2	5		1	**33**	9		1			0	**12**	5	1				1	**7.5**
2	0715 - 0730	44	8	1	7	1	2	**74**	16	2	1			1	**24**	12	2			1	3	**18**
3	0730 - 0745	49	4	1	5	1	2	**67**	20	3		1		2	**29**	14					2	**14**
4	0745 - 0800	59	1	2	9		1	**76**	12	3	1			2	**22**	17	2				2	**22**
5	0800 - 0815	42	4	2	11		0	**68**	16	3				1	**24**	10					0	**10**
6	0815 - 0830	45	1	1	8		1	**58**	27	3	1	3		0	**40**	18	5	1			0	**33**
7	0830 - 0845	48	3	0	5		0	**61**	40	4			1	0	**51**	19	8			1	1	**40**
8	0845 - 0900	38	3		4		2	**50**	36	5				0	**49**	19	4		2		1	**31**
9	0900 - 0915	45	1				4	**48**	28	4				2	**38**	17	5				1	**30**
10	0915 - 0930	48	3		2		2	**58**	31	1		1		2	**35**	13				4	2	**15**
11	0930 - 0945	33	3	1		2	0	**44**	22	3	2		2	0	**36**	8	4	1		2	0	**22**
12	0945 - 1000	42	2				1	**47**	25	2				1	**30**	14	3				0	**22**

Figure 1 - Traffic survey results

Pedestrian Traffic

	Time Period			F1	F2	F3	F4	F5	F6	F7	F8
1	0700	-	0715	3	0	4	0	1	2	1	0
2	0715	-	0730	3	1	3	0	3	1	3	2
3	0730	-	0745	2	6	3	0	3	0	0	2
4	0745	-	0800	0	5	10	2	0	3	1	3
5	0800	-	0815	1	0	5	1	3	1	3	8
6	0815	-	0830	6	7	14	3	3	5	4	0
7	0830	-	0845	7	15	31	1	6	0	5	2
8	0845	-	0900	6	13	28	4	5	2	3	5
9	0900	-	0915	5	11	23	3	5	2	5	4
10	0915	-	0930	3	9	18	3	0	3	6	4
11	0930	-	0945	0	2	7	0	2	1	7	3
12	0945	-	1000	2	5	4	2	1	2	6	1

				F9	F10	F11	F12	F13	F14	F15	F16
1	0700	-	0715	2	1	1	4	5	0	1	2
2	0715	-	0730	0	0	3	2	6	1	0	0
3	0730	-	0745	1	0	1	5	7	1	0	0
4	0745	-	0800	4	2	4	9	9	5	1	3
5	0800	-	0815	0	1	0	7	6	5	1	0
6	0815	-	0830	14	0	5	13	8	1	3	1
7	0830	-	0845	15	1	2	7	5	3	0	1
8	0845	-	0900	12	1	1	10	7	4	2	3
9	0900	-	0915	13	0	2	13	9	2	2	3
10	0915	-	0930	11	1	3	7	6	0	0	1
11	0930	-	0945	2	3	0	5	4	1	1	1
12	0945	-	1000	3	0	0	7	10	2	0	2

Figure 2 - Pedestrian survey results

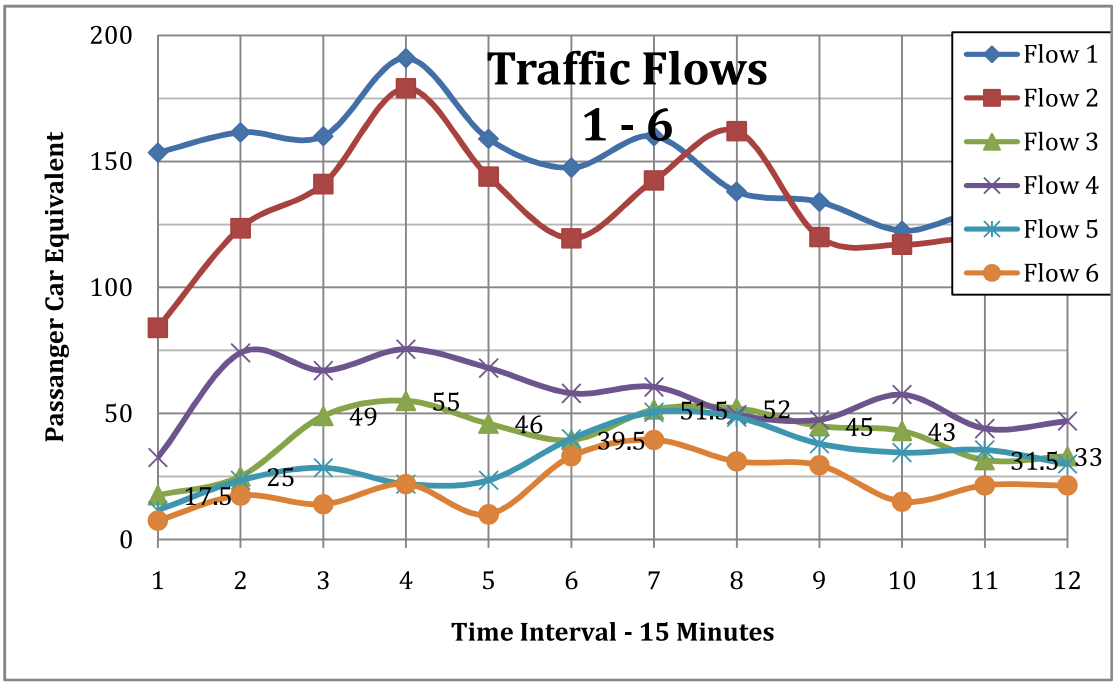


Figure 3 - Traffic flow graph

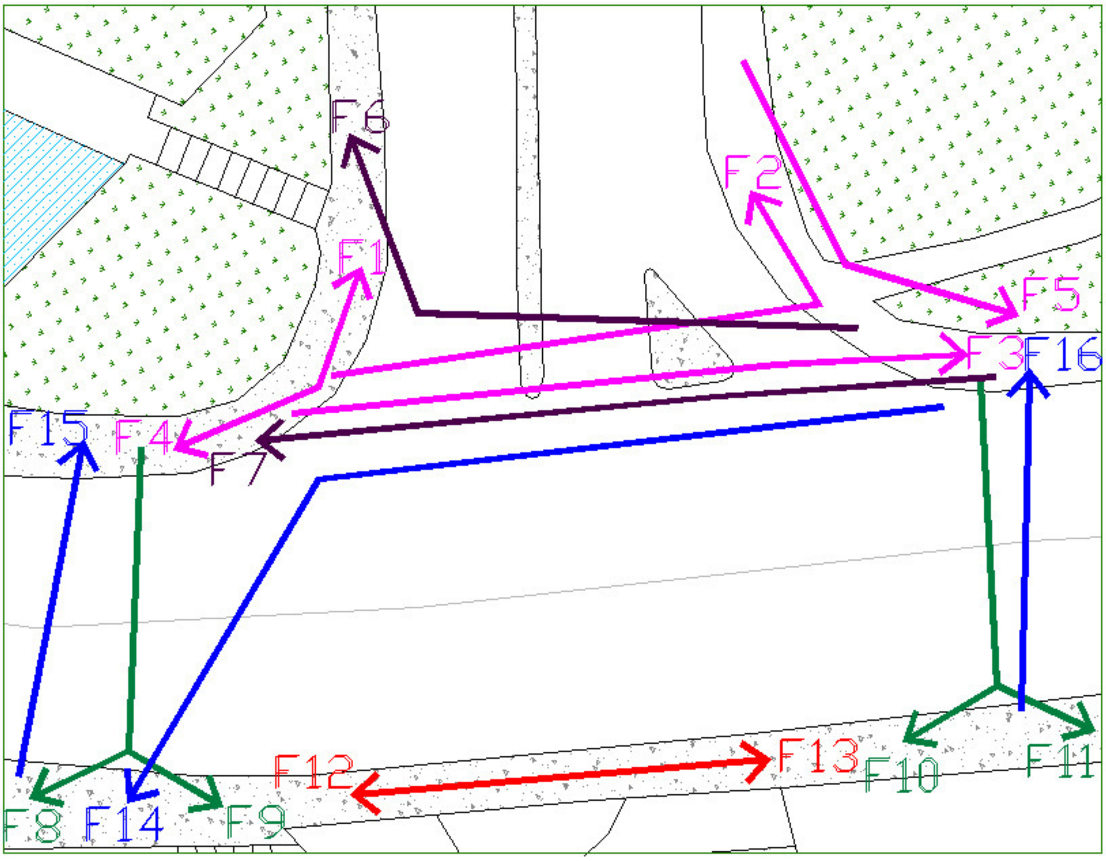


Figure 4 - Pedestrian graph

Future Mobility Plan

The present number of students is listed below. This number is expected to rise and with it the need for services will also have to be upgraded.

Student Category	2009/10	2010/11
UG FT	10,203	10,907
PG FT (research & taught)	860	1,080
UG PT	2,134	1,806
PG PT (research & taught)	804	1,162
Apprenticeship	2,431	2,060
CPD	1,116	1,012
Junior Music	930	949
Total	**18,478**	**18,976**

Figure 5 - Present student numbers

It is estimated, that when the Grangegorman development becomes fully operational 20,000 students plus staff are expected to use the campus each day. This figure can be broken down into the following:

Bus	28%	1,960	Students
Train	19%	1,330	Students
Luas	16%	1,120	Students
Car	7%	868	Students
Walk	11%	770	Students
Cycle	13%	910	Students
Metro N.	6%	420	Students

These results are estimated and based on a figure of 35% of the total student population. Cars make up 7% of the total student population, of which, 62% enter through the Broadstone Gate Entrance.

(See Appendix 1, for further details regarding the percentage breakdown)

Preliminary Design

Need for the Proposed Scheme

At present the junction in question is sufficiently designed to cope with the volumes of traffic. However the Grangegorman campus was originally scheduled to open in 2017. The campus is expected to facilitate 23,000 students plus approximately 4,000 staff. This development will contribute to an extensive increase in the volumes of both pedestrian and vehicular traffic to the area. The 'Constitution Hill - Western Way' junction is adjacent to a proposed major entrance to the campus, this will facilitate the majority of both traffic and pedestrians coming and going from the college.

Following investigation and research into traffic flows at the 'Constitution Hill - Western Way' junction, the authors have determined that the current state of the junction will not suffice, to handle the demand into the Grangegorman development, upon its opening.

Following a traffic survey it was found, that pedestrians using the junction have little regard for the designated road-crossing points. With the opening of Grangegorman, and the resulting increase of pedestrian traffic, the disregard for safe crossing paths will become a major health and safety issue. Due to the nature of the Grangegorman project the majority of traffic is expected to be pedestrian and cycling students between the ages of 17-24. It is the group's intention to re-design the junction to make it safer for the above road users.

Specific Objectives of the Proposed Project

The group intends to increase road safety of the junction, from the point of view of pedestrians and cyclists, without impeding the free-flow of traffic through the junction. In order to achieve this goal, the group intends to examine all reasonable options available and implement the most feasible approach.

Collision History and Records

As per the RSA online database there has been one minor collision at the junction within the last five years.

With the increase in pedestrian and traffic volumes there will be an increase in the number of accidents. This increase in can be prevented through careful planning with regard to safe designated routes and refuge points.

(See Appendix 2. for collision history)

Design Speed Calculations

Speed limits for the junction are presently 50km/h. This limit does not need to be altered.

Options Considered

The junction must be redesigned to make it safe for the projected increase in pedestrians and cyclists. As the junction is located in a ‘free flow zone’ disruption to vehicular traffic must be avoided.

The group has decided to examine three options in order to establish the best course of action. These options include

- An underground passageway
- An overpass
- On demand signalling, desire-lines and barriers
- Relocating a cycle path from a shared path

Constraints

As the junction is located within a free flow zone, disruption to vehicular traffic should be avoided. Nearby buildings and parks cannot be altered or removed.

Geometric Features

- The location is based on a hill
- The underground pass is at risk of flotation due to the underlying water table.

Signs, Signalling, Furniture and Road Markings.

In order to increase safety; the group intends to use barriers and signage to prevent pedestrians and cyclists from crossing the road at dangerous locations. Lighting, signalling, road markings and street furniture will also be altered to facilitate the new design.

Drainage Requirements

The main risks associated with the project are that the culvert tunnel does not flood, surface water is carried away from the junction and ground water drained to prevent culvert flotation. The site is located higher than the nearby River Liffy, this means that water can naturally flow down towards it.

Junction treatment

During construction compulsory diversions and lane closures will be necessary. Where possible, work will be preformed at night and during off peak times. Upon completion traffic and signalling will return to its previous form.

Requirements of Non-drivers

Pedestrians will be encouraged to use safe crossing and refuge points. This will be done using barrier and minimal waiting times at crossing points. As a result the risk and accidents at the junction will be greatly reduced.

Relaxing and Departures

The project has no relaxations or departures.

Cost of Accidents

The following takes into account previous 5 yearly accidents (2005-2009), and assumes a linear relationship between population and accidents. The table below shows projected population growth and a total cost of accidents to be €1,899,562.

Accident	Number of Accidents	Cost Per Accident €	Total Cost €
Fatal	1	1,694,481	1,694,481
Serious	1	190,400	190,400
Minor	10	14,681	140,681

Figure 6 - Cost of accidents 2005-2009

If the design proposals are not implemented, due to the 17-24 year old, population increase the estimated cost of accidents area as follows for the same duration following completion of the Grangegorman development. The total accident cost is €20,113,740.

Accident	Number of Accidents	Cost Per Accident €	Total Cost €
Fatal	9.9	1,694,481	16,775,361
Serious	9.9	190,400	1,884,960
Minor	99	14,681	1,453,419

Figure 7 - Cost of future accidents

Design

On the basis of these measurements, and taking into account the lack of queuing, we were able to establish that the junction is very well tailored to the traffic flows at that location. However, Grange Gorman is going to generate a significant additional volume of traffic and this must be taken into consideration when attempting to assess the future efficiency and safety of this particular junction.

On these ground, we have decided that there are two best-practice solutions to the increased traffic flows, especially with respect to vulnerable road users (cyclists, pedestrians and the disabled).

The junction at present is shown below:

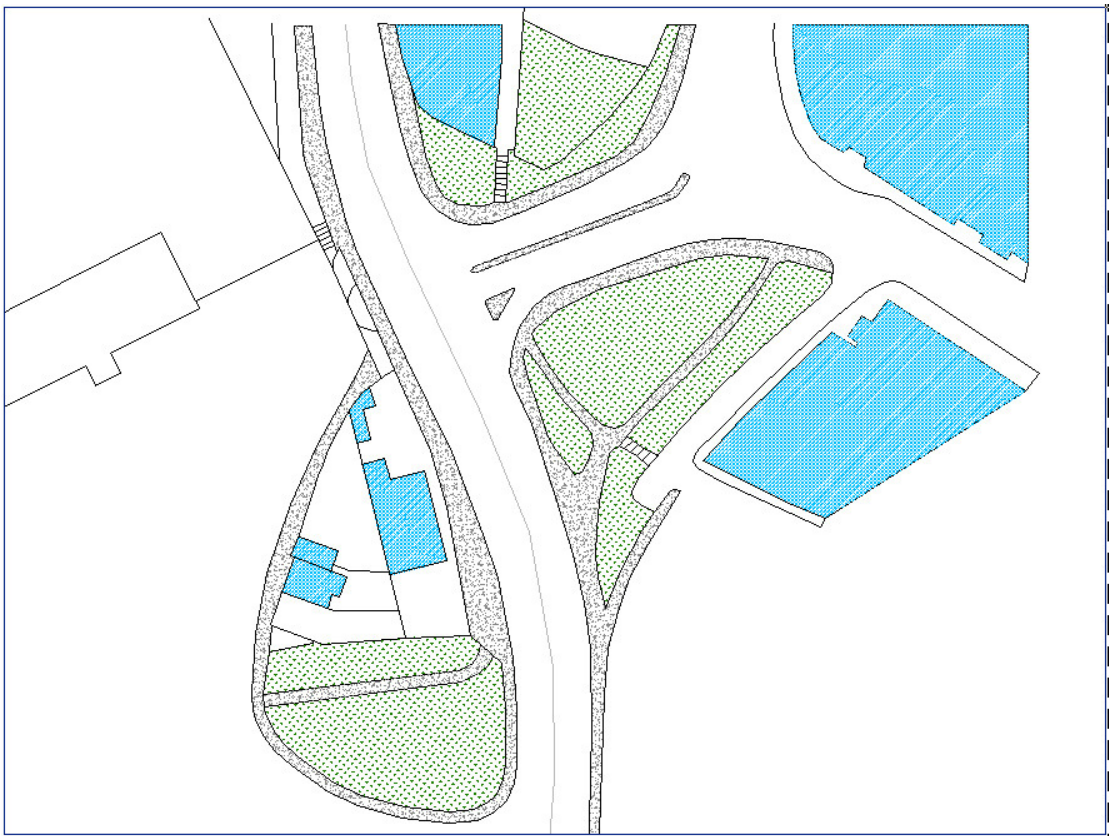


Figure 8 - Current junction layout

- GRASS
- FOOTPATHS
- BUILDINGS

The two proposed solutions are shown below:

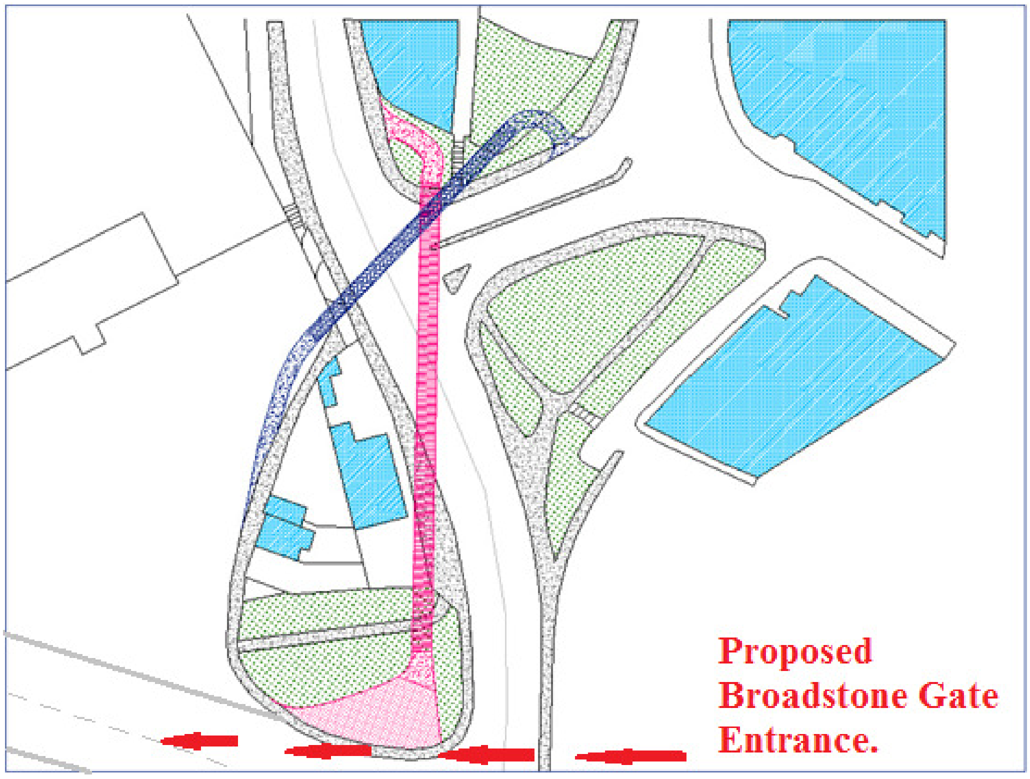


Figure 9 - Proposed junction layout

- GRASS
- FOOTPATHS
- BUILDINGS
- TUNNEL & ENTRANCES
- BRIDGE & RUN-INS

Cost analysis

On the basis of these two proposals, the group performed cost appraisals on both. Values for pricing were obtained from the NRA Roadwork's Unit Rate Database. The solutions are a precast section culvert tunnel and a truss bridge.

(For a detailed breakdown of costs please see Appendix 3 and 4)

Culvert Tunnel

- 110m in length
- 3.7m wide x 2.6m high
- Gradients not exceeding 1:12 on lead-ins
- Cost analysis includes for external and internal drainage and all associated costs
- Total construction cost €649,883.75

Truss Bridge

- 55m clear span
- 2.5m deck width, including cycle path
- Gradients below 1:20 throughout
- Cost analysis includes lead-in and on-bridge lighting and all services
- Total construction cost €594,487.40

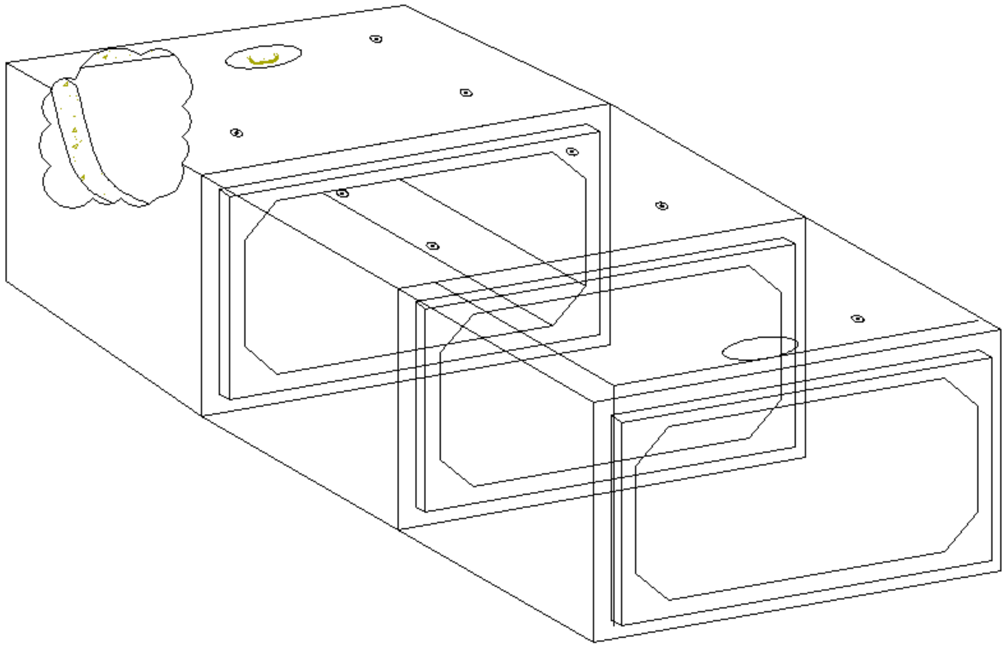


Figure 10 - 2.6 x 3.7m Underground culvert/Tunnel

The Ferry Cycle Bridge near Maghery Country Park

The Ferry Cycle Bridge opened Spring 2002 funded by Loughshores Area Strategy DARD EHS Craigavon/Dungannon Councils. This foot and cycle bridge cost £250K to build and was constructed especially for the route of the Lough Neagh Loughshore Trail which crosses the River Blackwater at Maghery.

Figure 11 - Typical overpass design

Conclusion

Following extensive research and design, the group felt that by introducing a footbridge, the safety of vulnerable road users would be enhanced and vehicular traffic not affected, even with the projected increase in volumes, both in the near future and after the design year.

While the overall cost of the project is considerable, it is small with respect to the overall cost of the Grangegorman Development and the cost of accidents per year. The cost of the overpass was close to six hundred thousand euro. Over a five year period the estimated total cost for fatal, serious and minor accidents was over twenty million euro, following completion of the Grangegorman development. By introducing an overpass the potential for loss of life and other accidents are greatly reduced as well as the financial saving being astronomical.

References

- RSA – Road Safety Authority. Irish Road Collisions [online] Available at: www.rsa.ie/Ireland-road-collisions. [Assessed on] 11-04-12.

- NRA Roadwork's Unit Rate Database. A reference material for costs associated with infrastructural development in the context of road networks. National Roads Authority [online] Available at: www.nra.ie. [Assessed on] 11-04-12.

- Google – Google Maps and Google Earth are mapping database that provides accurate GPS images and measurements. [onine] Available at: www.google.com. [Assessed on] 11-04-12.

- Grangegorman Development Agency – A reference material that highlights the plans and objectives planned to consolidate and modernise all of the DIT campuses. [online] Available at: www.ggda.ie. [Assessed on] 11-04-12.

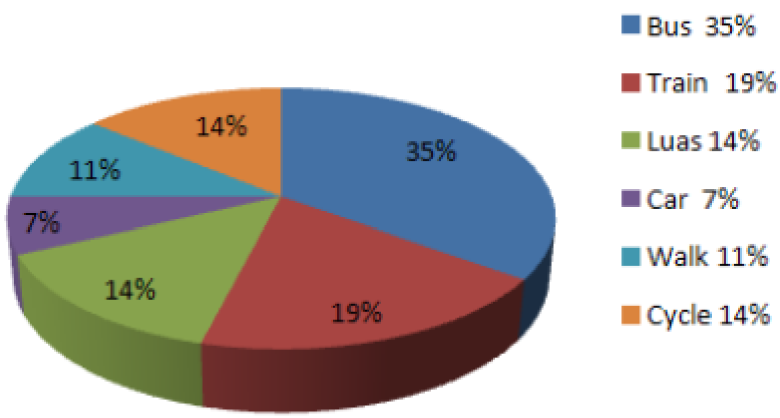
- Ferry Bridge [online] Available at http://www.geograph.ie/photo/504892 [Assessed on] 11-04-12.

- Collision Prevention Programme. An Garda Siochana. [online] Available at www.garda.ie [Assessed on] 11-04-12.

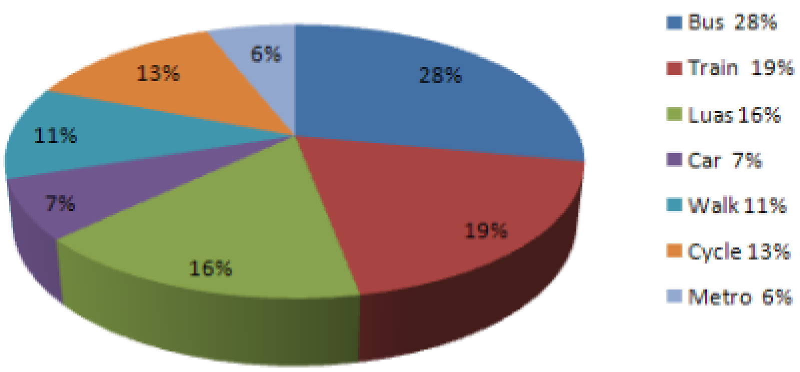
- **National Roads Authority** – 2008. NRA. The Project Appraisal Guidelines. Appendix 8 – TRL COBA report.

Appendix

Appendix 1 – Percentage breakdown for traffic

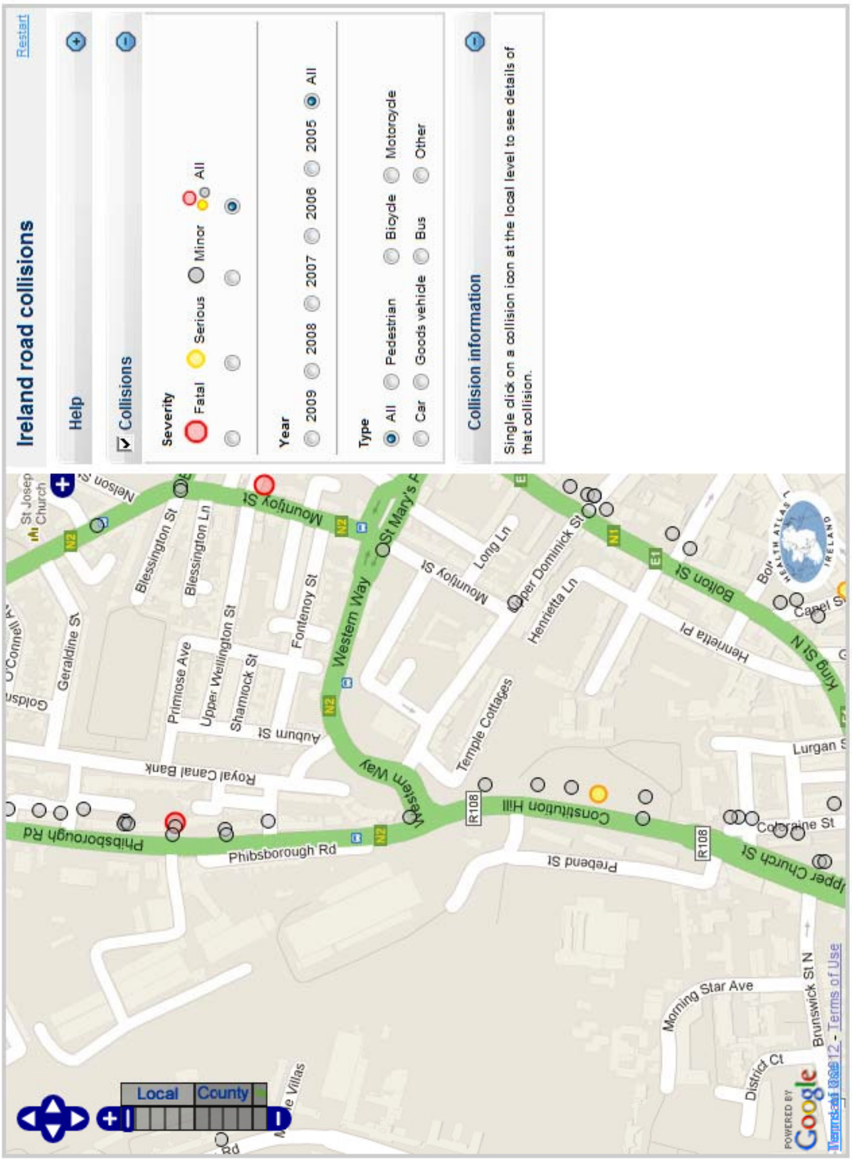


Future DIT Modal Split based on existing public transport



Future DIT Modal Split including Luas BX-D and Metro North

Appendix 2 - Collision History surrounding the Junction.



Appendix 3 – Cost analysis for Tunnel

Cost Analysis of 110 m Tunnel.					
Materials:	Size:	Length (m)	Unit	Rate (€)	Total cost (€):
Culvert	3.7 m x 2.6 m	110	(m)	€3,400.00	€374,000.00
Bedding layer	300 mm	122	(m^3)	€25.00	€3,050.00
Geotextile	9.5	110	(m^2)	€1.50	€1,567.50
Roadway.					
Hardcore fill.	18	110	(m^2)	€12.00	€23,760.00
Capping clause 804	5.5	110	(m^2)	€25.00	€15,125.00
Roadbase	5.5	110	(m^2)	€20.00	€12,100.00
Pavement Finish 75mm	5.5	110	(m^2)	€15.00	€9,075.00
Drainage system.					
left	0.225	110	(m)	€20.00	€2,200.00
Right	0.225	110	(m)	€20.00	€2,200.00
surface:	prime cost	//	//	//	€10,000.00
Civil costs/Services.	Prime cost	//	//	//	€40,000.00
	Length (m)			cost (€)/m	Total cost.
Crossing Barrier	50			€280.00	€14,000.00

External cost:						
		Unit	Amount.	Rate (€).	Total Cost (€).	
soil removal.	Soft	(m^3)	900	€9.00	€8,100.00	
	Hard	(m^3)	200	€30.00	€6,000.00	
Disposal of Material	Soft	(m^3)	900	€2.00	€1,800.00	
	Hard	(m^3)	200	€2.00	€400.00	
	days	Manhours/day	Crew	Shifts	cost per person/hour	Total Man Cost
Labour	15	7	11	3	€18.00	€62,370.00
Design.	10	7	2	1	€28.00	€3,920.00
Forman.	15	7	1	3	€22.75	€7,166.25
Site Engineer	15	8	1	1	€28.00	€3,360.00
Machinery					Per Day	
Crane	1.3	7	1	3	€300.00	€8,190.00
Contingency cost	15	//	//	//	€500.00	€7,500.00
	15	//	//	//	€4,000.00	€4,000.00
Loss of earnings	15	//	//	//	€2,000.00	€30,000.00
					Total cost of project:	€649,883.75

Appendix 4 – Cost analysis for overpass

The cost analysis for the bridge design has been taken from a 55m span, foot and cycle bridge near Maghery country park. The bridge cost € 300,000 in 2002. Using the present value formula it can be determind this bridge would cost € 488,668.40 in today's preset value. On this basis the Total cost of contrustion can be computed as follows:

	unit	Amount	Distance	Cost (€) / unit	Total cost
Materials:					
Cost of bridge	(€)	1	55	€8,884.88	€488,668.40
					€0.00
Hand Rails	(m)	1			€0.00
Paving at Bridge	(m^2)	2	50	€25.00	€2,500.00
electricals					
lighting column	//	6	1	€500.00	€3,000.00
wiring	(m)	1	200	€3.00	€600.00
signage	(m)	5	1	€200.00	€1,000.00
Bridge lighting	//	10	//	€35.00	€350.00

External cost.

	days	Manhours/day	Crew	Shifts	cost per person/hour	Total Man Cost
Labour	12	7	8	3	€18.00	€36,288.00
Design.	10	7	2	1	€28.00	€3,920.00
Forman.	12	7	1	3	€22.75	€5,733.00
Site Engineer	12	8	1	1	€28.00	€2,688.00
Specialist Fabricato	2	5	2	2	€26.00	€1,040.00
Machinery					Per Day	
Crane	1	8	1	3	€300.00	€7,200.00
Contingency cost	15	//	//	//	€500.00	€7,500.00
	15	//	//	//	€4,000.00	€4,000.00
Loss of earnings	15	//	//	//	€2,000.00	€30,000.00

Total Construction cost:	€594,487.40