

Riverdale Park East Feasibility Study
Mapping & Modelling Unit
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1.0 EXECUTIVE SUMMARY

1.1 Study Purpose

The purpose of this feasibility study is to assess potential remedial options to solve the flooding issue at Riverdale Park East, concluding a preferred approach.

1.2 Study Area History

The study area is focused on the La Salle Stream which is located within the Lagan (Greater Belfast) catchment. DFI Rivers Area staff have identified the area within Riverdale Park East as problematic, with flooding of commercial and domestic properties occurring routinely. An assessment of recorded flood events was completed to identify flooding mechanisms contributing to the issue, enabling remedial solutions to be trialled.

1.3 Hydraulic Modelling

Flood modelling software 'Infoworks ICM 6.0' was used to construct a two dimensional flood model of the study area. A full hydrological assessment was undertaken using the FEH Statistical Method to calculate design flows for flood events ranging from 5 year to 1000 year respectively. All events were simulated within the hydraulic model to identify flooding mechanisms.

1.4 Remedial Option Assessment

Upon identification of the flooding mechanisms, five separate remedial options were assessed including;

Option 1 – Culvert upgrade in Slieveban Drive, Slievegallion Drive and Riverdale Park East.

Option 2 – Culvert upgrade and wall construction to open channel section at Riverdale Park East.

Option 3 – Attenuation of flow utilising natural channel at the Andersonstown Shops with culvert upgrade upstream.

Option 4 – Attenuation of flow utilising a pre-cast concrete flood storage tank and upstream culvert upgrade.

Option 5 – Attenuation of flow using the natural channel at the Andersonstown Shops to construct a storage tank, with a culvert upgrade completed upstream.

Each option is successful at providing protection to all properties, commercial and residential, in a 100 year flood event.

1.5 Economic Assessment / Preferred Option

Each option has been economically assessed in line with the 'Northern Ireland guide to Expenditure Appraisal and Evaluation' to define a preferred option. Upon assessment of monetary and non-monetary attributes of each option the preferred option recommended for progression to detailed design stage is Option 3.

2.0 STUDY BRIEF

2.1 Purpose of Study

The purpose of this feasibility study is to identify the current mechanism for flooding at Riverdale Park East in Belfast, assess various remedial options and define a preferred approach.

2.2 Study Scope

The scope of work associated with this study can be defined as the following;

- Identify the flooding mechanism contributing to the previous flooding events in Riverdale Park East, with appropriate hydrological and hydraulic assessment.
- Identify the extents of the 1 in 100 year flood to identify properties directly affected.
- Identify and assess remedial options to provide protection against 1 in 100 year flooding.
- Undertake an economic appraisal, assessing each option individually to define a preferred option.

3.0 SITE DETAILS

3.1 Study Area Overview

The study area is focused on the La Salle Stream (designated watercourse no. U3BEL1S) which is located within the Lagan (Greater Belfast) catchment (see figure 3.1 for location details). The catchment consists predominantly of urban development with scattered green field areas. The topography of the land within the catchment is naturally steep, with the upper end reaching as far as Black Mountain (further catchment details included in section 5.1). Along the length of the watercourse there are various locations where the open channel has been culverted with a variety of both pipe and box shaped solutions.

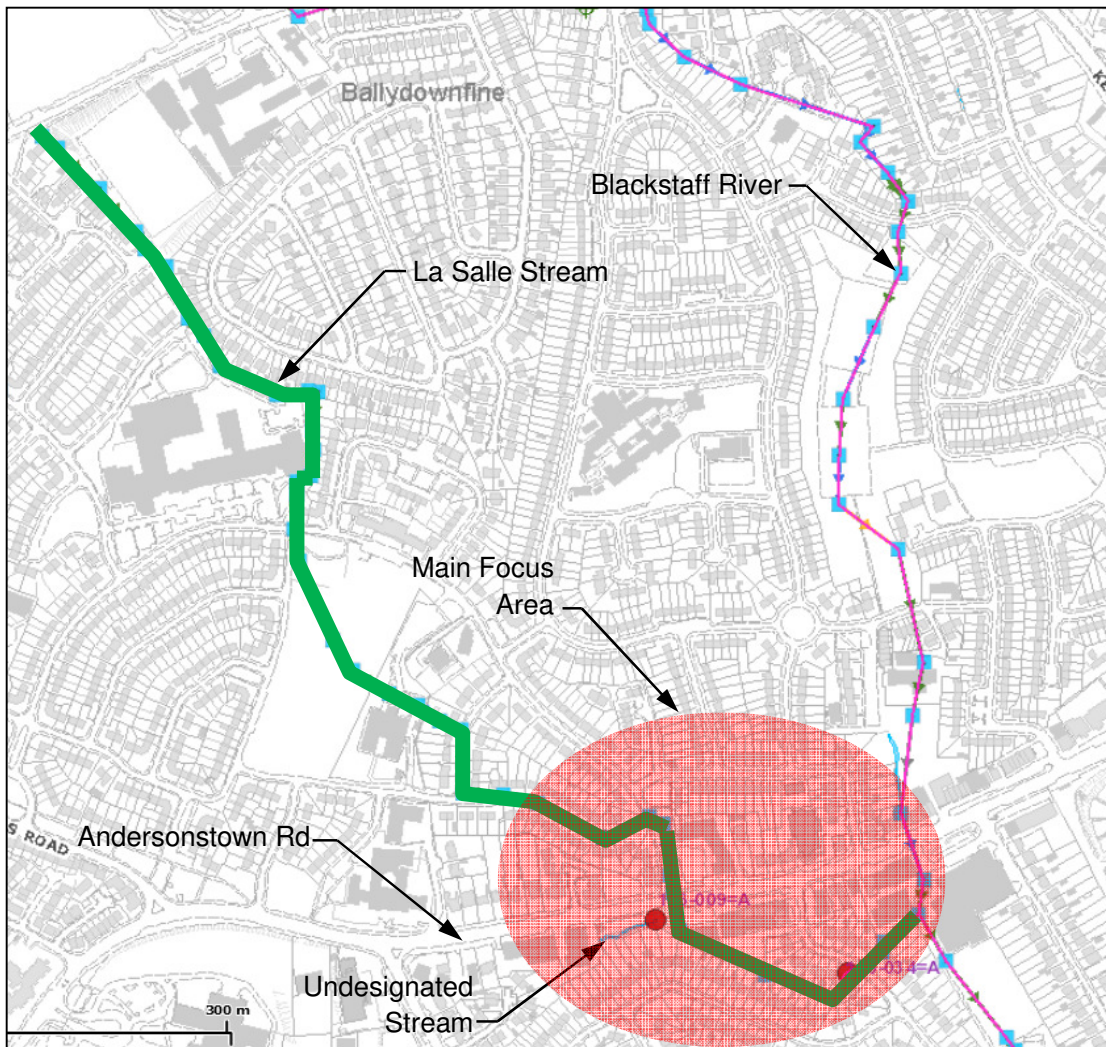


Figure 3.1 – Map overview of study area

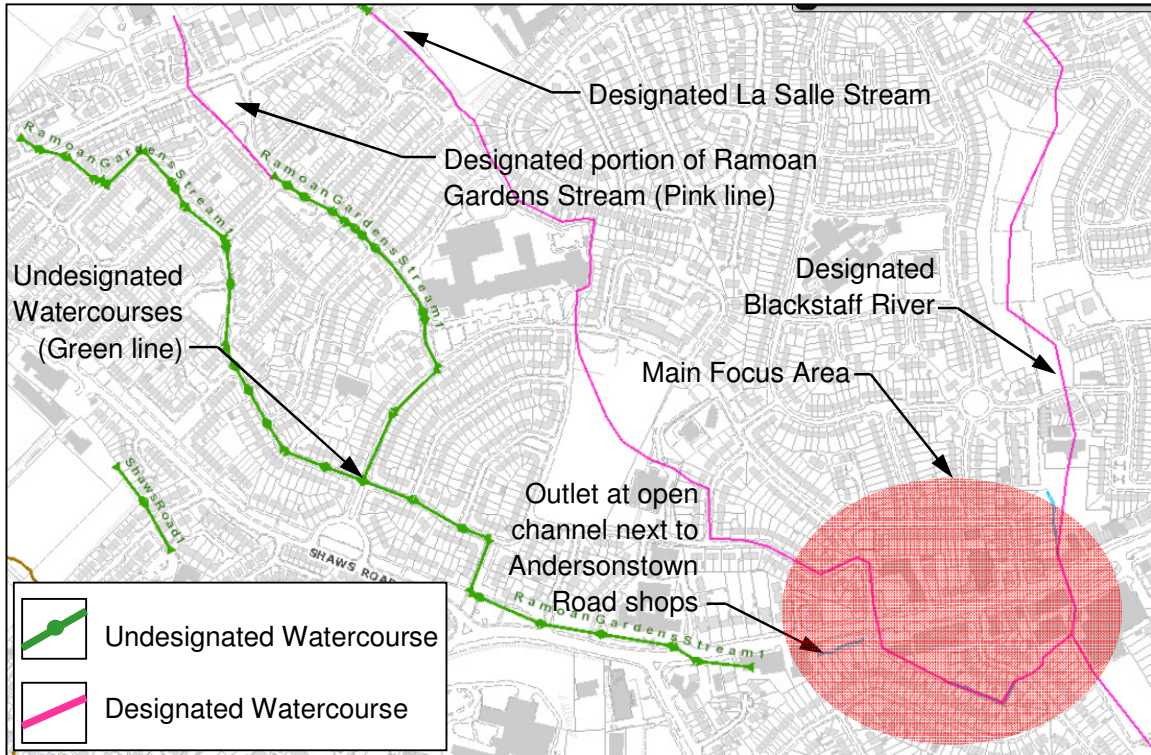


Figure 3.3 – Map overview of watercourse network

4.0 DESKTOP INVESTIGATION

4.1 Overview

A desktop study of the flooding problem was undertaken with the aim of gathering relevant flooding information to develop an understanding of the flooding problem affecting Riverdale Park East.

4.2 Pre-feasibility Study - December 2013

Following flooding incidents experienced at Riverdale Park East in June 2012, DFI Rivers Design Unit undertook a pre-feasibility study at the request of DFI Rivers Eastern Region. The purpose of the pre-feasibility study was to define the source of the flooding issue on this occasion, gather information on probable causes and to consider the requirement for a full feasibility study to be completed.

The report identified that the flooding was caused by the grille located between no.29 and no.31 Riverdale Park East blocking, causing flood water to spill out of channel and onto the carriageway affecting up to eight nearby homes. The report also commented that the culvert passing under Riverdale Park East could be hydraulically inefficient with reports of manhole lids displacing due to surcharging downstream of the inlet grille.

After further consultation with DFI Rivers Area staff, improvement works consisting of the widening of the existing inlet grille and upsizing the culvert under Riverdale Park East were initially considered as the preferred improvement option. The approximate cost of completing this work was £55,000, accounting for land compensation and design and supervision costs respectively. A total number of twenty properties were identified to benefit directly from the improvement works, with an estimated monetary benefit from the scheme of £460,000.



Figure 4.1 – Overview of pre-feasibility study findings

4.3 Flood Incidence Records

4.3.1 Flood Heat Map

Figure 4.2 shows the known properties affected by previous flood events in the Riverdale Park East area. The image identifies properties which have received emergency financial aid from their local council authority after being affected by flooding. Each claim is assessed by a council inspector and is designed to help with clean up costs associated with flood damage. The drawback of the flood heat map is that it does not provide the full number of properties affected by all flood events. Other dwellings may have been at risk but emergency procedures such as installing sandbags could have prevented any damage, hence no financial aid was required. The image identifies three properties adjacent to the inlet grille in Riverdale Park East and another affected dwelling in Slieveban Drive.



Figure 4.2 – Flooding Heat Map – Riverdale Park East

4.3.2 Flood Call Records

DFI Rivers maintains and updates a database which logs flood calls from the public. Figure 4.3 is a visual representation of the properties (coloured dots) which have contacted government authorities to log a flooding issue at their property. The earliest call log displayed is from 1986, with further calls logged up to and including June 2012. Flood calls have been logged at eight separate properties within Riverdale Park East and a single property in Slieveban Drive over this period.



Figure 4.3 – Flood call records – Riverdale Park East

4.4 Planning Issues

The 'Belfast Metropolitan Area Plan' was reviewed to identify constraints and potential future development directly affecting potential remedial options within the limits of the study area identified. Figure 4.4 is an extract from the Belfast Metropolitan Area Map entitled '4/003 Belfast City (West)' highlighting all planning designations, policies, proposals and zonings applicable to the study area. These are detailed as follows,

- **WB 02/07** – Zoned Housing – Zoned housing completed prior to 31/08/2011 at 159-161a Andersonstown Rd.
- **WB 04/10** – Zoned Housing – Zoned housing uncommitted at 31/08/2011 at land to the rear of 127-133 Andersonstown Rd.
- **WB 02/10** – Zoned Housing – Zoned housing completed prior to 31/08/2011 at Conor Close and Stewartstown Rd.
- **AR 01/08** – Designated Arterial Route – Andersonstown Rd/Stewartstown Rd.
- **BT 140** – Local landscape policy area (Trench) – This is an area of local amenity importance or nature conservation interest.

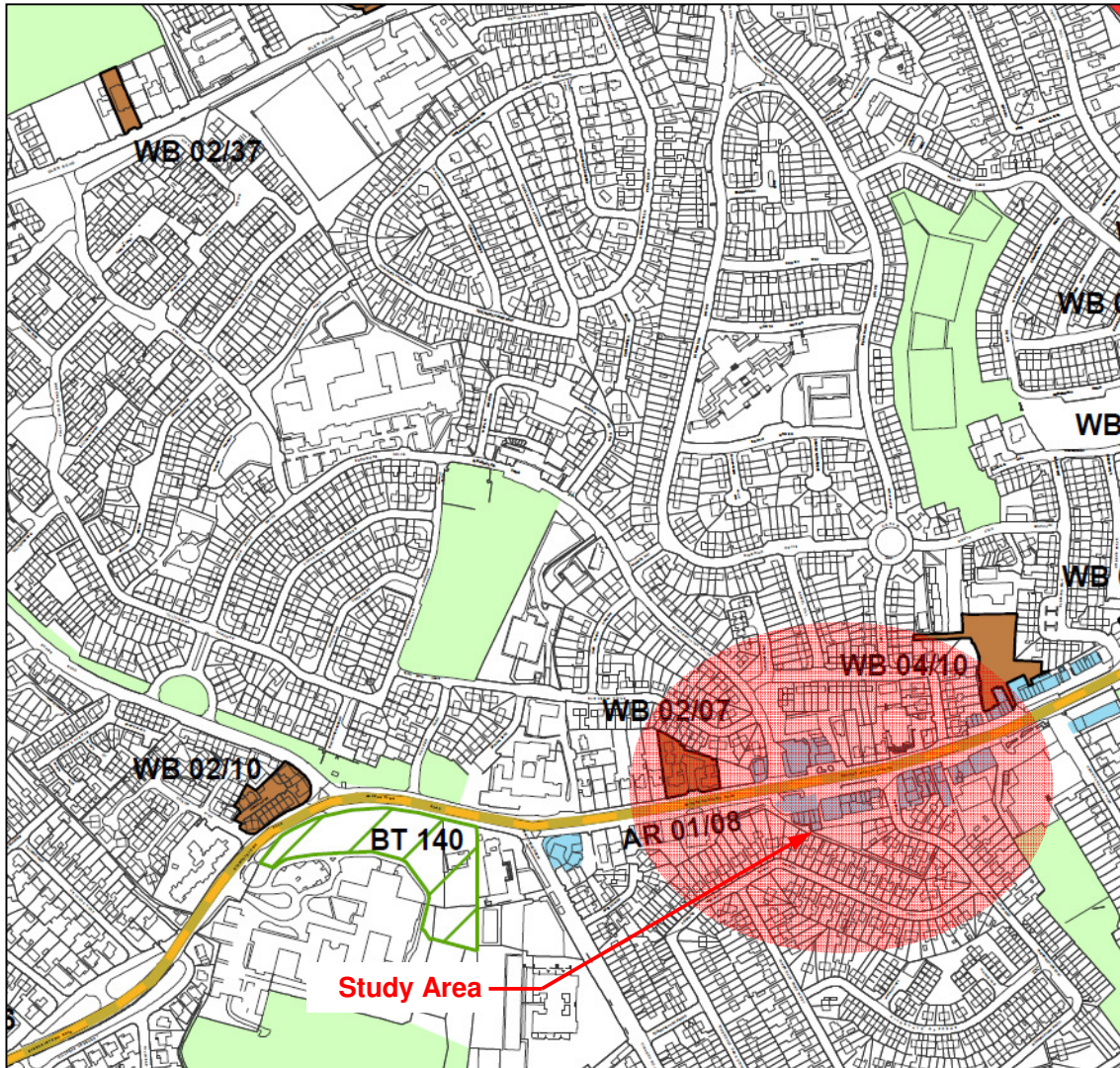


Figure 4.4 – Belfast Metropolitan Area Map 4/003 Belfast City (West) – Study Area

4.5 Environmental Issues

Consultation with DFI Rivers Environment Section was undertaken to identify environmental issues affecting the study area at Riverdale Park East. These can be categorised as follows,

- **Protected Areas** – There are no environmentally protected areas within the study area.
- **Water** – No impoundment or abstraction areas have been identified within the study area. No private water supplies have been identified from either of the reaches assessed within this study.
- **Invasive Species** – No evidence of the presence of invasive species was noted during watercourse inspection completed in July 2016.
- **Habitats** – No major habitat areas exist within the study area.
- **Historic Environment** – There are no historic buildings, monuments or areas of archaeological significance within the study area.
- **Pollution** – Due to urban environment, air quality and increased noise levels will be a significant factor affecting all remedial options considered.

4.6 Social Issues

The social impact of each remedial option for the flooding issue at Riverdale Park East must be addressed. Large impoundment structures close to residential properties can have a detrimental impact on mental well being. The oppressive nature of tall structures and the blocking of natural light to social areas of a home such as the garden are negative aspects of flood remedial options. The flood affected dwellings within Riverdale Park East are constructed at a high density with minimal outside clearance to property boundaries, hence the impact of structures in this environment will be high.

5.0 SITE DETAILS

5.1 Watercourse Catchment

The upstream catchment area of the study area at Riverdale Park East is approximately 1.71km² in size (see figure 5.1 for catchment map). The upper reach of the catchment is predominantly rural, steep sloping and mountainous, leading to a lower reach situated within the dense urban population centre of West Belfast. This catchment is un-gauged with no flow data present. Located within this catchment are the partly designated watercourses labelled 'Ramoan Gardens Stream' and 'La Salle Stream.'

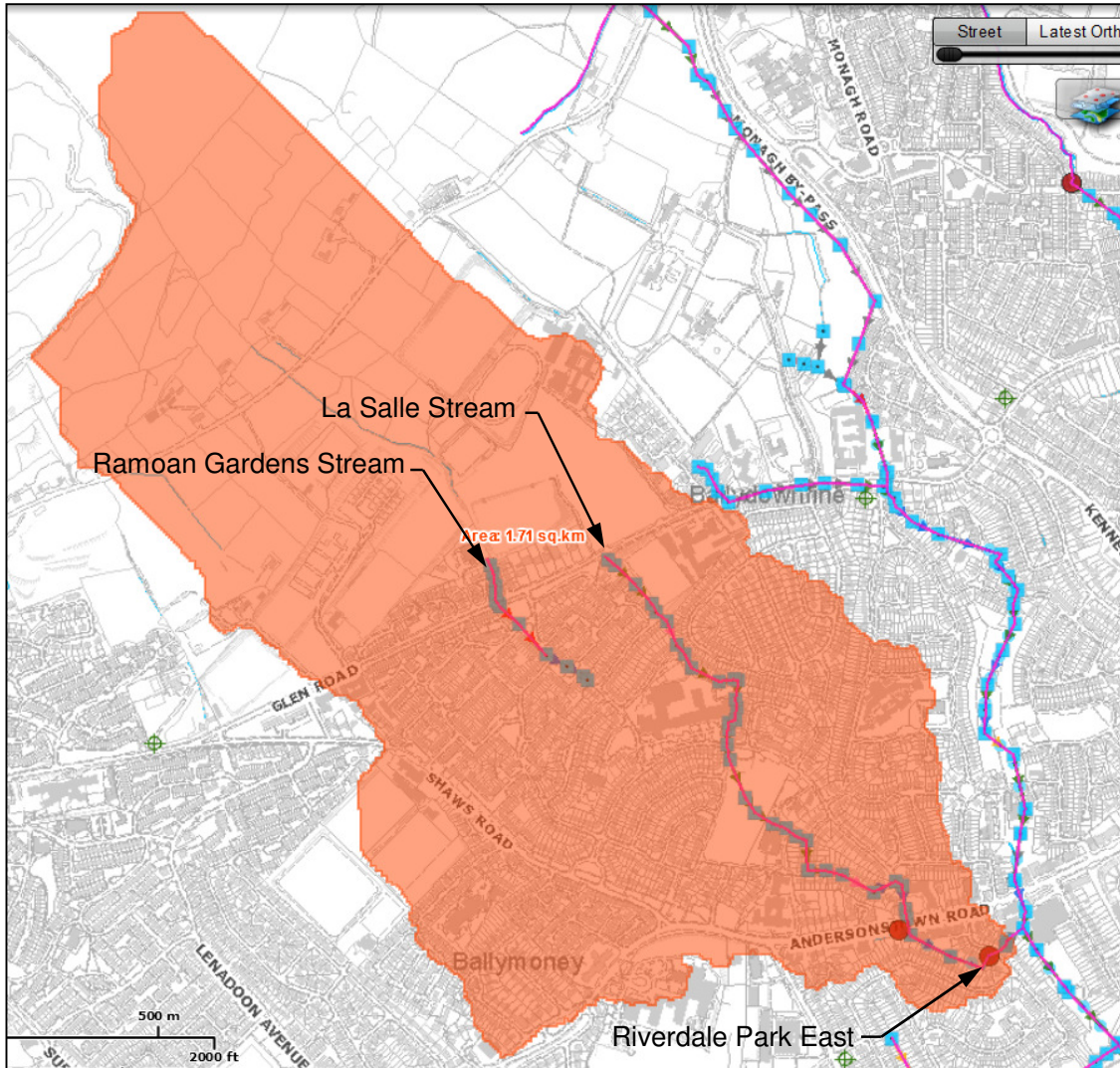


Figure 5.1 – Catchment Map

5.2 Hydraulic Features

The hydraulic features on the La Salle Stream and the Ramoan Gardens Stream were assessed as both watercourses are located within the catchment. Both reaches consist of a combination of culverts (box and pipe) and open channel sections at intermittent locations over their length.

5.2.1 Hydraulic Features - La Salle Stream

The La Salle Stream runs a length of 1.2km and consists of two culverts and a single open channel section at Riverdale Park East. Overview details of each hydraulic feature are contained within table 5-1, with further information and photos located within Appendix A.

Structure	Reach	Dimensions	Length (m)	Form	Description
U/S Culvert	Inlet at Glen Rd to open channel in Riverdale Park East	Min Diameter–0.5m Max Diameter–1.5m	1200m	Pipe	1.1km long concrete pipe culvert outlets into open channel at Riverdale Park East.
Inlet Grille	Downstream end of open channel in Riverdale Park East	Width – 1.5m Height – 1.5m Depth – 2m Bar Spacing – 0.15m	/	Screen	DFI Rivers standard metal inlet grille adjacent to no.29 Riverdale Park East.
D/S Culvert	Inlet grille at no.29 Riverdale Park East to connection to Blackstaff culvert.	Box Segment Width – 0.95m Height – 1.5m Length – 36.5m Pipe Segment Diameter – 1.20m Length – 50m	86.5m	Box and pipe	Concrete box culvert carries w/c under Riverdale Park East, changing to a concrete pipe culvert which outlets into the adjacent Blackstaff culvert network.

Table 5-1 – La Salle Stream Hydraulic Features

5.2.2 Hydraulic Features – Ramoan Gardens Stream

As identified the majority of the Ramoan Garden Stream is not designated and maintained by DFI Rivers, however this does not negate the effect the watercourse has on the La Salle Stream. The current condition and size of the culvert network is unknown. To attain accurate physical attributes a CCTV or walkthrough survey is required. Therefore for the purpose of this study the open channel section opposite 159 Andersonstown Rd will be taken as the commencement of the river reach. Overview details of each hydraulic feature from this point in Ramoan Gardens Stream are contained within table 5-2, with further information and photos located within Appendix A.

Structure	Reach	Dimensions	Length (m)	Form	Description
Inlet Grille	Downstream end of open channel along Andersonstown Rd	Width – 1.5m Height – 1.5m Depth – 2m Bar Spacing – 0.15m	/	Screen	DFI Rivers standard metal inlet grille adjacent to no.155 Andersonstown Rd.
D/S Culvert	From inlet grille of open channel along Andersonstown Rd to outlet point in La Salle culvert network	Diameter–0.9m	25m	Pipe	Concrete pipe culvert conveys Ramoan Gardens Stream to outlet point in La Salle Stream culvert network.

Table 5-2 – Ramoan Gardens Stream Hydraulic Features

5.3 Existing Services

An investigation of existing service infrastructure owned by statutory bodies within the main study area at Riverdale Park East was undertaken.

5.3.1 NI Water Network

The location of all infrastructure owned and maintained by NI Water within the study area is identified on the image 'NIW Network Map – Riverdale Park East' located within Appendix B.

5.3.2 NI Electric Network

The location of all infrastructure owned and maintained by NI Electricity within the study area is identified on the image 'NIE Network Map – Riverdale Park East' located within Appendix B.

5.3.3 Private Drainage Infrastructure

The majority of the Ramoan Gardens Stream is currently undesignated. A tributary (unnamed) joins the Ramoan Gardens Stream at the junction of Tullymore Gardens and Edenmore Drive.

5.4 Levels

Topographical survey information to determine the ground profile for the entire study area was provided by Land and Property Services. The study area was surveyed on the 04/04/2007 using the airborne LIDAR survey system. Dwelling threshold levels were surveyed on the 08/08/2016 using a Leica GPS unit (refer to Appendix C for details of threshold heights).

6.0 HYDROLOGY

6.1 Overview

Hydrological analysis of the study area was completed to determine the peak flow for a 100 year flood event, enabling the construction of a hydraulic flood model. A flood model produced by JBA Consulting labelled 'Blackstaff,' supplied to DFI Rivers as part of the Blackstaff flood study, contained flows for various flood events for the study area at Riverdale Park East. Calculated flows and supplied flows from JBA Consulting were compared with the most applicable values used in flood modelling.

6.2 Flow Estimation

The upstream catchment identified in section 5.1 is un-gauged, therefore a hydrological estimation method was required to calculate flow data for flood modelling purposes. Three estimation methods were utilised to estimate peak flow including 'Poots Cochrane,' 'FEH Statistical Method,' and the 'Revitalised flood hydrograph method (ReFH).' The methodology followed to estimate flows for a 100 year flood event for each of the three estimation methods is detailed within Appendix D.

6.3 Flow Estimation - Results

Each estimation methodology calculated a different peak flow value for a 100 year flood event. Table 6-1 includes the peak flow calculated for the catchment using each of the three estimation techniques. The table also includes the peak flow for a 100 year flood event as estimated by JBA Consulting using the FEH statistical method and is included within the flood model they completed for the Blackstaff flood study.

	Poots Cochrane	FEH Statistical Method	ReFH Method	JBA Consulting
Q100 Flow	4.041 m ³ /s	3.959 m ³ /s	4.14 m ³ /s	5.763 m ³ /s

Table 6-1 – Comparison of estimated 100 year flood flows

The peak flow estimated by JBA Consulting using the FEH statistical method is the largest calculated. This flow has been chosen as the peak 100 year flow for this study as being the largest it will provide the worst possible flooding leading to a more conservative design.

6.4 Outfall Level & Tidal Effect

The network assessed under this study along the La Salle stream outfalls directly into the adjacent Blackstaff River culvert network via a manhole structure. To accurately model the La Salle system, a downstream boundary water level is required. The flood model supplied by JBA Consulting as part of the Blackstaff flood study completed was used to identify the maximum water level within the system. The 1 in 100 year flood simulation was interrogated to define the maximum water level at the outlet of the Blackstaff Culvert into the Woodlands River (U3BEL1T) the location at which the model outfalls (to the south of Musgrave Industrial Park). The downstream tie in level has been identified as 12.294m above ordnance datum Belfast (AOD). This value was used as the downstream boundary level for each model simulation completed for this study. An additional assessment of tidal effects on the flow through the network within the study area was completed. The maximum tide level of 2.39m AOD is significantly lower than the downstream boundary level of 12.294m AOD previously identified. Hence due to the large level difference it can be concluded that the culvert network within the study area is under no influence from tidal events.

7.0 FLOOD MODELLING METHODOLOGY

7.1 Overview

Flood modelling software 'Infoworks ICM 6.0' was used to construct a two dimensional flood model of the study area. The process of collecting data, defining design parameters and the methodology used to build the flood model are detailed within this chapter.

7.2 Survey Data

Lidar data was acquired from DFI Rivers Mapping and Modelling Unit who provided a 'Digital Terrain Model' (DTM) for the area. The DTM provides topographical data and is based on a one metre square grid, with the data covering a total area of 1km². The DTM is best described as a bare surface ground model as it does not take into account structures such as buildings or trees.

7.3 Model Network

The flood model constructed by JBA Consulting as part of the Blackstaff flood study has been utilised as a base reference from which a new model has been constructed. The Blackstaff model was firstly truncated to encompass only the reaches that directly affect the study area at Riverdale Park East. The truncated model was then updated to include features which were either missing or have been altered from the time of the original Blackstaff model construction. Alterations are defined as,

- **River Reach at Andersonstown Shops** – A 60m long section of open channel adjacent to the shops at Andersonstown Road has been included. This river reach carries flow from the Ramoan Gardens Stream.
- **Inlet Screen** – An inlet screen was inserted at the downstream end of the river reach at Andersonstown shops.
- **Inlet structure** - A culvert inlet structure was inserted at the downstream end of the river reach at the Andersonstown Road shops.
- **Piped Culvert** – A 900mm diameter concrete culvert pipe, 14.8m in length, was inserted to join the inlet structure at the Andersonstown shops river reach to a manhole structure on the La Salle culvert network (see Appendix E for details).

DFI Rivers Asset Management Unit maintains an 'ICM Infonet' database to record the physical properties of all assets under their stewardship. A cross referencing exercise was undertaken to identify physical properties of elements within the model network which were outdated. No alterations were required as all physical properties matched current recorded values.

7.4 Hydraulic Parameters

7.4.1 Inlet Structure Design Co-efficient

The design co-efficients used for each of the inlet structures within the study area have been taken from 'Table D1' of the publication 'CIRIA Report 168 Culvert Design Manual' and are detailed within table 7-1.

Inlet Structure Model ID	Shape	Material	Inlet Type	K	M	c	V	Ki
A/town shops inlet	Circular	Concrete	Headwall–Socket end of pipe	0.0078	2.0	0.0292	0.74	0.3
Riverdale Park East inlet	Rectangular	Concrete	Headwall & wingwalls at 0° to barrel/square edge	0.061	0.75	0.0423	0.82	0.7

Table 7-1 – Inlet structures design co-efficient

7.4.2 Roughness Co-efficient for Culvert Barrels

The design roughness co-efficients used for each inlet structure in the model have been taken from ‘Table D2’ of the publication ‘CIRIA Report 168 Culvert Design Manual.’ The chosen parameters are displayed in table 7-2. With the internal finish of each culvert unknown the ‘unfinished’ description was chosen to provide a more conservative estimate of flow through the network.

Inlet Structure Model ID	Material	Wall & joint Description	Manning’s ‘n’ value
La Salle Stream network	Concrete Pipe	Unfinished	0.014 – 0.020
Ramoan Gardens Stream network	Concrete Pipe	Unfinished	0.014 – 0.020
Blackstaff River network	Concrete Pipe	Unfinished	0.014 – 0.020

Table 7-2 – Roughness co-efficient for culvert barrels

7.4.3 Roughness Co-efficient for Natural Channels

Within the model both a river reach and the surrounding land area require a manning’s ‘n’ value to be assigned. ‘Table D3’ from the publication ‘CIRIA Report 168 Culvert Design Manual’ was used to determine a value for each. During a site walkover survey the characteristics of each open channel river section within the study area was assessed. In choosing a manning’s value the normal condition value was chosen as the site characteristics were deemed to be typical. A value of 0.045 was chosen for the river channel at Andersonstown Road shops, with a value of 0.090 chosen for the river channel within Riverdale Park East. The river banks of the open channel in Riverdale Park East are constructed from concrete blocks with no render applied, hence a higher roughness co-efficient is necessary. A value of 0.050 was chosen upon assessment of the surrounding ground surface of each river reach. All values outlined are displayed within table 7-3.

Channel Reference	Channel Type & Description	Manning's 'n' value
Andersons Road Shops	Clean, winding, some pools and shoals with some weeds and stones.	0.045
Riverdale Park East	Clean, winding with concrete blocks (no render) to banks.	0.090
Surrounding Flood Plain	Scattered brush with weeds	0.050

Table 7-3 – Roughness co-efficient for natural channels

7.4.4 Discharge Co-efficient & Modular Limit

The accepted industry standards of 1.0 for the discharge co-efficient and 0.9 for the modular limit have been applied to this model where a vertical face is present along the bank edge e.g. along walls. Otherwise the values of 0.8 for the discharge co-efficient and 0.5 for the modular limit have been used to simulate natural conditions. Both values were assigned to all river banks within the modelled river reaches to control the discharge of flood water over bank crests.

8.0 FLOOD ASSESSMENT AND IMPACT

8.1 Overview

To develop effective remedial solutions to the flooding problem in Riverdale Park East it is necessary to firstly identify the flooding mechanism. Flood events were simulated using the 'ICM Infoworks 6.0' hydraulic model and hydrology detailed previously, to provide a flood outline along with a real time visual model displaying flood water flows. Details of this process and the resulting outcomes are included within this chapter.

8.2 Simulation Results – Flood Outline

Multiple simulations using flow conditions estimated for flood events ranging from 5 year to 1000 year were completed using 'ICM Infoworks' software, enabling an assessment of the current flooding mechanism at Riverdale Park East. Figure 8.1 is a screenshot from the simulation output, with flood water shown to directly affect properties within Riverdale Park East, Andersonstown Road, Slievegallion Drive and Slieveban Drive.



Figure 8.1 – 100 Year flood event results

8.3 Simulation Results – Flooding Mechanisms

Upon review of each flood event simulation three separate mechanisms were identified which directly contribute to the flooding problem at Riverdale Park East. Figure 8.2 provides a visual representation of the flow path taken by flood water as it flows overland within the study area. The location of each flooding mechanism is also displayed on figure 8.2.

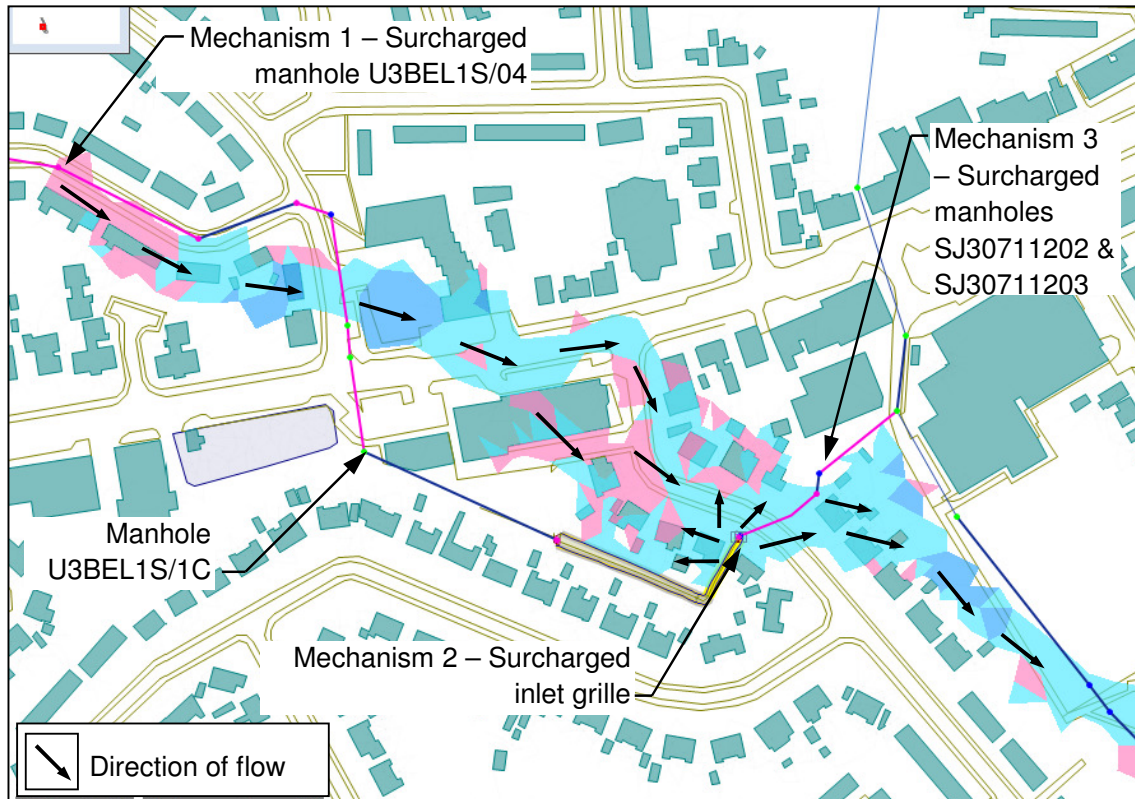


Figure 8.2 – Flooding Mechanisms – Flow of flood water

8.3.1 Flooding Mechanism 1 – Surcharged manhole in Slieveban Drive

A surcharging manhole (U3BEL1S/04) located within the carriageway in front of no.28 Slieveban Drive allows flood water to exit the network and flow south towards the Andersonstown Rd (see figure 8.2 for details). This manhole surcharges due to backflow from the piped culvert immediately downstream which is also surcharging. The downstream section of culvert from manholes U3BEL1S/04 to U3BEL1S/1C is hydraulically undersized causing flooding at a 5 year flood event and greater. This section of the La Salle Stream network consists of 600mm diameter concrete pipes, which outlet into a 1500mm diameter culvert pipe via a manhole connection.

8.3.2 Flooding Mechanism 2 – Surcharged culvert in Riverdale Park East

A box culvert within Riverdale Park East is hydraulically undersized, causing flow to surcharge and exit the network at the grille located adjacent to no.29 Riverdale Park East. The box culvert is a concrete structure with a width of 1500mm and height of 950mm. The culvert passes underneath the carriageway over a distance of 36.7m and outlets into a manhole (SJ30711202) adjacent to no.12 Riverdale Park East. The subsequent downstream culvert section consists of 1200mm diameter concrete pipes which constrict flow, further contributing to the surcharging effect. Out of bank flow commences during a 100 year flood event and greater.

8.3.3 Flooding Mechanism 3 – Surcharged manholes in Riverdale Park East

Two manholes (SJ30711202 & SJ30711203) located in land adjacent to property no.12 Riverdale Park East surcharge allowing flow to exit the underground network. The culvert sections flowing into and out of the manholes are hydraulically undersized, causing flow to

surcharge and force the manhole lids open during a 50 year flood event and greater. The culvert is a 1200mm diameter concrete pipe running a distance of 50m to the point of confluence with the Blackstaff River culvert network.

8.4 Receptors

8.4.1 Private Dwellings & Commercial Units

A list of private dwellings and commercial properties affected by flood water is detailed within Appendix F. Table 8-1 below includes details of the magnitude of flood event at which commercial and residential dwellings incur damages resulting from flood water flow. In total, 33 residential dwellings and 15 commercial properties are affected by flood water resulting from a 100 year flood event.

Street Name	Building Type	Flood event magnitude at which damages occur
Riverdale Park East	Residential	5 Year Flood
	Commercial	25 Year Flood
Andersonstown Road	Commercial	5 Year Flood
Slieveban Drive	Residential	5 Year Flood
Slievegallion Drive	Residential	5 Year Flood

Table 8-1 – Flood event magnitudes at which damages occur

8.4.2 Public Infrastructure

The public road network affected includes the Andersonstown Road, Riverdale Park East, Slieveban Drive and Slievegallion Drive. The Andersonstown Road is a main arterial route through the West of Belfast City and is a major transport link used by public and private vehicles. The other identified affected roads are used mainly for residential access to privately owned dwellings.

9.0 REMEDIAL OPTIONS

9.1 Overview

Various remedial options were assessed to determine the most applicable solution to flooding within Riverdale Park East. A 2D hydraulic model was constructed for each remedial option using 'ICM Infoworks 6.0' software, with a 100 year flood simulation and flood outline output completed. Options considered include;

Do Nothing - Cease all activity incurring no further monetary spend.

Do Minimum - Provide all affected properties with individual property level protection and continue maintenance and inspection regime at current levels.

Option 1 - Culvert upgrade in Slieveban Drive, Slievegallion Drive and Riverdale Park East.

Option 2A & 2B - Culvert upgrade and wall construction to open channel section at Riverdale Park East.

Option 3A & 3B - Attenuation of flow utilising natural channel at the Andersonstown Shops with culvert upgrade upstream.

Option 4 - Attenuation of flow utilising a pre-cast concrete flood storage tank and upstream culvert upgrade.

Option 5 - Attenuation of flow using the natural channel at the Andersonstown Shops to construct a storage tank, with a culvert upgrade completed upstream.

9.2 Remedial Option Assessment

9.2.1 Do Nothing

In order to define a baseline damage figure against which the cost benefit of each remedial option can be assessed, it is necessary to consider a 'Do nothing' scenario. This scenario analyses the flood damages incurred if no further money on infrastructure, maintenance or inspection was spent.

9.2.2 Do Minimum

The 'Do Minimum' scenario assesses the benefit of installing individual property level protection at properties identified as flooding during a 100 year event. This scenario will also account for the current level of inspection and maintenance by DFI Rivers area staff to be maintained at current levels. All associated works, advantages and disadvantages of the option are as follows;

<i>Works Involved</i>	<ul style="list-style-type: none">- Continue maintenance and inspection works at current levels.- Install individual property level protection measures at affected properties. Measures include barriers for doorways and airbricks, non-return valves, de-watering pumps, waterproofing and sealants.
<i>Advantages</i>	<ul style="list-style-type: none">- Solves the flooding problem for a 100 year flood event.- Flexible solution, barriers heights can be easily increased to allow for higher magnitude flood events resulting from climate change.- Low capital cost of initial scheme.- Simple construction methods with a short installation timeframe enables flood protection to be provided within a relatively short period, avoiding further potential damages.- No works on public land such as in gardens, roads, private yards. This will minimise the potential for delays and limits disruption for property owners in the area.
<i>Disadvantages</i>	<ul style="list-style-type: none">- Although the option provides protection to individual properties, flood water will still encroach upon property exteriors. This will allow external flooding to occur, causing personal damage to vehicles and local infrastructure.- Although the risk of flooding can never be wholly eliminated with hard defences, the public perception is more receptive to the construction of hard defences when compared to the installation of individual property protection measures. This option will require 'buy in' from local property owners to ensure measures are correctly installed during times of flooding, placing the responsibility solely upon them.

9.2.3 Option 1 – Double Culvert Upgrade

Upon assessment of the base model and the identification of the three mechanisms of flooding in Riverdale Park East, it is evident that the current network is hydraulically ineffective in two separate sections. The first assessed option aimed to deal directly with this ineffectiveness by up-sizing the identified sections of culvert. As a result of the steep topography of the surrounding land, upgrading the existing culverts causes out of bank flow to occur in the narrow open channel at Riverdale Park East. Therefore a vertical wall structure along both banks of the channel was included within the model for this remedial option. All associated works, advantages and disadvantages of the option are as follows;

Works Involved

- Upgrade of six sections (U3BEL1S/04 to U3BEL1S/1C) of piped culvert from 600mm to 1050mm in diameter within Slieveban Drive and Slievegallion Drive (red line on figure 9.1), 222m length in total.
- Bank levels of open channel at Riverdale Park East have been increased in height by introducing a vertical wall, approx 400mm - 500mm higher than current bank levels.
- Upgrade culvert in Riverdale Park East (SJ30711201 to U3BEL1/23) to 1500mm concrete pipe, total length of 87m (blue line on figure 9.1).
- Seal two manholes immediately downstream of inlet grille (SJ30711202 & SJ30711203).

Advantages

- Solves the flooding problem for a 100 year flood event.
- The height of the wall required at the open channel within Riverdale Park East is relatively low in comparison to the surrounding ground.

Disadvantages

- High complexity as solution involves culverts, manholes and walls.
 - There may be a significant number of manholes to be totally replaced due to the large increase in culvert size.
 - Culvert upgrade works would be extremely disruptive to local residents and requires traffic management measures to be implemented throughout the scheme.
 - Restrictive working area within the highly developed residential streets. This will have a negative effect on project cost and duration.
 - Wall construction in residents back garden requires long term maintenance, is unsightly and unwanted by residents.
-

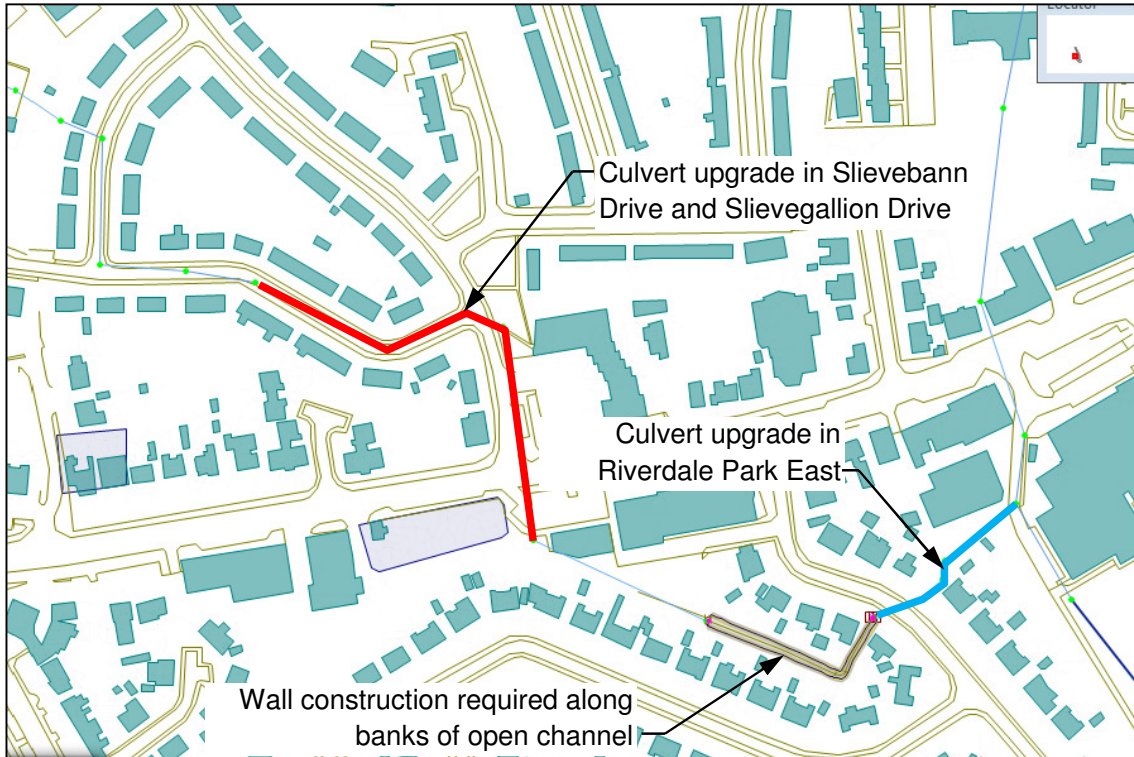


Figure 9.1 – Remedial Option 1 – Culvert upgrade overview

9.2.4 Option 2 – Single Culvert Upgrade & Impounding Walls at Riverdale Park East

With the aim of decreasing the quantity of works within the space restricted Riverdale Park East, the option of using the current open channel between Riverdale Park East and North as an impoundment structure to attenuate flow downstream was assessed.

9.2.4.1 Option 2A – Culvert upgrade & impoundment walls

The first version of this option modelled was the introduction of a fully enclosed wall structure around the existing open channel at Riverdale Park East. All works involved, advantages and disadvantages of this option are identified as follows;

Works Involved	<ul style="list-style-type: none">- Upgrade of six sections (U3BEL1S/04 to U3BEL1S/1C) of piped culvert from 600mm to 1250mm in diameter within Slieveban Drive and Slievegallion Park (red line on figure 9.2), 222m length in total.- Wall to encompass the entire open channel in Riverdale Park East. The impounding wall is 214m in length, with a varying height of between 1.69m and 3.17m from the surrounding ground level.- Seal two manholes immediately downstream of inlet grille in Riverdale Park East (SJ30711202 & SJ30711203).
Advantages	<ul style="list-style-type: none">- Solves the flooding problem for a 100 year flood event.- No culvert upgrade works required within Riverdale Park East.
Disadvantages	<ul style="list-style-type: none">- High complexity as solution involves culverts, manholes and walls.- Culvert upgrade works are still required, although to a lesser extent, would be extremely disruptive to local residents and requires traffic management measures to be implemented throughout the scheme.- The height of the wall within the rear gardens of properties in Riverdale Park East is excessive. This will create a social problem for residents, requires long term maintenance and creates a safety issue of storing water with such a large head variation so close to property. A catastrophic failure of the flood wall has the potential to cause a fatality.- Maintaining access for channel and grille maintenance works would be complex due to the tall, narrow and vertical profile of the new walls.

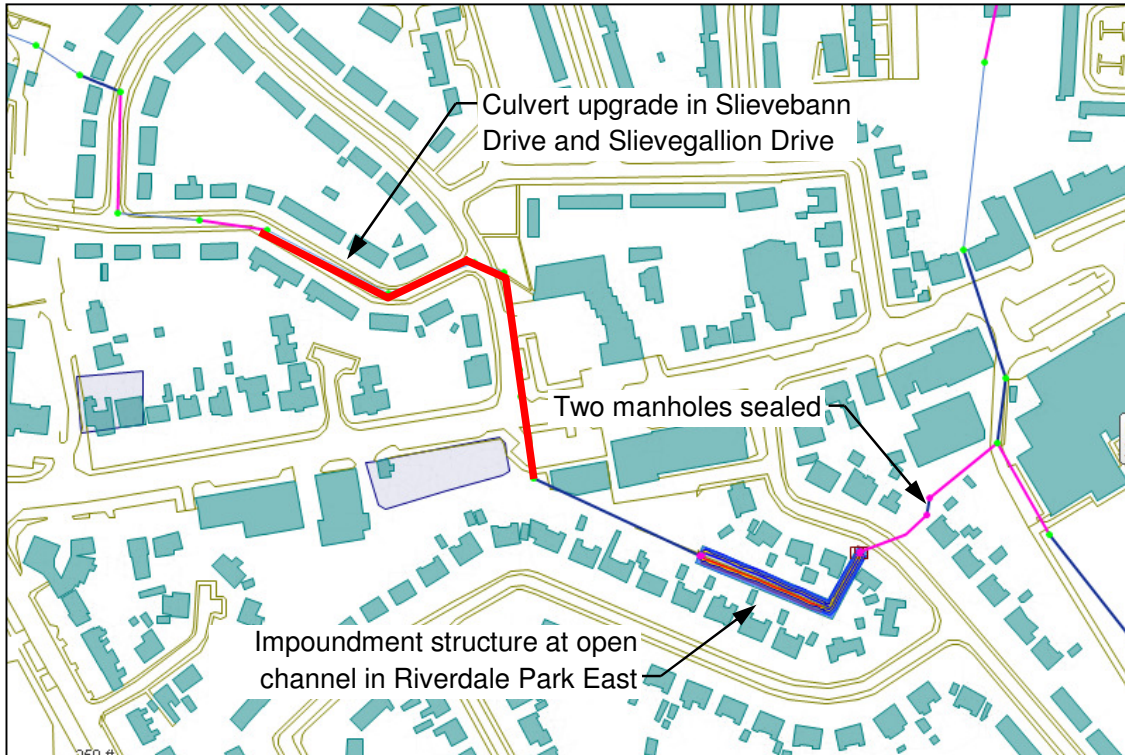


Figure 9.2 – Remedial Option 2A Overview

9.2.4.2 Option 2B – Culvert upgrade, impoundment walls & hydraulic throttle

As identified in option 2A the wall required to impound unrestricted 100 year event flows at Riverdale Park East is excessive and unrealistic. A second version of this option was modelled to include a 825mm diameter orifice at the outlet from the channel at Andersonstown shops. All works involved, advantages and disadvantages of this option are identified as follows;

Works Involved	<ul style="list-style-type: none"> - Upgrade of six sections (U3BEL1S/04 to U3BEL1S/1C) of piped culvert from 600mm to 1250mm in diameter within Slieveban Drive and Slievegallion Park (red line on figure 9.3), 222m length in total. - Wall to encompass the entire natural open channel at Riverdale Park East. The impounding wall is 214m in length, with a maximum height of 1.8m from the surrounding ground level. - Seal two manholes immediately downstream of inlet grille in Riverdale Park East (SJ30711202 & SJ30711203). - Introduction of 825mm diameter orifice at the outlet from the channel at Andersonstown shops into the La Salle Stream network.
Advantages	<ul style="list-style-type: none"> - Solves the flooding problem for a 100 year flood event. - No culvert upgrade works required within Riverdale Park East. - Significant reduction in height of wall required at Riverdale Park East to a maximum 1.8m above existing ground levels.
Disadvantages	<ul style="list-style-type: none"> - High complexity as solution involves the construction of culverts, manholes and walls. - Culvert upgrade works are still required, although to a lesser extent, would be extremely disruptive to local residents and requires traffic management measures to be implemented throughout the scheme.

-
- The height of the wall within the rear gardens of properties in Riverdale Park East is still excessive. This will create a social problem for residents, requires long term maintenance and creates a safety issue of storing water with such a large head variation so close to residential dwellings. A catastrophic failure of the flood wall has the potential to cause a fatality.
 - Maintaining access for river channel and grille maintenance works would still be complex due to the tall, narrow and vertical profile of the new impounding walls.
-

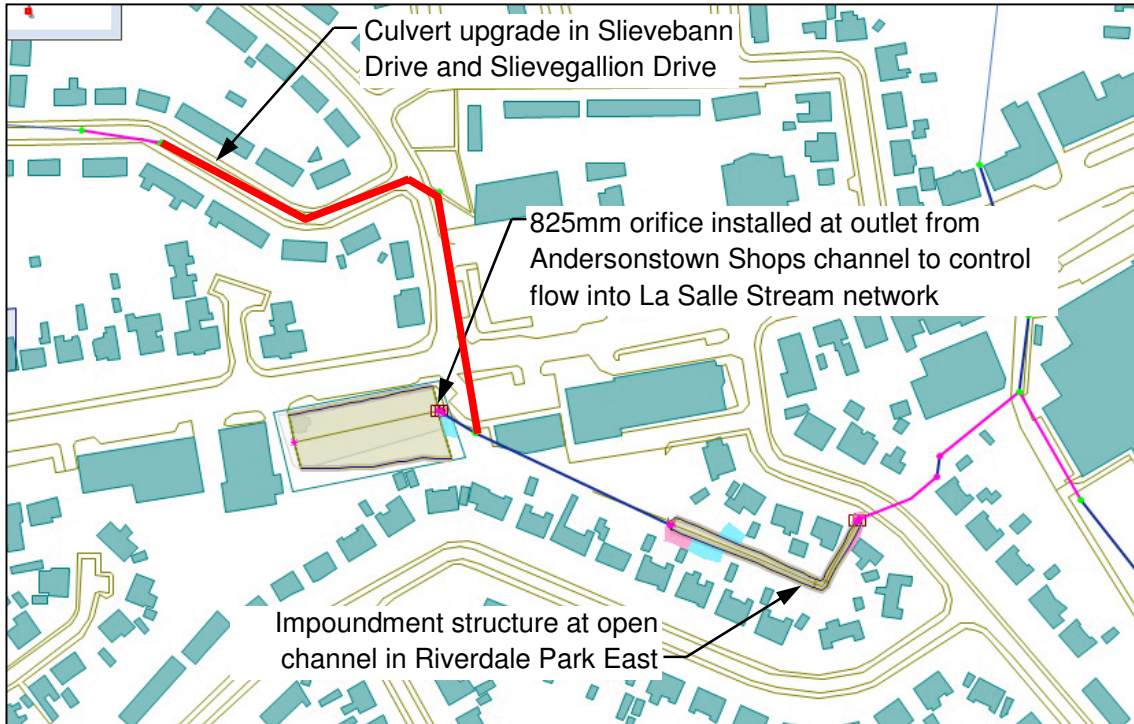


Figure 9.3 – Remedial Option 2B Overview

A further version of this option was trialed by introducing a smaller orifice at the outlet from the Andersonstown Road Shops channel with the aim of further reducing the impounding wall height. This arrangement was unsuccessful however as it caused out of bank flow to occur at the Andersonstown shops, flooding the adjacent commercial units. An additional flood wall would therefore be required around the Andersonstown Road Shops channel, adding to construction time and projects costs and making the solution unfeasible.

9.2.5 Option 3 – Attenuation Utilising Natural Storage

The option of attenuating flow to control the volume of water within the La Salle Stream network was hydraulically modelled for a 100 year event. The aim of trialling this option was to eliminate the main disadvantage of both options 1 and 2, namely complex culverting and wall construction in a densely inhabited area. The natural channel section at the Andersonstown Shops was identified as the ideal location from which to control flow. Approximately 40% of the flow upstream of Riverdale Park East in the La Salle Stream network enters at the Andersonstown Shops. Flow is solely contributed to the partially designated Ramoan Gardens Stream which outlets into the open channel at the shops. Two orifice sizes, 600mm and 750mm diameter, have been modelled with results assessed.

9.2.5.1 Option 3A – Attenuation using 600mm diameter orifice

The first version of this option modelled was the introduction of a 600mm diameter orifice at the outlet of the natural channel at the Andersonstown shops. All works involved, advantages and disadvantages of this option are identified as follows;

Works Involved

- Upgrade of six sections (U3BEL1S/04 to U3BEL1S/1C) of piped culvert from 600mm to 1250mm in diameter within Slieveban Drive and Slievegallion Park (red line on figure 9.4), 222m length in total.
- Wall to encompass the entire natural open channel at the Andersonstown Shops constructed on top of the current banks. The wall ranges from 200mm to 1700mm in height above existing ground level and is 175m in length.
- Seal two manholes immediately downstream of inlet grille in Riverdale Park East (SJ30711202 & SJ30711203).
- Introduction of 600mm diameter orifice at the outlet from the channel at Andersonstown shops into the La Salle Stream network.

Advantages

- Solves the flooding problem for a 100 year flood event.
- No culvert upgrade works required within Riverdale Park East.
- No wall required at the natural channel within Riverdale Park East
- Relatively low height of the wall at the upstream end of the channel will enable access for river maintenance to be easily maintained.
- Fewer residents in locality, hence less opposition to the construction of a wall in this location
- A wall at the Andersonstown Shops channel would be less complex to construct as there is more working room and greater access for plant and materials at this location.

Disadvantages

- High complexity as solution involves culverts, manholes and walls.
 - Culvert upgrade works are still required, although to a lesser extent, would be extremely disruptive to local residents and requires traffic management measures to be implemented throughout the scheme.
 - A wall is required around the natural channel at Andersonstown Shops. This creates a social issue as the wall would be imposing to residents of Riverdale Park North as it boundaries the rear garden of several properties. The maximum wall height of 1700mm is significant.
 - Safety hazard is still present, storing a large body of water in an urban environment with a significant head variation has several associated problems. Long term maintenance, inspection and repair costs will all be incurred to maintain DFI Rivers standards on the structure.
-

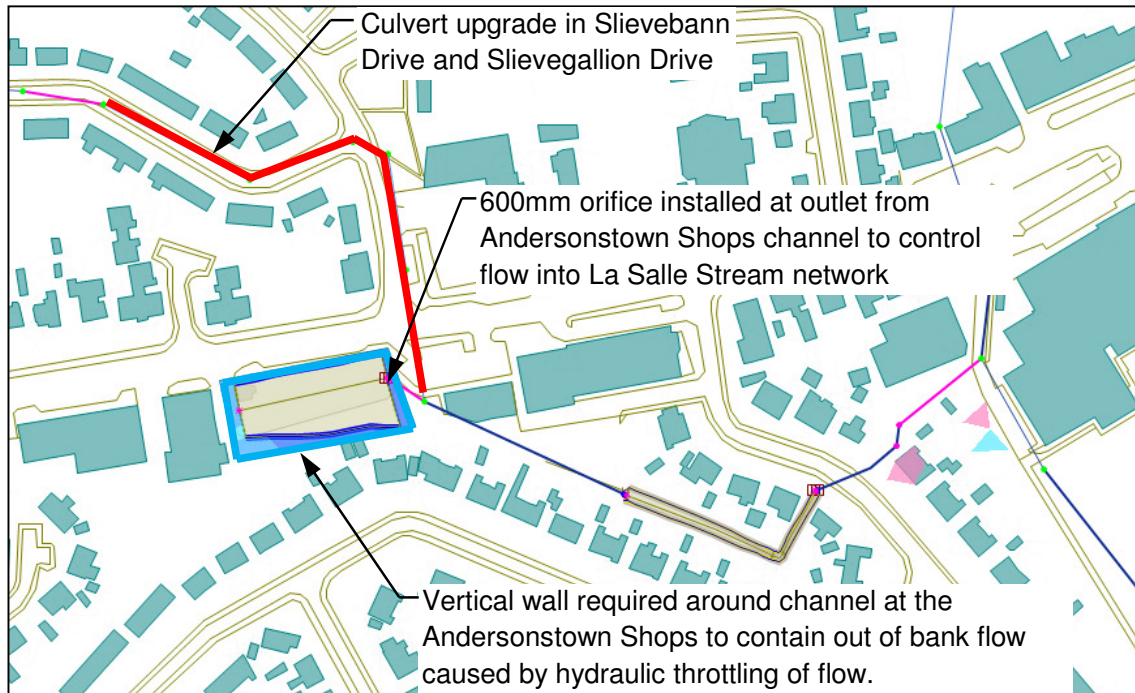


Figure 9.4 – Remedial Option 3A Overview

9.2.5.2 Option 3B – Attenuation using 750mm diameter orifice

The second version of this option modelled was the introduction of a 750mm diameter orifice at the outlet of the natural channel at the Andersonstown shops. All works involved, advantages and disadvantages of this option are identified as follows;

Works Involved

- Upgrade of six sections (U3BEL1S/04 to U3BEL1S/1C) of piped culvert from 600mm to 1250mm in diameter within Slieveban Drive and Slievegallion Park (red line on figure 9.5), 222m length in total.
- Wall to encompass the entire natural open channel at the Andersonstown Shops constructed on top of the current banks. The wall ranges from 0mm to 1100mm in height above existing ground level and is 75m in length.
- Seal two manholes immediately downstream of inlet grille in Riverdale Park East (SJ30711202 & SJ30711203).
- Introduction of 750mm diameter orifice at the outlet from the channel at Andersonstown shops into the La Salle Stream network.
- Wall to encompass the entire open channel at Riverdale Park East. The wall has a maximum height of 800mm above the existing ground level and is 72m in length.

Advantages

- Solves the flooding problem for a 100 year flood event.
- No culvert upgrade works required within Riverdale Park East.
- Decreased height and length of wall at Andersonstown Road Shops.
- The wall at the Andersonstown Road Shops channel would be relatively uncomplicated to construct as there is more working room and greater access for plant and materials at this location. Relatively low height of the wall at the upstream end of the channel will enable access for river maintenance to be easily maintained.
- Fewer residents in locality, hence less opposition to the construction of a wall in this location

- High complexity as solution involves the construction of culverts, manholes and walls.
- Culvert upgrade works are still required, although to a lesser extent, would be extremely disruptive to local residents and requires traffic management measures to be implemented throughout the scheme.
- Unlike option 3A, a wall is required downstream at Riverdale Park East, however the length and height of the wall is less than the options presented in 2A and 2B respectively. However this additional wall increases the construction programme, costs and disruption experienced by residents.

Disadvantages

- A wall is required around the natural channels at Andersonstown Shops and Riverdale Park East. This creates a social issue as the walls would be imposing to residents of Riverdale Park North and East as it boundaries the rear garden of several properties. The maximum wall height of this arrangement is lessened by the attenuation technique, with a maximum wall height of 1100mm.
- A safety hazard is still present, storing a large body of water in an urban environment with a significant head variation has several associated problems. Long term maintenance, inspection and repair costs will all be incurred to maintain DFI Rivers standards on the structure.

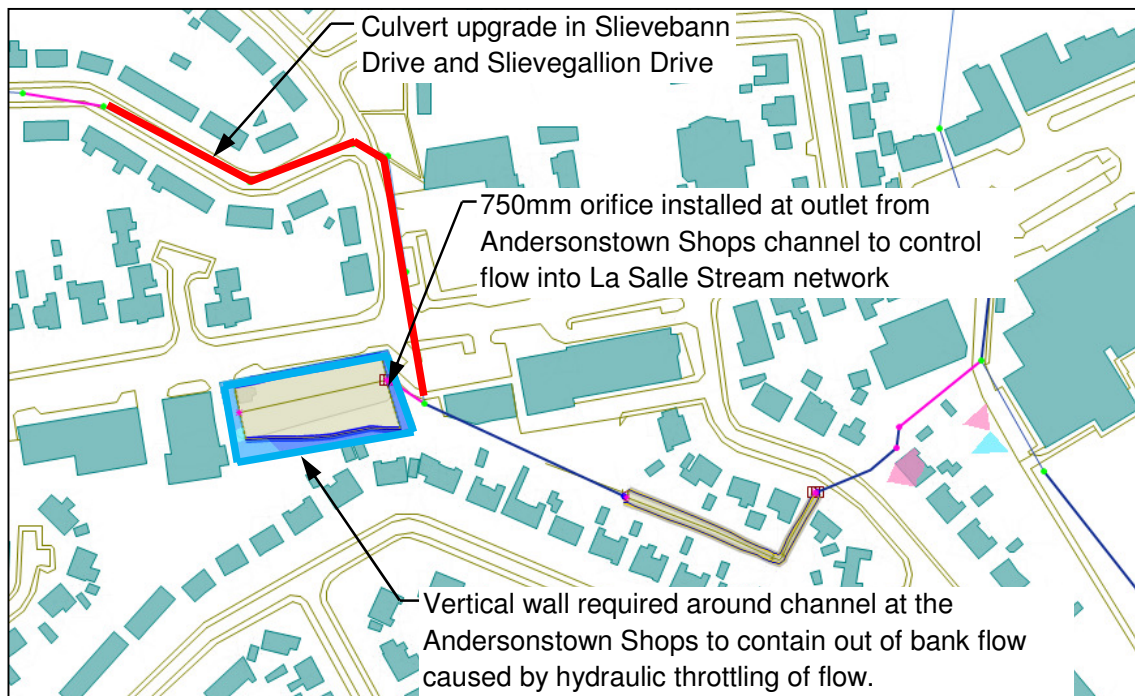


Figure 9.5 – Remedial Option 3B Overview

9.2.6 Option 4 – Attenuation Utilising Underground Storage

As discussed, options 2 and 3 both solve the flooding issue at Riverdale Park East, however the construction of flood walls has many associated long term negative consequences. The option of installing a large scale underground storm water storage tank as an alternative means of attenuating flows was assessed. All works involved, advantages and disadvantages of this option are identified as follows;

Works Involved

- Upgrade of six sections (U3BEL1S/04 to U3BEL1S/1C) of piped culvert from 600mm to 1250mm in diameter within Slieveban Drive and Slievegallion Park (red line on figure 9.6), 222m length in total.
- Installation of a pre-cast concrete 'Stormstore' (pink shaded area on figure 9.6) in the land to the rear of the Andersonstown Shops. Tank dimensions required are 40.4m x 200m x 2.125m. This tank size has the capacity to store up to 17,000m³ of water.
- Seal two manholes immediately downstream of inlet grille in Riverdale Park East (SJ30711202 & SJ30711203).
- Introduction of 825mm diameter orifice at the outlet from the channel at Andersonstown shops into the La Salle Stream network.

Advantages

- Solves the flooding problem for a 100 year flood event.
- No culvert upgrade works required within Riverdale Park East.
- Avoids the need for wall construction on either open channel.
- Decreased health and safety risk in comparison to wall construction.
- Provides a long term aesthetically pleasing solution when compared to the alternative approach of wall construction.

Disadvantages

- High complexity as solution involves the construction of an underground tank in an area that is densely developed. Restrictive working room for plant and materials will add to construction duration and costs.
 - Culvert upgrade works are still required, although to a lesser extent, would be extremely disruptive to local residents and requires traffic management measures to be implemented throughout the scheme.
 - Excessive land take required to construct 'Stormstore' tank size required for the 1 in 100 year flow.
 - Deep excavations required close to industrial and private buildings.
 - Long term maintenance issue for inspection and repair works to the 'Stormstore' as the structure is wholly buried.
 - The size of 'Stormstore' required, in conjunction with the necessary temporary works required during construction, is extremely expensive, thus effectively ruling this option unfeasible on cost benefit alone.
 - Negative environmental impact with large quantities of excavated earth sent to landfill.
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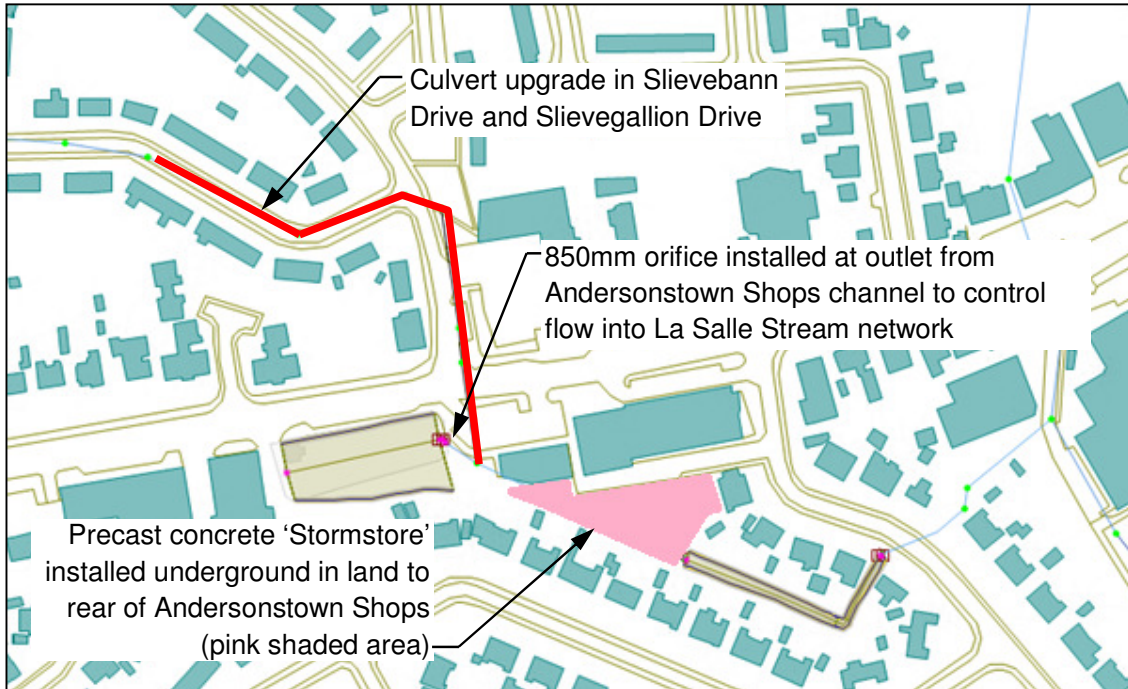


Figure 9.6 – Remedial Option 4 Overview

Although the option assessed solves the flooding problem at Riverdale Park East, there is insufficient free space within the study area to construct the size of 'Stormstore' required. When modelled for a 100 year event in conjunction with a hydraulic throttle located at the outlet of the Andersonstown Shops open channel, the size of 'Stormstore' required was still unfeasible. Also by introducing a hydraulic throttle upstream the main advantage of using the underground storage was negated as walls were then required to stop out of channel flow at the Andersonstown Shops channel.

For the above reasons, option 4 has been discounted from the study. Data shown later in the report relating to option 4 can generally be ignored, but is retained for information only.

9.2.7 Option 5 – Attenuation Utilising Engineered Structure

The option of using an engineered structure to store water for upstream attenuation was trialled. To provide capacity, the cross sectional profile of the river channel has been altered by installing a sheet-piled wall along each bank and excavating the remaining earth providing a rectangular river profile (see figure 9.8 for details). All works involved, advantages and disadvantages of this option are identified as follows;

Works Involved

- Upgrade of six sections (U3BEL1S/04 to U3BEL1S/1C) of piped culvert from 600mm to 1250mm in diameter within Slieveban Drive and Slievegallion Park (red line on figure 9.7), 222m length in total.
- Installation of interlocking sheet piles around the open channel at the Andersonstown Shops. The total length of piling required is 175m, with each pile approximately 8m long providing a crest height of 26.5m (blue line in figure 9.7). Maximum height from existing ground level of 2000mm to crest of wall.
- Seal two manholes immediately downstream of inlet grille in Riverdale Park East (SJ30711202 & SJ30711203).
- Introduction of 600mm diameter orifice at the outlet from the channel at Andersonstown shops into the La Salle Stream network.
- Excavation and disposal of the remaining earth within the channel at the Andersonstown shops.

Advantages

- Solves the flooding problem for a 100 year flood event.
- No culvert upgrade works required within Riverdale Park East.
- No wall required at open channel within Riverdale Park East.
- Reduction in crest height of wall at the Andersonstown Shops channel compared to similar solution assessed in option 3A. Lowered crest height will enable maintenance access to be maintained.
- Extremely robust construction technique will extend design life of the asset. Lower crest height and sheet pile construction will reduce risk posed from catastrophic failure mechanism. Lower maintenance and long term costs in comparison to a reinforced concrete structure.
- Disruption minimised as less working areas required.
- Additional storage capacity can be easily added to the structure in the future to account for the potential impact of climate change.

Disadvantages

- Culvert upgrade works are still required, although to a lesser extent, would be extremely disruptive to local residents and requires traffic management measures to be implemented throughout the scheme.
 - High initial capital cost as the construction of a permanent sheet piled wall to the required dimensions would require a significant budget.
 - Deep excavations and sheet piling works required close to industrial and private buildings. This will detrimentally impact air quality, noise and vibration levels during construction.
 - Negative environmental impact with large quantities of excavated earth sent to landfill.
 - Health and safety issues remain with the storage of water in an urban area.
 - Issue of significant vertical walls located along residential boundaries, creates a social issue and may meet resistance from residents.
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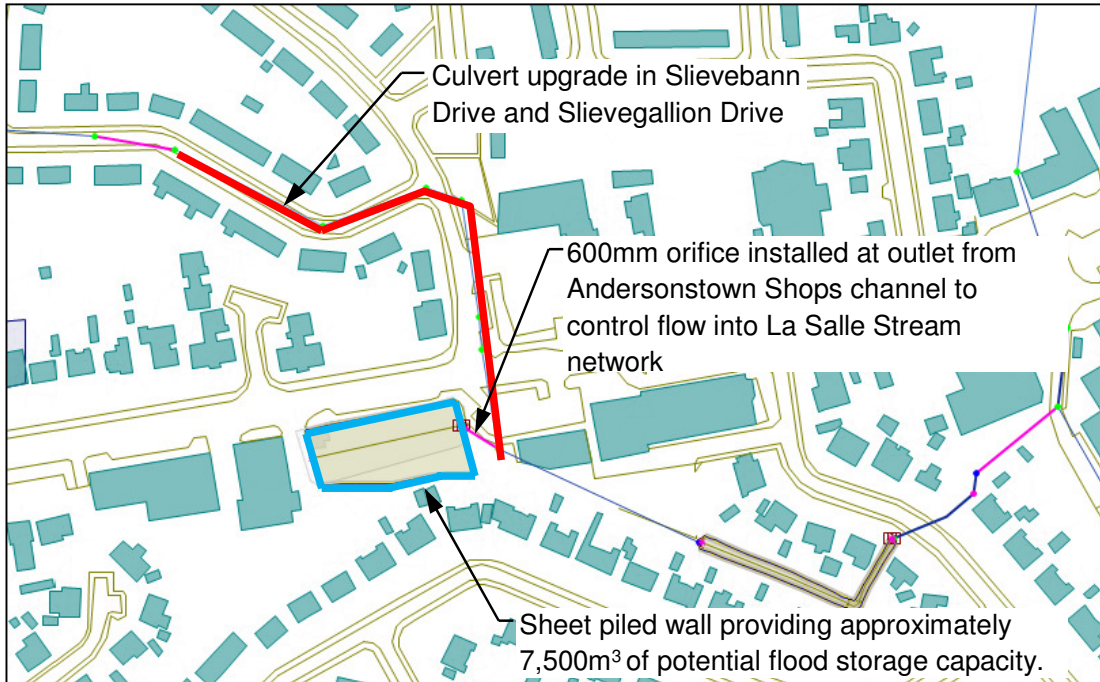


Figure 9.7 – Remedial Option 5 Overview

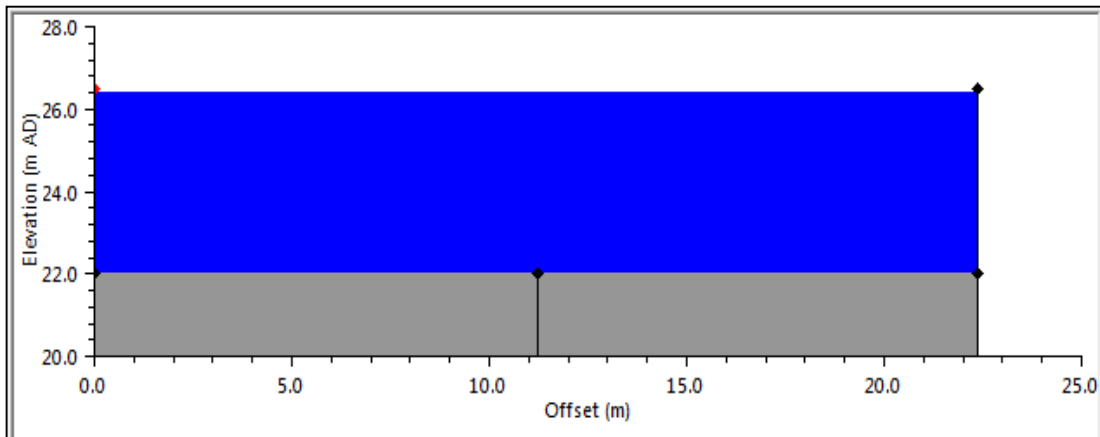


Figure 9.8 – Cross section showing new river profile after installation of sheet-piling

10.0 MONETARY COST AND BENEFIT ASSESSMENT

10.1 Introduction

The aim of the appraisal is to assess value for money from a broad economic perspective for flood remedial works at Riverdale Park East. This process requires assessment of the monetary cost of construction compared against the benefit gained through completing the scheme. Option costs include capital construction costs, maintenance costs and residual flood damage to each property. The option benefits are flood damage avoidance to existing properties by implementing the scheme and intangible benefits associated with a willingness to pay to avoid property flooding. Data relating to the discounted Option 4 is shown for information purposes only.

10.2 Capital Construction Costs

10.2.1 Do Minimum – Property Level Protection

A report published by 'JBA Consulting' and commissioned by DEFRA in Great Britain to evaluate a 'Property Level Protection Grant Scheme' was used to obtain the typical cost of property level protection measures. The report assessed a government backed flood protection scheme which provided local authorities with funding to alleviate flooding issues at property level in England. The report concluded that the average cost of protection per property was £4,832. This value included the fees for surveying and administration costs. The proposed standard of protection provided by the property level protection measures was for a 100 year flood event. Properties affected by flood water from an event of this magnitude have been identified as requiring property level protection.

The retail price index (RPI) has been used to uplift the cost figures to represent the current construction market. The report was published in 2012, however the rates detailed within the report are for 2011. The RPI over the succeeding five years was applied to uplift the construction costs and is calculated as 11.2% (see Appendix G for RPI calculation).

10.2.2 Remedial Options 1-5 - Construction Rates and Bill of Quantities

The capital construction cost of each option has been estimated using construction rates derived from the following sources;

- *CESMM4 Carbon & Price Book 2013* – This pricing manual, published by the Institution of Civil Engineers, has been used to provide industry indicative cost rates for the majority of the construction activities within each option. For construction activities where a directly comparative rate was not available, hourly rates for plant and labour resources have been calculated from the list of approved rates.
- *Historic Contracts* – Costs incurred for bespoke construction activities have been taken from previous works completed by DFI Rivers. All rates used are the final contract cost incurred by DFI Rivers, not the estimated tender values.

A bill of quantities (BOQ) has been developed for each option which complies with the Civil Engineering Standard Method of Measurement, 4th edition. Two additional factors have been applied to the basic cost of each option to take into account the following which affects all new construction;

- *Design & Supervision* - A design and supervision percentage has been applied to account for internal costs incurred by DFI Rivers in developing a detailed design and managing

construction activities on site. To accurately develop this figure all capital schemes from January 2010 to present were assessed, with all design and supervision costs quantified as a percentage of the total scheme cost. This accounted for 12 individual capital works schemes totalling £8.27m, with a total weighted percentage of 15.98% calculated.

- *General Item Allowance* - A final percentage mark-up has been applied to account for ancillary items such as insurances, accommodation and services. The value of 24% used for this calculation has been obtained from a worked example contained within the 'CESMM4 Carbon and Price' book.

The prices included within the CESMM4 pricing manual are correct until end of 2013. The retail price index over the succeeding three years was applied to uplift the construction costs to match present day values. The calculated RPI for the years 2014, 2015 and 2016 since publication of the pricing manual is 5% (see Appendix G for RPI calculation).

10.2.3 Option Costs - Capital

A summary of the calculated present day cost of construction for each assessed option is presented within 'Table 10-1' with detailed BOQ's for each option contained in Appendix H.

Option	Overview of Works	Construction Cost
Do Nothing	None	£ 0.00
Do Minimum	- Provide property level protection measures to properties affected by a Q100 event.	£ 257,912.83
Option 1	- Culvert renewal at Slieveban Drive, Slievegallion Drive and Riverdale Park East, - Reinforced concrete wall at Riverdale Park East open channel.	£ 619,042.49
Option 2A	- Culvert renewal at Slieveban Drive and Slievegallion Drives only, - Reinforced concrete wall at Riverdale Park East open channel.	£ 712,584.73
Option 2B	- Culvert renewal at Slieveban and Slievegallion Drives only, - Reinforced concrete wall at Riverdale Park East open channel, - Hydraulic throttle at the Andersonstown Shops open channel.	£ 647,523.84
Option 3A	- Culvert renewal at Slieveban and Slievegallion Drives only, - Reinforced concrete wall and hydraulic throttle at the Andersonstown Shops open channel.	£ 598,129.04
Option 3B	- Culvert renewal at Slieveban and Slievegallion Drives only, - Reinforced concrete wall and hydraulic throttle at the Andersonstown Shops open channel, reinforced concrete wall at Riverdale Park East open channel.	£ 597,196.54
Option 4	- Culvert renewal at Slieveban and Slievegallion Drives only, - Hydraulic throttle at the Andersonstown Shops open channel, - Reinforced pre-cast concrete 'Stormstore' in the car park at Andersonstown Shops.	£ 3,040,704.02
Option 5	- Culvert renewal at Slieveban and Slievegallion Drives only, - Steel sheet piled storage tank and hydraulic throttle at the Andersonstown Shops open channel.	£ 812,961.18

Table 10-1 – Summary of Construction Costs

10.2.4 Option Costs – Inspection & Maintenance

To fully analyse the whole life cost of each remedial option service and structural maintenance and inspection costs over the period of the design life must be assessed. The current inspection regime for DFI Rivers ensures each asset is inspected at least once in any five year period. Inspection costs have been taken from current contracted rates and applied as follows;

- Below ground CCTV Inspections - £1.00 per metre
- Below ground walkthrough inspections - £3.00 per metre
- Above ground visual inspections – Completed by in-house staff, no cost attributed.

Future maintenance requirements are difficult to accurately predict due to the large number of determining factors affecting the service and structural condition of any asset. The technical report published by the Environment Agency in May 2014 entitled 'FCRM Assets: Deterioration modelling and WLC analysis.' provided guidance on asset deterioration. The report detailed degradation rates and the time lapse between structural condition grades (Appendix I).

All newly constructed DFI Rivers drainage assets have a design life of at least 90 years. DFI Rivers currently only undertakes maintenance repairs if the structural condition of the asset is classified as grade four or grade five (i.e. reduced performance with increased likelihood of failure). Following the Environment Agency guidance, an asset with an average rate of deterioration will be classified as grade four approximately 80 years after construction. A provisional sum of 5% of the initial capital costs for maintenance repairs has been included in the cost of each option at year 80. This will account for all anticipated repair works required due to the predicted state of the drainage asset at year 80.

Service maintenance works are undertaken on a regular basis as the build up of silt and vegetation is detrimental to the efficiency and performance of drainage infrastructure. Current DFI Rivers practice ensures service maintenance works are carried out at least once every 5 years on assets. Service maintenance costs have been taken from current contracted rates and applied as follows;

- De-silting of culverts - £14.10 per metre
- Vegetation Management - £300 per year
- General service allowance – Provisional sum of £500 per annum

Inspection and maintenance costs per annum for each remedial option are summarised in 'Table 10-2.'

Option	CCTV	WT	De-Silting	Vegetation Management	General	Total Per Annum
Do-minimum	£ 0.00	£ 0.00	£ 0.00	£ 0.00	£ 500.00	£ 500.00
Option 1	£ 44.40	£ 52.20	£ 871.38	£ 300.00	£ 500.00	£ 1,767.98
Option 2A	£ 44.40	£ 0.00	£ 626.04	£ 300.00	£ 500.00	£ 1,470.44
Option 2B	£ 44.40	£ 0.00	£ 626.04	£ 300.00	£ 500.00	£ 1,470.44
Option 3A	£ 44.40	£ 0.00	£ 626.04	£ 300.00	£ 500.00	£ 1,470.44
Option 3B	£ 44.40	£ 0.00	£ 626.04	£ 600.00	£ 500.00	£ 1,770.44
Option 4	£ 44.40	£ 0.00	£ 626.04	£ 0.00	£ 500.00	£ 1,170.44
Option 5	£ 44.40	£ 0.00	£ 626.04	£ 300.00	£ 500.00	£ 1,470.44

Table 10-2 – Inspection and maintenance costs per annum

10.3 Flood Damages

10.3.1 Property Damages

The cost of flood damage to property is calculated using a methodology developed by Middlesex University Flood Hazard Research Centre and set out in the 'Multi Coloured Manual (MCM).' Methodology outlined in Chapter 4 of the MCM was followed to full scale appraisal level to calculate the residual estimated damage to residential properties for each scenario (Table 10-3).

A threshold level survey was undertaken on site to improve the accuracy of flood depths calculated at each affected property. Residential flood damages were assumed to start 300mm below threshold level. The MCM report was published in 2015 so the retail price index (RPI) has been used to uplift the damage estimate figures to represent their present value. The RPI increase figure from 2015 to present has been calculated as 1.27% (see Appendix G for RPI calculation). Flood depth experienced at each residential property for each remedial option is contained within Appendix J

	Estimated Damages - Residential							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
Do - Nothing	£ -	£40,829	£40,829	£ 82,009	£105,278	£213,846	£219,326	£274,009
Do - Minimum	£ -	£10,207	£10,207	£ 20,502	£ 26,320	£ 53,461	£ 54,831	£ 68,502
Option 1	£ -	£ -	£ -	£ -	£ -	£ -	£ 49,334	£107,600
Option 2A	£ -	£ -	£ -	£ -	£ -	£ -	£101,615	£197,080
Option 2B	£ -	£ -	£ -	£ -	£ -	£ -	£ 45,186	£119,324
Option 3A	£ -	£ -	£ -	£ -	£ -	£ -	£158,288	£220,963
Option 3B	£ -	£ -	£ -	£ -	£ -	£ -	£ 96,460	£158,752
Option 4	£ -	£ -	£ -	£ -	£ -	£ -	£ 62,777	£178,551
Option 5	£ -	£ -	£ -	£ -	£ -	£ -	£ 71,926	£164,545

Table 10-3 – Residential Property Estimated Damages

Methodology outlined in Chapter 5 of the MCM was followed to full scale appraisal level to calculate the residual estimated damage to non-residential properties for each scenario (Table 10-4). As before a threshold level survey was undertaken on site to improve the accuracy of flood depths calculated at each affected property. Properties were inspected to identify the presence of a basement. No commercial units within the study have a basement structure, therefore flood damage commences at threshold level. The RPI value of 1.27% has been applied to uplift the damage estimate figures to present value. Table 10-5 provides the combined total damages calculated for both residential and non-residential properties for each scenario. Flood depth experienced at each commercial property for each remedial option is contained within Appendix J

	Estimated Damages – Non-residential							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
Do - Nothing	£ -	£23,079	£24,222	£ 57,189	£ 57,189	£ 60,245	£ 64,913	£144,514
Do - Minimum	£ -	£ 5,770	£ 6,056	£ 14,297	£ 14,297	£ 15,061	£ 16,228	£ 36,128
Option 1	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ 53,148
Option 2A	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£364,901
Option 2B	£ -	£ -	£ -	£ -	£ -	£ -	£ 61,856	£160,641
Option 3A	£ -	£ -	£ -	£ -	£ -	£ -	£153,252	£178,495
Option 3B	£ -	£ -	£ -	£ -	£ -	£ -	£112,669	£178,897
Option 4	£ -	£ -	£ -	£ -	£ -	£ -	£ 57,189	£153,543
Option 5	£ -	£ -	£ -	£ -	£ -	£ -	£ 60,245	£143,842

Table 10-4 – Non-residential Property Estimated Damages

	Total Estimated Damages - Combined							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
Do - Nothing	£ -	£63,908	£65,051	£139,198	£162,467	£274,091	£284,238	£418,523
Do - Minimum	£ -	£15,977	£16,263	£ 34,800	£ 40,617	£ 68,523	£ 71,060	£104,631
Option 1	£ -	£ -	£ -	£ -	£ -	£ -	£ 49,334	£160,749
Option 2A	£ -	£ -	£ -	£ -	£ -	£ -	£101,615	£561,980
Option 2B	£ -	£ -	£ -	£ -	£ -	£ -	£107,042	£279,965
Option 3A	£ -	£ -	£ -	£ -	£ -	£ -	£311,540	£399,458
Option 3B	£ -	£ -	£ -	£ -	£ -	£ -	£209,128	£337,649
Option 4	£ -	£ -	£ -	£ -	£ -	£ -	£119,966	£332,094
Option 5	£ -	£ -	£ -	£ -	£ -	£ -	£132,171	£308,386

Table 10-5 – Total Property Estimated Damages

10.3.2 Emergency Services

Emergency service costs are included within the calculation of flood damages. These costs have been estimated from guidance provided within the 'Multi Coloured Manual.' Research of total emergency costs incurred by local authorities in the UK has determined that emergency costs represent 5.6% of the total economic property losses. This therefore represents a multiplier on top of property damages in the appraisal. The total property damages calculated in the appraisal have been multiplied by 1.056 to allow for the emergency costs. This figure is applied to all return period events in the appraisal.

10.3.3 Vehicle Damages

The depth of flooding encountered along the carriageways within the locality is less than 150mm during the maximum flood event simulated (1000 Year). This depth of flooding is not

deemed sufficient enough to cause damage to parked vehicles at individual properties, hence no damage has been accounted for this aspect.

A car park located adjacent to work units along the Andersonstown Road will be significantly affected by flood water. The surface level of the car park reduces from the entrance along Slievegallion Drive towards Andersonstown Road to effectively form a pondage area with a maximum depth of 900mm. During simulation runs this car park was found to quickly fill with flood water before overtopping within the South Eastern corner, allowing flood water to flow over the adjacent Andersonstown Road carriageway. The capacity of this car park is approximately 40 spaces with a high usage noted during site visits. Therefore vehicle damages were estimated with the car park at 75% capacity with a vehicle damage rate of £3,100 used (MCM Chapter 4).

10.3.4 Infrastructure Damages

The Andersonstown Road carriageway is affected by flooding from 5 year flood events and greater. The disturbance and potential damage this causes has been calculated using the diversion value method detailed within 'Chapter '6d' of the 'Multi Coloured Manual.' Details of the calculations are contained within Appendix K with results displayed in 'Table 10-6.'

	Infrastructure Damages							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
Do - Nothing	£ -	£ 4,097	£ 4,097	£ 4,097	£ 4,916	£ 5,735	£ 5,735	£ 5,735
Do - Minimum	£ -	£ 4,097	£ 4,097	£ 4,097	£ 4,916	£ 5,735	£ 5,735	£ 5,735
Option 1	£ -	£ -	£ -	£ -	£ -	£ -	£ 5,735	£ 5,735
Option 2A	£ -	£ -	£ -	£ -	£ -	£ -	£ 5,735	£ 5,735
Option 2B	£ -	£ -	£ -	£ -	£ -	£ -	£ 5,735	£ 5,735
Option 3A	£ -	£ -	£ -	£ -	£ -	£ -	£ 5,735	£ 5,735
Option 3B	£ -	£ -	£ -	£ -	£ -	£ -	£ 5,735	£ 5,735
Option 4	£ -	£ -	£ -	£ -	£ -	£ -	£ 5,735	£ 5,735
Option 5	£ -	£ -	£ -	£ -	£ -	£ -	£ 5,735	£ 5,735

Table 10-6 – Infrastructure Damages

10.3.5 Evacuation Costs

No supplementary information regarding previous evacuations of properties during flooding within the study area could be attained, therefore the input values within the MCM spreadsheet have not been altered from standard. The average evacuation cost for each house type has been used when calculating total evacuation costs. Details of each evacuation cost calculation can be found within Appendix K.

10.4 Scheme Benefits

To individual property owners and tenants, flooding causes increased inconvenience, stress and health damage. Although monetary values can be assigned to evacuation, temporary accommodation and property repairs, it is much more difficult to quantify the psychological impact upon those affected by flooding. Research by DEFRA, published in the FCDPAG3

Supplementary Guidance Note July 2004, proposed a method for assigning monetary value to psychological stress encountered. The research assessed a persons' willingness to pay to avoid health impacts caused by flooding to develop a risk reduction matrix which was used calculate the annual damages before and after each remedial scheme was completed (table 10-7). Table 10-8 summarises the intangible benefits achieved by each remedial option.

Standard of Protection After – AFP (RP in years)										
Standard of protection before – AFP (RP in years)			0.007	0.008	0.01	0.013	0.02	0.033	0.05	0.1
			-150	-125	-100	-75	-50	-30	-20	-10
	1	-1	£283	£279	£260	£198	£95	£33	£15	£6
	0.1	-10	£278	£273	£253	£192	£88	£28	£10	£0
	0.05	-20	£267	£262	£244	£183	£78	£17	£0	-
	0.033	-30	£250	£245	£227	£166	£61	£0	-	-
	0.02	-50	£188	£184	£164	£104	£0	-	-	-
	0.013	-75	£85	£81	£61	£0	-	-	-	-
	0.01	-100	£23	£19	£0	-	-	-	-	-
	0.008	-125	£5	£0	-	-	-	-	-	-

Table 10-7 – Intangible Benefits Associated with Flood Risk Management Improvements

Option	Standard of protection before scheme	No of residential properties affected	Standard of protection after scheme	Intangible benefits (No of Properties x Rate)	PV of Intangible Benefits
Do-Nothing	0	0	0	0	£0.00
Do-Minimum	0	34	1000	£9,622.37	£286,867.36
Option 1	0	26	100	£6,747.31	£201,154.39
Option 2A	0	26	100	£6,747.31	£201,154.39
Option 2B	0	26	100	£6,747.31	£201,154.39
Option 3A	0	26	100	£6,747.31	£201,154.39
Option 3B	0	26	100	£6,747.31	£201,154.39
Option 4	0	26	100	£6,747.31	£201,154.39
Option 5	0	26	100	£6,747.31	£201,154.39

Table 10-8 – Intangible Benefits Achieved by Each Remedial Option

11.0 NON-MONETARY COST AND BENEFIT ANALYSIS

11.1 Introduction

The identification of the non-monetary costs and benefits of each scheme is necessary to ensure a full assessment of each remedial option is achieved. Typical non-monetary issues such as environmental impact, aesthetics, social impact and disruption can change the order of preference of remedial options being considered. The non-monetary assessment will aid with the delivery of a more sustainable project and not one which is solely cost efficient.

11.2 Multi Criteria Analysis

The multi criteria analysis technique was used to assess and quantify the performance of each remedial option against relevant non-monetary issues following guidance set out within the HM Treasury Green Book. The methodology followed can be summarised as;

- Identify performance issues applicable to the project,
- Assign weightings to each performance issue category assessed against achievable long term goals/outcomes of scheme,
- Assign a score to each category for each remedial option,
- Review results and rank options.

Table 11-1 details the benefit and cost categories used for the multi criteria analysis and the weightings assigned to each.

Performance Issue	Description	Weightings
Reduce Flooding / Fear of flooding	Scheme design should provide protection to 100 year flooding. This will in turn reduce fear of flooding and perception within residents.	3
Design Adaptability	The unknown factor of climate change and the magnitude of the impact this will have on future flood events is immeasurable, hence future adaptability to increase flood resilience will be advantageous.	2
Reduced fear of loss of livelihood	Residual flood risk will affect business and investment within the area, contributing to socio-economic problems.	3
Reduction in risk to transport links	Flooding of infrastructure, especially within the city limits of Belfast, will have a negative impact on the wider transport network, causing delays.	2
Disruption to residents / local business	Disruption during construction and over the design life of any remedial option should be minimal. This includes access for maintenance and inspection works with land ownership issues often problematic.	2
Sustainability / Environment	The preferred remedial option should have a long term positive impact on the environmental health of the watercourse.	1
Long term social impact	A positive social impact upon residents through the implementation of remedial measures is desirable. Flood walls and embankments close to dwellings can impact negatively on residents.	2
Complexity and Construction Phase Duration	Simplistic design and construction methodology will decrease the construction phase and potential for cost increases.	3

Table 11-1 – Performance Issue Categories

The performance of each remedial option was assessed and assigned a score between zero and five. If the option did not have a positive impact on the performance issue then a score of zero was allocated, with the score increasing incrementally by one point the greater the positive impact demonstrated. The results of the analysis and reasoning for assigning each score are detailed within Table 11-2.

Options 3A, 3B and 5 have the joint highest rank when assessed against non-monetary issues. The 'Do-minimum' remedial option has the lowest positive impact on non-monetary issues and received the lowest overall score. The results of the multi criteria analysis will be used in conjunction with the monetary assessment to determine the preferred option.

	Do Minimum	Option 1	Option 2A	Option 2B	Option 3A	Option 3B	Option 4	Option 5
Reduce Flooding / Fear of flooding								
Score / 5	1	4	4	4	4	4	4	4
Reason	1000 year protection provided, however flood water would be all around property. Not a long term fixed solution, fear of flooding remains.	100 year protection will be provided by improvement works, but flood risk is never fully removed.	100 year protection will be provided by improvement works, but flood risk is never fully removed.	100 year protection will be provided by improvement works, but flood risk is never fully removed.	100 year protection will be provided by improvement works, but flood risk is never fully removed.	100 year protection will be provided by improvement works, but flood risk is never fully removed.	100 year protection will be provided by improvement works, but flood risk is never fully removed.	100 year protection will be provided by improvement works, but flood risk is never fully removed.
Design Adaptability								
Score / 5	3	2	2	2	4	4	0	4
Reason	No hard engineering, easily adaptable for future expansion.	Low adaptability, to increase capacity replacement of culverts would be required.	Low adaptability, to increase capacity replacement of culverts would be required.	Low adaptability, to increase capacity replacement of culverts would be required.	Easily adaptable as wall height at Andersonstown Shops can be increased along with throttle size to increase capacity.	Easily adaptable as wall height at Andersonstown Shops can be increased along with throttle size to increase capacity.	Stormtank buried under carpark, additional capacity or further adaptation is difficult.	Easily adaptable as wall height at Andersonstown Shops can be increased along with throttle size to increase capacity.
Reduced fear of loss of livelihood								
Score / 5	1	4	4	4	4	4	4	4
Reason	100 year protection provided, residual flooding outside.	100 year protection will be provided by improvement works, but flood risk is never fully removed.	100 year protection will be provided by improvement works, but flood risk is never fully removed.	100 year protection will be provided by improvement works, but flood risk is never fully removed.	100 year protection will be provided by improvement works, but flood risk is never fully removed.	100 year protection will be provided by improvement works, but flood risk is never fully removed.	100 year protection will be provided by improvement works, but flood risk is never fully removed.	100 year protection will be provided by improvement works, but flood risk is never fully removed.
Reduction in risk to transport links								
Score / 5	0	4	4	4	4	4	4	4
Reason	No protection to transport links.	Flood protection to 100 year provided, however larger events cause flooding to transport links.	Flood protection to 100 year provided, however larger events cause flooding to transport links.	Flood protection to 100 year provided, however larger events cause flooding to transport links.	Flood protection to 100 year provided, however larger events cause flooding to transport links.	Flood protection to 100 year provided, however larger events cause flooding to transport links.	Flood protection to 100 year provided, however larger events cause flooding to transport links.	Flood protection to 100 year provided, however larger events cause flooding to transport links.
Disruption to residents / local business								
Score / 5	2	0	1	1	1	1	0	0
Reason	Minimal disruption will be experienced during installation of property level protection measures. Long term disruption with ensuring measures are in place during flood events of 5 year and greater.	Extensive disruption due to working in numerous areas close to residents and within property boundaries. Extensive community liaison techniques required by contractor to maintain working relationship. Potential for remedial works to be viewed negatively by residents.	Extensive disruption due to working in numerous areas close to residents and within property boundaries. Extensive community liaison techniques required by contractor to maintain working relationship. Potential for remedial works to be viewed negatively by residents.	Extensive disruption due to working in numerous areas close to residents and within property boundaries. Extensive community liaison techniques required by contractor to maintain working relationship. Potential for remedial works to be viewed negatively by residents.	Extensive disruption due to working in numerous areas close to residents and within property boundaries. Extensive community liaison techniques required by contractor to maintain working relationship. Potential for remedial works to be viewed negatively by residents.	Extensive disruption due to working in numerous areas close to residents and within property boundaries. Extensive community liaison techniques required by contractor to maintain working relationship. Potential for remedial works to be viewed negatively by residents.	Working in car park will be disruptive to daily activities of adjacent businesses. Extensive disruption due to working in numerous areas close to residents and within property boundaries. Extensive community liaison techniques required by contractor to maintain working relationship. Potential for remedial works to be viewed negatively by residents.	Extensive disruption due to working in numerous areas close to residents and within property boundaries. Sheet piling is extremely noisy and disruptive technique. Extensive community liaison techniques required by contractor to maintain working relationship. Potential for remedial works to be viewed negatively by residents.

Environmental Impact								
Score / 5	3	1	2	2	3	3	0	3
Reason	No works completed to the watercourse during initial installation. A negative impact of allowing out of bank flow will enable contaminants and debris to enter to river as flood flow returns to channel.	Culverting of long sections of open watercourse is considered poor practice and current guidance suggests this should be avoided where possible	Less culverting than option 1, with an open channel maintained at Riverdale Park East. Potential for environmental improvements to be incorporated into open channel at Riverdale Park East.	Less culverting than option 1, with an open channel maintained at Riverdale Park East. Potential for environmental improvements to be incorporated into open channel at Riverdale Park East.	Less culverting than option 1, with an open channel maintained at Riverdale Park East and improvements at the Andersonstown Shops channel. Potential for environmental improvements to be incorporated into both open channels.	Less culverting than option 1, with an open channel maintained at Riverdale Park East and improvements at the Andersonstown Shops channel. Potential for environmental improvements to be incorporated into both open channels.	Creation of underground storage tank would have severe detrimental impact on environmental factors.	Less culverting than option 1, with an open channel maintained at Riverdale Park East and improvements at the Andersonstown Shops channel. Potential for environmental improvements to be incorporated into both open channels.
Long term social impact								
Score / 5	1	3	2	2	2	2	3	3
Reason	No hard defences, walls or embankments close to residential dwellings. However placing onus on public to be alert to flooding and act in timely fashion may cause long term anxiety. PLP not seen as solving problem. Property owners may encounter problems when either insuring or selling properties due to flood risk.	Majority of option is below ground culverts, however a wall, although low in height, required at the open channel in Riverdale Park East.	Provides 100 year protection so has a positive social impact by reducing fear of flooding, however significant raised defences are negative for neighbouring residents.	Provides 100 year protection so has a positive social impact by reducing fear of flooding, however significant raised defences are negative for neighbouring residents.	Provides 100 year protection so has a positive social impact by reducing fear of flooding, however significant raised defences are negative for neighbouring residents.	Provides 100 year protection so has a positive social impact by reducing fear of flooding, however significant raised defences are negative for neighbouring residents.	Provides 100 year protection so has a positive social impact by reducing fear of flooding.	Provides 100 year protection so has a positive social impact by reducing fear of flooding, however significant raised defences are negative for neighbouring residents.
Complexity and Construction Phase Duration								
Score / 5	5	3	2	2	2	2	1	2
Reason	Simplistic and least intrusive option.	Common Civil Engineering work tasks so work force familiar with techniques, shortening construction phase and minimising problems which could delay completion. Restrictive working area within Riverdale Park East could prove problematic, altering of work methods may be required to smaller equipment.	Common Civil Engineering work tasks so work force familiar with techniques, shortening construction phase and minimising problems which could delay completion. Restrictive working area within Riverdale Park East open channel could prove problematic, altering of work methods may be required to smaller equipment.	Common Civil Engineering work tasks so work force familiar with techniques, shortening construction phase and minimising problems which could delay completion. Restrictive working area within Riverdale Park East open channel could prove problematic, altering of work methods may be required to smaller equipment. Additional works required compared to option 2A.	Common Civil Engineering work tasks so work force familiar with techniques, shortening construction phase and minimising problems which could delay completion. Restrictive working area within Andersonstown Shops open channel could prove problematic, altering of work methods may be required to smaller equipment.	Common Civil Engineering work tasks so work force familiar with techniques, shortening construction phase and minimising problems which could delay completion. Restrictive working area within Riverdale Park East open channel could prove problematic, altering of work methods may be required to smaller equipment. Additional works required compared to option 3A.	Highly complex work unfamiliar to DFI Rivers staff. Pre-cast units are manufactured by a bespoke set of suppliers, contract over runs could happen easily if a delay in production of 'Stormstore' is encountered.	Common Civil Engineering work tasks so work force familiar with techniques, shortening construction phase and minimising problems which could delay completion. However sheet piling progress is unpredictable, high likelihood of delays and extra expense.
Base Score	16	21	21	21	24	24	16	24
Weighted Score	36	52	50	50	55	55	41	55
Rank	8 th	4 th	=5 th	=5 th	=1 st	=1 st	7 th	=1 st

Table 11-2 – Performance Issue Benefit Assessment

12.0 NET PRESENT VALUE AND SELECTION OF PREFERRED OPTION

12.1 Introduction

To assess the economic viability of each proposed remedial option it is necessary to compare the costs and benefits against those of the baseline option. The 'Environment Agency 2010, Flood and coastal erosion risk management appraisal guidance' (FCERM-AG) spreadsheet was used to standardise the approach to the cost benefit appraisal process. A cost benefit analysis of each remedial option has been completed with appraisal calculations for 5, 10, 25, 50, 75, 100, 200 and 1000 year flood return periods completed.

The baseline option against which each remedial option has been assessed is the 'Do-nothing' approach which assumes no further intervention or cost expenditure will be incurred, allowing nature to prevail. This baseline approach calculates the damages incurred as a result of doing nothing. The benefit of each remedial option is calculated from the damages avoided through completing the works rather than doing nothing. The benefit is assessed against whole life option costs to determine if the option is cost beneficial.

12.2 Present Value & Discounting

Costs and benefits calculated for each remedial option include future values up to the end of the 100 year design life. It is therefore necessary to calculate the present value of future costs and benefits to ensure the benefit gained from each remedial option is compared equally. The discounting method was used to convert future values to their present value. Standard discount rates (table 12-1) sourced from the HM Treasury Green Book were applied to all future costs and benefit values. The design life and hence the appraisal period for each remedial option is 100 years.

Year	0-30	31-75	75-125
Discount Rate	3.50%	3.00%	2.50%

Table 12-1 – HM Treasury Discount Rates

12.3 Optimism Bias

In line with recommendations within the HM Treasury Green Book an adjustment for optimism bias can be included during the calculation of total costs. This adjustment is designed to account for optimism displayed by the appraiser during cost estimation, providing a contingency for cost increases which are highly likely. Two optimism bias factors have been applied to capital costs. Firstly a value of 35% (in line with previously approved DFI Rivers feasibility studies) has been used for the 'Do Minimum' option as the construction works are straightforward and aren't subject to the same complexities as all the other options as the actual construction works involved is fairly minimal. A factor of 60%, the maximum permissible at feasibility stage, has been used for all other options and applied to capital costs only. This value has been chosen as there are considerable unknown factors at present such as ground conditions, limited services information, various access restrictions and access approval still to be negotiated, restricted working close to dwellings with a high potential risk of damage. This value can be reduced further at detailed design stage when the level of unknowns is reduced.

12.4 Cost / Benefit Summary

The cost benefit ratio of each scheme has been calculated (see Appendix L for calculations) with a summary of results displayed within Table 12-2. The 'Do-minimum' option has the highest cost benefit ratio, therefore it is considered the most cost effective remedial option.

	Remedial Options Cost Benefit Analysis								
	Do-nothing	Do Minimum	Option 1	Option 2A	Option 2B	Option 3A	Option 3B	Option 4	Option 5
COSTS:									
PV capital costs	£ 0	£ 257,913	£ 619,042	£ 712,585	£ 647,524	£ 598,129	£ 597,197	£ 3,040,704	£ 812,961
PV operation and maintenance costs	£ 0	£ 14,406	£ 50,940	£ 42,367	£ 42,367	£ 42,367	£ 51,011	£ 33,723	£ 42,367
Other Costs	£ 0	£ 0	£ 2,577	£ 2,967	£ 2,696	£ 2,490	£ 2,486	£ 12,660	£ 3,385
Optimism bias adjustment	£ 0	£ 90,269	£ 371,425	£ 427,551	£ 388,514	£ 358,877	£ 358,318	£ 1,824,422	£ 487,777
Total PV Costs	£ 0	£ 362,589	£ 1,043,985	£ 1,185,470	£ 1,081,101	£ 1,001,864	£ 1,009,012	£ 4,911,510	£ 1,346,490
BENEFITS:									
PV monetised flood damages	2,955,109	£ 1,267,386	£ 65,802	£ 148,382	£ 126,955	£ 165,331	£ 145,958	£ 132,889	£ 114,098
PV monetised flood damages avoided	N/A	£ 1,687,723	£ 2,889,307	£ 2,806,727	£ 2,828,154	£ 2,789,778	£ 2,809,151	£ 2,822,220	£ 2,841,011
Intangible Benefits	N/A	£ 286,867	£ 201,154	£ 201,154	£ 201,154	£ 201,154	£ 201,154	£ 201,154	£ 201,154
Total PV benefits £	N/A	£ 1,974,591	£ 3,090,461	£ 3,007,881	£ 3,029,308	£ 2,990,932	£ 3,010,306	£ 3,023,374	£ 3,043,165
DECISION-MAKING CRITERIA:									
Net Present Value NPV	N/A	£ 1,612,002	£ 2,046,476	£ 1,822,411	£ 1,948,207	£ 989,068	£ 2,001,294	£ -1,888,136	£ 1,695,675
Average benefit/cost ratio BCR	N/A	5.4	3.0	2.5	2.8	3.0	3.0	0.6	2.3
Cost / Benefit Rank	N/A	1 st	= 2 nd	6 th	5 th	= 2 nd	= 2 nd	8 th	7 th

Table 12-2 – Cost Benefit Analysis Summary

12.5 Risk Impact Analysis

A risk impact analysis is an essential tool in quantifying the best remedial option for the scheme. The severity and likelihood of all potential risks on the scheme are assessed and quantified to identify the least risky option for DFI Rivers. The impact of each risk on the delivery of scheme objectives has been individually quantified in table 12-3.

Risk	Impact of Risk (A) (1-3)	Likelihood/Probability (B) (1-5)								Overall Risk Score (A x B)								
		Do Min	1	2 A	2 B	3 A	3 B	4	5	Do Min	1	2A	2B	3A	3B	4	5	
Construction Cost Estimate	3	1	3	3	3	3	3	3	3	3	9	9	9	9	9	9	9	
Damages Estimate	3	1	1	1	1	1	1	1	1	3	3	3	3	3	3	3	3	
Climate Change	2	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	
Culvert Blockages	2	3	2	2	2	2	2	2	2	6	4	4	4	4	4	4	4	
Funding	2	3	3	3	3	3	3	5	3	6	6	6	6	6	6	10	6	
Site Investigation	1	1	2	2	2	2	2	3	2	1	2	2	2	2	2	3	2	
Overall Risk										21	26	26	26	26	26	31	26	
Risk Impact Rank (Lower score means less risky)										1st	=2nd	=2nd	=2nd	=2nd	=2nd	=2nd	8th	=2nd

Table 12-3 – Risk Impact Analysis

12.6 Assessment of Monetary & Non-monetary Rankings

Table 12-4 displays the overall rank achieved by each option after the assessment of monetary and non-monetary issues was completed. As a result of this analysis it can be concluded that Option 3 will deliver the greatest benefit in line with the scheme objectives.

Option	Cost Benefit Rank	Non-monetary Rank	Risk Impact Rank	Total Rank Score	Overall Rank
Do Minimum	1	8	1	10	=4 th
Option 1	2	4	2	8	3 rd
Option 2A	6	5	2	13	7 th
Option 2B	5	5	2	12	6 th
Option 3A	2	1	2	5	=1 st
Option 3B	2	1	2	5	=1 st
Option 4	8	7	8	23	8 th
Option 5	7	1	2	10	=4 th

Table 12-4 – Remedial Options Overall Ranking

12.5 Conclusion & Recommendation

The flooding problem at Riverdale Park East is complex, with three separate flooding mechanisms identified through research and hydraulic modelling. The range of options assessed within the feasibility study to remedy the issue all provide a positive outcome for property owners. However each option isn't without unique challenges which need to be overcome to ensure the successful delivery of a flood alleviation scheme is achieved. Each option has been assessed and ranked based on monetary and non-monetary criteria in line with governmental guidance.

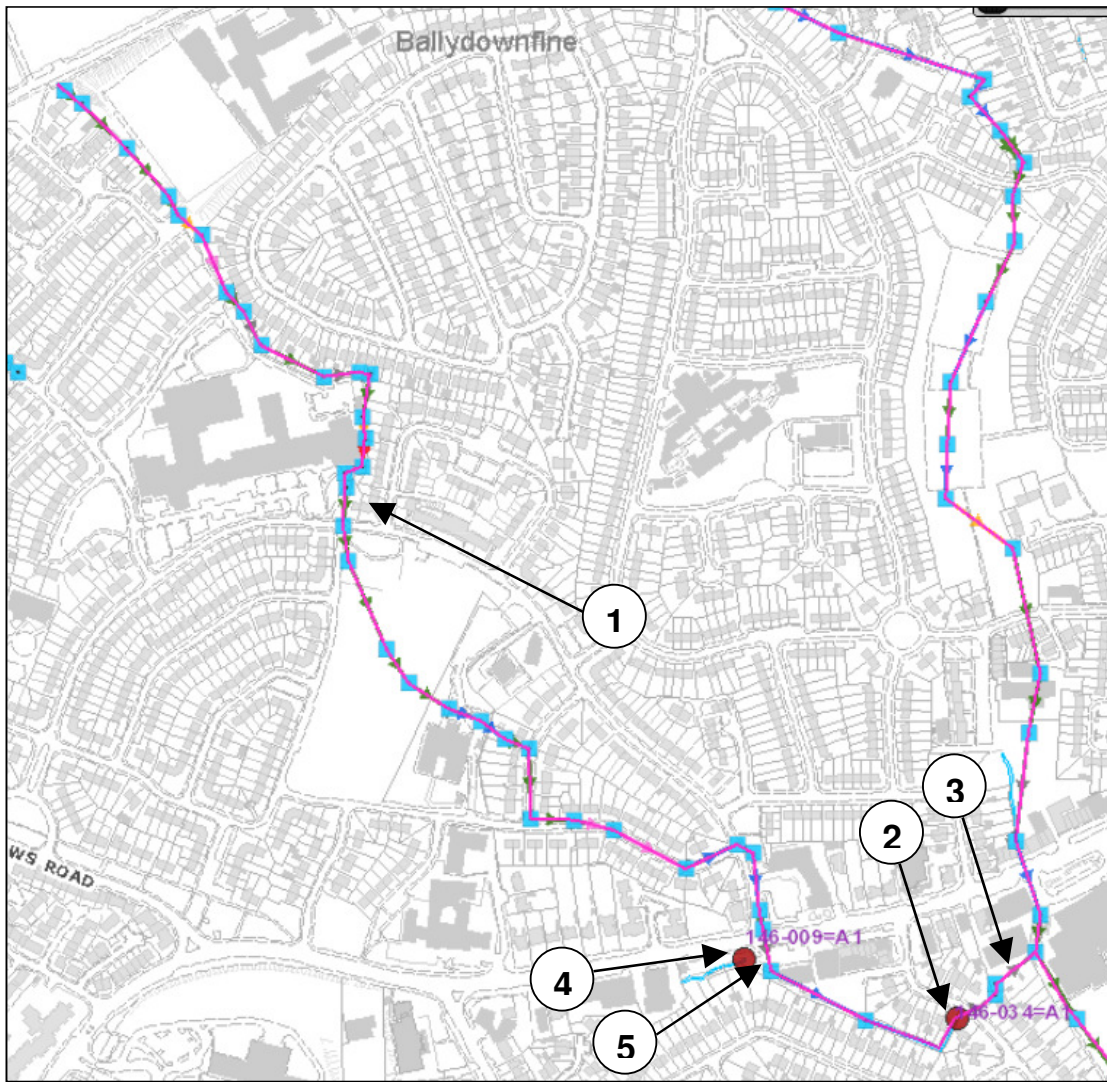
The top ranked remedial option is Option 3, with 3A and 3B scoring an equal 1st rank. Options 3A and 3B are in essence the same option with slightly altered arrangements. It is therefore recommended that Option 3 is taken forward to detailed design stage as the preferred solution.



To recap, Option 3 is the attenuation of flow utilising the natural channel at the Andersonstown Shops with a culvert upgrade upstream in Slieveban Drive and Slievegallion Drive. The two variations of this option assessed use a different diameter orifice which affects the height of vertical walls required in two separate locations.

APPENDIX A

Contained within appendix A is the record of the hydraulic features within the La Salle Stream and Ramoan Gardens Stream.

Hydraulic Features - La Salle Stream & Ramoan Gardens Stream

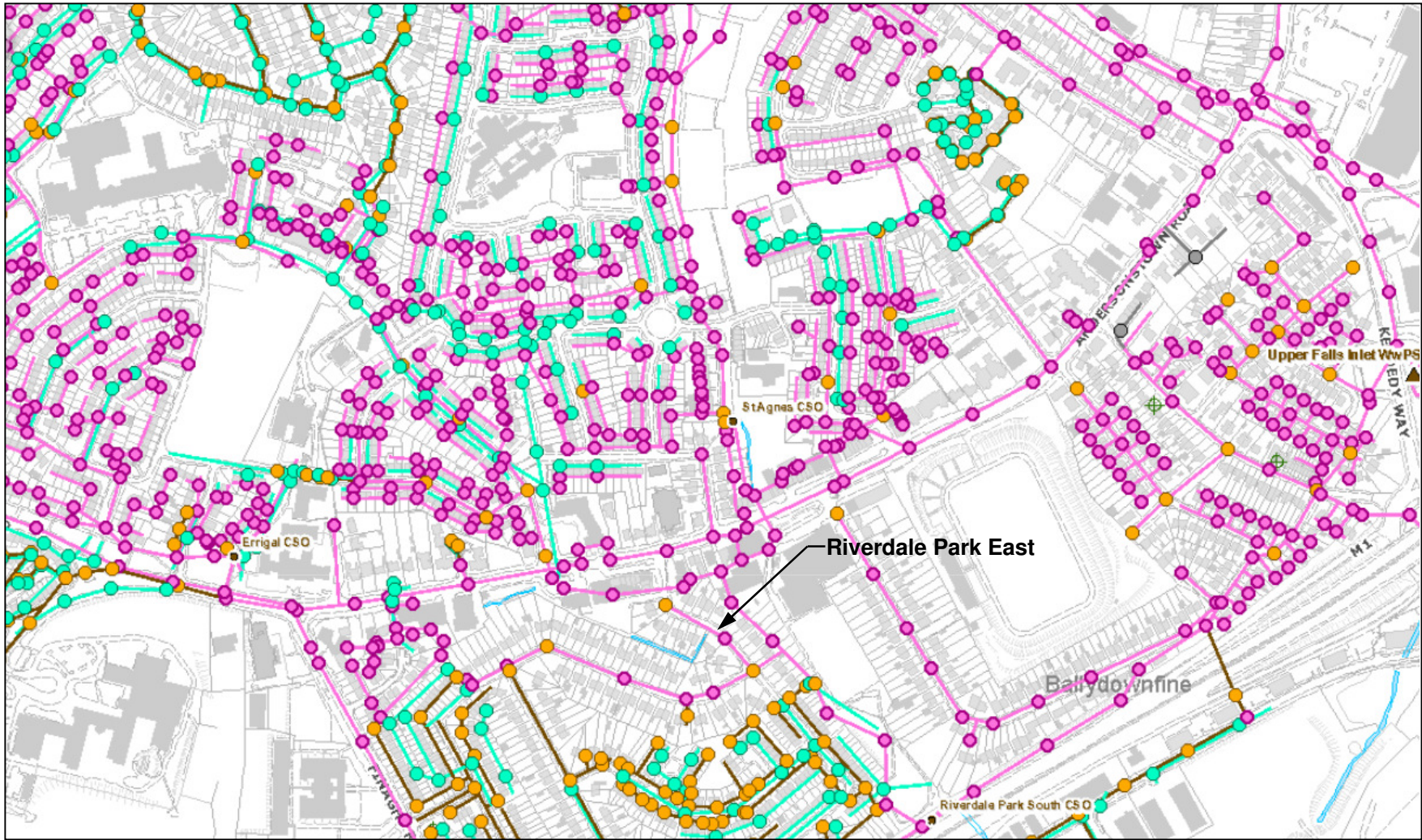


Structure No	Dimensions	Length (m)	Form	Image
1	Min Diameter–0.5m Max Diameter–1.5m	1200m	Pipe	N/A
2	Width – 1.5m Height – 1.5m Depth – 2m Bar Spacing – 0.15m	/	Screen	
3	Box Segment Width – 0.95m Height – 1.5m Length – 36.5m Pipe Segment Diameter – 1.2m Length – 50m	86.5m	Box and pipe	N/A
4	Width – 1.5m Height – 1.5m Depth – 2m Bar Spacing – 0.15m	/	Screen	
5	Diameter–0.9m	25m	Pipe	N/A

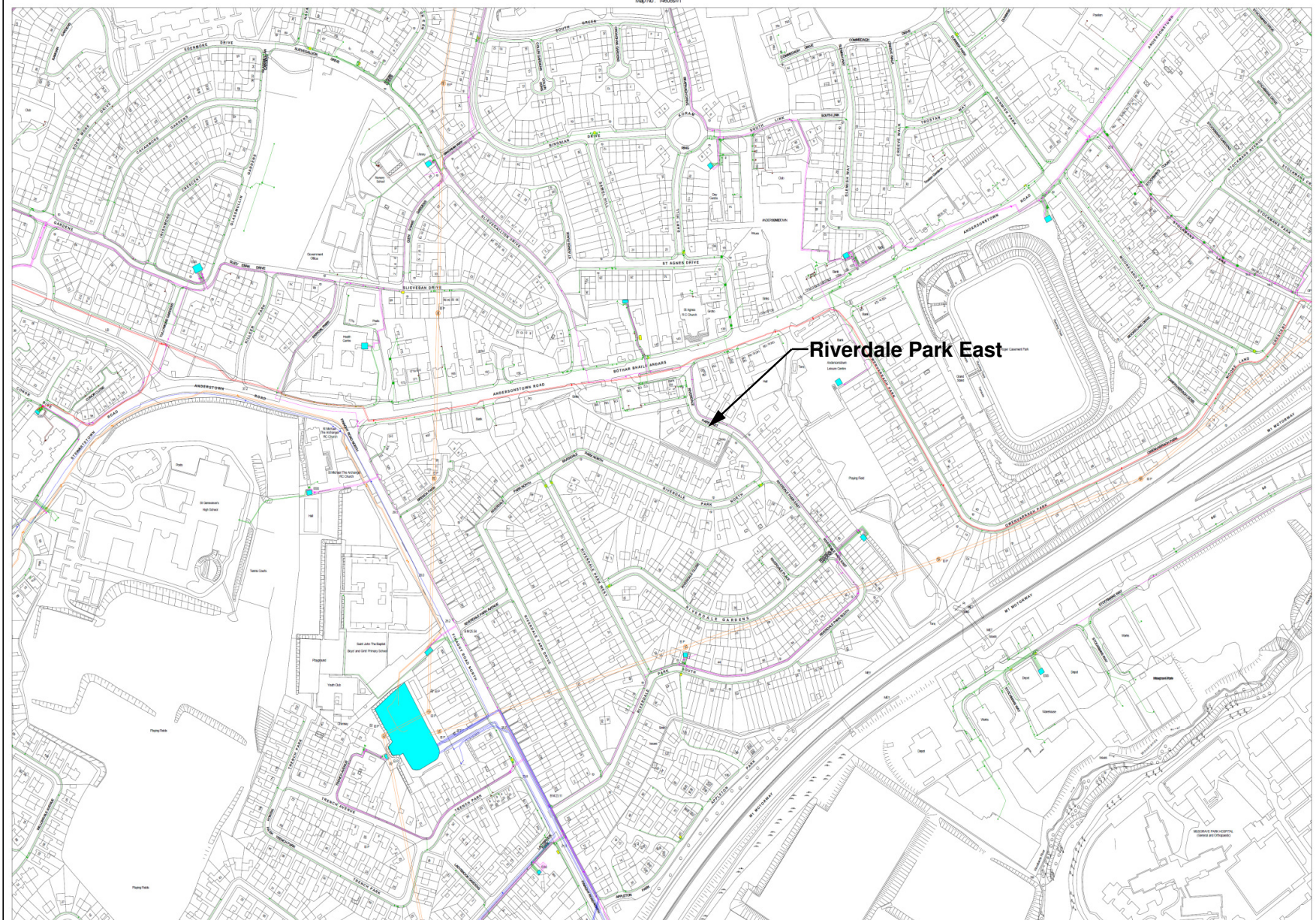
APPENDIX B

Contained within appendix B are details of NI Water and NI Electricity infrastructure within the main study area of Riverdale Park East.

NIW Network Map – Riverdale Park East



DRAWING KEY		
	Surface Water	
	Foul	
	Combined	



Riverdale Park East

Based upon the Ordnance Survey map with the permission of the director and the chief executive, Crown copyright. ©

Title: Riverdale Park East, Andersonstown, Belfast
Map Centre: 330027 37197

Project No: 160033221
Drawing No:







































Scale: 1:1250
Date: 01/09/2016 09:44:51



	40kV
	20kV
	11kV
	0.4/0.24kV
	Service

CAUTION CABLE POSITIONS ARE APPROXIMATE ONLY!
Please note that smaller service cables may not be shown. Always remember that it is the responsibility of the excavator to locate and avoid damage to U.E. equipment. Failure to do so may result in those responsible being held liable.



GNIS SYMBOLOGY	
	275 KV Overhead
	110 KV Overhead
	33 KV Overhead
	11 KV Overhead
	6.6 KV Overhead
	MV Overhead
	Services
	De-energised or Decommissioned
	275 KV Cable
	110 KV cable
	33 KV Cable
	11 KV Cable
	6.6 KV cable
	MV Cable
	Steel Pole
	Tower
	HV Pole
	Pole Mounted Sub
	Ground Mounted Sub
	Stay. Can be 2 Stay (2S) or 3 Stay (3S)
	3 Pole. Can be 4 Pole (4P)
	H Pole
	Jockey Pole
	V Stay
	Switching Site
	Leader Line
	Flying Stay
	MV Pole
	MV Stay
	MV 2 Stay
	MV Strut
	Mini Pillar
	UDB
	Steel Pole
	Jockey Pole
	Guard Wire
	Flying Stay
	Outrigger Stay

APPENDIX C

Contained within appendix C are details of the level survey undertaken to gain an accurate threshold level of affected properties.

The threshold survey was completed by DFI Rivers Mapping and Modelling Unit using a Leica GPS unit. The survey was completed on the 01/08/16. Property number, type and threshold level surveyed are as follows,

Property No	Street Name	Building Type	Threshold Level (mAoD)
1	Riverdale Park East	Commercial	20.23
3	Riverdale Park East	Commercial	20.23
5	Riverdale Park East	Commercial	20.23
7	Riverdale Park East	Commercial	20.23
2	Riverdale Park East	Residential	19.61
4	Riverdale Park East	Residential	19.69
6	Riverdale Park East	Residential	19.42
8	Riverdale Park East	Residential	19.75
10	Riverdale Park East	Residential	18.82
12	Riverdale Park East	Residential	18.14
14	Riverdale Park East	Residential	18.15
16	Riverdale Park East	Residential	18.20
18	Riverdale Park East	Residential	18.16
20	Riverdale Park East	Residential	18.24
22	Riverdale Park East	Residential	18.38
15	Riverdale Park East	Residential	19.94
17	Riverdale Park East	Residential	19.97
19	Riverdale Park East	Residential	19.50
21	Riverdale Park East	Residential	19.58
23	Riverdale Park East	Residential	19.29
25	Riverdale Park East	Residential	19.20
27	Riverdale Park East	Residential	19.06
29	Riverdale Park East	Residential	19.07
31	Riverdale Park East	Residential	18.88
134	Andersonstown Rd	Commercial	22.10
136	Andersonstown Rd	Commercial	22.10
138	Andersonstown Rd	Commercial	22.10
140	Andersonstown Rd	Commercial	22.15
142	Andersonstown Rd	Commercial	22.15
144	Andersonstown Rd	Commercial	22.19
146	Andersonstown Rd	Commercial	22.18
148	Andersonstown Rd	Commercial	22.21
150	Andersonstown Rd	Commercial	22.21
152	Andersonstown Rd	Commercial	22.21
154	Andersonstown Rd	Commercial	21.93
Parish Hall	Andersonstown Rd	Commercial	19.69
151 Unit A	Andersonstown Rd	Commercial	23.06
151 Unit B	Andersonstown Rd	Commercial	23.26
151 Unit C	Andersonstown Rd	Commercial	23.36
151 Unit D	Andersonstown Rd	Commercial	23.01
157	Andersonstown Rd	Commercial	25.13
162	Andersonstown Rd	Commercial	23.11
164	Andersonstown Rd	Commercial	23.05
166	Andersonstown Rd	Commercial	23.12
168	Andersonstown Rd	Commercial	23.14
170	Andersonstown Rd	Commercial	23.14

172	Andersonstown Rd	Commercial	23.13
174	Andersonstown Rd	Commercial	23.02
176	Andersonstown Rd	Commercial	23.58
178	Andersonstown Rd	Commercial	23.43
180	Andersonstown Rd	Commercial	23.81
182	Andersonstown Rd	Commercial	23.81
184	Andersonstown Rd	Commercial	23.96
186	Andersonstown Rd	Commercial	24.03
156	Andersonstown Rd	Commercial	26.00
158	Andersonstown Rd	Commercial	26.00
160	Andersonstown Rd	Commercial	26.00
28	Slieveban Drive	Residential	26.39
26	Slieveban Drive	Residential	26.39
24	Slieveban Drive	Residential	25.80
22	Slieveban Drive	Residential	25.80
20	Slieveban Drive	Residential	25.09
18	Slieveban Drive	Residential	25.09
16	Slieveban Drive	Residential	25.13
14	Slieveban Drive	Residential	25.13
12	Slieveban Drive	Residential	24.66
10	Slieveban Drive	Residential	24.66
8	Slieveban Drive	Residential	24.51
6	Slieveban Drive	Residential	24.51
4	Slieveban Drive	Residential	24.57
2	Slieveban Drive	Residential	24.69
2	Slievegallion Drive	Residential	23.96
4	Slievegallion Drive	Residential	23.96

APPENDIX D

Contained within appendix D are details of the flood estimation techniques used to calculate a peak 100 year flow.

FEH Statistical Method

The Flood Estimation Handbook (FEH) was published in January 2000 as an update to the original Flood Studies Report (FSR) released in 1975. The FEH online tool was used to extract catchment descriptors for the catchment and the WINFAP-FEH 3 software was used to generate a pooling group for the study catchment. This in turn was used to generate a flood frequency curve using the catchment descriptor estimate of Q_{med} , providing a flood estimate for each return period required.

Revitalised Flood Hydrograph Method

The Revitalised FSR/FEH rainfall runoff method is an updated model of the original rainfall runoff model which was conceived during the research that led to the publication of the Flood Studies Report (FSR). The model attempts to produce estimates of design flow by simulating the effects of a design rainfall event falling on a simplified theoretical catchment. The main advantage of this process is that it produces a full design hydrograph, which can be utilised within a river model rather than just a peak flow.

For this analysis the CEH ReFH spreadsheet (Version 1.3) was used with default catchment parameters from centre for Ecology and Hydrology online tool (<https://fehweb.ceh.ac.uk>) inputted to the spreadsheet to provide peak design flows for the catchment. The following screenshots show the process of calculating an event hydrograph from catchment descriptors inputted to the ReFH spreadsheet.

Revitalised FSR/FEH rainfall runoff method
 Spreadsheet application version 1.3
 Catchment sheet

Catchment name:

Catchment Descriptors (Descriptors in bold are used within model)

File name:

FEH CD ROM version Exported on

Easting Northing
 Area

FARL	<input type="text" value="1"/>	RMED-1H	<input type="text" value="9.8"/>
PROPWET	<input type="text" value="0.52"/>	RMED-1D	<input type="text" value="36.5"/>
ALTBAR	<input type="text" value="96"/>	RMED-2D	<input type="text" value="50"/>
ASPBAR	<input type="text" value="127"/>	SAAR	<input type="text" value="1051"/>
ASPVAR	<input type="text" value="0.86"/>	SAAR4170	<input type="text" value="1046"/>
BFIHOST	<input type="text" value="0.315"/>	SPRHOST	<input type="text" value="41.72"/>
DPLBAR	<input type="text" value="1.35"/>	URBCONC	<input type="text" value="0"/>
DPSBAR	<input type="text" value="104.9"/>	URBEXT1990	<input type="text" value="0.1711"/> heavily urbanised
LDP	<input type="text" value="2.75"/>	URBLOC	<input type="text" value="0"/>
C	<input type="text" value="-0.02106"/>	C(1km)	<input type="text" value="-0.021"/>
D1	<input type="text" value="0.44046"/>	D1(1km)	<input type="text" value="0.44"/>
D2	<input type="text" value="0.51611"/>	D2(1km)	<input type="text" value="0.519"/>
D3	<input type="text" value="0.23576"/>	D3(1km)	<input type="text" value="0.213"/>
E	<input type="text" value="0.25656"/>	E(1km)	<input type="text" value="0.255"/>
F	<input type="text" value="2.25692"/>	F(1km)	<input type="text" value="2.244"/>

Catchment Comment:

Catchment Comment list:

Screenshot 1 – Inputted Catchment Descriptors

Specify design rainfall

Time Step (hr)
 Duration (hr)
 Return Period (yr)

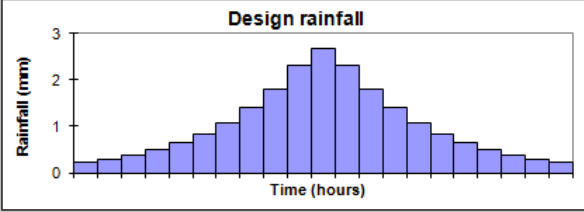
Season (Recommended Season is Summer as URBEXT is greater than, or equal to, 0.125)

Seasonal Correction Factor
 SCF method SCF

Areal Reduction Factor
 ARF method ARF

Rainfall Comment
 Rainfall Comment list

Design Rainfall Results



FEH DDF Model rainfall (mm)
 Design rainfall (mm)
 Peak rainfall (mm)

Screenshot 2 – Rainfall Data for event

Revitalised FSR/FEH rainfall runoff method
 Spreadsheet application version 1.3
 Model sheet

Catchment name

Specify Loss Model
 C_{Max} method C_{ini} method α factor method

Donor correction factor C_{Max} (mm) C_{ini} (mm) α factor

Specify Routing Model
 T_p method U_p method U_k method

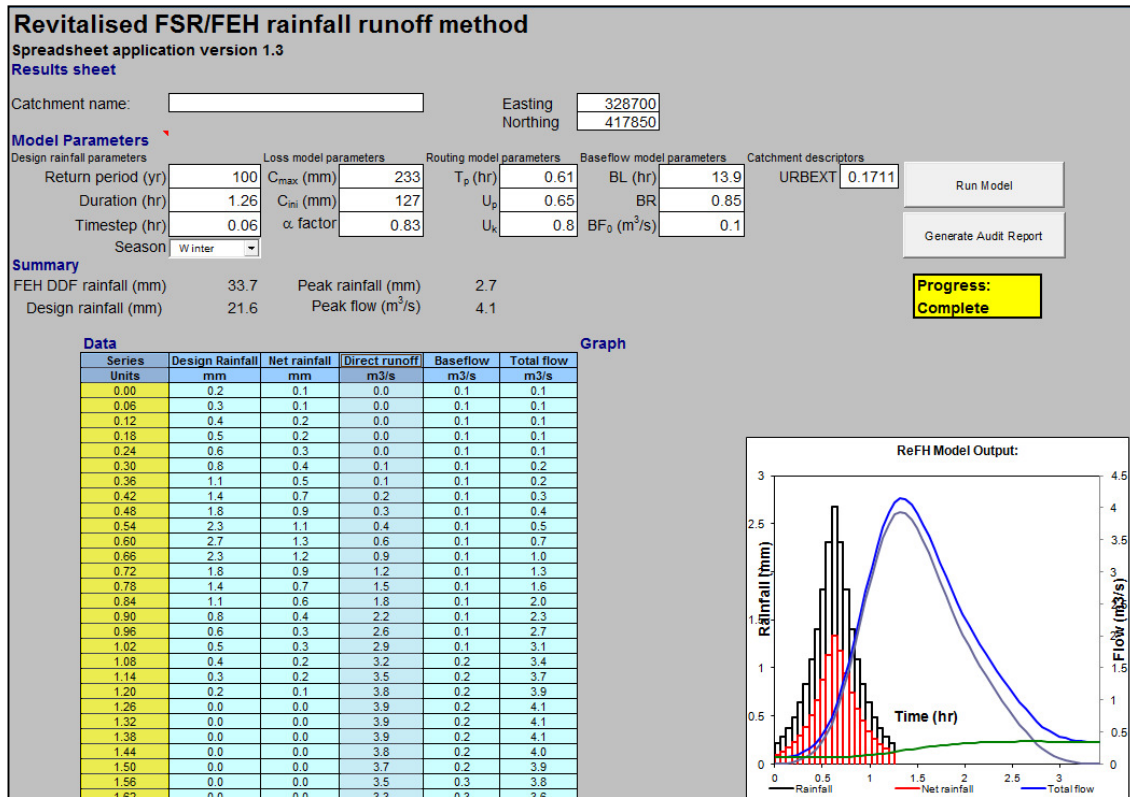
Donor correction factor T_p (hr) U_p U_k

Specify Baseflow Model
 BL method BR method BF_0 method

Donor correction factor BL (hr) Donor correction factor BR BF_0 (m^3/s)

Comments
 Model Comment
 Model Comment list

Screenshot 3 – Model Design Parameters



Screenshot 4 – Hydrograph Results

Poots Cochrane Method

The Flood Studies Report (FSR) was published in 1975 and was based on estimating Q_{BAR} , the mean annual flood which could then be factored up for larger return periods using a growth curve. Although the FSR was deemed suitable across the majority of the British Isles, it was thought by Poots & Cochrane (1975) and Hannah and Wilcock (1984) that when applied to Northern Ireland catchments the regional growth curve was too extreme for the relatively smaller and rural catchments found here. Work was undertaken to improve the estimation methods for Northern Ireland catchments with Alan D. Poots and Stanley Cochrane developing an equation applicable to catchments with an area less than 30km².

A calculation spreadsheet was used to estimate flows using this method as the catchment is well below the threshold of the 30km² cut off. Design safety factors are also incorporated in the Poots Cochrane estimation depending on the risk and the return period being estimated.

- $F_N = 1.000$ gives 50% certainty that Q_{BAR} is not underestimated. This multiplier is used when assessing the capacity of existing culverts and pipes.
- $F_N = 1.445$ gives 84% certainty that Q_{BAR} is not underestimated. This multiplier is most commonly used when assessing floods of less than 50 year return period.
- $F_N = 2.089$ gives a 95% certainty that Q_{BAR} is not underestimated. This multiplier is normally used for the assessment of higher magnitude floods.

The guidance suggests the choice of design factor rests with the user, but other historical information would be required in assessing the local situation. Knowledge of flows in adjacent catchments may be used in this assessment but where the user is in ignorance of

the actual behaviour of the catchment the design factor $F_N = 2.089$ should be used. For this estimation the larger safety factor of 2.089 has been used. Calculation for the safety factor of 1.445 was also completed for comparison.

<i>F_n</i>	<i>QBAR</i>	<i>Q3</i>	<i>Q5</i>	<i>Q10</i>	<i>Q20</i>	<i>Q25</i>	<i>Q50</i>	<i>Q100</i>	<i>QBAR PER UNIT AREA</i>	
	<i>Cumec</i>	<i>Cumec</i>	<i>Cumec</i>	<i>Cumec</i>	<i>Cumec</i>	<i>Cumec</i>	<i>Cumec</i>	<i>Cumec</i>	<i>Cum/Km2</i>	<i>Cus/MI2</i>
2.089	2.046	2.087	2.400	2.813	3.147	3.294	3.678	4.041	1.271	116.250
1.445	1.415	1.443	1.660	1.946	2.177	2.278	2.544	2.795	0.879	80.413

APPENDIX E

Contained within appendix E are details of the alterations made to the model supplied by 'JBA Consulting' to create a bespoke model for the study at Riverdale Park East.

Model Alterations

Below is a list of alterations completed to the hydraulic model supplied by 'JBA Consulting' to refine and capture missing data.

Reference	Change Detail	Reason
Network Alterations		
U3BEL1_1270	Truncation of 'Blackstaff' model supplied by JBA Consulting. All elements downstream of node U3BEL1_1270 deleted.	Model reduced in size to help with the speed of runs and to simplify.
U3BEL1_1270	Node type altered from 'Manhole' to 'Outfall.'	Allows water to flow from newly truncated model.
Upstream of U3BEL1S/1C	New river reach with culvert inlet, break node and conduit linking it to U3BEL1S/1C.	Omitted from supplied model, river channel surveyed using Leica GPS unit.
RPE 2D Zone	Re-meshing of 2D zone to take into account the new river reach.	Allows out of bank 2D flow from the new river reach to be modelled if occurring.
Hydrology Files		
RPE INIT	New inflow file created with inflows for all nodes identified within the truncated model. The flows within this file were used solely for the initialisation simulation.	Individual initialisation inflow file required which is applicable to each return period simulation. This file is applicable to the truncated model only.
RPE Q5 – Q1000	New inflow files created with inflows for all nodes identified within the truncated model. An individual file has been created for Q5, Q10, Q25, Q50, Q100, Q200 and Q1000 flows.	Individual inflow file required for each return period simulation. Files are applicable to inflows required for truncated model only.
D/S Q100 Level	New level file created and applied to downstream node of truncated model (U3BEL1_1270). File mimics water level of downstream boundary during a Q100 flood event.	Required to improve accuracy of model.

APPENDIX F

Contained within appendix F is a list of private dwellings and commercial properties currently affected by flood water during a 100 year flood event.

Property No	Street Name	Building Use	Property Type	Property Area
1	Riverdale Park East	Retail	-	35.75
3	Riverdale Park East	Retail	-	35.75
5	Riverdale Park East	Retail	-	35.75
7	Riverdale Park East	Retail	-	35.75
2	Riverdale Park East	Residential	Semi-detached	-
4	Riverdale Park East	Residential	Semi-detached	-
6	Riverdale Park East	Residential	Semi-detached	-
10	Riverdale Park East	Residential	Detached	-
12	Riverdale Park East	Residential	Semi-detached	-
14	Riverdale Park East	Residential	Semi-detached	-
16	Riverdale Park East	Residential	Semi-detached	-
18	Riverdale Park East	Residential	Semi-detached	-
20	Riverdale Park East	Residential	Semi-detached	-
17	Riverdale Park East	Residential	Semi-detached	-
19	Riverdale Park East	Residential	Semi-detached	-
21	Riverdale Park East	Residential	Semi-detached	-
23	Riverdale Park East	Residential	Semi-detached	-
25	Riverdale Park East	Residential	Semi-detached	-
27	Riverdale Park East	Residential	Semi-detached	-
29	Riverdale Park East	Residential	Semi-detached	-
31	Riverdale Park East	Residential	Detached	-
151 Unit A	Andersonstown Rd	Retail	-	67.78
151 Unit B	Andersonstown Rd	Retail	-	67.78
151 Unit C	Andersonstown Rd	Retail	-	67.78
151 Unit D	Andersonstown Rd	Retail	-	110.35
162	Andersonstown Rd	Retail	-	89.95
164	Andersonstown Rd	Retail	-	53.77
166	Andersonstown Rd	Retail	-	53.77
168	Andersonstown Rd	Retail	-	59.11
170	Andersonstown Rd	Retail	-	45.62
172	Andersonstown Rd	Retail	-	45
174	Andersonstown Rd	Retail	-	45
28	Slievebann Drive	Residential	Semi-detached	-
26	Slievebann Drive	Residential	Semi-detached	-
24	Slievebann Drive	Residential	Semi-detached	-
22	Slievebann Drive	Residential	Semi-detached	-
20	Slievebann Drive	Residential	Semi-detached	-
18	Slievebann Drive	Residential	Semi-detached	-
16	Slievebann Drive	Residential	Semi-detached	-
14	Slievebann Drive	Residential	Semi-detached	-
12	Slievebann Drive	Residential	Semi-detached	-
10	Slievebann Drive	Residential	Semi-detached	-
8	Slievebann Drive	Residential	Semi-detached	-
6	Slievebann Drive	Residential	Semi-detached	-
4	Slievebann Drive	Residential	Semi-detached	-
2	Slievebann Drive	Residential	Semi-detached	-
2	Slievegallion Drive	Residential	Semi-detached	-
4	Slievegallion Drive	Residential	Semi-detached	-

APPENDIX G

Contained within appendix G are details of the calculations undertaken to determine the retail price index multiplication factor.

Retail Price Index Calculation

The retail price index has been used to uplift outdated monetary values to present day equivalents. All retail price index information has been sourced from the office for national statistics website (<https://www.ons.gov.uk/economy/inflationandpriceindices>).

Applied to;

Calculated RPI	From	Applied To
1.27%	Jan 2015	Damage figures derived from MCM
5%	Jan 2013	Capital construction costs for remedial options.
11.2%	Jan 2011	Figures from Property Level Protection Grant Scheme during 'Do-minimum' costing exercise.

APPENDIX H

Contained within appendix H are bill of quantities of capital costs for each remedial option assessed within the study.

DO MINIMUM OPTION – COSTINGS

Average cost of property level protections - £4,832

Total Number of properties affected – 48 (33 Residential, 15 Commercial)

Total cost of Property Level Protection Scheme - £4,832 x 48 = £231,936

Increase factor for inflation since 2011 – 1.112

Total option cost taking account of inflation – 1.112 x £231,936 = **£257,912.83**

REMEDIAL OPTION 1 – BILL OF QUANTITIES

CESMM Category	CESMM Reference	Description	Unit Cost	Unit	Quantity	Total Price
Culvert Renewal at Slievbann Drive and Slievegallion Drive						
Class D - Demolition & Site Clearance	D6.3.0.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 600mm	16.52	m	222.00	£ 3,667.44
Class E - Earthworks	E4.2.4.01	Excavation of earth to a maximum depth 1-2m loaded into wagons	3.34	m ³	499.50	£ 1,668.33
	E4.4.1.02	Excavation of tarmacadam pavement	12.15	m ³	83.25	£ 1,011.49
	E5.2.2.02	Preparation of excavated surfaces - Inclined	2.51	m ³	499.50	£ 1,253.75
	E5.3.1.02	Disposal of excavated material & removal from site.	16.92	m ³	499.50	£ 8,451.54
	E6.1.5.03	Filling - Imported granular material	28.74	m ³	33.30	£ 957.04
Class I - Pipework	I2.5.3.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 1200mm.	258.66	m	222.00	£ 57,422.52
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.1.06	1500mm Pre-cast concrete manhole constructed to a maximum depth of 1.5m.	2312.69	nr	7.00	£ 16,188.83
	K7.1.3.01	Breaking up and temporary reinstatement of roads, pipe bore 900mm - 1800mm.	103.32	m	222.00	£ 22,937.04
Class L - Pipework - Supports and Protection, Ancillaries to laying and excavation	L1.2.8.01	Excavation of natural material below the final surface and backfilling with pea gravel to manholes.	56.52	m ³	0.89	£ 50.31
	L3.3.5.01	Pipe bedding, imported granular material to a depth of 100mm.	19.55	m	222.00	£ 4,340.10
	L5.3.5.01	Pipe surrounds, imported granular material of thickness 100mm.	95.62	m	222.00	£ 21,227.64
Class R - Roads and Paving	R1.3.4.01	Unbound sub-base 'Type 3' to a maximum depth of 150mm.	4.71	m ²	333.00	£ 1,568.43
	R3.1.4.02	Hot rolled asphalt base, 150mm thick.	24.49	m ²	333.00	£ 8,155.17
	R3.2.3.01	Hot rolled asphalt binder, 60mm thick.	13.32	m ²	333.00	£ 4,435.56
	R3.4.2.04	Dense asphalt concrete surface course, 60mm thick, 10mm aggregate.	8.6	m ²	333.00	£ 2,863.80
				Sub Total		£ 156,198.99

Culvert Renewal at Riverdale Park East						
Class D - Demolition & Site Clearance	D6.3.0.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 600mm	16.52	m	87.00	£ 1,437.24
Class E - Earthworks	E4.1.1.01	Excavation of topsoil, depth not exceeding 0.25m	2.3	m ³	77.00	£ 177.10
	E4.2.4.01	Excavation of earth to a maximum depth 1-2m loaded into wagons	3.34	m ³	348.00	£ 1,162.32
	E4.4.1.02	Excavation of tarmacadam pavement	12.15	m ³	43.50	£ 528.53
	E5.2.2.02	Preparation of excavated surfaces - Inclined	2.51	m ³	348.00	£ 873.48
	E5.3.1.02	Disposal of excavated material & removal from site.	16.92	m ³	348.00	£ 5,888.16
	E6.1.5.03	Filling - Imported granular material	28.74	m ³	17.40	£ 500.08
	E6.3.1.02	Filling - Excavated topsoil	3.91	m ³	77.00	£ 301.07
	E7.1.1.01	Trimming of filled topsoil to max incline of 45 degrees.	1.47	m ²	308.00	£ 452.76
	E7.2.1.02	Preparation of filled topsoil to max incline of 45 degrees.	2.62	m ²	308.00	£ 806.96
	E8.3.0.01	Grass re-seeding.	2.61	m ²	308.00	£ 803.88
Class I - Pipework	I2.6.3.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 1500mm.	416.71	m	87.00	£ 36,253.77
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.2.11	1800mm Pre-cast concrete manhole constructed to a maximum depth of 2m.	3233.55	nr	4.00	£ 12,934.20
	K7.1.3.01	Breaking up and temporary reinstatement of roads, pipe bore 900mm - 1800mm.	103.32	m	87.00	£ 8,988.84
Class L - Pipework - Supports and Protection, Ancillaries to laying and excavation	L1.2.8.01	Excavation of natural material below the final surface and backfilling with pea gravel to manholes.	56.52	m ³	0.51	£ 28.75
	L3.3.5.01	Pipe bedding, imported granular material to a depth of 100mm.	19.55	m	87.00	£ 1,700.85
	L5.3.5.01	Pipe surrounds, imported granular material of thickness 100mm.	95.62	m	87.00	£ 8,318.94
Class R - Roads and Paving	R1.3.4.01	Unbound sub-base 'Type 3' to a maximum depth of 150mm.	4.71	m ²	20.00	£ 94.20
	R3.1.4.02	Hot rolled asphalt base, 150mm thick.	24.49	m ²	20.00	£ 489.80
	R3.2.3.01	Hot rolled asphalt binder, 60mm thick.	13.32	m ²	20.00	£ 266.40

	R3.4.2.04	Dense asphalt concrete surface course, 60mm thick, 10mm aggregate.	8.6	m ²	20.00	£ 172.00
		New Grille construction to include reinforced concrete structure and steel screen as per DFI Rivers design standards, 1500mm internal diameter box inlet.	26529.86	nr	1.00	£ 26,529.86
				Sub Total	£ 108,709.18	
RC Wall Construction at Riverdale Park East						
Class D - Demolition & Site Clearance		Site Clearance including fencing and hedgerows	176.12	Hr	16.00	£ 2,817.92
Class E - Earthworks	E3.2.2.01	Excavation for foundations of maximum depth 0.25m - 0.5m	3.68	m ³	32.10	£ 118.13
	E5.2.2.01	Preparation of excavated surfaces	2.51	m ³	32.10	£ 80.57
	E6.4.5.08	Filling to wall base, imported granular fill type 1 to maximum depth 200mm.	6.76	m ²	128.40	£ 867.98
	E7.2.2.01	Preparation of filled surfaces, imported granular fill	2.41	m ²	128.40	£ 309.44
Class F - Insitu Concrete	F1.1.1.01	Provision of Concrete - C8/10 for mud mat	87.31	m ³	6.42	£ 560.53
	F1.8.2.01	Provision of Concrete - C32/40 for wall base	97.75	m ³	25.68	£ 2,510.22
	F1.8.2.01	Provision of Concrete - C32/40 for wall upright	97.75	m ³	21.40	£ 2,091.85
	F6.1.1.01	Placing of Concrete - Mudmat - Thickness not exceeding 150mm	24.45	m ³	38.00	£ 929.10
	F7.2.2.01	Placing of Concrete - Wall Base - Thickness 150 - 300mm	25.81	m ³	25.68	£ 662.80
	F7.4.2.01	Placing of Concrete - Wall Upright - Thickness 150 - 300mm.	32.6	m ³	21.40	£ 697.64
Class G - Concrete Ancillaries	G1.4.1.01	Formwork to wall base, standard finish	16.8	m	214.00	£ 3,595.20
	G1.4.3.01	Formwork for wall upright, standard finish	62.62	m ²	214.00	£ 13,400.68
	G5.1.5.01	Reinforcement - Standard bars to top and bottom of wall base slab.	1172.6	Ton	52.77	£ 61,880.92
	G5.1.5.01	Reinforcement - Standard bars to front and rear of wall upright	1172.6	Ton	42.22	£ 49,504.73
		Concrete Pump Hire	1000	Per Day	5.00	£ 5,000.00

			Sub Total			£ 145,027.72
	General item Mark Up - Class A - Insurance/Accomodation / Services	24.00%				£ 98,384.61
	Design and Supervision Costs	15.98%				£ 81,243.78
	RPI Adjustment	1.50%				£ 29,478.21
			Total			£ 619,042.49

REMEDIAL OPTION 2A – BILL OF QUANTITIES

CESMM Category	CESMM Reference	Description	Unit Cost	Unit	Quantity	Total Price
Culvert Renewal at Slievbann Drive and Slievegallion Drive						
Class D - Demolition & Site Clearance	D6.3.0.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 600mm	16.52	m	222.00	£ 3,667.44
Class E - Earthworks	E4.2.4.01	Excavation of earth to a maximum depth 1-2m loaded into wagons	3.34	m ³	777.00	£ 2,595.18
	E4.4.1.02	Excavation of tarmacadam pavement	12.15	m ³	97.13	£ 1,180.07
	E5.2.2.02	Preparation of excavated surfaces - Inclined	2.51	m ³	777.00	£ 1,950.27
	E5.3.1.02	Disposal of excavated material & removal from site.	16.92	m ³	777.00	£ 13,146.84
	E6.1.5.03	Filling - Imported granular material	28.74	m ³	38.85	£ 1,116.55
Class I - Pipework	I2.6.3.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 1500mm.	416.71	m	222.00	£ 92,509.62
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.2.07	1800mm Pre-cast concrete manhole constructed to a maximum depth of 2m.	3424.63	nr	7.00	£ 23,972.41
	K7.1.3.01	Breaking up and temporary reinstatement of roads, pipe bore 900mm - 1800mm.	103.32	m	222.00	£ 22,937.04
Class L - Pipework - Supports and Protection, Ancillaries to	L1.2.8.01	Excavation of natural material below the final surface and backfilling with pea gravel to manholes.	56.52	m ³	0.89	£ 50.31

laying and excavation	L3.3.5.01	Pipe bedding, imported granular material to a depth of 100mm.	19.55	m	222.00	£ 4,340.10
	L5.3.5.01	Pipe surrounds, imported granular material of thickness 100mm.	95.62	m	222.00	£ 21,227.64
Class R - Roads and Paving	R1.3.4.01	Unbound sub-base 'Type 3' to a maximum depth of 150mm.	4.71	m ²	388.50	£ 1,829.84
	R3.1.4.02	Hot rolled asphalt base, 150mm thick.	24.49	m ²	388.50	£ 9,514.37
	R3.2.3.01	Hot rolled asphalt binder, 60mm thick.	13.32	m ²	388.50	£ 5,174.82
	R3.4.2.04	Dense asphalt concrete surface course, 60mm thick, 10mm aggregate.	8.6	m ²	388.50	£ 3,341.10
					Sub Total	£ 208,553.59
RC Wall Construction at Riverdale Park East						
Class D - Demolition & Site Clearance		Site Clearance including fencing and hedgerows	176.12	Hr	16.00	£ 2,817.92
Class E - Earthworks	E3.2.2.01	Excavation for foundations of maximum depth 0.25m - 0.5m	3.68	m ³	32.10	£ 118.13
	E5.2.2.01	Preparation of excavated surfaces	2.51	m ³	32.10	£ 80.57
	E6.4.5.08	Filling to wall base, imported granular fill type 1 to maximum depth 200mm.	6.76	m ²	128.40	£ 867.98
	E7.2.2.01	Preparation of filled surfaces, imported granular fill	2.41	m ²	128.40	£ 309.44
Class F - Insitu Concrete	F1.1.1.01	Provision of Concrete - C8/10 for mud mat	87.31	m ³	6.42	£ 560.53
	F1.8.2.01	Provision of Concrete - C32/40 for wall base	97.75	m ³	32.10	£ 3,137.78
	F1.8.2.01	Provision of Concrete - C32/40 for wall upright	97.75	m ³	56.07	£ 5,480.65

	F6.1.1.01	Placing of Concrete - Mudmat - Thickness not exceeding 150mm	24.45	m ³	6.42	£ 156.97
	F7.2.2.01	Placing of Concrete - Wall Base - Thickness 150 - 300mm	25.81	m ³	32.10	£ 828.50
	F7.4.2.01	Placing of Concrete - Wall Upright - Thickness 150 - 300mm.	32.6	m ³	56.07	£ 1,827.82
Class G - Concrete Ancillaries	G1.4.1.01	Formwork to wall base, standard finish	16.8	m	214.00	£ 3,595.20
	G1.4.5.01	Formwork for wall upright, standard finish	48	m ²	560.68	£ 26,912.64
	G5.1.5.01	Reinforcement - Standard bars to top and bottom of wall base slab.	1172.6	Ton	52.77	£ 61,880.92
	G5.1.5.01	Reinforcement - Standard bars to front and rear of wall upright	1172.6	Ton	127.71	£ 149,751.82
		Concrete Pump Hire	1000	Per Day	5.00	£ 5,000.00
				Sub Total	£ 263,326.86	
		General item Mark Up - Class A - Insurance/Accommodation / Services	24.00%			£ 113,251.31
		Design and Supervision Costs	15.98%			£ 93,520.36
		RPI Adjustment	5.00%			£ 33,932.61
				Total	£ 712,584.73	

REMEDIAL OPTION 2B – BILL OF QUANTITIES

CESMM Category	CESMM Reference	Description	Unit Cost	Unit	Quantity	Total Price
Culvert Renewal at Slievebann Drive and Slievegallion Drive						
Class D - Demolition & Site Clearance	D6.3.0.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 600mm	16.52	m	222.00	£ 3,667.44
Class E - Earthworks	E4.2.4.01	Excavation of earth to a maximum depth 1-2m loaded into wagons	3.34	m ³	777.00	£ 2,595.18
	E4.4.1.02	Excavation of tarmacadam pavement	12.15	m ³	97.13	£ 1,180.07
	E5.2.2.02	Preparation of excavated surfaces - Inclined	2.51	m ³	777.00	£ 1,950.27
	E5.3.1.02	Disposal of excavated material & removal from site.	16.92	m ³	777.00	£ 13,146.84
	E6.1.5.03	Filling - Imported granular material	28.74	m ³	38.85	£ 1,116.55
Class I - Pipework	I2.6.3.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 1500mm.	416.71	m	222.00	£ 92,509.62
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.2.07	1800mm Pre-cast concrete manhole constructed to a maximum depth of 2m.	3424.63	nr	7.00	£ 23,972.41
	K7.1.3.01	Breaking up and temporary reinstatement of roads, pipe bore 900mm - 1800mm.	103.32	m	222.00	£ 22,937.04
Class L - Pipework - Supports and Protection, Ancillaries to laying and excavation	L1.2.8.01	Excavation of natural material below the final surface and backfilling with pea gravel to manholes.	56.52	m ³	0.89	£ 50.31
	L3.3.5.01	Pipe bedding, imported granular material to a depth of 100mm.	19.55	m	222.00	£ 4,340.10
	L5.3.5.01	Pipe surrounds, imported granular material of thickness 100mm.	95.62	m	222.00	£ 21,227.64
Class R - Roads and Paving	R1.3.4.01	Unbound sub-base 'Type 3' to a maximum depth of 150mm.	4.71	m ²	388.50	£ 1,829.84
	R3.1.4.02	Hot rolled asphalt base, 150mm thick.	24.49	m ²	388.50	£ 9,514.37

	R3.2.3.01	Hot rolled asphalt binder, 60mm thick.	13.32	m ²	388.50	£ 5,174.82
	R3.4.2.04	Dense asphalt concrete surface course, 60mm thick, 10mm aggregate.	8.6	m ²	388.50	£ 3,341.10
				Sub Total	£ 208,553.59	
RC Wall Construction at Riverdale Park East						
Class D - Demolition & Site Clearance		Site Clearance including fencing and hedgerows	176.12	Hr	16.00	£ 2,817.92
Class E - Earthworks	E3.2.2.01	Excavation for foundations of maximum depth 0.25m - 0.5m	3.68	m ³	32.10	£ 118.13
	E5.2.2.01	Preparation of excavated surfaces	2.51	m ³	32.10	£ 80.57
	E6.4.5.08	Filling to wall base, imported granular fill type 1 to maximum depth 200mm.	6.76	m ²	128.40	£ 867.98
	E7.2.2.01	Preparation of filled surfaces, imported granular fill	2.41	m ²	128.40	£ 309.44
Class F - Insitu Concrete	F1.1.1.01	Provision of Concrete - C8/10 for mud mat	87.31	m ³	6.42	£ 560.53
	F1.8.2.01	Provision of Concrete - C32/40 for wall base	97.75	m ³	32.10	£ 3,137.78
	F1.8.2.01	Provision of Concrete - C32/40 for wall upright	97.75	m ³	38.95	£ 3,807.17
	F6.1.1.01	Placing of Concrete - Mudmat - Thickness not exceeding 150mm	24.45	m ³	6.42	£ 156.97
	F7.2.2.01	Placing of Concrete - Wall Base - Thickness 150 - 300mm	25.81	m ³	32.10	£ 828.50
	F7.4.2.01	Placing of Concrete - Wall Upright - Thickness 150 - 300mm.	32.6	m ³	38.95	£ 1,269.70
Class G - Concrete Ancillaries	G1.4.1.01	Formwork to wall base, standard finish	16.8	m	214.00	£ 3,595.20
	G1.4.5.01	Formwork for wall upright, standard finish	48	m ²	389.48	£ 18,695.04
	G5.1.5.01	Reinforcement - Standard bars to top and bottom of wall base slab.	1172.6	Ton	52.77	£ 61,880.92
	G5.1.5.01	Reinforcement - Standard bars to front and rear of wall upright	1172.6	Ton	85.49	£ 100,247.08
		Concrete Pump Hire	1000	Per Day	5.00	£ 5,000.00

				Sub Total		£ 203,372.93
Installation of hydraulic throttle at the Andersontown Shops						
		New Grille construction to include reinforced concrete structure and steel screen as per DFI Rivers design standards, 825mm internal diameter inlet.	12928.75	nr	1.00	£ 12,928.75
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.2.07	1800mm Pre-cast concrete manhole constructed to a maximum depth of 2m.	3424.63	nr	1	£ 3,424.63
	K7.1.3.01	Breaking up and temporary reinstatement of roads, pipe bore 900mm - 1800mm.	103.32	m	5.00	£ 516.60
				Sub Total		£ 16,869.98
		General item Mark Up - Class A - Insurance/Accommodation / Services	24.00%			£ 102,911.16
		Design and Supervision Costs	15.98%			£ 84,981.70
		RPI Adjustment	5.00%			£ 30,834.47
				Total		£ 647,523.84

REMEDIAL OPTION 3A – BILL OF QUANTITIES

CESMM Category	CESMM Reference	Description	Unit Cost	Unit	Quantity	Total Price
Culvert Renewal at Slievbann Drive and Slievegallion Drive						
Class D - Demolition & Site Clearance	D6.3.0.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 600mm	16.52	m	222.00	£ 3,667.44
Class E - Earthworks	E4.2.4.01	Excavation of earth to a maximum depth 1-2m loaded into wagons	3.34	m ³	777.00	£ 2,595.18
	E4.4.1.02	Excavation of tarmacadam pavement	12.15	m ³	97.13	£ 1,180.07
	E5.2.2.02	Preparation of excavated surfaces - Inclined	2.51	m ³	777.00	£ 1,950.27
	E5.3.1.02	Disposal of excavated material & removal from site.	16.92	m ³	777.00	£ 13,146.84
	E6.1.5.03	Filling - Imported granular material	28.74	m ³	38.85	£ 1,116.55
Class I - Pipework	I2.6.3.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 1500mm.	416.71	m	222.00	£ 92,509.62
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.2.07	1800mm Pre-cast concrete manhole constructed to a maximum depth of 2m.	3424.63	nr	7.00	£ 23,972.41
	K7.1.3.01	Breaking up and temporary reinstatement of roads, pipe bore 900mm - 1800mm.	103.32	m	222.00	£ 22,937.04
Class L - Pipework - Supports and Protection, Ancillaries to laying and excavation	L1.2.8.01	Excavation of natural material below the final surface and backfilling with pea gravel to manholes.	56.52	m ³	0.89	£ 50.31
	L3.3.5.01	Pipe bedding, imported granular material to a depth of 100mm.	19.55	m	222.00	£ 4,340.10
	L5.3.5.01	Pipe surrounds, imported granular material of thickness 100mm.	95.62	m	222.00	£ 21,227.64
Class R - Roads and Paving	R1.3.4.01	Unbound sub-base 'Type 3' to a maximum depth of 150mm.	4.71	m ²	388.50	£ 1,829.84
	R3.1.4.02	Hot rolled asphalt base, 150mm thick.	24.49	m ²	388.50	£ 9,514.37
	R3.2.3.01	Hot rolled asphalt binder, 60mm thick.	13.32	m ²	388.50	£ 5,174.82

	R3.4.2.04	Dense asphalt concrete surface course, 60mm thick, 10mm aggregate.	8.6	m ²	388.50	£ 3,341.10
				Sub Total	£ 208,553.59	
RC Wall construction at the Andersontown Shops Channel						
Class D - Demolition & Site Clearance		Site Clearance including fencing and hedgerows	176.12	Hr	16.00	£ 2,817.92
Class E - Earthworks	E3.2.2.01	Excavation for foundations of maximum depth 0.25m - 0.5m	3.68	m ³	26.25	£ 96.60
	E5.2.2.01	Preparation of excavated surfaces	2.51	m ³	26.25	£ 65.89
	E6.4.5.08	Filling to wall base, imported granular fill type 1 to maximum depth 200mm.	6.76	m ²	105.00	£ 709.80
	E7.2.2.01	Preparation of filled surfaces, imported granular fill	2.41	m ²	105.00	£ 253.05
Class F - In situ Concrete	F1.1.1.01	Provision of Concrete - C8/10 for mud mat	87.31	m ³	5.25	£ 458.38
	F1.8.2.01	Provision of Concrete - C32/40 for wall base	97.75	m ³	26.25	£ 2,565.94
	F1.8.2.01	Provision of Concrete - C32/40 for wall upright	97.75	m ³	33.25	£ 3,250.19
	F6.1.1.01	Placing of Concrete - Mudmat - Thickness not exceeding 150mm	24.45	m ³	5.25	£ 128.36
	F7.2.2.01	Placing of Concrete - Wall Base - Thickness 150 - 300mm	25.81	m ³	26.25	£ 677.51
	F7.4.2.01	Placing of Concrete - Wall Upright - Thickness 150 - 300mm.	32.6	m ³	33.25	£ 1,083.95
Class G - Concrete Ancillaries	G1.4.1.01	Formwork to wall base, standard finish	16.8	m	175.00	£ 2,940.00
	G1.4.5.01	Formwork for wall upright, standard finish	48	m ²	332.50	£ 15,960.00
	G5.1.5.01	Reinforcement - Standard bars to top and bottom of wall base slab.	1172.6	Ton	43.16	£ 50,603.55
	G5.1.5.01	Reinforcement - Standard bars to front and rear of wall upright	1172.6	Ton	73.36	£ 86,026.04
		Concrete Pump Hire	1000	Per Day	5.00	£ 5,000.00
				Sub Total	£ 172,637.18	

Installation of hydraulic throttle at the Andersontown Shops						
		New Grille construction to include reinforced concrete structure and steel screen as per DFI Rivers design standards, 600mm internal diameter inlet.	10954.8	nr	1.00	£ 10,954.80
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.2.07	1800mm Pre-cast concrete manhole constructed to a maximum depth of 2m.	3424.63	nr	1.00	£ 3,424.63
	K7.1.3.01	Breaking up and temporary reinstatement of roads, pipe bore 900mm - 1800mm.	103.32	m	5.00	£ 516.60
				Sub Total		£ 14,896.03
		General item Mark Up - Class A - Insurance/Accommodation / Services	24.00%			£ 95,060.83
		Design and Supervision Costs	15.98%			£ 78,499.08
		RPI Adjustment	5.00%			£ 28,482.34
				Total		£ 598,129.04

REMEDIAL OPTION 3B – BILL OF QUANTITIES

CESMM Category	CESMM Reference	Description	Unit Cost	Unit	Quantity	Total Price
Culvert Renewal at Slievbann Drive and Slievegallion Drive						
Class D - Demolition & Site Clearance	D6.3.0.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 600mm	16.52	m	222.00	£ 3,667.44
Class E - Earthworks	E4.2.4.01	Excavation of earth to a maximum depth 1-2m loaded into wagons	3.34	m ³	777.00	£ 2,595.18
	E4.4.1.02	Excavation of tarmacadam pavement	12.15	m ³	97.13	£ 1,180.07
	E5.2.2.02	Preparation of excavated surfaces - Inclined	2.51	m ³	777.00	£ 1,950.27
	E5.3.1.02	Disposal of excavated material & removal from site.	16.92	m ³	777.00	£ 13,146.84
	E6.1.5.03	Filling - Imported granular material	28.74	m ³	38.85	£ 1,116.55
Class I - Pipework	I2.6.3.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 1500mm.	416.71	m	222.00	£ 92,509.62
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.2.07	1800mm Pre-cast concrete manhole constructed to a maximum depth of 2m.	3424.63	nr	7.00	£ 23,972.41
	K7.1.3.01	Breaking up and temporary reinstatement of roads, pipe bore 900mm - 1800mm.	103.32	m	222.00	£ 22,937.04
Class L - Pipework - Supports and Protection, Ancillaries to laying and excavation	L1.2.8.01	Excavation of natural material below the final surface and backfilling with pea gravel to manholes.	56.52	m ³	0.89	£ 50.31
	L3.3.5.01	Pipe bedding, imported granular material to a depth of 100mm.	19.55	m	222.00	£ 4,340.10
	L5.3.5.01	Pipe surrounds, imported granular material of thickness 100mm.	95.62	m	222.00	£ 21,227.64
Class R - Roads and Paving	R1.3.4.01	Unbound sub-base 'Type 3' to a maximum depth of 150mm.	4.71	m ²	388.50	£ 1,829.84
	R3.1.4.02	Hot rolled asphalt base, 150mm thick.	24.49	m ²	388.50	£ 9,514.37
	R3.2.3.01	Hot rolled asphalt binder, 60mm thick.	13.32	m ²	388.50	£ 5,174.82
	R3.4.2.04	Dense asphalt concrete surface course, 60mm thick, 10mm aggregate.	8.6	m ²	388.50	£ 3,341.10

					Sub Total	£ 208,553.59
RC Wall construction at the Andersontown Shops Channel						
Class D - Demolition & Site Clearance		Site Clearance including fencing and hedgerows	176.12	Hr	16.00	£ 2,817.92
Class E - Earthworks	E3.2.2.01	Excavation for foundations of maximum depth 0.25m - 0.5m	3.68	m ³	13.05	£ 48.02
	E5.2.2.01	Preparation of excavated surfaces	2.51	m ³	13.05	£ 32.76
	E6.4.5.08	Filling to wall base, imported granular fill type 1 to maximum depth 200mm.	6.76	m ²	52.20	£ 352.87
	E7.2.2.01	Preparation of filled surfaces, imported granular fill	2.41	m ²	52.20	£ 125.80
Class F - Insitu Concrete	F1.1.1.01	Provision of Concrete - C8/10 for mud mat	87.31	m ³	2.61	£ 227.88
	F1.8.2.01	Provision of Concrete - C32/40 for wall base	97.75	m ³	13.05	£ 1,275.64
	F1.8.2.01	Provision of Concrete - C32/40 for wall upright	97.75	m ³	5.22	£ 510.26
	F6.1.1.01	Placing of Concrete - Mudmat - Thickness not exceeding 150mm	24.45	m ³	2.61	£ 63.81
	F7.2.2.01	Placing of Concrete - Wall Base - Thickness 150 - 300mm	25.81	m ³	13.05	£ 336.82
	F7.4.2.01	Placing of Concrete - Wall Upright - Thickness 150 - 300mm.	32.6	m ³	5.22	£ 170.17
Class G - Concrete Ancillaries	G1.4.1.01	Formwork to wall base, standard finish	16.8	m	87.00	£ 1,461.60
	G1.4.5.01	Formwork for wall upright, standard finish	48	m ²	52.20	£ 2,505.60
	G5.1.5.01	Reinforcement - Standard bars to top and bottom of wall base slab.	1172.6	Ton	21.45	£ 25,157.19
	G5.1.5.01	Reinforcement - Standard bars to front and rear of wall upright	1172.6	Ton	10.73	£ 12,578.60
		Concrete Pump Hire	1000	Per Day	5.00	£ 5,000.00
					Sub Total	£ 52,664.94
RC Wall Construction at Riverdale Park East						
Class D - Demolition & Site Clearance		Site Clearance including fencing and hedgerows	176.12	Hr	16.00	£ 2,817.92
Class E - Earthworks	E3.2.2.01	Excavation for foundations of maximum depth 0.25m - 0.5m	3.68	m ³	32.10	£ 118.13

	E5.2.2.01	Preparation of excavated surfaces	2.51	m ³	32.10	£	80.57
	E6.4.5.08	Filling to wall base, imported granular fill type 1 to maximum depth 200mm.	6.76	m ²	128.40	£	867.98
	E7.2.2.01	Preparation of filled surfaces, imported granular fill	2.41	m ²	128.40	£	309.44
Class F - Insitu Concrete	F1.1.1.01	Provision of Concrete - C8/10 for mud mat	87.31	m ³	6.42	£	560.53
	F1.8.2.01	Provision of Concrete - C32/40 for wall base	97.75	m ³	32.10	£	3,137.78
	F1.8.2.01	Provision of Concrete - C32/40 for wall upright	97.75	m ³	12.84	£	1,255.11
	F6.1.1.01	Placing of Concrete - Mudmat - Thickness not exceeding 150mm	24.45	m ³	6.42	£	156.97
	F7.2.2.01	Placing of Concrete - Wall Base - Thickness 150 - 300mm	25.81	m ³	32.10	£	828.50
	F7.4.2.01	Placing of Concrete - Wall Upright - Thickness 150 - 300mm.	32.6	m ³	12.84	£	418.58
Class G - Concrete Ancillaries	G1.4.1.01	Formwork to wall base, standard finish	16.8	m	214.00	£	3,595.20
	G1.4.5.01	Formwork for wall upright, standard finish	48	m ²	128.40	£	6,163.20
	G5.1.5.01	Reinforcement - Standard bars to top and bottom of wall base slab.	1172.6	Ton	52.77	£	61,880.92
	G5.1.5.01	Reinforcement - Standard bars to front and rear of wall upright	1172.6	Ton	26.39	£	30,940.46
		Concrete Pump Hire	1000	Per Day	5.00	£	5,000.00
Sub Total						£	118,131.29
Installation of hydraulic throttle at the Andersontown Shops							
		New Grille construction to include reinforced concrete structure and steel screen as per DFI Rivers design standards, 600mm internal diameter inlet.	12178.23	nr	1.00	£	12,178.23
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.2.07	1800mm Pre-cast concrete manhole constructed to a maximum depth of 2m.	3424.63	nr	1.00	£	3,424.63
	K7.1.3.01	Breaking up and temporary reinstatement of roads, pipe bore 900mm - 1800mm.	103.32	m	5.00	£	516.60
Sub Total						£	16,119.46

General item Mark Up - Class A - Insurance/Accommodation / Services	24.00%			£ 94,912.63
Design and Supervision Costs	15.98%			£ 78,376.70
RPI Adjustment	5.00%			£ 28,437.93
		Total		£ 597,196.54

REMEDIAL OPTION 4 – BILL OF QUANTITIES

CESMM Category	CESMM Reference	Description	Unit Cost	Unit	Quantity	Total Price
Culvert Renewal at Slievbann Drive and Slievegallion Drive						
Class D - Demolition & Site Clearance	D6.3.0.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 600mm	16.52	m	222.00	£ 3,667.44
Class E - Earthworks	E4.2.4.01	Excavation of earth to a maximum depth 1-2m loaded into wagons	3.34	m ³	777.00	£ 2,595.18
	E4.4.1.02	Excavation of tarmacadam pavement	12.15	m ³	97.13	£ 1,180.07
	E5.2.2.02	Preparation of excavated surfaces - Inclined	2.51	m ³	777.00	£ 1,950.27
	E5.3.1.02	Disposal of excavated material & removal from site.	16.92	m ³	777.00	£ 13,146.84
	E6.1.5.03	Filling - Imported granular material	28.74	m ³	38.85	£ 1,116.55
Class I - Pipework	I2.6.3.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 1500mm.	416.71	m	222.00	£ 92,509.62
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.2.07	1800mm Pre-cast concrete manhole constructed to a maximum depth of 2m.	3424.63	nr	7.00	£ 23,972.41
	K7.1.3.01	Breaking up and temporary reinstatement of roads, pipe bore 900mm - 1800mm.	103.32	m	222.00	£ 22,937.04
Class L - Pipework - Supports and Protection, Ancillaries to laying and excavation	L1.2.8.01	Excavation of natural material below the final surface and backfilling with pea gravel to manholes.	56.52	m ³	0.89	£ 50.31
	L3.3.5.01	Pipe bedding, imported granular material to a depth of 100mm.	19.55	m	222.00	£ 4,340.10
	L5.3.5.01	Pipe surrounds, imported granular material of thickness 100mm.	95.62	m	222.00	£ 21,227.64

Class R - Roads and Paving	R1.3.4.01	Unbound sub-base 'Type 3' to a maximum depth of 150mm.	4.71	m ²	388.50	£ 1,829.84
	R3.1.4.02	Hot rolled asphalt base, 150mm thick.	24.49	m ²	388.50	£ 9,514.37
	R3.2.3.01	Hot rolled asphalt binder, 60mm thick.	13.32	m ²	388.50	£ 5,174.82
	R3.4.2.04	Dense asphalt concrete surface course, 60mm thick, 10mm aggregate.	8.6	m ²	388.50	£ 3,341.10
					Sub Total	£ 208,553.59
Stormstore at Andersontown Shops Car Park						
Class D - Demolition & Site Clearance		Site Clearance including fencing and hedgerows	176.12	Hr	16.00	£ 2,817.92
Class E - Earthworks	E4.2.4.01	Excavation of earth to a maximum depth 1-2m loaded into wagons	3.34	m ³	17000.00	£ 56,780.00
	E5.2.2.02	Preparation of excavated surfaces - Inclined	2.51	m ³	17000.00	£ 42,670.00
	E5.3.1.02	Disposal of excavated material & removal from site.	16.92	m ³	17000.00	£ 287,640.00
	E6.1.5.03	Filling - Imported granular material for bedding	28.74	m ³	800.00	£ 22,992.00
Class H - Pre-cast Concrete	H5.3.5.01	Prestressed pre-cast concrete floor and roof slabs for Stormstore tank.	425.14	nr	2178.00	£ 925,954.92
	H5.3.5.02	Prestressed pre-cast concrete slabs for Stormstore tank walls.	425.14	nr	960.00	£ 408,134.40
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.2.03	1050mm Pre-cast concrete manhole constructed to a maximum depth of 2m.	1745.3	nr	2.00	£ 3,490.60
Class R - Roads and Paving	R1.3.4.01	Unbound sub-base 'Type 3' to a maximum depth of 150mm.	4.71	m ²	8000.00	£ 37,680.00
					Sub Total	£ 1,788,159.84

Installation of hydraulic throttle at the Andersontown Shops						
		New Grille construction to include reinforced concrete structure and steel screen as per DFI Rivers design standards, 825mm internal diameter inlet.	12928.75	nr	1.00	£ 12,928.75
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.2.07	1800mm Pre-cast concrete manhole constructed to a maximum depth of 2m.	3424.63	nr	1.00	£ 3,424.63
	K7.1.3.01	Breaking up and temporary reinstatement of roads, pipe bore 900mm - 1800mm.	103.32	m	5.00	£ 516.60
				Sub Total		£ 16,869.98
		General item Mark Up - Class A - Insurance/Accommodation / Services	24.00%			£ 483,260.02
		Design and Supervision Costs	15.98%			£ 399,065.16
		RPI Adjustment	5.00%			£ 144,795.43
				Total		£ 3,040,704.02

REMEDIAL OPTION 5 – BILL OF QUANTITIES

CESMM Category	CESMM Reference	Description	Unit Cost	Unit	Quantity	Total Price
Culvert Renewal at Slievebann Drive and Slievegallion Drive						
Class D - Demolition & Site Clearance	D6.3.0.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 600mm	16.52	m	222.00	£ 3,667.44
Class E - Earthworks	E4.2.4.01	Excavation of earth to a maximum depth 1-2m loaded into wagons	3.34	m ³	777.00	£ 2,595.18
	E4.4.1.02	Excavation of tarmacadam pavement	12.15	m ³	97.13	£ 1,180.07
	E5.2.2.02	Preparation of excavated surfaces - Inclined	2.51	m ³	777.00	£ 1,950.27
	E5.3.1.02	Disposal of excavated material & removal from site.	16.92	m ³	777.00	£ 13,146.84
	E6.1.5.03	Filling - Imported granular material	28.74	m ³	38.85	£ 1,116.55
Class I - Pipework	I2.6.3.01	Concrete pipelines including concrete bed and surround 2m deep, nominal bore 1500mm.	416.71	m	222.00	£ 92,509.62
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.2.07	1800mm Pre-cast concrete manhole constructed to a maximum depth of 2m.	3424.63	nr	7.00	£ 23,972.41
	K7.1.3.01	Breaking up and temporary reinstatement of roads, pipe bore 900mm - 1800mm.	103.32	m	222.00	£ 22,937.04
Class L - Pipework - Supports and Protection, Ancillaries to laying and excavation	L1.2.8.01	Excavation of natural material below the final surface and backfilling with pea gravel to manholes.	56.52	m ³	0.89	£ 50.31
	L3.3.5.01	Pipe bedding, imported granular material to a depth of 100mm.	19.55	m	222.00	£ 4,340.10
	L5.3.5.01	Pipe surrounds, imported granular material of thickness 100mm.	95.62	m	222.00	£ 21,227.64
Class R - Roads and Paving	R1.3.4.01	Unbound sub-base 'Type 3' to a maximum depth of 150mm.	4.71	m ²	388.50	£ 1,829.84
	R3.1.4.02	Hot rolled asphalt base, 150mm thick.	24.49	m ²	388.50	£ 9,514.37
	R3.2.3.01	Hot rolled asphalt binder, 60mm thick.	13.32	m ²	388.50	£ 5,174.82
	R3.4.2.04	Dense asphalt concrete surface course, 60mm thick, 10mm aggregate.	8.6	m ²	388.50	£ 3,341.10
				Sub Total		£ 208,553.59

Sheetpiled storage tank at the Andersontown Shops Natural Channel						
Class D - Demolition & Site Clearance		Site Clearance including fencing and hedgerows	176.12	Hr	16.00	£ 2,817.92
Class E - Earthworks	E4.2.5.01	Excavation to a maximum depth of 5m	3.34	m ³	1965.00	£ 6,563.10
	E5.2.2.01	Preparation of excavated surfaces	2.51	m ³	1560.00	£ 3,915.60
	E6.4.7.06	Filling to base of sheet pile walls to prevent scouring	21.6	m ²	240.00	£ 5,184.00
	E7.2.3.02	Preparation of filled surfaces, imported granular fill	15.9	m ²	240.00	£ 3,816.00
Class F - In situ Concrete	F1.1.1.01	Provision of Concrete - C8/10 for mud mat	87.31	m ³	12.00	£ 1,047.72
	F1.8.2.01	Provision of Concrete - C32/40 for wall capping beam	97.75	m ³	48.00	£ 4,692.00
	F6.1.1.01	Placing of Concrete - Mudmat - Thickness not exceeding 150mm	24.45	m ³	12.00	£ 293.40
	F7.6.4.01	Placing of Concrete - Capping Beam - Thickness 150 - 300mm	33.96	m ³	38.40	£ 1,304.06
Class G - Concrete Ancillaries	G1.4.4.01	Formwork to concrete capping beam	54.21	m ²	48.00	£ 2,602.08
	G5.1.5.01	Reinforcement - Standard bars to top and bottom of capping beam	1172.6	Ton	88.78	£ 104,098.74
		Concrete Pump Hire	1000	Per Day	5.00	£ 5,000.00
Class P - Piles	P7.2.3.01	Interlocking steel piles, driven	146.51	m ²	1102.50	£ 161,527.28
Class Q - Piling Ancillaries	Q6.7.3.01	Cutting off surplus length of sheet piles	35.49	m	52.50	£ 1,863.23
	Q8.1.1.01	Pile load testing	10175.96	Nr	1.00	£ 10,175.96
				Sub Total	£ 314,901.08	
Installation of hydraulic throttle at the Andersontown Shops						
		New Grille construction to include reinforced concrete structure and steel screen as per DFI Rivers design standards, 600mm internal diameter inlet.	10954.8	nr	1.00	£ 10,954.80
Class K - Pipework - Manholes and Pipework Ancillaries	K1.5.2.07	1800mm Pre-cast concrete manhole constructed to a maximum depth of 2m.	3424.63	nr	1.00	£ 3,424.63
	K7.1.3.01	Breaking up and temporary reinstatement of roads, pipe bore 900mm - 1800mm.	103.32	m	5.00	£ 516.60
				Sub Total	£ 14,896.03	

General item Mark Up - Class A - Insurance/Accomodation / Services	24.00%			£ 129,204.17
Design and Supervision Costs	15.98%			£ 106,693.87
RPI Adjustment	5.00%			£ 38,712.44
		Total		£ 812,961.18

APPENDIX I

Contained within appendix I are extracts from the 'FCRM Assets: Deterioration modelling and WLC analysis' publication used to determine the design life of assets.

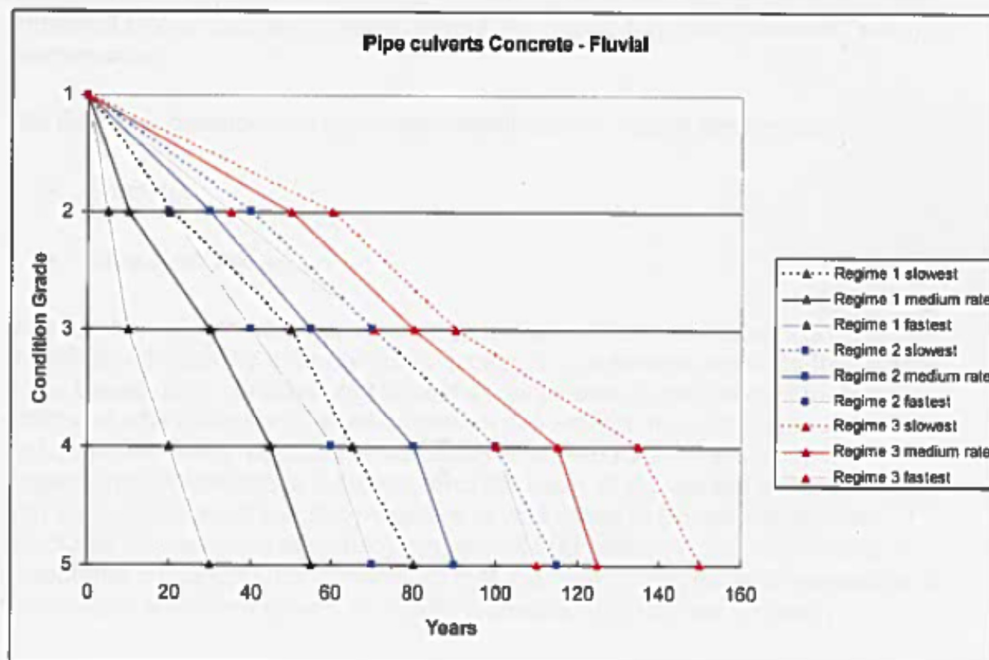
A.2.6 Culverts – pipe, box, arch (all fluvial)

A.2.6.1 Concrete

AIMS asset classification: Channel/simple OR complex culvert

Models:

Culverts Concrete – Fluvial					
Maintenance Regime	Condition Grade Transition (years)				
	1	2	3	4	5
Slowest rate					
1 – Low/Basic	0	20	50	65	80
2 – Medium	0	40	70	100	115
3 – High	0	60	90	135	150
Medium rate					
1 – Low/Basic	0	10	30	45	55
2 – Medium	0	30	55	80	90
3 – High	0	50	80	115	125
Fastest rate					
1 – Low/Basic	0	5	10	20	30
2 – Medium	0	20	40	60	70
3 – High	0	35	70	100	110



Assumptions:

Deterioration: Culvert deterioration mechanisms are: hydraulic wear (on invert and/or along the wet/dry line), seepage through boltholes/joints from backfill, and structural instability of the invert from ageing or through excessive material degradation.

The deterioration processes affecting these assets include:

1. Deformation to culvert
2. Settlement to invert or soffit
3. Cracking, fissuring, or spalling of concrete or other components
4. Corrosion of elements
5. Missing blocks
6. Sealant or joint fill material loss
7. Vegetation growth inside culvert/root penetration

With the exception of settlement, these processes can be controlled by maintenance including minor repair and blockwork repair, sealant replacement, joint repair, debris/vegetation clearance and removal of silt. Downstream scour protection may also be needed.

Replacement of protective coatings, backfill replacement, lining the culvert with additional plates and paving replacement are classed as refurbishment (and not maintenance).

The following deterioration processes dominate the rate of deterioration:

- Blockage
- Structural failure

Deterioration curves for culverts were provided in Phase 1. These were not identified with specific material types except for a reference made to the curves being based upon concrete and brick/masonry walls (fluvial) except for fastest estimates which are considered quicker in culverts (cf. fluvial brick and masonry and concrete walls), because of variability of materials and difficulties in inspections. These Phase 1 curves form the basis of the curves presented here with account taken of specific materials. It was noted in Phase 1 that some structures (material not specified) are almost 200 years old and reported as in acceptable condition. (It is considered that the design was more conservative in those days; a modern culvert of similar materials may not last so long.)

Maintenance Regime 1: Low/Basic 'do minimum'. This curve relates predominantly to the likelihood of extreme and rapid material degradation compounded by blockage and obstruction.

Maintenance Regime 2: Undertake maintenance to maintain at CG 3. Regular maintenance including minor repair, silt and obstruction removal and vegetation clearance offsets asset deterioration and more frequent inspection captures deterioration before it becomes a problem. Deterioration rates are predominantly defined by likelihood of movement in surrounding strata (or other deterioration processes not affected by maintenance works). Able to maintain at CG 3 (or better) for 80 years on this basis (at medium deterioration rate).

Maintenance Regime 3: High, maintain CG 2. Frequent maintenance including minor repair, silt and obstruction removal and vegetation clearance offsets asset deterioration and more frequent inspection captures deterioration before it becomes a problem (i.e. as for Maintenance Regime 2 above but with increased frequency and more stringent criteria for repair). Deterioration rates are predominantly defined by likelihood of movement in surrounding strata (or other deterioration processes not affected by maintenance works). Able to maintain at CG 2 (or better) for 80 years on this basis (at medium deterioration rate).

Slowest rate: The culvert is in continuous use, with a continued flow of deep water. It is self cleansing or there is little or no sediment within the channel.

Medium rate: Considered a typical rate providing a mid-range value.

Fastest rate: The culvert is at the extreme ends of use (either high or no flow) the upstream channel is heavily vegetated and is subject to high silt volumes. The culvert may suffer from poor quality materials/construction/or design.

APPENDIX J

Contained within appendix J are details of the flood depths calculated for each return period assessed for all remedial options. Data is displayed for residential and non residential properties.

No	Street Name	Threshold Level	Flood Water Levels								Depths							
			Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
2	Riverdale Park East	19.61	0	19.61	19.47	19.62	19.63	19.63	19.63	19.7	0	0	-0.14	0.01	0.02	0.02	0.02	0.09
4	Riverdale Park East	19.69	0	19.61	19.47	19.62	19.63	19.63	19.63	19.7	0	-0.08	-0.22	-0.07	-0.06	-0.06	-0.06	0.01
6	Riverdale Park East	19.42	0	19.18	19.10	19.32	19.20	19.3	19.33	19.33	0	-0.24	0	-0.1	-0.22	-0.12	-0.09	-0.09
8	Riverdale Park East	19.75	0	19.18	19.10	19.32	19.20	19.3	19.33	19.33	0	0	0	0	0	0	0	0
10	Riverdale Park East	18.82	0	18.67	18.68	18.83	18.84	18.88	18.86	18.87	0	-0.15	-0.14	0.01	0.02	0.06	0.04	0.05
12	Riverdale Park East	18.14	0	17.93	18.11	18.13	18.15	18.34	18.34	18.36	0	-0.21	-0.03	-0.01	0.01	0.2	0.2	0.22
14	Riverdale Park East	18.15	0	17.93	18.11	18.13	18.15	18.34	18.34	18.36	0	-0.22	-0.04	-0.02	0	0.19	0.19	0.21
16	Riverdale Park East	18.2	0	18.08	18.09	18.12	18.14	18.31	18.3	18.3	0	-0.12	-0.11	-0.08	-0.06	0.11	0.1	0.1
18	Riverdale Park East	18.16	0	18.08	18.09	18.12	18.14	18.31	18.3	18.3	0	-0.08	-0.07	-0.04	-0.02	0.15	0.14	0.14
20	Riverdale Park East	18.24	0	17.78	0.00	18.02	18.03	18.04	18.09	18.21	0	0	0	-0.22	-0.21	-0.2	-0.15	-0.03
22	Riverdale Park East	18.38	0	17.78	0.00	18.02	18.03	17.87	18.09	18.21	0	0	0	0	0	0	-0.29	-0.17
15	Riverdale Park East	19.94	0	19.87	19.93	19.64	19.88	19.94	19.94	19.95	0	-0.07	-0.01	0	-0.06	0	0	0.01
17	Riverdale Park East	19.97	0	19.87	19.93	19.64	19.88	19.94	19.94	19.95	0	-0.1	-0.04	0	-0.09	-0.03	-0.03	-0.02
19	Riverdale Park East	19.5	0	19.34	19.38	19.35	19.64	19.35	19.36	19.37	0	-0.16	-0.12	-0.15	0.14	-0.15	-0.14	-0.13
21	Riverdale Park East	19.58	0	19.34	19.34	19.35	19.64	19.35	19.36	19.37	0	-0.24	-0.24	-0.23	0.06	-0.23	-0.22	-0.21
23	Riverdale Park East	19.29	0	19.16	19.17	19.19	19.20	19.19	19.21	19.23	0	-0.13	-0.12	-0.1	-0.09	-0.1	-0.08	-0.06
25	Riverdale Park East	19.2	0	19.16	19.17	19.19	19.20	19.19	19.21	19.23	0	-0.04	-0.03	-0.01	0	-0.01	0.01	0.03
27	Riverdale Park East	19.06	0	19.01	19.02	18.92	19.04	18.99	19.08	19.08	0	-0.05	-0.04	-0.14	-0.02	-0.07	0.02	0.02
29	Riverdale Park East	19.07	0	19.01	19.02	18.92	19.04	18.93	19.08	19.04	0	-0.06	-0.05	-0.15	-0.03	-0.14	0.01	-0.03
31	Riverdale Park East	18.88	0	18.71	18.71	18.72	18.72	18.75	18.79	18.85	0	-0.17	-0.17	-0.16	-0.16	-0.13	-0.09	-0.03
28	Slievebann Drive	26.39	0	0	0	26.43	25.80	26.28	26.44	26.46	0	0	0	0.04	0	-0.11	0.05	0.07
26	Slievebann Drive	26.39	0	0	0	25.80	25.80	26.29	26.44	26.46	0	0	0	0	0	-0.1	0.05	0.07
24	Slievebann Drive	25.8	0	0	0	25.80	25.80	26.11	26.44	26.46	0	0	0	0	0	0.31	0.64	0.66
22	Slievebann Drive	25.8	0	0	0	25.80	25.50	25.55	25.55	25.8	0	0	0	0	0	-0.25	-0.25	0
20	Slievebann Drive	25.09	0	0	0	25.15	25.01	25.15	25.16	25.17	0	0	0	0.06	-0.08	0.06	0.07	0.08
18	Slievebann Drive	25.09	0	0	0	25.15	25.01	25.15	25.16	25.17	0	0	0	0.06	-0.08	0.06	0.07	0.08
16	Slievebann Drive	25.13	0	0	0	24.95	25.01	25.02	24.84	25.03	0	0	0	-0.18	-0.12	-0.11	-0.29	-0.1
14	Slievebann Drive	25.13	0	0	0	24.95	25.01	25.02	24.84	25.03	0	0	0	-0.18	-0.12	-0.11	-0.29	-0.1
12	Slievebann Drive	24.66	0	24.57	24.43	24.45	24.47	24.64	24.50	24.69	0	-0.09	-0.23	-0.21	-0.19	-0.02	-0.16	0.03
10	Slievebann Drive	24.66	0	24.57	24.43	24.45	24.47	24.64	24.50	24.69	0	-0.09	-0.23	-0.21	-0.19	-0.02	-0.16	0.03
8	Slievebann Drive	24.51	0	24.39	24.43	24.45	24.59	24.61	24.50	24.6	0	-0.12	-0.08	-0.06	0.08	0.1	-0.01	0.09
6	Slievebann Drive	24.51	0	24.39	24.43	24.45	24.59	24.61	24.50	24.6	0	-0.12	-0.08	-0.06	0.08	0.1	-0.01	0.09
4	Slievebann Drive	24.57	0	24.39	24.39	24.40	24.04	24.61	24.63	24.6	0	-0.18	-0.18	-0.17	0	0.04	0.06	0.03
2	Slievebann Drive	24.69	0	24.39	24.39	24.40	24.04	24.61	24.63	24.6	0	0	0	-0.29	0	-0.08	-0.06	-0.09
2	Slievegallion Drive	23.96	0	23.99	24.02	24.07	24.10	24.12	24.14	24.18	0	0.03	0.06	0.11	0.14	0.16	0.18	0.22
4	Slievegallion Drive	23.96	0	23.99	24.02	24.07	24.10	24.12	24.14	24.18	0	0.03	0.06	0.11	0.14	0.16	0.18	0.22

Residential Flood Depths – Do Nothing

No	Street Name	Threshold Level	Water Levels								Depths							
			Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
2	Riverdale Park East	19.61	0	19.61	19.47	19.62	19.63	19.63	19.63	19.7	0	0	0	0	0	0	0	0
4	Riverdale Park East	19.69	0	19.61	19.47	19.62	19.63	19.63	19.63	19.7	0	0	0	0	0	0	0	0
6	Riverdale Park East	19.42	0	19.18	19.10	19.32	19.20	19.3	19.33	19.33	0	0	0	0	0	0	0	0
8	Riverdale Park East	19.75	0	19.18	19.10	19.32	19.20	19.3	19.33	19.33	0	0	0	0	0	0	0	0
10	Riverdale Park East	18.82	0	18.67	18.68	18.83	18.84	18.88	18.86	18.87	0	0	0	0	0	0	0	0
12	Riverdale Park East	18.14	0	17.93	18.11	18.13	18.15	18.34	18.34	18.36	0	0	0	0	0	0	0	0
14	Riverdale Park East	18.15	0	17.93	18.11	18.13	18.15	18.34	18.34	18.36	0	0	0	0	0	0	0	0
16	Riverdale Park East	18.2	0	18.08	18.09	18.12	18.14	18.31	18.3	18.3	0	0	0	0	0	0	0	0
18	Riverdale Park East	18.16	0	18.08	18.09	18.12	18.14	18.31	18.3	18.3	0	0	0	0	0	0	0	0
20	Riverdale Park East	18.24	0	17.78	0.00	18.02	18.03	18.04	18.09	18.21	0	0	0	0	0	0	0	0
22	Riverdale Park East	18.38	0	17.78	0.00	18.02	18.03	17.87	18.09	18.21	0	0	0	0	0	0	0	0
15	Riverdale Park East	19.94	0	19.87	19.93	19.64	19.88	19.94	19.94	19.95	0	0	0	0	0	0	0	0
17	Riverdale Park East	19.97	0	19.87	19.93	19.64	19.88	19.94	19.94	19.95	0	0	0	0	0	0	0	0
19	Riverdale Park East	19.5	0	19.34	19.38	19.35	19.64	19.35	19.36	19.37	0	0	0	0	0	0	0	0
21	Riverdale Park East	19.58	0	19.34	19.34	19.35	19.64	19.35	19.36	19.37	0	0	0	0	0	0	0	0
23	Riverdale Park East	19.29	0	19.16	19.17	19.19	19.20	19.19	19.21	19.23	0	0	0	0	0	0	0	0
25	Riverdale Park East	19.2	0	19.16	19.17	19.19	19.20	19.19	19.21	19.23	0	0	0	0	0	0	0	0
27	Riverdale Park East	19.06	0	19.01	19.02	18.92	19.04	18.99	19.08	19.08	0	0	0	0	0	0	0	0
29	Riverdale Park East	19.07	0	19.01	19.02	18.92	19.04	18.93	19.08	19.04	0	0	0	0	0	0	0	0
31	Riverdale Park East	18.88	0	18.71	18.71	18.72	18.72	18.75	18.79	18.85	0	0	0	0	0	0	0	0
28	Slievebann Drive	26.39	0	0	0	26.43	25.80	26.28	26.44	26.46	0	0	0	0	0	0	0	0
26	Slievebann Drive	26.39	0	0	0	25.80	25.80	26.29	26.44	26.46	0	0	0	0	0	0	0	0
24	Slievebann Drive	25.8	0	0	0	25.80	25.80	26.11	26.4	26.4	0	0	0	0	0	0	0	0
22	Slievebann Drive	25.8	0	0	0	25.80	25.50	25.55	25.55	25.8	0	0	0	0	0	0	0	0
20	Slievebann Drive	25.09	0	0	0	25.15	25.01	25.15	25.16	25.17	0	0	0	0	0	0	0	0
18	Slievebann Drive	25.09	0	0	0	25.15	25.01	25.15	25.16	25.17	0	0	0	0	0	0	0	0
16	Slievebann Drive	25.13	0	0	0	24.95	25.01	25.02	24.84	25.03	0	0	0	0	0	0	0	0
14	Slievebann Drive	25.13	0	0	0	24.95	25.01	25.02	24.84	25.03	0	0	0	0	0	0	0	0
12	Slievebann Drive	24.66	0	24.57	24.43	24.45	24.47	24.64	24.50	24.69	0	0	0	0	0	0	0	0
10	Slievebann Drive	24.66	0	24.57	24.43	24.45	24.47	24.64	24.50	24.69	0	0	0	0	0	0	0	0
8	Slievebann Drive	24.51	0	24.39	24.43	24.45	24.59	24.61	24.50	24.6	0	0	0	0	0	0	0	0
6	Slievebann Drive	24.51	0	24.39	24.43	24.45	24.59	24.61	24.50	24.6	0	0	0	0	0	0	0	0
4	Slievebann Drive	24.57	0	24.39	24.39	24.40	24.04	24.61	24.63	24.6	0	0	0	0	0	0	0	0
2	Slievebann Drive	24.69	0	24.39	24.39	24.40	24.04	24.61	24.63	24.6	0	0	0	0	0	0	0	0
2	Slievegallion Drive	23.96	0	23.99	24.02	24.07	24.10	24.12	24.14	24.18	0	0	0	0	0	0	0	0
4	Slievegallion Drive	23.96	0	23.99	24.02	24.07	24.10	24.12	24.14	24.18	0	0	0	0	0	0	0	0

Residential Flood Depths – Do Minimum Scenario

No	Street Name	Threshold Level	Remedial Option 1				Remedial Option 2A				Remedial Option 2B			
			Flood Water level		Depths		Flood Water level		Depths		Flood Water level		Depths	
			Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000
2	Riverdale Park East	19.61	0	19.29	0	0	0	20.09	0	0.48	19.3	19.32	0	-0.29
4	Riverdale Park East	19.69	0	19.29	0	0	0	20.09	0	0.4	19.3	19.32	0	0
6	Riverdale Park East	19.42	0	18.91	0	0	18.96	19.01	0	0	19.11	19.12	0	0
8	Riverdale Park East	19.75	18.86	18.91	0	0	18.96	19.01	0	0	19.11	19.12	0	0
10	Riverdale Park East	18.82	18.69	18.74	-0.13	-0.08	18.84	18.9	0.02	0.08	18.68	18.74	-0.14	-0.08
12	Riverdale Park East	18.14	18.15	18.28	0.01	0.14	18.31	18.42	0.17	0.28	18.29	18.49	0.15	0.35
14	Riverdale Park East	18.15	18.15	18.28	0	0.13	18.31	18.42	0.16	0.27	18.29	18.49	0.14	0.34
16	Riverdale Park East	18.2	18.27	18.39	0.07	0.19	18.31	18.37	0.11	0.17	18.14	18.42	-0.06	0.22
18	Riverdale Park East	18.16	18.27	18.39	0.11	0.23	18.31	18.37	0.15	0.21	18.14	18.42	-0.02	0.26
20	Riverdale Park East	18.24	18.03	18.1	-0.21	-0.14	18.02	18.35	-0.22	0.11	18.06	18.17	-0.18	-0.07
22	Riverdale Park East	18.38	0	17.95	0	0	0	0	0	0	0	18.17	0	-0.21
15	Riverdale Park East	19.94	0	19.75	0	-0.19	0	19.88	0	-0.06	19.64	19.66	0	-0.28
17	Riverdale Park East	19.97	0	19.75	0	-0.22	0	19.88	0	-0.09	19.64	19.66	0	0
19	Riverdale Park East	19.5	0	19.36	0	-0.14	0	19.26	0	-0.24	19.37	19.39	-0.13	-0.11
21	Riverdale Park East	19.58	0	19.36	0	-0.22	19.21	19.26	0	0	19.37	19.39	-0.21	-0.19
23	Riverdale Park East	19.29	0	19.19	0	-0.1	19.12	19.22	-0.17	-0.07	19.21	19.3	-0.08	0.01
25	Riverdale Park East	19.2	19.1	19.19	-0.1	-0.01	19.21	19.23	0.01	0.03	19.21	19.3	0.01	0.1
27	Riverdale Park East	19.06	18.96	19.01	-0.1	-0.05	19.21	19.15	0.15	0.09	18.87	19.01	-0.19	-0.05
29	Riverdale Park East	19.07	18.93	19.01	-0.14	-0.06	19.17	19.18	0.1	0.11	18.87	19.01	-0.2	-0.06
31	Riverdale Park East	18.88	18.77	18.84	-0.11	-0.04	18.66	18.7	-0.22	-0.18	18.77	18.86	-0.11	-0.02
28	Slievebann Drive	26.39	0	0	0	0	0	0	0	0	0	0	0	0
26	Slievebann Drive	26.39	0	0	0	0	0	0	0	0	0	0	0	0
24	Slievebann Drive	25.8	0	0	0	0	0	0	0	0	0	0	0	0
22	Slievebann Drive	25.8	0	0	0	0	0	0	0	0	0	0	0	0
20	Slievebann Drive	25.09	0	0	0	0	0	0	0	0	0	0	0	0
18	Slievebann Drive	25.09	0	0	0	0	0	0	0	0	0	0	0	0
16	Slievebann Drive	25.13	0	0	0	0	0	0	0	0	0	0	0	0
14	Slievebann Drive	25.13	0	0	0	0	0	0	0	0	0	0	0	0
12	Slievebann Drive	24.66	0	24.6	0	-0.06	0	24.86	0	0.2	0	0	0	0
10	Slievebann Drive	24.66	0	24.6	0	-0.06	0	24.86	0	0.2	0	0	0	0
8	Slievebann Drive	24.51	0	24.59	0	0.08	0	24.32	0	-0.19	0	0	0	0
6	Slievebann Drive	24.51	0	24.59	0	0.08	0	24.32	0	-0.19	0	0	0	0
4	Slievebann Drive	24.57	0	24.23	0	0	0	24.27	0	0	0	0	0	0
2	Slievebann Drive	24.69	0	24.23	0	0	0	24.27	0	0	0	0	0	0
2	Slievegallion Drive	23.96	0	23.83	0	-0.13	0	24.28	0	0.32	0	0	0	0
4	Slievegallion Drive	23.96	0	23.83	0	-0.13	0	24.28	0	0.32	0	0	0	0

Residential Flood Depths – Remedial Option 1, 2A & 2B

No	Street Name	Thres hold Level	Remedial Option 3A				Remedial Option 3B				Remedial Option 4				Remedial Option 5			
			Flood Water level		Depths		Flood Water level		Depths		Flood Water level		Depths		Flood Water level		Depths	
			Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000
2	Riverdale Park East	19.61	20.05	20.06	0.44	0.45	19.51	19.51	-0.1	-0.1	19.3	19.5	0	-0.11	19.3	19.5	0	-0.11
4	Riverdale Park East	19.69	20.05	20.06	0.36	0.37	19.51	19.51	-0.18	-0.18	19.3	19.5	0	-0.19	19.3	19.5	0	-0.19
6	Riverdale Park East	19.42	19.85	19.93	0.43	0.51	18.88	19.12	0	0	19.12	19.13	0	-0.29	19.11	19.13	0	-0.29
8	Riverdale Park East	19.75	19.85	19.93	0.1	0.18	18.88	19.12	0	0	19.12	19.13	0	0	19.11	19.13	0	0
10	Riverdale Park East	18.82	18.7	18.74	-0.12	-0.08	18.7	18.75	-0.12	-0.07	18.68	18.73	-0.14	-0.09	18.69	18.76	-0.13	-0.06
12	Riverdale Park East	18.14	18.22	18.32	0.08	0.18	18.4	18.54	0.26	0.4	18.29	18.48	0.15	0.34	18.33	18.52	0.19	0.38
14	Riverdale Park East	18.15	18.22	18.32	0.07	0.17	18.4	18.54	0.25	0.39	18.29	18.48	0.14	0.33	18.33	18.52	0.18	0.37
16	Riverdale Park East	18.2	18.35	18.49	0.15	0.29	18.34	18.48	0.14	0.28	18.2	18.45	0	0.25	18.29	18.47	0.09	0.27
18	Riverdale Park East	18.16	18.35	18.49	0.19	0.33	18.34	18.48	0.18	0.32	18.2	18.45	0.04	0.29	18.29	18.47	0.13	0.31
20	Riverdale Park East	18.24	18.3	18.43	0.06	0.19	18.29	18.43	0.05	0.19	18.06	18.17	-0.18	-0.07	18.04	18.42	-0.2	0.18
22	Riverdale Park East	18.38	17.9	18.08	0	0	18.29	18.43	-0.09	0.05	0	18.17	0	-0.21	17.87	18.2	0	-0.18
15	Riverdale Park East	19.94	19.64	19.66	0	-0.28	19.64	19.66	0	-0.28	19.64	20.02	0	0.08	19.65	19.68	-0.29	-0.26
17	Riverdale Park East	19.97	19.64	19.66	0	0	19.64	19.66	0	0	19.64	20.02	0	0.05	19.68	19.68	-0.29	-0.29
19	Riverdale Park East	19.5	19.33	19.36	-0.17	-0.14	19.38	19.39	-0.12	-0.11	19.37	19.4	-0.13	-0.1	19.38	19.41	-0.12	-0.09
21	Riverdale Park East	19.58	19.33	19.36	-0.25	-0.22	19.38	19.39	-0.2	-0.19	19.37	19.4	-0.21	-0.18	19.38	19.41	-0.2	-0.17
23	Riverdale Park East	19.29	19.05	19.31	-0.24	0.02	19.22	19.3	-0.07	0.01	19.21	19.31	-0.08	0.02	19.24	19.34	-0.05	0.05
25	Riverdale Park East	19.2	19.05	19.31	-0.15	0.11	19.22	19.3	0.02	0.1	19.21	19.31	0.01	0.11	19.24	19.34	0.04	0.14
27	Riverdale Park East	19.06	18.85	19.03	-0.21	-0.03	19.01	19.03	-0.05	-0.03	18.99	19.08	-0.07	0.02	18.95	19.03	-0.11	-0.03
29	Riverdale Park East	19.07	18.85	19.03	-0.22	-0.04	19.01	19.03	-0.06	-0.04	18.99	19.08	-0.08	0.01	18.95	19.03	-0.12	-0.04
31	Riverdale Park East	18.88	18.81	18.86	-0.07	-0.02	18.813	18.86	0.067	-0.02	18.77	18.85	-0.11	-0.03	18.79	18.86	-0.09	-0.02
28	Slieuebann Drive	26.39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Slieuebann Drive	26.39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Slieuebann Drive	25.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Slieuebann Drive	25.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	Slieuebann Drive	25.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Slieuebann Drive	25.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Slieuebann Drive	25.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	Slieuebann Drive	25.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Slieuebann Drive	24.66	0	0	0	0	0	0	0	0	0	24.61	0	-0.05	0	0	0	0
10	Slieuebann Drive	24.66	0	0	0	0	0	0	0	0	24.53	24.61	-0.13	-0.05	0	0	0	0
8	Slieuebann Drive	24.51	0	0	0	0	0	0	0	0	24.53	24.59	0.02	0.08	0	0	0	0
6	Slieuebann Drive	24.51	0	0	0	0	0	0	0	0	24.53	24.59	0.02	0.08	0	0	0	0
4	Slieuebann Drive	24.57	0	0	0	0	0	0	0	0	24.32	24.4	-0.25	-0.17	0	0	0	0
2	Slieuebann Drive	24.69	0	0	0	0	0	0	0	0	23.99	24.4	0	-0.29	0	0	0	0
2	Slievegallion Drive	23.96	23.54	23.65	0	0	23.76	23.78	-0.2	-0.18	23.8	24.06	-0.16	0.1	0	0	0	0
4	Slievegallion Drive	23.96	23.54	23.65	0	0	23.76	23.78	-0.2	-0.18	23.8	24.06	-0.16	0.1	0	0	0	0

Residential Flood Depths – Remedial Option 3A, 3B, 4 & 5

No	Street Name	Threshold Level	Flood Water Levels								Depths							
			Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
1	Riverdale Park East	20.23	0	0	0.00	20.05	20.05	20.01	20.05	20.25	0	0	0	-0.18	-0.18	-0.22	-0.18	0.02
3	Riverdale Park East	20.23	0	0	0.00	20.05	20.05	20.01	20.05	20.25	0	0	0	-0.18	-0.18	-0.22	-0.18	0.02
5	Riverdale Park East	20.23	0	0	0.00	20.05	20.05	20.01	20.05	20.25	0	0	0	-0.18	-0.18	-0.22	-0.18	0.02
7	Riverdale Park East	20.23	0	0	0.00	20.05	20.05	20.01	20.05	20.25	0	0	0	-0.18	-0.18	-0.22	-0.18	0.02
134	Andersonstown Rd	22.1	0	0	0	0.00	0.00	0	0	21.82	0	0	0	0	0	0	0	-0.28
136	Andersonstown Rd	22.1	0	0	0	0.00	0.00	0	0	21.82	0	0	0	0	0	0	0	-0.28
138	Andersonstown Rd	22.1	0	0	0	0.00	0.00	0	0	21.86	0	0	0	0	0	0	0	-0.24
140	Andersonstown Rd	22.15	0	0	0	0.00	0.00	0	0	21.86	0	0	0	0	0	0	0	-0.29
142	Andersonstown Rd	22.15	0	0	0	0.00	0.00	0	0	20.2	0	0	0	0	0	0	0	0
144	Andersonstown Rd	22.19	0	0	0	0.00	0.00	0	0	20.2	0	0	0	0	0	0	0	0
146	Andersonstown Rd	22.18	0	0	0	0.00	0.00	0	0	19.92	0	0	0	0	0	0	0	0
148	Andersonstown Rd	22.21	0	0	0	0.00	0.00	0	0	19.92	0	0	0	0	0	0	0	0
150	Andersonstown Rd	22.21	0	0	0	0.00	0.00	0	0	19.93	0	0	0	0	0	0	0	0
152	Andersonstown Rd	22.21	0	0	0	0.00	0.00	0	0	19.93	0	0	0	0	0	0	0	0
154	Andersonstown Rd	21.93	0	0	0	0.00	0.00	0	0	20.21	0	0	0	0	0	0	0	0
Parish Hall	Andersonstown Rd	19.69	0	0	0	0.00	0.00	0	0	19.93	0	0	0	0	0	0	0	0.24
151 Unit A	Andersonstown Rd	23.06	0	23.18	23.22	23.24	23.25	23.1	23.27	23.49	0	0.12	0.16	0.18	0.19	0.04	0.21	0.43
151 Unit B	Andersonstown Rd	23.26	0	23.18	23.22	23.24	23.25	23.24	23.27	23.49	0	-0.08	-0.04	-0.02	-0.01	-0.02	0.01	0.23
151 Unit C	Andersonstown Rd	23.36	0	23.18	23.22	23.24	23.25	23.24	23.27	23.49	0	-0.18	-0.14	-0.12	-0.11	-0.12	-0.09	0.13
151 Unit D	Andersonstown Rd	23.01	0	23.18	23.22	23.44	23.45	23.47	23.49	23.49	0	0.17	0.21	0.43	0.44	0.46	0.48	0.48
157	Andersonstown Rd	25.13	0	24.15	24.18	24.26	24.30	24.31	24.36	23.55	0	0	0	0	0	0	0	0
162	Andersonstown Rd	23.11	0	0	0.00	0.00	0.00	22.89	22.9	22.95	0	0	0	0	0	-0.22	-0.21	-0.16
164	Andersonstown Rd	23.05	0	0	0.00	0.00	0.00	22.89	22.9	22.95	0	0	0	0	0	-0.16	-0.15	-0.1
166	Andersonstown Rd	23.12	0	0	22.89	22.90	22.91	22.9	22.9	22.95	0	0	-0.23	-0.22	-0.21	-0.22	-0.22	-0.17
168	Andersonstown Rd	23.14	0	22.88	22.89	22.90	22.91	22.92	22.94	22.98	0	-0.26	-0.25	-0.24	-0.23	-0.22	-0.2	-0.16
170	Andersonstown Rd	23.14	0	22.88	22.89	22.90	22.91	22.92	22.94	22.98	0	-0.26	-0.25	-0.24	-0.23	-0.22	-0.2	-0.16
172	Andersonstown Rd	23.13	0	22.88	22.89	22.90	22.91	22.92	22.94	22.98	0	-0.25	-0.24	-0.23	-0.22	-0.21	-0.19	-0.15
174	Andersonstown Rd	23.02	0	22.88	22.90	22.91	22.92	22.93	22.94	22.98	0	-0.14	-0.12	-0.11	-0.1	-0.09	-0.08	-0.04
176	Andersonstown Rd	23.58	0	0	22.90	22.91	22.92	22.93	22.94	22.98	0	0	0	0	0	0	0	0
178	Andersonstown Rd	23.43	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
180	Andersonstown Rd	23.81	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
182	Andersonstown Rd	23.81	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
184	Andersonstown Rd	23.96	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
186	Andersonstown Rd	24.03	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
156	Andersonstown Rd	26	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
158	Andersonstown Rd	26	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
160	Andersonstown Rd	26	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0

Non-Residential Flood Depths – Do Nothing

Property No	Street Name	Threshold Level	Water Levels								Depths							
			Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
1	Riverdale Park East	20.23	0	0	0.00	20.05	20.05	20.01	20.05	20.25	0	0	0	0	0	0	0	0
3	Riverdale Park East	20.23	0	0	0.00	20.05	20.05	20.01	20.05	20.25	0	0	0	0	0	0	0	0
5	Riverdale Park East	20.23	0	0	0.00	20.05	20.05	20.01	20.05	20.25	0	0	0	0	0	0	0	0
7	Riverdale Park East	20.23	0	0	0.00	20.05	20.05	20.01	20.05	20.25	0	0	0	0	0	0	0	0
134	Andersonstown Rd	22.1	0	0	0	0.00	0.00	0	0	21.82	0	0	0	0	0	0	0	0
136	Andersonstown Rd	22.1	0	0	0	0.00	0.00	0	0	21.82	0	0	0	0	0	0	0	0
138	Andersonstown Rd	22.1	0	0	0	0.00	0.00	0	0	21.86	0	0	0	0	0	0	0	0
140	Andersonstown Rd	22.15	0	0	0	0.00	0.00	0	0	21.86	0	0	0	0	0	0	0	0
142	Andersonstown Rd	22.15	0	0	0	0.00	0.00	0	0	20.2	0	0	0	0	0	0	0	0
144	Andersonstown Rd	22.19	0	0	0	0.00	0.00	0	0	20.2	0	0	0	0	0	0	0	0
146	Andersonstown Rd	22.18	0	0	0	0.00	0.00	0	0	19.92	0	0	0	0	0	0	0	0
148	Andersonstown Rd	22.21	0	0	0	0.00	0.00	0	0	19.92	0	0	0	0	0	0	0	0
150	Andersonstown Rd	22.21	0	0	0	0.00	0.00	0	0	19.93	0	0	0	0	0	0	0	0
152	Andersonstown Rd	22.21	0	0	0	0.00	0.00	0	0	19.93	0	0	0	0	0	0	0	0
154	Andersonstown Rd	21.93	0	0	0	0.00	0.00	0	0	20.21	0	0	0	0	0	0	0	0
Parish Hall	Andersonstown Rd	19.69	0	0	0	0.00	0.00	0	0	19.93	0	0	0	0	0	0	0	0
151 Unit A	Andersonstown Rd	23.06	0	23.18	23.22	23.24	23.25	23.1	23.27	23.49	0	0	0	0	0	0	0	0
151 Unit B	Andersonstown Rd	23.26	0	23.18	23.22	23.24	23.25	23.24	23.27	23.49	0	0	0	0	0	0	0	0
151 Unit C	Andersonstown Rd	23.36	0	23.18	23.22	23.24	23.25	23.24	23.27	23.49	0	0	0	0	0	0	0	0
151 Unit D	Andersonstown Rd	23.01	0	23.18	23.22	23.44	23.45	23.47	23.49	23.49	0	0	0	0	0	0	0	0
157	Andersonstown Rd	25.13	0	24.15	24.18	24.26	24.30	24.31	24.36	23.55	0	0	0	0	0	0	0	0
162	Andersonstown Rd	23.11	0	0	0.00	0.00	0.00	22.89	22.9	22.95	0	0	0	0	0	0	0	0
164	Andersonstown Rd	23.05	0	0	0.00	0.00	0.00	22.89	22.9	22.95	0	0	0	0	0	0	0	0
166	Andersonstown Rd	23.12	0	0	22.89	22.90	22.91	22.9	22.9	22.95	0	0	0	0	0	0	0	0
168	Andersonstown Rd	23.14	0	22.88	22.89	22.90	22.91	22.92	22.94	22.98	0	0	0	0	0	0	0	0
170	Andersonstown Rd	23.14	0	22.88	22.89	22.90	22.91	22.92	22.94	22.98	0	0	0	0	0	0	0	0
172	Andersonstown Rd	23.13	0	22.88	22.89	22.90	22.91	22.92	22.94	22.98	0	0	0	0	0	0	0	0
174	Andersonstown Rd	23.02	0	22.88	22.90	22.91	22.92	22.93	22.94	22.98	0	0	0	0	0	0	0	0
176	Andersonstown Rd	23.58	0	0	22.90	22.91	22.92	22.93	22.94	22.98	0	0	0	0	0	0	0	0
178	Andersonstown Rd	23.43	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
180	Andersonstown Rd	23.81	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
182	Andersonstown Rd	23.81	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
184	Andersonstown Rd	23.96	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
186	Andersonstown Rd	24.03	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
156	Andersonstown Rd	26	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
158	Andersonstown Rd	26	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0
160	Andersonstown Rd	26	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0

Non-Residential Flood Depths – Do Minimum

Property No	Street Name	Threshold Level	Remedial Option 1				Remedial Option 2A				Remedial Option 2B			
			Flood Water level		Depths		Flood Water level		Depths		Flood Water level		Depths	
			Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000
1	Riverdale Park East	20.23	0	0	0	0	0	0	0	0	20.01	20.26	-0.22	0.03
3	Riverdale Park East	20.23	0	0	0	0	0	0	0	0	20.01	20.26	-0.22	0.03
5	Riverdale Park East	20.23	0	0	0	0	0	0	0	0	20.01	20.26	-0.22	0.03
7	Riverdale Park East	20.23	0	0	0	0	0	0	0	0	20.01	20.26	-0.22	0.03
134	Andersonstown Rd	22.1	0	21.8	0	0	0	21.86	0	-0.24	0	21.98	0	-0.12
136	Andersonstown Rd	22.1	0	21.8	0	0	0	21.8	0	0	0	21.98	0	-0.12
138	Andersonstown Rd	22.1	0	21.8	0	0	0	21.8	0	0	0	21.98	0	-0.12
140	Andersonstown Rd	22.15	0	21.97	0	-0.18	0	22	0	-0.15	0	21.71	0	0
142	Andersonstown Rd	22.15	0	21.97	0	-0.18	0	22	0	-0.15	0	21.71	0	0
144	Andersonstown Rd	22.19	0	21.97	0	-0.22	0	0	0	0	0	21.71	0	0
146	Andersonstown Rd	22.18	0	0	0	0	0	0	0	0	0	19.93	0	0
148	Andersonstown Rd	22.21	0	0	0	0	0	0	0	0	0	19.93	0	0
150	Andersonstown Rd	22.21	0	0	0	0	0	0	0	0	0	19.93	0	0
152	Andersonstown Rd	22.21	0	0	0	0	0	0	0	0	0	19.93	0	0
154	Andersonstown Rd	21.93	0	0	0	0	0	0	0	0	0	21.49	0	0
Parish Hall	Andersonstown Rd	19.69	0	19.92	0	0.23	0	20.25	0	0.56	0	19.93	0	0.24
151 Unit A	Andersonstown Rd	23.06	0	23.01	0	-0.05	0	22.95	0	-0.11	23.09	23.13	0.03	0.07
151 Unit B	Andersonstown Rd	23.26	0	23.17	0	-0.09	0	22.94	0	0	23.24	23.32	-0.02	0.06
151 Unit C	Andersonstown Rd	23.36	0	23.17	0	-0.19	0	23.04	0	0	23.46	23.32	0.1	-0.04
151 Unit D	Andersonstown Rd	23.01	0	23.17	0	0.16	0	24.06	0	1.05	23.46	23.59	0.45	0.58
157	Andersonstown Rd	25.13	0	0	0	0	0	0	0	0	24.39	24.7	0	0
162	Andersonstown Rd	23.11	0	0	0	0	0	0	0	0	21.38	22.97	0	-0.14
164	Andersonstown Rd	23.05	0	0	0	0	0	0	0	0	21.38	22.97	0	-0.08
166	Andersonstown Rd	23.12	0	22.75	0	0	0	0	0	0	22.92	22.97	-0.2	-0.15
168	Andersonstown Rd	23.14	0	22.75	0	0	0	0	0	0	22.92	22.97	-0.22	-0.17
170	Andersonstown Rd	23.14	0	22.89	0	-0.25	0	0	0	0	22.92	23.05	-0.22	-0.09
172	Andersonstown Rd	23.13	0	22.79	0	0	0	0	0	0	22.93	23.05	-0.2	-0.08
174	Andersonstown Rd	23.02	0	22.79	0	-0.23	0	22.31	0	0	22.93	23.37	-0.09	0.35
176	Andersonstown Rd	23.58	0	0	0	0	0	22.92	0	0	23.13	23.37	0	-0.21
178	Andersonstown Rd	23.43	0	0	0	0	0	22.92	0	0	23.13	23.56	0	0.13
180	Andersonstown Rd	23.81	0	0	0	0	0	22.9	0	0	23.13	23.56	0	-0.25
182	Andersonstown Rd	23.81	0	0	0	0	0	22.9	0	0	23.91	23.56	0.1	-0.25
184	Andersonstown Rd	23.96	0	0	0	0	0	22.65	0	0	23.91	23.93	-0.05	-0.03
186	Andersonstown Rd	24.03	0	0	0	0	0	0	0	0	23.91	23.93	-0.12	-0.1
156	Andersonstown Rd	26	0	20.3	0	0	0	19.95	0	0	0	0	0	0
158	Andersonstown Rd	26	0	20.3	0	0	0	19.95	0	0	0	0	0	0
160	Andersonstown Rd	26	0	20.3	0	0	0	19.95	0	0	0	0	0	0

Non-Residential Flood Depths – Remedial Options 1, 2A & 2B

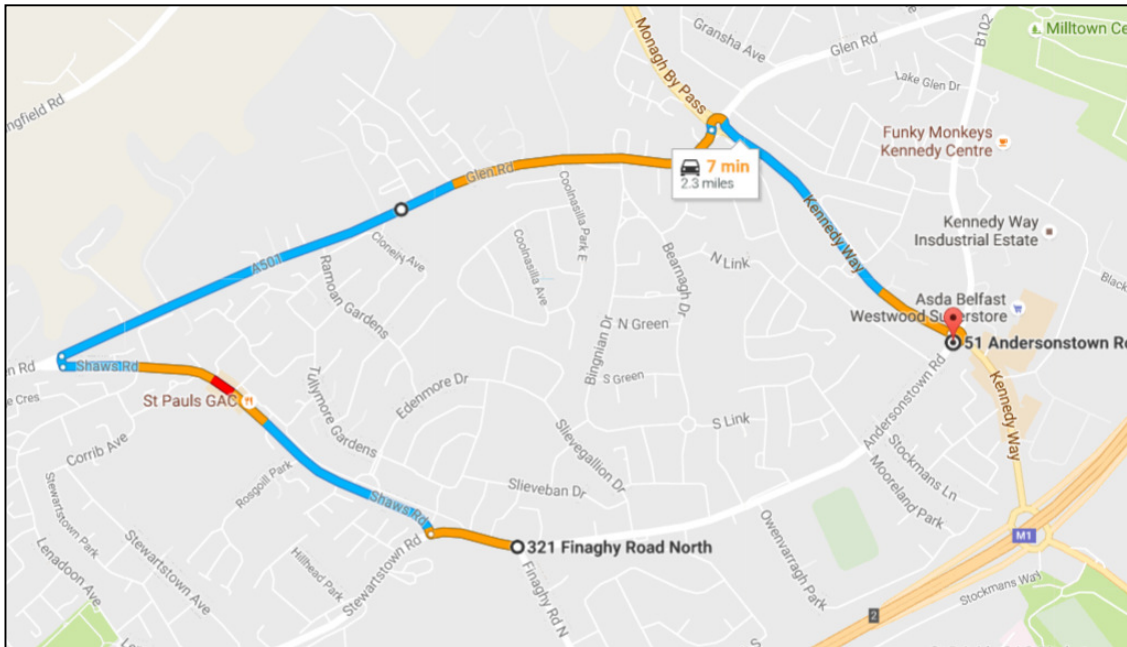
No	Street Name	Thres hold Level	Remedial Option 3A				Remedial Option 3B				Remedial Option 4				Remedial Option 5			
			Flood Water level		Depths		Flood Water level		Depths		Flood Water level		Depths		Flood Water level		Depths	
			Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000	Q200	Q1000
1	Riverdale Park E	20.23	20.25	20.26	0.02	0.03	20.63	20.26	0.4	0.03	20.01	20.26	-0.216	0.03	20.08	20.25	-0.15	0.02
3	Riverdale Park E	20.23	20.25	20.26	0.02	0.03	20.63	20.26	0.4	0.03	20.01	20.26	-0.216	0.03	20.08	20.25	-0.15	0.02
5	Riverdale Park E	20.23	20.25	20.26	0.02	0.03	20.63	20.26	0.4	0.03	20.01	20.26	-0.216	0.03	20.08	20.25	-0.15	0.02
7	Riverdale Park E	20.23	20.25	20.26	0.02	0.03	20.63	20.26	0.4	0.03	20.01	20.26	-0.216	0.03	20.08	20.25	-0.15	0.02
134	Andersonstown Rd	22.1	0	21.98	0	-0.12	0	21.98	0	-0.12	0	21.8	0	0	0	21.98	0	-0.12
136	Andersonstown Rd	22.1	0	21.98	0	-0.12	0	21.98	0	-0.12	0	21.8	0	0	0	21.98	0	-0.12
138	Andersonstown Rd	22.1	0	21.98	0	-0.12	0	21.98	0	-0.12	0	21.8	0	0	0	21.98	0	-0.12
140	Andersonstown Rd	22.15	0	19.93	0	0	0	22.01	0	-0.14	0	22.01	0	-0.14	0	22	0	-0.15
142	Andersonstown Rd	22.15	0	19.93	0	0	0	22.01	0	-0.14	0	22.01	0	-0.14	0	22	0	-0.15
144	Andersonstown Rd	22.19	0	19.93	0	0	0	22.01	0	-0.18	0	22.01	0	-0.18	0	22	0	-0.19
146	Andersonstown Rd	22.18	0	19.93	0	0	0	19.92	0	0	0	19.94	0	0	0	19.93	0	0
148	Andersonstown Rd	22.21	0	19.93	0	0	0	19.92	0	0	0	19.94	0	0	0	19.93	0	0
150	Andersonstown Rd	22.21	0	22.25	0	0.04	0	19.93	0	0	0	22.06	0	-0.15	0	19.93	0	0
152	Andersonstown Rd	22.21	0	22.25	0	0.04	0	19.93	0	0	0	22.06	0	-0.15	0	19.93	0	0
154	Andersonstown Rd	21.93	0	22.04	0	0.11	20.21	22.02	0	0.09	0	22.08	0	0.15	0	20.22	0	0
Parish Hall	Andersonstown Rd	19.69	18.97	19.93	0	0.24	18.96	19.92	0	0.23	0	19.94	0	0.25	0	19.93	0	0.24
151 Unit A	Andersonstown Rd	23.06	23.15	23.15	0.09	0.09	23.09	23.32	0.03	0.26	23.09	23.14	0.03	0.08	23.2	23.12	0.14	0.06
151 Unit B	Andersonstown Rd	23.26	23.8	23.15	0.54	-0.11	23.2	23.32	-0.06	0.06	23.24	23.38	-0.02	0.12	23.2	23.27	-0.06	0.01
151 Unit C	Andersonstown Rd	23.36	23.8	23.3	0.44	-0.06	23.24	23.56	-0.12	0.2	23.24	23.3	-0.12	-0.06	23.2	23.27	-0.16	-0.09
151 Unit D	Andersonstown Rd	23.01	23.74	23.64	0.73	0.63	23.45	23.56	0.44	0.55	23.46	23.65	0.45	0.64	23.38	23.51	0.37	0.5
157	Andersonstown Rd	25.13	23.54	23.65	0	0	24.72	24.75	0	0	24.09	24.71	0	0	24.4	24.71	0	0
162	Andersonstown Rd	23.11	22.68	22.92	0	-0.19	22.92	22.75	-0.19	0	0	23	0	-0.11	22.9	22.69	-0.21	0
164	Andersonstown Rd	23.05	22.68	22.92	0	-0.13	22.92	22.75	-0.13	0	0	23	0	-0.05	22.9	22.69	-0.15	0
166	Andersonstown Rd	23.12	22.68	23.08	0	-0.04	22.92	23.02	-0.2	-0.1	22.92	23	-0.2	-0.12	22.9	22.69	-0.22	0
168	Andersonstown Rd	23.14	22.68	23.08	0	-0.06	22.91	23.02	-0.23	-0.12	22.92	23	-0.22	-0.14	22.92	22.98	-0.22	-0.16
170	Andersonstown Rd	23.14	22.62	23.08	0	-0.06	22.91	23.02	-0.23	-0.12	22.92	23.06	-0.22	-0.08	22.92	22.98	-0.22	-0.16
172	Andersonstown Rd	23.13	22.62	23.08	0	-0.05	22.94	23.02	-0.19	-0.11	22.93	23.06	-0.2	-0.07	22.91	23	-0.22	-0.13
174	Andersonstown Rd	23.02	22.62	23.36	0	0.34	22.94	23.02	-0.08	0	22.93	23.06	-0.09	0.04	22.91	23	-0.11	-0.02
176	Andersonstown Rd	23.58	23.08	23.36	0	-0.22	23.36	23.4	-0.22	-0.18	23.42	23.38	-0.16	-0.2	23.36	23.39	-0.22	-0.19
178	Andersonstown Rd	23.43	23.88	23.89	0.45	0.46	23.53	23.19	0.1	-0.24	23.57	23.6	0.14	0.17	23.6	23.62	0.17	0.19
180	Andersonstown Rd	23.81	23.88	23.89	0.07	0.08	23.53	23.67	-0.28	-0.14	23.57	23.69	-0.24	-0.12	23.7	23.65	-0.11	-0.16
182	Andersonstown Rd	23.81	23.88	23.89	0.07	0.08	23.7	23.67	-0.11	-0.14	23.57	23.69	-0.24	-0.12	23.97	23.65	0.16	-0.16
184	Andersonstown Rd	23.96	23.88	23.89	-0.08	-0.07	23.9	23.94	-0.06	-0.02	23.67	23.93	-0.29	-0.03	23.97	23.99	0.01	0.03
186	Andersonstown Rd	24.03	23.88	23.89	-0.15	-0.14	23.9	23.94	-0.13	-0.09	23.91	23.93	-0.12	-0.1	23.97	23.99	-0.06	-0.04
156	Andersonstown Rd	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
158	Andersonstown Rd	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
160	Andersonstown Rd	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Non-Residential Flood Depths – Remedial Option 3A, 3B, 4 & 5

APPENDIX K

Contained within appendix k are details of the calculations undertaken to determine infrastructure damages and evacuation costs.

Infrastructure Damages



Diversion Route Map

Key Criteria

- Diversion route using Kennedy Way, Glen Road and Shaws Road.
- Start / End Points – Finaghy Rd North / Andersonstown Rd Junction, Kennedy Way / Andersonstown Rd Roundabout.
- Diversion Length – 3.54km
- Average Vehicles Per Hour – 1172 (Information supplied by Transport NI)
- Price per km - £ 0.39
- Retail Price Index – 1.0127
- Duration of Diversion

Base & Do Minimum Scenarios

- Q5 2.5 Hours
- Q10 2.5 Hours
- Q25 2.5 Hours
- Q50 3 Hours
- Q100 3.5 Hours
- Q200 3.5 Hours
- Q1000 3.5 Hours

All Remedial Options

- Q5 0 Hours
- Q10 0 Hours
- Q25 0 Hours
- Q50 0 Hours
- Q100 0 Hours
- Q200 3.5 Hours
- Q1000 3.5 Hours

Example Damage Calculation

Damage = Diversion Length x Avg Vehicles Per Hour x Price Per km x Diversion Duration X RPI Adjustment

'Do-Nothing' Scenario Q5 Damage = 3.54 x 1172 x 0.39 x 2.5 x 1.0127 = £ 4,096.53

Evacuation Costs

Max depth in house (cm)	Detached			Semi Detached			Terrace			Flat		
	Low	Mid	High	Low	Mid	High	Low	Mid	High	Low	Mid	High
0		1,007	1,631	609	865	1,419	588	838	1,387	532	782	1,330
10	1,308	1,928	3,126	1,169	1,653	2,714	1,126	1,600	2,652	1,018	1,491	2,540
20	2,511	3,662	5,954	2,232	3,108	5,126	2,146	3,002	5,001	1,928	2,781	4,776
30	2,694	3,928	6,387	2,394	3,334	5,499	2,302	3,221	5,364	2,069	2,984	5,123
60	3,625	5,269	8,575	3,216	4,458	7,363	3,090	4,303	7,179	2,772	3,980	6,850
100	4,342	6,299	10,256	3,848	5,320	8,793	3,696	5,134	8,572	3,312	4,744	8,175
100+	6,965	10,045	16,383	6,154	8,438	13,981	5,905	8,132	13,617	5,275	7,491	12,965

Source – MCM-Online Data and Techniques Chapter 4 Residential Properties

Max depth in house (cm)	% Evacuated	Duration (Weeks)
0	0.23	11
10	0.41	12
20	0.55	18
30	0.59	18
60	0.69	21
100	0.76	23
100+	0.87	33

Source – MCM-Online Data and Techniques Chapter 4 Residential Properties – Table 4.8

Example Evacuation Cost Calculation

Evacuation Cost = Cost of Evacuation x No. Of Properties x Percentage Evacuated X Duration of displacement

'Do-Nothing' Scenario Q5 Evacuation Cost = 865 x 21 x 0.23 x 11 = £ 45,967.87

Evacuation Costs – Properties Affected Do Nothing

	No. of dwellings affected							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
0	0	21	21	21	20	19	17	12
10	0	2	2	5	6	7	11	16
20	0	0	0	2	3	8	6	2
30	0	0	0	0	0	0	0	4
60	0	0	0	0	0	1	0	0
100	0	0	0	0	0	0	1	1
100+	0	0	0	0	0	0	0	0

Evacuation Costs – Do Nothing

	Evacuation Costs							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
0	£ -	£ 45,967.87	£45,967.87	£ 45,967.87	£ 43,778.93	£ 41,589.98	£ 37,212.09	£ 26,267.36
10	£ -	£ 16,265.15	£16,265.15	£ 40,662.88	£ 48,795.46	£ 56,928.04	£ 89,458.34	£130,121.23
20	£ -	£ -	£ -	£ 61,539.17	£ 92,308.75	£246,156.67	£184,617.50	£ 61,539.17
30	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£141,631.63
60	£ -	£ -	£ -	£ -	£ -	£ 64,594.34	£ -	£ -
100	£ -	£ -	£ -	£ -	£ -	£ -	£ 92,999.56	£ 92,999.56
100+	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Total	£ -	£ 62,233.03	£ 62,233.03	£ 148,169.92	£ 184,883.14	£ 409,269.02	£ 404,287.49	£ 452,558.94

Evacuation Costs – Option 1

	Evacuation Costs							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
0	£ -	£ -	£ -	£ -	£ -	£ -	£ 13,133.68	£ 32,834.20
10	£ -	£ -	£ -	£ -	£ -	£ -	£ 16,265.15	£ 16,265.15
20	£ -	£ -	£ -	£ -	£ -	£ -	£ 30,769.58	£ 92,308.75
30	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ 35,407.91
60	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
100	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
100+	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Total	£ -	£ -	£ -	£ -	£ -	£ -	£ 60,168.42	£ 176,816.01

Evacuation Costs – Option 2A

	Evacuation Costs							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
0	£ -	£ -	£ -	£ -	£ -	£ -	£ 6,566.84	£ 15,322.62
10	£ -	£ -	£ -	£ -	£ -	£ -	£ 16,265.15	£ 24,397.73
20	£ -	£ -	£ -	£ -	£ -	£ -	£ 184,617.50	£ 92,308.75
30	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£106,223.72
60	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£258,377.34
100	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
100+	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Total	£ -	£ -	£ -	£ -	£ -	£ -	£ 207,449.49	£ 496,630.17

Evacuation Costs – Option 2B

	Evacuation Costs							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
0	£ -	£ -	£ -	£ -	£ -	£ -	£ 19,700.52	£ 21,889.46
10	£ -	£ -	£ -	£ -	£ -	£ -	£ 8,132.58	£ 8,132.58
20	£ -	£ -	£ -	£ -	£ -	£ -	£ 61,539.17	£ -
30	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ 70,815.81
60	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ 129,188.67
100	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
100+	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Total	£ -	£ -	£ -	£ -	£ -	£ -	£ 89,372.26	£ 230,026.53

Evacuation Costs – Option 3A

	Evacuation Costs							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
0	£ -	£ -	£ -	£ -	£ -	£ -	£ 17,511.57	£ 15,322.62
10	£ -	£ -	£ -	£ -	£ -	£ -	£ 24,397.73	£ 8,132.58
20	£ -	£ -	£ -	£ -	£ -	£ -	£ 61,539.17	£123,078.33
30	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ 35,407.91
60	£ -	£ -	£ -	£ -	£ -	£ -	£193,783.01	£258,377.34
100	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
100+	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Total	£ -	£ -	£ -	£ -	£ -	£ -	£ 297,231.47	£ 440,318.78

Evacuation Costs – Option 3B

	Evacuation Costs							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
0	£ -	£ -	£ -	£ -	£ -	£ -	£ 26,267.36	£ 19,700.52
10	£ -	£ -	£ -	£ -	£ -	£ -	£ 8,132.58	£ 16,265.15
20	£ -	£ -	£ -	£ -	£ -	£ -	£ 61,539.17	£ 30,769.58
30	£ -	£ -	£ -	£ -	£ -	£ -	£ 70,815.81	£106,223.72
60	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
100	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
100+	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Total	£ -	£ -	£ -	£ -	£ -	£ -	£ 166,754.92	£ 172,958.98

Evacuation Costs – Option 4

	Evacuation Costs							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
0	£ -	£ -	£ -	£ -	£ -	£ -	£ 26,267.36	£ 28,456.30
10	£ -	£ -	£ -	£ -	£ -	£ -	£ 32,530.31	£ 73,193.19
20	£ -	£ -	£ -	£ -	£ -	£ -	£ 61,539.17	£ 92,308.75
30	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ 70,815.81
60	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£129,188.67
100	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
100+	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Total	£ -	£ -	£ -	£ -	£ -	£ -	£ 120,336.83	£ 393,962.73

Evacuation Costs – Option 5

	Evacuation Costs							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q1000
0	£ -	£ -	£ -	£ -	£ -	£ -	£ 19,700.52	£ 26,267.36
10	£ -	£ -	£ -	£ -	£ -	£ -	£ 16,265.15	£ 8,132.58
20	£ -	£ -	£ -	£ -	£ -	£ -	£ 92,308.75	£ 61,539.17
30	£ -	£ -	£ -	£ -	£ -	£ -	£ 35,407.91	£ 35,407.91
60	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£193,783.01
100	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
100+	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Total	£ -	£ -	£ -	£ -	£ -	£ -	£ 163,682.33	£ 325,130.01

APPENDIX L

Contained within appendix L are details of the calculations undertaken to determine the cost benefit of each option including maintenance costs.

Cost Benefit Summary

Project Summary Sheet										
Client/Authority	Rivers Agency				Prepared (date)	16.05.17				
Project name	Riverdale Park East				Printed	12/03/2018				
Project reference	Base date for estimates (year 0)				Prepared by	Ronan Devlin				
	Scaling factor (e.g. £m, £k, £)				Checked by	Craig Rankin				
	Year				Checked date	06/06/2017				
	Discount Rate									
	Optimism bias adjustment factor									
Costs and benefits of options										
	Costs and benefits £									
Option number	Option I	Option II	Option III	Option IV	Option V	Option VI	Option VII	Option VIII	Option IV	
Option name	Do-nothing	Do Minimum	Option 1	Option 2A	Option 2B	Option 3A	Option 3B	Option 4	Option 5	
COSTS:										
PV capital costs	0	257,913	619,042	712,585	647,524	598,129	597,197	3,040,704	812,961	
PV operation and maintenance costs	0	14,406	50,940	42,367	42,367	42,367	51,011	33,723	42,367	
Other Costs	0	0	2,577	2,967	2,696	2,490	2,486	12,660	3,385	
Optimism bias adjustment	0	90,269	371,425	427,551	388,514	358,877	358,318	1,824,422	487,777	
Total PV Costs £ excluding contributions	0	362,589	1,043,985	1,185,470	1,081,101	1,001,864	1,009,012	4,911,510	1,346,490	
BENEFITS:										
PV monetised flood damages	2,955,109	1,267,386	65,802	148,382	126,955	165,331	145,958	132,889	114,098	
PV monetised flood damages avoided		1,687,723	2,889,307	2,806,727	2,828,154	2,789,778	2,809,151	2,822,220	2,841,011	
Intangible Benefits		286,867	201,154	201,154	201,154	201,154	201,154	201,154	201,154	
Total PV benefits £		1,974,591	3,090,461	3,007,881	3,029,308	2,990,932	3,010,306	3,023,374	3,042,165	
DECISION-MAKING CRITERIA:										
Net Present Value NPV		1,612,002	2,046,476	1,822,411	1,948,207	1,989,068	2,001,294	-1,888,136	1,695,675	
Average benefit/cost ratio BCR		5.4	3.0	2.5	2.8	3.0	3.0	0.6	2.3	
Brief description of options:										
Option I	Do-nothing									
Option II	Do Minimum	Provide property level protection to Q1000 identified properties & continue maintenance								
Option III	Option 1	Culvert Renewal at Slieveban Drive, Slievegallion Drive and Riverdale Park East, RC wall at Riverdale Park East open channel								
Option IV	Option 2A	Culvert Renewal at Slieveban Drive and Slievegallion Drives only, RC wall at Riverdale Park East open channel								
Option V	Option 2B	Culvert Renewal at Slieveban Drive and Slievegallion Drives only, RC wall at Riverdale Park East open channel, hydraulic throttle at Andersonstown Shops open channel.								
Option VI	Option 3A	Culvert Renewal at Slieveban Drive and Slievegallion Drives only, RC wall and hydraulic throttle at Andersonstown Shops open channel.								
Option VII	Option 3B	Culvert Renewal at Slieveban Drive and Slievegallion Drives only, RC wall and hydraulic throttle at Andersonstown Shops open channel, RC Wall at Riverdale Park East open channel.								
Option VIII	Option 4	Culvert Renewal at Slieveban Drive and Slievegallion Drives only, hydraulic throttle at Andersonstown Shops open channel, RC Pre-cast 'Stormstore' in car park at Andersonstown Shops.								
Option IV	Option 5	Culvert Renewal at Slieveban Drive and Slievegallion Drives only, sheet piled storage tank and hydraulic throttle at Andersonstown Shops open channel.								

Summary Annualised Average Damage Calculation – Do Nothing Scenario

Summary Annual Average Damage										Sheet Nr.
Client/Authority										
DFI Rivers										
Project name										
Riverdale Park East										
Option:										
Do nothing										
Project reference										
Base date for estimates (year 0)	16.05.17	First year of damage:		0	Prepared (date)		16.05.17			
Scaling factor (e.g. £m, £k, £)	£	Last year of period:		99	Printed		06/06/2017			
	3.5% (0-30), 3.0% (30-75), 2.5% (75+)	PV factor for mid-year 0:		29.813	Prepared by		Ronan Devlin			
Discount rate					Checked by		Craig Rankin			
Applicable year (if time varying)					Checked date		06/06/2017			
Average waiting time (yrs) between events/frequency per year										Total PV
	2	5	10	25	50	100	200	1000	Infinity	£
	0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.001	0	
Damage category										
Damage £										
Residential property	0	40829.0259	40829.0259	82009.4587	105278.2666	213845.7828	219325.5025	274009.2771	287680.2	587646
Ind/commercial (direct)	0	23078.64647	24222.15693	57188.8332	57188.8332	60245.28333	64912.62859	144513.7652	164414	324549
Ind/comm (indirect)									0	0
Roads Infrastructure	0	4096.531507	4096.531507	4096.531507	4915.837808	5735.144109	5735.144109	5735.144109	5735.144	43844
Emergency services	0	3578.829653	3642.866238	7795.104347	9098.157589	15349.0997	15917.33534	23437.29037	25317.28	51083
Other (Vehicle, Evacuation)	0	156414.1273	156414.1273	242351.0243	279064.2381	503450.1211	498468.5944	546740.0419	558807.9	1947987
									0	0
									0	0
Total damage £	0	227997.1608	229204.7079	393440.9521	455545.3333	798625.4311	804359.2049	994435.5186	1041955	
Area (damagexfrequency)		34199.57	22860.09	18679.37	8489.86	6270.85	4007.46	3597.59	1018.20	
Total area, as above										99123.00
PV Factor, as above										29.813
Present value (assuming no change in damage or event frequency)										2955109
Notes										
Area calculations assume drop to zero at maximum frequency.										
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.										
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)										
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet										

Summary Annualised Average Damage Calculation – Do Minimum Scenario

Summary Annual Average Damage										Sheet Nr.
Client/Authority										
DFI Rivers										
Project name										
Riverdale Park East										
Project reference										
-										
Option:										
Do Minimum										
Base date for estimates (year 0) 16.05.17										
Scaling factor (e.g. £m, £k, £) £										
Discount rate 3.5% (0-30), 3.0% (30-75), 2.5% (75+)										
Applicable year (if time varying)										
First year of damage: 0										
Last year of period: 99										
Prepared (date) 16.05.17										
Printed 06/06/2017										
Prepared by Ronan Devlin										
Checked by Craig Rankin										
Checked date 06/06/2017										
Average waiting time (yrs) between events/frequency per year										Total PV
										£
2 5 10 25 50 100 200 1000 Infinity										
0.500 0.200 0.100 0.040 0.020 0.010 0.005 0.001 0										
Damage category										
Damage £										
Residential property	0	10207.25648	10207.26	20502.36	26319.57	53461.45	54831.38	68502.32	71920.06	146911
Ind/commercial (direct)	0	5769.661617	6055.539	14297.21	14297.21	15061.32	16228.16	36128.44	41103.51	81137
Ind/comm (indirect)									0	0
Roads Infrastructure	0	4096.531507	4096.532	4096.532	4915.838	5735.144	5735.144	5735.144	5735.144	43844
Emergency services	0	894.7074132	910.7166	1948.776	2274.539	3837.275	3979.334	5859.323	6329.32	12771
Other (Vehicle, Evacuation)	0	94181.1	94181.1	94181.1	94181.1	94181.1	94181.1	94181.1	94181.1	982722
									0	0
									0	0
Total damage £	0	115149.257	115451.1	135026	141988.3	172276.3	174955.1	210406.3	219269.1	
Area (damagexfrequency)		17272.39	11530.02	7514.31	2770.14	1571.32	868.08	770.72	214.84	
Total area, as above										
42511.83										
PV Factor, as above										
29.813										
Present value (assuming no change in damage or event frequency)										
1267386										
Notes										
Area calculations assume drop to zero at maximum frequency.										
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.										
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)										
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet										

Summary Annualised Average Damage Calculation – Remedial Option 1

Summary Annual Average Damage										Sheet Nr.
Client/Authority										
DFI Rivers										
Project name										
Riverdale Park East										
Project reference										
-										
Option:										
Option 1										
Base date for estimates (year 0)										
16.05.17										
Scaling factor (e.g. £m, £k, £)										
£										
3.5% (0-30), 3.0% (30-75), 2.5% (75+)										
Discount rate										
-										
Applicable year (if time varying)										
-										
First year of damage:										
0										
Last year of period:										
99										
PV factor for mid-year 0:										
29.813										
Prepared (date)										
16.05.17										
Printed										
06/06/2017										
Prepared by										
Ronan Devlin										
Checked by										
Craig Rankin										
Checked date										
06/06/2017										
Average waiting time (yrs) between events/frequency per year										Total PV
										£
2	5	10	25	50	100	200	1000	Infinity		
0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.001	0		
Damage category										
Damage £										
Residential property	0	0	0	0	0	0	49333.68	107600.4	122167.1	16459
Ind/commercial (direct)	0	0	0	0	0	0	0	53148.23	41103.51	4574
Ind/comm (indirect)									0	0
Roads Infrastructure	0	0	0	0	0	0	5735.144	5735.144	5735.144	1282
Emergency services	0	0	0	0	0	0	2762.686	9001.922	9143.152	1178
Other (Vehicle, Evacuation)	0	0	0	0	0	0	154349.5	270997.1	94181.1	42309
									0	0
									0	0
Total damage £	0	0	0	0	0	0	212181	446482.8	272330	
Area (damagexfrequency)		0.00	0.00	0.00	0.00	0.00	530.45	1317.33	359.41	
Total area, as above										
										2207.19
PV Factor, as above										
										29.813
Present value (assuming no change in damage or event frequency)										
										65802
Notes										
Area calculations assume drop to zero at maximum frequency.										
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.										
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)										
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet										

Summary Annualised Average Damage Calculation – Remedial Option 2A

Summary Annual Average Damage										Sheet Nr.
Client/Authority										
DFI Rivers										
Project name										
Riverdale Park East										
Project reference										
-										
Base date for estimates (year 0) 16.05.17										
Scaling factor (e.g. £m, £k, £) £										
3.5% (0-30), 3.0% (30-75), 2.5% (75+)										
Discount rate										
Applicable year (if time varying)										
Option: Option 2A										
First year of damage: 0										
Last year of period: 99										
Prepared (date) 16.05.17										
Printed 06/06/2017										
Prepared by Ronan Devlin										
Checked by Craig Rankin										
Checked date 06/06/2017										
Average waiting time (yrs) between events/frequency per year										Total PV
										£
Damage category										
Damage £										
Residential property	0	0	0	0	0	0	101615.3	197079.5	122167.1	30142
Ind/commercial (direct)	0	0	0	0	0	0	0	364900.8	41103.51	27809
Ind/comm (indirect)									0	0
Roads Infrastructure	0	0	0	0	0	0	5735.144	5735.144	5735.144	1282
Emergency services	0	0	0	0	0	0	5690.459	31470.9	9143.152	3245
Other (Vehicle, Evacuation)	0	0	0	0	0	0	301630.6	590811.3	94181.1	85904
									0	0
									0	0
Total damage £	0	0	0	0	0	0	414671.5	1189998	272330	
Area (damagexfrequency)		0.00	0.00	0.00	0.00	0.00	1036.68	3209.34	731.16	
Total area, as above										4977.18
PV Factor, as above										29.813
Present value (assuming no change in damage or event frequency)										148382
Notes										
Area calculations assume drop to zero at maximum frequency.										
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.										
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)										
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet										

Summary Annualised Average Damage Calculation – Remedial Option 2B

Summary Annual Average Damage										
Sheet Nr. 										
Client/Authority	DFI Rivers									
Project name	Riverdale Park East			Option: Option 2B						
Project reference	-									
Base date for estimates (year 0)	16.05.17			First year of damage:	0		Prepared (date)		16.05.17	
Scaling factor (e.g. £m, £k, £)	£			Last year of period:	99		Printed		06/06/2017	
Discount rate	3.5% (0-30), 3.0% (30-75), 2.5% (75+)			PV factor for mid-year 0:	29.813		Prepared by		Ronan Devlin	
Applicable year (if time varying)						Checked by		Craig Rankin		
						Checked date		06/06/2017		
Average waiting time (yrs) between events/frequency per year										
Damage £										
Damage category	2	5	10	25	50	100	200	1000	Infinity	Total PV £
	0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.001	0	
Residential property	0	0	0	0	0	0	45185.66	119324.4	122167.1	16776
Ind/commercial (direct)	0	0	0	0	0	0	61856.18	160641.1	41103.51	20884
Ind/comm (indirect)									0	0
Roads Infrastructure	0	0	0	0	0	0	5735.144	5735.144	5735.144	1282
Emergency services	0	0	0	0	0	0	5994.343	15678.07	9143.152	2109
Other (Vehicle, Evacuation)	0	0	0	0	0	0	301630.6	590811.3	94181.1	85904
									0	0
									0	0
Total damage £	0	0	0	0	0	0	420401.9	892190	272330	
Area (damagexfrequency)		0.00	0.00	0.00	0.00	0.00	1051.00	2625.18	582.26	
Total area, as above				4258.45						
PV Factor, as above				29.813						
Present value (assuming no change in damage or event frequency)				126955						126955
Notes										
Area calculations assume drop to zero at maximum frequency.										
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.										
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)										
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet										

Summary Annualised Average Damage Calculation – Remedial Option 3A

Summary Annual Average Damage										Sheet Nr.
Client/Authority										
DFI Rivers										
Project name										
Riverdale Park East										
Project reference										
-										
Option:										
Option 3A										
Base date for estimates (year 0) 16.05.17										
Scaling factor (e.g. £m, £k, £) £										
Discount rate 3.5% (0-30), 3.0% (30-75), 2.5% (75+)										
Applicable year (if time varying)										
First year of damage: 0 Prepared (date) 16.05.17										
Last year of period: 99 Printed 06/06/2017										
PV factor for mid-year 0: 29.813										
Prepared by Ronan Devlin										
Checked by Craig Rankin										
Checked date 06/06/2017										
Average waiting time (yrs) between events/frequency per year										Total PV
										£
2 5 10 25 50 100 200 1000 Infinity										
0.500 0.200 0.100 0.040 0.020 0.010 0.005 0.001 0										
Damage category										
Damage £										
Residential property	0	0	0	0	0	0	158288	220963	122167.1	39525
Ind/commercial (direct)	0	0	0	0	0	0	153252.2	178494.6	41103.51	34476
Ind/comm (indirect)									0	0
Roads Infrastructure	0	0	0	0	0	0	5735.144	5735.144	5735.144	1282
Emergency services	0	0	0	0	0	0	17446.25	22369.63	9143.152	4144
Other (Vehicle, Evacuation)	0	0	0	0	0	0	301630.6	590811.3	94181.1	85904
									0	0
									0	0
Total damage £	0	0	0	0	0	0	636352.2	1018374	272330	
Area (damagexfrequency)		0.00	0.00	0.00	0.00	0.00	1590.88	3309.45	645.35	
Total area, as above 5545.68										
PV Factor, as above 29.813										
Present value (assuming no change in damage or event frequency) 165331										
Notes										
Area calculations assume drop to zero at maximum frequency.										
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.										
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)										
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet										

Summary Annualised Average Damage Calculation – Remedial Option 3B

Summary Annual Average Damage										Sheet Nr.																				
Client/Authority																														
DFI Rivers																														
Project name																														
Riverdale Park East																														
Project reference																														
-																														
Option:																														
Option 3B																														
Base date for estimates (year 0) 16.05.17																														
Scaling factor (e.g. £m, £k, £) £																														
Discount rate 3.5% (0-30), 3.0% (30-75), 2.5% (75+)																														
Applicable year (if time varying)																														
First year of damage: 0																														
Last year of period: 99																														
Prepared (date) 16.05.17																														
Printed 06/06/2017																														
Prepared by Ronan Devlin																														
Checked by Craig Rankin																														
Checked date 06/06/2017																														
Average waiting time (yrs) between events/frequency per year										Total PV																				
										£																				
<table border="1"> <thead> <tr> <th>2</th> <th>5</th> <th>10</th> <th>25</th> <th>50</th> <th>100</th> <th>200</th> <th>1000</th> <th>Infinity</th> <th></th> </tr> </thead> <tbody> <tr> <td>0.500</td> <td>0.200</td> <td>0.100</td> <td>0.040</td> <td>0.020</td> <td>0.010</td> <td>0.005</td> <td>0.001</td> <td>0</td> <td></td> </tr> </tbody> </table>										2	5	10	25	50	100	200	1000	Infinity		0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.001	0		
2	5	10	25	50	100	200	1000	Infinity																						
0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.001	0																						
Damage category																														
Damage £																														
Residential property	0	0	0	0	0	0	96459.68	158751.9	122167.1	26594																				
Ind/commercial (direct)	0	0	0	0	0	0	112668.7	178896.7	41103.51	29061																				
Ind/comm (indirect)									0	0																				
Roads Infrastructure	0	0	0	0	0	0	5735.144	5735.144	5735.144	1282																				
Emergency services	0	0	0	0	0	0	11711.19	18908.32	9143.152	3117																				
Other (Vehicle, Evacuation)	0	0	0	0	0	0	301630.6	590811.3	94181.1	85904																				
									0	0																				
									0	0																				
Total damage £	0	0	0	0	0	0	528205.3	953103.3	272330																					
Area (damagexfrequency)		0.00	0.00	0.00	0.00	0.00	1320.51	2962.62	612.72																					
Total area, as above																														
4895.85																														
PV Factor, as above																														
29.813																														
Present value (assuming no change in damage or event frequency)																														
145958																														
Notes																														
Area calculations assume drop to zero at maximum frequency.																														
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.																														
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)																														
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet																														

Summary Annualised Average Damage Calculation – Remedial Option 4

Summary Annual Average Damage										Sheet Nr.
Client/Authority										
DFI Rivers										
Project name										
Riverdale Park East										
Project reference										
-										
Base date for estimates (year 0)										
16.05.17										
Scaling factor (e.g. £m, £k, £)										
£										
3.5% (0-30), 3.0% (30-75), 2.5% (75+)										
Discount rate										
-										
Applicable year (if time varying)										
-										
Option:										
Option 4										
First year of damage:										
0										
Prepared (date)										
16.05.17										
Last year of period:										
99										
Printed										
06/06/2017										
Prepared by										
Ronan Devlin										
Checked by										
Craig Rankin										
Checked date										
06/06/2017										
Average waiting time (yrs) between events/frequency per year										Total PV
										£
2 5 10 25 50 100 200 1000 Infinity										
0.500 0.200 0.100 0.040 0.020 0.010 0.005 0.001 0										
Damage category										
Damage £										
Residential property	0	0	0	0	0	0	62777.27	178551.2	122167.1	23551
Ind/commercial (direct)	0	0	0	0	0	0	57188.83	153543.1	41103.51	19729
Ind/comm (indirect)									0	0
Roads Infrastructure	0	0	0	0	0	0	5735.144	5735.144	5735.144	1282
Emergency services	0	0	0	0	0	0	6718.102	18597.28	9143.152	2424
Other (Vehicle, Evacuation)	0	0	0	0	0	0	301630.6	590811.3	94181.1	85904
									0	0
									0	0
Total damage £	0	0	0	0	0	0	434049.9	947237.9	272330	
Area (damagexfrequency)		0.00	0.00	0.00	0.00	0.00	1085.12	2762.58	609.78	
Total area, as above										
4457.48										
PV Factor, as above										
29.813										
Present value (assuming no change in damage or event frequency)										
132889										
132889										
Notes										
Area calculations assume drop to zero at maximum frequency.										
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.										
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)										
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet										

Summary Annualised Average Damage Calculation – Remedial Option 5

Summary Annual Average Damage										Sheet Nr.
Client/Authority										
DFI Rivers										
Project name										
Riverdale Park East										
Project reference										
-										
Option:										
Option 5										
First year of damage: 0 Prepared (date) 16.05.17										
Base date for estimates (year 0) 16.05.17										
Scaling factor (e.g. £m, £k, £) £ 99 Printed 06/06/2017										
Last year of period: 99										
Discount rate 3.5% (0-30), 3.0% (30-75), 2.5% (75+) PV factor for mid-year 0: 29.813 Prepared by Ronan Devlin										
Applicable year (if time varying) Checked by Craig Rankin										
Checked date 06/06/2017										
Average waiting time (yrs) between events/frequency per year										Total PV
										£
2 5 10 25 50 100 200 1000 Infinity										
0.500 0.200 0.100 0.040 0.020 0.010 0.005 0.001 0										
Damage category										
Damage £										
Residential property	0	0	0	0	0	0	71926	164544.5	122167.1	23734
Ind/commercial (direct)	0	0	0	0	0	0	60245.28	143841.7	41103.51	19416
Ind/comm (indirect)									0	0
Roads Infrastructure	0	0	0	0	0	0	5735.144	5735.144	5735.144	1282
Emergency services	0	0	0	0	0	0	7401.592	17269.63	9143.152	2416
Other (Vehicle, Evacuation)	0	0	0	0	0	0	257863.4	419311.1	94181.1	67250
									0	0
									0	0
Total damage £	0	0	0	0	0	0	403171.5	750702.1	272330	
Area (damagexfrequency)		0.00	0.00	0.00	0.00	0.00	1007.93	2307.75	511.52	
Total area, as above										
3827.19										
PV Factor, as above										
29.813										
Present value (assuming no change in damage or event frequency)										
114098										
Notes										
Area calculations assume drop to zero at maximum frequency.										
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.										
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)										
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet										

Present Value Costs – Includes maintenance and other cost details – Do Nothing and Do Minimum

year	cash sum	Option I Do-nothing				TOTALS:					Option II Do Minimum				TOTALS:				
		Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs	Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs
		0	0	0	0	0.00	0.00	0.00	0.00	0.00	257912.832	49500	0	0	307412.83	257912.83	14406.27	0.00	0.00
	Discount Factor																		
0	1.000	0	0	0	0	0.00	0.00	0.00	0.00	0.00	257912.832	0	0	0	257912.83	257912.83	0.00	0.00	0.00
1	0.966	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	483.09	0.00	0.00
2	0.934	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	466.76	0.00	0.00
3	0.902	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	450.97	0.00	0.00
4	0.871	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	435.72	0.00	0.00
5	0.842	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	420.99	0.00	0.00
6	0.814	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	406.75	0.00	0.00
7	0.786	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	393.00	0.00	0.00
8	0.759	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	379.71	0.00	0.00
9	0.734	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	366.87	0.00	0.00
10	0.709	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	354.46	0.00	0.00
11	0.685	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	342.47	0.00	0.00
12	0.662	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	330.89	0.00	0.00
13	0.639	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	319.70	0.00	0.00
14	0.618	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	308.89	0.00	0.00
15	0.597	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	298.45	0.00	0.00
16	0.577	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	288.35	0.00	0.00
17	0.557	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	278.60	0.00	0.00
18	0.538	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	269.18	0.00	0.00
19	0.520	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	260.08	0.00	0.00
20	0.503	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	251.28	0.00	0.00
21	0.486	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	242.79	0.00	0.00
22	0.469	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	234.58	0.00	0.00
23	0.453	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	226.64	0.00	0.00
24	0.438	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	218.98	0.00	0.00
25	0.423	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	211.57	0.00	0.00
26	0.409	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	204.42	0.00	0.00
27	0.395	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	197.51	0.00	0.00
28	0.382	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	190.83	0.00	0.00
29	0.369	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	184.37	0.00	0.00
30	0.356	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	178.14	0.00	0.00
31	0.346	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	172.95	0.00	0.00
32	0.336	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	167.91	0.00	0.00
33	0.326	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	163.02	0.00	0.00
34	0.317	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	158.27	0.00	0.00
35	0.307	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	153.66	0.00	0.00
36	0.298	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	149.19	0.00	0.00
37	0.290	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	144.84	0.00	0.00
38	0.281	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	140.62	0.00	0.00
39	0.273	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	136.53	0.00	0.00

40	0.265	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	132.55	0.00	0.00
41	0.257	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	128.69	0.00	0.00
42	0.250	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	124.94	0.00	0.00
43	0.243	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	121.30	0.00	0.00
44	0.236	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	117.77	0.00	0.00
45	0.229	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	114.34	0.00	0.00
46	0.222	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	111.01	0.00	0.00
47	0.216	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	107.78	0.00	0.00
48	0.209	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	104.64	0.00	0.00
49	0.203	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	101.59	0.00	0.00
50	0.197	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	98.63	0.00	0.00
51	0.192	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	95.76	0.00	0.00
52	0.186	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	92.97	0.00	0.00
53	0.181	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	90.26	0.00	0.00
54	0.175	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	87.63	0.00	0.00
55	0.170	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	85.08	0.00	0.00
56	0.165	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	82.60	0.00	0.00
57	0.160	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	80.20	0.00	0.00
58	0.156	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	77.86	0.00	0.00
59	0.151	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	75.59	0.00	0.00
60	0.147	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	73.39	0.00	0.00
61	0.143	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	71.25	0.00	0.00
62	0.138	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	69.18	0.00	0.00
63	0.134	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	67.16	0.00	0.00
64	0.130	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	65.21	0.00	0.00
65	0.127	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	63.31	0.00	0.00
66	0.123	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	61.46	0.00	0.00
67	0.119	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	59.67	0.00	0.00
68	0.116	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	57.94	0.00	0.00
69	0.112	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	56.25	0.00	0.00
70	0.109	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	54.61	0.00	0.00
71	0.106	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	53.02	0.00	0.00
72	0.103	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	51.47	0.00	0.00
73	0.100	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	49.98	0.00	0.00
74	0.097	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	48.52	0.00	0.00
75	0.094	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	47.11	0.00	0.00
76	0.092	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	45.96	0.00	0.00
77	0.090	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	44.84	0.00	0.00
78	0.087	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	43.74	0.00	0.00
79	0.085	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	42.68	0.00	0.00
80	0.083	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	41.64	0.00	0.00
81	0.081	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	40.62	0.00	0.00
82	0.079	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	39.63	0.00	0.00
83	0.077	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	38.66	0.00	0.00
84	0.075	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	37.72	0.00	0.00
85	0.074	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	36.80	0.00	0.00
86	0.072	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	35.90	0.00	0.00
87	0.070	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	35.03	0.00	0.00

88	0.068	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	34.17	0.00	0.00
89	0.067	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	33.34	0.00	0.00
90	0.065	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	32.53	0.00	0.00
91	0.063	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	31.73	0.00	0.00
92	0.062	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	30.96	0.00	0.00
93	0.060	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	30.20	0.00	0.00
94	0.059	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	29.47	0.00	0.00
95	0.057	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	28.75	0.00	0.00
96	0.056	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	28.05	0.00	0.00
97	0.055	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	27.36	0.00	0.00
98	0.053	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	26.70	0.00	0.00
99	0.052	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	500	0	0	500.00	0.00	26.04	0.00	0.00

Present Value Costs – Includes maintenance and other cost details – Option 1 and 2A

		Option III				Option 1					TOTALS:					Option IV				Option 2A					TOTALS:				
		Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs	Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs					
	cash sum	619042.494	175030.02	30952.1247	0	825024.64	619042.49	50940.00	2577.42	0.00	712584.7254	145573.56	35629.23627	0	893787.52	712584.73	42367.12	2966.89	0.00										
	Discount year																												
	Factor																												
0	1.000	619042.494	0	0	0	619042.49	619042.49	0.00	0.00	0.00	712584.7254	0	0	0	712584.73	712584.73	0.00	0.00	0.00										
1	0.966	0	1767.98	0	0	1767.98	0.00	1708.19	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1420.71	0.00	0.00										
2	0.934	0	1767.98	0	0	1767.98	0.00	1650.43	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1372.67	0.00	0.00										
3	0.902	0	1767.98	0	0	1767.98	0.00	1594.62	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1326.25	0.00	0.00										
4	0.871	0	1767.98	0	0	1767.98	0.00	1540.69	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1281.40	0.00	0.00										
5	0.842	0	1767.98	0	0	1767.98	0.00	1488.59	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1238.07	0.00	0.00										
6	0.814	0	1767.98	0	0	1767.98	0.00	1438.25	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1196.20	0.00	0.00										
7	0.786	0	1767.98	0	0	1767.98	0.00	1389.62	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1155.75	0.00	0.00										
8	0.759	0	1767.98	0	0	1767.98	0.00	1342.62	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1116.67	0.00	0.00										
9	0.734	0	1767.98	0	0	1767.98	0.00	1297.22	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1078.91	0.00	0.00										
10	0.709	0	1767.98	0	0	1767.98	0.00	1253.35	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1042.42	0.00	0.00										
11	0.685	0	1767.98	0	0	1767.98	0.00	1210.97	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1007.17	0.00	0.00										
12	0.662	0	1767.98	0	0	1767.98	0.00	1170.02	0.00	0.00	0	1470.44	0	0	1470.44	0.00	973.11	0.00	0.00										
13	0.639	0	1767.98	0	0	1767.98	0.00	1130.45	0.00	0.00	0	1470.44	0	0	1470.44	0.00	940.21	0.00	0.00										
14	0.618	0	1767.98	0	0	1767.98	0.00	1092.23	0.00	0.00	0	1470.44	0	0	1470.44	0.00	908.41	0.00	0.00										
15	0.597	0	1767.98	0	0	1767.98	0.00	1055.29	0.00	0.00	0	1470.44	0	0	1470.44	0.00	877.69	0.00	0.00										
16	0.577	0	1767.98	0	0	1767.98	0.00	1019.60	0.00	0.00	0	1470.44	0	0	1470.44	0.00	848.01	0.00	0.00										
17	0.557	0	1767.98	0	0	1767.98	0.00	985.13	0.00	0.00	0	1470.44	0	0	1470.44	0.00	819.33	0.00	0.00										
18	0.538	0	1767.98	0	0	1767.98	0.00	951.81	0.00	0.00	0	1470.44	0	0	1470.44	0.00	791.63	0.00	0.00										
19	0.520	0	1767.98	0	0	1767.98	0.00	919.62	0.00	0.00	0	1470.44	0	0	1470.44	0.00	764.86	0.00	0.00										
20	0.503	0	1767.98	0	0	1767.98	0.00	888.53	0.00	0.00	0	1470.44	0	0	1470.44	0.00	738.99	0.00	0.00										
21	0.486	0	1767.98	0	0	1767.98	0.00	858.48	0.00	0.00	0	1470.44	0	0	1470.44	0.00	714.00	0.00	0.00										
22	0.469	0	1767.98	0	0	1767.98	0.00	829.45	0.00	0.00	0	1470.44	0	0	1470.44	0.00	689.86	0.00	0.00										
23	0.453	0	1767.98	0	0	1767.98	0.00	801.40	0.00	0.00	0	1470.44	0	0	1470.44	0.00	666.53	0.00	0.00										
24	0.438	0	1767.98	0	0	1767.98	0.00	774.30	0.00	0.00	0	1470.44	0	0	1470.44	0.00	643.99	0.00	0.00										
25	0.423	0	1767.98	0	0	1767.98	0.00	748.12	0.00	0.00	0	1470.44	0	0	1470.44	0.00	622.21	0.00	0.00										
26	0.409	0	1767.98	0	0	1767.98	0.00	722.82	0.00	0.00	0	1470.44	0	0	1470.44	0.00	601.17	0.00	0.00										
27	0.395	0	1767.98	0	0	1767.98	0.00	698.37	0.00	0.00	0	1470.44	0	0	1470.44	0.00	580.84	0.00	0.00										
28	0.382	0	1767.98	0	0	1767.98	0.00	674.76	0.00	0.00	0	1470.44	0	0	1470.44	0.00	561.20	0.00	0.00										
29	0.369	0	1767.98	0	0	1767.98	0.00	651.94	0.00	0.00	0	1470.44	0	0	1470.44	0.00	542.22	0.00	0.00										
30	0.356	0	1767.98	0	0	1767.98	0.00	629.89	0.00	0.00	0	1470.44	0	0	1470.44	0.00	523.89	0.00	0.00										
31	0.346	0	1767.98	0	0	1767.98	0.00	611.55	0.00	0.00	0	1470.44	0	0	1470.44	0.00	508.63	0.00	0.00										
32	0.336	0	1767.98	0	0	1767.98	0.00	593.73	0.00	0.00	0	1470.44	0	0	1470.44	0.00	493.81	0.00	0.00										
33	0.326	0	1767.98	0	0	1767.98	0.00	576.44	0.00	0.00	0	1470.44	0	0	1470.44	0.00	479.43	0.00	0.00										
34	0.317	0	1767.98	0	0	1767.98	0.00	559.65	0.00	0.00	0	1470.44	0	0	1470.44	0.00	465.47	0.00	0.00										
35	0.307	0	1767.98	0	0	1767.98	0.00	543.35	0.00	0.00	0	1470.44	0	0	1470.44	0.00	451.91	0.00	0.00										
36	0.298	0	1767.98	0	0	1767.98	0.00	527.53	0.00	0.00	0	1470.44	0	0	1470.44	0.00	438.75	0.00	0.00										
37	0.290	0	1767.98	0	0	1767.98	0.00	512.16	0.00	0.00	0	1470.44	0	0	1470.44	0.00	425.97	0.00	0.00										
38	0.281	0	1767.98	0	0	1767.98	0.00	497.24	0.00	0.00	0	1470.44	0	0	1470.44	0.00	413.56	0.00	0.00										
39	0.273	0	1767.98	0	0	1767.98	0.00	482.76	0.00	0.00	0	1470.44	0	0	1470.44	0.00	401.52	0.00	0.00										

40	0.265	0	1767.98	0	0	1767.98	0.00	468.70	0.00	0.00	0	1470.44	0	0	1470.44	0.00	389.82	0.00	0.00
41	0.257	0	1767.98	0	0	1767.98	0.00	455.05	0.00	0.00	0	1470.44	0	0	1470.44	0.00	378.47	0.00	0.00
42	0.250	0	1767.98	0	0	1767.98	0.00	441.79	0.00	0.00	0	1470.44	0	0	1470.44	0.00	367.44	0.00	0.00
43	0.243	0	1767.98	0	0	1767.98	0.00	428.93	0.00	0.00	0	1470.44	0	0	1470.44	0.00	356.74	0.00	0.00
44	0.236	0	1767.98	0	0	1767.98	0.00	416.43	0.00	0.00	0	1470.44	0	0	1470.44	0.00	346.35	0.00	0.00
45	0.229	0	1767.98	0	0	1767.98	0.00	404.30	0.00	0.00	0	1470.44	0	0	1470.44	0.00	336.26	0.00	0.00
46	0.222	0	1767.98	0	0	1767.98	0.00	392.53	0.00	0.00	0	1470.44	0	0	1470.44	0.00	326.47	0.00	0.00
47	0.216	0	1767.98	0	0	1767.98	0.00	381.10	0.00	0.00	0	1470.44	0	0	1470.44	0.00	316.96	0.00	0.00
48	0.209	0	1767.98	0	0	1767.98	0.00	370.00	0.00	0.00	0	1470.44	0	0	1470.44	0.00	307.73	0.00	0.00
49	0.203	0	1767.98	0	0	1767.98	0.00	359.22	0.00	0.00	0	1470.44	0	0	1470.44	0.00	298.76	0.00	0.00
50	0.197	0	1767.98	0	0	1767.98	0.00	348.76	0.00	0.00	0	1470.44	0	0	1470.44	0.00	290.06	0.00	0.00
51	0.192	0	1767.98	0	0	1767.98	0.00	338.60	0.00	0.00	0	1470.44	0	0	1470.44	0.00	281.61	0.00	0.00
52	0.186	0	1767.98	0	0	1767.98	0.00	328.74	0.00	0.00	0	1470.44	0	0	1470.44	0.00	273.41	0.00	0.00
53	0.181	0	1767.98	0	0	1767.98	0.00	319.16	0.00	0.00	0	1470.44	0	0	1470.44	0.00	265.45	0.00	0.00
54	0.175	0	1767.98	0	0	1767.98	0.00	309.87	0.00	0.00	0	1470.44	0	0	1470.44	0.00	257.72	0.00	0.00
55	0.170	0	1767.98	0	0	1767.98	0.00	300.84	0.00	0.00	0	1470.44	0	0	1470.44	0.00	250.21	0.00	0.00
56	0.165	0	1767.98	0	0	1767.98	0.00	292.08	0.00	0.00	0	1470.44	0	0	1470.44	0.00	242.92	0.00	0.00
57	0.160	0	1767.98	0	0	1767.98	0.00	283.57	0.00	0.00	0	1470.44	0	0	1470.44	0.00	235.85	0.00	0.00
58	0.156	0	1767.98	0	0	1767.98	0.00	275.31	0.00	0.00	0	1470.44	0	0	1470.44	0.00	228.98	0.00	0.00
59	0.151	0	1767.98	0	0	1767.98	0.00	267.29	0.00	0.00	0	1470.44	0	0	1470.44	0.00	222.31	0.00	0.00
60	0.147	0	1767.98	0	0	1767.98	0.00	259.51	0.00	0.00	0	1470.44	0	0	1470.44	0.00	215.83	0.00	0.00
61	0.143	0	1767.98	0	0	1767.98	0.00	251.95	0.00	0.00	0	1470.44	0	0	1470.44	0.00	209.55	0.00	0.00
62	0.138	0	1767.98	0	0	1767.98	0.00	244.61	0.00	0.00	0	1470.44	0	0	1470.44	0.00	203.44	0.00	0.00
63	0.134	0	1767.98	0	0	1767.98	0.00	237.49	0.00	0.00	0	1470.44	0	0	1470.44	0.00	197.52	0.00	0.00
64	0.130	0	1767.98	0	0	1767.98	0.00	230.57	0.00	0.00	0	1470.44	0	0	1470.44	0.00	191.77	0.00	0.00
65	0.127	0	1767.98	0	0	1767.98	0.00	223.85	0.00	0.00	0	1470.44	0	0	1470.44	0.00	186.18	0.00	0.00
66	0.123	0	1767.98	0	0	1767.98	0.00	217.33	0.00	0.00	0	1470.44	0	0	1470.44	0.00	180.76	0.00	0.00
67	0.119	0	1767.98	0	0	1767.98	0.00	211.00	0.00	0.00	0	1470.44	0	0	1470.44	0.00	175.49	0.00	0.00
68	0.116	0	1767.98	0	0	1767.98	0.00	204.86	0.00	0.00	0	1470.44	0	0	1470.44	0.00	170.38	0.00	0.00
69	0.112	0	1767.98	0	0	1767.98	0.00	198.89	0.00	0.00	0	1470.44	0	0	1470.44	0.00	165.42	0.00	0.00
70	0.109	0	1767.98	0	0	1767.98	0.00	193.10	0.00	0.00	0	1470.44	0	0	1470.44	0.00	160.60	0.00	0.00
71	0.106	0	1767.98	0	0	1767.98	0.00	187.47	0.00	0.00	0	1470.44	0	0	1470.44	0.00	155.92	0.00	0.00
72	0.103	0	1767.98	0	0	1767.98	0.00	182.01	0.00	0.00	0	1470.44	0	0	1470.44	0.00	151.38	0.00	0.00
73	0.100	0	1767.98	0	0	1767.98	0.00	176.71	0.00	0.00	0	1470.44	0	0	1470.44	0.00	146.97	0.00	0.00
74	0.097	0	1767.98	0	0	1767.98	0.00	171.57	0.00	0.00	0	1470.44	0	0	1470.44	0.00	142.69	0.00	0.00
75	0.094	0	1767.98	0	0	1767.98	0.00	166.57	0.00	0.00	0	1470.44	0	0	1470.44	0.00	138.54	0.00	0.00
76	0.092	0	1767.98	0	0	1767.98	0.00	162.51	0.00	0.00	0	1470.44	0	0	1470.44	0.00	135.16	0.00	0.00
77	0.090	0	1767.98	0	0	1767.98	0.00	158.54	0.00	0.00	0	1470.44	0	0	1470.44	0.00	131.86	0.00	0.00
78	0.087	0	1767.98	0	0	1767.98	0.00	154.68	0.00	0.00	0	1470.44	0	0	1470.44	0.00	128.64	0.00	0.00
79	0.085	0	1767.98	0	0	1767.98	0.00	150.90	0.00	0.00	0	1470.44	0	0	1470.44	0.00	125.51	0.00	0.00
80	0.083	0	1767.98	30952.1247	0	32720.10	0.00	147.22	2577.42	0.00	0	1470.44	35629.23627	0	37099.68	0.00	122.45	2966.89	0.00
81	0.081	0	1767.98	0	0	1767.98	0.00	143.63	0.00	0.00	0	1470.44	0	0	1470.44	0.00	119.46	0.00	0.00
82	0.079	0	1767.98	0	0	1767.98	0.00	140.13	0.00	0.00	0	1470.44	0	0	1470.44	0.00	116.55	0.00	0.00
83	0.077	0	1767.98	0	0	1767.98	0.00	136.71	0.00	0.00	0	1470.44	0	0	1470.44	0.00	113.70	0.00	0.00
84	0.075	0	1767.98	0	0	1767.98	0.00	133.38	0.00	0.00	0	1470.44	0	0	1470.44	0.00	110.93	0.00	0.00
85	0.074	0	1767.98	0	0	1767.98	0.00	130.12	0.00	0.00	0	1470.44	0	0	1470.44	0.00	108.22	0.00	0.00
86	0.072	0	1767.98	0	0	1767.98	0.00	126.95	0.00	0.00	0	1470.44	0	0	1470.44	0.00	105.58	0.00	0.00
87	0.070	0	1767.98	0	0	1767.98	0.00	123.85	0.00	0.00	0	1470.44	0	0	1470.44	0.00	103.01	0.00	0.00

88	0.068	0	1767.98	0	0	1767.98	0.00	120.83	0.00	0.00	0	1470.44	0	0	1470.44	0.00	100.50	0.00	0.00
89	0.067	0	1767.98	0	0	1767.98	0.00	117.88	0.00	0.00	0	1470.44	0	0	1470.44	0.00	98.05	0.00	0.00
90	0.065	0	1767.98	0	0	1767.98	0.00	115.01	0.00	0.00	0	1470.44	0	0	1470.44	0.00	95.65	0.00	0.00
91	0.063	0	1767.98	0	0	1767.98	0.00	112.20	0.00	0.00	0	1470.44	0	0	1470.44	0.00	93.32	0.00	0.00
92	0.062	0	1767.98	0	0	1767.98	0.00	109.47	0.00	0.00	0	1470.44	0	0	1470.44	0.00	91.04	0.00	0.00
93	0.060	0	1767.98	0	0	1767.98	0.00	106.80	0.00	0.00	0	1470.44	0	0	1470.44	0.00	88.82	0.00	0.00
94	0.059	0	1767.98	0	0	1767.98	0.00	104.19	0.00	0.00	0	1470.44	0	0	1470.44	0.00	86.66	0.00	0.00
95	0.057	0	1767.98	0	0	1767.98	0.00	101.65	0.00	0.00	0	1470.44	0	0	1470.44	0.00	84.54	0.00	0.00
96	0.056	0	1767.98	0	0	1767.98	0.00	99.17	0.00	0.00	0	1470.44	0	0	1470.44	0.00	82.48	0.00	0.00
97	0.055	0	1767.98	0	0	1767.98	0.00	96.75	0.00	0.00	0	1470.44	0	0	1470.44	0.00	80.47	0.00	0.00
98	0.053	0	1767.98	0	0	1767.98	0.00	94.39	0.00	0.00	0	1470.44	0	0	1470.44	0.00	78.51	0.00	0.00
99	0.052	0	1767.98	0	0	1767.98	0.00	92.09	0.00	0.00	0	1470.44	0	0	1470.44	0.00	76.59	0.00	0.00

Present Value Costs – Includes maintenance and other cost details – Option 2B and 3A

		Option V				Option 2B					TOTALS:					Option VI				Option 3A					TOTALS:				
		Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs	Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs					
	cash sum	647523.8	145573.6	32376.19	0	825473.59	647523.84	42367.12	2696.01	0.00	598129	145573.6	29906.45	0	773609.06	598129.04	42367.12	2490.35	0.00										
year	Discount Factor																												
0	1.000	647523.8	0	0	0	647523.84	647523.84	0.00	0.00	0.00	598129	0	0	0	598129.04	598129.04	0.00	0.00	0.00										
1	0.966	0	1470.44	0	0	1470.44	0.00	1420.71	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1420.71	0.00	0.00										
2	0.934	0	1470.44	0	0	1470.44	0.00	1372.67	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1372.67	0.00	0.00										
3	0.902	0	1470.44	0	0	1470.44	0.00	1326.25	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1326.25	0.00	0.00										
4	0.871	0	1470.44	0	0	1470.44	0.00	1281.40	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1281.40	0.00	0.00										
5	0.842	0	1470.44	0	0	1470.44	0.00	1238.07	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1238.07	0.00	0.00										
6	0.814	0	1470.44	0	0	1470.44	0.00	1196.20	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1196.20	0.00	0.00										
7	0.786	0	1470.44	0	0	1470.44	0.00	1155.75	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1155.75	0.00	0.00										
8	0.759	0	1470.44	0	0	1470.44	0.00	1116.67	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1116.67	0.00	0.00										
9	0.734	0	1470.44	0	0	1470.44	0.00	1078.91	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1078.91	0.00	0.00										
10	0.709	0	1470.44	0	0	1470.44	0.00	1042.42	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1042.42	0.00	0.00										
11	0.685	0	1470.44	0	0	1470.44	0.00	1007.17	0.00	0.00	0	1470.44	0	0	1470.44	0.00	1007.17	0.00	0.00										
12	0.662	0	1470.44	0	0	1470.44	0.00	973.11	0.00	0.00	0	1470.44	0	0	1470.44	0.00	973.11	0.00	0.00										
13	0.639	0	1470.44	0	0	1470.44	0.00	940.21	0.00	0.00	0	1470.44	0	0	1470.44	0.00	940.21	0.00	0.00										
14	0.618	0	1470.44	0	0	1470.44	0.00	908.41	0.00	0.00	0	1470.44	0	0	1470.44	0.00	908.41	0.00	0.00										
15	0.597	0	1470.44	0	0	1470.44	0.00	877.69	0.00	0.00	0	1470.44	0	0	1470.44	0.00	877.69	0.00	0.00										
16	0.577	0	1470.44	0	0	1470.44	0.00	848.01	0.00	0.00	0	1470.44	0	0	1470.44	0.00	848.01	0.00	0.00										
17	0.557	0	1470.44	0	0	1470.44	0.00	819.33	0.00	0.00	0	1470.44	0	0	1470.44	0.00	819.33	0.00	0.00										
18	0.538	0	1470.44	0	0	1470.44	0.00	791.63	0.00	0.00	0	1470.44	0	0	1470.44	0.00	791.63	0.00	0.00										
19	0.520	0	1470.44	0	0	1470.44	0.00	764.86	0.00	0.00	0	1470.44	0	0	1470.44	0.00	764.86	0.00	0.00										
20	0.503	0	1470.44	0	0	1470.44	0.00	738.99	0.00	0.00	0	1470.44	0	0	1470.44	0.00	738.99	0.00	0.00										
21	0.486	0	1470.44	0	0	1470.44	0.00	714.00	0.00	0.00	0	1470.44	0	0	1470.44	0.00	714.00	0.00	0.00										
22	0.469	0	1470.44	0	0	1470.44	0.00	689.86	0.00	0.00	0	1470.44	0	0	1470.44	0.00	689.86	0.00	0.00										
23	0.453	0	1470.44	0	0	1470.44	0.00	666.53	0.00	0.00	0	1470.44	0	0	1470.44	0.00	666.53	0.00	0.00										
24	0.438	0	1470.44	0	0	1470.44	0.00	643.99	0.00	0.00	0	1470.44	0	0	1470.44	0.00	643.99	0.00	0.00										
25	0.423	0	1470.44	0	0	1470.44	0.00	622.21	0.00	0.00	0	1470.44	0	0	1470.44	0.00	622.21	0.00	0.00										
26	0.409	0	1470.44	0	0	1470.44	0.00	601.17	0.00	0.00	0	1470.44	0	0	1470.44	0.00	601.17	0.00	0.00										
27	0.395	0	1470.44	0	0	1470.44	0.00	580.84	0.00	0.00	0	1470.44	0	0	1470.44	0.00	580.84	0.00	0.00										
28	0.382	0	1470.44	0	0	1470.44	0.00	561.20	0.00	0.00	0	1470.44	0	0	1470.44	0.00	561.20	0.00	0.00										
29	0.369	0	1470.44	0	0	1470.44	0.00	542.22	0.00	0.00	0	1470.44	0	0	1470.44	0.00	542.22	0.00	0.00										
30	0.356	0	1470.44	0	0	1470.44	0.00	523.89	0.00	0.00	0	1470.44	0	0	1470.44	0.00	523.89	0.00	0.00										
31	0.346	0	1470.44	0	0	1470.44	0.00	508.63	0.00	0.00	0	1470.44	0	0	1470.44	0.00	508.63	0.00	0.00										
32	0.336	0	1470.44	0	0	1470.44	0.00	493.81	0.00	0.00	0	1470.44	0	0	1470.44	0.00	493.81	0.00	0.00										
33	0.326	0	1470.44	0	0	1470.44	0.00	479.43	0.00	0.00	0	1470.44	0	0	1470.44	0.00	479.43	0.00	0.00										
34	0.317	0	1470.44	0	0	1470.44	0.00	465.47	0.00	0.00	0	1470.44	0	0	1470.44	0.00	465.47	0.00	0.00										
35	0.307	0	1470.44	0	0	1470.44	0.00	451.91	0.00	0.00	0	1470.44	0	0	1470.44	0.00	451.91	0.00	0.00										
36	0.298	0	1470.44	0	0	1470.44	0.00	438.75	0.00	0.00	0	1470.44	0	0	1470.44	0.00	438.75	0.00	0.00										
37	0.290	0	1470.44	0	0	1470.44	0.00	425.97	0.00	0.00	0	1470.44	0	0	1470.44	0.00	425.97	0.00	0.00										
38	0.281	0	1470.44	0	0	1470.44	0.00	413.56	0.00	0.00	0	1470.44	0	0	1470.44	0.00	413.56	0.00	0.00										
39	0.273	0	1470.44	0	0	1470.44	0.00	401.52	0.00	0.00	0	1470.44	0	0	1470.44	0.00	401.52	0.00	0.00										

40	0.265	0	1470.44	0	0	1470.44	0.00	389.82	0.00	0.00	0	1470.44	0	0	1470.44	0.00	389.82	0.00	0.00
41	0.257	0	1470.44	0	0	1470.44	0.00	378.47	0.00	0.00	0	1470.44	0	0	1470.44	0.00	378.47	0.00	0.00
42	0.250	0	1470.44	0	0	1470.44	0.00	367.44	0.00	0.00	0	1470.44	0	0	1470.44	0.00	367.44	0.00	0.00
43	0.243	0	1470.44	0	0	1470.44	0.00	356.74	0.00	0.00	0	1470.44	0	0	1470.44	0.00	356.74	0.00	0.00
44	0.236	0	1470.44	0	0	1470.44	0.00	346.35	0.00	0.00	0	1470.44	0	0	1470.44	0.00	346.35	0.00	0.00
45	0.229	0	1470.44	0	0	1470.44	0.00	336.26	0.00	0.00	0	1470.44	0	0	1470.44	0.00	336.26	0.00	0.00
46	0.222	0	1470.44	0	0	1470.44	0.00	326.47	0.00	0.00	0	1470.44	0	0	1470.44	0.00	326.47	0.00	0.00
47	0.216	0	1470.44	0	0	1470.44	0.00	316.96	0.00	0.00	0	1470.44	0	0	1470.44	0.00	316.96	0.00	0.00
48	0.209	0	1470.44	0	0	1470.44	0.00	307.73	0.00	0.00	0	1470.44	0	0	1470.44	0.00	307.73	0.00	0.00
49	0.203	0	1470.44	0	0	1470.44	0.00	298.76	0.00	0.00	0	1470.44	0	0	1470.44	0.00	298.76	0.00	0.00
50	0.197	0	1470.44	0	0	1470.44	0.00	290.06	0.00	0.00	0	1470.44	0	0	1470.44	0.00	290.06	0.00	0.00
51	0.192	0	1470.44	0	0	1470.44	0.00	281.61	0.00	0.00	0	1470.44	0	0	1470.44	0.00	281.61	0.00	0.00
52	0.186	0	1470.44	0	0	1470.44	0.00	273.41	0.00	0.00	0	1470.44	0	0	1470.44	0.00	273.41	0.00	0.00
53	0.181	0	1470.44	0	0	1470.44	0.00	265.45	0.00	0.00	0	1470.44	0	0	1470.44	0.00	265.45	0.00	0.00
54	0.175	0	1470.44	0	0	1470.44	0.00	257.72	0.00	0.00	0	1470.44	0	0	1470.44	0.00	257.72	0.00	0.00
55	0.170	0	1470.44	0	0	1470.44	0.00	250.21	0.00	0.00	0	1470.44	0	0	1470.44	0.00	250.21	0.00	0.00
56	0.165	0	1470.44	0	0	1470.44	0.00	242.92	0.00	0.00	0	1470.44	0	0	1470.44	0.00	242.92	0.00	0.00
57	0.160	0	1470.44	0	0	1470.44	0.00	235.85	0.00	0.00	0	1470.44	0	0	1470.44	0.00	235.85	0.00	0.00
58	0.156	0	1470.44	0	0	1470.44	0.00	228.98	0.00	0.00	0	1470.44	0	0	1470.44	0.00	228.98	0.00	0.00
59	0.151	0	1470.44	0	0	1470.44	0.00	222.31	0.00	0.00	0	1470.44	0	0	1470.44	0.00	222.31	0.00	0.00
60	0.147	0	1470.44	0	0	1470.44	0.00	215.83	0.00	0.00	0	1470.44	0	0	1470.44	0.00	215.83	0.00	0.00
61	0.143	0	1470.44	0	0	1470.44	0.00	209.55	0.00	0.00	0	1470.44	0	0	1470.44	0.00	209.55	0.00	0.00
62	0.138	0	1470.44	0	0	1470.44	0.00	203.44	0.00	0.00	0	1470.44	0	0	1470.44	0.00	203.44	0.00	0.00
63	0.134	0	1470.44	0	0	1470.44	0.00	197.52	0.00	0.00	0	1470.44	0	0	1470.44	0.00	197.52	0.00	0.00
64	0.130	0	1470.44	0	0	1470.44	0.00	191.77	0.00	0.00	0	1470.44	0	0	1470.44	0.00	191.77	0.00	0.00
65	0.127	0	1470.44	0	0	1470.44	0.00	186.18	0.00	0.00	0	1470.44	0	0	1470.44	0.00	186.18	0.00	0.00
66	0.123	0	1470.44	0	0	1470.44	0.00	180.76	0.00	0.00	0	1470.44	0	0	1470.44	0.00	180.76	0.00	0.00
67	0.119	0	1470.44	0	0	1470.44	0.00	175.49	0.00	0.00	0	1470.44	0	0	1470.44	0.00	175.49	0.00	0.00
68	0.116	0	1470.44	0	0	1470.44	0.00	170.38	0.00	0.00	0	1470.44	0	0	1470.44	0.00	170.38	0.00	0.00
69	0.112	0	1470.44	0	0	1470.44	0.00	165.42	0.00	0.00	0	1470.44	0	0	1470.44	0.00	165.42	0.00	0.00
70	0.109	0	1470.44	0	0	1470.44	0.00	160.60	0.00	0.00	0	1470.44	0	0	1470.44	0.00	160.60	0.00	0.00
71	0.106	0	1470.44	0	0	1470.44	0.00	155.92	0.00	0.00	0	1470.44	0	0	1470.44	0.00	155.92	0.00	0.00
72	0.103	0	1470.44	0	0	1470.44	0.00	151.38	0.00	0.00	0	1470.44	0	0	1470.44	0.00	151.38	0.00	0.00
73	0.100	0	1470.44	0	0	1470.44	0.00	146.97	0.00	0.00	0	1470.44	0	0	1470.44	0.00	146.97	0.00	0.00
74	0.097	0	1470.44	0	0	1470.44	0.00	142.69	0.00	0.00	0	1470.44	0	0	1470.44	0.00	142.69	0.00	0.00
75	0.094	0	1470.44	0	0	1470.44	0.00	138.54	0.00	0.00	0	1470.44	0	0	1470.44	0.00	138.54	0.00	0.00
76	0.092	0	1470.44	0	0	1470.44	0.00	135.16	0.00	0.00	0	1470.44	0	0	1470.44	0.00	135.16	0.00	0.00
77	0.090	0	1470.44	0	0	1470.44	0.00	131.86	0.00	0.00	0	1470.44	0	0	1470.44	0.00	131.86	0.00	0.00
78	0.087	0	1470.44	0	0	1470.44	0.00	128.64	0.00	0.00	0	1470.44	0	0	1470.44	0.00	128.64	0.00	0.00
79	0.085	0	1470.44	0	0	1470.44	0.00	125.51	0.00	0.00	0	1470.44	0	0	1470.44	0.00	125.51	0.00	0.00
80	0.083	0	1470.44	32376.19	0	33846.63	0.00	122.45	2696.01	0.00	0	1470.44	29906.45	0	31376.89	0.00	122.45	2490.35	0.00
81	0.081	0	1470.44	0	0	1470.44	0.00	119.46	0.00	0.00	0	1470.44	0	0	1470.44	0.00	119.46	0.00	0.00
82	0.079	0	1470.44	0	0	1470.44	0.00	116.55	0.00	0.00	0	1470.44	0	0	1470.44	0.00	116.55	0.00	0.00
83	0.077	0	1470.44	0	0	1470.44	0.00	113.70	0.00	0.00	0	1470.44	0	0	1470.44	0.00	113.70	0.00	0.00
84	0.075	0	1470.44	0	0	1470.44	0.00	110.93	0.00	0.00	0	1470.44	0	0	1470.44	0.00	110.93	0.00	0.00
85	0.074	0	1470.44	0	0	1470.44	0.00	108.22	0.00	0.00	0	1470.44	0	0	1470.44	0.00	108.22	0.00	0.00
86	0.072	0	1470.44	0	0	1470.44	0.00	105.58	0.00	0.00	0	1470.44	0	0	1470.44	0.00	105.58	0.00	0.00
87	0.070	0	1470.44	0	0	1470.44	0.00	103.01	0.00	0.00	0	1470.44	0	0	1470.44	0.00	103.01	0.00	0.00

88	0.068	0	1470.44	0	0	1470.44	0.00	100.50	0.00	0.00	0	1470.44	0	0	1470.44	0.00	100.50	0.00	0.00
89	0.067	0	1470.44	0	0	1470.44	0.00	98.05	0.00	0.00	0	1470.44	0	0	1470.44	0.00	98.05	0.00	0.00
90	0.065	0	1470.44	0	0	1470.44	0.00	95.65	0.00	0.00	0	1470.44	0	0	1470.44	0.00	95.65	0.00	0.00
91	0.063	0	1470.44	0	0	1470.44	0.00	93.32	0.00	0.00	0	1470.44	0	0	1470.44	0.00	93.32	0.00	0.00
92	0.062	0	1470.44	0	0	1470.44	0.00	91.04	0.00	0.00	0	1470.44	0	0	1470.44	0.00	91.04	0.00	0.00
93	0.060	0	1470.44	0	0	1470.44	0.00	88.82	0.00	0.00	0	1470.44	0	0	1470.44	0.00	88.82	0.00	0.00
94	0.059	0	1470.44	0	0	1470.44	0.00	86.66	0.00	0.00	0	1470.44	0	0	1470.44	0.00	86.66	0.00	0.00
95	0.057	0	1470.44	0	0	1470.44	0.00	84.54	0.00	0.00	0	1470.44	0	0	1470.44	0.00	84.54	0.00	0.00
96	0.056	0	1470.44	0	0	1470.44	0.00	82.48	0.00	0.00	0	1470.44	0	0	1470.44	0.00	82.48	0.00	0.00
97	0.055	0	1470.44	0	0	1470.44	0.00	80.47	0.00	0.00	0	1470.44	0	0	1470.44	0.00	80.47	0.00	0.00
98	0.053	0	1470.44	0	0	1470.44	0.00	78.51	0.00	0.00	0	1470.44	0	0	1470.44	0.00	78.51	0.00	0.00
99	0.052	0	1470.44	0	0	1470.44	0.00	76.59	0.00	0.00	0	1470.44	0	0	1470.44	0.00	76.59	0.00	0.00

Present Value Costs – Includes maintenance and other cost details – Option 3B, 4 and 5

Year	Discount Factor	Option VII				TOTAL S:					Option VIII				TOTALS :					Option IV				TOTAL S:					
		Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	PV Negative costs	Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	PV Negative costs	Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	PV Negative costs	
		597196.5406	175273.6	29859.83	0	802329.93	597196.54	51010.88	2486.47	0.00	3040704.017	115873.6	152035.2	0	3308612.78	3040704.02	33723.36	12660.16	0.00	812961.793	145573.6	40648.06	0	999182.80	812961.18	42367.12	3384.81	0.00	
0	1.000	597196.54	0	0	0	597196.54	597196.54	0.00	0.00	0.00	3040704.02	0	0	0	3040704.02	3040704.02	0.00	0.00	0.00	812961	0	0	0	812961.18	812961.18	0.00	0.00	0.00	
1	0.966	0	1770.44	0	0	1770.44	0.00	1710.57	0.00	0.00	0	1170.44	0	0	1170.44	0.00	1130.86	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	1420.71	0.00	0.00
2	0.934	0	1770.44	0	0	1770.44	0.00	1652.72	0.00	0.00	0	1170.44	0	0	1170.44	0.00	1092.62	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	1372.67	0.00	0.00
3	0.902	0	1770.44	0	0	1770.44	0.00	1596.84	0.00	0.00	0	1170.44	0	0	1170.44	0.00	1055.67	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	1326.25	0.00	0.00
4	0.871	0	1770.44	0	0	1770.44	0.00	1542.84	0.00	0.00	0	1170.44	0	0	1170.44	0.00	1019.97	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	1281.40	0.00	0.00
5	0.842	0	1770.44	0	0	1770.44	0.00	1490.66	0.00	0.00	0	1170.44	0	0	1170.44	0.00	985.48	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	1238.07	0.00	0.00
6	0.814	0	1770.44	0	0	1770.44	0.00	1440.25	0.00	0.00	0	1170.44	0	0	1170.44	0.00	952.15	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	1196.20	0.00	0.00
7	0.786	0	1770.44	0	0	1770.44	0.00	1391.55	0.00	0.00	0	1170.44	0	0	1170.44	0.00	919.96	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	1155.75	0.00	0.00
8	0.759	0	1770.44	0	0	1770.44	0.00	1344.49	0.00	0.00	0	1170.44	0	0	1170.44	0.00	888.85	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	1116.67	0.00	0.00
9	0.734	0	1770.44	0	0	1770.44	0.00	1299.03	0.00	0.00	0	1170.44	0	0	1170.44	0.00	858.79	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	1078.91	0.00	0.00
10	0.709	0	1770.44	0	0	1770.44	0.00	1255.10	0.00	0.00	0	1170.44	0	0	1170.44	0.00	829.75	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	1042.42	0.00	0.00
11	0.685	0	1770.44	0	0	1770.44	0.00	1212.66	0.00	0.00	0	1170.44	0	0	1170.44	0.00	801.69	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	1007.17	0.00	0.00
12	0.662	0	1770.44	0	0	1770.44	0.00	1171.65	0.00	0.00	0	1170.44	0	0	1170.44	0.00	774.58	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	973.11	0.00	0.00
13	0.639	0	1770.44	0	0	1770.44	0.00	1132.03	0.00	0.00	0	1170.44	0	0	1170.44	0.00	748.38	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	940.21	0.00	0.00
14	0.618	0	1770.44	0	0	1770.44	0.00	1093.75	0.00	0.00	0	1170.44	0	0	1170.44	0.00	723.08	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	908.41	0.00	0.00
15	0.597	0	1770.44	0	0	1770.44	0.00	1056.76	0.00	0.00	0	1170.44	0	0	1170.44	0.00	698.62	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	877.69	0.00	0.00
16	0.577	0	1770.44	0	0	1770.44	0.00	1021.02	0.00	0.00	0	1170.44	0	0	1170.44	0.00	675.00	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	848.01	0.00	0.00
17	0.557	0	1770.44	0	0	1770.44	0.00	986.50	0.00	0.00	0	1170.44	0	0	1170.44	0.00	652.17	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	819.33	0.00	0.00
18	0.538	0	1770.44	0	0	1770.44	0.00	953.14	0.00	0.00	0	1170.44	0	0	1170.44	0.00	630.12	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	791.63	0.00	0.00
19	0.520	0	1770.44	0	0	1770.44	0.00	920.90	0.00	0.00	0	1170.44	0	0	1170.44	0.00	608.81	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	764.86	0.00	0.00
20	0.503	0	1770.44	0	0	1770.44	0.00	889.76	0.00	0.00	0	1170.44	0	0	1170.44	0.00	588.22	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	738.99	0.00	0.00
21	0.486	0	1770.44	0	0	1770.44	0.00	859.67	0.00	0.00	0	1170.44	0	0	1170.44	0.00	568.33	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	714.00	0.00	0.00
22	0.469	0	1770.44	0	0	1770.44	0.00	830.60	0.00	0.00	0	1170.44	0	0	1170.44	0.00	549.11	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	689.86	0.00	0.00
23	0.453	0	1770.44	0	0	1770.44	0.00	802.52	0.00	0.00	0	1170.44	0	0	1170.44	0.00	530.54	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	666.53	0.00	0.00
24	0.438	0	1770.44	0	0	1770.44	0.00	775.38	0.00	0.00	0	1170.44	0	0	1170.44	0.00	512.60	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	643.99	0.00	0.00
25	0.423	0	1770.44	0	0	1770.44	0.00	749.16	0.00	0.00	0	1170.44	0	0	1170.44	0.00	495.27	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	622.21	0.00	0.00
26	0.409	0	1770.44	0	0	1770.44	0.00	723.82	0.00	0.00	0	1170.44	0	0	1170.44	0.00	478.52	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	601.17	0.00	0.00
27	0.395	0	1770.44	0	0	1770.44	0.00	699.35	0.00	0.00	0	1170.44	0	0	1170.44	0.00	462.34	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	580.84	0.00	0.00
28	0.382	0	1770.44	0	0	1770.44	0.00	675.70	0.00	0.00	0	1170.44	0	0	1170.44	0.00	446.70	0.00	0.00	0	1470.44	0	0	0	1470.44	0.00	561.20	0.00	0.00

29	0.369	0	1770.4	0	0	1770.44	0.00	652.85	0.00	0.00	0	1170.4	0	0	1170.44	0.00	431.60	0.00	0.00	0	1470.4	0	0	1470.44	0.00	542.22	0.00	0.00
30	0.356	0	1770.4	0	0	1770.44	0.00	630.77	0.00	0.00	0	1170.4	0	0	1170.44	0.00	417.00	0.00	0.00	0	1470.4	0	0	1470.44	0.00	523.89	0.00	0.00
31	0.346	0	1770.4	0	0	1770.44	0.00	612.40	0.00	0.00	0	1170.4	0	0	1170.44	0.00	404.86	0.00	0.00	0	1470.4	0	0	1470.44	0.00	508.63	0.00	0.00
32	0.336	0	1770.4	0	0	1770.44	0.00	594.56	0.00	0.00	0	1170.4	0	0	1170.44	0.00	393.06	0.00	0.00	0	1470.4	0	0	1470.44	0.00	493.81	0.00	0.00
33	0.326	0	1770.4	0	0	1770.44	0.00	577.24	0.00	0.00	0	1170.4	0	0	1170.44	0.00	381.62	0.00	0.00	0	1470.4	0	0	1470.44	0.00	479.43	0.00	0.00
34	0.317	0	1770.4	0	0	1770.44	0.00	560.43	0.00	0.00	0	1170.4	0	0	1170.44	0.00	370.50	0.00	0.00	0	1470.4	0	0	1470.44	0.00	465.47	0.00	0.00
35	0.307	0	1770.4	0	0	1770.44	0.00	544.11	0.00	0.00	0	1170.4	0	0	1170.44	0.00	359.71	0.00	0.00	0	1470.4	0	0	1470.44	0.00	451.91	0.00	0.00
36	0.298	0	1770.4	0	0	1770.44	0.00	528.26	0.00	0.00	0	1170.4	0	0	1170.44	0.00	349.23	0.00	0.00	0	1470.4	0	0	1470.44	0.00	438.75	0.00	0.00
37	0.290	0	1770.4	0	0	1770.44	0.00	512.87	0.00	0.00	0	1170.4	0	0	1170.44	0.00	339.06	0.00	0.00	0	1470.4	0	0	1470.44	0.00	425.97	0.00	0.00
38	0.281	0	1770.4	0	0	1770.44	0.00	497.94	0.00	0.00	0	1170.4	0	0	1170.44	0.00	329.19	0.00	0.00	0	1470.4	0	0	1470.44	0.00	413.56	0.00	0.00
39	0.273	0	1770.4	0	0	1770.44	0.00	483.43	0.00	0.00	0	1170.4	0	0	1170.44	0.00	319.60	0.00	0.00	0	1470.4	0	0	1470.44	0.00	401.52	0.00	0.00
40	0.265	0	1770.4	0	0	1770.44	0.00	469.35	0.00	0.00	0	1170.4	0	0	1170.44	0.00	310.29	0.00	0.00	0	1470.4	0	0	1470.44	0.00	389.82	0.00	0.00
41	0.257	0	1770.4	0	0	1770.44	0.00	455.68	0.00	0.00	0	1170.4	0	0	1170.44	0.00	301.25	0.00	0.00	0	1470.4	0	0	1470.44	0.00	378.47	0.00	0.00
42	0.250	0	1770.4	0	0	1770.44	0.00	442.41	0.00	0.00	0	1170.4	0	0	1170.44	0.00	292.48	0.00	0.00	0	1470.4	0	0	1470.44	0.00	367.44	0.00	0.00
43	0.243	0	1770.4	0	0	1770.44	0.00	429.52	0.00	0.00	0	1170.4	0	0	1170.44	0.00	283.96	0.00	0.00	0	1470.4	0	0	1470.44	0.00	356.74	0.00	0.00
44	0.236	0	1770.4	0	0	1770.44	0.00	417.01	0.00	0.00	0	1170.4	0	0	1170.44	0.00	275.69	0.00	0.00	0	1470.4	0	0	1470.44	0.00	346.35	0.00	0.00
45	0.229	0	1770.4	0	0	1770.44	0.00	404.87	0.00	0.00	0	1170.4	0	0	1170.44	0.00	267.66	0.00	0.00	0	1470.4	0	0	1470.44	0.00	336.26	0.00	0.00
46	0.222	0	1770.4	0	0	1770.44	0.00	393.07	0.00	0.00	0	1170.4	0	0	1170.44	0.00	259.86	0.00	0.00	0	1470.4	0	0	1470.44	0.00	326.47	0.00	0.00
47	0.216	0	1770.4	0	0	1770.44	0.00	381.63	0.00	0.00	0	1170.4	0	0	1170.44	0.00	252.29	0.00	0.00	0	1470.4	0	0	1470.44	0.00	316.96	0.00	0.00
48	0.209	0	1770.4	0	0	1770.44	0.00	370.51	0.00	0.00	0	1170.4	0	0	1170.44	0.00	244.95	0.00	0.00	0	1470.4	0	0	1470.44	0.00	307.73	0.00	0.00
49	0.203	0	1770.4	0	0	1770.44	0.00	359.72	0.00	0.00	0	1170.4	0	0	1170.44	0.00	237.81	0.00	0.00	0	1470.4	0	0	1470.44	0.00	298.76	0.00	0.00
50	0.197	0	1770.4	0	0	1770.44	0.00	349.24	0.00	0.00	0	1170.4	0	0	1170.44	0.00	230.88	0.00	0.00	0	1470.4	0	0	1470.44	0.00	290.06	0.00	0.00
51	0.192	0	1770.4	0	0	1770.44	0.00	339.07	0.00	0.00	0	1170.4	0	0	1170.44	0.00	224.16	0.00	0.00	0	1470.4	0	0	1470.44	0.00	281.61	0.00	0.00
52	0.186	0	1770.4	0	0	1770.44	0.00	329.19	0.00	0.00	0	1170.4	0	0	1170.44	0.00	217.63	0.00	0.00	0	1470.4	0	0	1470.44	0.00	273.41	0.00	0.00
53	0.181	0	1770.4	0	0	1770.44	0.00	319.61	0.00	0.00	0	1170.4	0	0	1170.44	0.00	211.29	0.00	0.00	0	1470.4	0	0	1470.44	0.00	265.45	0.00	0.00
54	0.175	0	1770.4	0	0	1770.44	0.00	310.30	0.00	0.00	0	1170.4	0	0	1170.44	0.00	205.14	0.00	0.00	0	1470.4	0	0	1470.44	0.00	257.72	0.00	0.00
55	0.170	0	1770.4	0	0	1770.44	0.00	301.26	0.00	0.00	0	1170.4	0	0	1170.44	0.00	199.16	0.00	0.00	0	1470.4	0	0	1470.44	0.00	250.21	0.00	0.00
56	0.165	0	1770.4	0	0	1770.44	0.00	292.48	0.00	0.00	0	1170.4	0	0	1170.44	0.00	193.36	0.00	0.00	0	1470.4	0	0	1470.44	0.00	242.92	0.00	0.00
57	0.160	0	1770.4	0	0	1770.44	0.00	283.97	0.00	0.00	0	1170.4	0	0	1170.44	0.00	187.73	0.00	0.00	0	1470.4	0	0	1470.44	0.00	235.85	0.00	0.00
58	0.156	0	1770.4	0	0	1770.44	0.00	275.69	0.00	0.00	0	1170.4	0	0	1170.44	0.00	182.26	0.00	0.00	0	1470.4	0	0	1470.44	0.00	228.98	0.00	0.00
59	0.151	0	1770.4	0	0	1770.44	0.00	267.66	0.00	0.00	0	1170.4	0	0	1170.44	0.00	176.95	0.00	0.00	0	1470.4	0	0	1470.44	0.00	222.31	0.00	0.00
60	0.147	0	1770.4	0	0	1770.44	0.00	259.87	0.00	0.00	0	1170.4	0	0	1170.44	0.00	171.80	0.00	0.00	0	1470.4	0	0	1470.44	0.00	215.83	0.00	0.00
61	0.143	0	1770.4	0	0	1770.44	0.00	252.30	0.00	0.00	0	1170.4	0	0	1170.44	0.00	166.80	0.00	0.00	0	1470.4	0	0	1470.44	0.00	209.55	0.00	0.00
62	0.138	0	1770.4	0	0	1770.44	0.00	244.95	0.00	0.00	0	1170.4	0	0	1170.44	0.00	161.94	0.00	0.00	0	1470.4	0	0	1470.44	0.00	203.44	0.00	0.00
63	0.134	0	1770.4	0	0	1770.44	0.00	237.82	0.00	0.00	0	1170.4	0	0	1170.44	0.00	157.22	0.00	0.00	0	1470.4	0	0	1470.44	0.00	197.52	0.00	0.00
64	0.130	0	1770.4	0	0	1770.44	0.00	230.89	0.00	0.00	0	1170.4	0	0	1170.44	0.00	152.64	0.00	0.00	0	1470.4	0	0	1470.44	0.00	191.77	0.00	0.00

			4								4									4								
65	0.127	0	1770.4 4	0	0	1770.44	0.00	224.17	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	148.20	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	186.18	0.00	0.00
66	0.123	0	1770.4 4	0	0	1770.44	0.00	217.64	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	143.88	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	180.76	0.00	0.00
67	0.119	0	1770.4 4	0	0	1770.44	0.00	211.30	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	139.69	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	175.49	0.00	0.00
68	0.116	0	1770.4 4	0	0	1770.44	0.00	205.14	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	135.62	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	170.38	0.00	0.00
69	0.112	0	1770.4 4	0	0	1770.44	0.00	199.17	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	131.67	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	165.42	0.00	0.00
70	0.109	0	1770.4 4	0	0	1770.44	0.00	193.37	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	127.83	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	160.60	0.00	0.00
71	0.106	0	1770.4 4	0	0	1770.44	0.00	187.73	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	124.11	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	155.92	0.00	0.00
72	0.103	0	1770.4 4	0	0	1770.44	0.00	182.27	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	120.50	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	151.38	0.00	0.00
73	0.100	0	1770.4 4	0	0	1770.44	0.00	176.96	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	116.99	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	146.97	0.00	0.00
74	0.097	0	1770.4 4	0	0	1770.44	0.00	171.80	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	113.58	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	142.69	0.00	0.00
75	0.094	0	1770.4 4	0	0	1770.44	0.00	166.80	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	110.27	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	138.54	0.00	0.00
76	0.092	0	1770.4 4	0	0	1770.44	0.00	162.73	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	107.58	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	135.16	0.00	0.00
77	0.090	0	1770.4 4	0	0	1770.44	0.00	158.76	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	104.96	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	131.86	0.00	0.00
78	0.087	0	1770.4 4	0	0	1770.44	0.00	154.89	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	102.40	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	128.64	0.00	0.00
79	0.085	0	1770.4 4	0	0	1770.44	0.00	151.11	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	99.90	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	125.51	0.00	0.00
80	0.083	0	1770.4 4	29859. 83	0	31630.2 7	0.00	147.43	2486. 47	0.00	0	1170.4 4	15203 5.2	0	153205. 64	0.00	97.46	12660. 16	0.00	0	1470.4 4	40648. 06	0	42118.5 0	0.00	122.45	3384. 81	0.00
81	0.081	0	1770.4 4	0	0	1770.44	0.00	143.83	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	95.09	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	119.46	0.00	0.00
82	0.079	0	1770.4 4	0	0	1770.44	0.00	140.32	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	92.77	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	116.55	0.00	0.00
83	0.077	0	1770.4 4	0	0	1770.44	0.00	136.90	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	90.51	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	113.70	0.00	0.00
84	0.075	0	1770.4 4	0	0	1770.44	0.00	133.56	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	88.30	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	110.93	0.00	0.00
85	0.074	0	1770.4 4	0	0	1770.44	0.00	130.30	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	86.14	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	108.22	0.00	0.00
86	0.072	0	1770.4 4	0	0	1770.44	0.00	127.13	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	84.04	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	105.58	0.00	0.00
87	0.070	0	1770.4 4	0	0	1770.44	0.00	124.02	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	81.99	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	103.01	0.00	0.00
88	0.068	0	1770.4 4	0	0	1770.44	0.00	121.00	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	79.99	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	100.50	0.00	0.00
89	0.067	0	1770.4 4	0	0	1770.44	0.00	118.05	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	78.04	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	98.05	0.00	0.00
90	0.065	0	1770.4 4	0	0	1770.44	0.00	115.17	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	76.14	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	95.65	0.00	0.00
91	0.063	0	1770.4 4	0	0	1770.44	0.00	112.36	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	74.28	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	93.32	0.00	0.00
92	0.062	0	1770.4 4	0	0	1770.44	0.00	109.62	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	72.47	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	91.04	0.00	0.00
93	0.060	0	1770.4 4	0	0	1770.44	0.00	106.95	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	70.70	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	88.82	0.00	0.00
94	0.059	0	1770.4 4	0	0	1770.44	0.00	104.34	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	68.98	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	86.66	0.00	0.00
95	0.057	0	1770.4 4	0	0	1770.44	0.00	101.79	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	67.30	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	84.54	0.00	0.00
96	0.056	0	1770.4 4	0	0	1770.44	0.00	99.31	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	65.65	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	82.48	0.00	0.00
97	0.055	0	1770.4 4	0	0	1770.44	0.00	96.89	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	64.05	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	80.47	0.00	0.00
98	0.053	0	1770.4 4	0	0	1770.44	0.00	94.53	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	62.49	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	78.51	0.00	0.00
99	0.052	0	1770.4 4	0	0	1770.44	0.00	92.22	0.00	0.00	0	1170.4 4	0	0	1170.44	0.00	60.97	0.00	0.00	0	1470.4 4	0	0	1470.44	0.00	76.59	0.00	0.00

