Northumbria Integrated Drainage Partnership

NIDP South Stanley and Craghead Stage 2 SN019/0143-2.1.1

Stage 2 Diagnostic Study Report
February 2021

Client: NIDP

Project: South Stanley & Craghead Stage 2 Diagnostic Study

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South Stanley & Craghead NIDP Stage 2 Diagnostic Study and Identification of Opportunities

Project Overview: The South Stanley and Craghead NIDP Project aims to reduce flooding risk from surface water and combined drainage systems as well as provide wider benefits to the area including improved strategic drainage, investment in the local area, alignment with redevelopment, and enhancement to the local biodiversity, habitats, and green infrastructure.

The project included data collection, model updates to include surface overland flow routes, validation of existing issues, confirmation of flood risk, identification and optimisation of solutions, risk characterisation and an economic assessment of costs and benefits.

Partnership Project between:

Durham County Council

NORTHUMBRIAN WATER living water

Environment Agency

Opportunities in the area have led to a range of solutions including separation of highway drainage and connection to surface water systems, rain gardens, bunds, attenuation of surface water, attenuation on the combined drainage network, and improvements to the existing drainage network.

Costs

Opportunity Area	Cost Estimate	Potential Funding via FCERM GiA	Additional Funding Required
Park Road	£4,528,000	£4,100,000	£420,000
Avon Road	£3,986,000	£3,700,000	£260,000
Cookson Place	£838,000	£530,000	£310,000
The Middles	£472,000	£705,000	-
Total	**£9,824,000**	**£9,035,000**	**£990,000**

Benefits

	1142	Properties with reduced flood risk
	575	Properties moved EA Flood Risk Category
	89	Properties that have reported flooding with reduced flood risk
	0.88 ha	New habitat and improved biodiversity
	13.3 ha	Runoff area reduction, that no longer drains to treatment
	112 No.	Reduced CSO spills per year
	58,600 m^3	Reduced CSO spill volume per year
	10,200 m^3	Additional surface water discharged per year to the Stanley Burn rather than conveyed by the combined drainage system
	Improved	Attenuation of surface water runoff and CSO spill reductions support WFD investigation recommendations
SOAF	Reduced	CSO spill reductions support NWG's Storm Overflow Assessment Framework
	£24 M	Property Flood Damages Avoided
	£4 M	Additional Benefits Identified
	4 schemes	Included in the EA's Medium Term Plan
	2:1	Benefit Cost Ratio
	Regeneration	Investment in an area with planned redevelopment and potential to align works
	Green Infrastructure	New assets that support flood risk reduction while offering opportunities for education, health, and well being
	Partnership Project	Funding Potential from EA's FCERM GiA, EA's Local Levy, Council Investment, NWG Investment

Flood Risk Reduction by Area

Opportunity Area	Properties with reduced flood risk	Properties moved EA Flood Risk Category	Properties that have reported flooding with reduced flood risk
Park Road	551	242	27
Avon Road	421	257	49
The Middles	86	46	9
Cookson Place	84	30	4
Total	**1142**	**575**	**89**

Look ahead for Planning Team and New Development Approvals

Opportunity Area	Action	Possible Timeline
Park Road	There are proposals to develop the farmland to the south of Hustledown Road, at the proposed location for Option A5 attenuation basin. The NIDP solution could be incorporated into the drainage for this development. **Alignment of works by the developer and with the NIDP project would lead to efficiencies and reduce any rework in the future.**	2021 – to be confirmed

2. STUDY OVERVIEW

As part of the Northumbria Integrated Drainage Partnership, the South Stanley and Craghead Stage 2 Diagnostic Study is a joint partnership study between Durham County Council (DCC), the Environment Agency (EA), and Northumbrian Water (NWG) to manage surface water and reduce flood risk from a number of sources. The study also aims to understand current and future drainage issues in the area, share data, promote integrated sustainable drainage solutions, promote 'best possible' service to the public while balancing environmental needs and costs, and provide risk based evidence for future business planning.

Participants in this study include;

- Northumbrian Water Group (NWG) – Sewerage Service Provider
- Durham County Council (DCC) – Lead Local Flood Authority and Highway Authority
- Environment Agency (EA)
- Esh Stantec – Lead Consultant

NWG are responsible for the foul, combined and surface water sewer networks in the area. DCC are responsible for overland surface water runoff, culverted watercourses, ordinary watercourses, and highway drainage. The EA is responsible for main rivers.

Key individuals within the project are identified in Table 1.1.

Table 1.1 – South Stanley & Craghead NIDP Project Team

Name	Organisation	Role
Loren Jennings	Northumbrian Water Group	Investment Delivery Project Manager
Brian Weatherall	Durham County Council Council	Flood Risk Manager
Nicola Hyslop	Environment Agency	Lead Partnerships and Strategic Overview
Joe McCarty	Environment Agency	Strategic Studies Liaison
Craig Stephenson	Esh Stantec	Consultant Project Manager
Gwen Rhodes	Esh Stantec	Consultant Technical Lead
Sam Nelson	Esh Stantec	Project Modeller / Engineer

The project will be delivered in discrete stages:

- Stage 1 – Desktop study of existing data and prioritisation of opportunities
- Stage 2 – Diagnostic study and identification of future opportunities
- Stage 3 – Outline Business Case / Preliminary Design
- Stage 4 – Detailed Design
- Stage 5 – Construction

This report documents Stage 2, the diagnostic study and identification of future opportunities. Stage 2 includes data collection, model updates, review of the baseline flood risk, agreement of opportunity areas, opportunity identification, long list of options, solution testing, preferred solution identification, flood risk assessments, benefit assessments, cost estimates, and future programme development.

3. STAGE 1 RECOMMENDATIONS

An extensive data collection and review exercise was completed as part of Stage 1 of the South Stanley & Craghead Strategic Study (SN019/0143-2.1.1) and was completed in 2019. Following the data review exercise, a total of five opportunity areas were identified by the project team, which are:

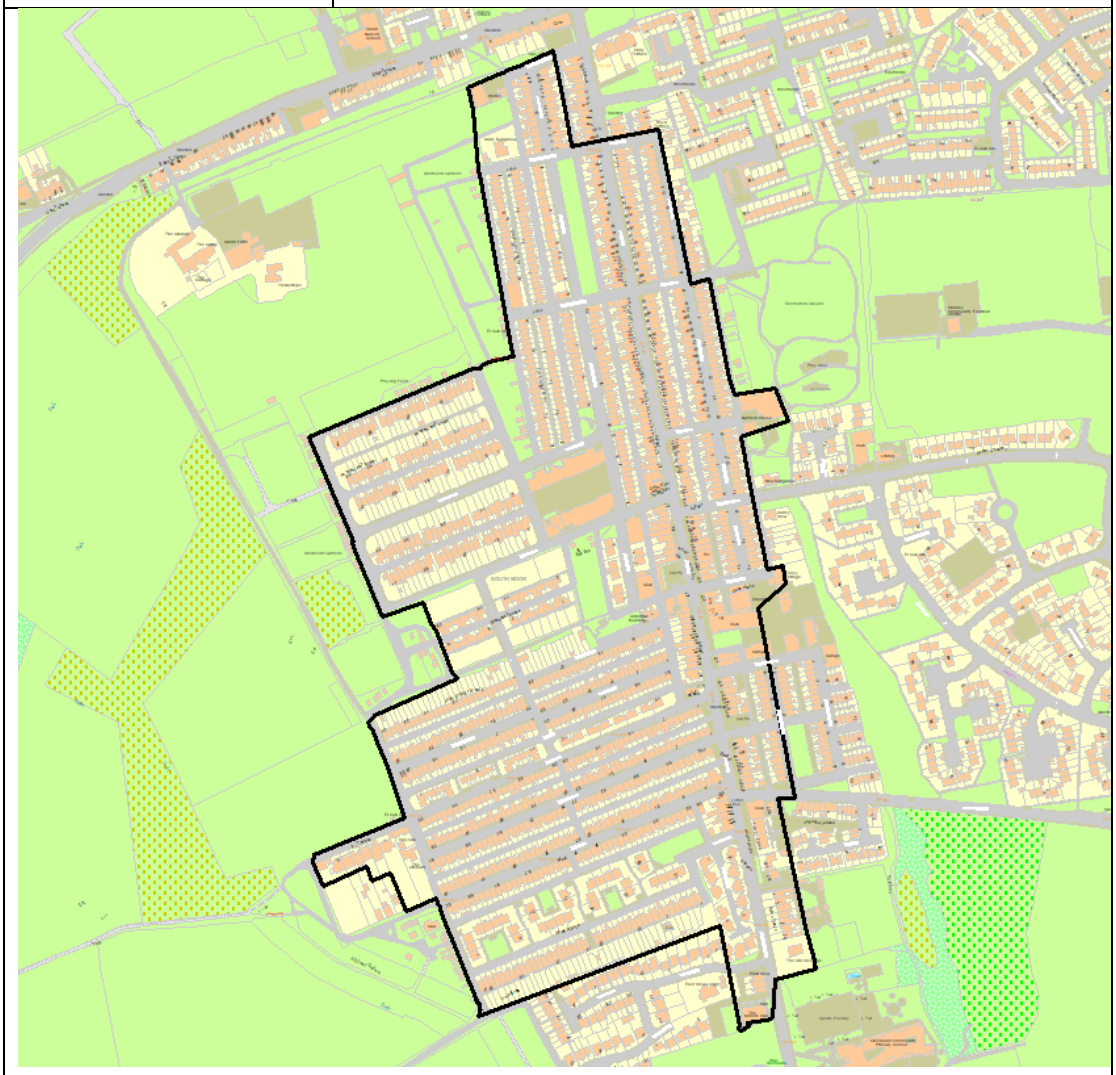
- Park Road/South Moor (Issue Refs 2, 5, 8 & 11);
- Avon Road (Issue Refs 3, 4, 12, 13 & 14);
- Cookson Place (Issue Refs 6 & 9).
- Middles Road (Issue Ref 7).

The Stage 1 deliverables and study plan are located on Sharepoint here: https://nwgcloud.sharepoint.com/sites/sn019-0143/default.aspx

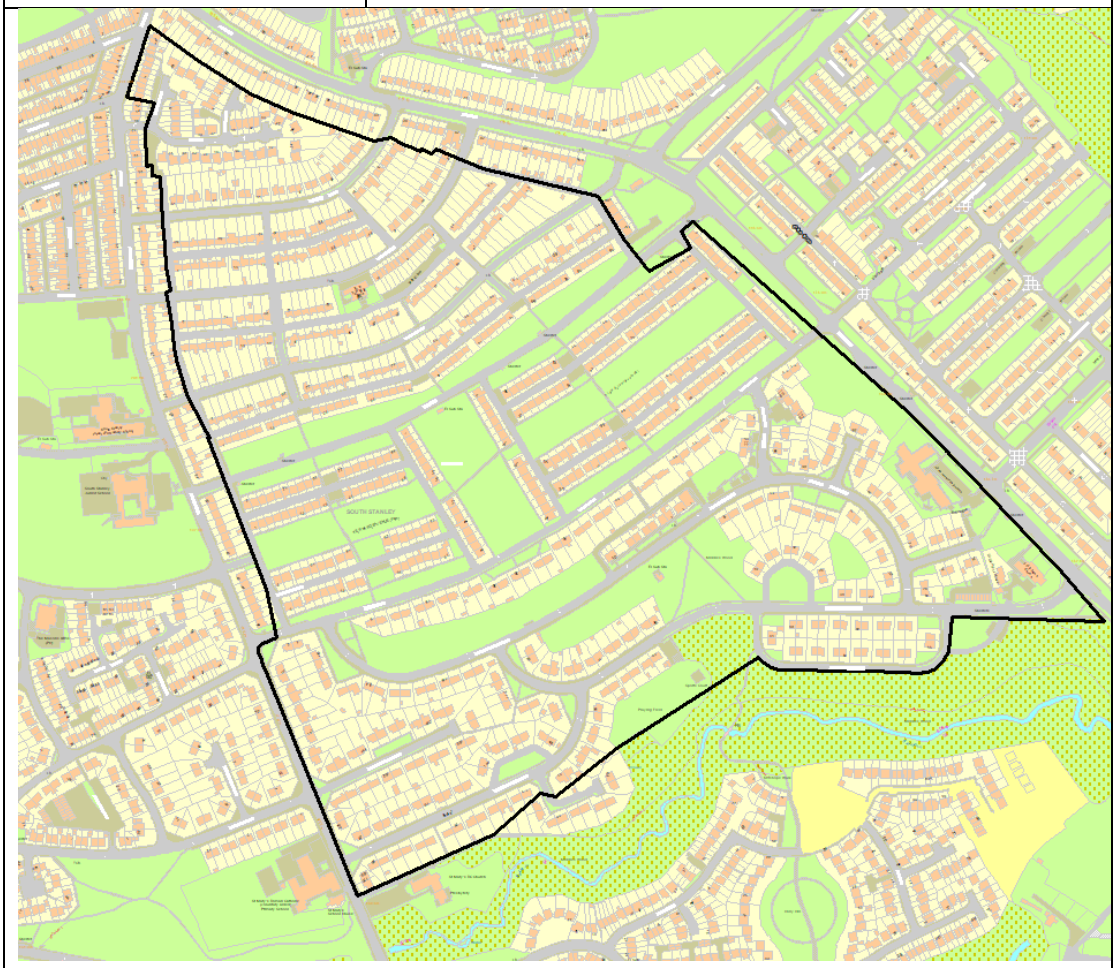
The Stage 1 Study recommended further data collection including:

- CCTV / connectivity surveys and desktop investigations of existing assets;
- Manhole survey data to locally enhance the NWG CAP sewer model;
- Survey of North Stanley Burn to identify any signs of pollution, cross connections, and any opportunities for habitat improvement.
- Integrated hydraulic assessment of sewers, overland flow from greenfield runoff and 2D modelling of overland flow paths;
- Produce outline solutions to reduce flood risk to all parties;
- Define the benefits to each stakeholder; and
- Produce outline cost estimates of the preferred options.

4. OPPORTUNITY AREAS

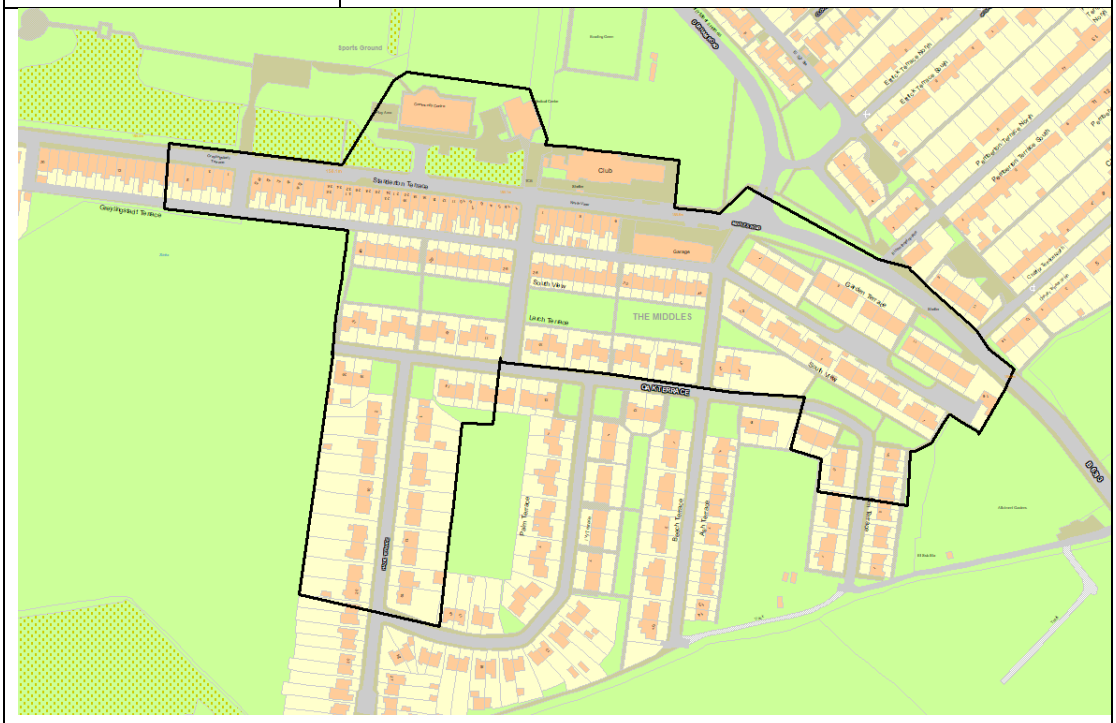
Opportunity Area	Park Road
	
Description of area	This opportunity area is located within the central and western part of the South Stanley and Craghead Drainage Area (07-D14) and spans approximately 27 ha with a population of around 3800. The urban area is of high-density residential areas with commercial buildings mostly along Park Road itself. The study area slopes very heavily towards the south.
Existing drainage of area	The area is predominately served by a combined network. A small amount of the storm network is present and drains to a culverted watercourse which flows west to east through the opportunity area, discharging to the Stanley Burn. The combined network flows into a sewer located in Park Road and flows south to a bifurcation at NZ19510601

	From here, continuation flows head east towards Husltedown Road CSO (NZ19513622). In larger events flows can spill south, and flow towards East View CSO (NZ19510401). All spill flows discharge to the Stanley Burn watercourse (which becomes the Twizell Burn east of The Middles opportunity area).
Reported Issues	• Internal flooding predicted at South Moor Road, Poplar Street, Elm Street, Park Street, John Street, Moore Street, Oliver Street and Eyre Street • Park Road and South Moor reported by DCC to suffer from flooding during rainfall. Approximately ten properties reported internal flooding. • Internal and curtilage flooding reported to NWG • Retrofit SuDS have been delivered in a number of streets including Pine Street, Schemes include large-scale planters and rain gardens on the side of the road. • Issues can also be located on the plan, 41526482-01-GIS-0001 (Appendix A)
Previous Studies	The Water Hub – South Moor rain gardens and planters - 2017 NWG WFD Phase 1 Study (2016) and Phase 2 Study (2017) Twizell Burn

Opportunity Area	Avon Road
	
Description of area	This opportunity area is located in the centre of the South Stanley and Craghead drainage area (07-D14) and spans approximately 37 ha with a population of around 1700. The urban area is of medium-density residential areas with numerous areas of greenspace. The study area slopes steeply towards the south.
Existing drainage of area	The area is predominately combined. A small amount of the storm network present in the Southern area of the study area drains to the Stanley Burn Watercourse. The combined sewer which takes flows from the west of the drainage area and south west opportunity area flows through Holly Hill Gardens South Moor CSO (NZ19519907). Flows continue east towards Holly Hill Gardens CSO (NZ20513907). Flows from the rest of the opportunity area also pass through this CSO. (From here flows continue towards Hustledown Sewage

	Treatment Works. All spill flows discharge to the Stanley Burn.
Reported Issues	• Internal, highway and curtilage flooding reported to NWG • Internal property flooding predicted at Tees and Marx Crescent, Tweed and Lenin Terrace, Holly Hill Gardens and Avon Road. • Holly Hill Gardens – NWG PLP Programme – Internal and external residential property flooding. CSO is also known to be a frequent spiller. Issues can also be located on the plan, 41526482-01-GIS-0002 (Appendix A)
Previous Studies	Holly Hill Gardens Property Level Protection – No. 103 Holly Hill Gardens has been provided with a rear flood door to prevent internal flooding. Nos. 57, 104, 110 & 111 were also reviewed under the PLP programme but deemed unable to protect due to passed on risk. NWG WFD Phase 1 Study (2016) and Phase 2 Study (2017) Twizell Burn Wear Rivers Trust – Surface Water Management Twizell Burn, Stanley, May 2017 NWG Cause Report

Opportunity Area	Cookson Place
	
Description of area	This opportunity area is in the eastern part of the South Stanley and Craghead drainage area (07-D14) and spans just under 2 ha with a population of around 140. Cookson Place is a small cul-de-sac adjacent to the North Stanley Burn. It consists of 64 properties and is surrounded by green space. It is at the bottom of a very steep wooded slope down from Humber Hill.
Existing drainage of area	The drainage in this area is separate with the storm flows draining into North Stanley Burn. The foul network connects into the combined system which flows towards the nearby Husteldown Sewage Treatment works.
Reported Issues	• EA surface water flood maps predict flooding to15 properties. • Stanley is highlighted as a key Surface Water Risk Area as outlined in DCC surface Water Management Plan. • NWG has had reports of internal and curtilage flooding. This has been attributed to blockages in the sewers. Issues can also be located on the plan, 41526482-01-GIS-0003 (Appendix A).
Previous Studies	None

Opportunity Area	The Middles
	
Description of area	This opportunity area is in the South-Eastern part of the South Stanley and Craghead drainage area (07-D14) and spans just over 6 ha with a population of around 140. This area is mostly residential with a handful of commercial properties and a school along Greylingstadt and Standerton Terrace. There are pockets of greenspace in the area and on the outskirts, are Craghead Millenium Green / sports ground and approximately 4ha of farmland.
Existing drainage of area	The drainage in this area is predominantly served by a combined sewer system. A number of streets are shown to be partially separate with highway drainage and front of properties connecting to surface water sewers which discharge to the Stanley Burn to the north. The combined sewers flow towards The Middles Durham Road CSO 14 (NZ20517602) with spill flows entering the Stanley Burn, which becomes the Twizell Burn approximately 0.5 km downstream.
Reported Issues	• The Middles / Greylingstadt Terrace - Flooding reported in 2012 / 2013. Flows from permeable surfaces to the south unable to enter the culvert, resulting in flooding of the highway. Fields and culvert entrances are privately owned. Some recent ditch clearing has been undertaken in response to a request from DCC. • Highway and curtilage flooding reported to NWG. Issues can also be located on the plan, 41526482-01-GIS-0004 (Appendix A).
Previous Studies	None

5. UNDERSTANDING THE ISSUES

Following on from the desktop data collection at Stage 1, Stage 2 includes targeted data collection and model updates to better represent the existing drainage systems and reported flooding. These updates improve the understanding existing flood risk and will allow for successful solution development.

The following tasks were completed and are described in the sections below:

- Data collection to understand connectivity, capacity, and drainage assets;
- Hydraulic model updates to utilise additional data, add detail in the opportunity areas, and improve model confidence;
- Baseline model assessment to replicate current issues and understand a range of flooding mechanisms;
- Present day and 2040 scenarios were created, and models run for a set of rainfall events;
- Flood risk assessment to compile model results, identify worst cases, and analyse locations of flood risk; and
- Review and agreement of areas to progress.

A site visit was planned for Spring 2020, but did not occur due to restrictions related to the COVID-19 pandemic. A site visit to identify flow routes, key features to include in the model, and potential options in each area was not completed. A site visit did occur during the data collection phase and also as part of NWG's PLP programme. Mapping tools, aerial photos, and knowledge from DCC were utilised. A site visit will be planned for the next phase of works.

5.1 Data Collection

In Stage 2, various survey works were undertaken to increase confidence in the hydraulic model in the study areas. A total of 71 manhole surveys, six outfall and five CSO surveys were completed by 360 Mapping in September 2019, and CCTV, connectivity and gulley tracing surveys by Kilbrides in August 2019. A watercourse cross section survey of the North Stanley Burn near Cookson Place opportunity area was completed by 360 Mapping in December 2019.

5.1.1 *Park Road Data Collection*

The following data collection was completed in the Park Road opportunity area:

- 28 manhole surveys were requested for Park Road. The manholes identified for survey were those that held potential separation opportunities and where confirmation of levels and pipe sizes were needed.
- Also included in the request, were four CSO surveys to gain confidence of levels and further CSO information.
- Gully tracing was carried out in sections of highway at Poplar Street and John Street to identify potential presence of surface water sewers that were not

mapped on GIS. The survey confirmed the presence of highway drainage in these streets, which connect to the combined sewer.

5.1.2 *Avon Road*

The following data collection was completed in the Avon Road opportunity area:

- A total of 15 manhole surveys were requested. These manholes were deemed key manholes or to have potential to be utilised for surface water separation opportunities.
- Also included in the request, was one CSO survey to gain confidence of levels and further CSO information.
- Gully tracing was carried out in Holly Hill Gardens West highway to identify potential presence of surface water sewers that were not mapped on GIS. The survey showed the highway to be partially separate with some gullies connecting to the combined and others connecting to an unmapped surface water drainage which eventually discharges to the Stanley Burn to the south.
- Connectivity survey was completed at St Marys RC Primary School to identify any separation opportunities and to confirm where drainage connected to. The survey showed the school to be combined.

5.1.3 *Cookson Place Data Collection*

The following data collection was completed in the Cookson Place opportunity area:

- A total of 13 manhole surveys were requested. These manholes were deemed key manholes around main flooding areas or where confirmation of levels and pipe sizes were needed.
- Watercourse cross section and three outfall surveys along the North Stanley Burn were requested. The survey results were used to create an integrated 2D model.
- Connectivity of seven properties at Cookson Place was completed to confirm where foul flows connected to due to limited GIS in this area.
- Connectivity survey was also completed at Burnside Primary School to identify any separation opportunities and to confirm where drainage connected to. The survey showed the school was served by a separate system, which connects into the combined sewer and is a potential separation opportunity.
- CCTV survey was completed on the surface water sewer between NZ20525110 and NZ20527101 to determine the diameter and condition of the sewer as well as any incoming connections.

5.1.4 *The Middles*

The following data collection was completed in The Middles opportunity area:

- A total of 15 manhole surveys were requested. These surveys were to obtain definite levels of key manholes and potential opportunities for surface water separation.

- Two inlet surveys were requested at the inlets to the culverted watercourse and one outfall survey was requested.

- Connectivity survey was also completed at Bloemfontein Primary School and Craghead Social Club to identify any separation opportunities and to confirm where drainage connected to. The survey showed the school and club to be combined except for the southern side of the school play yard which discharges to a ditch to the south.

5.2 Hydraulic Model Updates

An existing Infoworks ICM hydraulic model for the South Stanley & Craghead drainage area (05-D35), which was updated and verified in some areas as part of NWG's CAP programme, was provided by NWG for use in this study. The following updates were made to the hydraulic model as part of this Stage 2 study;

- Manhole survey data collected as part of this study was added to the hydraulic model. Stantec attended site for The Middles surveys due to conflicting data around the sewerage arrangement between the model / GIS and a previous third party connectivity survey.

- Five CSO surveys were completed across Park Road and Avon Road Opportunity Areas. This information was utilised to supplement drawings of these assets.

- Cross sectional surveys were completed at three various points along the North Stanley Burn. This data was then used to better represent the channel.

- Three outfall surveys were completed near Cookson Place where the storm sewer discharges into the North Stanley Burn. Two inlet and one outfall surveys were completed at The Middles. The model was updated with the returned data.

- Gully tracing surveys helped identify gully locations and confirm which sewer they drained. The surveys also confirmed the presence of surface water sewers that were not mapped on GIS in the Park Road and Avon Road areas.

- CCTV surveying was completed on a section of storm sewer adjacent to Cookson Place to confirm pipe diameters and condition.

- Connectivity surveys were conducted on Stanley Burnside Primary School, St Marys RC Primary School, Bloemfontein Primary School and Craghead Social Club to obtain details of private drainage and help to understand the contributing flows from these areas.

- Subcatchment detail further enhanced in Park Road and Avon Road. Subcatchment detail in The Middles and Park Road was already at a good level from the existing model.

A 2D model of the NIDP Study Area was created in InfoWorks ICM to allow an assessment of overland flow paths. The following improvements to the 2D model were completed:

- Ground model created from available 1m, 2m and 5m resolution DTM data.
- Assessment of ground model using Arc Hydro to determine contributing areas (runoff from green spaces) and overland flow paths. This was used to size the 2D zone defined in the hydraulic model.
- In order to generate runoff in open green space, a method was developed to apply rainfall directly and utilise the NewUK runoff to slow flow and allow some losses that can vary with initial conditions and with time.
- Buildings have been included in the 2D model as porous polygons, to force flow to route around the properties. Building polygons were extracted from MasterMap data.
- All properties were assumed to have a 150mm threshold.

5.3 Performance Assessment

Stage 2 model simulations were completed for the design storm events agreed by the project team. These events were 5, 10, 15, 20, 30, 40, 50, 75, 100, 200 year return periods for summer and winter events for 3 durations (short, medium, long). As the design is progressed at a later stage, additional durations will need to be completed. The following models were created. In addition, revised FEH13 rainfall should be utilised at the next phase. The following models were created.

Table 5.3.1 – South Stanley and Craghead Strategic Study Models

Scenario Reference	Model Reference	Description	Comment
Base	MB04	Existing model. Assumes clean system. Recent developments are included.	Baseline
Base - Future	MB04 2040 CC	Creep and new developments modelled for 2040 design horizon and rainfall applied with a 20% uplift for climate change	2040 Design Horizon Baseline

***Note a Do Nothing (No Maintenance) scenario has not been modelled.

5.4 Baseline Assessment

Following data collection and model updates, the baseline model was run. The results were analysed to understand the flood risk from the different mechanisms and to identify where this is caused by a network incapacity within the drainage systems and / or overland flow issues.

5.4.1 *Park Road*

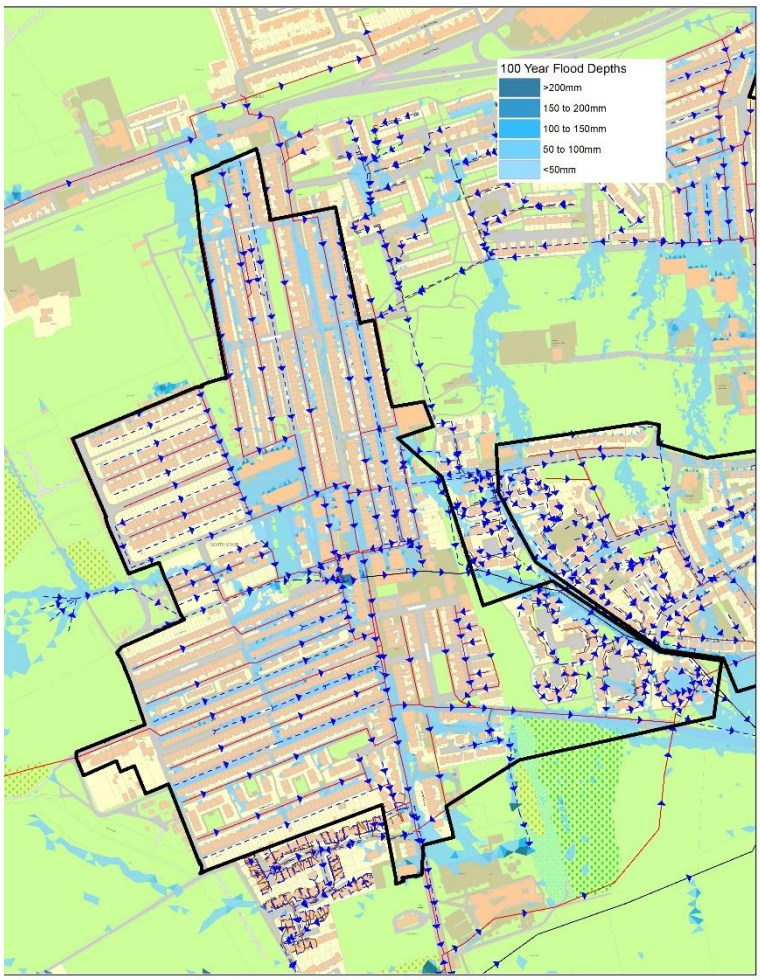


Figure 5.4.1 – Baseline Model Results at Park Road (1 in 100 year)

Figure 5.4.1 shows the maximum depth of flooding on the surface for a 1 in 100 year critical duration event for the baseline model at Park Road. The 2D model predicts flooding around Park Road and Rydal Avenue due to incapacity in the combined sewer system. Flooding from manholes flows overland and heads south pooling in Park Road. Flood risk in the area is due to overland flow and surcharge on the combined sewer. In longer duration storm events, flooding is also predicted from overland flow from fields west of Rydal Avenue which aligns with the EA surface water flood mapping. An unreported flow path is predicted from fields to the north of Windermere Terrace which overland flows south. The study area boundary was extended east to include properties on South Fields which are predicted to be at risk from flooding from the culverted watercourse which passes through the opportunity area. As shown on the problem definition plan (41526482-01-GIS-0001, Appendix A), the predicted flooding aligns with reported flooding in the area.

5.4.2 *Avon Road*

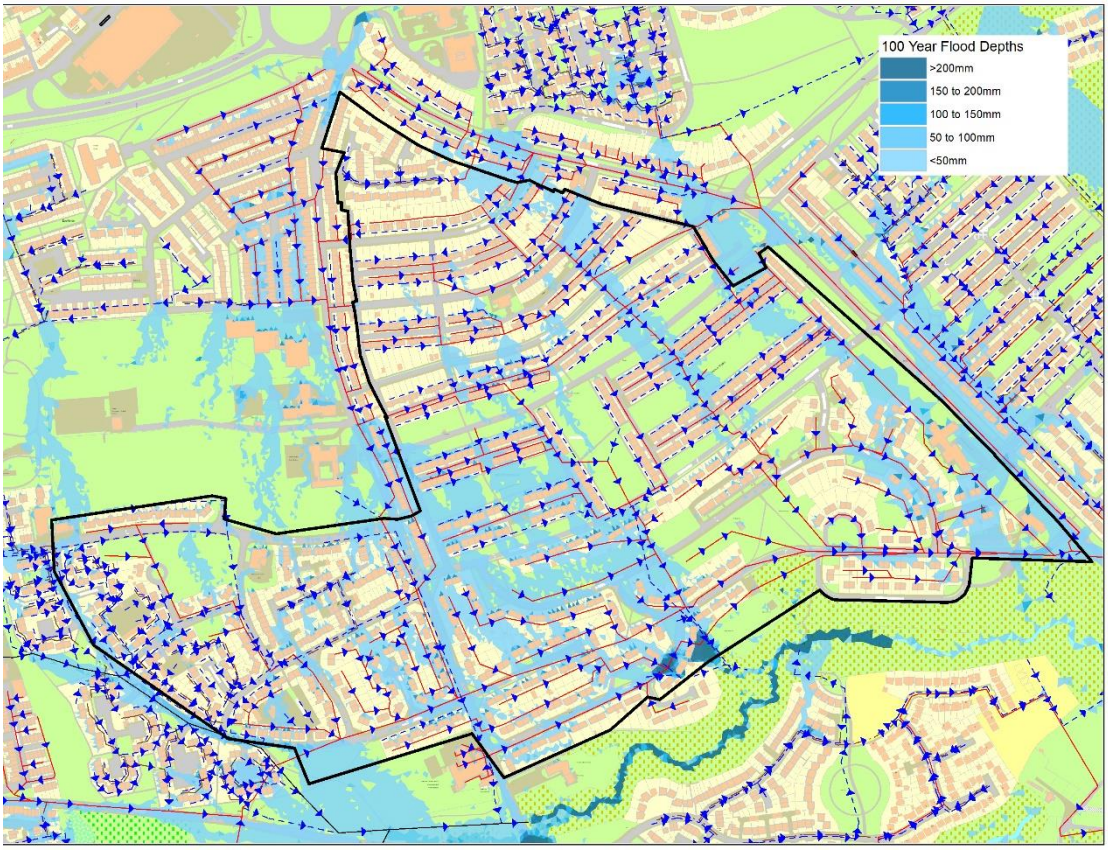


Figure 5.4.2 – Baseline Model Results at Avon Road (1 in 100 year)

Figure 5.4.2 shows the maximum depth of flooding on the surface for a 1 in 100 year critical duration event for the baseline model at Avon Road. The 2D model predicts flooding across the catchment due to incapacity on the combined sewer. Flooding is predicted to flow overland heading southwards, due to the steep catchment and is predicted to pool around Holly Hill Gardens West. Flooding is also predicted from the combined sewer in this area, upstream of Holly Hill Gardens South Moor CSO (NZ19519907). This is a known issue with properties included on the NWG PLP programme due to internal and external flooding. The model also predicts an unreported overland flow route from South Stanley Junior School playing fields which would impact on properties to the south. The Avon Road opportunity area boundary was extended west to include properties impacted by this overland flow route. As shown on the problem definition plan (41526482-01-GIS-0002 Appendix A), the predicted flooding aligns with reported flooding in the area.

5.4.3 *Cookson Place*

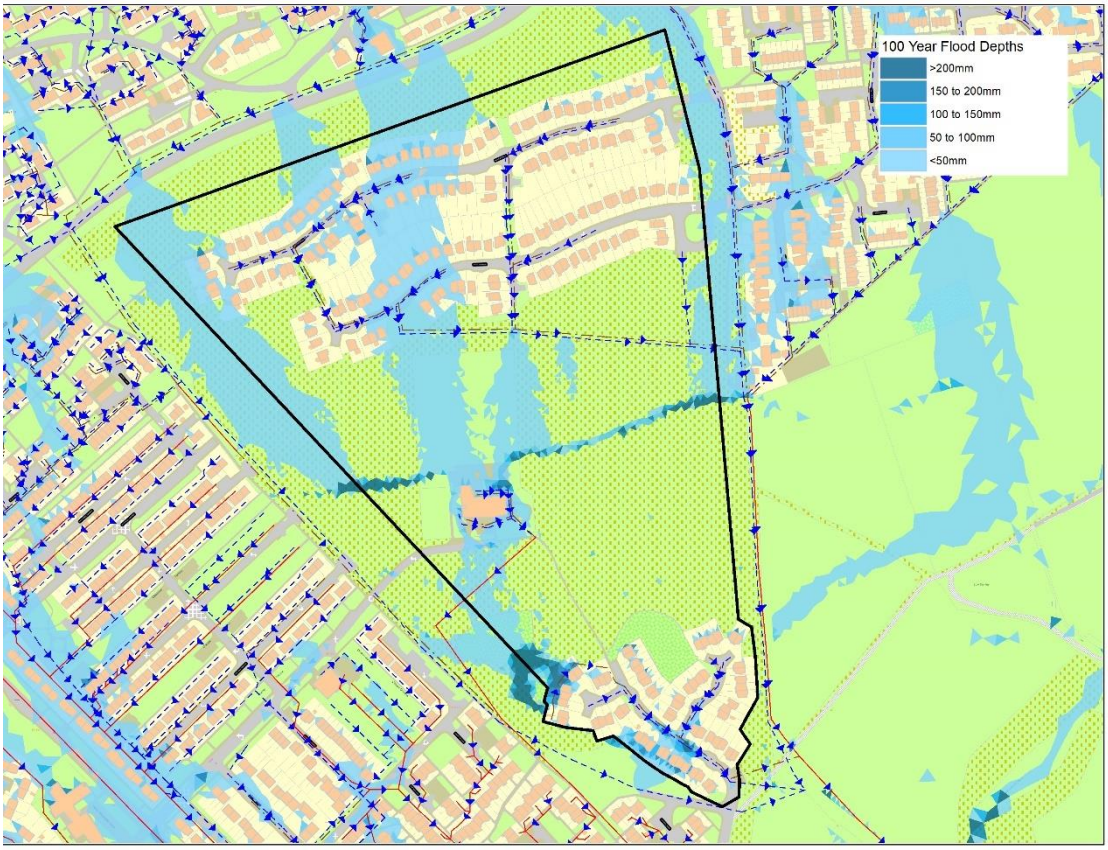


Figure 5.4.3 – Baseline Model Results at Cookson Place (1 in 100 year)

Figure 5.4.3 shows the maximum depth of flooding on the surface for a 1 in 100 year critical duration event for the baseline model at Cookson Place. The 2D model predicts flooding from the surface water system on Humber Hill would overland flow southwards, pooling at Cookson Place. This overland flow route is also predicted to impact on properties on Mowlam Drive, Sheridan Drive and Stanley Burnside Primary School. The model also predicts overland flow from greenspace to the north of Cookson Place would cause flooding in long duration events. The EA surface water maps had also predicted risk to 15 properties in this area. Locally, flooding is also predicted on the combined and surface water sewers to the west, with flooding predicted to flow overland and pool at Cookson Place. The study area boundary was extended northwards to include properties impacted by the Humber Hill overland flow route. As shown on the problem definition plan (41526482-01-GIS-0003, Appendix A), the predicted flooding aligns with reported flooding in the area.

5.4.4 *The Middles*

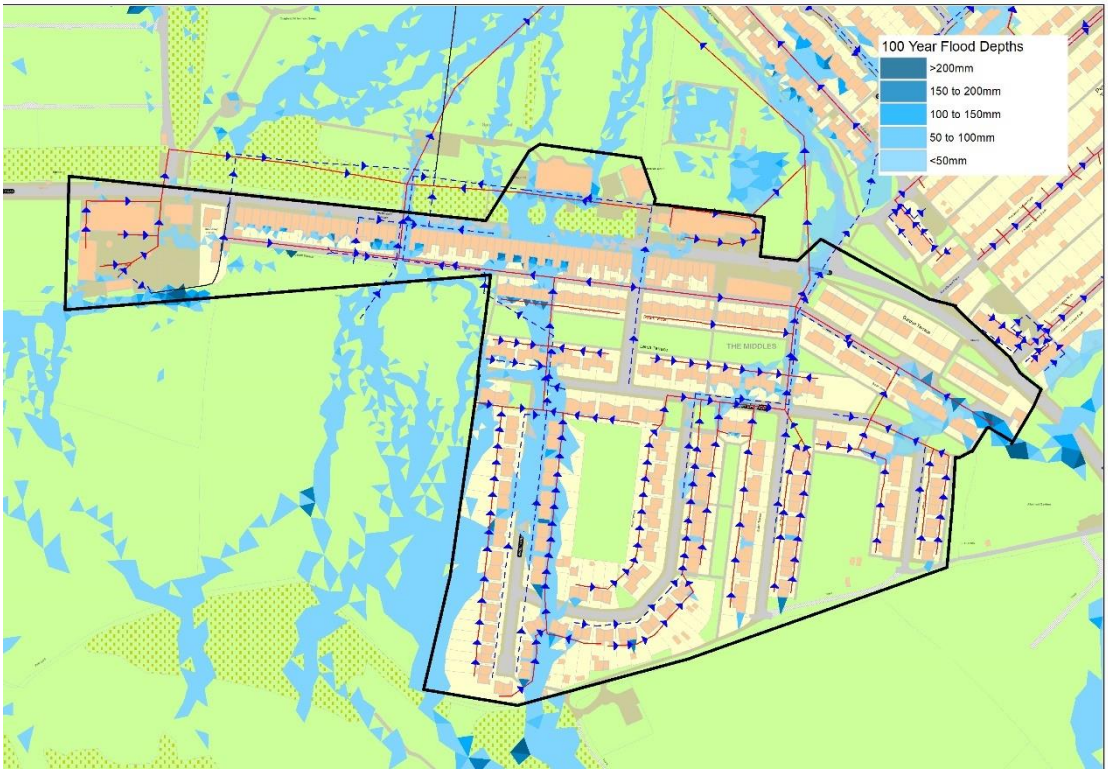


Figure 5.4.4 – Baseline Model Results at The Middles (1 in 100 year)

Figure 5.4.4 shows the maximum depth of flooding on the surface for a 1 in 100 year critical duration event for the baseline model at The Middles. The model predicts, in long duration events, overland flow from fields to the south overland flow towards Greylingstadt Terrace, between a gap in the wall. This overland flow route is confirmed by DCC who have reported flooding in this area. The model also predicts incapacity on the combined sewer system which runs along Greylinstadt Terrace and is predicted to cause surcharge flood risk to properties. As shown on the problem definition plan (41526482-01-GIS-0004, Appendix A), the predicted flooding aligns with reported flooding in the area.

5.5 Flood Risk Assessment

Updates to the existing model and replicating reported issues in the area were a milestone within the project. These model outputs were used to complete a flood risk assessment across the range of events. Flood risk is assessed by the EA for 20, 30, 75, 100, and 200 year return periods to correspond with the very significant, significant, intermediate, moderate, and low risk bands respectively. Flood risk is assessed by NWG for 5, 10, 15, 20, 30, 40 year return periods. In addition, a 50 year RP was run to input into the damages assessment.

5.6 Stage 2 Interim Memo

The baseline flood risk and residential properties that potentially would benefit from a solution were reviewed. Esh Stantec provided a Stage 2 Interim Memo (Appendix B) summarising this information for each opportunity area.

For Stage 2 the project partners agreed to progress all four opportunity areas.

6. OPPORTUNITIES

For each opportunity area, a long list of options was considered that include a range of solutions such as catchment wide strategic solutions, localised flooding solutions, sustainable urban drainage opportunities, above ground attenuation, below ground storage solutions and upsizing of drainage networks. All of the options considered for an area have been compiled into a 'Long List of Options'.

From this long list, many factors were considered to determine the best options to take forward in a short list and as a preferred solution; model results, flood risk reduction, land use, disruption, cost were considered. The options agreed to be most viable are discussed in more detail in Sections 6.2 – 6.5.

An economic assessment was then completed for the preferred solutions. This assessment analysed the cost of the project (or the investment to the area), the damages avoided due to flood risk reduction, and the wider benefits such as biodiversity, amenity, or recreation.

6.1 Method

6.1.1 *Long List of Options*

A long list of options was compiled and is included in sections 6.2 – 6.4. This list includes a comprehensive list of options that considers ways to change the source, modify the pathway, manage or modify receptors with the aim of reducing flood risk, improving drainage, and making use of available space for surface water attenuation. Every combination of options was not modelled. The minimum number of options were progressed to achieve widespread flood risk reduction. The effectiveness of options was tested, and options were altered or eliminated if flood risk reduction was not achieved. Options were considered to allow for adaptation to future changes in risk. strategic and catchment changing options were identified where appropriate to consider long term betterment and incorporation of future development.

6.1.2 *Preferred Options*

Preferred options and ideas were discussed with the project partners and variations were tested within the hydraulic model to maximise benefits. Options with greater environmental and social benefits were prioritised where possible. Discussions of option development from meetings were recorded in the Collaboration Tool, which is included in Appendix C. All options will require further development and stakeholder engagement.

6.1.3 *Geological Data*

A geotechnical desk study report was carried out as part of the Stage 2 Study for The Middles and Cookson Place opportunity areas and is included in Appendix D. Note due to the large extents of Avon Road and Park Road opportunity areas, a desk study was not completed.

Cookson Place:

- The site is shown to lie within an area with potential for groundwater flooding to occur at surface.

- Potential for ground gas due to areas of infilled ground

- Potential for Made Ground across the site associated with residential development and infilled land.

The Middles:

- The opportunity area is shown to lie within an area with potential for groundwater flooding to occur at the surface.

- Made Ground is mapped in the northern area associated with former refuse and slag heaps. There is also the potential for ground gas associated with this made ground.

The following recommendations from the geotechnical desk study:

It is recommended that a ground investigation be undertaken at the sites to evaluate and mitigate the potential risks:

- to determine the nature, sequence and geotechnical properties of the strata likely to be encountered within the depth of the proposed works;
- to identify areas of land which might affect health and safety requirements during both the ground investigation and construction works, and to assess the long-term integrity of the structures;
- to determine the groundwater conditions beneath the sites;
- to determine the ground gas conditions beneath the sites;
- to determine the presence of potential contaminants, material suitability for reuse and or hazardous materials at the sites; and
- to provide installations for recording and monitoring groundwater levels, ground gases and sampling of the groundwater if required.

A geotechnical desk study for the solution locations at Park Road and Avon Road opportunity areas should be completed once there is more certainty that the study will progress to the next phase.

6.1.4 *Ecological Information*

An environmental screening was carried out by NWG. This identified:

- Protected species – further surveys required once a specific working area is determined.
- Historic Environment Record Check – DCC archaeology team to be contacted for any archaeological interest within opportunity areas.
- BAP species or habitat – further surveys will be required once a specific working area is determined.
- Invasive Species – further surveys required.
- TPO / Hedgerow consents required.

A site specific ecological study should be carried out during Stage 3 to identify the risks and opportunities to ecology with regards to the proposed works.

6.1.5 *Utility Services*

Utility services information was requested for all the Opportunity Areas. This information was utilised in the option development process.

Further review of the utility crossings, potential diversion requirements, GPR surveys, and trial holes should be carried out during Stage 3 to identify risks and improve cost estimates.

6.1.6 *Flooding Damages*

Flood damage cost values were based on the Flood and Coastal Erosion Risk Management Handbook for Economic Appraisal (or "Multi-Coloured Handbook") (2020), noting that the National Receptor Database assigns a compatible "MCM code" defining the category of each receptor in the database. The difference between the baseline flood risk and the solution flood risk is the avoided damages, or the benefit of the scheme.

In addition to residential and non-residential property damages, the economic appraisal considers the following forms of damage or benefit based on the MCM method:

- Emergency services response costs; as per MCM (2020) guidance, this is assumed to equal 5.6% of total (capped) property damage costs.

Damages related to residential evacuation and emergency accommodation costs, privately-owned vehicle damage, and intangible health benefits to the economy associated with a reduction in flood risk to residential properties could be further assessed.

Sensitivity testing was completed to check the impact of a few locations with high surcharge predictions. A cap of 750 mm was applied to surcharge depths due to the steep nature of the catchments and some unrealistic depths.

6.1.7 *Additional Benefits*

Wider benefits were also reviewed for inclusion in the economic appraisal, where appropriate, using the methodology set out in the CIRIA Research Project RP993, Demonstrating the Multiple Benefits of SuDS (2015) and the B£ST Evaluation Tool (Release 5; July 19). Benefits that were assessed include:

- Air quality related to the addition of basins and trees;
- Amenity related to street improvements through greening;
- Biodiversity and ecology related to changes to land use by providing semi-wet areas, pockets of greenspace / habitat, and diversifying planting;
- Education by providing areas for use and discussion;
- Enabling development by providing new surface water drainage and reducing demand on the existing combined sewer network;
- Water quality related to the reduction in CSO spill frequency and volume; and

- Reduced area contributing runoff to the combined sewer.

A summary of the benefit assessment is included in Appendix I.

In addition, water quality improvements have qualitatively been summarised and CSO spill reductions have been quantified. These water quality improvements support the recommendations of the Water Framework Directive (WFD) catchment investigation of the Twizell Burn / Stanley Burn that was completed in 2017. Recommendations from that study included:

- continue to monitor CSO performance;
- high frequency spillers should be investigated further by NWG under the Storm Overflow Assessment Framework (SOAF); and
- continue to identify opportunities to work with other catchment partners to improve the watercourse resilience.

6.1.8 *EA Partnership Funding Calculator*

The EA's Partnership funding calculator for FCERM Grant-in-Aid spreadsheet (dated 2020) was completed in conjunction through discussions with the project partners. A version was provided in July 2020 for submission for the EA's 10 Year Medium Term Plan update. Following updates to solution modelling, 2040 design horizon modelling, and a review of cost estimates, an update of the FCERM GiA Calculators is included in Appendix F.

6.2 Options – Park Road

6.2.1 *Long list of options*

Solutions for this opportunity area will reduce flood risk from surface water runoff, reduce flood risk from the combined sewer system by removing surface water and improving capacity by providing combined storage, provide localised surface water attenuation, separate surface water flows from the combined system to reduce CSO spills, and provide a new strategic surface water route to the Stanley Burn.

Table 6.2.1 – List of Options Considered

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
A1	Do Nothing	No Cost	No	Does not resolve flooding issues
A2	Do minimum	Low cost – would provide basic maintenance of system	No	Would not resolve incapacity in the combined sewer network

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
A3	Bund in the field to the West of Rydal Avenue to attenuate flows on the surface until levels in the network allow these to enter system	Green solution which prevents flows from running towards properties and create new habitat	Yes	N/A
A4	Basin to grassed area to the West of Greenlands	Reduces flood risk	No	The gradient of this area made is difficult to attenuate any substantial volumes Additionally, risk of combined sewer surcharge from surrounding manholes posed a risk of contamination.
A5	Surface water removal in most surrounding streets. New surface water route to the Stanley Burn with attenuation before discharge	Reduce strain on combined network, reduce flood risk, and reduce flows to CSOs.	Yes	N/A
A6	Rain gardens in surrounding available green areas	Green solution which prevents flows from running towards properties in smaller return periods	No	New storm sewer provided.
A7	Rain gardens for roof drainage at School on Rydal Avenue	Provides capacity in combined system	No	Roof and paved area disconnected from combined and connected to new storm sewer. School site does not appear to be occupied.
A8	Combined sewer upsizing (Rydal Avenue / Park Road) and storage in grassed area on Parmeter Street	Increases capacity in combined system	Yes	N/A

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
A9	Bund in field north of Windermere Terrace to intercept overland flow.	Intercept overland flow, reducing flood risk to properties on Windsor Terrace	Yes	N/A
A10	Same as A5, except without the attenuation	Reduce strain on combined network, reduce flood risk, and reduce flows to CSOs. Does not require above ground storage in private land;	No	Discharge rate to Stanley Burn would be approximately 0.8 m^3/s, which may be detrimental to this small watercourse; No biodiversity benefits from attenuation; No water quality improvements from attenuation
A11	Same as A5 except instead of final 160 m of new surface water, the Stanley Burn culvert is daylighted and the pipework connects into the new section of watercourse	Daylighted watercourse that provides new habitat and increases watercourse resilience, reduces new pipework needed	No	More data needed on existing culvert, existing habitat, and land ownership

6.2.2 *Short list of options and Preferred Options*

Option A3 involves constructing a bund in the field west of Rydal Avenue (110 m long and 200 mm high) to encourage overland flow to enter the field drainage system. Approximately 45 m^3 would be attenuated behind the bund in a 100 year return period event.

Option A5 involves constructing 2.4 km of new surface water sewers along Park Road, Rydal Avenue, School Terrace, School Lane, Fern Avenue, William Street, Pine Street and Hustledown Road. The new storm sewer will also pick-up existing storm sewer connections in these areas which currently connect to the combined sewer. A total of 2.99 ha of highway, 1.8 ha of roofs that currently discharge to the highway, and 1.76 ha green areas will be removed from the combined sewer network. Flows from the new storm sewers are conveyed east along Hustledown Road in a new 600 mm diameter sewer to a 2030 m^3 attenuation basin located in farmland to the south of Hustledown Road with flows controlled to 20 l/s. Flows from the attenuation basin continue east along Hustledown Road for 245 m before discharging to the Stanley Burn via a new outfall. Note the proposed location for the attenuation basin is within land earmarked for development, within the next 5 years. The development reference is *Land off Hustledown Road* (18NO5543D0). The developers should be contacted to see if this basin could be incorporated into the SUDS features of the site.

Option A8 consists of upsizing 178m of the existing combined sewer on Rydal Avenue, Park Road and Bridge Street. A new relief weir will be constructed at manhole NZ18519804 to allow flows to spill to a new 600mm combined relief sewer which conveys flows south along Park Road, east along Mundell Street and south along Parmeter Street to a new combined storage tank (420 m³). Flows discharge to existing combined manhole NZ19511602 at a controlled rate of 50 l/s.

Option A9 comprises a bund along the field boundary to the north of Windermere Terrace (240 m long and 1 m high). Approximately 440 m³ would be attenuated behind the bund in a worst case 100 year event. Flows will discharge to the new storm sewer at Windermere Terrace (Option A5) at a controlled rate of 5 l/s.

The proposed options are shown on '41526482-01-GIS-4005 – Park Road Solution Plan'. See Appendix E.

6.2.3 *Options Summary*

Option	Option Ref.	Summary
Bund in the field to the West of Rydal Avenue	A3	• Bund 110 m long and 200 mm high • 10 trees on the edge of the field • 45 m³ formalised storage behind bund
Surface water removal in most surrounding streets, and new surface water route to the Stanley Burn	A5	• 288 m of 150 mm surface water sewer • 566 m of 225 mm surface water sewer • 512 m of 300 mm surface water sewer • 158 m of 375 mm surface water sewer • 53 m of 450 mm surface water sewer • 855 m of 600 mm surface water sewer • New outfall surface water outfall to the Stanley Burn • 2030 m³ attenuation basin with a 20 l/s control • 49 New manholes

Option	Option Ref.	Summary
Combined sewer upsizing and storage	A8	• Upsize 11 m of combined sewer to 300 mm • Upsize 241 m of combined sewer to 450 mm • 5 m of 200 mm combined sewer • 12 m of 225 mm combined sewer • 134 m of 600 mm combined sewer • 420 m³ combined gravity returned tank • Hydrobrake controlling tank outflow to 50 l/s • New weir in manhole NZ18519804 (to spill to new sewer)
Bund in field north of Windermere Terrace	A9	• Bund 240 m long and 1 m high • 10 trees on the edge of the field • 5 l/s flow control • 50 m of 225 mm surface water sewer • 440m³ formalised storage behind bund

6.2.4 *Stakeholders*

Stakeholders that should be consulted would include local residents, local businesses, Wear Rivers Trust, DCC highways department, DCC planning department, developers, allotment holders, landowners, council ecologist, and utility service providers if any diversions are required.

6.2.5 *Site Constraints*

Site constraints that will need to be considered include:

- Overhead cables;
- Service crossing including low pressure gas main, water, foul sewers, culverted watercourse, electricity, and broadband;
- Liaison with ecologist on mature trees within close proximity of works;
- Liaison with allotment holders near Rose Avenue and residents on Windemere Terrace to confirm if there is an overland flow route and confirm extent of bund required;

- Services;
- Bus routes along proposed roads where works proposed;
- Liaison with developers of the proposed development on Hustledown Road to see if Option A5 attenuation can be incorporated into their SUDs features;
- The owner/occupiers of the fields west of Rydal Avenue and north of Windermere Terrace will also need to be engaged with;
- A consent will be required from DCC / Environment Agency for the new surface water outfall;
- Pipe-laying along residential streets will cause disruption to a large number of residents.

6.2.6 *Additional Data Requirements*

Additional survey data at drainage connection locations, confirm connectivity queries, and confirm levels for crossing of existing assets or other services. Confirm if the school on Rydal Avenue / School Lane is in use. Consider if a section of the culverted Stanley Burn could be daylighted by surveying the culvert, understanding the existing land use, and consulting with the landowner.

6.2.7 *Water Quality Impact*

Water quality modelling has not been carried out as part of this work. Qualitatively, the attenuation of surface water prior to discharge to the watercourse could decrease sediment and grit and pollutant discharges. Reductions in CSO spill volume and frequency would also have a beneficial impact on the water quality.

The 10 year times series rainfall was run for a typical year (2015) to assess the impact of the solution on CSOs in the opportunity area.

Table 6.2.7.1 – Park Road CSO summary

Asset Hierarchy	Location	Model Reference	Base (MB04)		Solution (S02_1)	
			Spill Frequency	Spill Volume (m^3)	Spill Frequency	Spill Volume (m^3)
South Stanley & Craghead CSO 20	South Moor CSO South Moor Road Football Ground	DER69NEW.2	4	931	4	795
South Stanley & Craghead CSO 18	Osbourne Buildings, William Street	NZ18519826.2	23	1,424	4	180
South Stanley & Craghead CSO 8	East View DER098	NZ19510401.2	2	142	1	21
South Stanley & Craghead CSO 19	Oliver St (No 13) Southmoor	NZ19510813.4	14	829	8	413
South Stanley & Craghead CSO 21	Hustledown Rd. Adj. Bus Stop	NZ19513622.3	76	22,163	58	11,958

The model results indicate the proposed solution results in a total spill volume reduction of 12,122 m^3. The largest decrease is at South Stanley and Craghead CSO 21 (Hustledown Road).

6.2.8 *Flood Risk*

A flood risk assessment was completed for the solution. The change of flood risk was compared to the baseline to determine the number of properties with reduced flood risk. Flood risk is assessed by the EA for 20, 30, 75, 100, and 200 year return periods to correspond with the very significant, significant, intermediate, moderate, and low risk bands respectively. Flood risk is assessed by NWG for 5, 10, 15, 20, 30, and 40 year return periods for internal and external (curtilage). The changes in flood risk are shown in Appendix F FCERM Calculator and Appendix G NWG Asset Planning Table and shown on the Solution Plans in Appendix E.

Table 6.2.8.1 – NWG Flood Risk Improvements - Internal

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr
Baseline	110	61	45	14	17	27
Solution	0	17	29	13	29	14
Difference	-110	-44	-16	-1	+12	-13

Table 6.2.8.2 – NWG Flood Risk Improvements - External

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr	> 1 in 40 yr
Baseline	52	59	74	22	37	33	0
Solution	15	19	29	45	58	44	239
Difference	-37	-40	-45	+23	+21	+11	+239

In total, 551 properties would benefit from flood risk reduction when looking at this range of return periods, which includes 274 from internal flood risk reduction and 277 from external flood risk reduction. This includes 27 properties that have reported flooding based on data in InfoNet. The full table is included in Appendix G and will be used by NWG Asset Planning.

Table 6.2.8.3 – EA Flood Risk Improvements

	20 yr Very Significant	30 yr Significant	75 yr Intermediate	100 yr Moderate	200 yr Low
Baseline	337	34	106	31	50
Solution	186	42	104	35	191
Difference	-151	+8	-2	+4	+141

In total, 242 properties have moved flood risk category. There are some additional neighbouring properties that may also be able to be improved with some optimisation of the solution at a later phase.

6.2.9 *Costs*

To estimate costs of the solution, NWG's DWMP Cost Estimate tool was utilised which provides unit rates for a range of sustainable and traditional solutions. These costs were supplemented with high level costs from Esh Stantec cost estimators for additional items. The cost estimate does not include for any landowner compensation that may be required. Design costs were estimated to be 10% of the construction cost. The detailed cost estimate is provided in Appendix H.

Table 6.2.9.1 – Summary of Costs

Cost Element	Cost Estimate (£)
Design and Construction Cost (£)	3,380,000
Project Overheads Cost (£)	770,000
Risk (10%) (£)	338,000
Total Cost + Risk (£)	4,488,000

Cost Element	Cost Estimate (£)
OPEX Cost (£)	40,000
Total Cost + Risk + OPEX (£)	**4,528,000**

6.2.10 *Benefits*

Benefits were assessed as described in Section 6.1 and are summarised below.

Table 6.2.10.1 – List of Benefits

Types of Benefit	
Flood Risk – Residential Property Damages Avoided (£ NPV)	£14,000,000
Flood Risk – Non-Residential Property Damages Avoided (£ NPV)	£2,200,000
Other Flooding Damages Avoided	£900,000
Wider Benefits (£ NPV)	£3,750,000
Water Quality (CSO Reductions – volume, frequency)	12,100 m^3, 44 No.
Habitat Creation and Biodiversity Enhancement (m^2, type)	2500 m^2, attenuation basins
Reduced Contribution Area to Public Sewer (ha)	6.5
Benefit : Cost Ratio	4.6 : 1

6.2.11 *FCERM GiA Calculator*

The costs and benefits were put into the EA's FCERM GiA Calculator to determine potential funding that may be available. The FCERM GiA Calculator is included in Appendix F.

Funding Sources	
Potential funding available via FCERM	£4,100,000
Additional funding required from other sources	£420,000

The additional funding would need to be considered by the project partners to determine if the project is viable to progress.

6.3 Options - Avon Road

6.3.1 *Long list of options*

Solutions for this opportunity area will reduce flood risk from the combined sewer system by removing surface water and improving capacity, provide localised surface water attenuation, and separate surface water flows from the combined system to reduce CSO spills.

Table 6.3.1 – List of Options Considered

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
B1	Do nothing	No Cost	No	Does not resolve flooding issues
B2	Do Minimum	Low cost – would provide basic maintenance of system	No	Would not resolve incapacity in the combined sewer network
B3	Surface water attenuation at St Marys RC Primary School in the form of rain gardens / educational features	Reduce flows to the combined sewer. Ecological benefit and educational aspect could be incorporated	No	Provides negligible improvement to capacity in combined sewer. Not progressed.
B4	Rain gardens / swales / bunds in surrounding available green areas	Green solution which prevents flows from running towards properties and create new habitat	No	Little benefit in flood risk reduction in large events. New storm sewer route created. Rain gardens could be incorporated in the next stage to gain additional benefits
B5	Surface water removal in most surrounding streets and attenuation	Reduces flood risk from combined sewer and reduces CSO spills	Yes	N/A
B6	Combined sewer upsize (Near Holly Hill Gardens around CSO)	Reduce flood risk from combined sewer	Yes	N/A

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
B7	Attenuation of SW flows from South Stanley Junior and Infant School and football pitch and connection to storm sewer to south	Increased capacity on combined sewer and overland flow intercepted to reduce property flood risk. Ecological benefit and educational aspect could be incorporated	Yes	N/A
B8	Bund / Attenuation to rear of properties Holly Hill Gardens West, to provide relief point to flooding from manhole NZ19518911	Reduces flood risk from surface water sewer. Could be planted to create new habitat with ecological benefits.	Yes	N/A

6.3.2 *Short list of options and preferred options*

Option B5 involves the construction of 2.4 km of new storm sewers along Wansbeck Avenue, Tees Crescent, Valley Close, Tweed Terrace and Avon Road to pick up highway and roof runoff from these areas. Existing storm sewers along the new surface water route, on Avon Road, Tweed Terrace, Valley Close and Wansbeck Avenue (located in rear of properties) would be disconnected from the combined sewer and connected to the new storm sewer. A total of 2.38 ha of highway, 0.39 ha of roofs and 0.081 ha green areas will be removed from the combined sewer network. Flows collected by the new storm sewer will flow to a new 1600 m³ attenuation basin located in green space at Marx Crescent. This is a steeply sloping green space, so a series of swales may be utilised to provide this attenuation. Flows will discharge back to the existing storm sewer at a controlled rate of 5 l/s.

Option B6 Holy Hill Gardens West – This option involves constructing a new manhole on the existing 450mm combined sewer (within the pathway outside of 108 Holly Hill Gardens West), and upsizing between the new manhole and Holly Hill Gardens South Moor CSO to 750 mm. The option also includes adding a bifurcation to manhole NZ19518805 to allow flows to spill to a new 70m³ combined tank located within grassed area of Holly Hill gardens West. Flows connect to existing manhole NZ19518807 via a new 900 mm combined sewer, and additional upsizing to 900mm downstream of this to manhole NZ19519803. The option also involves upsizing 186 m of the existing combined sewer to 525 mm, from the rear garden of No.57, north east, through the playing field behind Holy Hill Gardens West towards NZ20510902 Holly Hill Gardens East. To the north, a bifurcation will be constructed at NZ19528009 (Lenin Terrace) to allow flows to spill to a new 600 mm pipe, flows return via a 150 mm pipe.

Option B7 involves disconnecting South Stanley Junior School surface water drainage from the combined sewer, attenuating surface water flows across the site, and connecting to SuDS features within the school grounds. The model results indicate a

total volume of 2440 m³ would need to be attenuated in a 100 year event with flows returning to the existing surface water sewer in Tyne Road East (NZ19515908) at a controlled rate of 20 l/s. It is envisioned that the attenuation will be accommodated at multiple attenuation features across the site. The option also includes a swale which runs along the southern boundary of the school to intercept overland flow and convey to an attenuation basin. The locations of the attenuation and SUDS features would need to be agreed with the school.

Option B8 involves the construction a bund to rear of properties on Holly Hill Gardens West, to provide a relief point from surface water manhole NZ19518911 via a new 300 mm sewer. Attenuated flows will drain back to the surface water system when levels allow.

The proposed options are shown on '41526482-01-GIS-4006 – Avon Road Solution Plan'. See Appendix E.

6.3.3 *Options Summary*

Option	Option Ref.	Summary
Surface water removal in most surrounding streets and attenuation	B5	• 1224 m of 150 mm surface water sewer • 524 m of 225 mm surface water sewer • 212 m of 300 mm surface water sewer • 55 m of 375 mm surface water sewer • 95 m of 450 mm surface water sewer • 255 m of 525mm surface water sewer • 47 no. New Manholes • 1600 m³ Attenuation basin • 5 l/s flow control on basin • 20 new trees

Option	Option Ref.	Summary
Combined sewer upsize (Near Holly Hill Gardens around CSO)	B6	• Upsize 29 m of combined sewer to 375 mm • Upsize 186 m of combined sewer to 525 mm • Upsize 41 m of combined sewer to 750 mm • Upsize 37 m of combined sewer to 900 mm • 7 m of 150 mm combined sewer • 17 m of 300 mm combined sewer • 43 m of 600 mm combined sewer • 22 m of 900 mm combined sewer • 70 m³ combined gravity returned tank • 7 no. New Manholes
Attenuation of SW flows from South Stanley Junior and Infant School and football pitch and connection to storm sewer to south	B7	• 155 m of 225mm surface water sewer • 2440 m³ attenuation basin (spread out across multiple locations, which are to be agreed with school) • 180 m long swale (assumed to connect into attenuation basin) • 2 No. 20 l/s flow controls • 10 new trees
Bund / Attenuation to rear of properties Holly Hill Gardens West	B8	• Bund 61 m long and 390 mm high • 50 m of 300 mm surface water sewer • 5 new trees • 40 m³ formalised storage behind bund

6.3.4 *Stakeholders*

Stakeholders that should be consulted would include local residents, local businesses, DCC highways department, South Stanley Junior and Infant School, local users of the football fields landowners, council ecologist, and utility service providers if any diversions are required.

6.3.5 *Site Constraints*

Site constraints that will need to be considered include:

- Overhead cables;
- Service crossings including low pressure gas mains, water, sewer, electricity, and broadband;
- Steeply sloping area that will require consideration in gulley locations and ways to encourage surface water into the drainage network;
- Steeply sloping area that will require attenuation is designed appropriately;
- Liaison with South Stanley Junior and Infant School on location and types of surface water features;
- Agreement for location of new trees;
- Liaison with ecologist on mature trees within close proximity of works;
- Services;
- Liaison with local residents on attenuation basin.

6.3.6 *Additional Data Requirements*

Additional survey data at drainage connection locations, connectivity of South Stanley Junior and Infant school to confirm if there is any existing onsite attenuation, confirm connectivity queries, and confirm levels for crossing of existing assets or other services.

6.3.7 *Water Quality Impact*

Water quality modelling has not been carried out as part of this work. Qualitatively, the attenuation of surface water prior to discharge to the watercourse could decrease sediment and grit and pollutant discharges. Reductions in CSO spill volume and frequency would also have a beneficial impact on the water quality.

The 10 year times series rainfall was run for a typical year (2015) to assess the impact of the solution on CSO's in the opportunity area.

Table 6.3.7.1 – Avon Road CSO summary

Asset Hierarchy	Location	Model Reference	Base (MB04)		Solution (S02_1)	
			Spill Frequency	Spill Volume (m^3)	Spill Frequency	Spill Volume (m^3)
South Stanley & Craghead CSO	Holly Hill Gardens	DER101.2	135	101,549	105	70,779
South Stanley &	Hollyhill Gardens (No	NZ19519907.2	69	10,109	40	3,752
		NZ19519907.3	1	213	0	0

Asset Hierarchy	Location	Model Reference	Base (MB04)		Solution (S02_1)	
			Spill Frequency	Spill Volume (m³)	Spill Frequency	Spill Volume (m³)
Craghead CSO 22	41) Southmoor	(Relief)				
South Stanley & Craghead CSO	Nightingale Place DER079	DER79.2	2	197	2	187

The model results indicate the proposed solution results in a spill volume reduction of 37,351m³ in a typical year. The largest decrease is at Holly Hill Gardens (NZ20513907). This CSO is included within the Storm Overflow Assessment Framework, which identifies high frequency spilling CSOs and aims to improve their performance.

6.3.8 *Flood Risk*

A flood risk assessment was completed for the solution. The change of flood risk was compared to the baseline to determine the number of properties with reduced flood risk. Flood risk is assessed by the EA for 20, 30, 75, 100, and 200 year return periods to correspond with the very significant, significant, intermediate, moderate, and low risk bands respectively. Flood risk is assessed by NWG for 5, 10, 15, 20, 30, and 40 year return periods for internal and external (curtilage). The changes in flood risk are shown in Appendix F FCERM Calculator and Appendix G NWG Asset Planning Table and shown on the Solution Plans in Appendix E.

Table 6.3.8.1 – NWG Flood Risk Improvements - Internal

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr
Baseline	111	46	32	20	32	14
Solution	0	15	15	11	19	26
Difference	-111	-31	-17	-9	-13	+12

Table 6.3.8.2 – NWG Flood Risk Improvements - External

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr	> 1 in 40 yr
Baseline	67	39	14	11	17	18	0
Solution	25	24	27	23	21	27	188
Difference	-42	-15	+13	+12	+4	+9	+188

In total, 421 properties would benefit from flood risk reduction when looking at this range of return periods, which includes 255 from internal flood risk reduction and 166

from external flood risk reduction. This includes 49 properties that have reported flooding based on data in InfoNet. The full table is included in Appendix G and will be used by NWG Asset Planning.

Table 6.3.8.3 – EA Flood Risk Improvements

	20 yr Very Significant	30 yr Significant	75 yr Intermediate	100 yr Moderate	200 yr Low
Baseline	330	45	76	17	49
Solution	169	33	65	18	232
Difference	-161	-12	-11	+1	+183

In total, 257 properties have moved flood risk category. There are some additional neighbouring properties that may also be able to be improved with some optimisation of the solution at a later phase.

6.3.9 *Costs*

To estimate costs of the solution, NWG's DWMP Cost Estimate tool was utilised which provides unit rates for a range of sustainable and traditional solutions. These costs were supplemented with high level costs from Esh cost estimators for additional items such as bunds and inlets. The cost estimate does not include for any landowner compensation that may be required. Design costs were estimated to be 10% of the construction cost. The detailed cost estimate is provided in Appendix H.

Table 6.3.9.1 – Summary of Costs

Cost Element	Cost Estimate (£)
Design and Construction Cost (£)	2,960,000
Project Overheads Cost (£)	680,000
Risk (10%) (£)	296,000
Total Cost + Risk (£)	3,936,000
OPEX Cost (£)	50,000
Total Cost (£)	**3,986,000**

6.3.10 *Benefits*

Benefits were assessed as described in Section 6.1 and are summarised below.

Table 6.3.10.1 – List of Benefits

Types of Benefit	Quantity
Flood Risk – Residential Property Damages Avoided (£ NPV)	£5,300,000
Flood Risk – Non-Residential Property Damages Avoided (£ NPV)	£270,000
Other Flooding Damages Avoided	£310,000
Wider Benefits	£2,900,000
Water Quality (CSO Reductions – volume, frequency)	37,350 m^3, 60 No.
Habitat Creation and Biodiversity Enhancement (m^2, type)	4040 m^2, basins
Reduced Contribution Area to Public Sewer (ha)	6.6 ha
Benefit : Cost Ratio	2.2:1

6.3.11 *FCERM GiA Calculator*

The costs and benefits were put into the EA's FCERM GiA Calculator to determine potential funding that may be available. This includes a 10% risk contingency. The FCERM GiA Calculator is included in Appendix F.

Funding Sources	
Potential funding available via FCERM	£3,700,000
Additional funding required from other sources	£260,000

The additional funding would need to be considered by the project partners to determine if the project is viable to progress.

6.4 Options – Cookson Place

6.4.1 *Long list of options*

Solutions for this opportunity area will reduce flood risk from surface water runoff, reduce flood risk from the combined sewer system by providing some localised upsizing and provide localised surface water attenuation.

Table 6.4.1 – List of Options Considered

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
C1	Do nothing	No Cost	No	Does not resolve flooding issues
C2	Do Minimum	Low cost – would provide basic maintenance of system	No	Would not resolve incapacity in sewer system or overland flow from green spaces.
C3	Surface water attenuation at Stanley Burnside Primary School in the form of rain gardens / educational features	Reduces flood risk and peak flows to the combined sewer. Ecological benefit and educational aspect could be incorporated	No	Minimal impact on flooding from combined sewer
C4	Local upsize to storm sewer adjacent to Cookson Place	Would provide capacity in existing drainage system. Attenuation would need to be included to prevent increasing peak flows to ditch / watercourse	Yes	N/A
C5	Bund / attenuation at rear of properties at Cookson Place	Reduces flood risk	Yes	N/A
C6	Swale to intercept overland flow from Humber Hill and convey to surface water system	Reduces flood risk. Ecological benefit.	Yes	N/A
C7	New CSO at combined flooding manhole NZ20525204	Reduces flood risk	No	Not sustainable. Expensive and would solve only a few properties

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
C8	Local upsize of combined sewer adjacent to Cookson Place	Reduces flood risk	Yes	N/A
C9	Bund to the north of Cookson Place to intercept overland flow	Reduces flood risk	Yes	N/A

6.4.2 *Short list of options and preferred options*

Option C4 involves upsizing 73 m of existing storm sewer adjacent to Cookson Place to 800mm. The existing storm sewer has a reduction in size in this location which causes incapacity.

Option C5 includes the construction of a bund behind properties on Cookson Place. A new relief point will be constructed, and flows attenuated behind the bund. Flows will drain back to the same system once levels allow. The northern section of C5 bund will intercept overland flow from green space to the north. The attenuated flows are proposed to discharge to Cookson Place surface water manhole NZ20527203 at a controlled rate of 5 l/s. Note no site visit was completed due to Covid-19 pandemic. It is recommended that a site visit is completed should the scheme progress to confirm the best locations for the bunds due to this option being located in a wooded area. It is proposed that new trees are planted to offset those which are removed.

Option C6 includes a new 366 m long swale along the southern side of Humber Hill to intercept overland flow and convey flows west. Flows are proposed to connect to existing surface water sewer via a 225 mm pipe, downstream of NZ20522610.

Option C8 consists of upsizing consists of upsizing 175 m of existing combined sewer to 525 mm in the greenspace between NZ20526106 and NZ20527032.

Option C9 comprises of a bund to the north of Cookson Place to intercept overland flow. Flows will be attenuated behind the bund and discharge to Cookson Place surface water manhole NZ20527209 at a controlled rate of 5 l/s.

The proposed options are shown on ‘41526482-01-GIS-4007 – Cookson Place Solution Plan’. See Appendix E.

6.4.3 *Options Summary*

Option	Option Ref.	Summary
Local Upsize to storm sewer adjacent to Cookson Place	C4	• Upsize 73 m of surface water sewer to 800 mm
Bund / attenuation at rear of properties at Cookson Place	C5	• 21 m of 150 mm surface water sewer (relief point) • 95 m of 225 mm surface water sewer • 158 m long 400 mm high bund along west of Cookson Place and 95 m long 650 mm high bund along north west of Cookson Place. Both 1 m wide. • 5 l/s flow control • 4 No. new manholes • 890 m^3 formalised storage to north and 160m^3 formalised storage to south
Attenuation / suds features to intercept overland flow from Humber Hill	C6	• 366 m long swale • 29 m of 225 mm surface water sewer • 1 No. new manhole
Local upsize of combined sewer adjacent to Cookson Place	C8	• Upsize 175 m of combined sewer to 525 mm • 4 No. new manholes
Bund to the north of Cookson Place to intercept overland flow	C9	• 166 m long 750 mm high, 1 m wide bund • 80 m of 225 mm surface water sewer • 5 l/s flow control • 2 No. new manholes • 50 trees • 280 m^3 formalised storage behind bund

6.4.4 *Stakeholders*

Stakeholders that should be consulted would include local residents, local businesses, DCC planning department, DCC highways department, landowners, council ecologist, archaeologists, and utility service providers if any diversions are required.

6.4.5 *Site Constraints*

Site constraints that will need to be considered include:

- Overhead cables;
- Liaison with ecologist on mature trees within close proximity of works;
- Liaison with landowners of the forested / vegetated area where bunds are proposed;
- Liaison with Stanley Burnside Primary School which is located within close proximity to the works;
- Services;
- Bus routes along roads where works are proposed;

6.4.6 *Additional Data Requirements*

Additional survey data at drainage connection locations, site walkover to confirm locations for bunds / identify if there are any existing features which affect overland flow paths, topographical surveys of proposed bund locations, and confirm levels for crossing of existing assets or other services.

6.4.7 *Flood Risk*

A flood risk assessment was completed for the solution. The change of flood risk was compared to the baseline to determine the number of properties with reduced flood risk. Flood risk is assessed by the EA for 20, 30, 75, 100, and 200 year return periods to correspond with the very significant, significant, intermediate, moderate, and low risk bands respectively. Flood risk is assessed by NWG for 5, 10, 15, 20, 30, and 40 year return periods for internal and external (curtilage). The changes in flood risk are shown in Appendix F FCERM Calculator and Appendix G NWG Asset Planning Table and shown on the Solution Plans in Appendix E.

Table 6.4.7.1 – NWG Flood Risk Improvements - Internal

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr
Baseline	18	5	2	3	3	1
Solution	0	2	2	0	3	0
Difference	-18	-3	0	-3	0	-1

Table 6.4.7.2 – NWG Flood Risk Improvements - External

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr	> 1 in 40 yr
Baseline	23	10	3	1	4	11	0
Solution	16	1	0	3	1	5	51
Difference	-7	-9	-3	+2	-3	-6	+51

In total, 84 properties would benefit from flood risk reduction when looking at this range of return periods, which includes 32 from internal flood risk reduction and 52 from external flood risk reduction. This includes 4 properties that have reported flooding based on data in InfoNet. The full table is included in Appendix G and will be used by NWG Asset Planning.

Table 6.4.7.3 – EA Flood Risk Improvements

	20 yr Very Significant	30 yr Significant	75 yr Intermediate	100 yr Moderate	200 yr Low
Baseline	45	3	1	2	2
Solution	21	3	2	3	24
Difference	-24	0	+1	+1	+22

In total, 30 properties have moved flood risk category. There are some additional neighbouring properties that may also be able to be improved with some optimisation of the solution at a later phase.

6.4.8 *Costs*

To estimate costs of the solution, NWG's DWMP Cost Estimate tool was utilised which provides unit rates for a range of sustainable and traditional solutions. These costs were supplemented with high level costs from Esh cost estimators for additional items such as bunds and inlets. Uplifts were included for restricted access to the site and being environmentally sensitive. Design costs were estimated to be 10% of the construction cost. The cost estimate does not include for any landowner compensation that may be required. The detailed cost estimate is provided in Appendix H.

Table 6.4.8.1 – Summary of Costs

Cost Element	Cost Estimate (£)
Design and Construction Cost (£)	580,000
Project Overheads Cost (£)	160,000
Risk (10%) (£)	58,000
Total Cost + Risk (£)	798,000

Cost Element	Cost Estimate (£)
OPEX Cost (£)	40,000
Total Cost (£)	**838,000**

6.4.9 *Benefits*

Benefits were assessed as described in Section 6.1 and are summarised below.

Table 6.4.9.1 – List of Benefits

Types of Benefit	
Flood Risk – Residential Property Damages Avoided (£ NPV)	£560,000
Flood Risk – Non-Residential Property Damages Avoided (£ NPV)	£2,000
Other Flooding Damages Avoided	£31,000
Wider Benefits	£560,000
Water Quality (CSO Reductions – volume, frequency)	0
Habitat Creation and Biodiversity Enhancement (m^2, type)	366 m^2 swale
Reduced Contribution Area to Public Sewer (ha)	0
Benefit : Cost Ratio	1.4 : 1

6.4.10 *FCERM GiA Calculator*

The costs and benefits were put into the EA's FCERM GiA Calculator to determine potential funding that may be available. This includes a 10% risk contingency.

The FCERM GiA Calculator is included in Appendix F.

Funding Sources	
Potential funding available via FCERM	£530,000
Additional funding required from other sources	£310,000

The additional funding would need to be considered by the project partners to determine if the project is viable to progress.

6.5 Options – The Middles

Solutions for this opportunity area will reduce flood risk from surface water runoff, reduce flood risk from the combined sewer system by providing bifurcation to an adjacent system with capacity, provide bunds to intercept overland flow, separate surface water flows from the combined system.

Table 6.5.1 – List of Options Considered

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
D1	Do nothing	No Cost	No	Does not resolve flooding issues
D2	Do Minimum	Low cost – would provide basic maintenance of system	No	Would not resolve incapacity in combined sewer system or overland flow from green spaces.
D3	Surface Water Separation in highway of Ivy Terrace	Reduces flood risk and removes flows from an under capacity system. Would also allow more flows to enter inlet near Greylingstadt Terrace	Yes	N/A
D4	Bunding / attenuation along Northern boundary of field at Greylingstadt Terrace	Prevents flows from pooling around properties. Would instead attenuate in field and drain away once capacity in the SW system allowed.	Yes	N/A
D5	Upsizing upstream of culvert	Reduces flood risk	No	This solution was discounted as minor diversions upstream created capacity in the sewers between Greylinstadt Terrace and the culvert

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
D6	Attenuation in section of green space along Larch Terrace	Green solution which prevents flows from running towards properties and creating new habitat	No	A solution which involved minor diversions upstream proved to provide more benefit than this option which involved storing water in close proximity to surrounding properties
D7	Rain Gardens	Ecological benefit and reduce peak flows from highway runoff	Yes	N/A
D8	Combined sewer diversion	Reduces capacity in combined sewer and utilises existing sewer with sufficient capacity.	Yes	N/A
D9	Surface water attenuation at Bloemfontein Primary School and new surface water pipework	Remove surface water from combined network; educational opportunities	No	Minimal improvement on downstream flood risk

6.5.1 *Short list of options and preferred options*

Option D3 will disconnect surface water on Ivy Terrace from combined manhole NZ20517102 and connect to the existing surface water sewer within Ivy Terrace highway to the north. The surface water sewer from Hazel Terrace will be diverted at manhole NZ20516203 to the existing surface water sewer at Larch Terrace, which has capacity. To allow the diverted flows to connect, 62 m of the existing surface water sewer would need to be re-laid. Note, this has not been surveyed; surveys would be required to confirm this is necessary. This will reduce flood risk at from surface water at Greylingstadt Terrace.

Option D4 comprises of a bund around the boundary of the field, south of Greylingstadt Terrace to intercept approximately 70 m^3 of overland flow. The bund has been costed for 468 m long 500 mm high bund. This is likely to be conservative, with some walls present along the field boundary. A site visit would be required to determine the length of bund required. Improvements would be made to the inlet to the culvert and the addition of new gullies. Surface water would drain away once there is capacity. Liaison with the landowner would be required to agree the area that could be utilised for attenuation. Landscaping of the field may be required. Compensation to the landowner would need to be negotiated.

Option D7 comprises of two rain gardens in green spaces on Oak Terrace to attenuate highway runoff from Beach Terrace and Ivy Terrace and 10 trees in this area.

Option D8 consists of a new combined sewer to allow flows to spill from the combined sewer to rear of Standerton Terrace north to NZ20516328 (adjacent to the club). The existing sewer between NZ20516303 and NZ20516306 will be upsized to 225 mm and re-laid to allow flows to bifurcate between the two systems.

The proposed options are shown on '41526482-01-GIS-4008 – The Middles Solution Plan'. See Appendix E.

6.5.2 *Options Summary*

Option	Option Ref.	Summary
Surface water separation / diversion in highway	D3	• 15 m of 225 mm surface water sewer • 12 m of 300 mm surface water sewer • Relay 63 m of 300 mm sewer at a deeper gradient to allow connection from diverted sewer. Costed as new sewer. • 2 No. New manholes
Bunding / attenuation along northern boundary of field at Greylingstadt Terrace	D4	• 30 m of 300 mm surface water sewer to connect highway drainage and new gullies. • 468 m long bund, 500 mm high and 1 m wide • Compensation to the landowner
Rain Gardens	D7	• 2 no. rain gardens totalling 472 m^2 • 50 m of 150 mm surface water sewer • 2 No. New manholes • 10 new trees nearby
Combined sewer diversion	D8	• 54 m of new 225 mm combined sewer • 54 m of new 225 mm combined sewer to be and replace and relay an existing 150 mm diameter combined sewer to allow flows to spill to a diversion. • 2 No. New manholes

6.5.3 *Stakeholders*

Stakeholders that should be consulted would include local residents, local businesses, DCC planning department, DCC highways department, landowners, council ecologist, archaeologists, and utility service providers if any diversions are required.

6.5.4 *Site Constraints*

- Overhead cables;
- Liaison with ecologist on mature trees within close proximity of works;
- Liaison with landowners;
- Liaison with Bloemfontein Primary School which is located within close proximity to the works;
- Liaise with council and residents on locations of new trees;
- Negotiation with owner of the field for utilising northern section for attenuation;
- Horses are sometimes grazed on the field;
- Services;
- Bus routes along proposed roads where works proposed.

6.5.5 *Additional Data Requirements*

Additional survey data at drainage connection locations, confirm connectivity queries, and confirm levels for crossing of existing assets or other services. In addition, a survey of the surface water inlet in the field (Option D4) south of Greylingstadt Terrace should be completed to confirm any changes required.

6.5.6 *Water Quality Impact*

Water quality modelling has not been carried out as part of this work. Qualitatively, the attenuation of surface water prior to discharge to the watercourse could decrease sediment and grit and pollutant discharges. Reductions in CSO spill volume and frequency would also have a beneficial impact on the water quality.

The 10 year times series rainfall was run for a typical year (2015) to assess the impact of the solution on CSO's in the opportunity area.

Table 6.5.6.1 – The Middles CSO summary

Asset Hierarchy	Location	Model Reference	Base (MB04)		Solution (S02_1)	
			Spill Frequency	Spill Volume (m^3)	Spill Frequency	Spill Volume (m^3)
South Stanley & Craghead CSO 14	The Middles Craghead Durham Road DER080	NZ20517602.2	19	530	15	473
South Stanley & Craghead CSO 1	Kimberley Gardens (No24) DER082	NZ21511452.2	153	26,292	153	25,540

The model results indicate the proposed solution results in a total spill volume reduction of 809 m^3.

6.5.7 *Flood Risk*

A flood risk assessment was completed for the solution. The change of flood risk was compared to the baseline to determine the number of properties with reduced flood risk. Flood risk is assessed by the EA for 20, 30, 75, 100, and 200 year return periods to correspond with the very significant, significant, intermediate, moderate, and low risk bands respectively. Flood risk is assessed by NWG for 5, 10, 15, 20, 30, and 40 year return periods for internal and external (curtilage). The changes in flood risk are shown in Appendix F FCERM Calculator and Appendix G NWG Asset Planning Table and shown on the Solution Plans in Appendix E.

Table 6.5.7.1 – NWG Flood Risk Improvements - Internal

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr
Baseline	11	2	16	7	10	6
Solution	0	1	2	1	1	0
Difference	-11	-1	-14	-6	-9	-6

Table 6.5.7.2 – NWG Flood Risk Improvements - External

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr	> 1 in 40 yr
Baseline	17	3	1	2	4	7	0
Solution	1	2	3	2	2	1	70
Difference	-16	-1	+2	0	-2	-6	+70

In total, 86 properties would benefit from flood risk reduction when looking at this range of return periods, which includes 52 from internal flood risk reduction and 34 from external flood risk reduction. This includes 9 properties that have reported flooding based on data in InfoNet. The full table is included in Appendix G and will be used by NWG Asset Planning.

Table 6.5.7.3 – EA Flood Risk Improvements

	20 yr Very Significant	30 yr Significant	75 yr Intermediate	100 yr Moderate	200 yr Low
Baseline	43	10	13	0	8
Solution	13	5	3	2	51
Difference	-30	-5	-10	+2	+43

In total, 46 properties have moved flood risk category. There are some additional neighbouring properties that may also be able to be improved with some optimisation of the solution at a later phase.

6.5.8 *Costs*

To estimate costs of the solution, NWG's DWMP Cost Estimate tool was utilised which provides unit rates for a range of sustainable and traditional solutions. These costs were supplemented with high level costs from Esh cost estimators for additional items such as bunds and inlets. Design costs were estimated to be 10% of the construction cost. The detailed cost estimate is provided in Appendix H.

Table 6.5.8.1 – Summary of Costs

Cost Element	Cost Estimate (£)
Design and Construction Cost (£)	320,000
Project Overheads Cost (£)	100,000
Risk (10%) (£)	32,000
Total Cost + Risk (£)	452,000
OPEX Cost (£)	20,000
Total Cost (£)	**472,000**

6.5.9 *Benefits*

Benefits were assessed as described in Section 6.1 and are summarised below.

Table 6.5.9.1 – List of Benefits

Types of Benefit	
Flood Risk – Residential Property Damages Avoided (£ NPV)	£790,000
Flood Risk – Non-Residential Property Damages Avoided (£ NPV)	£100,000
Other Flooding Damages Avoided	£50,000
Wider Benefits	£590,000
Water Quality (CSO Reductions – volume, frequency)	809 m^3, 4 No.
Habitat Creation and Biodiversity Enhancement (m^2, type)	472 m^2, rain gardens
Reduced Contribution Area to Public Sewer (ha)	0.18
Benefit : Cost Ratio	3.2 : 1

6.5.10 *FCERM GiA Calculator*

The costs and benefits were put into the EA's FCERM GiA Calculator to determine potential funding that may be available. This includes a 10% risk contingency. 15 properties that received PLP from NCC have been excluded from this although these properties will have improved flood protection.

The FCERM GiA Calculator is included in Appendix F.

Funding Sources	
Potential funding available via FCERM	£705,000
Additional funding required from other sources	-

While additional funding may not be required from other sources, all project partners would benefit from the scheme and may be willing and able to contribute to the project. In addition to the project partners, there may be other stakeholders that will be considered and may be able to contribute to the project.

6.6 Impact on Hustledown STW

All solutions for the four opportunity areas were modelled within the same hydraulic model. The 10 year times series rainfall was run for a typical year (2015) to assess the impact of the solutions on the STW, storm overflow.

Table 6.6.1 – Hustledown STW Storm Overflow

Asset Hierarchy	Location	Model Reference	Base (MB04)		Solution (S02_1)	
			Spill Frequency	Spill Volume (m^3)	Spill Frequency	Spill Volume (m^3)
Hustledown STW	Storm Overflow	STORM.1	46	55,214	42	46,965

The model results indicate a reduction in spill volume of 8,249 m^3.

7. NEXT STAGE

7.1 Programme

A programme for the next stages of the project have been included in Appendix J. This is subject to prioritisation and funding decisions by each of the partner organisations: Durham County Council, Northumbrian Water, and the Environment Agency. In addition, land negotiations and liaison with other stakeholders may impact the programme.

7.2 Recommendations

In the next design phase of the project, the following additional data collection is recommended.

- Topographic surveys of green areas where attenuation basins are proposed;
- Surveys of crossings and connection locations;
- Connectivity survey at South Stanley Junior School;
- Threshold level surveys at properties with suspect connection levels;
- Site visit to further development options and identify any additional risks or data requirements;
- Geotechnical Desk Study of Park Road and Avon Road opportunity areas;
- Ground Investigation;
- Ecological Walkover;
- Trial Pits and GPR surveys;
- Confirm land ownership;
- Liaison with developer at Park Road;
- Confirm ownership and maintenance of new assets;
- Engage with stakeholders to maximise environmental and social benefits from proposals;
- Update of FEH13 rainfall.

7.3 Risks

Some risks that should be noted and explored further at the next stage include:

- Land ownership,
- Services,
- Ground conditions,
- Ecological constraints,
- Unidentified surface water / land drainage connections,
- Unidentified foul connections into drainage to be utilised as surface water,
- Alignment of funding sources from project partners, and
- Agreement on operation and maintenance of assets.

Appendix A - Problem Definition Plans

Appendix B - Stage 2 Interim Memo

Appendix C – Collaboration Tool

Appendix D – Geotechnical Desk Study

Appendix E – Solution Plans

Appendix F – FCERM GiA Calculator

Appendix G - NWG Asset Planning Table

Appendix H - Cost Estimates

Appendix I - Benefit Assessment

Appendix J - Programme