Berwick Acceleration Concept Report

31 March 2025

THE living water ENTERPRISE

1. INTRODUCTION

Northumbrian Water are required to reduce overflow spills at 31 overflows in the Berwick catchment to meet targets set out in the Storm Overflow Discharge Reduction Plan (SODRP) and PR24 Water Industry National Environment Programme (WINEP) drivers for storm overflows reductions. Northumbrian Water were awarded an Accelerated Infrastructure Delivery Project to make an early start on the scheme.

"The £1.85 million will fund model verification and feasibility work on proposed options and costs to determine how best to reduce overflow spills." Accelerated infrastructure delivery project, Final Decision, Ofwat, June 2023.

OFWAT set a number of requirements on the project:

- Provide evidence on where maintenance activities could reduce the overflow spills
- Disclose if any of the Berwick overflows require interventions to make them compliant with environmental permits
- Undertake further investigation to determine the root cause of spills
- Proportionally allocate costs between base and enhancement
- Modelling of the asset operation pre and post completion of the enhancement scheme and an explanation of the methodology and assumptions underpinning both sets of modelling.
- Consider opportunities for inclusion of nature-based and surface water management at source type solutions.
- Develop a best value solution to meet all investment drivers

Northumbrian Water submitted an interim report on compliance risk on 31 October 2024.

- There are no particular compliance issues with flow to full treatment, screen, storm tank or discharges from Berwick Sewage Treatment Works
- The 32 catchment combined sewer overflows meet their pass forward flow requirements when assessed on an individual basis assuming no downstream hydraulic restrictions.
- Investigation of the 16 Sewage Pumping Stations (SPSs) on the Berwick System was underway and had identified two mismatches at SPS 7 Magdalene Fields and SPS 9 Westfield between the design capacity of the pumps and the Flow Passed Forward (FPF) value in the permit.

This report summarises the findings of the Accelerated Infrastructure Delivery Project and includes options to resolve these stations from base funding.

2. DATA COLLECTION

Existing records, desk based studies and site surveys were collected as part of the study and are summarised in Table 1.

TABLE 1: SOURCES OF DATA

Information	Source/Description
Mapping	From Northumbrian Water Elyx GIS
Network GIS	From Northumbrian Water Elyx GIS
Hydraulic Model	Verified model of the catchment used for the Drainage and Wastewater Management Plan.
Overflow Permits	Northumbrian Water Records
New developments	Provided by Northumbrian Water New Development and Local authority planning portal
Archaeology	A Heritage and Archaeological desk study was undertaken to identify constraints to any new works in the catchment
Environmental Constraints	Records of designated sites, habitats of principal importance and protected and notable species taken from Environmental Records Information Centre North East (ERIC North East). Habitat assessment conducted by AiDash - online maps processed using Arc
Geotechnical	A geotechnical desk study was undertaken for Berwick which identified geohazards including hazards relating to infiltration and poor ground conditions.
Utilities Information	Data obtained from National Underground Assets Register including Northumbrian Water sewers/water pipes, Northern Gas Networks, Northern Power Grid, Linesearch Before U Dig & others
NIDP study	Desk studies identifying historic instances of flooding, pollution and blockages within Berwick in addition to solutions optioneering to reduce instances of flooding etc.
Flow Survey	A survey consisting of 95 flow monitors, 6 depth monitors and 8 rain gauges recorded the rainfall, flow depth and velocity at locations within the network between 08/04/2024 and 15/07/2024 to analyse how the sewer network responds to storm events. The flow survey also recorded pipe diameters, depths to inverts to all pipes in the chamber and a cover level of all the chambers where flow monitors were installed.
Asset Surveys	Dimensional surveys off all pumping stations and combined sewer overflows were completed in April 2024. SPS drop tests were conducted in May 2024. Key manhole surveys, outfall surveys, were carried out April – May 2024.
Connectivity and Impermeable Area Surveys	Connectivity surveys (identifying uncharted, private and highway drainage around properties) and Impermeable Area Surveys (identifying the drainage paths of roof, road and other hard surfaces and their discharge point) improve understanding of the catchment and were undertaken in May 2024
EDM Data	Event Duration Monitoring data was used for historic 12/24 spill counts and comparing model level and sewer level for verification storm events
Groundwater and mine water information	Project Groundwater Northumbria

3. ROOT CAUSE ANALYSIS

3.1. APPROACH

The Storm Overflow Assessment Framework (SOAF) is a process for evaluating the impact of sewage spills and storm overflows on the environment. It is used to identify which overflows are most problematic and how to mitigate their impact. **THE STAGES IN THIS APPROACH ARE OUTLINED IN**

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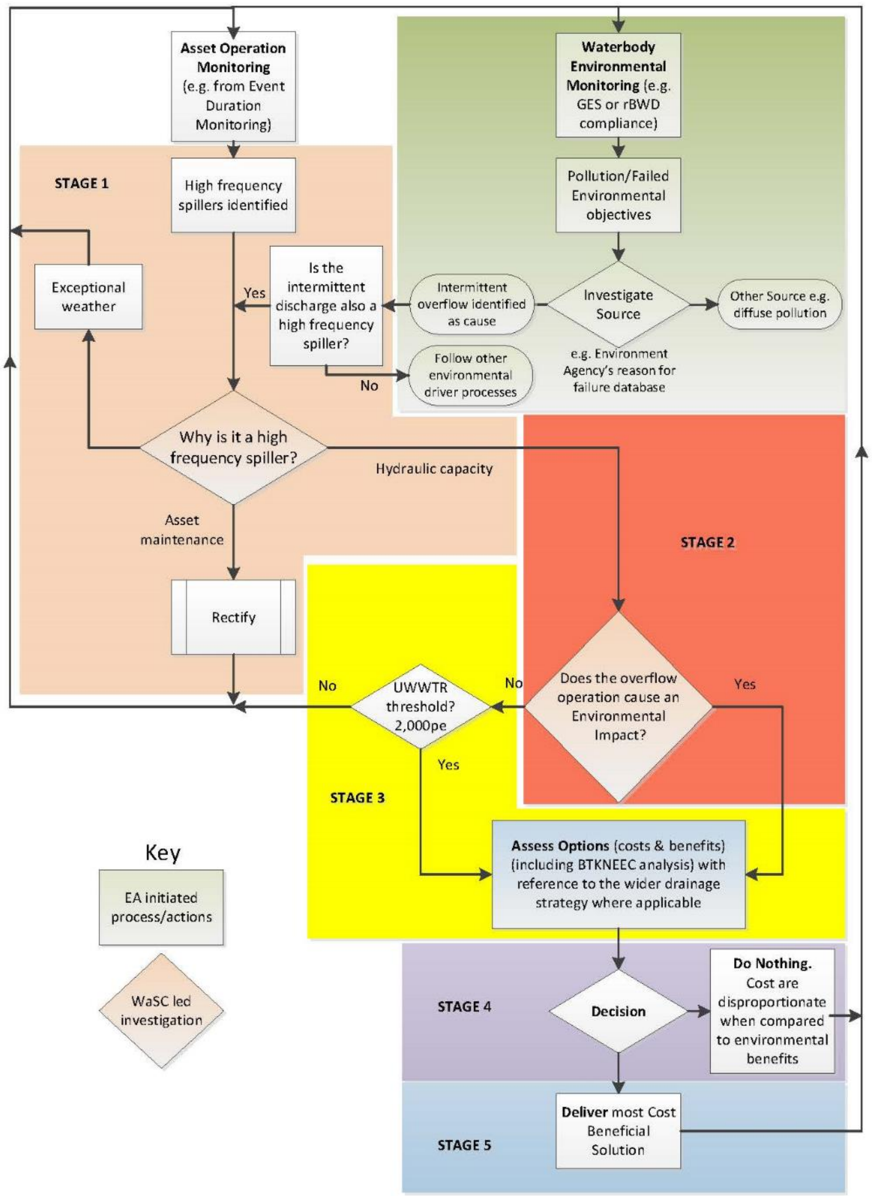

FIGURE 1: ASSESSMENT FRAMEWORK FOR ADDRESSING HIGH FREQUENCY DISCHARGES FROM STORM OVERFLOWS UNDER THE UWWTR, STORM OVERFLOW ASSESSMENT FRAMEWORK V1.6, ENVIRONMENT AGENCY, JUNE 2018

Stage 1 of the assessment examines “Why is it a high frequency spiller?” and identifies the factors that are causing frequent spills:

- exceptional weather
- asset maintenance
- hydraulic capacity

Exceptional weather

Catchment rainfall should be reviewed to determine whether rainfall was exceptional during any of the EDM reporting years. Any exceptional weather periods within the record were not extended enough to affect long term spill frequencies and is not the primary cause of high spill frequency.

Asset maintenance

This stage in the process is about investigating the asset and potentially parts of the upstream and downstream catchment to examine if the high spill frequency is the result of a maintenance issue.

TABLE 2 ASSET INSPECTION CONSIDERATIONS FOR STORM OVERFLOW MAINTENANCE ISSUES

Investigation	
Storm overflows on gravity sewers	• Review surveys for chamber and control condition • Review CCTV for downstream sewer defects and blockages • Records of blockages
Storm overflows at pumping stations	• Pumping station pass forward compliance • Operational issues
Storm overflows at sewage treatment works	• Overflow arrangement • Condition of inlet screens and actuated penstock • Flow Pass Forward compliance
Infiltration assessments	• Review mCerts for seasonal flow response due to groundwater or rainfall induced infiltration • Review flow survey data for groundwater • Operations knowledge
Crossed connections / misconnections investigation	• Locations of dual manholes on GIS • Unusual storm response in flow survey

Hydraulic Capacity
A hydraulic model of the Berwick catchment was updated and verified for this project. This model was used to assess if hydraulic capacity is the primary cause of high spill frequency.

3.2. PERFORMANCE OF EXISTING OVERFLOWS

Table 3 lists the combined sewer overflows within Berwick and the primary cause of high spill frequency.

TABLE 3: BERWICK COMBINED SEWER OVERFLOWS

CSO/PS No	STC Reference	Name	AMP	Type	Permit	Primary cause of high spill frequency	Model Spill frequency - 2050 –
CSO 1	NU00516502	SEA ROAD CSO	No	Hole-in-Wall	EPR/PP3227GJ	-	2
CSO 3	NU00511806	SPITTAL QUAY CSO (BT7)	8	High side weir	210/1360	Hydraulically Controlled	44.1
CSO 4	NU00513805	CAR PARK CSO	8	Hole-in-Wall	210/1344	Hydraulically Controlled	11.8
CSO 5	NT99526102	33 DOCK ROAD CSO	8	Hole-in-Wall	210/1345	Hydraulically Controlled	26.9
CSO 6	NT99519801	BRANDYWELL CSO	8	Low side weir	210/1359	Hydraulically Controlled	141.9
CSO 7	NU00515505	MAIN STREET SPITTAL CSO	No	Hole-in-Wall	210/1349	-	2
CSO 8	NT99523802	CSO AT BLAKEWELL ROAD	8	Hole-in-Wall	210/0938	Hydraulically Controlled	27.7
CSO 9	NT99525309	MILL STRAND COMBINED SEWER OVERFLOW	10	Low side weir	210/1348	Hydraulically Controlled	22.7
CSO 10	NT99524001	MOUNT ROAD CSO BT003	8	Low side weir	210/1358	Hydraulically Controlled	28
CSO 11	NT99526101	TOWER ROAD CSO	8	Hole-in-Wall	210/0943	-	0.8
CSO 12	NT99528001	DOCK ROAD CSO (BT44)	8	High side weir	210/1363	Hydraulically Controlled	4.1
CSO 13	NT98525004	TWEEDSIDE INDUSTRIAL ESTATE CSO	8	Low side weir	210/1335	Hydraulically Controlled	77.4
CSO 14	NT99523700	SSO AT WEST END	8	Hole-in-Wall	210/0939	Hydraulically Controlled	24.8
CSO 15	NU00496501	DERWENT WATER TERRACE CSO BT022	10	Low side weir	EPR/AB3090VG	-	0.4
CSO 16	NT99525301	JNC CHURCH ROAD/DOCK ROAD CSO	10	Hole-in-Wall	210/1346	Hydraulically Controlled	24.1
CSO 17	NT99529605	PALACE STREET NORTH CSO 1	8	Low side weir	210/1361	Hydraulically Controlled	26.6
CSO 18	NT99545602	MAGDALENE FIELDS NORTH CSO M2 monitoring	10	Low side weir	210/1355	Hydraulically Controlled	115.3
CSO 19	NT99547300	MAGDALEN FIELDS SOUTH COMBINED SEWW	10	High side weir	210/1362	Hydraulically Controlled	130.8
CSO 20	NT99534501	CASTLE TERRACE NO2 (BT341) CSO	No	Low side weir	WQD000697	-	2.6
CSO 21	NT99534502	CASTLE TERRACE 1 CSO	8	Low side weir	210/1356	Hydraulically Controlled	67.9
CSO 22	NT99529506	PALACE STREET NORTH CSO 2	8	Low side weir	210/1357	Hydraulically Controlled	7.7
CSO 23	NU00523600	BERWICK NO 4 SEWAGE PUMPING STATION	8	Hole-in-Wall	210/1329	-	0
CSO 24	NT99545101	WESTFIELD NO 9 PS	No	Low side weir	210/0983	-	4.2
CSO 26	NT99535303	RAILWAY STREET	8	Hole-in-Wall	210/1350	Hydraulically Controlled	24.1
CSO 27	NT99524600	QUEENS GARDENS CSO	8	Low side weir	210/1007	Hydraulically Controlled	79.4

CSO 28	NT99524607	BT41 MAIN STREET NO 4 CSO	11	Low side weir	210/0940	-	0
CSO 29	NT99528623	SHOREGATE CSO	8	Transverse Weir	210/1347	-	0.8
CSO 31	NT99528600	QUAY WALL SPS SANDGATE CSO	8	High side weir	210/0935	Hydraulically Controlled	99
CSO 32	NT99545604	MAGDALENE FIELDS NORTH CSO High level M3	10	Low side weir	Included in CSO 18 permit	Hydraulically Controlled	64.9
SPS 5	NT99534505	BERWICK SPS RAIL STATION NO 5	No	Dry well centrifugal, overflow at inlet chamber	210/1270	Hydraulically Controlled	115.5
SPS 6	NT98529504	BERWICK SPS TWEEDSIDE TRADING ESTATE NO 6	No	Dry well centrifugal, overflow at unknown point upstream	210/1352	-	0
CSO X	NU00541101 CSO	BERWICK CSO MAGDALENE FIELD	10	Low side weir	210/1351	Hydraulically Controlled	27.5
SPS 7 EO	NU00541104	BERWICK (MAGDALENE FIELD) SPS NO 7 EO	10	2 pump submersible, overflow from wetwell	210/1351	-	0
SPS 8	NU00532504	BERWICK SPS CLUB HOUSE NO7A	No	2 pump submersible, overflow from wetwell	210/0960	-	0.1
SPS 9	NT99546103	BERWICK SPS WESTFIELD NO 9 EO and SO	No	2 pump submersible, overflow from wetwell	210/0983	Hydraulically Controlled	18.9
SPS 10	NT97516503	MILLFIELD SPS	10	2 pump submersible, overflow from wetwell	210/A/0440	Hydraulically Controlled	95.2
SPS 12	NU00531004	RAVENSDOWNE BARRACKS SPS	No	2 pump submersible, overflow from wetwell	210/1251	-	0
SPS 13	NT98504905	TWEEDMOUTH SPS HIVEACRES	No	2 pump submersible, overflow from wetwell	210/1249	-	0
SPS 14	NT99534301	CASTLE VALE SPS	No	2 pump submersible, overflow from wetwell	210/1000	-	0
SPS 15	NU00486803	SCREMERSTON NO 1 SPS	10	2 pump submersible, overflow from wetwell	210/0880	-	4.9
SPS 16	NU00499601	SCREMERSTON NO 2 SPS	10	2 pump submersible, overflow from wetwell	EPRTB3996RM	Hydraulically Controlled	46.6
BERWICK STW	NT98522500	BERWICK STW	8	Spill from storm tanks	210/1273	Hydraulically Controlled	40.4

Model spill frequency is the average annual spill frequency calculated from the ten year series using the 2050 design horizon model.

4. BASELINE INVESTMENT

Northumbrian Water undertake regular inspection and maintenance activities designed according to the nature of the asset and risks and provide 24 hour cover to respond to e.g. telemetry alarms for reactive maintenance as required by permits. Northumbrian Water also operate an early warning system which monitors other levels in the system and flags up any potential issues that may result in a spill. An Asset Management Process System is in place to raise and track maintenance works.

In addition to regular inspections, NWG have a number of planned preventative maintenance initiatives in Berwick:

- Pledge 5 is a region wide project aimed at reducing spills from storm overflows to an average of 20 per year by 2025. Storm overflows are prioritised based on analysis of EDM spills and targeted inspection, maintenance and appropriate action is undertaken to mitigate spills.
- A bathing waters maintenance programme and consists of pre bathing season inspection and cleansing. This year the programme monitored 10 storm overflows in Berwick and CCTV surveyed and cleansed 3024m of network. A follow up survey is undertaken post bathing waters to monitor and assess if any further action is warranted.

These maintenance activities are aimed at reducing overflow spills and are funded through the base spend. Further maintenance identified as part of this study is discussed below.

Table 4 lists the works that have been undertaken at pumping stations to reduce compliance risk.

TABLE 4: WORKS UNDERTAKEN AT PUMPING STATIONS

Pumping Station	Works undertaken
SPS 1	Cleansing New impellors and wear plates. Volute and wear plate pump 2
SPS 2	Cleansing 3 x new pump install.
SPS 3	Cleansing New impellors and wear plates. Wear parts and volutes on pump 1-3
SPS 7	Cleansing New pumps New NRV
SPS 11	Cleansing New pumps
Scremerston North	Cleansing New pumps Site refurbishment

Table 5 shows the operational and maintenance costs for interventions at the existing pumping stations.

TABLE 5: OPTIONS/COSTS FOR RESOLVING EXISTING PUMPING STATIONS

Operational Intervention	£23,000
Maintenance Intervention	£90,000
Total	**£113,000**

Investigation of the 16 SPSs on the Berwick System was underway and had identified two mismatches at SPS7 Magdalene Fields and SPS 9 Westfield between the design capacity of the pumps and the FPF value in the permit.

SPS 7 is permitted as a storm and emergency overflow and has a flow passed forward setting of 74 l/s. The storm overflow is located in a separate chamber immediately upstream of the station and an EO is present in the wet well. The SPS pumps to a combined sewer upstream of CSO 31 and SPS 3. The station currently passes 52 l/s. A Formula A value of 56.7 l/s would be achievable by changing pumps in the existing well and would not require upsizing downstream. SPS 7 is not designed for the permit of 74 l/s and would require a full station rebuild and new rising main. Furthermore, increasing the flow passed forward would result in detriment (flooding) in the receiving sewer. Works to increase the flow passed forward would require upsize of 551m combined sewer through Berwick old town, including crossing the Elizabethan Ramparts.

SPS 9 Westfield is permitted as a storm and emergency overflow and has a flow pass forward setting of 13.5 l/s. The station is located downstream of CSO 24 Westfield and pumps to SPS 7. The overflow is located in the wet well. The modelled 2050 spill frequency is 18 spills per year and is not identified for investment.

TABLE 6 OPTIONS TO RESOLVE SPS 7 AND SPS 9

Asset	Description of Option	Advantages	Disadvantages
SPS 7	Revise permit to Formula A plus replace pumps	Pumps replaced with minimum disruption	Continues to spill higher then 10 spills per year until AMP 10 investment
	Station refurbishment (larger pumps) plus upsize downstream sewer	Meets the permit	Passing more flow forward would increase spills to the estuary bathing waters at CSO 31 Significant works required Works would be redundant once spill frequency solution is in place
SPS 9	Revise permit to Formula A	No works required	The SPS is not identified for investment and spill frequency is higher than 10 spills
	Station refurbishment (pumps and main)	Meets the current permit Reduces spill frequency from the pumping station overflow	Passing more flow forward would increase spills at SPS 7 and to the estuary bathing waters at CSO 31

Northumbrian Water have commenced a dialogue with the EA on the optimum way of managing the compliance of these assets.

5. OPTIONS CONSIDERED

Table 7 shows the types of options considered for Berwick.

TABLE 7: OPTIONS CONSIDERED

Option Considered	Description
Minor modifications	Including raising weirs, small amounts of pipe upsizing, opening up CSOs, upgrades to pumping stations
Source control	Measures near residential and commercial properties, highways, car parks and other paved areas including tree pits, rain gardens, bioretention and permeable paving
Disconnection of surface water systems	Disconnecting SW sewers which connect to the combined system and diverting to existing outfalls, with or without attenuation in detention basins, bioretention or geocellular storage
Separation of combined sewer systems	Surface water removal by diverting surface water from combined sewers to new separate surface water sewers connecting to existing outfalls, with or without attenuation in detention basins, bioretention or geocellular storage
Storage	Online/offline storage tanks
Storm overflow treatment	Treatment of storm overflows - only applicable at treatment works

The approach to optioneering favours surface water removal through source control, disconnections and separation of combined sewer systems, using nature-based and surface water management at source type options where reasonably practicable. Green infrastructure measures follow the principles set out in the SuDS manual. Options have been presented to local planning and highways authorities to gain feedback.

The factors affecting provision of green infrastructure are:

- Practicalities of accessing the surface water source, space to build including tree canopy, ability to infiltrate or return of flows to a network or watercourse
- Cost and likely benefits the measures would return
- Environmental and archaeological constraints and impact on the community e.g. loss of car parking space
- Estimate of the impermeable area that measures can intercept and potential impact on spill frequency.

The shortlisting criteria from the Surface Water Management Plan Technical Guidance (Figure 2) was used to identify opportunities with highest potential.

Criteria	Description	Score
Technical	Is it technically possible and buildable? Will it be robust and reliable?	U (unacceptable) – measure eliminated from further consideration - 2 severe negative outcome - 1 moderate negative outcome +1 moderate positive outcome +2 high positive outcome
Economic	Will benefits exceed costs?	
Social	Will the community benefit or suffer from implementation of the measure?	
Environmental[43]	Will the environment benefit or suffer from implementation of the measure?	
Objectives	Will it help to achieve the objectives of the SWMP partnership?	

FIGURE 2 EXAMPLE OF SHORT-LISTING CRITERIA FROM SURFACE WATER MANAGEMENT PLAN TECHNICAL GUIDANCE, DEFRA, MARCH 2010

Any excess spills following surface water removal were addressed by storage. The approach to developing storage options was

- Group storm overflows to one storage area
- Find space to build
- Determine if online storage is feasible or offline storage with pump return is required
- Consideration of capacity of the network and STW to drain down tanks

The project produced concept stage schematic designs for the purposes of pricing and evaluation, to be developed at the next project stage.

Options were developed with the benefit of a verified hydraulic model. Model assumptions are summarised in Table 8.

TABLE 8 HYDRAULIC MODELLING ASSUMPTIONS

Modelling Input	Base (2025)	5 Year Planning Horizon (2030)	25 Year Planning Horizon (2050)
Growth	Short-term committed development to be provided by NWG.	Local Plan / SHLAA data to be provided by NWG and used to update hydraulic model.	
Urban Creep	No application of urban creep.	To be updated in accordance with the UKWIR methodology.	
Design Rainfall	FEH22 The following return period storms will be simulated and used for level of service checks and flood risk assessment. • DWF • 1 in 20 year and 1 in 40 year		
Time Series Rainfall	Ten-year TSR dataset for Berwick has been produced for the current day from the rain gauge at Berwick STW		2050 TSR dataset has been generated which has been updated for the impacts of climate change using the UK Water Industry Research (UKWIR) climate perturbation tool, 'RedUP'.
Climate Change Uplift	Not applicable.	Not applicable.	25% uplift to be applied to all (summer and winter) design storms, in line with Environment Agency central allowance for Tweed Management catchment.
Infiltration	Modelled base flows to be calibrated against the short-term flow survey. This will also be checked against MCERTS data.	As Base Model.	
Per Capita Consumption	138l/hd/day, default CIRIA profile to be applied in all of the planning horizon hydraulic model simulations.		
Trade / Industrial Flows	Latest available information (Feb 2024) provided by NWG.	As Base Model.	
Boundary Conditions / Tide	Applied, where appropriate. Propose to use mean high tide for TSR Simulations Mean High Water Springs for design events. Applied, where appropriate, during design storms only.	Uplifted in line with allowance for Northumbria catchment **Flood risk assessments: climate change allowances - GOV.UK**	Uplifted in line with allowance for Northumbria catchment **Flood risk assessments: climate change allowances - GOV.UK**

6. EVALUATION

6.1. OPTIMISATION

The best value solution is the combination of options which resolves the storm overflows at the lowest cost:benefit i.e. taking account of the wider benefits to the community and environment. Modefrontier design optimisation software and Infoworks ICM were used to test the combination of options and evaluate costs and benefits of those optionst. The optimiser identifies a number of combinations that meet the spill frequency criteria at the lowest cost. These solutions may then be assessed in more detail.

The variables that were assessed during optimisation are listed in Table 9:

TABLE 9: VARIABLES ASSESSED DURING OPTIMISATION

CSO weir raised	up to a level maintaining existing levels of service
Conduit upsize downstream of CSOs	to allow passing flow forward
Modification of pass forward flows at CSOs	to allow limiting or increasing flows, while maintaining formula A
Pump upgrades at all stations	assumes 10% uplift is achievable with current installation and above this requires a new station
Surface Water Removal across the catchment	based on reasonably practicable
Storage at 12 locations and the works	space is available at 4, 6, 10, 12, 16, 18, 19, 21, 24, 27, 31, SPS16.

The preferred option from the best value solutions identified by the optimiser minimises storage and maximises the wider benefits value from implementing surface water removal solutions.

6.2. STORM OVERFLOW PERFORMANCE

Table 10 shows the predicted spill frequency post completion of the enhancement scheme against a 2050 design horizon.

TABLE 10: SPILL FREQUENCY AT OVERFLOWS FOLLOWING INTERVENTIONS

CSO/PS No	STC Reference	Name	AMP	Bathing Water/ Inland	Annual/BW Spill frequency 2050	Storage required?	Screen required?	Summary
CSO 1	NU00516502	SEA ROAD BT 008	No AMP	BW	0			Overflow may be abandoned
CSO 3	NU00511806	DOCK ROAD SPITTAL QUAY) BT007	AMP 8	BW	2	Yes	Static screen	New chamber and storage
CSO 4	NU00513805	SANDSTELL ROAD	AMP 8	BW	0		Static screen	Overflow may be abandoned
CSO 5	NT99526102	BERWICK DOCK ROAD NO 33	AMP 8	BW	0		Static screen	Retained as high level overflow (screen TBD)
CSO 6	NT99519801	SPITTAL BT 005	AMP 8 BW	BW	2	Yes	Mechanical screen	New chamber and storage
CSO 7	NU00515505	MAIN STREET BLENHEIM PLACE	No AMP	BW	0			Retained as high level overflow. Do nothing (no AMP).
CSO 8	NT99523802	BLAKEWELL ROAD BT 042	AMP 8	Inland	0		Static screen	Overflow may be abandoned
CSO 9	NT99525309	MILL STRAND (NO3)	AMP 10	BW	0			Overflow may be abandoned
CSO 10	NT99524001	MOUNT ROAD CSO BT003	AMP 8	BW	1.5		Static screen	Retained as high level overflow (screen TBD)
CSO 11	NT99526101	CSO - BT 002 Tower Rd, Tweedmouth.	AMP 8	BW	0		Static screen	Overflow may be abandoned
CSO 12	NT99528001	DOCK ROAD NO 39 BT 044	AMP 8	BW	2	Yes	Static screen	New chamber and storage
CSO 13	NT98525004	TWEEDSIDE INDUSTRIAL ESTATE BT 004	AMP 8	Inland	10	Yes	Static screen	Retrofit
CSO 14	NT99523700	WEST END (NO67) BT 043	AMP 8	Inland	0		Static screen	Overflow may be abandoned
CSO 15	NU00496501	DERWENT WATER TCE SCREMERSTON BT 022	AMP 10	Inland	0			Do nothing (AMP 10)
CSO 16	NT99525301	CHURCH ROAD DOCK ROAD	AMP 10	BW	10	Yes		New chamber and storage
CSO 17	NT99529605	PALACE STREET EAST (NO4) BT038	AMP 8	BW	0		Static screen	Overflow may be abandoned
CSO 18	NT99545602	MAGDALEN FIELDS A (NORTH) BT 029	AMP 10	Inland	10	Yes		Do nothing (AMP 10)
CSO 19	NT99547300	MAGDALEN FIELDS (SOUTH) BT 030	AMP 10	Inland	10	Yes		Do nothing (AMP 10)
CSO 20	NT99534501	CASTLE TERRACE (EAST) BT 341	No AMP	Inland	0			Overflow may be abandoned
CSO 21	NT99534502	CASTLE TERRACE (EAST) BT 034	AMP 8	Inland	10	Yes	Static screen	New chamber and storage
CSO 22	NT99529506	PALACE STREET EAST PALACE STREET BT381	AMP 8	BW	0		Static screen	Overflow may be abandoned
CSO 23	NU00523600	PIER ROAD BT 036	AMP 8	BW	0		Static screen	New chamber

CSO 24	NT99545101	WESTFIELD ROAD (NO6) BT 032	No AMP	Inland	2.4	Yes		Do nothing (no AMP)
CSO 26	NT99535303	RAILWAY STREET (NO16) TWEED STREET BT 031	AMP 8	Inland	3		Static screen	New chamber
CSO 27	NT99524600	QUEENS GARDENS TWEEDMOUTH BT 040	AMP 8	Inland	10	Yes	Static screen	New chamber and storage
CSO 28	NT99524607	WEST END ROAD, TWEEDMOUTH BT 041	AMP 11	Inland	0			Overflow may be abandoned
CSO 29	NT99528623	SHORE GATE QUAYSIDE	AMP 8	BW	0		Static screen	Overflow may be abandoned
CSO 31	NT99528600	SANDGATE, BERWICK BT 033	AMP 8	BW	2	Yes	Mechanical screen	New chamber and storage
CSO 32	NT99545604	MAGDALENE FIELDS NORTH, BERWICK	AMP 10	Inland	0			Do Nothing (AMP 10)
SPS 5 EO	NT99534505	BERWICK SPS RAIL STATION NO 5	No AMP	Inland	0			Requires upgrade to facilitate CSO20/21 works
SPS 6 EO	NT98529504	BERWICK SPS TWEEDSIDE TRADING ESTATE	No AMP	Inland	0			Overflow not found
CSO X	NU00541101 CSO	BERWICK CSO MAGDALENE FIELD	AMP 10	Inland	8.7	Yes		Do Nothing (AMP 10)
SPS 7 EO	NU00541104	BERWICK (MAGDALENE FIELD) SPS NO 7	AMP 10	Inland	0			May require works to meet permit
SPS 8 EO	NU00532504	BERWICK SPS CLUB HOUSE NO7A	No AMP	Inland	0.1			Do nothing (no AMP)
SPS 9 EO and SO	NT99546103	BERWICK SPS WESTFIELD NO 9	No AMP	Inland	0			May require works to meet permit
SPS 10 EO and SO	NT97516503	BERWICK SPS EAST ORD NO 10	AMP 10	Inland	10	Yes		Do Nothing (AMP 10)
SPS 12 EO and SO	NU00531004	BERWICK SPS RAVENSDOWNE BARRACKS	No AMP	BW	0			Do nothing (no AMP)
SPS 13 EO	NT98504905	TWEEDMOUTH SPS HIVEACRES	No AMP	BW	0			Do nothing (no AMP)
SPS 14 EO and SO	NT99534301	BERWICK SPS CASTLE VALE RESIDENTIAL HOME	No AMP	Inland	0			Do nothing (no AMP)
SPS 15 EO and SO	NU00486803	SCREMERSTON SOUTH SPS 1	AMP 10	Inland	3.1			Do nothing (AMP 10)
SPS 16 EO and SO	NU00499601	SCREMERSTON NORTH SPS 2	AMP 10	Inland	10	Yes		Do nothing (AMP 10)
BERWICK UPON TWEED STW	NT98522500	BERWICK UPON TWEED STW	AMP 8	BW	2	Yes		Additional storm tanks

The following pumping stations have no physical overflow and share an overflow with the upstream CSO:

SPS1, SPS2, SPS 3, SPS 4, SPS 11

Annual/BW Spill frequency 2050 is the average annual spill frequency for inland discharges or average bathing season spill frequency for bathing water discharges calculated from the ten year series using the 2050 solution model and using the 12/24 spill count method.

6.3. COSTS AND BENEFITS

A summary of the costs and monetised benefits for the project are shown in **Error! Reference source not found.**.

TABLE 11 SUMMARY OF COSTS AND BENEFITS FOR THE WHOLE CATCHMENT SOLUTION

Option	Brief Description of Option	CAPEX	OPEX	Benefits	NPV	WHOLE LIFE CARBON (tCO_2e)
Minor modifications	Raising weirs/abandonment of 15 storm overflows	£115m whole catchment	£0.8m NPV	£45m Flood risk benefit to 758 residential and commercial properties, biodiversity net gain	-£47m	15,000
Surface Water Removal	Removal of 398,681m^2 of impermeable area across catchment					
Pumping Station Upgrade	Upgrade at SPS 5 to manage storage tank draindown					
Storage	7,899m^3 storage at 12 locations within the network 3,840m^3 storage at works					

CAPEX is the total project cost for delivering the scheme as a present value and includes for estimating uncertainty and risk. Costs are based on unit rates for infrastructure items in the NWG HIVE Market Rate application applied to bill of quantities values. Where cost data was unavailable, Unit Rate Costs from various sources across the UK Water Industry recording Base Date and BCIS Inflation factors applied to 2025 Q1 were used.

OPEX is the projected operational cost for maintaining the works over a 40 year period, discounted to a present day value.

Benefits value is the quantified wider benefits associated predominantly with green infrastructure for biodiversity improvement, carbon, amenity improvements, education and flood risk reduction. Monetised benefits for amenity and education have been calculated using CIRIA's "benefits estimation tool - B£ST" (CIRIA 2024). Biodiversity benefits have been calculated from "Enabling a Natural Capital Approach (ENCA) 2024 Services Databook" (DEFRA 2025) and carbon benefits from "The Department for Energy Security and Net Zero's Traded carbon values used for modelling purposes" (DESNZ 2023). Flood risk benefits were measured in terms of changes to Annual Average Damages (AAD).

The results of the flood risk assessment suggest that there are around 658 residential and 100 non-residential properties with a significantly reduced risk of flooding as a result of the catchment solution. These are generally properties that are currently at risk of internal or external flooding in a 1 in 20 year event that will move to no risk in the 2050 solution model.

Whole Life Carbon is the total capital embodied carbon and the operational carbon over the life of the asset, taken as 40 years.

Embodied carbon values were assessed using "A Framework for Accounting for Embodied Carbon in Water Industry Assets" (UKWIR 2012, 2022) and the HM Treasury's Green Book (HM Treasury, 2022) and its supplementary guidance (DESNZ, 2023) for undertaking a carbon assessment. Carbon emissions are measured in kgCO2e and values are taken from environmental product declarations (EPDs) produced by suppliers. Where EPDs were not available, values were assumed based on carbon values for similar materials/components.

7. CONCLUSIONS

- Northumbrian Water have in place a robust monitoring and planned preventative maintenance and specific initiatives to reduce the risk of spills at Berwick.
- This project identified further investment at key pumping stations to reduce the risk of non-compliance. These maintenance activities are funded from base.
- Investigation of the 16 SPSs on the Berwick System identified two mismatches at SPS7 Magdalene Fields and SPS 9 Westfield between the design capacity of the pumps and the FPF value in the permit. Northumbrian Water have opened up discussions with the Environment Agency to determine the best course of action. This would be delivered from base funding.
- Data collection including a survey of all pumping stations and storm overflows, targeted manhole surveys and CCTV and a catchment wide flow survey were undertaken to inform the investigation.
- A hydraulic model of the Berwick catchment was updated with additional data collection and verified against the new flow survey for this study. The model was used to assess asset operation pre and post completion of the enhancement scheme against a 2050 design horizon.
- A root cause assessment of spills identifies hydraulic control as the primary source of high spill frequency at the driver overflows
- The approach to optioneering favours surface water removal through source control, disconnections and separation of combined sewer systems, using nature-based and surface water management at source type options where reasonably practicable
- An optimiser was used to assess the combinations of options across the catchment and identify the best value solutions that deliver the drivers