



Managing Adaptive REsponses to changing flood risk

Sheffield Central area Flood Protection Don Valley Sheffield

Sheffield City Council in collaboration with the partners of the
MARE project

List of stakeholders

The stakeholders should be listed against the standard list. However the terms in the standard list should be used within the case study in order to enable readers to more easily understand

Ref. No.	Stakeholder	Developers		Long term ownership		Interest																					
						Regulators										Planning bodies								Knowledge development			
						Wild life	Heritage	Environment	Water quality	Water quantity	Emergency planning	Strategy planners	Development control	Building control	Road/Transport	Initiators	Create state of the art knowledge	knowledge	maintenance								
		A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D
	Public authorities and water utility organisations																										
	Sheffield City Council				X										X	X	X	X	X	X	X	X	X	X			
	Environment Agency									X	X	X	X	X	X												
	Yorkshire Water				X						X	X	X	X													
	Citizens, organisations and communities																										
	Wicker Traders Group memberss		X		X																						
	Forgemasters		X		X																						
	British Land		X		X																						
	Royal Mail		X		X																						
	Irwin Mitchell solicitors		X		X																						
	Home Office		X		X																						
	Aizlewood Mill business centre		X		X																						
	River Stewardship Company																										
	Groundwork																										
	Interest groups																										
	Sheffield and District Afro-Caribbean Community Association			X																							

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1 Introduction

This report describes the plans and developments for flood risk management for the Sheffield Central Area Flood Protection in the City of Sheffield, South Yorkshire. In June 2007, there was a major incident with flooding from the rivers in the River Don catchment and from other sources in Sheffield. Since then, Sheffield City Council (SCC) and other stakeholders have been developing flood risk management plans that will address this flooding. As part of this process, measures have been implemented in several places because high levels of flood risk have been affecting the livelihood of local communities.

1.1 Aims and objectives

The aims are twofold:

- To reduce and manage the risk of river flooding within the Wicker Area of Sheffield and reduce subsequent downstream overland valley flows.
- To demonstrate the application of the MARE toolbox especially in relation to MARE 1

The specific objectives is to test valuation tools in relation to multi-value

1.2 Background

The River Don within Sheffield is little more than a large stream as its response time is a matter of hours limiting the effectiveness of temporary flood protection measures. In the aftermath of the 2007 flood, the decision to prioritise SCAFP Phase 1: the Wicker was driven by the vulnerability of the Wicker community, a collection of residents, shops, food outlets, small businesses and offices, and the need to sustain the regeneration process in the area. The project is led by Sheffield City Council (SCC) in close collaboration with the Environment Agency (EA), the body with a strategic function and responsibility for main rivers in England and Wales.

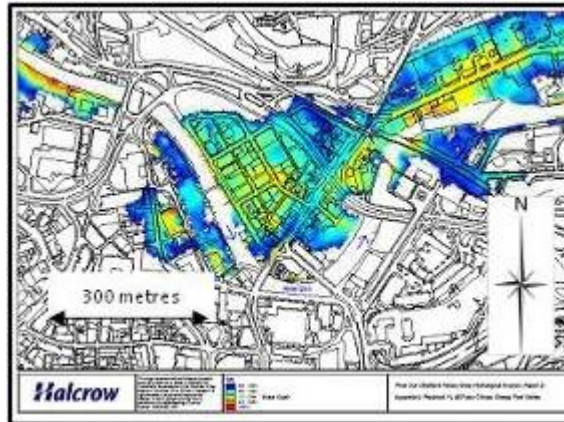


Figure 1: Area of 1 in 100 year flood event for SCAFP



Figure 2: Flooding in the Wicker area in 2007

Major flooding within the River Don in Sheffield, is not a frequent occurrence in terms of the memories of current stakeholders, including the Environment Agency, although much of the Don Valley is termed a susceptible to flooding. The consequence of this is that a culture of flood awareness has not featured amongst individuals, residents, professionals, businesses and others. Prior to 2007, flooding had not been experienced within living memory and therefore was not seen as a high priority.

Even though the Wicker area was identified through flood maps as vulnerable it was not until the flood event that actions were undertaken.

A desire to satisfy a mixture of community demands within the area and with the need for city regeneration were seen to depend in part on flood alleviation. This required a partnership approach to enable a more creative mix of funding to be accessed than available from a single source. The responses following the flooding in 2007 were not guided by an overarching flood risk management strategy, as this was not in place at that time. See Sheffield flood risk management planning for more details on wider FRM activity.

This project has necessarily initially focussed on the relatively small-scale community encompassed by the Sheffield Central Area Flood Protection (SCAFP) project which has led to a modest participant list. There are many businesses of varying sizes in the area potentially affected. The smaller businesses are represented through a Traders groups which organise a local forum - a regular meeting to discuss a breadth of issues including flood risk management. In addition there were other groups that provided a route to garner opinions on flood management solutions, for example the Sheffield and District Afro-Caribbean Community Association, South Yorkshire African and Caribbean Business and Enterprise Training Centre and a local business centre. Larger businesses and organisations were involved individually, such as a nationally significant solicitors and one of the Central Government's Home Office buildings.



Fig 3 The meander of the River Don shown by the tree line where the river overtopped causing extensive flooding in 2007

The main flood risk management authorities involved are SCC and the EA. Within both of these organisations there are multiple facets of engagement, for example the EA is simultaneously a funder, regulator and Flood Risk manager. SCC is concurrently a regeneration agent, planning regulator and development promoter, highway authority, land drainage authority and funder. Emerging from this process and coincidentally timing with government legislation is an increasing role for the council as Flood risk manager being formalised during this project as Lead Local Flood Authority (LLFA), a designation given to all unitary and upper tier municipal authorities in England.

The process of addressing the flood risk in this area of Sheffield was and is facilitated by a regeneration team with support from the flood risk manager within the council.

Knowledge base participants included the MARE partner, the Pennine Water Group, the URSULA project (both University of Sheffield), the latter a nationally funded research project looking at multi-value from urban rivers. Interest groups on the river were the Kayak club and a fishing organisation, SPRITE.

Other significant players associated with flood risk in this area are the River Stewardship Company who are taking a role in managing the river and riverside environment and Groundwork, a national charity, who are working alongside the Environment Agency on flood awareness.

1.2 Regulations, procedures and standards

Since 2007 there have been a number of significant changes, especially to the way in which local flood risks are managed in England, with the passing of the Flood and Water Management Act in 2010 and related instruments, including the Flood Risk Regulations 2009¹. Under the new legislation, the main parties in flood risk management are:

- the Environment Agency which has the overview function and specific duties with respect to rivers and large streams, This includes the writing of the catchment flood management plan for the Don a broad proposal on flood risk management. This document was produced post 2007.

¹ Great Britain. Parliament, 2009. SI 2009 No. 3042 Environmental Protection. The Flood Risk Regulations. London The Stationery Office.

- the Regional Water and Sewerage Undertaker which is responsible for sewer related flooding and
- the Lead Local Flood Authorities (LLFAs) such as Sheffield City Council which as local responsibilities for all other types of flooding.

Although other organisations are also involved in the process

In 2011 a number of strategic guidelines and directions related especially to local flood risk practice and funding were published; encouraging co-funding partnerships for flood risk management² in England. These recognise the synergies, interactions and opportunities for managing flood risks as part of normal urban planning processes, for which Sheffield CC has control.

² Defra/EA (2011) Understanding the risks, empowering communities, building resilience. The national flood and coastal erosion risk management strategy for England. www.official-documents.gov.uk.

1.3 Timeline and flow diagram

Year	Events
2007	Major flood event 25 th June
2008	Strategic Flood Risk Assessment, feasibility study
2009	
2010	Construction of SCAFP Phase 1: The Wicker
2011	Design and sanction of SCAFP Phase 2: Nursery Street
2012	Construction of SCAFP Phase 1
2013	Final handover of SCAFP scheme post defects and establishment period
2014	Possible replacement of intermediate defence

2 Details

2.1 Analysis and assessment

2.1.1 Flooding

June 2007 was the wettest month on record since 1882 with a total rainfall of 285mm. Two periods of heavy rain occurred - 13th -15th June when 135mm fell saturating the catchment uplands and 24th-25th June (the day of the flood) when there was 87mm of rain. The latter is estimated to be between a 1 in 150 and 1 in 200 (0.5%AEP) return period event. More than

100 businesses were affected and one person lost their life in the Wicker area. As the Sheffield Central Area Flood Protection (SCAFP) was the first project as a reaction to this it was also the first to take into account a greater depth of analysis of the flooding vulnerability in the City than had been done before.

2.1.2 Summary of Flood studies undertaken

2.1.2.1 SCAFP specific [*Strategic Flood Risk Assessment \(SFRA\) 2 July 2008 Jacobs*](#)

A 1D /2D computational model study was set up in response to the flooding and a need to update the city wide Strategic Flood Risk assessment (SFRA). A SFRA effectively provides land use planners with a tool to steer development away from flood risk areas. Modelling confirmed there was out of channel flow from the left bank that then flowed through the streets of the Wicker before partially returning to the river channel or continuing downstream along the valley bottom. Depths of flow between 400mm and 1000mm travelling at high speeds were shown to have occurred across developed land and roads. The bridges played a part in raising flood levels especially Lady's Bridge at the heart of the area due to blockages during events and sediment build up inbetween .

Recommendations have been made that

development is discouraged from the low lying areas to the south of the Wicker, although land raising and corresponding compensation may assist with riverside development.

2.1.2.2 SCAFP Detailed options

The following studies were undertaken to look at the scheme within the locality of Sheffield Central Area Flood Protection

2.1.2.2.1 River Don (Sheffield) Nursery Street Hydrological Analysis Oct 2008 (Halcrow)

This refined the 2nd stage strategic flood risk assessment (SFRA 2) study to allow testing of the computational model with various options to deliver recommended standards of protection as described in MARE 2. It highlighted the options available for flood alleviation including removing or reducing crest heights of weirs, new or raised flood walls, and channel clearance. New flood walls and channel clearance were the chosen options for their ability to alleviate flooding. Crest heights for flood defences were approximately determined for both left bank and right bank to allow progression with detailed design.

2.1.2.2.2 Hydraulic review Halcrow, Final design test Halcrow/Sheffield City Council 2011.

This used updated guidance from the EA on hydrological flood estimation and results from a study of upstream storage at Beeley Wood carried out since the first feasibility investigation in order to refine the levels for standards of protection (MARE 2). This has also included a refined modelled peak flow and better gauging of the flows from adjoining tributary, the River Sheaf, which lies upstream from the key Don River flow gauge used to calibrate the hydraulic models.

Three scenarios have been modelled with 2 - 0.1% AEP – this was done to clearly show the impact of the scheme and from which state was the baseline:

- The condition of the Don prior to 2007, with minor changes such as Manning's roughness coefficient changed to 0.4
- The current situation reflecting the channel clearance and new defence at Kelham Island. This revealed that the channel debris and sediment clearance has improved protection from a 10% AEP (1 in 10) to a 4% AEP (1 in 25)

- The proposed defences on the left and right bank. These would be overtopped in a 1% AEP (1 in 100). There is an allowance for freeboard. Defence heights inclusive of Climate change would cause flooding to increase upstream, which was not acceptable. Note the right bank was set at a higher level to ensure the left continues to flood first as is the present case.

2.1.3 Detecting urban problems or potentials

2.1.3.1 Regeneration context

By understanding the regeneration processes we are able to combine problems and potentials from the different perspectives of water and of the city (as MARE1 suggests). As an example, Wicker Riverside, the key area targeted by the SCAFP, is a key strategic regeneration area which contains one of two new business districts identified in the City Centre masterplan of 2008. The Wicker Riverside Action Plan started prior to the 2007 floods and recognised the flooding issue (most of the area lies within a designated flood plain), but this aspect was revised after the floods as being critical to the area's regeneration potential. This plan identified a lot of development sites and the transformational

opportunities available to promote the area as a gateway to the city. Many new newly constructed buildings to the south of the Wicker were already built with resilience in mind, for example raised door thresholds.

The critical infrastructure of the inner relief road was built to improve traffic flows for the city but also allowed the Wicker area to be brought 'closer to the city centre' by removing severing road infrastructure thus allowing the area to be 'stitched back' into the city centre. This facilitated the addressing of the quality of the environment as the area was seen as a failing, overlooked and neglected backwater of shops and small businesses. Public realm investment bolstered the previous investment in black and ethnic minority business support in the area. As a result the numbers of vacant business units decreased and there was improved investment.

The flooding of 2007 hit confidence in the area, making the desired residential proportion of overall development very difficult to achieve. A combination of greater difficulty in negotiating planning rules through flood risk assessments and the economic downturn stagnated the

area’s continued regeneration. Flood risk was in addition, predicted to increase due to Climate change impacts causing faster flood flows from the upland and urban catchments.

The need for emergency vehicle access across the city via the inner relief road was not considered at the time of design (early this millennium?) due to the infrequency of flooding historically. This is therefore a key aspect of the flood protection that needs to be addressed.

The Inner relief road has significantly altered the traffic dynamics of the area making it possible to improve the public realm of the Wicker, the key commercial street of the area and thus start to address some of the negative image of the area as a socially problematic part of the city. It has also provided the opportunity to develop the riverside as a resource by allowing the riverside road, Nursery Street, to be earmarked for partial closure to motor vehicles. Like much of the city centre there is an increase in residential developments for which the quality of the environment as a recreational resource is another driver promoting change in the area.

One key aspect to the Wicker Action plan was to look at the urban design improvements that could be delivered in the area. This included

improving the permeability of the grid of streets to pedestrian movement and the incorporation of open spaces with key arrival space being next to the river. Built development would be either office or residential with ground floor shop or café/restaurant type uses. (Fig 4)

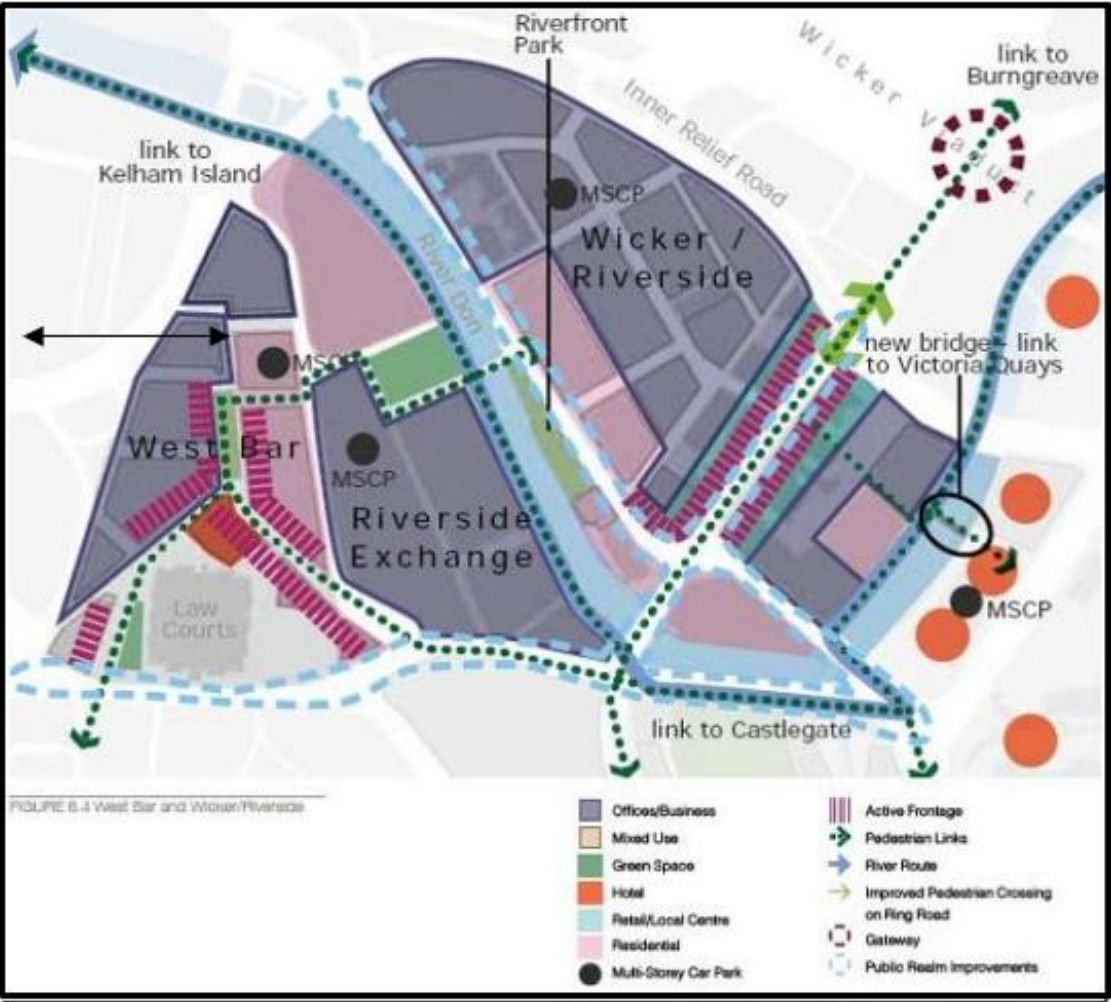


Fig 4 Proposals for the new Riverside Business district with early suggestions of a riverside park

2.2 Problem definition

The high level problems for the partnership are detailed in the report Sheffield Don Flood Risk management planning. Specific local problems for the SCAFP project are:

- Seeking a solution that gives greater confidence to the local community of businesses and residents
- Flood vulnerable building with difficult adaptation
- Key transport infrastructure in flooded area requiring flood protection
- Ensuring the river as an environmental asset fulfils benefits to the neighbourhood.
- Requiring that if works are undertaken there is no exacerbation of flooding elsewhere
- Tailoring works to limited available funding
- Uncertainty over other interlinked FRM interventions elsewhere within the catchment
- Channel management solutions in view of bridges

2.3 Options considered

2.3.1 Sheffield Central Area Feasibility study Sheffield City Council 2008

It was necessary from a business planning point of view to examine the options available to deliver improved flood risk management for the Wicker Community. This study examined the issues of flood risk management within its urban context and summarises the key aspects of flood risk management open to use, many of which have been and will continue to be taken and some of which form an iterative process of improvement. The SCAFP project was in some respects a test case to start to examine the wider aspects of flood risk management. The options are summarised in the report Flood Risk Management Planning Don Valley Sheffield .

In summary whilst raising awareness and improving the sign up to flood warnings and avoidance through ensuring the right development happens in the flood vulnerable areas were recognised as important it was felt that the actual river flow needed management changes. Whilst assistance could be tailored to the vulnerable communities as a single response the depth and speed of flow, blockage of the Inner Relief Road and vulnerability of

buildings called for protection through alleviation.

2.3.2 Learning from best practice

Designers working on the project sought information on comparable situations, for example where river cross sections had been changed to make the most of new space for public activity (see fig 6).

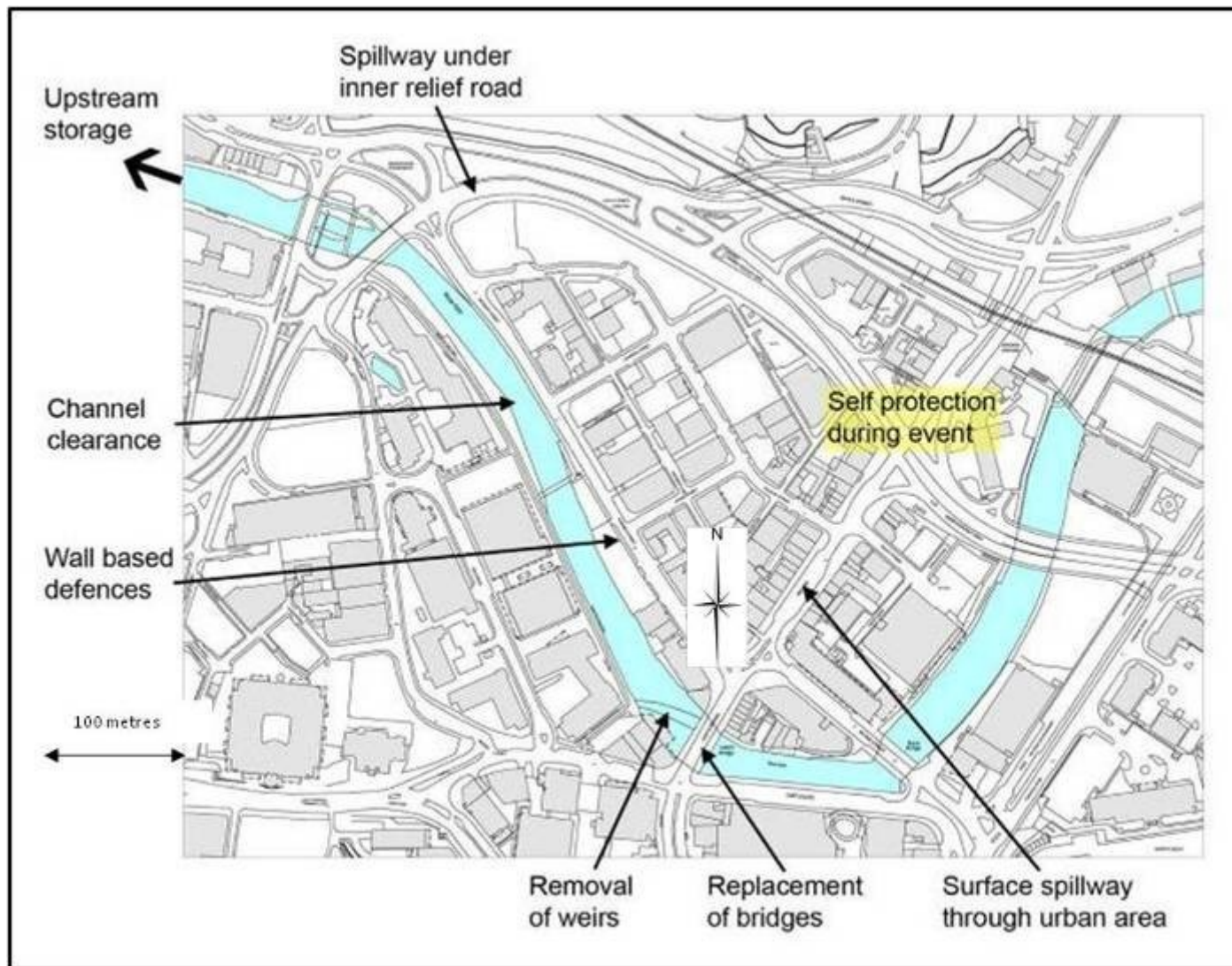


Figure 5 Plan showing Wicker area, ring road and options for alleviation



Figure 6 Copenhagen

2.4 Selected option

2.4.1 Summary

In the absence of a strategy for the whole Sheffield Don River system, individual interventions in the Wicker were deemed appropriate and necessary given the risks and expected time delays for a full Sheffield catchment plan.

Although broad flood management options were considered, the regeneration driver led to a focus on bankside alleviation as a relatively quick measure to visibly reduce flooding and its resultant effects. This was seen as the priority compared with building resilience within the community as most of the existing buildings in the areas considered could not easily be adapted to withstand flooding. A major consideration was the need for properties to be eligible for insurance cover necessitating a 1 in

75 standard of protection as a minimum³. In addition much flooding within the area leads to overland flows further down river on to the road network. Thus alleviation through wall based defences were considered important, and effectively the key strategy for strategic flood risk management as these would keep the river contained in its' channel. Aesthetic or access considerations were considered to be subordinate to providing a reduced probability of flooding, i.e. only flooding frequency was considered in the decision process, not vulnerability or impacts.

The SCAFP project is focussed on the alleviation aspects of flooding, with initial work concentrating on traditional defences but with parallel effort to pursue the use of existing upstream reservoirs for controlling river flows.

Localised alleviation was the chosen route for improved flood risk management. The modelling exercise determined that a combination of channel clearance and flood defences was the most effective solution with the least disbenefits. Removing bridges and weirs was seen as too controversial and not

³ this is an agreed protocol between the UK Government and the Association of British Insurers and expires in 2013 (when it will no longer be valid).

delivering enough benefit. Spillways were seen as too land hungry or too expensive

More consideration needs to be given to co-design, embracing multiple land uses and benefits and this is now encouraged by Government guidance and standards for shared funding that make a multi-beneficial approach mandatory. However, it is crucial that in regenerating areas business confidence is maintained and this is most easily done by constructing visible and 'we know it works' hard infrastructure defences (alleviation). Changing mindsets (awareness) to accept floodable areas, risking loss of valuable land for development, being willing to be flooded even every 100 years or so, are all excellent aspirations, but in the short term, a pragmatic and more traditional approach is unfortunately essential otherwise business funding and acceptance will not be forthcoming.

2.4.1.1 Standards of protection and Climate change

The most recent computer modelling has shown that defences for the Wicker scheme exceeding a 1%AEP standard of protection will cause upstream flooding by backing up which would require further alleviation in upstream areas. Limited funding means that it was necessary to avoid a scheme that would impact

over a wider area with additional costs. Because of this, any allowance for Climate Change requiring higher defences (typically 20% increase in future flows), has not been possible to accommodate, as this would further exacerbate upstream water levels and the need for more extensive defences. It has also meant that some local communities may not be defended against a flood equivalent to 2007 (although this is hard to prove as the effects of bridge blockages causing localised river level increases are difficult to quantify during an event) especially as in 2007 much of the problems were caused by debris trapped at the bridge inlets.

With regard to managing the impacts of climate change, the following options can be pursued as part of the forward strategy, but as yet are not determined:

- Adaptable defences allowing standards of protection to be maintained for individual flood cells (MARE 2)
- Upstream storage - Recent considerations suggest that the use of reservoirs in the uplands immediately above Sheffield may be the best way to effectively provide this additional protection. Thus providing a higher

standard of protection than the 1%AEP or at least maintain the standard of protection of 1%AEP as climate change impacts on rainfall (MARE 2).

- Planning for increased overtopping associated with a reduced Standard of protection (MARE 3), for example directing out of channel flood water along pre-planned (blue infrastructure) pathways, redeveloping with resilience and developing appropriate assistance in times of flood.

The latter item is as yet unexplored as the focus has predominantly been on protection. If upstream storage proves not possible and raising defences appears not practical for example because of cost or urban design requirements then an allowance may be needed for reduced standards of flood protection.

2.4.2 Summary

2.4.3 Integrating flood defence with green infrastructure MARE 1

As described in the Regeneration context the nature of the urban area has meant environmental improvements have been key to its success including identifying the riverside as

an opportunity. The flood defence project has chosen to take advantage of the urban design aims of the area by integrating with a new focal pocket park for the residential and business communities (see fig 7). This development has brought other funding forward as match to flood defence investment. Although the park itself is not involved in the hydraulic management of the river for flood purposes the opportunity to incidentally bring these two aspects together and cofund has been very beneficial.

This aspect of the project illustrates the best practice performance as described by MARE 1 (Climate Proof Tool box) where multiple benefits are accrued from an individual investment and a positive relationship is garnered from the coexistence of both the defences and the park.



Fig 7 Artists impression of pocket park

2.5 Implementation

The phase 1 SCAFP project has undergone testing as detailed above. Designs are complete and construction was completed in September 2012.

The defence solution includes (see fig 8):

Left bank

- Permanent section of new wall within or adjacent to park
- Building window infills and bankside door sealing
- Intermediate walled defence section to be replaced in the future as part of a wider renewal of the area, for example pedestrianisation

Right bank

- Small scale raising of river wall to counter increased river level caused by left bank defence.

Defence design included the following consideration/issues. The evolution of the design of the scheme went through a number of stages as a result of these factors:

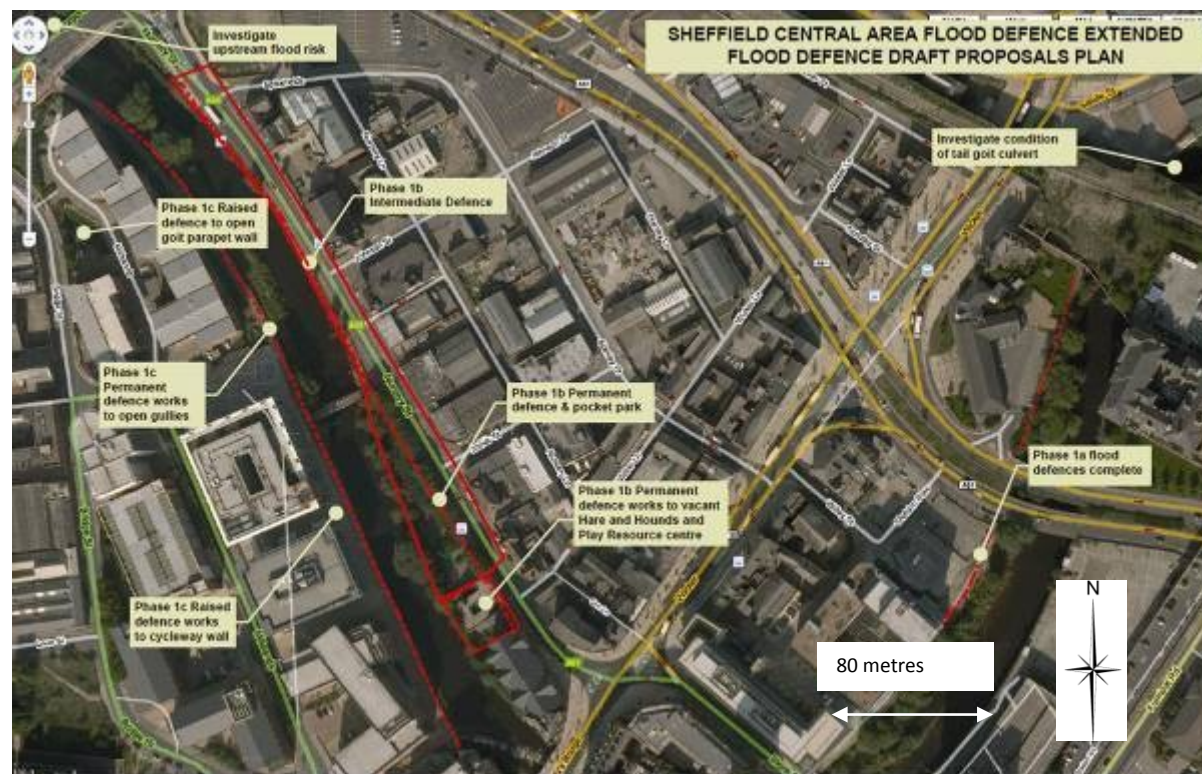


Fig 8 Interventions for Sheffield Central Area Flood Protection

2.5.1 Adoptability

Within the municipality there is a lack of clarity regarding who is responsible for flood risk management assets. The scheme is led by the municipality, whereas in other contexts the EA may have taken the lead. The long-term management appears to be the responsibility of the body delivering the scheme, which in the case of Sheffield will be the Council⁴. Where a defence is adjacent to private land it is expected that the landowner would be responsible to ensure that the defence is fit for purpose and

⁴ The new duties and responsibilities as a Lead Local Flood Authority are still being defined

maintained. The SCAFP scheme is entirely on Council land, however, there has not been a tradition of Council managed flood defences. Some maintenance has been done in the past on highway walls where these have also served a flood function, with the latter being incidental. All floodwalls are to be on a register under the new legislation and there will be a need to ensure the defence is not interfered with by the owner. The problem within Councils is the internal politics of which department takes responsibility. Highways would be a logical location as they have facilities to look after infrastructure. However Sheffield has embarked on a 30 year Private Finance Initiative for its Highway management in which any variations on the primary contract will be costly and the transfer of the liability for flood management assets will be difficult especially if the new manager is liable for the consequences of failed defences because of management incompetence. Presently the outcome is that Highways will look after the SCAFP assets but not as flood defences, which is not satisfactory.

2.5.2 Ongoing management requirement

The pocket park part of the SCAFP project is to become part of the portfolio of sites managed by the River Stewardship Company. It will fall under the Council Parks team in ownership.

Resources to manage such sites, however good the argument is for their development, are very difficult to acquire. Developer contributions will provide a short-term solution and maybe combined across city centre small open space sites to improve efficiencies of scale through the parks team. The park provides a high profile window for the RSC which has been established as a vehicle for river channel management for the numerous riparian owners alongside the river through Sheffield.

2.5.3 Footprint

A number of options of design were explored for the intermediate defence where the project team were conscious of the aesthetics of a temporary structure which may be around for 5 years. A major factor was the difficult footprint of where defences could go with an abundance of services within the land next to the river making a number of designs impractical, for example planted bastions. The only solution was to build on the top of the existing river wall.

2.5.4 Effectiveness as a defence

The final scheme had to be effective under the everyday conditions of an urban area and under the strain of the weight of water during a flood. One design involving clear polycarbonate sheeting attached to existing strengthened

railings, that allowed views of the river (Fig 9), was deemed too vulnerable. Another design involving wire bastions was deemed too permeable to leakage during a flood.



Fig 9 Polycarbonate attached defence

2.5.5 Buildability

One considerable problem is the inherited old river walls which if deemed unviable during partial deconstruction could prove a major problem for the delivery of the scheme. Structural engineers are also aware that if extensions on top of new defences are proposed in the future that there may be a need for a total river wall rebuild.

2.5.6 Visibility of river

Fortunately this aspect of the design process was positively determined by the need to keep defences at the lower 1%AEP which meant

defences were low enough to see over . This was especially useful for those running alongside the back side of the pocket park where this would improve safety by improving visibility.

The larger remaining Lower Don Valley scheme is within the feasibility stage but would be looking to implement on the ground in 2014.

2.6 Performance and effects of selected option

Delivering this investment in flood defence integrated with open space/green infrastructure will provide a recognised standard of protection and a quality environmental resource for the community. The new modelling undertaken for the scheme was the best to date but like any modelling will be open to review into the future as better understanding is obtained. Already with the new Sheffield model there may be suggestions of how the defence could have been done differently, for example in the impacts associated with bridge blockages and consequent allowances for this in defence heights. Nevertheless a defence will be provided that will allow businesses to receive insurance or to argue for reduced premiums.

The defence is a 'permanent structure and does not rely on moving parts/ manual operation. However there may be questions over whether defences could be raised in the future if required (MARE2).

The pocket park investment provides a resource to the community but also a chance to heighten awareness of flooding through the design and onsite interpretation (MARE1).

2.6.1 Multi value

As part of MARE 1 the Sheffield Central Area Flood Protection scheme (SCAFP) has been analysed from a point of view of building a suggested value utilizing available techniques and information. MARE 1 as part of the Climate proof toolbox suggests that investments in flood risk management should seek to integrate with other functions within urban areas. Indeed an investment can deliver a number of planned functions as well as other values such as is encompassed within ecosystem services. This presents a logical approach as many flood risk management investments may be asked to perform infrequently for example every decade. Thus as urban infrastructure it is better from numerous points of view if they are performing everyday benefits as well. This multi-beneficial approach is not only a result from investments it can also be key behind

resourcing and managing investments. Pooling investments with different purposes can deliver a greater whole and assets with multiple functions should garner greater support for management.

Nursery Street, the focus of SCAFP from a multi value point of view includes a pocket park which accommodates a part of the flood defence for this area. A defence that considerably reduces downstream overland flow to further communities. Although the park contributes little to the hydraulic behaviour of the river, such as making room for the river/space for water it, as a location for conventional wall based flood defences, has allowed cofunding driven largely by flood risk management (regulatory services) and urban green space (cultural services). This co-location also enables heightened awareness of flooding.

The idea of a park was highlighted in regeneration documents such as the Wicker Riverside Action Plan and the urban design proposals. The Wicker was seen as a backwater to the City centre and was failing economically and socially. The completion of the Inner relief road (inner city ring road) removed severing traffic routes allowing the Wicker area, as it is known, to be stitched back into the city centre. New office and residential development took

place as well as street-scape improvements. Removing huge traffic volumes meant the riverside at Nursery street became considerably quieter so post 2007 the idea of realizing open space/ public realm improvements by the river could be tied with flood alleviation proposals.

Initially a considerable proportion of Nursery Street was included in the proposals where the street was re-profiled to allow access to the river level. However, the costs associated with such a scheme were very high due to the need to divert services within the street. A lesser scheme was developed on vacant land that had previously been a run down car park. The adjoining Nursery Street would form part of a second phase but would in the interim accommodate a temporary defence to protect the community. These proposals were developed with the local traders group with input from local residents and larger offices.

The urban environment is changing within the area with like, in many cities, an increasing emphasis on city living. Although there is a national hold on housing within flood zone 3 of which this is such a designation there may be challenges to this prior to this date which could be waived through on regeneration grounds as has already happened within Sheffield. Irrespective of this there is likely to be an

increasing number of people living in this area with many vacant development plots which could be of mixed size including family accommodation. The quality of the environment will therefore be an increasingly important factor for the existing and predicted communities. Modern office development and business spaces have already been developed and will also feature in the future. An attractive river side will be an asset to these businesses. Within this area there are a considerable number of long-term small businesses – shops and food outlets etc. Building on existing improvements will help to improve footfall and attractive environments will contribute to sustainable new residential communities that will need local provisions.

The river environment is slowly being developed as a leisure resource with this area connected to the rest of the Don within Sheffield by riverside access routes. The pocket park provides a very important resting/gathering space on these routes. Improving the overall experience for a wide audience. Nursery Street presently is proving to be a gap in activity in the peripheral areas to the city centre. Improving this area will better tie the Kelham Island area into the Wicker / Castlegate Markets redevelopment. (see fig 10)

Urban river corridors are heavily modified. The need for maintaining the channel as a clear conduit for flows is critical as blockage structures such as bridges can substantially exacerbate flooding. The recent floods of 2007 have highlighted this problem uncovering the decades of neglect. The result has been a huge investment in channel clearance and a realization that perhaps the future picture of the urban river corridor is one of limited vegetation particularly trees. The canalized nature of the river largely formed by its historic industrial past means opportunities for riverside tree canopies become very limited for example because ownership remains in private hands and is serving an economic function to the city. This means sites like Nursery Street where green space adjoin the river become highly valued as opportunities to incorporate biodiverse landscapes. They also become environments where the cooling effect of the river combined with trees can be appreciated by the community.

Whilst maintaining the channel to sustain unimpeded flows reduces the number of trees solutions to deliver this may also improve the aesthetics of the channel by removing unsightly debris that for the public maybe the key negative aspect of the river. The park in addition to providing a recreational resource has created a permanent access point into the river for this purpose which would otherwise be difficult to achieve.

The actual space prior to investment was an area that received dumping and drug taking activity and was a blight on the environment. It in effect provided no value apart from biodiversity associated with existing poor condition trees and invasive vegetation.

2.6.1.1.1 Project objectives:

Restore the physical and ecological condition of the river by:

- re-naturalising the river bank;
- improving biodiversity of river
- improving the river corridor;
- showing how EU Water Framework Directive goals can be met;

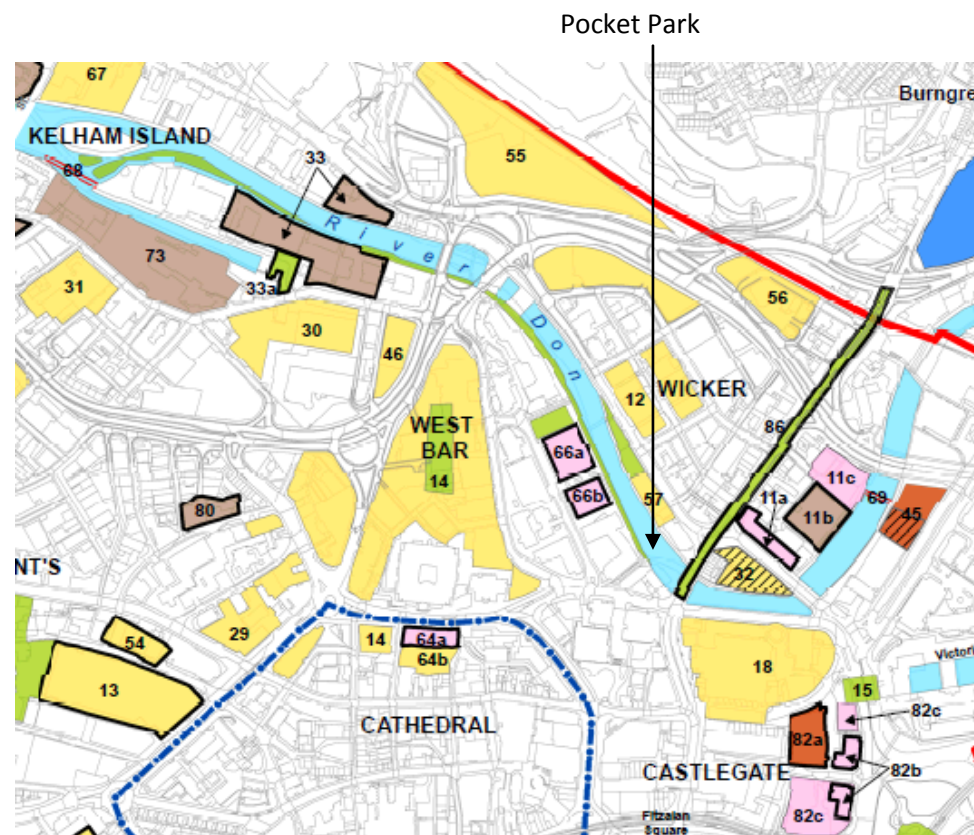


Fig 10 Map showing the Wicker and the pocket park in between Kelham Island and Castlegate

Creation of park by:

- restoration of derelict land;
- improving biodiversity in the park;
- planting trees as part of a replacement of channel tree removal
- improving ecosystem services; and
- reducing flood risk to properties adjacent to and downstream of the park.

Socio-economic uplift by:

- creating a park as an asset for public use;
- promoting regeneration of the area;
- improving safety, security and public perception;
- providing environmental education for local schools and colleges
- and general public; and
- increasing public understanding of climate change adaptation and
- river restoration.

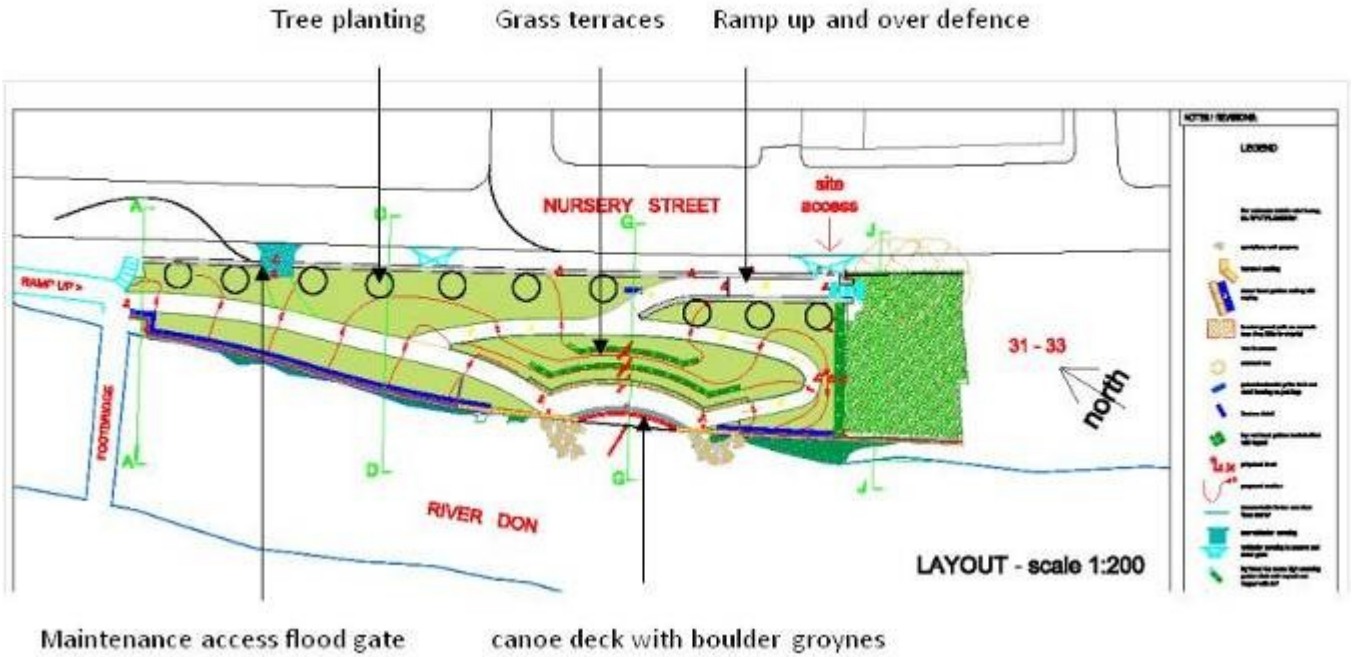


Fig 11 Plan of pocket park

There is an increasing effort to value investments in terms of multiple benefits to build stronger arguments for investment but also to start to address questions such as who are the recipients of benefits and how can this be recognized. Valuation methods are subject to numerous variables many of which are difficult to prescribe. Results therefore have to be open in assumptions, for example in setting boundaries of the impact of benefits or how values have been sought, for example from raw studies from similar scenarios. Hence such studies should be seen as indicative only.

The following table uses the Millennium Ecosystem Services Assessment to carry out a brief analysis of the main services provided by the investment. Values are generated by transferring from other projects where this exercise has been undertaken with adjustments made accordingly. Values are only attributed where there is more confidence in evidence. Benefits transfer used where possible
Willingness To Pay. – Note raw information on values is from a range of sources, e.g. Introduction to Valuing ES 2007 HM Green Book, EVRI, UKNEA, NERC Valuing Nature Network

Nursery Street Flood Defence and Pocket Park Ecosystem Services	Likelihood of impact for locality	Likelihood of impact for city	What changes	Gross annual value
Provisionng services	0	0		
Freshwater	0	0		
Food	0	0		
Fibre and fuel	0	0		
Genetic resources	0	0		
Biochemical, natural medicines, pharmaceuticals	0	0		
Ornamental resources (flowers)	0	0		
TOTAL				0
Regulatory services				
Air quality	+	0	Role of river corridor in city air quality	0 Methodology for evidence gathering is not available
Climate regulation (local temperature/precip, greenhouse gas sequestration	+	0	Carbon sequestration through vegetative landscapes. Cooling reducing incidence of heat stress	0 Carbon sequestration minimal. Cooling impacts- methodology for evidence gathering is not available
Water regulation (timing and scale of run-off, flooding)	++	++	Pre and post levels of flood protection	0 provided by ecosystem but there are huge benefits from engineered structures (see later)
Natural hazard regulation (Storm protection)	0	0	Absorption of storm energy ,e.g. through roughness	0 Methodology for evidence gathering is not available
Pest regulation	0	0		
Disease regulation	0	0		
Erosion regulation	0	0		
Water purification and waste treatment	0	0		
Pollination	0	0		
TOTAL				0

Nursery Street Flood Defence and Pocket Park Ecosystem Services	Likelihood of impact for locality	Likelihood of impact for city	What changes	Gross annual value
Cultural services				
Cultural heritage	+	+	Improved awareness of historical value of industrial past to Sheffield	
Recreation and tourism	++	+	People using river as a recreational resource, wider riverside access network. Previously derelict, abused site	Studies show there can be a value loss associated with closure of facilities (O’Gorman <i>et al.</i> 2009) for example £16.90 per person-day where closure of a waterway deters visitors. The Mayesbrook study adjusts this for a lower income population to £8.45. This could be further reduced to £6 for the small scale of the site in providing for shorter visits. Estimated 20 visits per day could equate to £43800 per year.
Aesthetic value	++	+	Perception change of area	Difficult to monetise
Spiritual and religious value	+	0		Difficult to monetise
Inspiration of art, folklore, architecture	+	+		Difficult to monetise
Social relations (fishing, grazing, cropping communities)	++	+	Kayaking, fishing, volunteer days, reduction in crime associated with distracting activities -	Covered under rec and tourism. Property value uplift could be as a result of investment. CABE 2004 suggest between 7 and 34% rise in house values. Taking half the lower figure as it is a small site and an impact area of a radius of 0.25kilometres there are estimated to be 1200 properties with an average value of £100K this equates to £4,200,00 Office values have not been assessed
TOTAL				£4,243,800
Supporting services				
Soil formation	0	0		
Primary production	0	0		
Nutrient recycling	0	0		
Water recycling	0	0		
Photosynthesis	0	0		
Provision of habitat	+	0	Bank profile change to more naturalistic	Difficult to monetise
TOTAL				£43800 (plus prop uplift of £4,200,000)

The valuation of benefits from an ecosystem services approach are still subject to contending ideas about the boundaries to be set, and hence such evaluations should currently be seen as indicative only. In this case, the gross lifetime benefit is almost £142K after discounting over 40 years plus some £4.2M uplift to the 100 year value of adjacent properties, giving a total of some £4,342,000. All of this added value is to cultural services. Thus the monetised benefits to costs are £4,342,000 relative to scheme costs of £650K, producing a benefit-to-cost ratio of almost 7:1. It should be noted that through an ISIS Damages software model exercise the engineered flood wall provides an estimated damage reduction of £9.938M from the baseline of 'without these defences to 'with these Defences'

This includes a 43.3% addition to the Direct Damages to cover:

- Temporary accommodation
- Vehicle damage (not traffic disruption)
- Emergency services costs
- Disruption to Communications
- Damage to Utilities

This equates to a 15.29:1 benefits ratio. This is largely due to reducing overland flow further down the valley.

Values associated with business activity uplift and land values has not been carried out. Anecdotal evidence from meeting businesses does suggest that they are encouraged by the pocket park development as a important part of the images of the area and that future residential development will benefit from it. The existence of the flood defence with a responsible owner now provides security for new development although they will continue to need to look at residual risk from overtopping and appropriate development in these circumstances, for example non-vulnerable ground floor uses, 1 in 100 year flood level standards of protection and safe access/egress. Although the nature of the area places it as one of the hot spots for new residential development depressed land values continue to hamper new development.

Although this site could be assessed from the ecosystems services point of view this assessment usually implies the natural environment providing the services. In the case of Nursery Street it is an engineered structure – a flood wall, that delivers the flood protection although it does also provide a boundary to contain the park as well as a park seat so as an engineered structure it is multifunctional. Should the wall be included in an assessment of ecosystem services? When does the level of

engineering preclude the inclusion of features within natural environments?

In assessing value we usually examine change. With this site the decision to convert to an open space may have gone in a different direction, for example to build development, thus whole value should be sought not change from previous state, e.g. biodiversity wise this site was potentially as valuable before development and would therefore show no or negative change, run-off may have increased from the site. Through the park development this area has therefore been retained and in this respect the whole value is more useful, i.e. the biodiversity and permeable area.

The key service provision of this whole investment are the regulatory ones of flood protection and cultural services such as recreation and property value however there are without doubt other values but these are either too small or difficult to evidence such as ,historic importance, air quality and urban cooling. These services are however providing

a contribution to cumulative impacts and perhaps can be further valued in the future along with other investments.

Urban green space construction in this context would therefore be of major public value, fully justifying the planned investment and providing firm evidence that investment in urban green infrastructure' is highly favourable for the health and wellbeing of local people and the economic improvement of urban areas. On these grounds alone this investment presents a strong argument. If we ignore the fact that flood alleviation is delivered by an engineered structure and is therefore not countable as an ecosystem service provided by the natural environment this adds considerable further value to the investment.

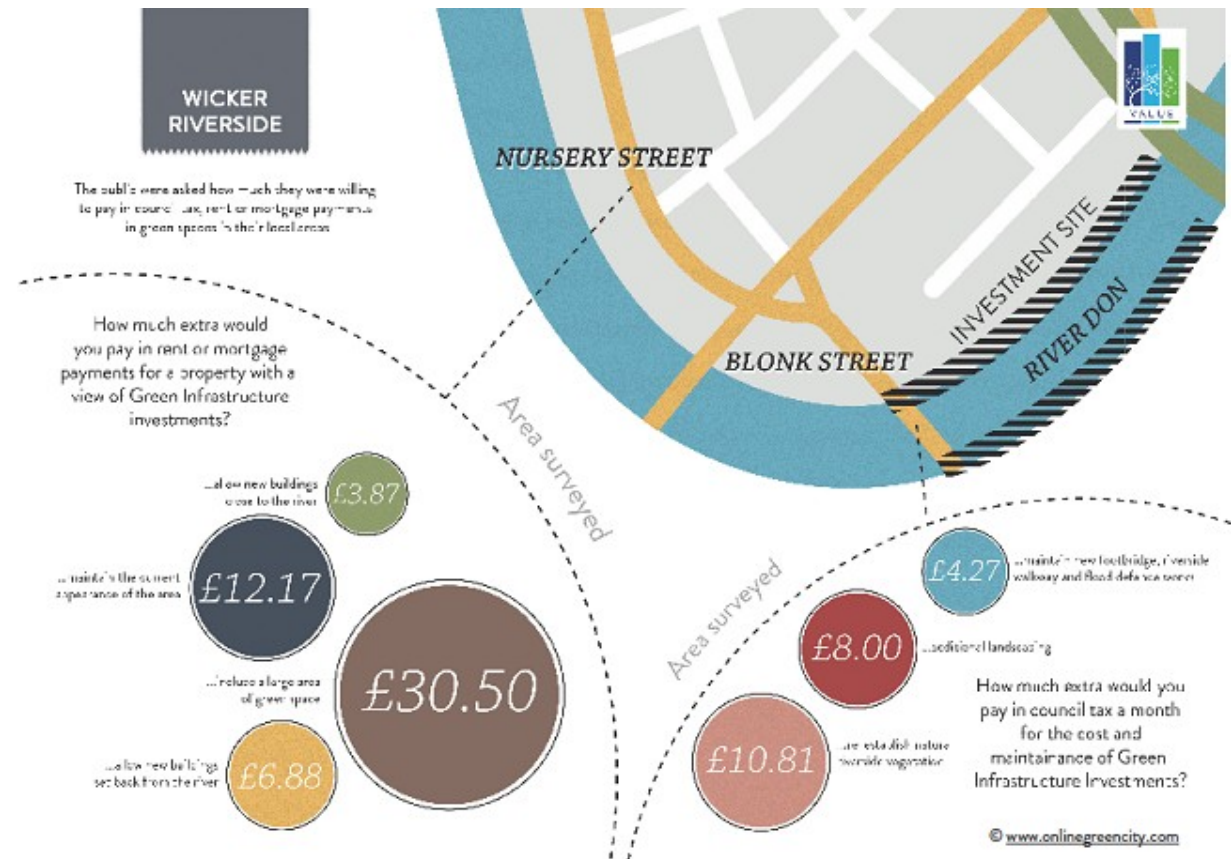


Fig 12 Another way to determine value is to look at willingness to pay through surveys to generate other supportive information. The above (fig 12) summarises an 500 respondent survey of attitudes to Green infrastructure investments. This was carried out by the VALUE North west Europe Interreg project. Wicker: willing to pay £50-£65 pcm extra on £575 rent, to improve green infrastructure & return to a more rugged, unspoilt natural appearance © www.onlinegreencity.com

2.7 Difficulties encountered

Loss of knowledge within Sheffield Municipality associated with local government cuts has meant this project has suffered from a gradual reduction during design in flood risk management expertise. This may have had an impact on continuity of input etc for example in model changes impacting on design leading to difficult discussions with the community around lower standards of protection

Existing infrastructure for example services, archaeology (Fig 13) causing problems with design with numerous iterations and prolonged feasibility.



Fig 13 Previous works on the site of the pocket park

3 Review

3.1 Conclusion

There is no doubt that SCAFP Flood alleviation investment has proven to be good value for money on flood damage reduction alone. This is because it is such a strategic location in overland flows. The defences could have been built in isolation and would if being just walls have delivered no other benefits. The defence was in effect non-reliant on the park investment. The synergistic (MARE1) aspect of this project is about timing and investment in that the arranged mix of funding was able to deliver a better integrated scheme with many different areas of value. In terms of policy this is what the English government pushes. One exercise is to perhaps look at what might have happened if the timing and investment aspects had not coincided, e.g. it may have been likely that defences would have been built next to the river making future investment in set back defences associated with a park prohibitively expensive. Indeed a pre-built defence may have made open space investment less attractive.

The key lesson is about keeping knowledge connected so that synergistic opportunities can be realised. The Wicker Action plan also provides an example of where pre-emptive work can prime an area for these sort of multi-

beneficial projects. In identifying multiple values the challenge is how to ensure recipients of benefits can contribute to the investment cost and long-term management. These missing markets could provide a stimulus to better integrated working in the future.