Kilcreggan Surface Water Management Plan

Final Report

April 2019

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Revision history

Revision Ref / Date	Amendments	Issued to
11/12/18	-	G Whyte, Argyll & Bute Council
02/04/19	ABC Comments	G Whyte, Argyll & Bute Council

Contract

This report describes work commissioned by Grant Whyte on behalf of Argyll & Bute Council by Purchase Order number AB315359. Argyll & Bute Council's representative for the contract was Grant Whyte. Steven Thomson of JBA Consulting carried out this work.

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Purpose

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Abbreviations

AAD	Annual Average Damages
DTM	Digital Terrain Model
FEH	Flood Estimation Handbook
FRM	Flood Risk Management
GIS	Graphical Information System
LDP	Local Development Plan
LFRMP	Local Flood Risk Management Plan
LiDAR	Light Detection and Ranging
LPD	Local Planning District
mAOD	Meters Above Ordnance Datum
MCA	Multi-criteria assessment
NFM	Natural Flood Management
OS	Ordnance Survey
PLP	Property Level Protection
PLR	Property Level Resistance
PVA	Potentially Vulnerable Area
RBMP	River Basin Management Plan
SAIFF	Scottish Advisory and Implementation Forum for Flooding
SDP	Strategic Development Plan
SEPA	Scottish Environmental Protection Agency
SPAADE	Scottish Pluvial Average Annual Damages Estimates
SuDS	Sustainable Urban Drainage System
SWMP	Surface Water Management Plan
WFD	Water Framework Directive
WWTW	Waste Water Treatment Works

1 Introduction

1.1 Background to Flood Risk Management in Scotland

In 2009 the Scottish Government introduced the Flood Risk Management (FRM) Act which established a 6 year planning cycle for assessing and sustainably managing flood risk in Scotland. The FRM act was created to reduce the negative impact of all types of flooding including from surface water.

The key FRM strategies that relate to surface water are to:

- Identify areas at greatest risk.
- Set objectives to reduce risk in those areas.
- Identify actions to achieve the objectives:
    - Inform the responsible authorities to develop and implement SWMPs to reduce the risk of surface water flooding for areas with greatest risk.
    - Describe the relevant actions that have been identified through the SWMP process to reduce surface water flood risk.

The locations requiring a SWMP were identified by the FRM strategies published by SEPA in 2015[1]. The FRM strategies lead to the creation of Local Flood Risk Management Plans (LFRMPs) which set out who will lead the SWMP process, timescales for developing the SWMPs and timescales for implanting actions identified in the SWMPs.

Figure 1-1: Summary of the flood risk management process in Scotland[2]

[1] Flood Risk Management Strategies: http://apps.sepa.org.uk/FRMStrategies/

[2] SAIFF, Surface Water Management Planning Guidance – 2nd Edition – May 2017

1.2 What is the aim of a Surface Water Management Plan and why is it needed?

The aim of a surface water management plan is to reduce the risk of surface water flooding in the most sustainable way as required by the FRM Act. It is a plan which outlines the preferred surface water management strategy in a given location. In this context surface water flooding describes flooding from artificial drainage networks (sewers & drains), groundwater, runoff from land (pluvial), small watercourses and ditches (including culverts) that occurs as a result of heavy rainfall.

Surface water flooding accounts for 23% of all annual flood damages in Scotland with estimated annual damages of approximately £58 million[3]. Surface water flooding is expected to increase in the future due to climate change and the effects of urban creep (loss of greenspace due to urbanisation). The effects of climate change alone are predicated to increase the properties and businesses at risk by 45% by 2080.

Figure 1-2: Surface water flooding on School Road

1.3 Key Stakeholders

The organisations which need to be involved in SWMPs will vary as with location depending on the local environment and type of problems encountered. Three partners have been identified as part of this study Argyll and Bute Council and Scottish Water. Due to the high-level assessment it is necessary to restrict stakeholders initially in order to progress the consultation and engagement process efficiently. Should more detailed studies be required as part of the SWMP potential additional stakeholders will be identified. Each of the three organisations are integral to managing flood risk. The following section outlines their roles and responsibilities in the SWMP and how the SWMP will be used by each organisation.

[3] SEPA 2013 Flood Risk Data

1.3.1 Argyll and Bute Council

Argyll and Bute Council are the Lead Partner and has the overall responsibility of the SWMP. Three separate departments of the council are involved and can influence the SWMP process

Flooding

Argyll and Bute Council have general powers to manage flood risk (from all sources, including surface water flooding) in their area under the FRM Act. This includes implementing actions described in the LFRMPs, flood protection schemes or any other flood protection work.

Roads

Argyll and Bute Council (as a roads authority) have a requirement to maintain and manage public roads under the Roads (Scotland) Act 1984. As such they have the powers to drain roads and where drains (including SuDS) are constructed they are also required to maintain them.

Planning & Building Standards

Argyll and Bute Council (as a planning authority) have powers to grant or refuse planning applications of which flood risk assessments form an important consideration. As well as planning application the council also creates Strategic Development Plans and Local Development Plans which includes infrastructure investments required as well as the drainage associated.

Scottish planning policy generally takes a precautionary approach to flood risk and promotes SuDS as a way of limiting the effect of the increase in impermeable areas often associated with new developments. Planning policy requires that any new development is designed to withstand surface water flooding at the 1:200yr storm event and that surface water discharge is limited to the equivalent greenfield runoff rate.

As well as planning the council is also responsible for building standards. Building standards have duties to ensure that surface water management infrastructure (drainage and flooding) is designed to appropriate standards, where that infrastructure is owned by the land / home owners rather than vested by Scottish Water or a local authority (as roads authority). Section 3.6 of the Building (Scotland) Regulations 2004 sets out the requirements for surface water drainage.

Outputs from the SWMP will be used by Argyll and Bute Council to carry out other activities such as emergency planning, control drainage, review LDP land allocations, and Strategic Development Plans (SDP), at the same time as satisfying the requirements of the FRM Act.

1.3.2 Scottish Water

Scottish Water has duties under the Sewerage (Scotland) Act 1968 to provide and maintain public sewers that can effectively drain surface water from the curtilage of properties under ‘usual’ rainfall events (1:30 year rainfall event). The definition of flooding under the FRM Act does not include flooding solely from a sewerage system (which falls under Scottish Water duties). The Sewerage (Scotland) Act sets out vesting process for new infrastructure draining the curtilage of properties. They also have the duty to receive water from adopted SuDS systems.

Scottish Water is an essential partner in the SWMP. The outputs from the SWMP will be used by Scottish Water to prepare for emergencies, undertake their Drainage Area and Sewerage Management Plans, plan their investment and respond to climate and population change in addition to development pressures.

1.3.3 SEPA

SEPA has responsibilities under the FRM Act to map and assess flood risk (including surface water flood risk), produce FRM Strategies (that take into account surface water flooding), provide a flood warning service and issue flood risk advice to planning authorities.

SEPA is an essential Partner in the SWMP. The outputs from the SWMP will be issued to the SEPA to review and assess existing and new emergency plans, communicate with local residents on flood risk issues, and finalise asset management plans (investment, operations and maintenance).

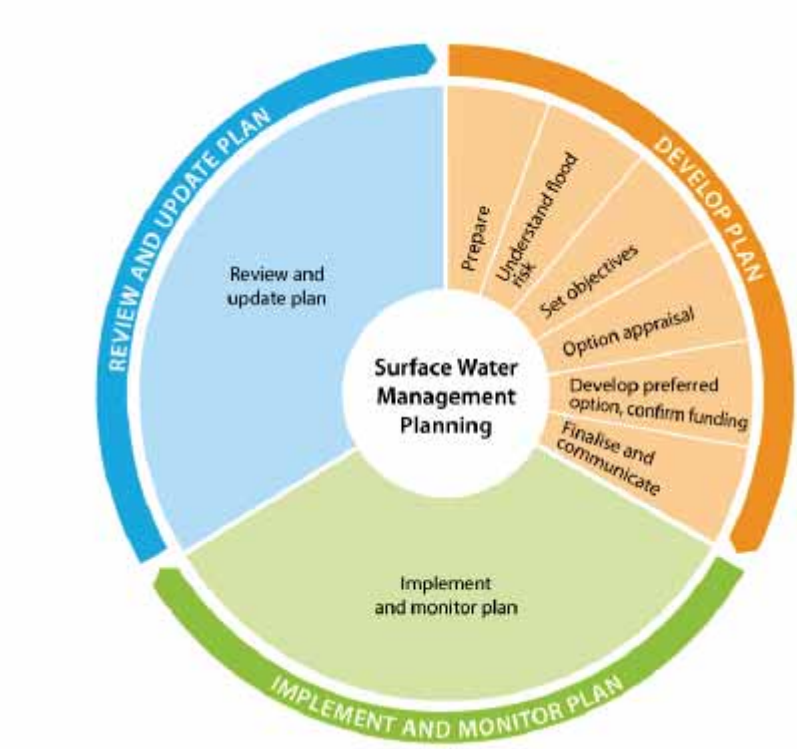
2 Scope of the Surface Water Management Plan

From a planning perspective SWMPs can provide a framework to alleviate surface water flooding for new developments, whilst contributing to improving the water quality of our water networks and achieving the requirements of the Water Framework Directive (WFD).

The SWMP consists of 3 key areas:

- Developing the plan
    - Prepare – Gather and collate existing flooding information, allocate resource, validate existing information and identify the geographical extent of the SWMP area.
    - Understand flood risk – analyse, interrogate and interoperate available information to understand surface water flood hazard and risk. Use this information to identify areas with the greatest risk and communicate the findings to key stakeholders.
    - Set Objectives – Using the objectives specified from FRM strategies to set more detailed objectives for areas with greatest risk. Once the objectives are identified they can be prioritised and shared with key stakeholders for potential future collaborative efforts to reduce flood risk.
    - Options Appraisal – A high level appraisal for all objectives and a more detailed appraisal and design for priority objectives. Developing and comparing proposed options in order to select a preferred option. This stage also includes consulting and co-ordination of the preferred options with stakeholders.
    - Develop preferred option, confirm funding – This step involves developing the preferred option in more detail, confirming responsibility of the stakeholders and identify how the project could be funded.
    - Finalise and communicate plan – the final step of the Development Process is to produce a SWMP that summarises the key findings and outputs and includes proposals for monitoring, implementing, reviewing and updating the SWMP.
- Implement and monitor plan
    - Implementing the action identified in the SWMP and monitoring the success of the action to determine if objectives have been achieved.
- Review and update plan
    - The SWMP is a long-term process subject to the cyclic nature of the flood risk management planning circle. When SWMP are updated the development stage is revisited to account for any changes during the implementation period.

Figure 2-1: Surface water management planning process[4]



2.1 Links to Other Documents

Local Flood Risk Management Plans

To help manage flood risk and reduce impacts of flooding on communities SEPA developed it's first Flood Risk Management Strategies published in December 2015. Scotland has been separated into 14 Local Plan Districts (LPDs), these districts being based on river catchments across administrative and institutional boundaries. Each LPD has a bespoke overarching strategy in place to manage flood risk.

Argyll and Bute Council, as an authority responsible for flood risk management, is a member of The Clyde and Loch Lomond LPDs and has had detailed involvement in the preparation and agreement of the LPD strategies and local plans.

[4] SAIFF, Surface Water Management Planning Guidance – 2nd Edition – May 2017

3 Summary of Surface Water Management Plan Analysis

The flowing section contains a brief synopsis of the works undertaken to create the SWMP. The full report for each subject can be found in appendix A to D.

3.1 Organising, Collating and Verifying Available Data

The first step in the SWMP is to gather all of the available existing data on surface water flooding provided by the key stakeholders:

SEPA

- Regional Pluvial Flood Hazard Mapping
- National Pluvial Flood Hazard Mapping
- Natural Flood Management Data
- Flooding Receptors
- Strategic Appraisal Baseline

Scottish Water

- GIS network
- Anonymised Flood Records Spreadsheet
- Drainage Network Model

Argyll and Bute Council

- Flood records database
- Local development plan
- Photographic records
- Grontmij Reports 2010

Other

- Information on settlements and localities – National Records of Scotland
- Catchment descriptors - Flood Estimation Handbook
- Social vulnerability to flooding and flood disadvantage – Scottish Government

3.2 Current Surface Water Management Activities

The council have already implemented surface water management improvement works along Argyll Road to improve the collection of hillside runoff. A large concrete channel has been constructed with oversized kerbs on the north edge of the road. The channel directs water into the existing underground infrastructure. Although the works have improved collection of hillside runoff it is frequently over topped due to capacity issues in the existing drainage network.

3.3 Natural Catchments Characteristics

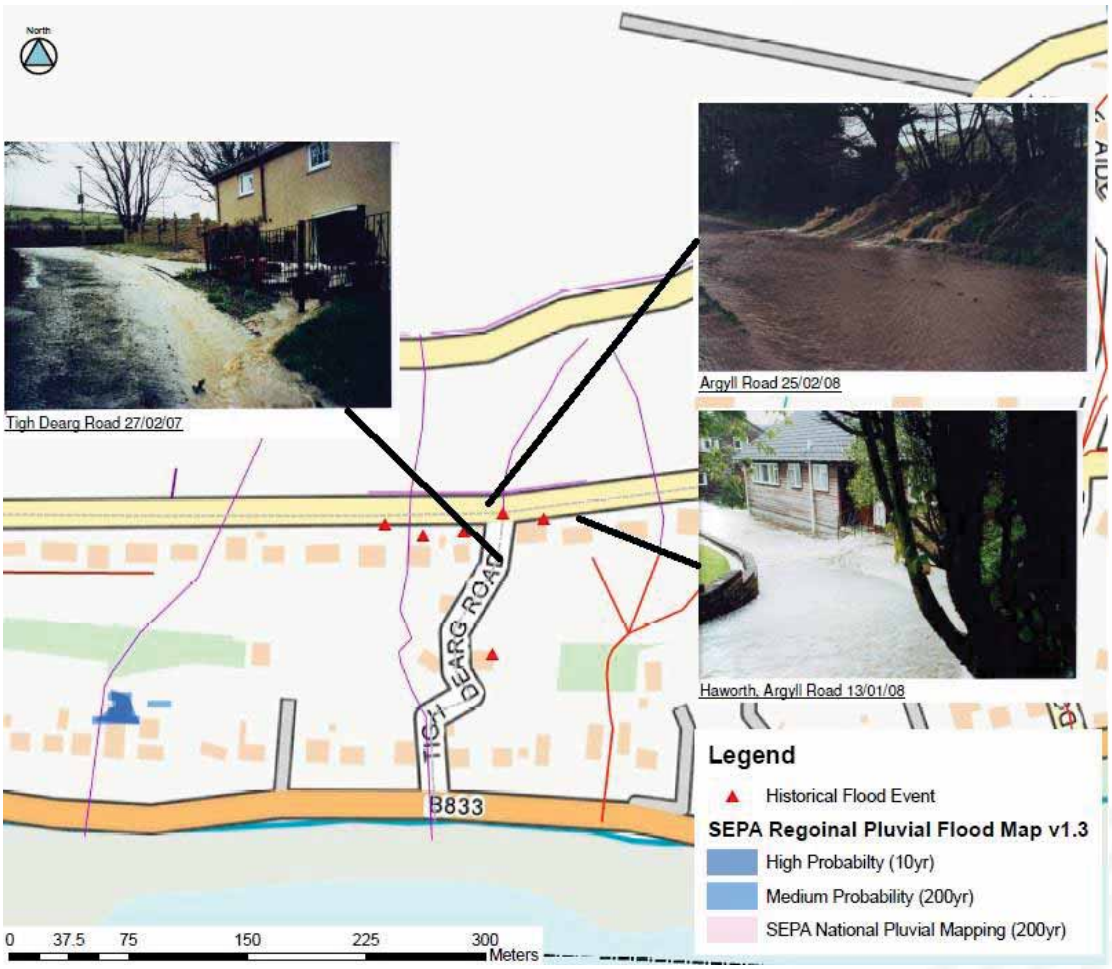
The natural catchment characterises watercourses in each of the SWMP areas are described fully in appendix A. The catchment area and other catchment descriptors have been extracted from FEH handbook or from a hydrological assessment undertaken by Grontmij in 2010 on behalf of Argyll and Bute Council. The description of the catchment can be used to get an idea of how the watercourses are likely to behave during a flood event. For example, debris load and the type of debris will affect the likelihood of blockages at downstream constrictions e.g. culverts and bridges.

Although the SWMP is a pluvial study the guidance documents require it to also consider fluvial events where watercourses have small catchments (3km^2) or are predominantly urban.

3.4 Model Verification

Verification of all the collated data is undertaken using the GIS data to compare the modelled hazard and risk data against observed events. The purpose of the verification process is to identify areas where good alignment between modelled and observed flooding occurs and that the mechanisms of flooding are identifiable. These areas will be deemed suitable for assessing the consequences of flooding. The process also identifies where poor calibration exists between modelled data and observed flood events. This could be a location where flooding is predicted, but has not occurred, or conversely a location where flooding has occurred, but is not predicted by the model. The section below provides a summary of the model verification for each of the SWMP areas. Further details on this process can be found in appendix A.

Figure 3-1: Example of model verification in Kilcreggan



3.4.1 Kilcreggan SWMP Model Verification Summary

The modelled and observed data has shown that this area is considered to be at significant risk of surface water flooding. There is a strong correlation between the model and observed data, particularly in high risk areas. However, the model does not account for mitigation measures installed by the council which are known to have lowered the flood risk in particular areas. Overall, the model confidence is moderate in this SWMP area.

3.4.2 Model Verification Statement

The observed data has shown that this area is considered to be at significant risk of surface water flooding, particularly the Tigh Dearg Road area. There is almost no model data from SEPA in the SWMP area. This is likely to be due to the steep topography not allowing water to pond at significant depths as depths less than 10cm are not recorded in the model. Here the issues relate to large volumes of low depth – high velocity surface water which are not represented in the model. Hence, there is a poor correlation between the model and observed data, particularly in high risk areas. Overall, the model confidence is low in the Kilcreggan SWMP area.

4 Understanding Surface Water Flood Risk

Phase 2 of the SWMP focuses on understanding surface water flood risk with each of the SWMP areas identified in Phase 1 of the report.

It is well documented that Kilcreggan has a history of surface water flooding. The purpose of this phase of the report is to take a closer look at the flooding within these areas, to understand the flooding mechanisms at work as well as the associated hazard and risk.

Understanding the causes and consequences of flooding is crucial for making well informed decisions on how to manage flood risk. This will be done by analysing available information to gain an appreciation of the sources, pathways, receptors, flood risk and flood hazard.

4.1 Determining Surface Water Vulnerable areas (Flooding Hotspots)

In order to understand surface water flood risk, it is necessary to break down each of the surface water management areas into smaller flooding “hotspots”. The flooding hotspots are defined by the flooding mechanism. Flooding mechanisms within a hotspot may be singular or linked with multiple different mechanisms causing flooding in one area. An example of this could be where hillside runoff floods properties before passing into the drainage network which subsequently surcharges effecting nearby properties.

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4.1.1 Understanding Key Features Within the SWMP Area

Before defining the hotspots an analysis of key information within each SWMP area is undertaken to identify catchment wide factors that may influence the definition of the flooding hotspot. This analysis includes:

- Significant surface water flood events
- Natural drainage features
- Artificial drainage features
- Interactions between the natural and artificial drainage systems
- Existing surface water management infrastructure

4.2 Defining and Prioritising Surface Water Flooding Hotspots

Defining flood risk hotspots is a manual process which involves analysing all of the information available. However, initially to define the geographical area the primary focus is on the SEPA regional pluvial flood hazard mapping, Scottish Water flood spreading assessment results and also the historic flood database. At this stage it is also important to refer back to the model verification step to incorporate the model confidence when defining the hotspot.

A site visit was also undertaken, where engineers visited the hotspots where model confidence was low or there was uncertainty over the flooding mechanism.

When analysing the hotspots, it is important to consider not only the current flood risk but also the future flood risk. The future flood risk looks at factors such as

climate change, urban creep, demographic change as well as potential development sites. Future developments can provide an opportunity to not only manage surface water within the site but to the areas connected to the site.

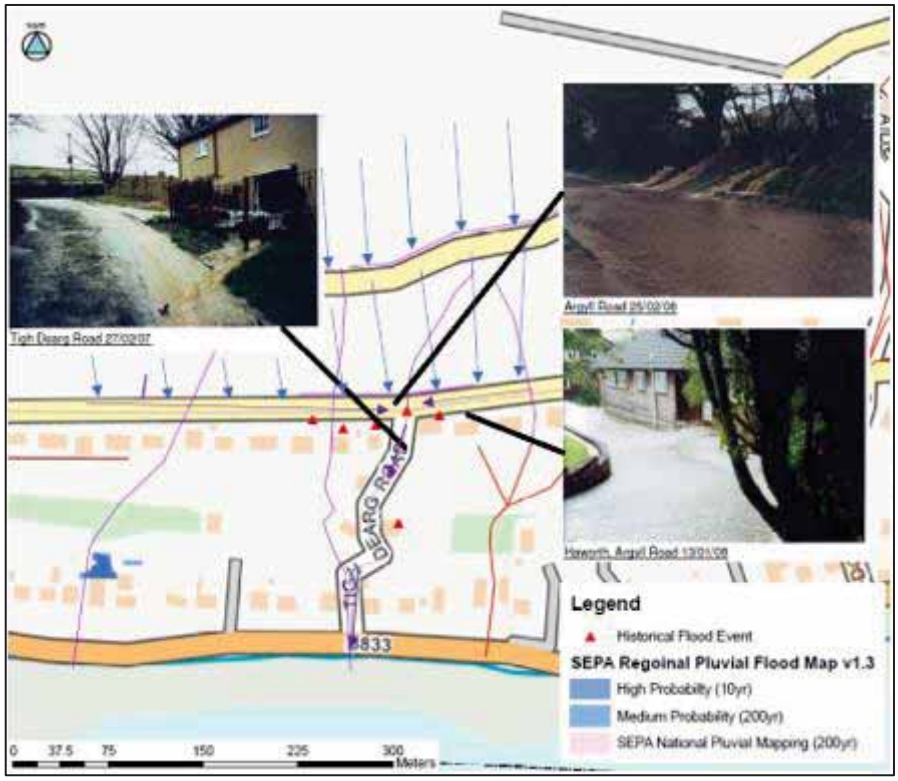
Once the hotspots have been identified and damages have been assigned, it is necessary prioritise the hotspots so that efforts can be focused where there is the most benefit. The factors that influence the ranking are as follows:

- The value of the average annual damages within each hotspot.
- The number of residential properties assessed to be at risk for the 1:200 year event.
- The number of non-residential properties assessed to be at risk for the 1:200 year event.
- Where the management of the risk lies within the powers of the SWMP stakeholders.
- The number and presence of vulnerable facilities.
- Where existing schemes are already operating hence reducing the benefit of implementing additional measures and allowing non-protected areas to be addressed.
- Social vulnerability to flooding dataset, published by the Scottish Government.

The figures below are examples of the analysis from the hotspot creation phase. A total of 16 surface water flooding hotspots were derived during the study. Each hotspot is covered in substantial detail in appendix B.

Figure 4-1: Example of GIS output from hotspot analysis of Argyll Road East (KIL_HS01)

Figure 4-2: Example of GIS output from hotspot analysis of Tigh Dearg (KIL_HS02)



4.3 Kilcreggan Surface Water Flood Risk Overview

It is estimated that surface water flooding accounts for 10% of annual average flood damages in the Kilcreggan PVA (Helensburgh & Loch Long, based on SEPA modelled data).

Table 4-1: Kilcreggan Flood Risk Overview

	Surface water AAD	River AAD	Coastal AAD
Kilcreggan PVA	£43,000	£43,000	£304,000

A summary of the surface water flood risk for each of the SWMP areas below. For details on the surface water flood risk and information on how these number were derived see section appendix B.

Table 4-2: Kilcreggan SWMP Risk Overview

Location	Non Residential Properties at risk 200yr event	Residential properties at risk 200yr event	Residential properties at risk in area more socially vulnerable to flooding 200yr event (>Relatively high)	Total annual average damages (SPAADE)
Kilcreggan	0	11	0	£20,257

5 Setting Initial Objectives

5.1 Introduction

The Flood Risk Management Strategy for LPD 11 contains high-level objectives for surface water management within the PVAs. The FRM document also identifies priority areas for the SWMPs which have been further broken down into hotspots as discussed in Phase 2. The high-level objectives are:

- To avoid an increase in surface water flood risk (applies everywhere including SWMP areas).
- To reduce surface water flood risk (applies to SWMP areas at the town and city scale).

More detailed and localised objectives for reducing surface water flood risk are based on the understanding of flood risk and the assessment of responsible authorises (stakeholders). The objectives available to be used in the SWMP are described in the table below.

Table 5-1: Objectives for SWMPs

Objective	Example
Reduce surface water flood risk	Areas where the greatest risk of surface water flooding (hotspots) has been identified in phase 2 through analysis of the model and historic events. Areas where there are critical facilities or infrastructure that carry a risk i.e. schools, hospitals, main roads.
Accept flood risk and maintain existing actions	Areas where there are already surface water management feature/schemes in place to reduce flood risk i.e. surface water storage, pumping stations.
Improve understanding of surface water flood risk	Areas where, from the analysis undertaken in Phase 2, it is not clear how or why flooding is occurring or how to remediate the flooding. This can be applied to individual hotspots or larger areas depending on the outcome of the model verification undertaken in Phase 1.

5.2 Advancing Initial Objectives

In order to develop the initial objectives identified by SEPA in the LPD Strategies a 2 part process is required:

1. The initial objectives proposed in the FRM strategies have been updated following the results of the Understanding Surface Water Flood Risk section (Phase 2). This process creates targeted objectives for each of the hotspots identified. The objectives are also assigned a draft priority at this stage.
2. The objectives are then subject to stakeholder consultation where they will be appraised, selected and prioritise for implementation based in the knowledge of upcoming projects and funding opportunities.

5.3 Prioritising Objectives

Once the objectives have been assigned it is necessary to prioritise the various objectives. An accurate timeline is not given at this stage as it is more an indication of which objectives could be possible in the long and short term.

When considering the priority of the objectives there is no prescriptive method to do so however, factors to consider are:

- Surface water flood risk (using information on impacts of flooding).
- Surface water flood risk to priority receptor groups, e.g. schools, hospitals, homes at risk in socially vulnerable areas.
- Locations with a history of flooding.
- Areas where there is no history of flooding but are predicted to flood and should therefore be treated with caution, particularly where more detailed models are not available. It is sensible to balance predicted and actual flooding information when prioritising.
- Locations where there are opportunities for joint working (e.g. making management more cost-effective and delivering multiple benefits).

The initial objectives have been set for each of the hotspots identified. Details can be found in Appendix C.

6 Options Appraisal

The options appraisal stage of the SWMP is key to ensure the most sustainable and feasible actions are identified and implemented as required by the FRM Act. The SWMP guidance shows that the most sustainable options for managing surface water flood risk will be identified using the process in the figure below focusing on the assessment of costs, flood risk mitigation benefits as well as other associated benefits.

6.1 Scoping the Appraisal

Before undertaking the long list of potential actions, it is necessary to conduct a high level assessment for all the objectives identified in Phase 3 - Setting Initial Objectives. To enable focussed effort on surface water flood risk management within the SWMP cycle, the identified hotspots have been prioritised. The highest-ranking hotspots have been assessed further to identify options for implementation. The hotspots not being taken through to the next stage will be reassessed in the next SWMP cycle. This initial appraisal has been conducted to remove hotspots which are either:

- Predominantly fluvial flood events from which secondary surface water flooding is a minor factor and would not have occurred without the fluvial event. A fluvial study may be required for these areas which is outwith the scope of the SWMP.
- Have existing flood protection/mitigation measures where maintaining the asset provides a suitable level of protection.

The hotspots which are not being taken through to the next stage are identified in the table within appendix D. The table also identifies possible options that have been identified to aid the development of the next SWMP.

6.2 Identifying and Screening Long List of Actions

A long list of potential actions has been developed against each of the verified remaining flooding hotspots. Following the SWMP guidance, broad categories of actions were identified including structural and non-structural options. A total of 25 actions have been considered against each hotspot. The available actions are listed in a table in Appendix D. The long list actions are designed to identify and screen potential options and are not developed in detail.

It is necessary to screen the long list of actions to remove any actions which are clearly unfeasible leaving a smaller number to be taken through to the next step of the appraisal process. Here sustainability is a key issue with unsustainable actions disregarded.

During this process actions are screened against 3 main criteria – technical, legal and economic. Each action is attributed a score of 1, 2 or 3. A score of 1 represents an action that is to be taken forward into the options appraisal stage. A score of 2 represents an action that only partially addresses pluvial flood risk. A score of 2 could also be used where there is an action that would mitigate flood risk but is subject to substantial constraints that may make the action unattractive and potentially unfeasible. A score of 3 was attributed where actions are clearly unfeasible or unlikely to reduce surface water flood risk.

Table 6-1: Long List Actions Initial Screening

	Action	KIL HS02	KIL HS03
Non-structural actions	Adhere to existing planning policy	2	2
	Implement more stringent land use policies	2	2
	Clarify new Surface Water infrastructure responsibility	3	3
	Clarify existing Surface Water infrastructure responsibility	1	1
	Emergency response plans	2	2
	Improve understanding of flood mechanisms	2	2
	Options appraisal and design	1	2
	Improve information on Surface Water flooding	3	2
	Business continuity planning	3	3
	Community action group	2	2
	Flood insurance	2	2
	Raise awareness	2	2
	Property Level Protection (PLP)	1	1
	Property Level Resilience	2	1
	Flood forecasting and warning	2	2
	Asset management and maintenance	2	1
	Watercourse management and maintenance	3	2
	Relocation	3	3
Structural actions	Infiltration/evapotranspiration	2	3
	Conveyance	1	3
	Storage	3	3
	Restoring urban watercourses	3	2
	Urban watercourse engineering/ direct defences	3	1
	Run-off reduction strategy	2	2
	Reducing surface water in the sewer	1	1
	Land management	1	2
	Underground storage	3	3
	Underground conveyance	1	1
	Modification of culverted watercourses	3	1

6.3 Assessing Options

The following section contains information on each of the high priority hotspots selected for options appraisal. Each surface water flood risk hotspot is described before a Multi-Criteria Assessment is undertaken on the viable actions identified in table above using the procedure described in Section 3.3 of Appendix D. The multi-criteria assessment is similar to the scoring mechanism used for the long list of actions but with more criteria and a more complex scoring method.

The actions identified as viable from the Multi-Criteria Assessment have been taken forward as options.

The proposed options listed below were created by JBA Consulting before being reviewed by representatives of Argyll and Bute Council and Scottish Water at a stakeholder workshop on 22nd November 2018.

Details of the options presented to the stakeholders can be found in appendix D.

7 Preferred Options

A stakeholder workshop was held at Argyll and Bute Council's office in Helensburgh on Thursday 22nd November 2018. JBA presented the findings of the SWMP to members of Argyll and Bute Council and Scottish Water.

The presentation started with a recap of how the SWMP had progressed and the techniques/methods used in each of the preceding reports. JBA then presented each of the hotspots explaining the flooding mechanisms as well as the current and future flood risk. JBA discussed how the short list of actions had been derived and how these subsequently formed options.

Following open discussions, the following consensuses was agreed for the 2 remaining priority hotspots. Graphical representations of the preferred options can be found in Appendix D.

7.1 KIL_HS02: Tigh Dearg Road

7.1.1 Preferred Option: Option 3 – Clarify existing Surface Water Infrastructure responsibility with options appraisal and design

During the stakeholder consultation each of the potential options were discussed along with outputs of the Grontmij report undertaken in 2010 which also proposed mitigation options. As part of the discussions, the ownership of the 225mm diameter pipe was discussed and it was confirmed as a Scottish Water asset listed as a Highway Drainage however, it was confirmed that the pipe also conveys foul flows from old septic tank connections.

Each of the options were discussed in detail however, with the information available it was agreed that it was not possible to choose a preferred mitigation measure at this time. Options appraisal was selected to allow all of the feasible options to be investigated in more detail, this will include a feasibility statement as well as a cost benefit analysis. With this additional information a preferred option can be selected and taken forward for implementation.

7.2 KIL_HS03: School Road

7.2.1 Preferred Option: Change objective to accept risk and maintain existing assets

Given the work already undertaken by Scottish Water to separate the surface water and sewer networks the flood risk has been lowered substantially. The remaining flood risk relates to blockages at the inlet screen of the open section of watercourse causing flows to divert overland through the garden of a private property. It was agreed at this time the best solution would be to lower the initial priority, continue to maintain the existing assets (including the screen) and monitor events during the SWMP cycle.

Table 7-1: SWMP Action Plan and SMART Objectives

Hotspot	Preferred Option	Final Objective	Final Priority	Responsibility	Potential Funding Route	Target Implement ation Date	Target Standard of protection	Number of homes and businesses better protected
KIL_HS02: Tigh Dearg Road	*Improve understanding of flooding mechanism*	*Improve understanding of surface water flood risk*	*High*	*Argyll and Bute Council*	*LA capital via FRM strategies*	*2022-2028*	*1 in 200 year*	*34*
KIL_HS03: School Road	*Asset management and maintenance*	*Accept risk and maintain existing assets*	*On-going*	*Argyll and Bute Council*	*LA revenue*	-	-	-

8 Next Steps

8.1 Develop Preferred Option

Now that the preferred option has been selected it will need to be developed and assessed in more detail. The level of detail required will depend on the flood risk and scale of the action (e.g. enough detail should be provided to have high confidence in the effectiveness of the action, and to inform and have high confidence in funding decisions).

Timings for confirming funding are likely to be inline with the FRM funding cycle with application for funding due in late 2019 for the next cycle 2022-2028.

Good design is essential to ensure that surface water management infrastructure is able to realise multiple benefits, including integrating with and enhancing the urban landscape. It is therefore important that multidisciplinary teams include landscape architects, as well as flood management and drainage engineers.

8.1 Implement and Monitor Plan

Once implemented, actions can be monitored to determine progress towards achieving objectives. Monitoring can also determine how effective actions are at managing surface water and realising multiple benefits. As more information is gathered, over time, other actions can be implemented and improved.

Updated summaries of all actions and their status (e.g. 'live implementation plan') should be maintained to help co-ordination and communication. The summaries should confirm when an action has been completed and capture key information about that action. Key data (e.g. standard of protection, number of properties protected etc.) on completed structural actions in particular should be collected and shared with stakeholders, including SEPA and Argyll and Bute Council. This will help to confirm the status of any relevant actions that are in the LFRMP and FRM Strategy and also allow reduction in flood risk to be collated, quantified and communicated to monitor progress against the objectives of reducing flood risk.

8.2 Review and Update

Flood risk management planning follows a six-year cycle, with stages covering understanding flood risk, setting objectives and implementing actions to achieve objectives. SWMPs should be reviewed and updated with LFRMP and FRM Strategy timescales in mind.

When reviewing and updating a SWMP, the development process should be repeated and any required changes made, e.g. to update understanding of flood risk, objectives and actions.

Key drivers of a review may include:

• Updated flood hazard and risk information.

• The occurrence of a flood.

• FRM Strategy publications (containing updated SWMP areas and confirmed funding of actions).

• Outcome of investment decisions by partner agencies that deviate from the preferred plan.

• Monitoring of the implementation of actions, e.g. indicating where changes can be made to replicate success and / or improve outcomes where actions have not been successful.

• New development or other changes in the area that affect surface water flooding.

Appendices

A Model Verification

Appendix A – Phase 1 Organising, Collating and Verifying Available Data

Contents

1 Preparatory Work

1.1 Introduction

The National Flood Risk Assessment has identified Kilcreggan as part of the Helensburgh to Loch Long Potentially Vulnerable Area 11/02.

This SWMP includes Kilcreggan which is situated at the southern tip of the Rosneath Peninsula in Argyll and Bute. This SWMP interrogates detailed data to identify proportionate flood hazard and risk.

During this stage consultation was limited to Argyll and Bute Council, SEPA and Scottish Water.

1.2 Geographical Extent of SWMP

The spatial scale of the SWMP is limited to Kilcreggan and the southern extent of Cove. The area of Rosneath Peninsula to be covered by the SWMP was supplied by Argyll and Bute Council. As the surface water flooding issues are well documented by the council this allows the SWMP to concentrate on detailed information in specific areas. The SWMP area is located on the southern slopes of Aiden Hill. The upper slope of the hill is predominately steep, open grassed fields where as the lower slope is still steep but features the small residential settlement of Kilcreggan. The SWMP area is bound by the Firth of Clyde to the south.

The SWMP boundary has been selected by considering the following:

- The areas of greatest impact of surface water flooding, using the SEPA pluvial flood maps, Scottish Water model data and historical flooding records (SEPA, Scottish Water, & Argyll and Bute Council).
- The extent of urban areas.
- The size and extent of natural drainage features.
- The size and extent of artificial drainage networks.

The geographical area can be seen in the SWMP drawing D01 presented in Appendix A.

1.3 The Project Data Register

A project specific data register has been created for the Kilcreggan SWMP and can be viewed in Appendix B. The data register records all sources of information used to develop the SWMP and specifically identifies the following;

- What data and information is available
- Who owns the data / information
- Licensing information and limitations on use
- Data format
- Level of confidence and suitability for use

2 Collating Available Data

2.1 SEPA Data

2.1.1 Regional Pluvial Flood Hazard Mapping (website version)

The Regional Pluvial Dataset consists of high quality shapefiles showing flood depth, extent and velocity. Three return periods have been provided:

- low probability = 1000 year return period
- Medium probability = 200 year return period
- High probability = 10 year return period

The DTM is derived from predominantly good quality LiDAR data which has been edited to prevent false blockage at culverts and bridges. The dataset is a combination of the regional pluvial hazard and Scottish Water data augmented with national pluvial data where there is no regional data. These are a good basis for validating the SEPA pluvial hazard data. The regional pluvial flood hazard dataset is the primary model-based source of flooding information for this SWMP.

2.1.2 Regional Pluvial Flood Hazard Mapping (detailed version)

SEPA provided the detailed regional pluvial hazard maps. However, the coverage does not include Kilcreggan.

2.1.3 National Pluvial Flood Hazard Mapping

The National Pluvial Dataset is suitable for high level studies and contains shapefiles showing flood extent, depth and velocity. This has since been superseded with the Regional Pluvial dataset which is used in its place where available. Confidence in this data set is poor and only used if regional maps are not available. However, the regional pluvial dataset included all SWMP areas hence the National dataset was not used.

2.1.4 Natural Flood Management (NFM) Data

Contains shapefiles with information on floodplain storage, runoff likelihoods and information on sediment transport. There is an error in the data which has made it only visible a very high scales, this has made the data difficult to use. As a result, a medium level of confidence is appropriate.

2.1.5 Receptor Dataset

Available throughout the SWMP area contains shapefiles for a comprehensive range of receptors useful for determining flood hazard and risk. The dataset ties in well with the background mapping hence confidence is high.

2.1.6 Strategic Appraisal Baseline Dataset

Contains appraisal baseline outputs for the regional and national pluvial datasets as well as the Average Annual Damages (ADD) point data which are a vital part of determining and prioritising flood risk. The dataset is produced by SEPA and derived from various receptor datasets and the regional pluvial mapping. However, there is very little SEPA mapping in Kilcreggan (likely as a result of the area being very steep with little ponding). This means that the damages dataset does not corroborate well with the known surface water flooding hotspots. As a result, there is a low level of confidence in the appraisal baseline dataset.

2.2 Scottish Water Data

Under Section 16 of the FRM (Scotland) Act 2009 Scottish Water have a duty to assess flood risk from sewerage systems. As such Scottish Water have provided the following data:

2.2.1 GIS Network

Scottish Water have provided a detailed GIS sewer network for all of the SWMP areas. The GIS networks are either compiled by GIS points or polylines. The very high volume of points makes the dataset very difficult to use and interoperate. In its raw state, its suitability for use is moderate due to it being difficult to use. To improve the usefulness within the SWMP study, the data has been rationalised to include the following:

- Manholes, pipes and outfalls. The data has been stripped back to the essential components only.
- Networks have been coloured according to the type of sewer i.e. red for combined, blue for surface water, brown for foul etc.

There are gaps in the model throughout Kilcreggan and discrepancies against paper-based documents provided, as such the level of confidence is moderate.

2.2.2 Drainage Network Model

Scottish Water are due to undertake a flood spreading assessments for the Cove and Kilcreggan WWTW catchment in line with Section 16 of the Flood Risk Management (Scotland) Act 2009. Modelling is expected to be completed by the end of 2018 and will be ready for inclusion in the next SWMP cycle.

2.3 Argyll and Bute Council Flood, Planning and Roads Data

2.3.1 Local Development Plan (LDP) areas

The LDP dataset consists of shapefiles used in the creation of the Argyll and Bute Local Development Plan 2015 and indicates sites earmarked for future uses such as housing or business. These files are vital in assessing future flood risk and opportunities for surface water management in future developments. The data was used to create the LDP reports, confidence is high.

2.3.2 Flood Records

Records of observed flooding in the Argyll and Bute Council have been included in the SEPA flood database.Additional information was provided by operational staff and has been included in the dataset. This data is very important and is required to validate the model. The level of detail in the data entries is good and includes a description of flood origins and damages as well as investigation undertaken to date. Confidence is high in this dataset.

2.3.3 Photographic records

Historic flood photographs were provided. This data is crucial as it conveys the scale and damage of the surface water flooding in this area. All of the photographs provided are well geo-referenced which makes them very easy to use. This data is considered to provide a high level of confidence.

2.3.4 Council Asset Database

PDF files detailing existing drainage schemes have been digitised for use in this SWMP. This information was used to understand existing operational measures to manage surface by the council. Locations correlate well with aerial mapping and

google street view, confidence is high. This dataset could be improved by providing information on inspection locations and inspection/maintenance regimes.

2.4 Drainage Network Information

Argyll and Bute Council are responsible for managing and maintaining road drainage. This extends from road gullies to their connection to the local drainage system. Responsibility for open drainage ditches/channels varies depending on the watercourse and ownership such as Argyll and Bute Council and Riparian Owners, SEPA undertakes a regulatory role. The responsibility for culverted watercourses also varies and can include Argyll and Bute Council, Scottish Water as well Riparian Owners. Responsibility for the sewer network and operation of the associated pumping stations falls with Scottish Water.

2.5 Flood Management Programme – Phase 1 – Grontmij – September 2010

Grontmij investigated flooding problems at Tigh Dearg Road, Kilcreggan. The scope of the work included fieldwork, identification of the cause(s) of flooding, appraisal of options and the production of a detailed design and tender documentation for the agreed mitigation works.

2.6 Other data

- **Information on Settlement and localities** – The National Records of Scotland provide GIS files for information regarding settlements including settlement boundaries. There is a high level of confidence in the data.
- **Social Vulnerability to Flooding (Scottish Government)**– Social vulnerability to flooding is understood as the varying degree to which people's health and well-being would be negatively affected if they came into contact with flooding. The higher the vulnerability, the greater the negative effect of flooding. There is a high level of confidence in the data.
- **Catchment Boundaries** – Catchments of influential watercourses have also been digitised as part of this SWMP. The Catchment boundaries and a description of the catchment characteristics can be found in Section 4 below. There is a high level of confidence in the data.
- **Site Visit** – JBA staff were shown the flooding hotspots by Argyll and Bute staff which helped to get an appreciation and an understanding of the flood mechanisms at work.

3 Current Surface Water Management Activities

3.1 Argyll and Bute Council Maintenance and Inspection

Argyll and Bute Council undertake a proactive inspection and maintenance regime to allow for efficient and effective flood management (all sources) within the Local Authority area. When flooding is forecast teams are sent out to ensure that key surface water infrastructure such as trash screens are clear. This work is undertaken and managed by the Road, Traffic and Transportation department. This department are responsible for maintaining public roads, including drainage, as well as clearing debris and potential blockages from watercourses and structures which are deemed a flood risk. It is the responsibility of the riparian owners to maintain the bed and banks of a watercourse and also for protecting individual properties.

3.2 Surface Water Flood Alleviation Measures

The council have already implemented surface water management improvement works along Argyll Road to improve the collection of hillside runoff. A large concrete channel has been constructed with oversized kerbs on the north edge of the road. The channel directs water into the existing underground infrastructure. Although the works have improved collection of hillside runoff it is frequently over topped due to capacity issues in the existing drainage network.

3.3 Flood Warning

Flood warning systems only operate on large watercourses/catchments, there are no such watercourses in the SWMP area.

The remaining areas are covered by the Flood Alert Service. The Scottish Flood Forecasting Service provides daily flood guidance statements at a national level to Category 1 and 2 agencies including emergency services and Local Authorities. This service provides a 5 day forecast of surface water flood risk.

3.4 Future Development

The Argyll and Bute Council Local Development Plan (2015) identifies potential development sites. These sites often present opportunities to manage surface water both on site and the surrounding areas. Only one such site has been identified in Kilcreggan. This is assessed in the summary tables presented in Appendix A.

3.5 Flood Advice for Future Development

All new developments are required to limit surface water run off to greenfield runoff rates. This is achieved by using various SuDS to attenuate runoff therefore avoiding an increase in runoff which is often associated with new developments. The issue of non-adoption of SuDS and the failure to manage facilities properly is a potential concern to local authorities.

4 Model Verification

Verification of all the collated data was undertaken using the GIS data to compare the modelled hazard and risk data against observed events. The purpose of the verification process is to identify areas where good alignment between modelled and observed flooding occurs and the mechanisms of flooding are well understood. These areas will be deemed suitable for assessing the consequences of flooding. The process also identifies where poor calibration exists between modelled data and observed flood events. This could be a location where flooding is predicted, but has not occurred, or conversely a location where flooding has occurred, but is not predicted by the model.

A precautionary approach has been used in developing the SWMP i.e. where flooding is predicted in the model, but has not been observed, the predicted flooding will be taken forward in the SWMP. Where flooding is not predicted in the model but has been observed indicates that further information is likely to be required. Model confidence has been classed as high, moderate or low where:

- High confidence represents good correlation between observed historic data and modelled data such as SEPA pluvial mapping or Scottish Water flood spreading mapping.
- Moderate confidence represents areas where there are some model results but they do not tie in perfectly with the observed data but there is a clear link. Areas where the model has shown flooding with no historic data could be due to SuDS or other drainage infrastructure preventing ponding, here the model confidence could be moderate.

  Moderate confidence can also be used to describe overall model confidence where there is mix of low and high model confidence within one SWMP area.
- Low model confidence is used when there is a poor correlation between observed historic data and model data or where the model is inaccurate. An example of low model confidence is where minor watercourses are poorly defined causing water to come out of bank where there are no records of this occurring.

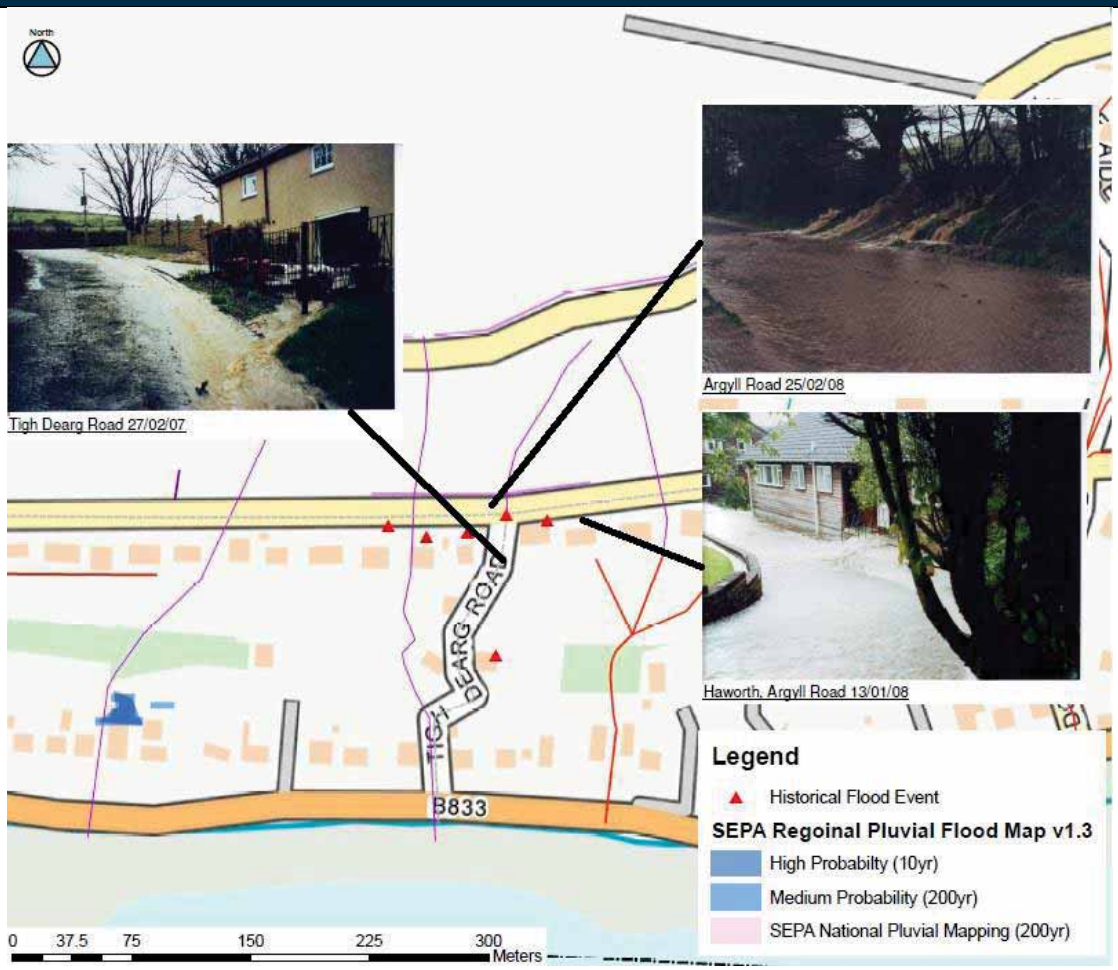
The following section presents figures from the model highlighting areas of good and/or bad correlation with recorded flood events records and photographs where available. Full details of correlations with all historic events can be found in the SWMP model results and confidence table in the appendix.

4.1 Comparison of modelled flood extents and observed flooding in Kilcreggan

Kilcreggan model correlation example

The above figure represents the model in the east of Kilcreggan. It is clear there is no SEPA or Scottish Water modelled flooding data in this area. The junction of Argyll Road and the B833 is a known flooding hotspot with flows escaping the road drainage network and flowing overland down the B833. This has not been captured by the model data as it is likely at too small a scale to have been captured by a regional model.
Therefore, the alignment with the model is poor and confidence at this location is low.

Kilcreggan model correlation example



The figure above shows an area prone to surface water flooding on Tigh Dearg Road in the centre of Kilcreggan. The historic observed data suggests that the flooding is a result of hill side run off which overwhelms existing drainage infrastructure. The alignment between the model and observed data is poor hence confidence in the model is low at this location.

Kilcreggan model correlation example

The figure above shows the School Road area in the west of Kilcreggan. There is very little model data in this area. The main cause of flooding in this area relates to interactions between the combined sewer and a culverted watercourse which results in surcharging of a manhole on School Road. The alignment between the model and observed data is poor hence confidence in the model is low at this location.

5 Model Verification Statement

The observed data has shown that this area is considered to be at significant risk of surface water flooding, particularly the Tigh Dearg Road area. There is almost no model data from SEPA in the SWMP area. This is likely to be due to the steep topography not allowing water to pond at significant depths as depths less than 10cm are not recorded in the model. Here the issues relate to large volumes of low depth – high velocity surface water which are not represented in the model. Hence, there is a poor correlation between the model and observed data, particularly in high risk areas. Overall, the model confidence is low in the Kilcreggan SWMP area.

Appendices

A 2018s0549_KIL_D01

North

1.
2.
3.
4.
4.
4.

North Ailey Cottages
Fire Station
Education Facility
Millbrain Plantation
Sports/Leisure Centre
Kilcreggan

0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

- Historical Flood Event
- SWMP Area
- Scottish Water - Combined
- Scottish Water - Foul
- Scottish Water - Highway Drainage
- Scottish Water - Natural Water
- Scottish Water - Surface Water
- Scottish Water - Proposed

SEPA Regional Pluvial Flood Map v1.3

- High Probabilty (10yr)
- Medium Probability (200yr)

Kilcreggan Watercourses

- 1. Ailey Burn
- 2. Kilcreggan Burn
- 3. Lindowan Burn
- 4. Unamed Watercourse

Council Operated Drainage

- Cundy
- Drainage Channel
- Pipe

KEYPLAN

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including inter alia, the following organisations:

The Centre for Ecology and Hydrology
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Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

KILCREGGAN SWMP AREA

2018s0549_KIL_D01

B SWMP Model Results & Confidence Tables

Historic Surface Water Flooding	
Location	Junction of Argyll Road and B833
No. of Incidents	Multiple occurrence
Description of flooding	It has been reported by Argyll and Bute Council that the roadside drainage at the eastern extent of Argyll Road has flooded causing overland flowdown the B833 before flowing off the road into an existing watercourse. The land around this area is steep with hillside runoff contributing to flows along the road. The condition and capacity of the road drainage is unknown. There have been no damages recorded to date.
Alignment with model results	At this location there is no modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor. The poor correlation is potentially due to a poor representation of Kilcreggan in the SEPA pluvial mapping. The regional mapping does not account for road drainage or very shallow overland flow paths.

Historic Surface Water Flooding	
Location	Tigh Dearg Road
No. of Incidents	Multiple occurrence
Description of flooding	Hillside runoff generated on the southern slope of Aiden Hill causes substantial flooding to the properties in the Tigh Dearg Road area. Existing drainage on Barbour Road and Argyll Road are overwhelmed by the volume of surface water experienced. Damages are high with many properties suffering severe internal flooding during each event. Tigh Dearg Road has also been resurfaced due to damage and a residential border wall partially collapsed which indicates the high volume and velocity of surface water in this area. Reports from Argyll and Bute Council suggest that the existing drainage could be overtopped as frequently as every 10 weeks.
Alignment with model results	At this location there is no modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor. The poor correlation is potentially due to a poor representation of Kilcreggan in the SEPA pluvial mapping. The regional mapping does not account for road drainage or very shallow overland flow paths.

Historic Surface Water Flooding	
Location	School Road
No. of Incidents	Multiple occurrence
Description of flooding	In the School Road area there is a culverted watercourse that interacts with a foul/combined sewer which causes flooding via surcharged manholes resulting in damages to the "Glentrae" property and/or discharges untreated effluent into the sea (environmental damage). From information provided by Argyll and Bute Council it appears there has been a great deal of confusion regarding the source of the flood and who is responsible. From the information available the unnamed culverted watercourse is connected to a foul sewer at a weir/baffle (located in a manhole). The original purpose of this was to help clean the foul sewer when surface water flow was sufficient to over top the weir crest. However, Argyll and Bute Council has noted that the surface water culvert is "99% blocked" downstream of this manhole. This has caused the vast majority of the surface water to enter the combined sewer (previously foul only) which includes a sediment load consisting of coarse gravels which have caused substantial damages to a Scottish Water pumping station. Works have since been undertaken by Argyll and Bute council to remove the blockage and the pipe is known to flow freely (May 2018).
Alignment with model results	At this location there is no modelled flooding however it has been highlighted by historic observed data hence the confidence in the model data at this location is low as the model alignment is poor. The poor correlation is potentially due to a poor representation of Kilcreggan in the SEPA pluvial mapping. There are no Scottish Water models in this area and there may still be confusion regarding the various culverts and pipes which operate in this area.

Historic Surface Water Flooding	
Future Surface Water Flooding	
Properties at risk: *11 residential dwellings, 1 pumping station*	
Potential Additional Stakeholders	
Cove and Kilcreggan Community Council, Emergency Services	
Potential Development Sites	
Potential developments sites at surface water risk are taken from the Argyll and Bute Council Local Development Plan 2015. AFA2001 Kilcreggan: The Area for Action No. 2001 has been earmarked for local environmental enhancement. There are no known surface water issues in this area and it does not represent an opportunity to mitigate flooding from the observed flooding locations. There are no other areas of potentially developed land within the SWMP boundary.	
Conclusion	
The observed data has shown that Kilcreggan is considered to be at significant risk of surface water flooding. As a result, this area shall continue on to the Understanding Surface Water Flood Risk stage of the SWMP process.	

C Project Data Register

PROJECT DATA REGISTER

Project name:	Kilcreggan SWMP
Project number:	2018s0282
Data manager:	Nicci Buckely
Client:	Argyll and Bute Council

Owner	Description	Transfer type	Data format	Received from	Licenced to JBA? (yes / no)	Licence expiry date	Comment on level of confidence / suitability for use
SEPA	National Pluvial Hazard Mapping	JBarn	Various GIS	ABC: Grant Whyte	yes	End of project	National pluvial dataset suitable for high level studies. This has since been superseded with the Regional Pluvial data set which will be used in its place where available hence confidence in this data set is poor and only used if regional
SEPA	Regoinal Pluvial Hazard Mapping (detailed dataset)	JBarn	Various GIS	ABC: Grant Whyte	yes	End of project	Regional pluvial flood hazard (detailed) dataset is one of the primary model based source of flooding information. High quality detailed originally created by JBA. This SWMP will use SEPA Regional Pluvial Mapping V1.3 which is the latest dataset hence confidence is high. The "detailed" dataset contains 14 different storm scenarios, varying minimum ponding depths as well as inforation on velocity direction.
SEPA	Regoinal Pluvial Hazard Mapping (website dataset)	JBarn	Various GIS	ABC: Grant Whyte	yes	End of project	Regional pluvial flood hazard (website) dataset is one of the primary model based source of flooding information. High quality detailed originally created by JBA. This SWMP will use SEPA Regional Pluvial Mapping V1.3 which is the latest dataset hence confidence is high. The "website" data set includes Scottish Water flooding information and incorportates SEPA's National dataset where there is a data gap.
SEPA	NFM Data	JBarn	shapefile	ABC: Grant Whyte	yes	End of project	The dataset supplied is only visible from a scale of 1:400,000 or above. Although the dataset is visible it is not possible to interegate the data. Although this is unfortunte the main data required from the NFM data set is the runoff potential. Hillside run-off is well documented as an issue in Kilcreggan hence not having the model data acceptable.
SEPA	Risk Receptor Datasets	JBarn	shapefile	ABC: Grant Whyte	yes	End of project	Available throughout the SWMP areas contains shapefiles for a comprehensive range of receptors useful for determining flood risk. The dataset produce by SEPA ties in well with the background mapping hence confidence is high.
SEPA	SEPA Flood Risk Management Strategic Appraisal Baseline (RECEPTOR DATASETS, GUIDANCE, APPRAISAL BASELINE OUTPUTS, AAD GRIDS)	JBarn	shapefile	ABC: Grant Whyte	yes	End of project	AAD point data is a vital part of determining and prioritise flood risk. High level of confidence
Scottish Water	GIS Sewer Network	JBarn	shapefile	ABC: Grant Whyte	yes	End of project	Scottish Water have provided a detailed GIS sewer network for all of the SWMP areas. The GIS networks are either compiled by GIS points or polylines. The very high volume of points makes the dataset very difficult to use and interoperate. The level of confidence in the data is low as there are significant gaps in the network and an area of "highway drainage" is known to be a combined sewer. The inforamtion is also out of date and does not include the pumping stations along Shore Road. The layout on School Lane is also not completely
ABC	OS 1:50:000 Map	JBarn	.tif	ABC: Grant Whyte	yes	End of project	Official OS data hence confidence is high.
ABC	Kilcreggan Background Info: Flood history, photographs, emails, drawings, flooding reports, engineering design reports	JBarn	pdf, word, jpg	ABC: Grant Whyte	no	End of project	This data is very important and is required to validate the model. The level of detail in the data entries includes a description of flood origins and damages. Confidence is high.
ABC	Kilcreggan Incidents Since 2011: Flood history, photographs, emails, drawings, reports	JBarn	pdf, word, jpg	ABC: Grant Whyte	no	End of project	This data is very important and is required to validate the model. The level of detail in the data entries includes a description of flood origins and damages. Confidence is high.

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B Understanding Surface Water Flood Risk

Appendix B – Phase 2 Understanding Surface Water Flood Risk

Contents

1 Introduction

Phase 2 of the SWMP focuses on understanding surface water flood risk with each of the SWMP areas identified in Phase 1 of the report. The SWMP areas identified are:

- Kilcreggan

Kilcreggan has a substantial history of surface water flooding. The purpose of this phase of the report is to take a closer look at the flooding within these areas, to understand the flooding mechanisms at work as well as the associated hazard and risk.

Understanding the causes and consequences of flooding is crucial for making well informed decisions on how to manage flood risk. This will be done by analysing available information to gain an appreciation of the sources, pathways, receptors, flood risk and flood hazard.

2 Determining Surface Water Vulnerable Areas (Flooding Hotspots)

In order to understand surface water flood risk, it is necessary to break down each of the surface water management areas into smaller flooding "hotspots". The flooding hotspots are defined by the flooding mechanism. Flooding mechanisms within a hotspot may be singular or linked with multiple different mechanisms causing flooding in one area. An example of this could be where hillside runoff floods properties before passing into the drainage network which subsequently surcharges effecting nearby properties.

The size of the hotspot will also vary between neighbourhood and street level again, depending on the flooding mechanism and the extent of flooding. Analysing data at this scale will allow for objectives and actions to be more focused which, will in turn allow flood risk to be summarised and monitored over time to determine the effectiveness of implemented actions.

2.1 Understanding Key Features Within the SWMP Area

Before defining the hotspots an analysis of key information within each SWMP area is undertaken to identify catchment wide factors that may influence the definition of the flooding hotspot. This analysis includes:

- Significant surface water flood events – this is a brief summary of historic surface water flood events which will describe flooding in terms of where it took place, who or what was affected and level of damages.
- Natural drainage features – this includes a description of the watercourses and catchments in each area.
- Artificial drainage features – this is a description of the sewer catchments within the SWMP area including where separated systems operate and where the catchment drains to.
- Interactions between the natural and artificial drainage systems – this is a summary of where the 2 networks crossover including features such as outfalls in to channels, combined sewer overflows and in particular where surface water enters the combined sewer.
- Existing surface water management – this is a brief summary of all current surface water management infrastructure. This includes SuDS, Council operated surface water drainage, Council operated flood protection/alleviation measures and Scottish Water capacity improvement schemes.

2.2 Defining Surface Water Flooding Hotspots

Defining flood risk hotspots is a manual process which involves analysing all of the information available. However, initially to define the geographical area the primary focus is on the SEPA regional pluvial flood hazard mapping and the historic flood database. At this stage it is also important to refer back to the model verification stage to incorporate the model confidence when defining the hotspot.

2.2.1 Selection of Return Periods

For the SEPA Regional Pluvial Flood hazard data the 1:10 year and 1:200 year flood events have been used in the hotspot analysis. The majority of the analysis is undertaken using the 200 year event with the 10 year event used to highlight areas more prone to flooding and where flood depths are likely to be greater.

The Scottish Water Flood Spreading Assessment results were not available for inclusion in this SWMP. The modelling is expected to be completed late 2018 and will be included in the next SWMP cycle.

2.2.2 Identifying Receptors at Risk

Using the SEPA Risk Receptor Dataset the number of receptors effected by the flooding can be determined. As the receptor dataset consists of points only, it is typically necessary to apply a level of engineering judgement to determine whether a property is likely to be affected. For example, a house is represented by a single point typically found within the boundary of the building, without apply judgement the property would only be at risk if flood water came into contact with the point by which point flood water may already have encroached on the building footprint. This would also not account for damages to gardens, garages and other out buildings. In this case as there is so little model data there is a reliance on observed historical data. Other receptors such as utilities and infrastructure have also been included in the analysis.

2.2.3 Analysing Flooding Impact

The SEPA regional pluvial damages data has been utilised to provide a monitory value for the damages accrued in each hot spot. The damages are presented in average annual damages (AAD) which are based on the SEPA regional pluvial mapping and SEPA Risk Receptor Dataset. The data is available as a 1km^2 grid tile and also point data sets. The grid tiles are the sum of the point values with in each grid square. Due to the variable nature of the hotspots there are occasions where multiple exist within a single grid tile or where hotspots cross into multiple grid tiles. However, as stated above there is very little to no SEPA Regional flood mapping in this area hence there is no AAD data as the model correlation is poor.

As this is the case SEPA's Scottish Pluvial Annual Average Damage Estimate (SPAADEs) dataset shall be used. SPAADEs are not based on observed pluvial flood damages; instead they are derived from strategic national modelling. The SPAADE values derived in 2010 are £1,100 for a residential property and £1,700 for non-residential property. An uplift has been applied on these figures based on the Retail Price Index (RPI) from the Office of National Statistics. The uplifted values to be used in this SWMP are £1,387 for residential properties and £2,133 for non-residential properties.

Where SEPA AAD datasets are available and model confidence is good then the ADD values take precedence over the SPAADE dataset. Given the records of the observed flood events available known damages will also be used where possible.

2.2.4 Site Visit

A site visit was undertaken at the start of the project. JBA met with staff from the Argyll and Bute Council in Kilcreggan. The site walkover included 3 sites which were photographed and the flooding mechanisms/consequences were discussed. The site visit has formed an important part of the generation of hotspots due to the lack of SEPA flood mapping.

2.3 Future Flood Risk

The future flood risk has been assessed during the analysis of each hotspot. There are 3 main areas associated with future flood risk, any of these items could increase the likelihood of future flooding.

Climate change – Using SEPA's 1:1000 year event pluvial flood hazard map it is possible to gain an appreciation for the effects of climate change. While all areas are likely to see flows increase and rainfall intensify, this will have a greater effect on some areas than others, typically this is related to the topography.

Urban Creep – Refers to the trend of replacing permeable ground with impermeable surfaces e.g. gardens replaced with driveways or areas re-developed with higher density buildings. Rates of urban creep vary, and no data has been supplied in order to assess this. However, this is not thought to be a significant issue in Kilcreggan.

Demographics – The local development plan has been used when assessing the flooding hotspots to determine how future expansion may affect flood risk at each hotspot. New developments will be subject to factors such as planning policy, development planning and development management which will interact with demographic change to influence flood risk. Scottish Planning Policy seeks to ensure that new developments are not at risk from surface water flooding and do not increase surface water flood risk elsewhere. No new developments are planned within the vicinity of the hotspots selected.

Development creep has the same impact as climate change and the 1000 year maps are considered to represent these influences.

2.4 Prioritising Surface Water Flooding Hotspots

Once the hotspots have been identified and damages have been assigned, it is necessary prioritise the hotspots so that efforts can be focused where there is the most benefit. The factors that influence the ranking are as follows:

- The value of the average annual damages within each hotspot.
- The number of residential properties assessed to be at risk for the 1:200 year event.
- The number of non-residential properties assessed to be at risk for the 1:200 year event.
- Where the management of the risk lies within the powers of the SWMP stakeholders.
- The number and presence of vulnerable facilities.
- Where existing schemes are already operating hence reducing the benefit of implementing additional measures and allowing non-protected areas to be addressed.
- Social vulnerability to flooding dataset, published by the Scottish Government.

The prioritisation is a manual process using engineering judgement in the first instance. The initial ranking is then communicated to the SWMP stakeholders to gain their knowledge and experience before a final ranking is agreement.

3 Kilcreggan Surface Water Flood Risk Overview

It is estimated that surface water flooding accounts for 10% of annual average flood damages in the Helensburgh and Loch Long area (based on SEPA modelled data).

The SEPA PVA report for Helensburgh and Loch Long recognises the poor representation of surface water flooding in Kilcreggan by the SEPA mapping. As such they have provided the following statement which is to be used as an indicator when monitoring any SWMP objectives:

"This objective will be monitored using surface water flood risk across the Potentially Vulnerable Area. For 11/02 there are 10 residential properties at risk and Annual Average Damages of £43,000."

A summary of the surface water flood risk for the SWMP area is presented in the table below. For details on the surface water flood risk and information on how these number were derived see section 4.

Table 3-1: Kilcreggan SWMP Risk Overview

Location	Non Residential Properties at risk 200yr event	Residential properties at risk 200yr event	Residential properties at risk in area more socially vulnerable to flooding 200yr event (>Relatively high)	Total annual average damages (SPAADE + Assumed values)
Kilcreggan	0	11	0	£20,257

4 SWMP Hotspot Analysis

See Appendices A-H for flooding hotspot maps for each SWMP area.

4.1 Kilcreggan

4.1.1 Significant Surface Water Flood Events

Kilcreggan has significant reoccurring issues with surface water flooding which are related to the settlements geographical location, at the foot for Aiden Hill.

Flooding in the Tigh Dearg Road area is substantial and is consistently reoccurring. Here large volumes of hillside runoff flows down the upper slopes of Aiden Hill onto Barbour Road before flowing over another area of open ground on to Argyll Road. Despite efforts by Argyll and Bute Council to increase the volume of surface water captured by the drainage system, flooding still occurs. Due to the topography the depth of water is shallow however, the velocity is significant causing substantial damages. Significant damages (internal and external) have been experienced to multiple properties in the area leading to residents creating flood gates and diversion channels in an attempt to defend their properties.

The sewer network below School Road frequently surcharges sending foul material into the street. This then flows down the road and into the Firth of Clyde. This is due to a blockage within a culverted watercourse which sends the majority of flows into the combined sewer. The coarse granular sediment load has also damaged a Scottish Water pumping station. The property "Glentrae" owns a parcel of land north of the house which features a short section of open watercourse as well as several raised manholes. This property has also suffered an unknown level of damage as a result of surface water flooding. Flood waters are expected to have either come from either a surcharged manhole within their property or out of bank flow caused by a blocked headwall screen.

There is a history of nuisance flooding at the eastern extent of Arygll Road. Here road side drainage overtops as it is piped below the road at the junction with the B833 (Rosneath Road). The surface water then flows down the B833 for approximately 100m before the watercourse is directed into an existing watercourse. No damages have been reported as a result of this flooding.

4.1.2 Artificial Drainage Systems

There is a combined sewer network which covers the majority of Kilcreggan with the only separated systems in the Meikle Aiden Brae area.

All combined sewers are collected by an intercepting combined sewer beneath Shore Road. This sewer and a total of 6 pumping stations pass all flows from Kilcreggan to the Cove and Kilcreggan WWTW. Previous to this all sewers discharged directly into the Firth of Clyde.

There is a contrast in information on sewer beneath Argyll Road and Tigh Dearg Road with the GIS data provided by Scottish Water showing as "Highway Drainage" and drainage investigation undertaken by Grontmij suggests that the network also receives foul flow from old septic tank connects.

A study by Grontmij in 2010[1] indicated that the capacity of the existing drainage network that flows down Tigh Dearg Road is approximately equal to the 1 in 2 year rainfall return period.

---

[1] Argyll Road/Tigh Dearg Road, Kilcreggan, Flood Management Program - Phase 1, Grontmij, 2010

4.1.3 Natural Drainage Features

Lindowan Burn

The Lindowan Burn originates from the Lindowan Reservoir which is situated between Aiden Hill and Toman Dubh north of Kilcreggan. The reservoir is fed by multiple streams which drain an area of marsh/bog as well as the Garelochhead forest. From the reservoir the watercourse flows south in a wooded valley for approximately 500m before reaching Kilcreggan itself. From here the burn flows openly to the south through gardens and is still mostly tree lined. The watercourse is culverted below several roads to its outfall into the Firth of Clyde. The watercourse is particularly steep in its upper reach before flattening at Shore Road.

Kilcreggan Burn

Although the Kilcreggan Burn also originates from the Lindowan Reservoir it then drains the eastern slope of Toman Dubh in particular the Millbrae Plantation. The watercourse flows north east down the side of the hill before routing south towards Portkil Farm. From here the watercourse flows for approximately 800m south west towards the eastern extent on Kilcreggan where the watercourse discharges into the Firth of Clyde. The watercourse generally flows open in a gentle sloping wooded valley. Both the bank and bed slope are slacker than the Lindowan Burn.

Unnamed Burn (School Road)

An unnamed watercourse originates on the south west slope of Aiden Hill flowing open through grass and gorse fields for 600m before reaching Barbour Road. From Barbour Road the watercourse is culverted south west to an area of open ground at the junctions of Fairfield Gardens and School Road. Here the watercourse flows open in a wooded area for an unknown distance thought to be less than 5m. The watercourse is then flows through a headwall and screen into a culverted section below School Road. The watercourse then flows south before emerging in a private garden at Shore Road. Mapping shows the watercourse to outfall into the Firth of Clyde although from the site visit it was thought that the outfall was abandoned as there was flow within the garden but not at the outfall. It is assumed the watercourse is collected by the combined sewer interceptor under Shore Road or has been badly damaged resulting in surface water percolating into the ground at a break beneath Shore Road.

Tigh Dearg Road - Surface Water Runoff Catchments

The flood investigation at Tigh Dearg Road undertaken by Grontmij in 2010 on behalf of Argyll and Bute Council also included a review of the contributing areas of surface water runoff.

Figure 4-1: Tigh Dearg Road Catchment[2]

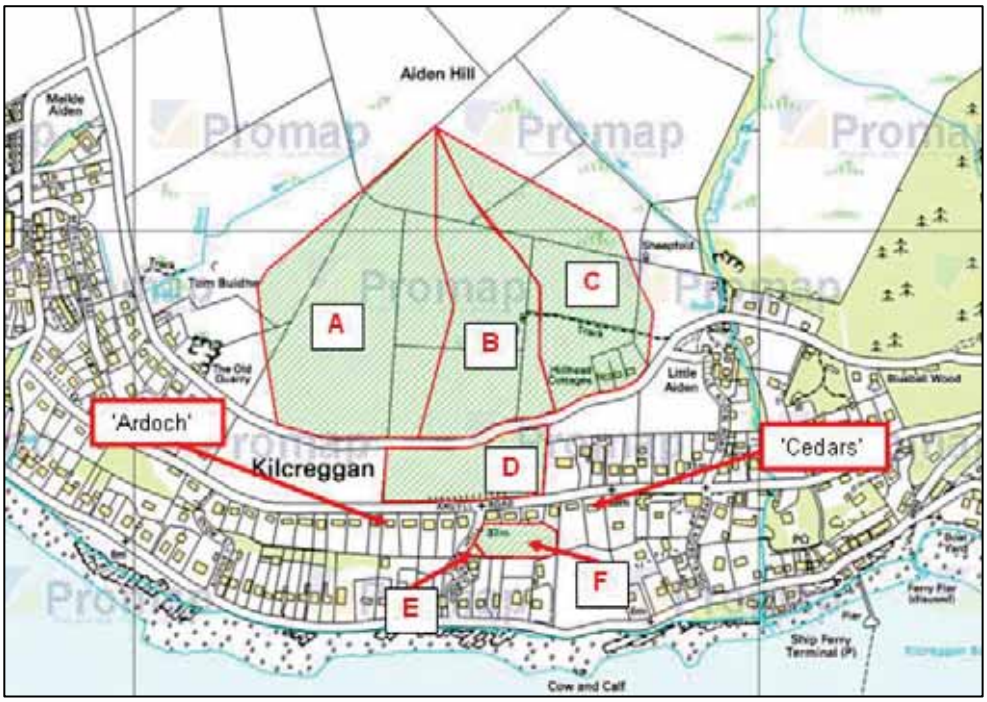


Figure 4-2: Tigh Dearg Road Catchment Peak Flows[7]

	A	B	C	D	E	F
Area (ha)	10.4	5.5	6.2	2.4	0.1	1.0
30yr (l/s)	226.9	128.4	143.4	25.6	3.7	35.5
200 yr +CC (l/s)	429.9	243.3	271.6	115.17	7	67.3

[2] Argyll Road/Tigh Dearg Road, Kilcreggan, Flood Management Program - Phase 1, Grontmij, 2010

4.1.4 Existing Surface Water Management Features

The council constructed a concrete channel on the north side of Argyll Road for the purpose of improving interception of hillside run-off. The channel is approximately 140m long draining to a low point north of Tigh Dearg Road. The channel connects to the combined sewer which flows down Tigh Dearg Road.

4.1.5 Interactions Between Natural and Artificial Drainage System

There are significant crossovers between artificial and natural drainage throughout Kilcreggan.

Drainage ditches in the east of Barbour Road drain in to a Scottish Water Surface Water pipe which flows around 'The Long View' and connects to the combined sewer on Argyll Road. In the fields between Barbour Road and Argyll Road there are 4 stone cundies 2 of which drain to the combined sewer the other cundies discharge into the Firth of Clyde.

In the School Road area, a historic culverted watercourse (stone culverts shown on 1860 map) enters into the combined sewer at a baffle located within a manhole on School Road itself. The original intention of the baffle was to use surface water to flush out the foul sewer during times of high flows. However, the stone culvert downstream of this point is thought to be up to 95% blocked forcing the vast majority of the flow into the combined sewer. This causes surcharging at a downstream manhole.

The interceptor sewer under Shore Road not only collects the combined sewer flow but collects at least some of the flow from the stone cundies.

4.1.6 Flood Risk Hotspots

KIL_HS01: Argyll Road East and B833

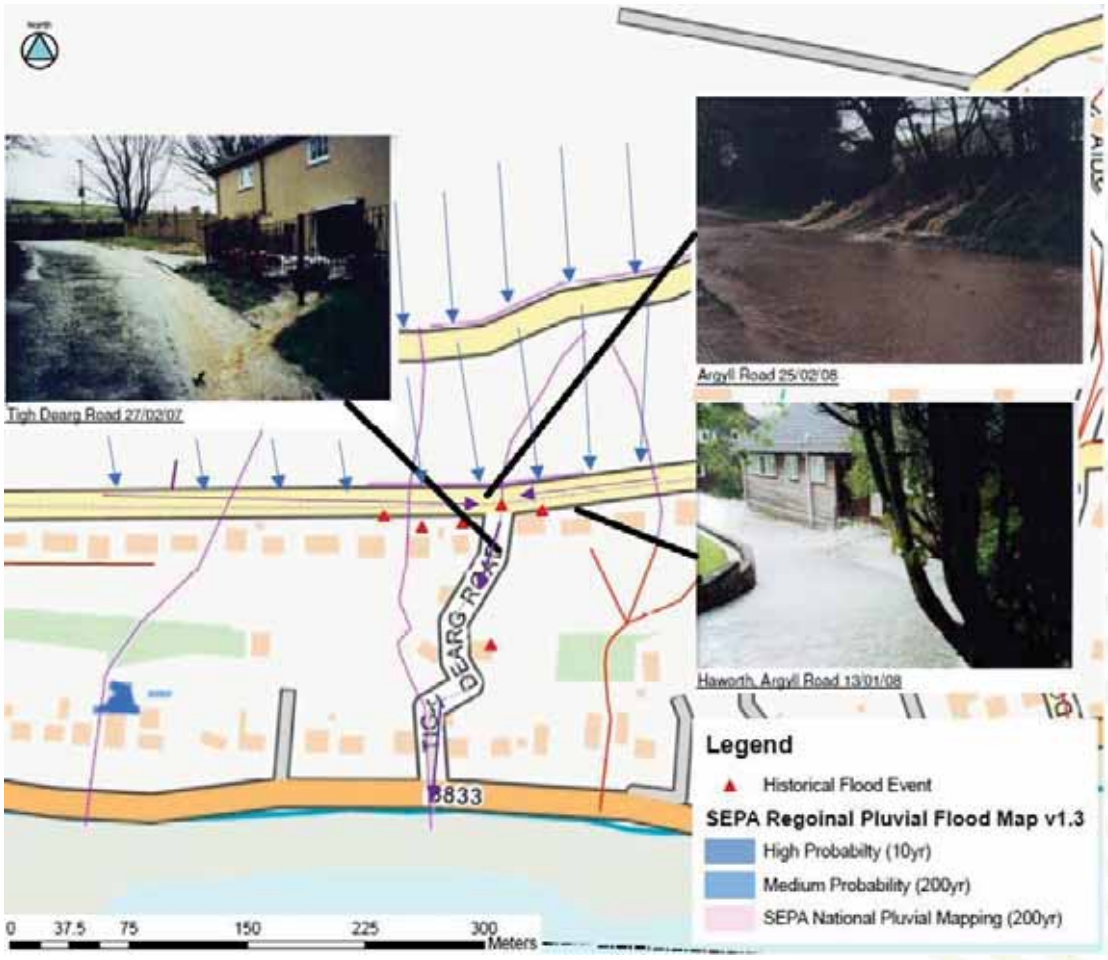
Here surface water runoff from the hillside to the north and road surface is collected by a series of drains and ditches. The roadside drainage flows east along the northern edge of Argyll road towards the B833. Before reaching the end of the road the pipe is opens into a ditch before turning 90 degrees where it is piped below Argyll Road. This is the location where the surface water over tops road before flowing south on the B833 for approximately 90m. At this point surface water leaves road and connects to an existing small watercourse in a wooded valley to the south east. The road drainage network is suspected to be under capacity particularly with the volume of hill side runoff that is suspected to be carried. It is also possible that the pipe below Argyll Road is blocked or damaged thereby reducing capacity. Although the flooding is known to be reoccurring there are no recorded damages however, there is the potential that damage will be caused to the road's surface over time. Due to the reoccurring nature of the flooding the flood risk is high however due to the shallow depth and location of the flooding the flood hazard is low. There are no developments planned in this area however future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change.

Figure 4-3: Argyll Road East and B833 – Flow paths

KIL_HS02: Tigh Dearg Road

Hillside runoff is a substantial issue on the southern slope of Aiden Hill. Argyll Road collects runoff from the field immediately to north as well as the field upslope from Barbour Road. The volume of surface water experienced overwhelms the drainage ditches along Barbour Road causing high velocity low depth flood water to continue down the hillside onto Argyll Road. The drainage network along Argyll Road was enhanced by Argyll and Bute Council in 2011 to improve the capture and conveyance of runoff on the north side of Argyll Road. The channel is constructed from oversized kerbs and concrete is approximately 140m long and drains to a gully at the top of Tigh Dearg Road. This is then connected to a 225mm ∅ Scottish Water combined sewer which flows down Tigh Dearg Road and connects to combined sewer interceptor along Shore Road. Flooding is very frequent at this location with 8 events occurring between 2011-2014. Although the works undertaken by Argyll and Bute Council have improved capture of the runoff there has still be multiple flood events in which this has over topped. Damages are significant ranging from substantial interior flooding of multiple properties, damage to boundary walls and also damages to road surfacing. Due to the steep nature of the topography flood waters are shallow but high velocity and have been described as "frightening" by residents. Several residents have installed DIY flood gates and other defences to deflect flood water. The current flood risk is high as the flooding known to be reoccurring. The flood hazard is also high due to the damages causes and velocity of the flood water. There are no developments planned in this area however future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change.

Figure 4-4: Tigh Dearg Road – Flow paths



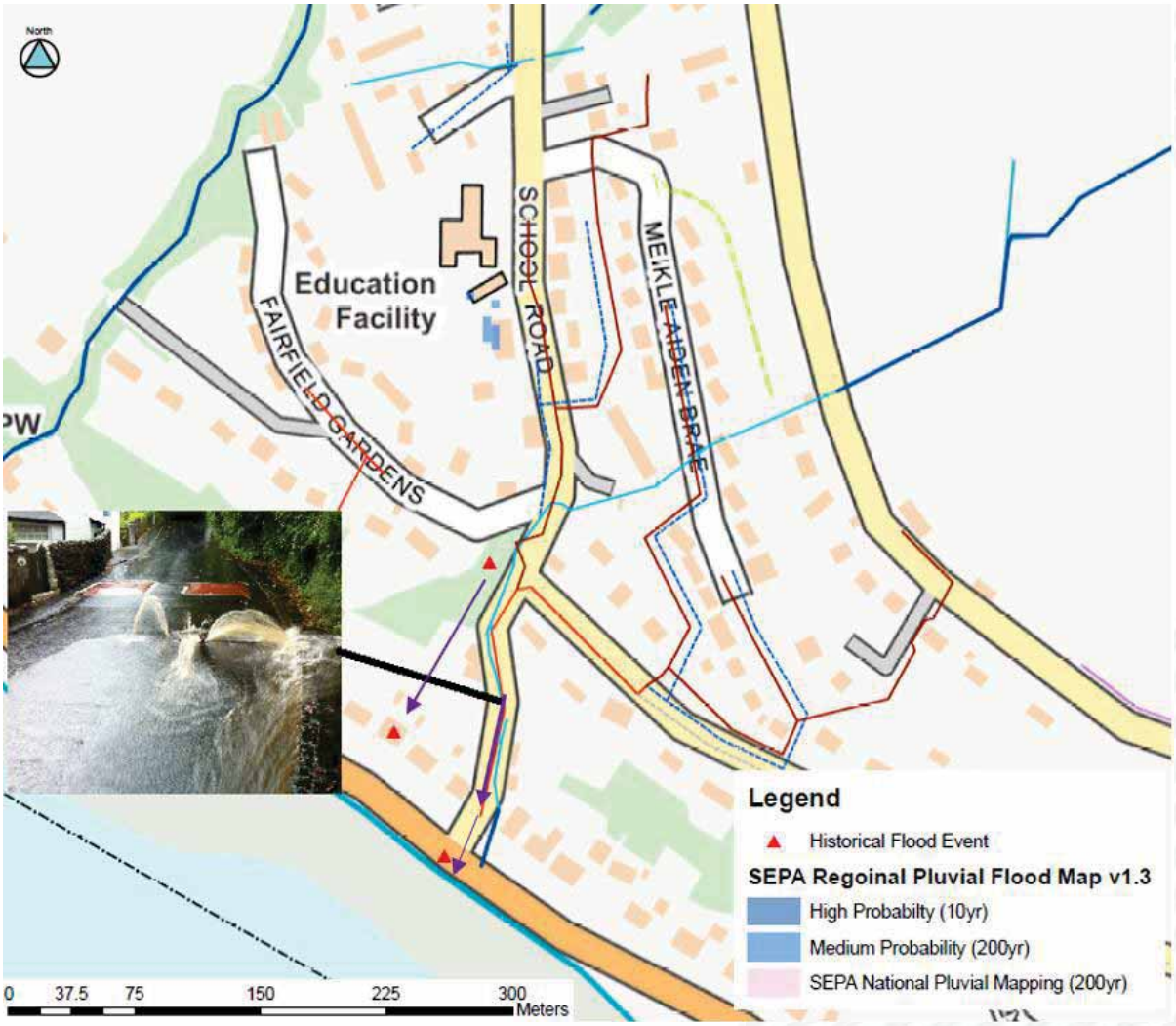
KIL_HS03: School Road

An unnamed watercourse flows down the south western slope of Aiden Hill before entering a stone culvert beneath the Meikle Aiden Brae area. The cundy (old stone culvert) is visible on the oldest historic map available (1860) at which point the land was undeveloped. The 375mm ∅ stone cundy opens on to a parcel of ground south of Fairfield Gardens. Another pipe suspected to be road drainage also enters at this point. The watercourse flows open for a few meters before entering 600mm ∅ stone culvert via brick headwall and screen which is susceptible to blockage. The culvert continues to flow downhill in the parcel of land at Glentrae Cottage in which there are 2 raised manholes. At this location the foul sewer is diverted from the road to the parcel of land where there is a third raised manhole which connects the sewer to a former septic tank.

Both the culvert and the foul sewer leave the parcel of land and flow under School Road.

In a manhole west of Eyrie House on School Road there is a baffle system where both the culvert and sewer interact. The original purpose of this was allow the surface water to overtop the baffle during high flows and flush out the foul sewer. Investigations now show that the culvert is "99%" blocked downstream of the baffle forcing the vast majority of the surface water into the foul sewer. This leads to surcharging of the downstream manhole and flows continue down School Road and into the Firth of Clyde. Other manholes in the parcel of land are believed to have over topped in the past causing damage to Glentrae Cottage. Alternatively the blocked headwall may have diverted flow toward the property. Scottish Water have also reported damage to their pumping station as a result of the sediment load (gravel) that the culverted watercourse is supplying. The current flood risk is high as the flooding is known to be reoccurring. The flood hazard is also high due to the damages caused and the foul material with the floodwater. There are no developments planned in this area however future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change.

Figure 4-5: School Road



4.1.7 Flood Risk Hotspot Summary Table

Rank	Hotspot name and location		Total Annual Average Damage (AAD)	Non Residential Properties	Residential Properties	Community facilities	Listed buildings	Infrastructure
		Return Period (yr)	**200**	**200**	**200**	**200**	**200**	**200**
		History of flooding Confidence in data						
1	**KIL_HS02: Tigh Dearg Road**	*History of surface water flooding due to extensive volume hillside runoff overwhelming existing surface water drainage infrastructure. Low confidence in model data*	*£13,870 (SPAADE data) + £4,000 for road resurfacing works*	*0*	*10*	-	-	*Approximately 100m Tigh Dearg Road resurfacing*
2	**KIL_HS03: School Road**	*History of surface water flooding caused by blocked culverts north of housing scheme with model showing greater extent of flooding. Good confidence in model data.*	*£1,387 (SPAADE data) + Assumed £5,000 for pumping station damage works £6,387*	*0*	*1*	-	-	*Scottish Water Pumping station damage*
3	**KIL_HS01: Argyll Road East and B833**	*History of surface water flooding due to hillside runoff and overtopping of roadside drainage. Low confidence in model data*	*£0 (SPAADE data)*	*0*	*0*	-	-	-

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Appendices

A SWMP Overview Hotspot Map

North

Rosheath Peninsula

KIL_HS03

KIL_HS02

KIL_HS01

Kilcreggan

0 125 250 500 750 1,000 Meters

LEGEND

- SWMP Area
- KIL_HS01
- KIL_HS02
- KIL_HS03

JBA consulting

KILCREGGAN HOTSPOT OVERVIEW

2018s0549_KIL_D02

B Kilcreggan Hotspots

North

BOUR ROAD

Sports/Leisure Centre

B833

#

LEGEND

- # Historical Flood Event
- ^ Residential Properties at Risk
- KIL_HS01
- Protected Open Space
- AFA2001 Environmental Enhancement
- Scottish Water - Highway Drainage
- Scottish Water - Foul
- Scottish Water - Natural Water
- Scottish Water - Surface Water
- Scottish Water - Combined
- Scottish Water - Proposed
- ABC - Cundy
- ABC - Drainage Channel
- ABC - Pipe

SEPA Regoinal Pluvial Flood Map v1.3

- High Probabilty (10yr)
- Medium Probability (200yr)
- SEPA National Pluvial Mapping (200yr)

SWMP HOTSPOT LOCATION

JBA consulting

KIL_HS01

JUNCTION OF ARGYLL ROAD AND B833

North

BARBOUR ROAD

ARGYLL ROAD

AIDENVALE ROAD

TIGH DEARG ROAD

LITTLE AIDEN ROAD

DONALDSONS BRAE

ARGYLL ROAD

BARBOUR

PO

3833

LEGEND

- Historical Flood Event
- Residential Properties at Risk
- KIL_HS02
- Protected Open Space
- AFA2001 Environmental Enhancement
- Scottish Water - Highway Drainage
- Scottish Water - Foul
- Scottish Water - Natural Water
- Scottish Water - Surface Water
- Scottish Water - Combined
- Scottish Water - Proposed
- ABC - Cundy
- ABC - Drainage Channel
- ABC - Pipe

SEPA Regoinal Pluvial Flood Map v1.3

- High Probabilty (10yr)
- Medium Probability (200yr)
- SEPA National Pluvial Mapping (200yr)

SWMP HOTSPOT LOCATION

JBA consulting

KIL_HS02

TIGH DEARG ROAD

North

Education Facility

SCHOOL ROAD

MEIKLE AIDEN BRAE

FAIRFIELD GARDENS

B833

ARGYLL ROAD

0 40 80 160 240 320 Meters

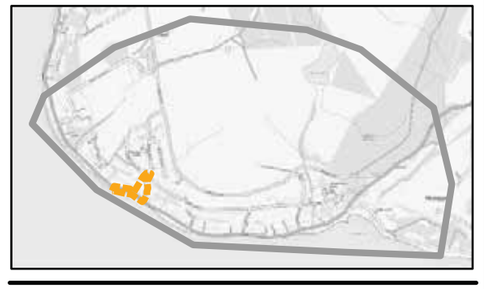
LEGEND

- # Historical Flood Event
- ^ Residential Properties at Risk
- ! Utilities at Risk
- KIL_HS03
- Protected Open Space
- AFA2001 Environmental Enhancement
- Scottish Water - Highway Drainage
- Scottish Water - Foul
- Scottish Water - Natural Water
- Scottish Water - Surface Water
- Scottish Water - Combined
- Scottish Water - Proposed
- ABC - Cundy
- ABC - Drainage Channel
- ABC - Pipe

SEPA Regoinal Pluvial Flood Map v1.3

- High Probabilty (10yr)
- Medium Probability (200yr)
- SEPA National Pluvial Mapping (200yr)

SWMP HOTSPOT LOCATION



JBA consulting

KIL_HS03

SCHOOL ROAD

Offices at

Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

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C Setting Initial Objectives

Appendix C – Phase 3 Setting SMART Objectives

Contents

1 Introduction

The Flood Risk Management Strategy for LPD11 contains high-level objectives for surface water management within the PVAs. The FRM document also identifies priority areas for the SWMPs which have been further broken down into hotspots as discussed in Phase 2. The high-level objectives are:

- To avoid an increase in surface water flood risk (applies everywhere including SWMP areas).
- To reduce surface water flood risk (applies to SWMP areas at the town and city scale).

The Local Flood Risk Management Plans have identified objectives that are in line with the objectives set in the Strategies. The Clyde and Loch Lomond LPD has the following objectives:

Table 1-1: Clyde and Loch Lomond LPD Objectives in the Flood Risk Management Strategy[1]

Target area	Objectives	Objective ID	Indicators
Applies across Clyde and Loch Lomond Plan District	Avoid an overall increase in flood risk	11127	70 residential properties £390,000,000 Annual Average Damages
Applies across Clyde and Loch Lomond Plan District	Reduce overall flood risk	11132	

Within the Clyde and Loch Lomond LPD objectives were also set for each PVA.

Table 1-2: PVA Level Objectives in the Flood Risk Management Strategy[6]

Target area	Objectives	Objective ID	Indicators
Kilcreggan	Reduce the economic damages and risk to people from surface water flooding in Kilcreggan.	11084	• 10 residential properties • £43,000 Annual Average Damages

[1] Flood Risk Management Strategy, Forth LPD 9, SEPA 2015

More detailed and localised objectives for reducing surface water flood risk are based on the understanding of flood risk and the assessment of responsible authorises (stakeholders). The objectives available to be used in the SWMP are described in the table below.

Table 1-3: Objectives for SWMPs

Objective	Example
Reduce surface water flood risk	Areas where the greatest risk of surface water flooding (hotspots) has been identified in phase 2 through analysis of the model and historic events. Areas where there are critical facilities or infrastructure that carry a risk i.e. schools, hospitals, main roads.
Accept flood risk and maintain existing actions	Areas where there are already surface water management feature/schemes in place to reduce flood risk i.e. surface water storage, pumping stations.
Improve understanding of surface water flood risk	Areas where, from the analysis undertaken in Phase 2, it is not clear how or why flooding is occurring or how to remediate the flooding. This can be applied to individual hotspots or larger areas depending on the outcome of the model verification undertaken in Phase 1.

In order to manage objectives and gauge their success it is necessary to use a number of indicators. The indicators used are the receptors which are at risk from surface water flooding e.g. Number of properties effected, annual average damages.

2 Advancing Initial Objectives

In order to develop the initial objectives identified by SEPA in the LPD Strategies a 2 part process is required:

1. The initial objectives proposed in the FRM strategies have been updated following the results of the Understanding Surface Water Flood Risk section (Phase 2). This process creates targeted objectives for each of the hotspots identified. The objectives are also assigned a draft priority at this stage.
2. The objectives are then subject to stakeholder consultation where they will be appraised, selected and prioritise for implementation based in the knowledge of upcoming projects and funding opportunities.

3 Prioritising Objectives

Once the objectives have been assigned it is necessary to prioritise the various objectives. An accurate timeline is not given at this stage as it is more an indication of which objectives could be possible in the long and short term.

When considering the priority of the objectives there is no prescriptive method to do so however, factors to consider are:

- Surface water flood risk (using information on impacts of flooding).
- Surface water flood risk to priority receptor groups, e.g. schools, hospitals, homes at risk in socially vulnerable areas.
- Locations with a history of flooding.
- Areas where there is no history of flooding but are predicted to flood and should therefore be treated with caution, particularly where more detailed models are not available. It is sensible to balance predicted and actual flooding information when prioritising.
- Locations where there are opportunities for joint working (e.g. making management more cost-effective and delivering multiple benefits).

4 Consultation and Co-ordination

Consultation with key stakeholders is vital at this stage in order to ensure that all parties are accepting of the hotspots identified and understand the flooding mechanisms at work. Consultation with stakeholders is vital at the Objectives stage in order to identify links with other projects and initiatives, prioritise area according to other investment taking place in these areas and to ensure co-ordinated approaches or joint implementation. This would improve efficiencies and potentially deliver multiple benefits. Through consultation it is hoped that other projects will be identified that may be co-ordinated or implemented jointly with surface water flood management. It is important that the stakeholders involved have input into the proposed objectives and the prioritisation process.

Information requested from stakeholders includes:

- Scottish Water planned work
- Local Authority roads department planned work
- Local Authority land use planning areas identified for development or regeneration.
    - Information on green space
    - Proposals to enhance existing or develop new open / green space (e.g. open space strategies, local biodiversity actions plans, 'green and blue' network development, footpath and cycle path development, urban watercourse restoration, park development, climate change adaptation plans).
- SEPA RBMP and proposals for river restoration.
- Any other projects that might influence surface water management such as community initiatives and flood studies.
- Any other planned work in vicinity of the surface water flooding hotspots in which the stakeholders can influence.

Table 4-1: Stakeholder Input

Stakeholder	Key Input/Multiple Benefit Opportunities
Argyll and Bute Council	No new data.
Scottish Water	Kil_HS03: the manhole on School Road which is known to have a baffle separating the foul and surface water pipe was inspected by Scottish Water in Autumn of 2018. Subsequently, the baffle was repaired and the 2 networks no long interact with no surface water entering the sewer network. The only flood risk at this location relates to overland flow from the culvert screen.
SEPA	No new data.

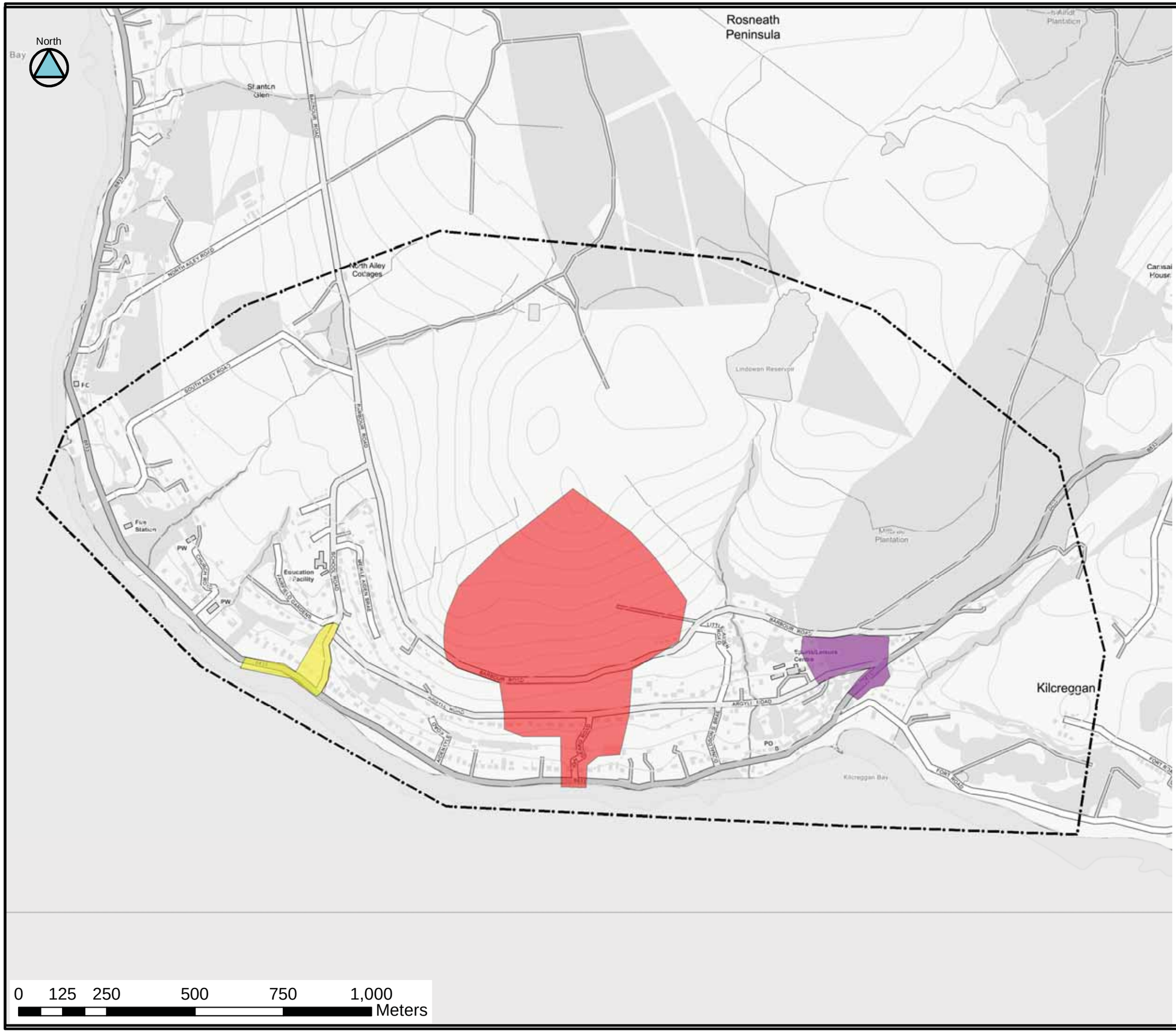
5 Targeted Objectives for the Management of Surface Water Flooding by Hotspot

5.1 Kilcreggan

Hotspot name and location	History of flooding Confidence in data	Initial Objective	Initial Priority	Objective Indicators					Timescale
				Annual Average Damages (ADD) (all return periods)	Non-Residential (1:200yr)	Residential (1:200yr)	Community facilities (1:200yr)	Infrastructure (1:200yr)	
KIL_HS02: Tigh Dearg Road	*History of surface water flooding due to extensive volume hillside runoff overwhelming existing surface water drainage infrastructure. Low confidence in model data*	*Reduce surface water flood risk*	*High*	*£13,870 (SPAADE data) + Assumed £30,000 for road resurfacing works £43,870*	-	*10*	-	*Approximately 100m Tigh Dearg Road resurfacing*	*2022-2028*
KIL_HS03: School Road	*History of surface water flooding caused by blocked culverts north of housing a single property. Low confidence in model data.*	*Improve understanding of surface water flood risk*	*Low*	£1,387 *(SPAADE data)*	-	*1*	-		*2022-2028*
KIL_HS01: Argyll Road East and B833	*History of surface water flooding due to hillside runoff and overtopping of roadside drainage. Low confidence in model data*	*Accept risk and maintain existing actions*	*On-going*	*£0 (SPAADE data)*	-	-	-	-	*2022-2028*

Appendices

A SWMP Flood Risk Priorities



LEGEND

- High Priority - KIL_HS02
- Medium Priority - KIL_HS03
- On-going - KIL_HS01

JBA consulting

KILCREGGAN SURFACE WATER FLOOD RISK PRIORITIES

2018s0549_KIL_D03

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D Appraisal of Options to Mitigate Flood Risk

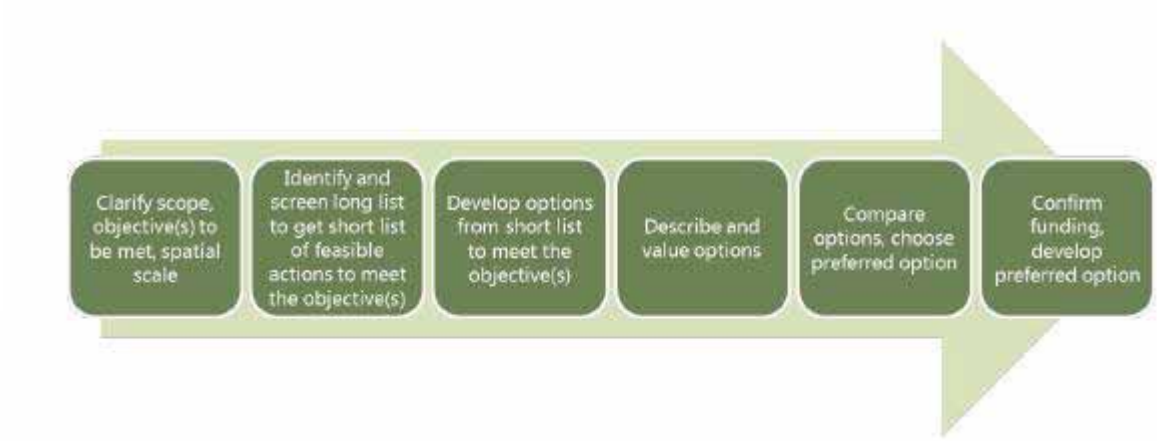
Appendix D – Phase 4 Options Appraisal

Contents

1 Introduction

The options appraisal stage of the SWMP is key to ensure the most sustainable and feasible actions are identified and implemented as required by the FRM Act. The SWMP guidance shows that the most sustainable options for managing surface water flood risk will be identified using the process in the figure below focusing on the assessment of costs, flood risk mitigation benefits as well as other associated benefits.

Figure 1-1: Options appraisal process[1]



The options selected will be compiled of one or more actions designed to mitigate surface water flood risk. Actions can be both structural or non-structural, a full list of potential actions can be found in Section 3.1. The guidance documents listed below have been followed in order to generate and appraise options:

- The Green Book: Appraisal and Evaluation in Central Government (HM Treasury, 2014);
- Public Finance Manual (Scottish Government, 2011);
- Sustainable Flood Risk Management – Principles of appraisal: a policy statement (Scottish Government, 2011);
- Surface Water Management Planning Guidance (SEPA, Scottish Water, Scottish Government, 2017);
- Flood Protection Appraisals: Guidance for SEPA and Responsible Authorities;
- Delivering Sustainable Flood Risk Management (Scottish Government, 2011);
- Flood Protection Schemes – Guidance for Local Authorities Chapter 5 Project Appraisal (Scottish Government, 2012);
- Cost Benefit Analysis of Options to Manage Surface Water Flooding; Guidance to replace chapter 6 of Surface Water Management Planning Guidance (SEPA & SAIFF, December 2014)
- Appraisal Method for Flood Risk Management Strategies (SEPA, 2013).

[1] SWMP Guidance, SAIFF, 2017

2 Scoping the Appraisal

2.1 Clarify the Objectives

Before undertaking the long list of potential actions, it is necessary to conduct a high level assessment for all the objectives identified in Phase 3 - Setting Initial Objectives. Due to the small size of this SWMP only 3 hotspots have been identified. To enable focussed effort on surface water flood risk management within the SWMP cycle, the identified hotspots have been prioritised. The highest-ranking hotspots have been assessed further to identify options for implementation. The hotspots not being taken through to the next stage will be reassessed in the next SWMP cycle. This initial appraisal has been conducted to remove hotspots which are either:

- Predominantly fluvial flood events from which secondary surface water flooding is a minor factor and would not have occurred without the fluvial event. A fluvial study may be required for these areas which is out with the scope of the SWMP.
- Have existing flood protection/mitigation measures where maintaining the asset provides a suitable level of protection.

The hotspots which are not being taken through to the next stage are identified in the table below. Possible options have been identified to aid the development of the next SWMP.

Table 2-1: Deferred objectives

Hotspot name and location	History of flooding Confidence in data	Initial Objective	Initial Priority	Include in options appraisal
KIL_HS01: Argyll Road East and B833	*History of surface water flooding due to hillside runoff and overtopping of roadside drainage.* *Low confidence in model data*	*Accept risk and maintain existing actions*	*Low*	Not at this time – The are no known damages as a result of this flooding.

3 Identifying and Screening Long List of Actions

3.1 Identify the Long List

A long list of potential actions has been developed against each of the verified flooding hotspots. Following the SWMP guidance, broad categories of actions were identified including structural and non-structural options. A total of 25 actions have been considered against each hotspot. The available actions are listed in the table below. The long list actions are designed to identify and screen potential options and are not developed in detail.

The long list of actions has been assessed with the following points in mind:

Meeting the objectives – All actions that are structural or non-structural that could at least partially complete the objectives regardless of the implementation scale i.e. property, neighbourhood or strategic level, shall be considered. Actions with varying implementation timelines should be considered including those which are aspirational. Consider whether there are opportunities to help meet objectives for reducing fluvial flood risk and improving river quality.

Sustainable actions – should be promoted where possible considering the impact of actions on surface water flood risk now and in the future. Actions which deliver multiple sustainable goals such as increasing community amenities, improving biodiversity and reducing the costs associated with waste water treatment should be actively encouraged.

Stakeholder engagement – actions are identified that would be undertaken by the full range of stakeholders, judgement should not be influenced by responsibilities, funding concerns or delivery method.

Table 3-1: Long List of Potential Actions

	Action
Non-structural actions	Adhere to existing planning policy
	Implement more stringent land use policies
	Clarify new Surface Water infrastructure responsibility
	Clarify existing Surface Water infrastructure responsibility
	Emergency response plans
	Improve understanding of flood mechanisms
	Options appraisal and design
	Improve information on Surface Water flooding
	Business continuity planning
	Community action group
	Flood insurance
	Raise awareness
	Property Level Protection (PLP)
	Property Level Resilience
	Flood forecasting and warning
	Asset management and maintenance
	Watercourse management and maintenance
	Relocation
Structural actions	Infiltration/evapotranspiration
	Conveyance
	Storage
	Restoring urban watercourses
	Urban watercourse engineering
	Run-off reduction strategy
	Reducing surface water in the sewer
	Land management
	Underground storage
	Underground conveyance
	Modification of culverted watercourses

3.2 Screening the Long List to determine the Short List

It is necessary to screen the long list of actions to remove any actions which are clearly unfeasible leaving a smaller number to be taken through to the next step of the appraisal process. Here sustainability is a key issue with unsustainable actions disregarded.

During this process actions are screened against 3 main criteria – technical, legal and economic.

Technical – is it technically achievable?

Removing actions which are not technically feasible. An example could be that the infiltration action could not be implemented due naturally low permeability ground or perhaps the estimated storage space required cannot physically fit into the available space.

Legal – is it legal and safe to implement?

Removing actions which will require insurmountable legal challenges including health and safety and land purchasing. This will also include how the action legally affects environmental or cultural sites.

Economic – is it economically viable?

Consider costs at a very high level and remove actions which are likely to be disproportionately high compared to the associated benefits.

An initial screening was undertaken using engineering judgement in order to produce a series of options to present at a stakeholder workshop. The screening is subject to change during stakeholder consultation as new information is shared. In the table below the 6 hotspots are assessed using a simple numeric marking scheme. Each action is attributed a score of 1, 2 or 3. A score of 1 represents an action that is to be taken forward into the options appraisal stage. A score of 2 represents an action that only partially addresses pluvial flood risk. A score of 2 could also be used where there is an action that would mitigate flood risk but is subject to substantial constraints that may make the action unattractive and potentially unfeasible. A score of 3 was attributed where actions are clearly unfeasible or unlikely to reduce surface water flood risk.

Table 3-2: Long List Actions Initial Screening

	Action	KIL HS02	KIL HS03
Non-structural actions	Adhere to existing planning policy	2	2
	Implement more stringent land use policies	2	2
	Clarify new Surface Water infrastructure responsibility	3	3
	Clarify existing Surface Water infrastructure responsibility	1	1
	Emergency response plans	2	2
	Improve understanding of flood mechanisms	2	2
	Options appraisal and design	1	2
	Improve information on Surface Water flooding	3	2
	Business continuity planning	3	3
	Community action group	2	2
	Flood insurance	2	2
	Raise awareness	2	2
	Property Level Protection (PLP)	1	1
	Property Level Resilience	2	1
	Flood forecasting and warning	2	2
	Asset management and maintenance	2	1
	Watercourse management and maintenance	3	2
	Relocation	3	3
Structural actions	Infiltration/evapotranspiration	2	3
	Conveyance	1	3
	Storage	3	3
	Restoring urban watercourses	3	2
	Urban watercourse engineering/ direct defences	3	1
	Run-off reduction strategy	2	2
	Reducing surface water in the sewer	1	1
	Land management	1	2
	Underground storage	3	3
	Underground conveyance	1	1
	Modification of culverted watercourses	3	1

3.3 Method of assessing and prioritising options

The assessment process aims to scope measures that will achieve multiple objectives in the context of site constraints and future development. We will complete a Multi-Criteria Assessment (MCA) screening exercise to consider the relative merits of each measure. JBA have experience of reviewing a range of flood mitigation options. It is recognised that it is important to ensure options are compared thoroughly, consistently and carefully reviewing options against the following criteria:

- Technical Feasibility – is it easily implemented?
- Relative Cost – how expensive is it in comparison to other measures?
- Economic Viability – is it expensive to implement?
- Social Impact and Acceptability – how will it impact on residents?
- Environmental – how will it impact the environment?
- Sustainability – is it a sustainable approach?

Detailed cost estimates have not been prepared as the funding and delivery mechanisms are not yet known. Each management option will be scored against each of the criteria set out above using relative indicator, in line with UK guidance:

- **U** - not applicable or unacceptable outcome
- **-2** - severely negative outcome
- **-1** - moderately negative outcome
- **0** - neutral outcome
- **+1** - moderately positive outcome, or
- **+2** - strongly positive outcome

The measures with the lowest overall combined scores from the MCA will be screened out to produce a short list of preferred options. The short-listed mitigation measures provide the starting point for a more detailed economic assessment should the Partners wish to take any of the sites further and implement surface water management measures.

4 Assessing Options

The following section contains information on each of the high priority hotspots selected for options appraisal. Each surface water flood risk hotspot is described before a Multi-Criteria Assessment is undertaken on the viable actions identified in table 3-2 using the procedure described in Section 3.3.

The proposed options listed below were created by JBA Consulting before being reviewed by representatives of Argyll and Bute Council and Scottish Water at a stakeholder workshop on 22nd November 2018.

A series of figures have been produced to accompany the results of the MCA assessment, the figures can be found in Appendix A.

4.1 KIL_HS02: Tigh Dearg Road

Hillside runoff is a substantial issue on the southern slope of Aiden Hill. Argyll Road collects runoff from the field immediately to north as well as the field upslope from Barbour Road. The volume of surface water experienced overwhelms the drainage ditches along Barbour Road causing high velocity low depth flood water to continue down the hillside onto Argyll Road.

The drainage network along Argyll Road was enhanced by ABC in 2011 to improve the capture and conveyance of runoff on the north side of Argyll Road. The channel is constructed from oversized kerbs and concrete is approximately 140m long and drains to a gully at the top of Tigh Dearg Road. This is then connected to a 225mm ∅ Scottish Water combined sewer which flows down Tigh Dearg Road and connects to combined sewer interceptor along Shore Road. Flooding is very frequent at this location with 8 events occurring between 2011-2014. Although the works undertaken by ABC have improved capture of the runoff there has still be multiple flood events in which this has over topped. Damages are significant ranging from substantial interior flooding of multiple properties, damage to boundary walls and also damages to road surfacing. Due to the steep nature of the topography flood waters are shallow but high velocity and have been described as "frightening" by residents.

Several residents have installed DIY flood gates and other defences to deflect flood water. The current flood risk is high as the flooding known to be reoccurring. The flood hazard is also high due to the damages causes and velocity of the flood water. There are no developments planned in this area however future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change.

Using SEPAs Scottish Pluvial Annual Average Damages Estimates (SPAADE) dataset the estimated damages for this hotspot are £17,870.

Figure 4-1: Tigh Dearg Road – Flow paths

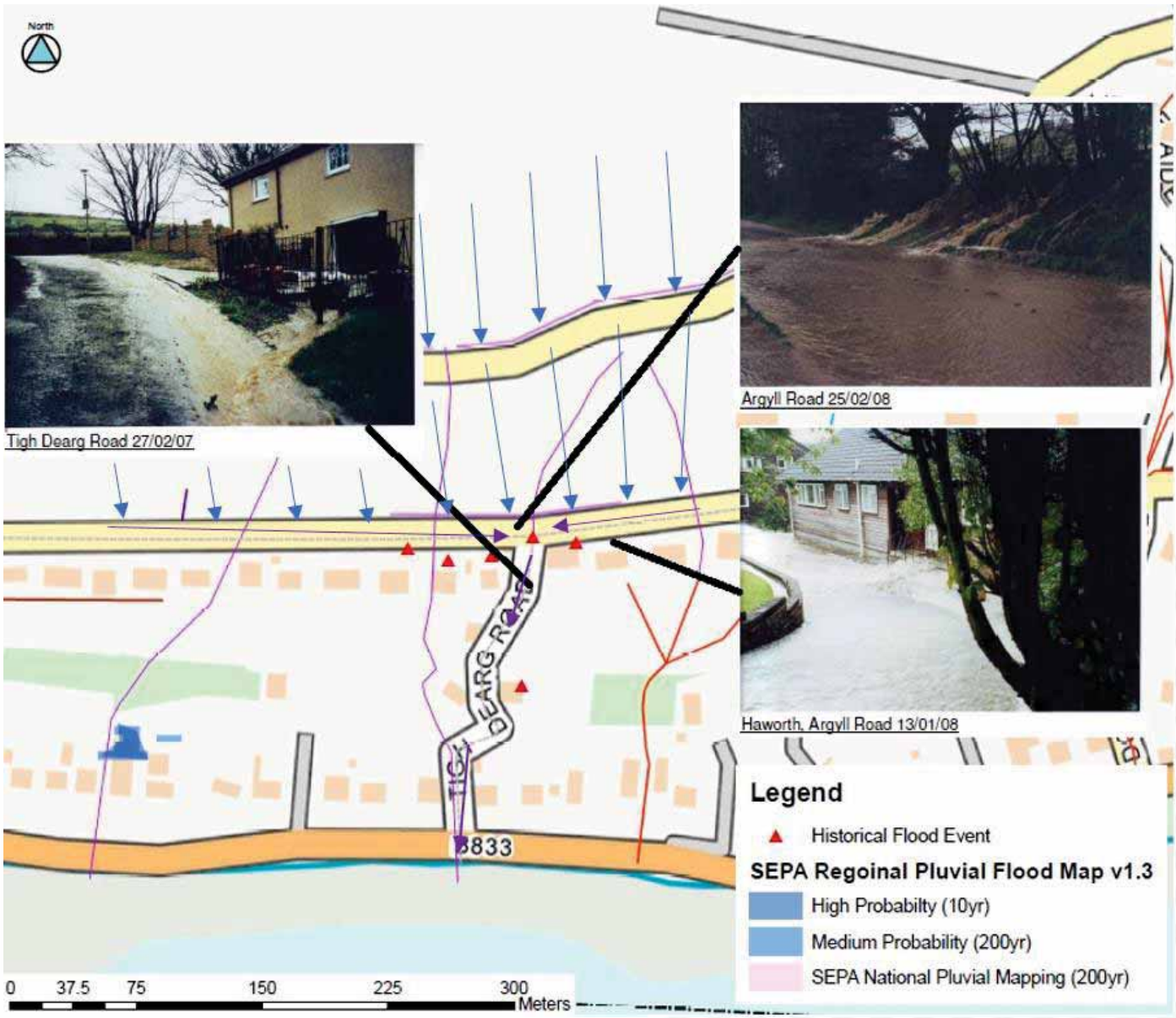


Table 4-1: KIL_HS02 Options Matrix.

Mitigation Measures	Technical	Relative Cost	Economic	Social Impact	Environment	Sustainability	Overall	Shortlist?
Clarify existing Surface Water infrastructure responsibility	+2	+1	+1	0	0	0	4	Yes
Options appraisal and design	+2	+1	+1	0	0	0	4	Yes
Property Level Protection (PLP)	+2	+1	0	+1	0	-1	3	Maybe
Conveyance	-2	-1	+1	+1	+1	0	0	No
Reducing surface water in the sewer	-1	-2	-1	+2	+2	+2	2	Maybe
Land management	+2	0	0	+2	+2	+2	8	Yes
Underground conveyance	+1	-1	-1	+2	-1	-1	-1	No

Table 4-2: KIL_HS02 Options

Objective: Improve understanding of surface water flood risk	
Do minimum	Current situation for comparison, includes maintaining existing drainage, pipes, channels and culverts.
Option 1	**Land management & reducing surface water entering the sewer** Using natural flood management, it is possible to significantly decrease the volume of runoff flowing down Aiden Hill towards Argyll Street. • Woodland creation on the fields between Argyll Street and Barbour Road as well as the slope north of Barbour Road. Woodland creation can increase infiltration rates substantially which would limit the volume of runoff passed onto the existing drainage infrastructure which would reduce flood risk substantially. Studies have shown that infiltration rates could be up to 60 times greater than heavily grazed pasture with 90% of the improvement in soil infiltration occurring within 2 years of stock removal and tree planting[2].
Option 2	**Property level protection** This option would involve a study of the flooding impacts at each of the vulnerable properties identified and designing property level protection/resistance measures to combat flood waters. This option will require the home owner to implement or install devices at the time of flooding which makes it a less effective option.
Option 3	**Clarify existing Surface Water Infrastructure responsibility with options appraisal and design** This option will involve determining who is responsible for the existing pipe in Tigh Dearg Road before for undertaking a more detailed options appraisal. This is required as the high level options appraisal in the SWMP has not been able to identify/differentiate between viable hard engineering options such as the Grontmij proposal without further analysis.

[2] SEPA Natural Flood Management Handbook – December 2015

4.2 KIL_HS03: School Road

An unnamed watercourse flows down the south western slope of Aiden Hill before entering a stone culvert beneath the Meikle Aiden Brae area. The cundy (old stone culvert) is visible on the oldest historic map available (1860) at which point the land was undeveloped. The 375mm ∅ stone cundy opens on to a parcel of ground south of Fairfield Gardens. Another pipe suspected to be road drainage also enters at this point. The watercourse flows open for a few meters before entering 600mm ∅ stone culvert via brick headwall and screen which is susceptible to blockage. The culvert continues to flow downhill in the parcel of land at Glentrae Cottage in which there are 2 raised manholes. At this location the foul sewer is diverted from the road to the parcel of land where there is a third raised manhole which connects the sewer to a former septic tank.

Both the culvert and the foul sewer leave the parcel of land and flow under School Road.

In a manhole west of Eyrie House on School Road there is a baffle system where both the culvert and sewer interact. The original purpose of this was allow the surface water to overtop the baffle during high flows and flush out the foul sewer. Investigations now show that the culvert is "99%" blocked downstream of the baffle forcing the vast majority of the surface water into the foul sewer. This leads to surcharging of the downstream manhole and flows continue down School Road and into the Firth of Clyde. Other manholes in the parcel of land are believed to have over topped in the past causing damage to Glentrae Cottage. Alternatively, the blocked headwall may have diverted flow toward the property. Scottish Water have also reported damage to their pumping station as a result of the sediment load (gravel) that the culverted watercourse is supplying. The current flood risk is high as the flooding is known to be reoccurring. The flood hazard is also high due to the damages caused and the foul material with the floodwater. There are no developments planned in this area however future flood risk is likely to increase as a result of more frequent intense rainfall events associated with climate change.

Using SEPAs Scottish Pluvial Annual Average Damages Estimates (SPAADE) dataset and an assumed AAD of £5,000 to Scottish Water infrastructure, the estimated damages for this hotspot are £6,387.

Figure 4-2: School Road –Flow paths

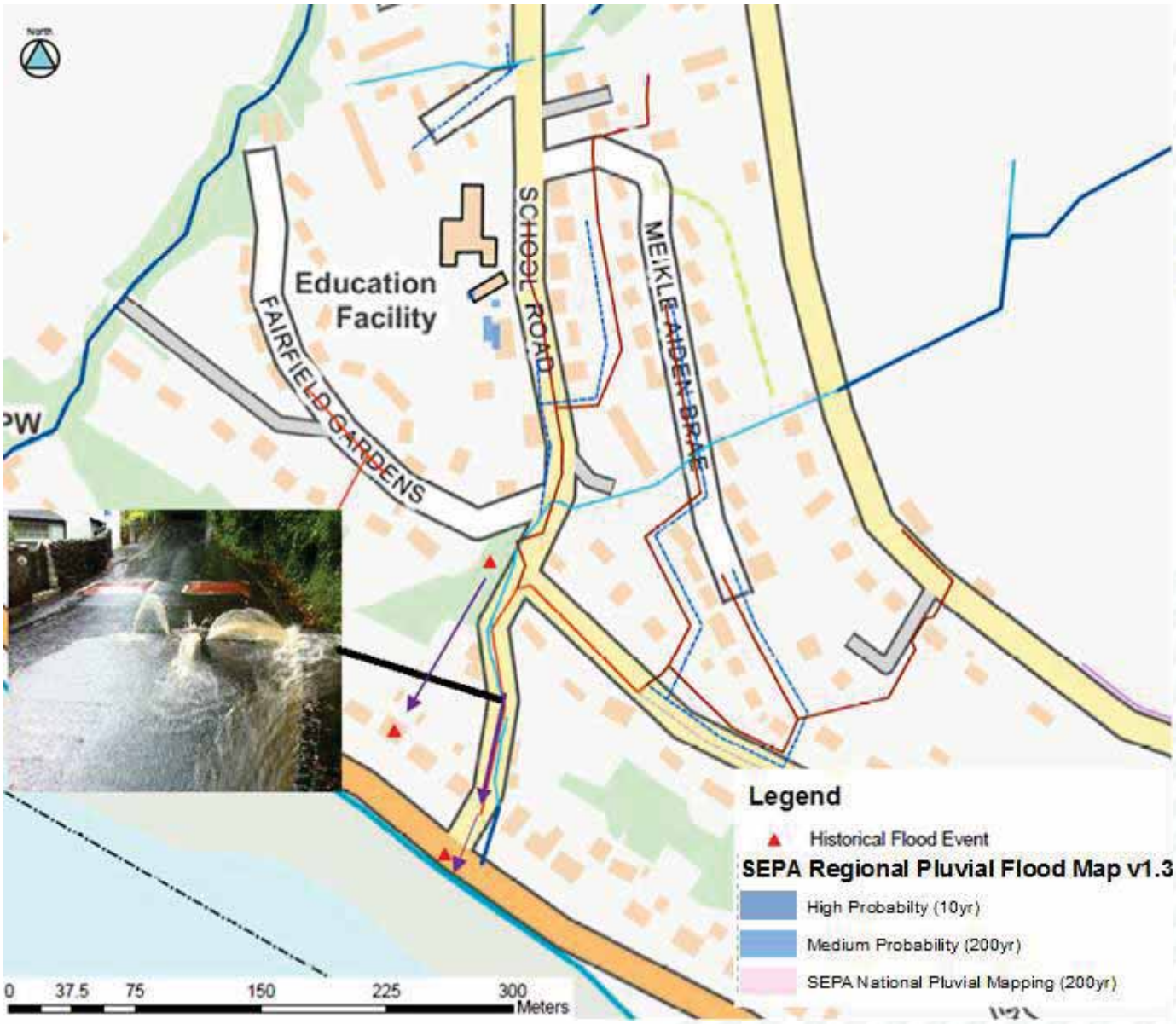


Table 4-3: KIL_HS03 Options Matrix

Mitigation Measures	Technical	Relative Cost	Economic	Social Impact	Environment	Sustainability	Overall	Shortlist?
Clarify existing Surface Water infrastructure layout	+1	+2	+2	0	0	0	5	Yes
Property Level Protection/Resistance (PLP/PLR)	+1	+1	0	+1	0	-1	2	No
Asset management and maintenance	+1	+1	0	+1	+1	+1	5	Yes
Urban watercourse engineering – Improve headwall/Screen	+2	0	+1	0	0	0	3	Maybe
Urban watercourse engineering – Culvert short open section	+2	+1	+1	0	0	+1	5	Yes
Modification of culverted watercourses	-1	-2	-2	0	+2	+2	-1	No

Table 4-4: KIL_HS03 Options

Objective: Improve understanding of surface water flood risk	
Do minimum	Current situation for comparison, includes maintaining existing drainage, headwalls, channels and culverts.
Option 1	**Clarify existing surface water infrastructure layout and Asset management and maintenance.** Under this option as well as separating the networks there is a need to understand the layout and condition of the surface water culverts and particularly at the downstream extent beneath shore road and the outfall to the Firth of Clyde. To achieve this: • Conduct CCTV and/or dye testing downstream of the current "baffled" manhole to the open section in the garden of the property on Shore Road. The pipe beneath Shore Road to the outfall also needs to be investigated. • The survey should include cleaning and jetting of the culverts where required and instruct future maintenance works if damaged areas are identified. • The open section of watercourse should be added to the watercourse inspection regime which will allow it to be cleared and maintained with routine trash screen cleaning implemented.
Option 2	**Option 1 with Urban Watercourse Engineering – Culvert short open section** Once the watercourse and sewer have been separated, the surface water culverts have been surveyed and cleaned out there is an opportunity to reduce the future blockage risk: • Culvert the open section of watercourse (approx. 5-10m) in the wooded area. This could be done relatively cheaply and would remove the blockage issue at the headwall and stop wooded debris entering the pipe and causing blockages. This would also remove the maintenance requirement to clear the headwall/screen of debris. This option has the potential to mitigate flood risk to the Glentrae property by containing watercourse within a culvert and also reduces maintenance burden saving time and money in the long term.

5 Stakeholder Workshop

A stakeholder workshop was held at Argyll and Bute Council's office in Helensburgh on Thursday 22nd November 2018. JBA presented the findings of the SWMP to representatives of Argyll and Bute Council and Scottish Water.

The presentation started with a recap of how the SWMP had progressed and the techniques/methods used in each of the preceding reports. JBA then presented each of the hotspots explaining the flooding mechanisms as well as the current and future flood risk. JBA discussed how the short list of actions had been derived and how these subsequently formed options.

Following open discussions, the following consensuses was agreed for the 2 remaining priority hotspots. Graphical representations of the preferred options can be found in Appendix A.

5.1 KIL_HS02: Tigh Dearg Road

5.1.1 Preferred Option: Option 3 – Clarify existing Surface Water Infrastructure responsibility with options appraisal and design

During the stakeholder consultation each of the potential options were discussed along with outputs of the Grontmij report undertaken in 2010 which also proposed mitigation options. As part of the discussions, the ownership of the 225mm diameter pipe was discussed and it was confirmed as a Scottish Water asset however, it is not clear whether the pipe conveys surface or combine flows.

Each of the options were discussed in detail however, with the information available it was agreed that it was not possible to choose a preferred mitigation measure at this time. Options appraisal was selected to allow all of the feasible options to be investigated in more detail, this will include a feasibility statement as well as a cost benefit analysis. With this additional information a preferred option can be selected and taken forward for implementation.

5.2 KIL_HS03: School Road

5.2.1 Preferred Option: Change objective to accept risk and maintain existing assets

Given the work already undertaken by Scottish Water to separate the surface water and sewer networks the flood risk has been lowered substantially. The remaining flood risk relates to blockages at the inlet screen of the open section of watercourse causing flows to route overland through the garden of a private property. It was agreed at this time the best solution would be to lower the initial priority, continue to maintain the existing assets (including the screen) and monitor events during the SWMP cycle.

Table 5-1: SWMP Action Plan and SMART Objectives

Hotspot	Preferred Option	Final Objective	Final Priority	Responsibility	Potential Funding Route	Target Implementation Date	Target Standard of protection	Number of homes and businesses better protected
KIL_HS02: Tigh Dearg Road	*Improve understanding of flooding mechanism*	*Improve understanding of surface water flood risk*	*High*	*Argyll and Bute Council*	*LA capital via FRM strategies*	*2022-2028*	*1 in 200 year*	*34*
KIL_HS03: School Road	*Asset management and maintenance*	*Accept risk and maintain existing assets*	*On-going*	*Argyll and Bute Council*	*LA revenue*	-	-	-

Appendix A

North

Education Facility

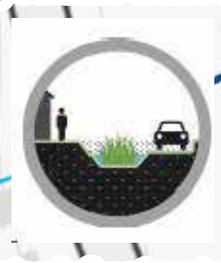
FAIRFIELD GARDENS

SCHOOL ROAD

MEIKLE AIDEN BRAE

B833

Reducing surface water in the sewer



Clarify existing surface water infrastructure layout/responsibilities and Asset management and maintenance.

Urban Watercourse Engineering
Culvert short open section

0 37.5 75 150 225 300 Meters

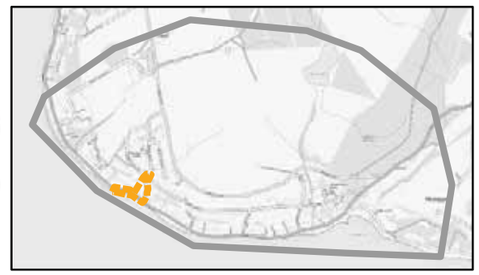
LEGEND

- # Historical Flood Event
- ^ Residential Properties at Risk
- ! Utilities at Risk
- KIL_HS03
- Protected Open Space
- AFA2001 Environmental Enhancement
- Scottish Water - Highway Drainage
- Scottish Water - Foul
- Scottish Water - Natural Water
- Scottish Water - Surface Water
- Scottish Water - Combined
- Scottish Water - Proposed
- ABC - Cundy
- ABC - Drainage Channel
- ABC - Pipe

SEPA Regoinal Pluvial Flood Map v1.3

- High Probabilty (10yr)
- Medium Probability (200yr)
- SEPA National Pluvial Mapping (200yr)

SWMP HOTSPOT LOCATION



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Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

KIL_HS03 - OPTION 3

SCHOOL ROAD

North

Education Facility

FAIRFIELD GARDENS

SCHOOL ROAD

MEIKLE AIDEN BRAE

B833

Reducing surface water in the sewer

Clarify existing surface water infrastructure layout/responsibilities and Asset management and maintenance.

0 37.5 75 150 225 300 Meters

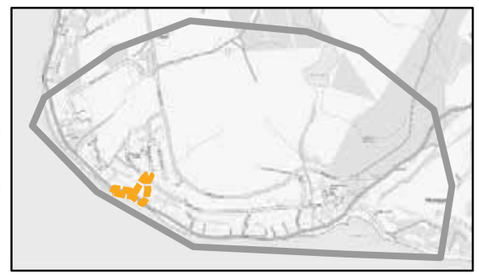
LEGEND

- # Historical Flood Event
- ^ Residential Properties at Risk
- ! Utilities at Risk
- KIL_HS03
- Protected Open Space
- AFA2001 Environmental Enhancement
- Scottish Water - Highway Drainage
- Scottish Water - Foul
- Scottish Water - Natural Water
- Scottish Water - Surface Water
- Scottish Water - Combined
- Scottish Water - Proposed
- ABC - Cundy
- ABC - Drainage Channel
- ABC - Pipe

SEPA Regoinal Pluvial Flood Map v1.3

- High Probabilty (10yr)
- Medium Probability (200yr)
- SEPA National Pluvial Mapping (200yr)

SWMP HOTSPOT LOCATION



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Scottish Water
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KIL_HS03 - OPTION 2

SCHOOL ROAD

North

Education Facility

FAIRFIELD GARDENS

SCHOOL ROAD

MEIKLE AIDEN BRAE

B833

Reducing surface water in the sewer

0 37.5 75 150 225 300 Meters

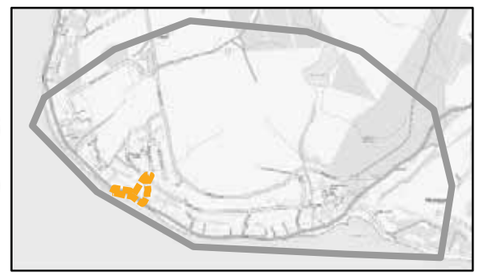
LEGEND

- Historical Flood Event
- Residential Properties at Risk
- Utilities at Risk
- KIL_HS03
- Protected Open Space
- AFA2001 Environmental Enhancement
- Scottish Water - Highway Drainage
- Scottish Water - Foul
- Scottish Water - Natural Water
- Scottish Water - Surface Water
- Scottish Water - Combined
- Scottish Water - Proposed
- ABC - Cundy
- ABC - Drainage Channel
- ABC - Pipe

SEPA Regoinal Pluvial Flood Map v1.3

- High Probabilty (10yr)
- Medium Probability (200yr)
- SEPA National Pluvial Mapping (200yr)

SWMP HOTSPOT LOCATION



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SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

JBA consulting

KIL_HS03 - OPTION 1

SCHOOL ROAD

North

Clarify existing surface water infrastructure

Options apprasial and design

BARBOUR ROAD

ARGYLL

TIGH DEARG ROAD

LITTLE AIDEN ROAD

DONALDSON'S BRAE

3833

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0 50 100 200 300 400 Meters

LEGEND

- Historical Flood Event
- Residential Properties at Risk
- KIL_HS02
- Protected Open Space
- AFA2001 Environmental Enhancement
- Scottish Water - Highway Drainage
- Scottish Water - Foul
- Scottish Water - Natural Water
- Scottish Water - Surface Water
- Scottish Water - Combined
- Scottish Water - Proposed
- ABC - Cundy
- ABC - Drainage Channel
- ABC - Pipe

SEPA Regoinal Pluvial Flood Map v1.3

- High Probabilty (10yr)
- Medium Probability (200yr)
- SEPA National Pluvial Mapping (200yr)

SWMP HOTSPOT LOCATION

JBA consulting

KIL_HS02 - OPTION 3

TIGH DEARG ROAD

North

Property level protection

BARBOUR ROAD

ARGYLL

TIGH DEARG ROAD

LITTLE AIDEN ROAD

DONALDSON'S BRAE

3833

0 50 100 200 300 400 Meters

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LEGEND

- Historical Flood Event
- Residential Properties at Risk
- KIL_HS02
- Protected Open Space
- AFA2001 Environmental Enhancement
- Scottish Water - Highway Drainage
- Scottish Water - Foul
- Scottish Water - Natural Water
- Scottish Water - Surface Water
- Scottish Water - Combined
- Scottish Water - Proposed
- ABC - Cundy
- ABC - Drainage Channel
- ABC - Pipe

SEPA Regoinal Pluvial Flood Map v1.3

- High Probabilty (10yr)
- Medium Probability (200yr)
- SEPA National Pluvial Mapping (200yr)

SWMP HOTSPOT LOCATION

JBA consulting

KIL_HS02 - OPTION 2

TIGH DEARG ROAD

North

Land management

Reduce surface water entering the sewer

MEIKLE TARDEN DRIVE

BARBOUR ROAD

ARGYLL ROAD

TIGH DEARG ROAD

LITTLE AIDEN ROAD

DONALDSON'S BRAE

B833

0 55 110 220 330 440 Meters

LEGEND

- Historical Flood Event
- Residential Properties at Risk
- Potential Woodland
- KIL_HS02
- Protected Open Space
- AFA2001 Environmental Enhancement
- Scottish Water - Highway Drainage
- Scottish Water - Foul
- Scottish Water - Natural Water
- Scottish Water - Surface Water
- Scottish Water - Combined
- Scottish Water - Proposed
- ABC - Cundy
- ABC - Drainage Channel
- ABC - Pipe

SEPA Regoinal Pluvial Flood Map v1.3

- High Probabilty (10yr)
- Medium Probability (200yr)
- SEPA National Pluvial Mapping (200yr)

SWMP HOTSPOT LOCATION

JBA consulting

KIL_HS02 - OPTION 1

TIGH DEARG ROAD

Offices at

Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

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