CAPITA

Ramsgate SWMP Modelling Methodology

Purpose

The purpose of this study is to develop a detailed understanding of the existing and future surface water flood risk within Ramsgate based on the creation of an integrated urban drainage (IUD) model that represents the combined drainage system, roads, ground surface and other local water infrastructure that affects the drainage of the town.

Identifying the pluvial flood risk will assist Kent County Council (KCC) and partners in selecting practical, feasible and cost effective outline solution(s) to manage surface water flood risk. The creation of the IUD model will also assist with the development a robust action plan that identifies additional works and actions to manage the risk identified from the hydraulic modelling of the town. The IUD model has been constructed using InfoWorks Integrated Catchment Model (ICM) software.

The aim of this document is to outline the overall approach to the development of the IUD model. The data collected for the study has been assessed, any data gaps noted and recommendations made for additional data capture.

Data Collection

Existing Hydraulic Model

The following table summarises the existing hydraulic model received for use in this study. The use of this model is discussed later in the report.

Model Name	Description/Purpose	Model Owner
Weatherlees InfoWorks CS Model	1D only model developed by Southern Water. The model purpose was to identify deficiencies within the network, assess flood alleviation schemes and any implications of proposed growth within the catchment. The extent of the model includes Ramsgate, Deal and Sandwich.	Southern Water

The Weatherlees Model extent covers the entire sewer network in the study area, which is primarily a combined system.

Topographic Data

The Environment Agency (EA) has provided 1m resolution LiDAR data for the study, which covers the entire study area. The LiDAR was flown in 2011 and is considered a good representation of the local topography.

Sewer Network Data

Southern Water has provided GIS layers of the sewer network pipes and manholes within Ramsgate. The GIS layers provide limited information on the sewer network. A review of the dataset highlighted missing invert levels for all pipes and manholes. Some parts of the pipe network appear to outfall to pumping stations for which pumping rates and rules have not been provided outside of the model inputs. The gaps in this data are not considered to be problematic as the Weatherlees InfoWorks CS[1] model covers the entire study area, thereby providing a complete record of sewer network data.

Kent Highways has provided a GIS layer of gullies within the study area. The layer provides gully locations only –no information has been provided on invert levels, dimensions or gully type. Therefore these were not explicitly modelled as flow controls into the network.

Defences

The Environment Agency has provided defence data for Kent County, which indicate that there are no defences within study area. However, aerial mapping indicated coastal defences along some stretches of the coastline in the study area. A site visit determined the location of formal defences, which have been incorporated into the model.

Historical Flood Information

GIS layers showing recorded flood incidents in the study area have been provided by Kent Highways and Thanet District Council. Southern Water has provided the DG5 register of sewer flooding incidents for the study area. The majority of recorded flood incidents occurred in or around Ramsgate town centre and the Royal Harbour Marina. This data was used for verification of model outputs.

Model Methodology

A fully integrated urban drainage model has been constructed using ICM version 4.5. This version of ICM was the most up to date at the time the model was built. The following sections of this report discuss the methodology for key aspects of the model.

Model Extent

Sewer network

The Weatherlees InfoWorks CS model has been utilised to represent the drainage network in Ramsgate. The CS model has been trimmed to remove the areas of the model that extend to Deal and Sandwich as these are outside of the areas of interest.

Gullies have been represented in the model based on the information provided by Kent Highways. Gullies in Ramsgate were found to be fairly evenly distributed across the drainage network, with an average of four gullies per manhole. Manholes were modelled as type 2D to represent the exchange of water between the floodplain and the drainage network.

A different modelling approach was used for lower and higher flood events. The combined modelling approach is outlined below:

- For events with return period smaller than or equal to 40 years, rainfall was applied onto the drainage system sub-catchments (as provided with the Southern Water model) and entering directly into the pipe network for the urban areas . The rainfall was applied onto the 2D surface outside the sub-catchments.
- For events with return period greater than 40 years rainfall applied to the entire 2D domain (runoff enters pipe network via 2D manhole connections). To avoid double

[1] A few manholes and pipes were located above ground level. These were adjusted to coincide with the ground level in the model.

counting of the rainfall, the contributing areas of the 1D sub-catchments within the 2D domain were set to zero.

The reasons for choosing this combined approach were as follows:

- The usual design standard for the sewer network is approximately 1 in 30yr. Therefore it is reasonable to assume that the surface runoff from rainfall events with up to 1 in 40yr return period will be able to enter the pipe network. In this case the method of applying rainfall to the sub-catchments and to the 2D zone outside of sub-catchments should give most realistic representation of flooding in the urban areas for events of this magnitude
- However this method will under-predict the sewer flooding for events with return periods of 100yr or more. These events exceed sewer design standards, and it is unlikely that the surface runoff will be able to fully enter the pipe network due to inlet restrictions and surcharging. Therefore for the events with higher return period the rain was applied onto the 2D mesh everywhere and eliminate the subcatchments (by turning their contributing areas to zero). Nevertheless, it must be noted that since individual gully pots (and other sewer entries) are not explicitly represented in the model, this method may under-estimate the flow into the sewer network, which can only happen at manholes, and consequently may over-estimate the surface flooding.

Adoption of the above combined approach gives reasonable extents for more frequent events and a conservative estimate of the less frequent events.

2D Extent

The 2D model extent has been digitised based on the provided LiDAR data, and ensures all rainfall runoff entering the area of interest is captured. The extent is bounded by the English Channel to the south and south east. To the west, the model extent follows a ridge line to the north-north-east, starting at the coastline just below Chalk Hill and roughly following Haine Road as far as Manston Court Road. The extent then continues along a ridge to the south-east down to the coast at King George VI Memorial Park. The study area is largely urban with a few surrounding rural areas. The total area of the catchment to be modelled is approximately $12km^2$. Figure 1 below shows the extent of the drainage network and 2D Zone.

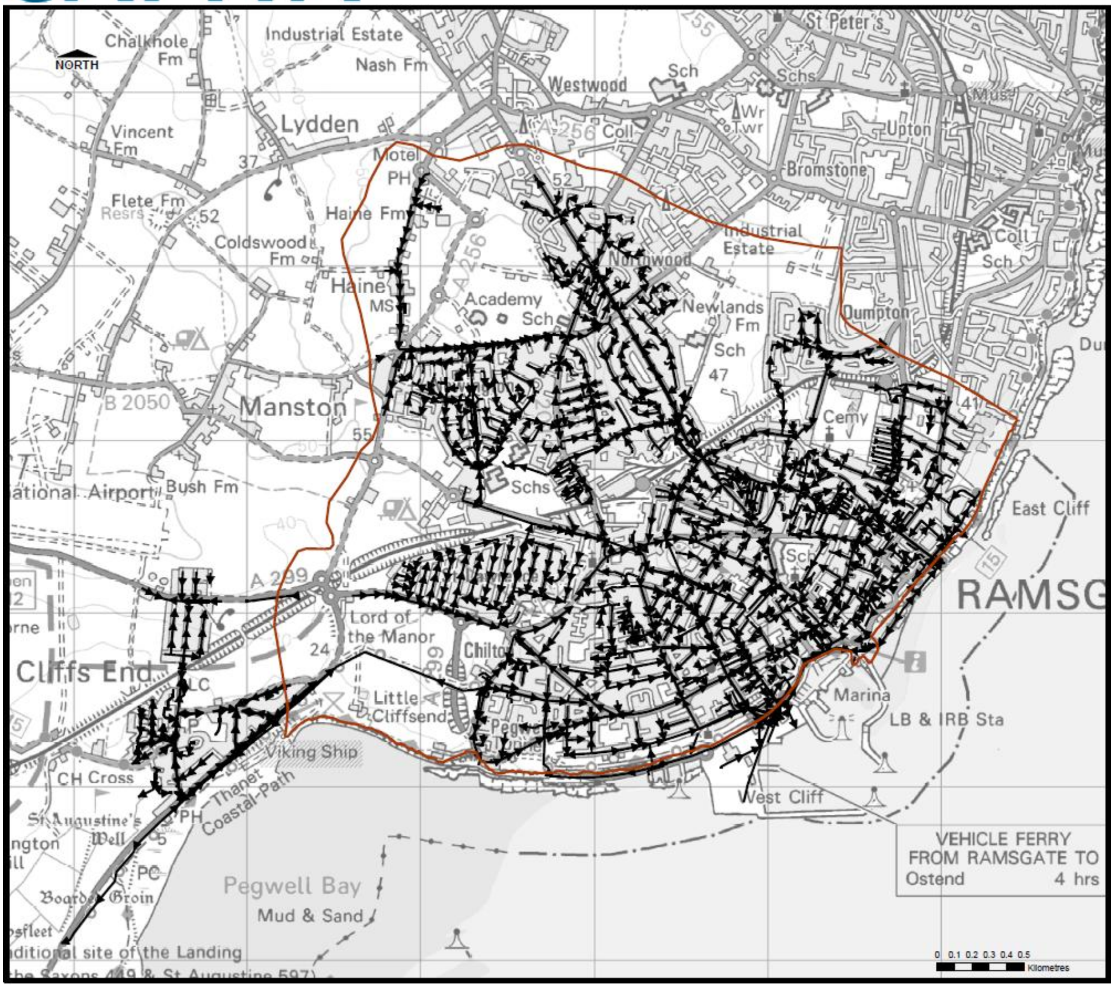

Figure 1: Model Extent

Model Boundaries

The combined drainage network within Ramsgate flows in a southward direction to the Military Road Terminal Pumping station, before being pumped to Weatherlees Hill Wastewater Treatment Works. The pump rates in the existing CS model have been applied to the ICM model.

Two Combined Sewer Overflows (CSOs) have been represented at Military Road Terminal Pumping station which discharges into the Royal Harbour. Tide locking of the CSOs has not been considered in the existing model. As part of this study, the Mean High Water Spring (MHWS) tidal level has been obtained and applied as a downstream boundary to the CSO to assess the tidal impact on predicted flood extents.

Critical duration

The hydraulic model was simulated for a range of storm durations to determine the critical duration for the site. The durations tested were 1 hour, 3 hours and 6 hours. The maximum flood depth and extent of surface water flooding for the three durations were compared and it was found that the 3 hour duration produced the largest flood extent and maximum flood depth for the area of interest, therefore providing the most conservative results. As such, storm duration of 3 hours was selected for this study.

Model Hydrology

The InfoWorks ICM model was run for the following rainfall events:

- 1 in 20 year;

- 1 in 40 year;
- 1 in 100 year; and
- 1 in 200 year.

Rainfall hyetographs have been extracted for the 1 hour, 3 hour and 6 hour durations. The maximum values for depths and hazard where predicted for the 3 hours storm duration and will be used to create the maximum flood extent and hazard to the town of Ramsgate.

Roughness

Roughness values in the floodplain have been defined based on landuse demarcated within the OS MasterMap data provided by the Environment Agency. These were inserted to the model as roughness zones. Each roughness zone has been used to identify land use and assigned a roughness value. Generally, the MasterMap data represented accurately the current landuses.

Table 0 below shows the Manning's n roughness values applied to each land use within the floodplain.

Table 0: Manning's Roughness

Feature Code	Descriptive Group	Comment	Manning's Roughness
10021	Building		0.500
10056	General Surface	Grass, parkland	0.020
10111	Natural Environment (Coniferous/Non-coniferous Trees)	Heavy woodland and forest	0.100
10167	Rail	Manmade	0.050
10172	Roads Tracks And Paths	Tarmac	0.020
10183	Roads Tracks And Paths (Roadside)	Pavement	0.020
10185	Structure	Roadside structure	0.030
10187	Structure	Communications	0.500
10089	Water		0.035

The Weatherlees CS model assumes Colebrook-White roughness coefficients of 1.5mm for the bottom third of the conduit and 0.6mm for the top two-thirds of the conduit for the majority of the modelled pipe network. This value is equivalent to culverts constructed of rough concrete, with visible marks. These roughness values have been deemed appropriate and have been retained for this study.

Infiltration

The infiltration zones functionality within ICM has been used to account for soil infiltration within permeable land uses. MasterMap data provided for this study has been used to define different land use within the study area and runoff coefficients assigned to each landuse.

Constant infiltration of 20 mm/hr was applied to areas that are covered by trees and to all natural surfaces in general. The same infiltration value was also applied to residential yards. Zero infiltration was applied to impermeable surfaces (such as buildings and general manmade surfaces) or watercourses.

Dry Weather and Trade Flows

Both Dry Weather Flows (DWFs) and trade flows were applied to the existing Weatherlees CS Model. As part of this study, the availability of updates to the data sources will be sought from Southern Water and incorporated into the model.

2D Mesh

The ground model used to represent the floodplain was derived from the provided LiDAR DTM data set. Breaklines have been digitised along roads to ensure that the created mesh captures the key flow paths through the predominately urban study area. The minimum and maximum element sizes have been chosen to ensure a good balance between level of detail and model simulation time. The maximum triangle area is $100m^2$ and the minimum element area is $25m^2$.

Representation of Building Footprints

Buildings have been represented by raised building stubs to encourage surface water runoff at low depths around the buildings and onto the roads. In the absence of survey data, a stub height of 150mm has been assumed, which has been based on buildings regulations requirements for thresholds to be above local ground levels as well as observation on site.

Model Simulation

Simulation Time

All design events for the Ramsgate model were simulated for 6 hours. The simulation time was established by trial and error method as follows: The model results for the final few time steps were checked to determine if water depths in the floodplain were still increasing significantly, and whether new flow paths were forming or existing flow paths still propagating. If either of these conditions were found to exist, the simulation time was extended for a further hour after which the checks were repeated until none of the conditions were satisfied. The 6 hour duration was found to be suitable for the model using this assessment method.

Time step

The model was simulated with a 10 second time step in the 2D domain for lower return periods and 5 second time step in the 2D domain for higher return periods. The chosen time steps were deemed suitable for the model grid size and were shown to produce stable model results.