CAMDEN COUNCIL PUBLIC EXHIBITION DOCUMENT 2022

REVIEW OF UPPER SOUTH CREEK FLOOD STUDY IN THE CONTEXT OF ONGOING DEVELOPMENT: APPENDIX F – REGIONAL FLOOD MODEL FRAMEWORK

(Draft Report)

Memorandum

TO: Camden Council
FROM: WMAwater
DATE: 30 October 2020
SUBJECT: Upper South Creek Regional Model Framework
PROJECT NUMBER: 118112

1. INTRODUCTION

The Upper South Creek Regional Model User Guide accompanies the handover of Camden Council's Upper South Creek flood model to consultants that propose to develop within the catchment. It outlines the approach to the modelling and makes recommendations on methods to apply when completing flood impact assessments for proposed development. This document has been reviewed and updated based on feedback from Council and other consultants based on feedback received during two stakeholder workshops.

2. BASE CASE AND PROPOSED CONDITIONS

This document refers to scenarios as follows:

- The "Base case" is catchment conditions as at November 2018.
- The "Revised base case" may include revisions to reflect detailed survey or approved development in the vicinity of the site (see Section 5.1 for more discussion).
- The "Proposed case" includes the proposed changes from the development to be assessed.

3. XP-RAFTS METHODOLOGY

3.1. Overview

An XP-RAFTS hydrologic model has been developed for the Upper South Creek Catchment. The model consists of fine resolution subcatchments in the urban areas, with larger broad-scale subcatchments in the rural areas. This model is used to derive inflows into the TUFLOW model.

3.2. Subcatchment Delineation

Subcatchments have been delineated to provide inflows upstream of modelled pipes (such as culvert crossings) and key hydraulic structures (such as dams). There are currently 1,474 subcatchments in the model. Since any model over 1,000 nodes requires a higher licence level, the model has been split into 3 separate models covering Lowes Creek and Thompsons Creek (West Model), South Creek (Mid Model) and Bonds Creek, Scalabrini Creek, Kemps Creek and Rileys Creek (East Model). If the model is to be used to assess flood impacts of a precinct-scale development, then the subcatchment delineation may need to be revised based on the proposed landform. Subcatchments to proposed structures (such as culvert crossings and detention basins) may then need to be delineated.

Updated subcatchment boundaries (either for base case conditions or proposed conditions) should be delineated using GIS or CAD software, and are to be mapped in the impact assessment report. The number and size of subcatchments between the base case and proposed case for an impact assessment should be reasonably consistent.

3.3. Model Parameters

The primary subcatchment parameters used in XP-RAFTS include:

- Area,
- Slope,
- Impervious fraction,
- Surface roughness.

These parameters should be updated for the new subcatchments that have been delineated. Each of these is outlined in the following sections. A '*Bx*' value of 1 should be used for the entire model. Lag links have been used throughout the model. These have been assigned based on the length of the flow path through the catchment and an estimated stream velocity of 1 m/s. Since local catchment inflows are used in the TUFLOW model, these lag links are not required in order to obtain flows for use in the TUFLOW model.

The XP-RAFTS model may be used for preliminary options assessment for design of flow detention structures, but for the impact assessment report all hydraulic routing should be undertaken in the TUFLOW model.

3.3.1. Area

The catchment area should be calculated in hectares using a GIS program.

3.3.2. Slope

The slope parameter was calculated using CatchmentSIM software. If this program is not used, the catchment slope should be calculated by considering the average catchment slope for flow paths within the catchment. The slope should be calculated using the 'equal area' method.

3.3.3. Impervious Fraction

Australian Rainfall and Runoff 2019 (ARR 2019, Reference 1). ARR 2019 identifies three types of areas for the purpose of estimating urban storm losses:

- Directly Connected Impervious Areas (DCIA) which are impervious areas directly connected to the drainage system;
- Pervious Areas consisting of parks and bushland areas; and
- Indirectly Connected Impervious Areas (ICIA) which consist of impervious areas which are not directly connected to the drainage system and the pervious areas which interact with indirectly connected impervious areas.

These areas are shown visually in Diagram **1**.

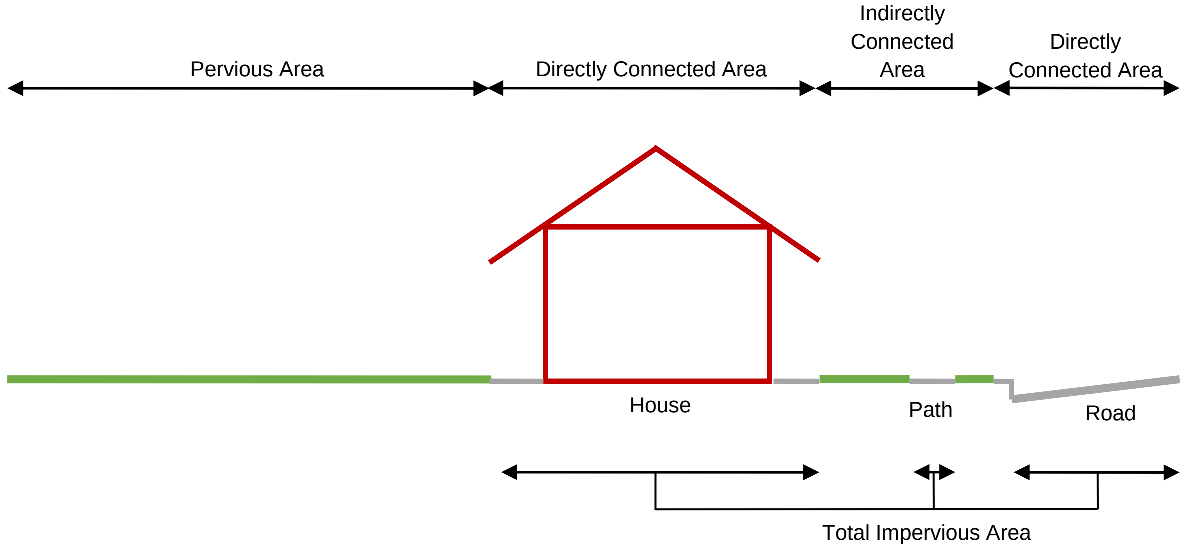

Diagram 1: Delineation of Urban Impervious Areas

The Total Impervious Area (TIA) is the sum of the DCIA and ICIA.

While it is usually easy to apply reasonable rainfall losses and routing to the directly connected impervious areas, the inclusion of the indirectly connected areas is not straightforward. This is because some of the indirectly connected area is pervious and some is impervious. This is further complicated by the fact that the impervious areas can flow through pervious areas and experience some loss into the soil before reaching the drainage system. The fact that this infiltration occurs at a different location from the location where the rain falls is not compatible with an initial loss/continuing loss framework that removes the losses from the rainfall before it is applied to the model.

To account for this, ARR 2019 recommends the use of ‘Effective Impervious Area’ (EIA), which is a concept identifying the amount of impervious area that acts as directly connected for total runoff purposes, including consideration of both the DCIA and ICIA.

A detailed GIS analysis was undertaken for a typical residential street block from Oran Park and it was found that the TIA was approximately 80%. Using the literature from Australian studies in ARR 2019, the ratio of EIA/TIA is typically in the range from 60% to 80%. WMAwater’s assessment is that in light of the relatively large proportion of roof area to block area (with roof area being directly connected) for the typical Oran Park development, the degree of directly connected surfaces is most likely quite high. An EIA/TIA fraction of 75% is considered to be reasonable for new development in this area. This results in an EIA fraction of 60% of the total urbanised residential area as follows:

$$TIA = 0.8$$
$$EIA = 0.75 * TIA = 0.6$$

Commercial and industrial areas will have slightly higher recommendations based on similar reasoning. XP-RAFTS adopts a typical split catchment approach, with one subarea representing the pervious fraction, and the other representing the impervious fraction (or EIA in this case). The implementation of this methodology in the Upper South Creek XP-RAFTS models is outlined visually in Diagram **2**.

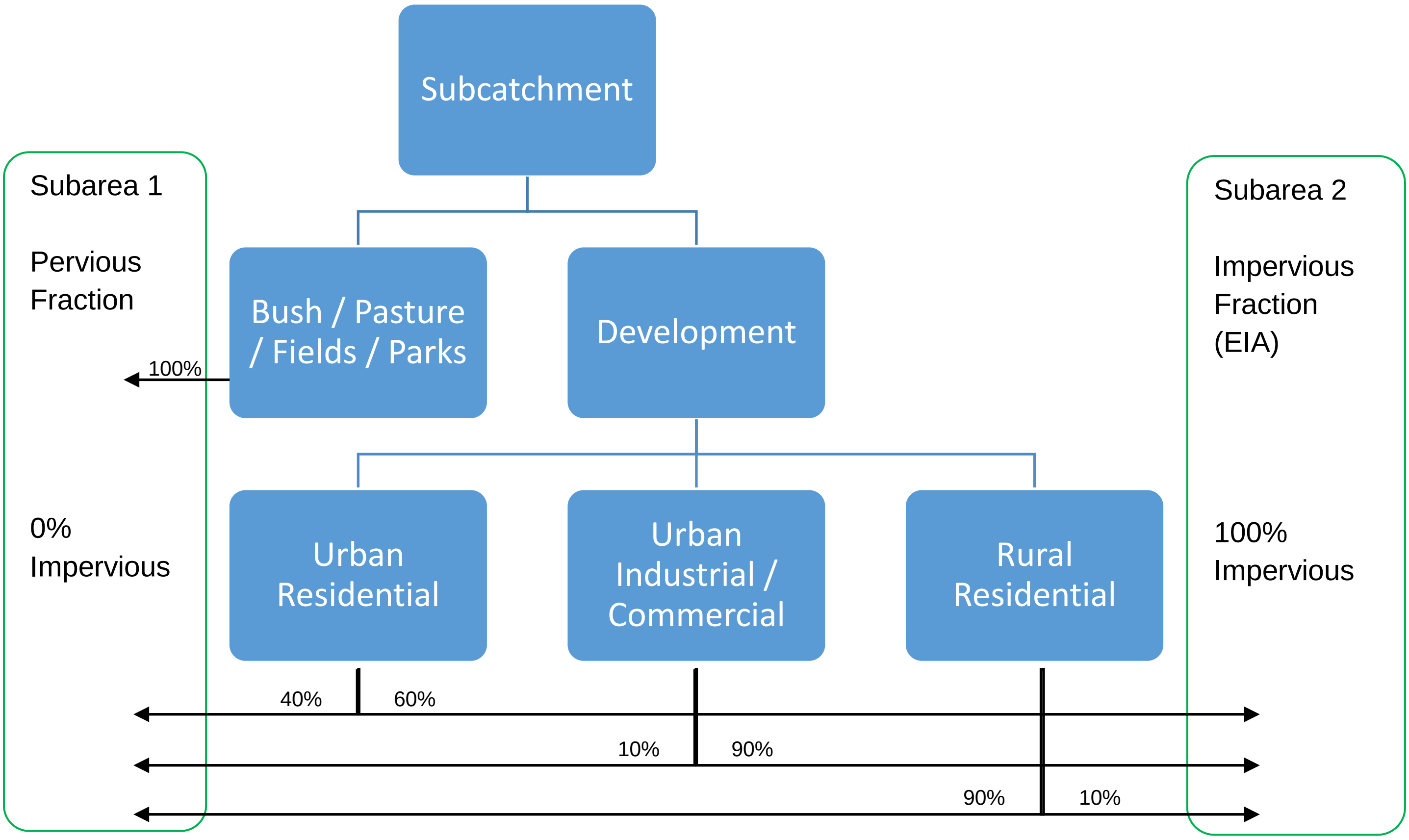

Diagram 2: Determining Impervious Fractions of a Subcatchment for the XP-RAFTS Model

3.3.4. Surface Roughness

The surface roughness of the two sub areas outlined above depends on the dominant land use type in each area. The pervious subarea should be assigned a Manning's 'n' of 0.04 if it is primarily rural bushland and grasses, while any developed areas with a pervious component should be assigned 0.025. The impervious component should always be assigned a Manning's 'n' value of 0.015. This is summarised in Table 1. In subcatchments that consist of a mix of land use types, the dominant one should be chosen for selecting the Manning's 'n' value.

Table 1: Manning's 'n' Values for Subareas Depending on Land Use Type

Dominant Subcatchment Land Use	XP-RAFTS Subarea 1 (Pervious) Mannings 'n'	XP-RAFTS Subarea 2 (Impervious) Mannings 'n'
Bush / Pasture / Grass	0.04	0.015
Urban Residential	0.025	0.015
Urban Industrial/ Commercial	0.025	0.015
Rural Residential	0.025	0.015

3.4. Design Storms

The modelled design AEP storms adopt ARR 2019 methodology (Reference 1). The data used to derive these storms is provided with the model. The catchment has been split into 3 IFD zones, corresponding to the 3 models, as outlined in Table 2. The design rainfall depth obtained at the IFD location noted was applied to all subcatchments within the major creek catchment areas listed in Table 2.

Table 2: IFD Zones Adopted in the XP-RAFTS Model

Zone / Model	IFD Location	Catchments Covered
East	33.9819°S 150.791°E	Bonds Creek, Scalabrini Creek, Kemps Creek, Rileys Creek
Mid	33.9906°S 150.754 °E	South Creek
West	33.9676°S 150.723 °E	Lowes Creek, Thompsons Creek

Three storms were selected for each event to represent the critical duration and mean temporal pattern in the upper, middle and lower catchment areas. The same storms were selected for each temporal pattern bin. A summary of the adopted storms is contained in Table 3. The design flood results for a particular event are an envelope of the three corresponding storms.

Table 3: Design Storm Events Selected

Bin	Events	Duration (mins)	Temporal Pattern ID (Ensemble No.)
Frequent	50% AEP 20% AEP	30	4523 (9)
		540	4771 (5)
		1440	4879 (6)
Intermediate	10% AEP 5% AEP	60	4568 (6)
		360	4591 (1)
		1080	4826 (6)
Rare	2% AEP 1% AEP 0.5% AEP 0.2% AEP	30	4402 (1)
		360	4694 (5)
		720	4785 (8)
N/A	PMP	60	GSDM
		120	GSDM
		240	GSDM

The Bureau of Meteorology's Generalised Short Duration Method (GSDM) was adopted for the Probable Maximum Precipitation (PMP, Reference 2). Spatial distribution of the PMP was undertaken for the Upper South Creek catchment (including Rileys Creek and Lowes Creek), with Scalabrini, Kemps and Bonds Creeks being assigned ellipse A in the lower half and ellipse B in the upper half, and smaller tributaries to Bringelly Road being assigned to ellipse A.

Table 4: Adopted Rainfall Losses

Event	Duration (mins)	Initial Loss (mm)	Continuing Loss (mm/hr)
50% AEP	30	25.4	0.9
	540	24.4	0.9
	1440	29.9	0.9
20% AEP	30	12.7	0.9
	540	16.5	0.9
	1440	22.8	0.9
10% AEP	60	12.3	0.9
	360	12.3	0.9
	1080	19.4	0.9
5% AEP	60	12.9	0.9
	360	10.5	0.9
	1080	18.1	0.9
2% AEP	30	12.4	0.9
	360	9.4	0.9
	720	13.8	0.9
1% AEP	30	10.6	0.9
	360	5.6	0.9
	720	6.7	0.9
0.5% AEP	30	10.6	0.9
	360	5.6	0.9
	720	6.7	0.9
0.2% AEP	30	10.6	0.9
	360	5.6	0.9
	720	6.7	0.9
PMP	60	1	0
	120	1	0
	240	1	0

ARR Datahub data was adopted at a single location for the entire catchment. This information is used to select the temporal patterns and rainfall losses. Probability neutral burst initial losses (recommended in NSW) and factored continuing losses (factored by 0.4, as recommended for NSW in Reference 3) were adopted. The losses adopted for each storm event were input into each XP-RAFTS model in the global database. The adopted losses for pervious areas are shown in Table 4. Impervious areas were assigned an initial loss of 1 mm and continuing loss of 0 mm/hr.

Since the focus of the flood study was the entire catchment, an areal reduction factor was applied to all subcatchments according to ARR 2019 (using the equations found in the Datahub output), adopting an area of 56 km^2 (the Upper South Creek catchment area to Bringelly Road) for all events except the PMP.

3.5. Running the Model

The model should be run using XP-RAFTS 2018.1.1. Each event and duration combination has been set up in a different model file, meaning that each model can be run and results obtained for each design storm separately.

4. TUFLOW METHODOLOGY

4.1. Overview

A 1D-2D linked TUFLOW model has been developed for the Upper South Creek Catchment. The model utilises the TUFLOW Highly Parallelised Computing (HPC) engine to simulate flooding across the 2D domain, with 1D hydraulic structures (culverts, pits and pipes) dynamically linked to the 2D domain. The model represents catchment conditions as at November 2018 (when the LiDAR was obtained). Features within the model are generally separated into existing urban features and existing rural features. The guidance provided in Reference 4 has been used to develop this model. The model was calibrated to the June 2016 flood event, at the Elizabeth Drive gauge and to a number of flood marks across the catchment.

Impact assessments undertaken using the model should follow the same general principles for schematisation as outlined below.

4.2. Extent and Resolution

The TUFLOW model 2D domain covers the entire Upper South Creek Catchment, from its headwaters in Oran Park and Gregory Hills to approximately 250 m downstream of Bringelly Road. The model also includes the tributaries of Kemps Creek, Scalabrini Creek and Bonds Creek. The Bonds Creek catchment, which traverses Denham Court (outside the study area), is only modelled from Camden Valley Way to Bringelly Road. The 2D domain covers an area of approximately 78 km^2. While the model has been developed to be run at numerous grid sizes, the design flood events have been run with a grid size of 3 m, which provides a balance between resolution and run time.

A one-dimensional (1D) representation of South Creek downstream of Bringelly Road was retained from the Upper South Creek Floodplain Risk Management Study and Plan (Reference 5) for the purpose of calibrating to the stream gauge located at Elizabeth Drive. This portion of the model, however, has been removed for the design flood events as it is beyond the required study area.

4.3. Terrain

The TUFLOW model 2D terrain is based on the November 2018 LiDAR dataset. The 1 m DEM was read into the TUFLOW model directly to develop the underlying terrain.

There are a number of ongoing projects within the Upper South Creek Catchment. Design levels for some of these projects were available in the form of a triangular irregular network (TIN), which were read into the model. These include:

- The Northern Road,
- Bringelly Road, and
- Emerald Hills Estate.

There were several modifications made to this terrain to ensure topographic features were represented correctly. These modifications are discussed in the following sections.

4.3.1. Roads

In areas where roads form a significant obstruction to flow or where flow paths cross under road embankments, the crest of the road has been included in the TUFLOW model as a breakline. These breaklines are sampled directly from the relevant terrain data (either LiDAR or the TINs above) and ensure that road crests (the overtopping level of the road) are correctly represented in the model. This includes some creek crossing locations where the LiDAR data displays the creek channel rather than the road embankment.

In the urban areas, where a kerb and gutter system is present, the gutters have also been represented in the TUFLOW model as breaklines which lower the terrain by 0.1 m. This enables the representation of the conveyance of flows along street gutters in the TUFLOW model.

4.3.2. Basins

Generally the detention basins throughout the newly urbanised areas are well represented in the LiDAR data. Some adjustments to the terrain have been made where the basin was under construction, or where ponded water results in the LiDAR not representing the basin form properly. If data was available from Development Application (DA) drawings, the basin inverts and spillways have been represented in the TUFLOW model.

4.3.3. Dams

Rural farm dams are prevalent through the catchment. Breaklines for the crest of some of the larger dams that are located ‘on-stream’ were included to ensure that these dams were represented in the model. These breaklines were sampled from the LiDAR data. The LiDAR survey cannot penetrate water surfaces and hence the LiDAR data typically shows the water surface in areas where ponding occurs, such as these farm dams. For the Pondicherry Dam, survey was available which included ground levels below the water surface and this survey data was used to define the bathymetry of the dam.

4.3.4. Creeks

Breaklines have also been included for many of the creeks, to ensure that the creek invert is sufficiently represented in the TUFLOW model and conveyance of water between the TUFLOW grid cells is adequate.

4.4. Surface Roughness

Surface roughness values have been defined across the TUFLOW 2D domain, represented by the Mannings 'n' coefficient. The roughness is based upon the land use, which was visually inspected using the November 2018 aerial imagery. Each land use category was assigned a Mannings 'n' value, as outlined in Table 5.

Table 5: Mannings 'n' Values Adopted in the TUFLOW Model

Land Use Category	Mannings 'n'
Bare earth	0.02
Maintained grass / parks / ovals	0.03
Floodplain grass / pasture	0.04
Light vegetation	0.045
Medium vegetation	0.06
Dense vegetation	0.08
Riparian vegetation	0.12
Creeks and open water	0.03
Roads	0.02
Road corridor	0.035
Paved areas	0.02
Low density (rural) residential	0.045
Medium density (urban) residential	0.06
Industrial / commercial / schools	0.03
Railway	0.06

4.5. Buildings

Buildings were represented as solid obstructions to flow by blocking them out of the TUFLOW grid. The buildings layer provided with the capture of LiDAR data was used to represent the building footprints.

4.6. Pit and Pipe Network

The pit and pipe network has been included in the TUFLOW model as a 1D network. The pits enable the transfer of flows from the 2D domain to the 1D pipes below the ground. The pipes carry flows to the outlet where it discharges to the 2D domain. The pit and pipe data received from Council could not be used directly in the TUFLOW model. Each branch of the network was analysed and the following modifications were made to the GIS layers to enable an adequate representation of the network in TUFLOW:

- Pipes smaller than 450 mm in diameter were removed (including pits connected to these pipes).

- Pipes were connected to downstream pipes to ensure continuity of each branch to the outlet. In some cases, the outlet was not defined and the most likely outlet location was chosen, taking pipe sizes from the most downstream pipe available.
- Pipe were checked and adjusted to ensure consistent pipe sizes (downstream pipes were the same size or larger than upstream pipes), including assigning reasonable pipe sizes to those where data was missing.
- Pipe polylines were reversed to be drawn from upstream to downstream, where this was not already the case in the stormwater database.
- Invert levels of outlets (where they were not provided) were obtained from the LiDAR data.
- Invert levels of pipes (where they were not provided) were taken to be the ground level (from LiDAR) minus 1.35 m (the average depth to pipe obverts where invert levels were available), minus the pipe diameter or height.
- Pipes were assigned a Mannings 'n' of 0.012.
- Grated pits (determined by inspection of the November 2018 aerial imagery) were assigned a size based on an approximate measurement of the grate from the aerial image (where they were not provided).
- Kerb inlet pit lintels (where they were not provided) were assumed to be 1.8 m wide (the approximate average lintel width where data was provided).
- Kerb inlet pits that were not located close to the gutter (within approximately 1 m) were moved to the gutter (and actual pit location if it could be seen on the aerial imagery) to ensure that pits drain the flows that will be within the gutter in TUFLOW.

A total of 2,922 pipes and 2,796 pits were included in the TUFLOW model to represent the stormwater network. Typically the source of the data and any modifications to the data have been included in the GIS files in a comment field.

In addition to the street stormwater network, the low flow outlets of urban detention basins also typically consist of pits and basins. These were also represented in the TUFLOW model. Many of the basins have complicated multi-level outlets to maximise detention of water for different storm events. Where the information was available from DA drawings, these outlets have been represented in the TUFLOW model.

For all design events, a blockage factor of 50% has been applied to all pits, with pipes having no blockage.

4.7. Culverts and Bridges

Culverts were included in the TUFLOW model as 1D elements where they were 450 mm in diameter and greater. The parameter values for the culverts were based on the geometrical properties of the structure (circular or rectangular). There are a number of arch culverts within the study area and these were represented in the TUFLOW model by calculating a width-height relationship. Depending on the source of information, invert levels were obtained from topographic survey (undertaken for the previous flood study), DA design drawings, or estimated based on the LiDAR road levels and a depth of cover. Typically, the source of the information is included in the GIS file in a comment field. A blockage factor of 50% was applied to all culverts with a maximum opening (width or height) of less than 1 m and 20% blockage applied to those structures greater than or equal to 1 m. For some large key structures, the ARR 2019 (Reference 1) blockage methodology has been applied to determine AEP dependent blockage factors.

Bridge structures were modelled in the 2D domain. The primary structures are the South West Rail Link bridges and the Bringelly Road twin bridges over South Creek (under construction). Details of these structures were obtained from design drawings. Additional structures which were surveyed in the field and large enough to influence flow behaviour were also included in the model. The bridge soffit and deck levels are included in the TUFLOW model, with an estimate of the hydraulic obstruction and losses due to the piers and deck. These loss coefficients were estimated using Reference 6. Most bridge structures were assigned a blockage factor in line with ARR 2019 (Reference 1) blockage methodology. Some minor bridge structures (such as footbridges) were assigned a nominal blockage factor of 5%.

Detention basin outlets should also have blockage considered. For basin outlets, all grated pits should have a blockage factor of 25% and all headwall outlets should have 10% blockage applied.

4.8. Inflows

Inflows into the TUFLOW model are sourced from the XP-RAFTS simulated local runoff hydrographs for each subcatchment. Where subcatchments drain to urban pits, the flow is applied to 2D cells at the pit inlet. Elsewhere, the subcatchment flow is applied to a group of 2D cells located at the subcatchment outlet (the lowest point of the terrain).

For Bonds Creek, which is modelled from Camden Valley Way in the TUFLOW model, the total catchment flow to this point is applied at the model boundary.

4.9. Downstream Boundary

For the creeks that cross Bringelly Road, a stage-discharge boundary was applied at least 250 m downstream of Bringelly Road. The stage discharge relationship is automatically calculated by TUFLOW, given the cross section of each creek or tributary and a channel slope.

There several other small catchments upstream of Camden Valley Way that discharge east into Bonds Creek. At these locations, a stage-discharge boundary was also applied, or in some circumstances culverts that flow under Camden Valley Way and out of the model were extended and have a fixed water level applied at their downstream end.

4.10. Running the Model

The model is to be run with TUFLOW version 2018-03-AE in single precision (iSP) mode. The model should be run using the HPC engine and typically runs quicker on a graphics card as opposed to multiple CPU cores.

The model requires events and scenarios to be defined to run as follows:

- One event “e1” defines the AEP. Valid options for this event variable are [50pc, 20pc, 10pc, 5pc, 2pc, 1pc, 1in200, 1in500 or PMF].
- The second event “e2” defines the storm duration. For the PMF, this is a three digit number followed by the letter “m” (e.g. 030m for 30 minutes). For other design events, this is a four digit number followed by “m” (e.g. 0360m for 6 hours). The relevant critical durations for each AEP are summarized in Table 3.

- The first scenario “s1” defines the grid cell resolution. This is to be kept as “G3” for impact assessments undertaken using this model.
- Additional scenarios (e.g. “s2” and up) should be added to reflect proposed development cases.

The runs take approximately 0.5 to 1 times the simulated storm duration using a PC equipped with an *NVIDIA 1080 Ti* GPU card.

Model users should run the base case and ensure that the results obtained are exactly the same as those provided with the model before proceeding to edit the models.

5. IMPACT ASSESSMENTS USING REGIONAL MODEL FRAMEWORK

These hydrologic and hydraulic Regional Models have been developed to facilitate assessment of impacts of proposed developments. While each proposed development will be different and the modelling may need to be tailored for each assessment, the following provides a general outline of the process and parameters that should be adopted.

5.1. Process

The general process that should be adopted involves the following:

1. If required, prepare a new scenario to represent “Base Case” conditions at the time of the assessment. The models may require updating to represent any development that has occurred between November 2018 and the date of the assessment (for example, development of a precinct upstream of the subject site). There may also be more detailed information at the site of interest from detailed survey that may have been conducted, and this can be included in the model. Any and all changes to the base case must be fully documented and justified in the impact assessment report, and the impacts of the base case revisions on peak flood behaviour must be reported.
2. Prepare a new scenario to represent “Proposed” conditions (post-development). The proposed development will need to be included in the models. In the XP-RAFTS model, this will typically involve refining the subcatchment boundaries to align with the topography and hydraulic controls in the proposed development, and increasing the fraction impervious. In the TUFLOW model, this will typically involve altering the terrain to reflect the proposed earthworks, altering the surface roughness to reflect the proposed land use and incorporating proposed hydraulic structures such as stormwater networks, detention basins and culverts.
3. Ensure consistency of modelling schematization approach between “base case” conditions and “proposed” conditions models. The models should be consistent between the two scenarios such that the only difference is that of the proposed development. This will enable an accurate assessment of impacts. For example, if catchments were subdivided further for the proposed conditions, then these subdivisions should also be represented in the existing conditions model. Modelling of the stormwater network, hydraulic structures and buildings should use a consistent approach with that used for similar structures in the base case model.
4. Undertake an impact assessment. This involves a comparison of post-development peak flows and pre-development peak flows at the boundary of the site, and a comparison of post-

development peak flood levels and pre-development peak flood levels. Impacts are to be reported as indicated in Section 5.4.

5. If required, refine the design to ensure there are no increases in peak flows at the project boundary, and no increases in peak flood levels (greater than ±0.01 m) upstream or downstream of the site.

5.2. Model Parameters

In general, the model parameters and schematisation should be consistent with those outlined in Section 3 and 4 for any modifications made to the models. For XP-RAFTS, this includes:

- Bx of 1.0,
- Impervious fractions using the methodology summarised in Diagram **2**,
- Manning's 'n' values outlined in Table **1**,
- Rainfall losses outlined in Table 4.

For TUFLOW, this includes:

- Maintain a grid size of 3 m and model the whole catchment to Bringelly Road.
- Represent the proposed landform within the TUFLOW model, including bulk earthworks, creek corridors and detention basins.
- Include key hydraulic structures such as basin outlets, cross drainage culverts, stormwater network (if available). Parameters should be consistent with those adopted for the current model (as outlined in Section 4.6 and 4.7).
- Adopt the Manning's 'n' values outlined in Table 5.
- Detention basin outlets should include an allowance for blockage. For basin outlets, all grated pits should have a blockage factor of 25% and all headwall outlets should have 10% blockage applied for design runs.

If there are numeric computational impacts arising from the adaptive time-step feature in HPC, it is recommended that the control number factor be set to 0.8 for both the pre-development and post-development scenarios.

For the purpose of the impact assessment, it should be assumed that:

- Existing farm dams start full (initial water level is at the height of the lowest level of the dam embankment crest), and
- Existing and proposed detention basins start with a water level equal to the lowest outlet level.

The TUFLOW model should be run for a duration long enough such that the South Creek peak flow has been passed at Bringelly Road, and that the peak water levels within basins and dams have been reached. The XP-RAFTS model should be run for a duration that covers the TUFLOW model run time at a minimum.

If there is any deviation from the parameter values or schematisation methodology specified in this guide, then these should be clearly documented and justified.

5.3. Design Events to be Modelled

The assessment should demonstrate there are no significant adverse off-site impacts for the 20%, 5% and 1% AEP events, for all three event durations specified in Table 3.

The PMF 60 minute duration should also be modelled, to identify high hazard flood extents in and around the site for proposed development conditions.

The storm events outlined in Table 3 should be simulated in both the XP-RAFTS model and TUFLOW model, for both the pre-development and post-development scenarios.

5.4. Reporting Requirements

The following should be provided with the flood impact assessment report:

1. A mapped comparison of peak flood levels from TUFLOW should be provided (mapped impact grids) for the 20% AEP, 5% AEP and 1% AEP events, including changes in flood extents. Comparisons should be provided for the following scenarios:
    a) Confirmation that the provided November 2018 “base case” model has been re-run and the results obtained are exactly the same as those provided with the model. This map should show no change in 1% AEP peak flood levels (i.e. results for the 20% AEP and 5% AEP is not required).
    b) If the base case model has been revised by including detailed survey or nearby approved development, a grid comparing the impacts of the base case model revision for the 1% AEP event (i.e. results for the 20% AEP and 5% AEP is not required).
    c) Impacts of the updates to the hydrologic model to represent proposed development, without any landform or structure modifications in TUFLOW (i.e. just the impacts of the change in hydrologic model parameters from proposed development) (only for the 1% AEP event).
    d) Impacts of the proposed development scenario in TUFLOW (including hydrology changes plus all land-use, topography and structural changes etc. in the hydraulic models) compared with the base case or revised base case as relevant (for each of the three design AEP events).

   For each design event the mapped results should be the envelope of the maximum results from three storm durations simulated. The impact grid should be the difference between the envelope of durations for the post-development scenario, versus the envelope of the three durations from the base scenario. This grid should encompass the entire TUFLOW Model extent. Any impacts outside the range of ±0.01 m should be mapped.
2. Peak flow hydrographs for both pre-development and post-development conditions for each flow path at the downstream boundary of the site. Flow hydrographs are to be extracted from TUFLOW, for both pipes and overland flow if relevant. Any downstream locations at junctions on major creek systems should also be provided (for example, if the development is located within the Lowes Creek catchment, hydrographs at the Lowes Creek and South Creek junction should be provided. Flow hydrographs should also be provided just upstream of Bringelly Road, for the creek to which the development discharges. The critical duration for each event should be provided at each location.

3. Peak flood depth and hazard maps for the base case and proposed case (20% AEP, 5% AEP, 1% AEP and PMF).
4. Documentation of all model adjustments.
5. Documentation of assumptions for proposed hydraulic structures and detention basins, and the method of model schematization for these structures.
6. Provision of the amended XP-RAFTS and TUFLOW model files and results in a similar file structure to the model provided by Council.

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