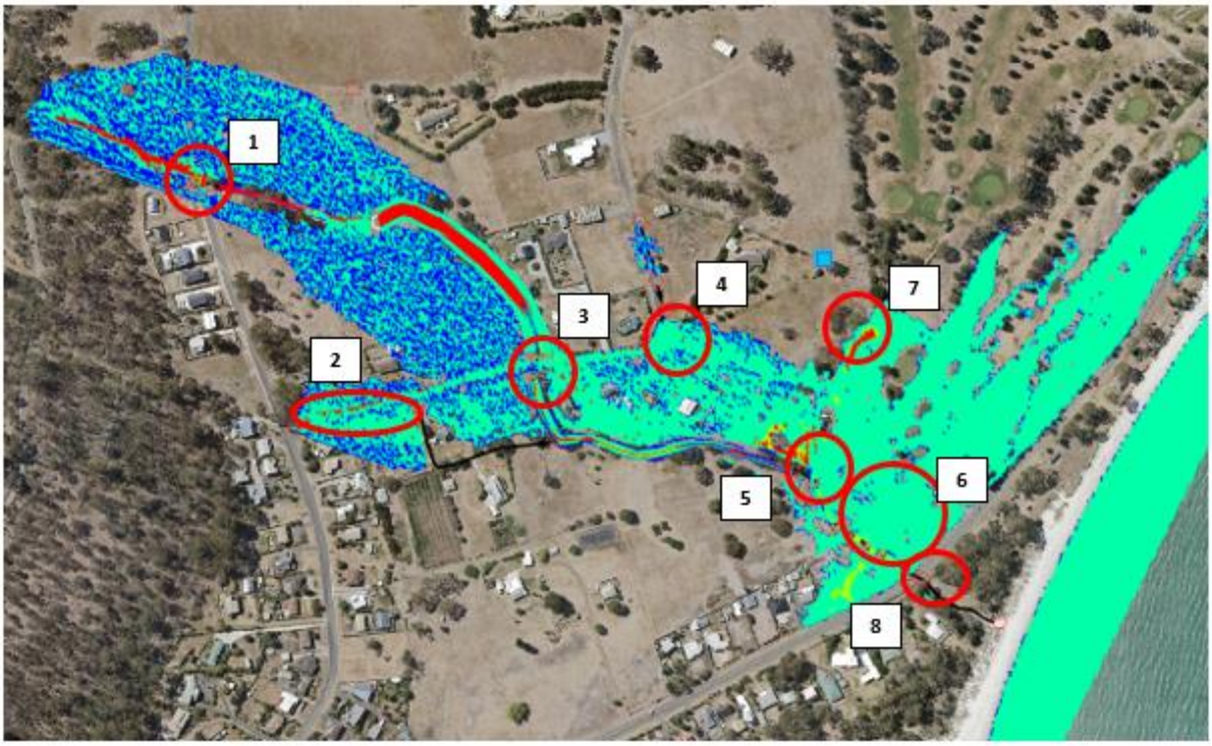
Holkham Court Stormwater Assessment

Brighton Council Anna Wilson



Contents

Overview

The northern area of Orford is located within a small catchment of an unnamed minor watercourse that runs from Rudds hill to an outfall behind Raspins Beach. The base of the catchment consists of residential developed areas, undeveloped areas, a caravan park and a highway. Many of these areas have received some inundation in recent large rainfall events.

Development applications have been received for significant portions of the midsection of the catchment. These will increase the number of roads, amount of drainage infrastructure and the impervious percentages of the catchment with possible effects on the downstream properties.

Glamorgan Spring Bay Council has requested Brighton Council undertake modelling of this catchment. The catchment has been modelled to establish the existing conditions and then model possible future conditions to establish an appropriate pattern of development and an infrastructure plan. Climate change adaptation information for the area indicates a 30% increase in runoff that has been applied to the model.

This report examines the existing conditions, identifies areas of interest and issues, models possible future scenarios and provides some insight into possible solutions. This report does not consider the effects of tidal influences and storm surge.

Scope and Objectives

The scope of this report is to model stormwater flows throughout the Rudds Hill – Raspins Beach catchment.

Establish a current flow level for the 20 year and 100 year events and identify existing overland flow paths.

Assess overland flow and infrastructure required to meet the Councils Climate Adaptation policy of a 30% increase in runoff.

Model the Holkam and Alma Court subdivisions and assess the stormwater consequences to overland flow and infrastructure upgrades.

Model the future low density residential zoning area to assess the stormwater consequences to overland flow and infrastructure upgrades.

Recommend possible infrastructure upgrades for the minor and major flow paths.

Modelling Process.

The area was modelled using procedures in line with Australian Rainfall and Runoff 2016 using XP SWMM modelling software.

A 1D 2D base model was set up using Lidar at 1m centres for the terrain model. The open channel was modelled with 1D channels and culverts linking to a 2D overland flow model.

This model was run as per the ARR 2106 procedures with a suite of event times and storm ensembles to select the appropriate storms for catchment modelling. Storms selected for modelling are the 2hr storm number 7 for the 5% event and the 4.5 hr storm number 2 for the 1% event.

With the appropriate critical storms selected the 1.5m grid model which has greater accuracy will be run with the selected storms. This model will now be the base model for analysis.

Base model including climate change

Climate change adjustments. As per the adopted climate change scenario there will be an increase in runoff of 30%. This is added to the program by increasing the rainfall multiplier by 1.3. The existing and climate change values for the chosen rainfall events are provided below.

Name	Initial Multiplier	Climate Change value
SST_5pct_2hr_7	35.1	45.63
SST_5pct_4_5hr_4	52.7	68.51
SST_1pct_4_5hr_2	67.8	88.14

The climate change multipliers will be used for all models.

Scenarios

There are a number of scenarios to model utilising the base model to compare against.

The scenario manager is used to assess each scenario.

Scenario 1: Culvert blockages. Photographic evidence demonstrates that the HWY culverts may experience reduced flow due to sediment blockages. This will be modelled with a 30% blockage to this culvert.

Scenario 2: Outlet blockage. Full outflow to the ocean is often impeded by dune movement. Has been modelled by raising the outfall to cause some impedance to the outflow.

Scenario 3: Holkam sub. Add Holkam sub area into scenario. Added via new catchment with 40% impervious and free outfall at southern end of subdivision. Site coverage for structures in planning scheme is up to 25% plus added impervious areas for roads and driveways.

Scenario 4: Alma sub 40% impervious

Scenario 5: Full low density residential – 40% impervious for all catchments within the low density residential zoning.

Scenario Results Analysis

Scenarios 1 and 2: Highway Culvert Blockage and Outlet Blockage.

The highway culvert blockage had a significantly greater impact on the area of inundation upstream of the culvert than blocking the outlet. Culvert blockage was therefore considered highest risk and of significant likelihood and was selected for further modelling.

Scenarios 3, 4 and 5: Holkham Subdivision, Alma Subdivision and Full low Density Residential Models.

It quickly became apparent that assessing either subdivision alone was relatively pointless as any future infrastructure upgrades will need to cater for full low density residential development to future proof the upgrades hence further modelling focussed on managing the issues of full low density residential development. Interestingly all the issues raised by increased development are already occurring due to inappropriate infrastructure.

The other notable result is that due to the nature of the catchment increases in impervious areas don't make a significant difference to the higher flow rates. This is due to two things, firstly the soil becomes saturated causing flow on pervious areas to act in the same manner as flow on impervious areas and secondly is the large upper portion of catchment the flow from which dominates the later stages of runoff events.

Overall Points of interest:

The waterway running through the catchment is disrupted in several areas causing flow to be dispersed into properties unnecessarily. Maintaining the major flow path will be a priority for this area.

Results Assessment and Analysis

Summary of issues:

1. **Alma Road Culvert**. Flow from creek line overflows Alma Road at this location.
2. **Holkham road entrance and first culvert**. The road geometry allows flow to cross the road and flow overland through private property into the secondary drain.
3. **Holkham Culvert**. Undersized for this location. Forces water onto the road. This then flows along the road east to the turning circle and flows over the road into private property 24 and 30 and possibly 34 Holkham Court.
4. **Holkham Turning Circle**. Flows occur overland from the south side of this area. Low flow depths only however the water path has to floe overland for some distance through private property prior to re-entering the main channel. It then re-enters at the top of the caravan park where infrastructure is insufficient to manage this flow.
5. **Top Caravan Culvert** causes flows to back up and extend outwards. Addressing this issue will change the area of inundation.
6. **Caravan Park and Golf Club building area**. This area receives significant inundation affecting the caravan park and the golf club building.
7. **Holkham Court Subdivision**. This subdivision will create flow that does not flow into any currently defined flow paths.
8. **Highway Culvert.** The highway under the culvert is undersized and throttles flow. This is exacerbated by the culvert being periodically affected by sediment blockage.

Note issues 1 to 4 are independent of impacts from tidal variations and storm surge. Storm surge and tidal impacts do not form part of this model.

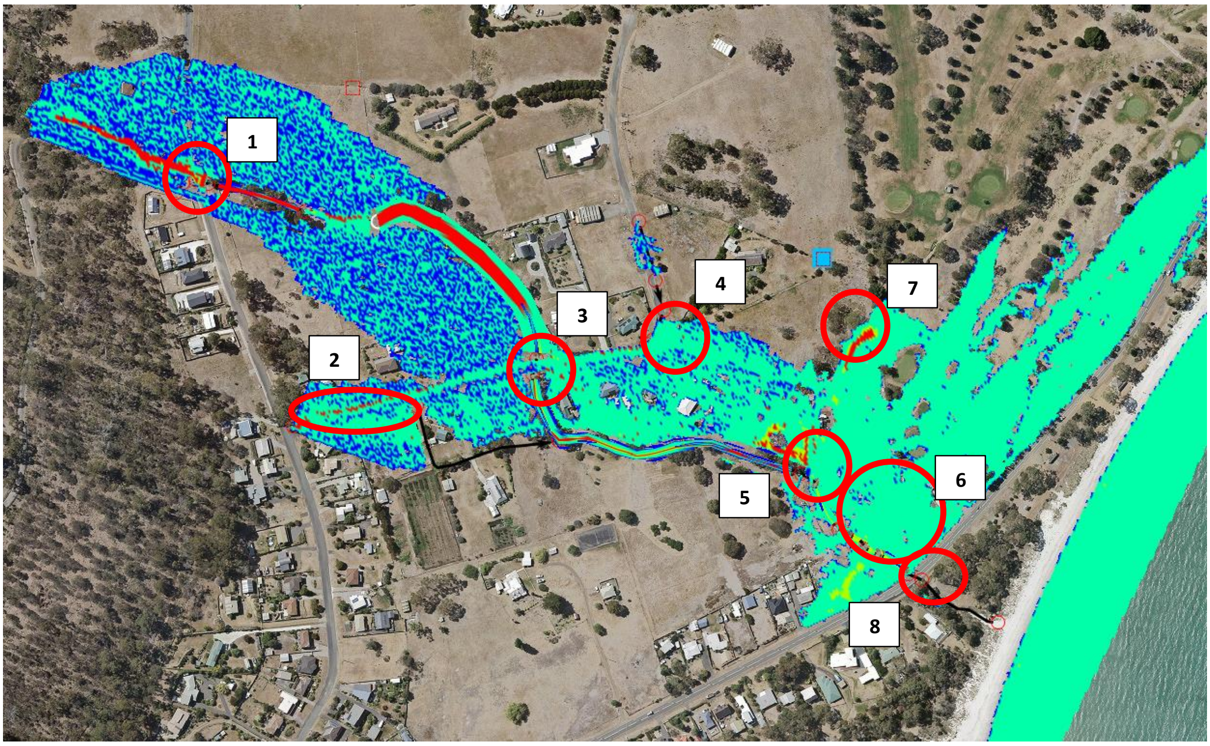


*Figure 1***.** Low Density Residential model Hazard Mapping results. Depth x Velocity. Showing areas of inundation and areas of particular concern. 5pct_2hr climate change model.

Total Overland Flow Area

The above map shows the entire area of inundation. Further maps will show areas with inundation deeper than 0.1m as a 10 cm water depth is of minimal concern.

5% RESULTS

Overland Flow of Depths Greater than 0.1m. 5% Result.

*Figure 2***. 5%** 2hr Climate Change **Base model** results. Max Water Depth. Map showing depths greater than 0.1m. 5pct_2hr climate change model**.**

Overland Flow of Depths Greater than 0.1m. 5% Low Density Residential Result.

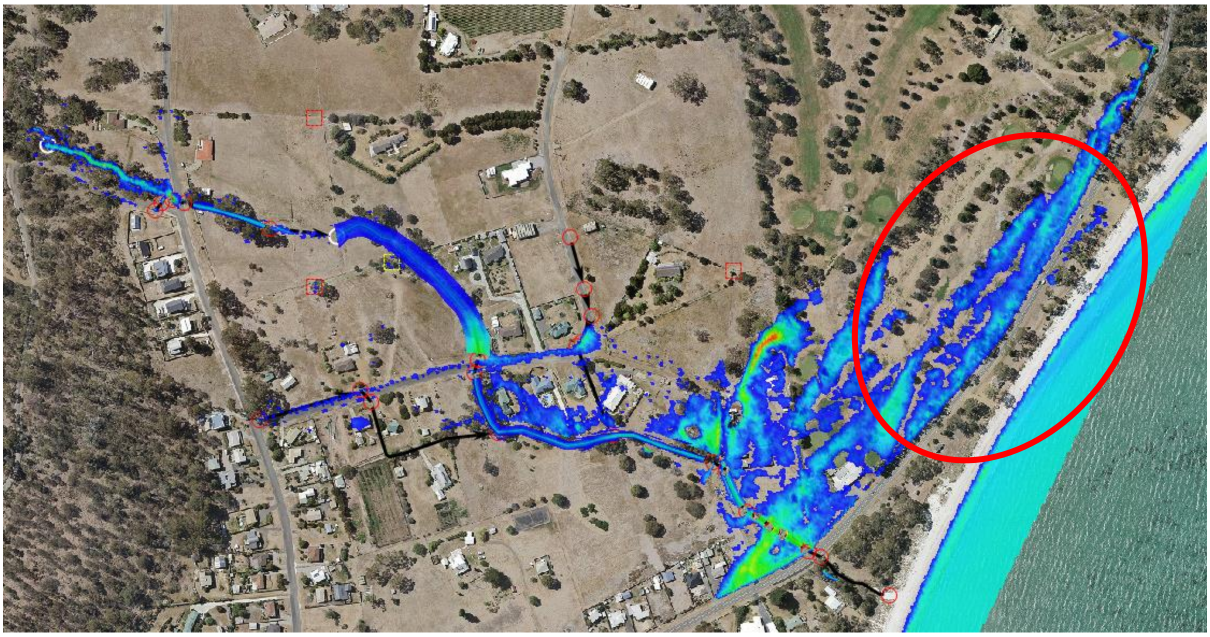


*Figure 3***.** 2hr Climate Change **Low Density Residential model** results. Max Water Depth. Map showing depths greater than 0.1m. 5pct_2hr climate change model. **This is the assumed future scenario.**

Comparing the above two images it is obvious the increase in impervious area caused by increasing the low density residential area results in a much greater volume of pooling water. This is most noticeable in the golf course area. However, the changes do not result in increased peak flow rates in these larger events as shown by the graph below. This graph shows that in the early stages of the event increases in impervious area from development make a large difference but over the duration of the event the impact of increased impervious area is negated by the increased flows in the later stages of the event.

Conduit central_drain_4 from junction_2 to cvan_us_1

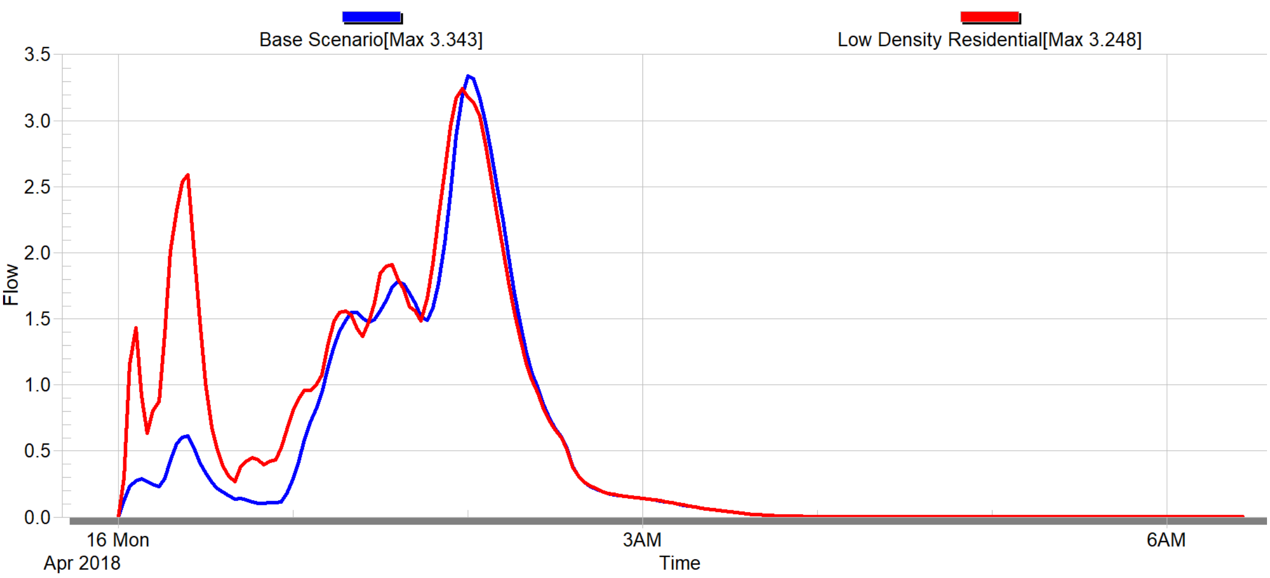


Figure 4. **Graph of flow rates for Base model and Low Density Residential model for Central drain 4 section as shown above.**

1%RESULTS

Overland Flow of Depths Greater than 0.1m. 1% Low Density Residential Result

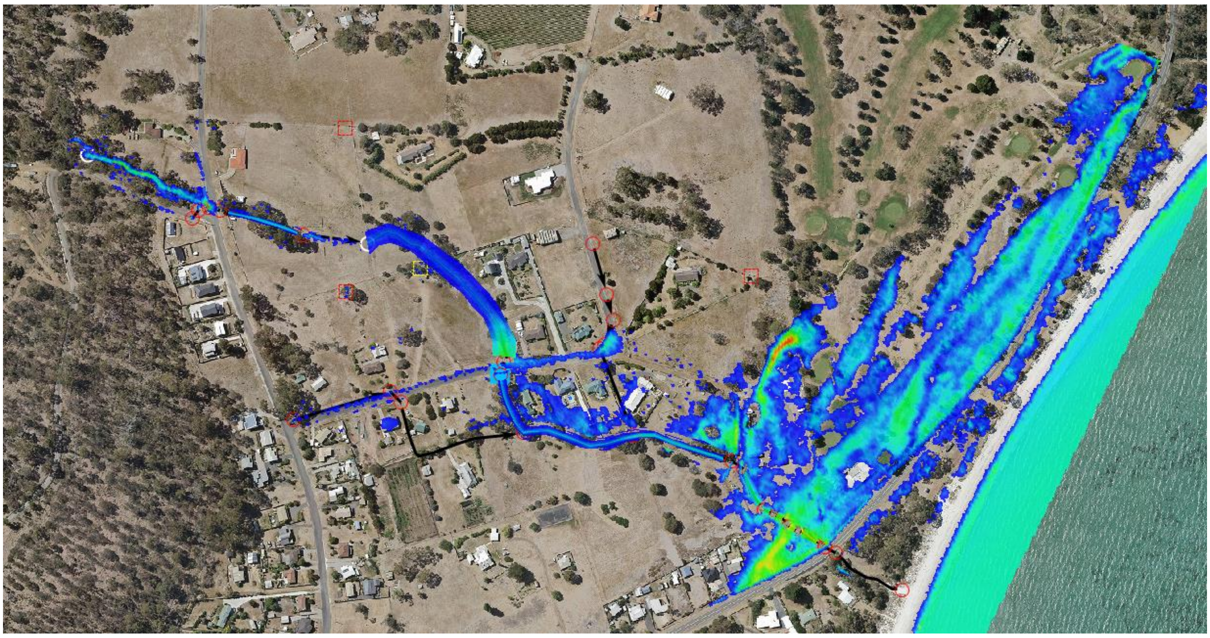


*Figure 5***. 1pct** 4.5hr Climate Change Low Density Residential model results. Max Water Depth. Map showing depths greater than 0.1m**.**

Total Overland Flow Area. 1% Low Density Residential Result

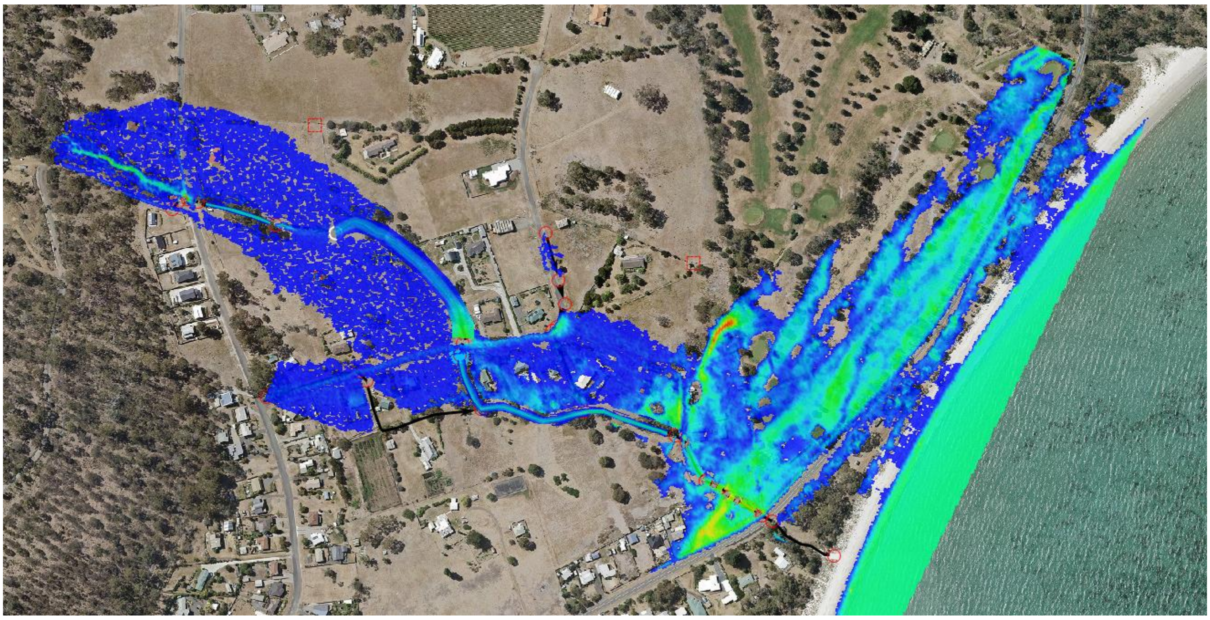


Figure 6. 1pct 4.5hr Climate Change Low Density Residential model results. Max Water Depth. Map showing **all depths for comparison**.

Note in the 1pct event the flood area extends throughout the golf course and overtops the highway in multiple locations.

E:\Orford climate change 2hr base video.avi

AREAS OF INTEREST RESULTS

1. **Alma Road Culvert**

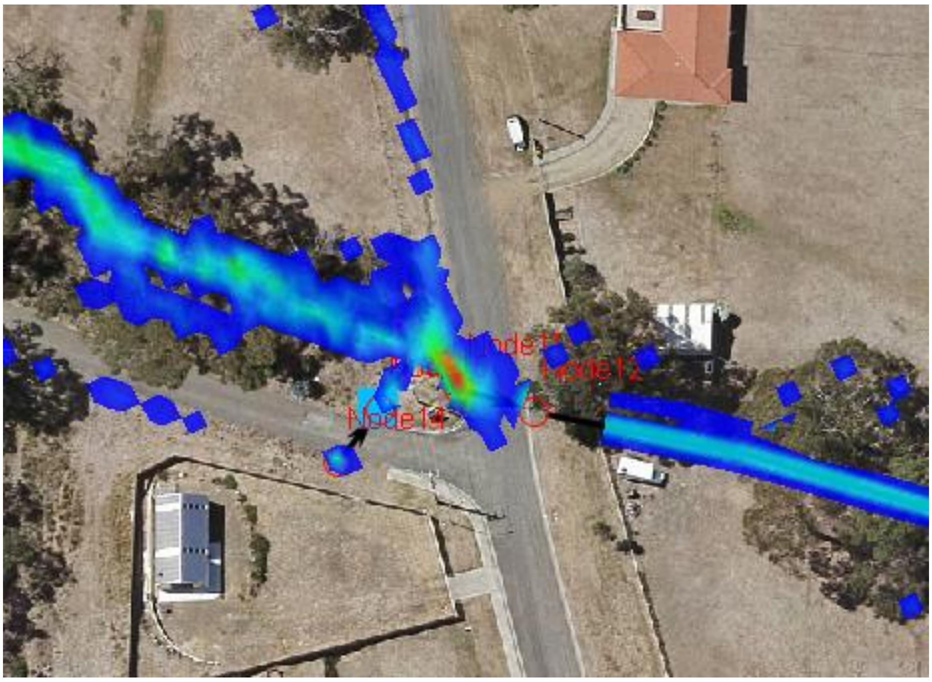


Figure 7. 2hr Climate Change **Base model** results showing flow overtopping Alma Road.

2. **Holkham road entrance and first culvert**

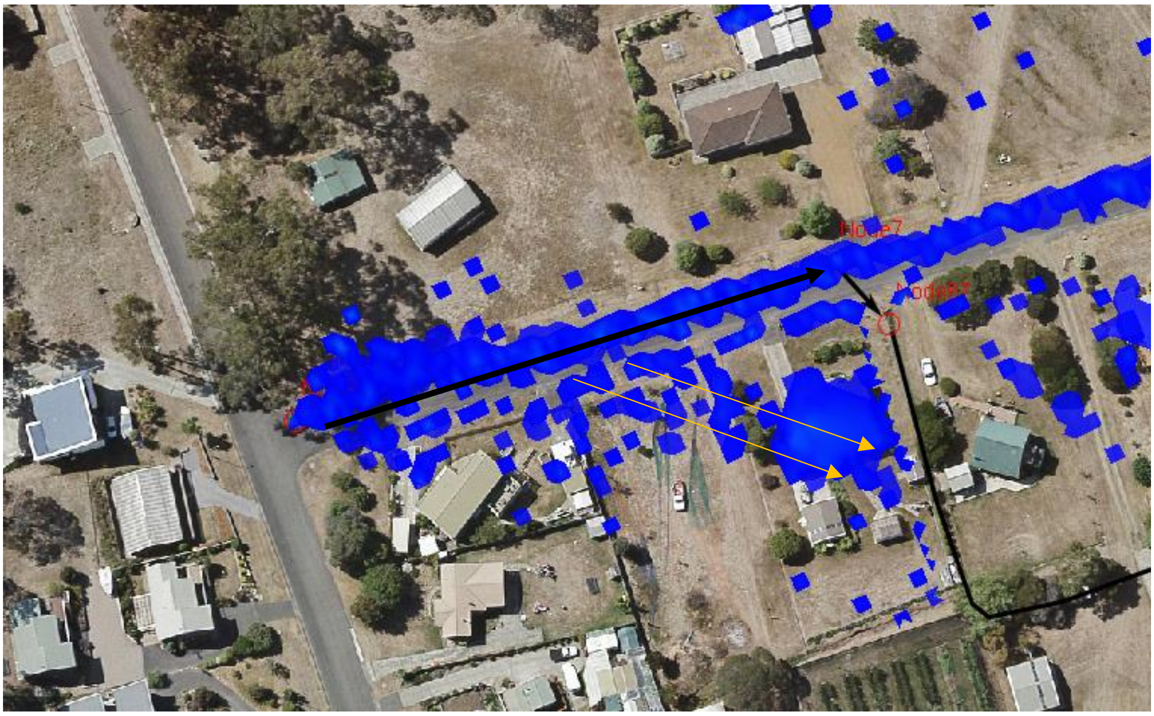


Figure 8.. 2hr Climate Change **Base model** showing 5cm of water flow. This shows that water comes across Holkham Court and crosses private property to enter the small open drain.

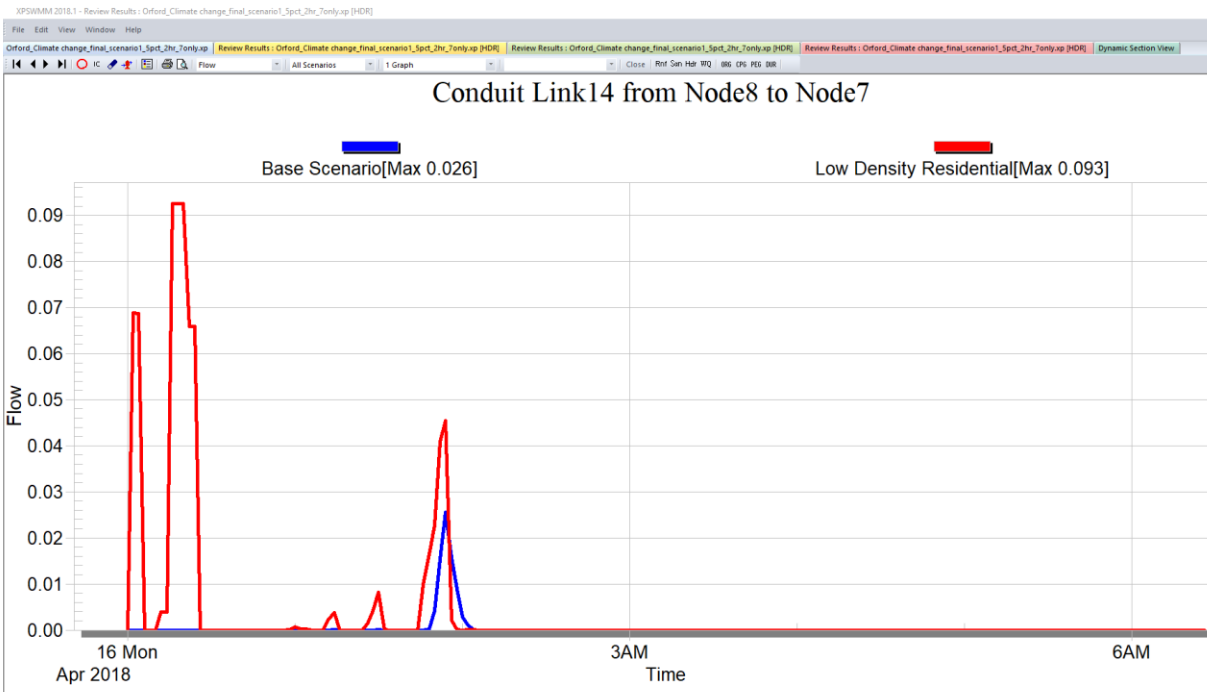
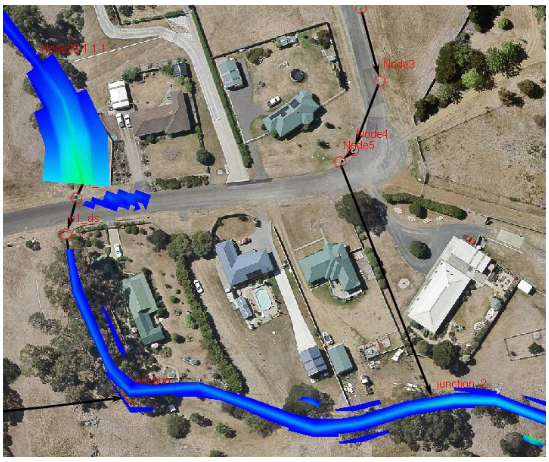
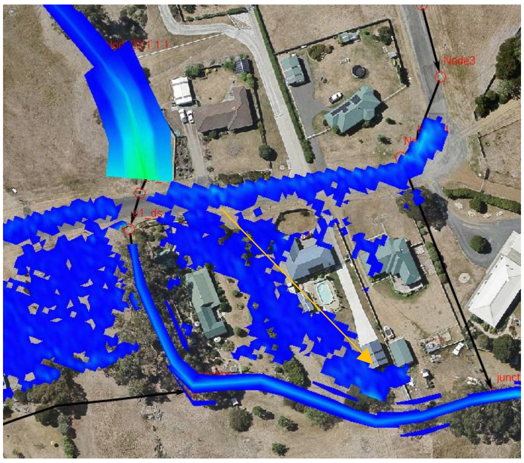


Figure 9.. **Flow rate in Link 14 –** roadside drain in Fig X above. Showing the flow increasing here from increased development. Flows here should be restricted onto the road and drainage network. This shows that this will become increasingly important as development increases.

3 & 4. Holkham Culvert and Holkham Turning Circle.





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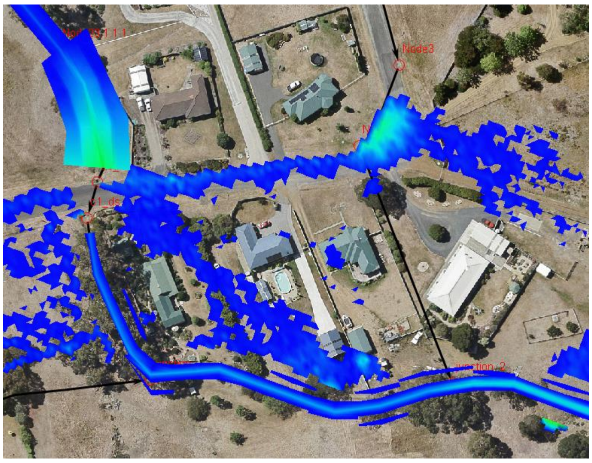

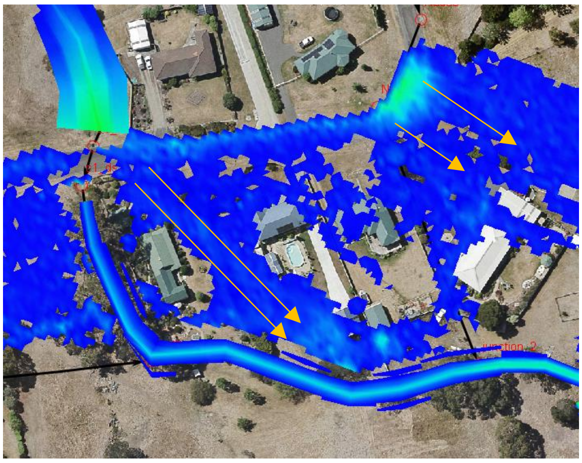

3 **4**

Figure 10. **.** 2hr Climate Change **Low Density Residential model** showing all water flow. This series of images shows that the water that backs up at the Holkham Road culvert overtops onto the road and diverts east along Holkham Court where it flows out over a low point at the turning circle. The flow also overtops straight over Holkham Court and through private properties prior to re-entering the open drain.

5 & 6. Top Caravan Culvert

The culverts in the caravan park cause constrictions in the flow path. This causes the water to spread further into areas that may otherwise be unaffected.

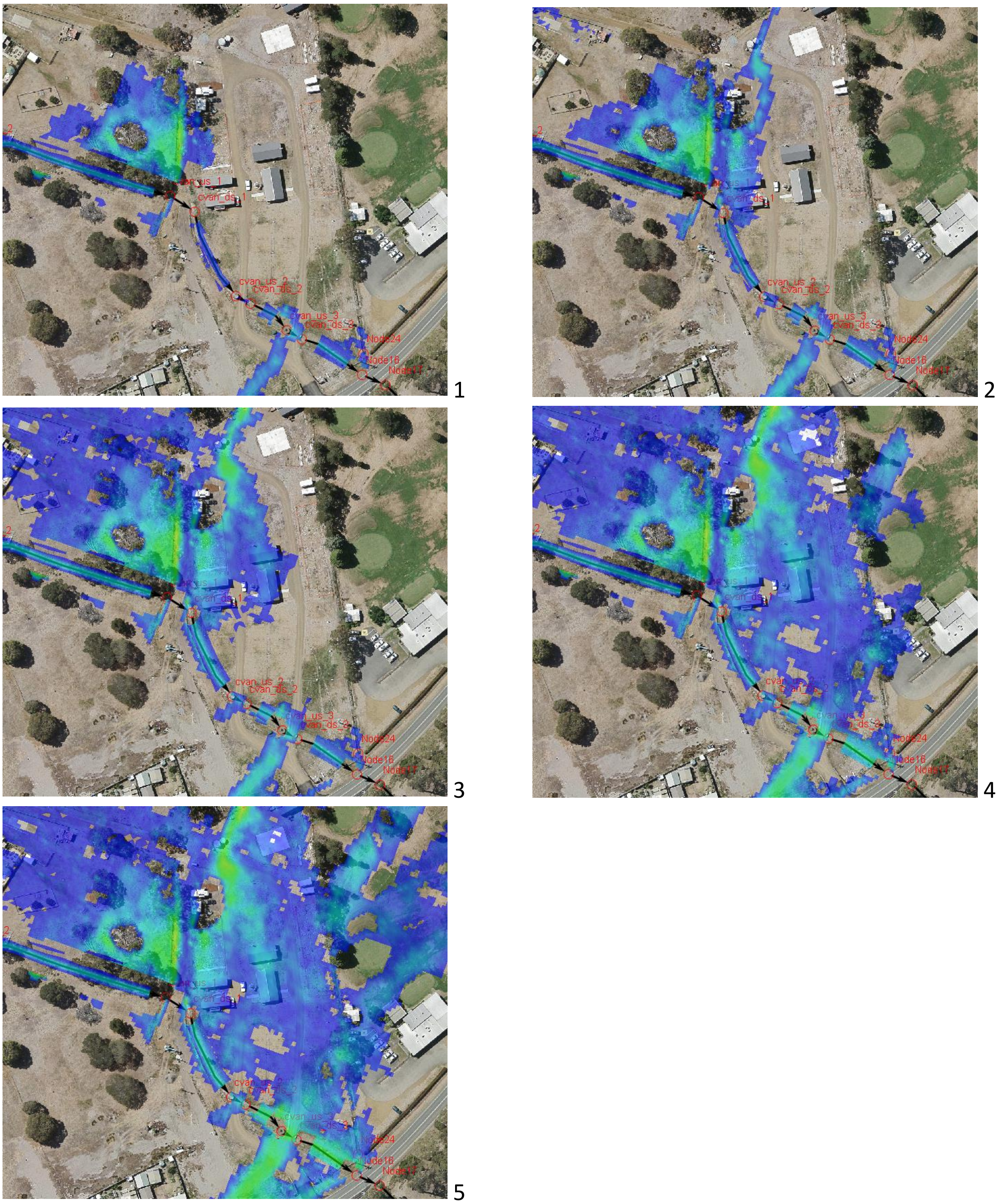

Figure 11. **Series showing effects of restrictions caused by road and culverts in the caravan park.**

7. Holkham Court Subdivision

This subdivision will divert water into the highlighted node.

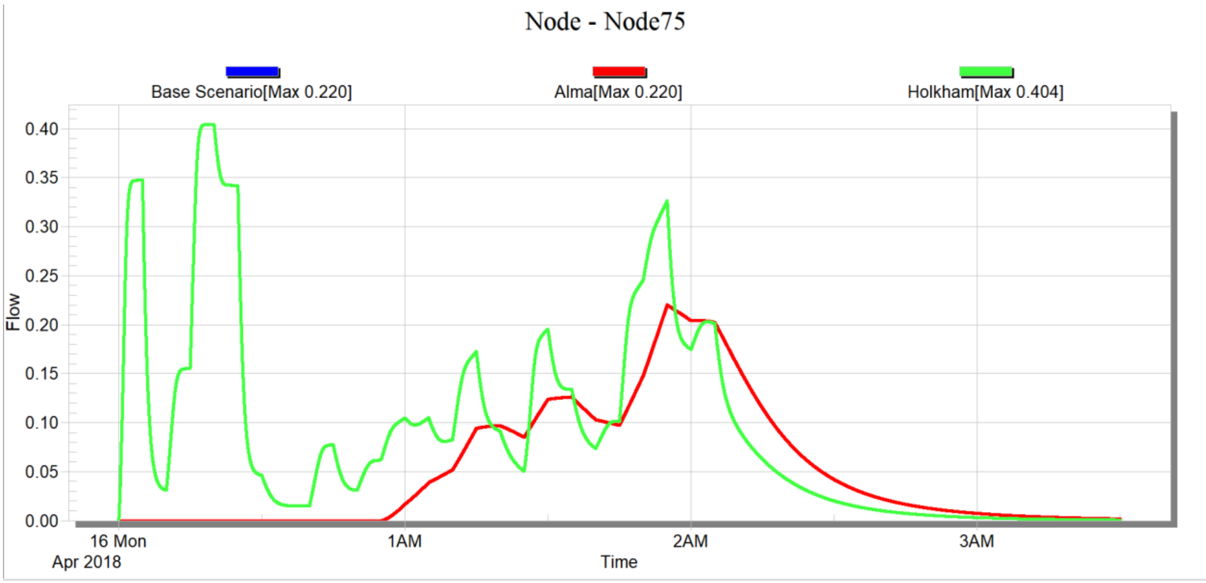

Figure 12. **Runoff results from Holkham catchment developed.**

This graph shows the extra outflow created from the south-east corner of the proposed Holkham subdivision. This results in a large amount of extra flow along this eastern boundary area but the overall impact on the peak flow rate within the caravan park area is unaffected as shown by the graph of the node highlighted in the caravan park below.

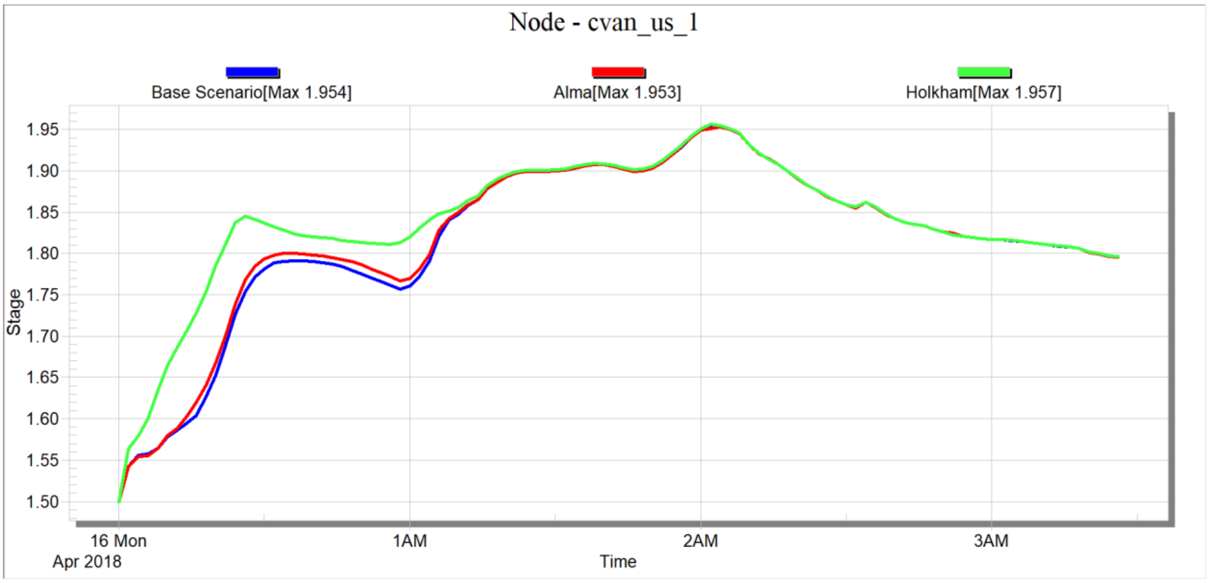

Figure 13.. **Hydraulic Results from the upstream culvert in the caravan park.**

The above result shows the top culvert in the caravan park. As shown the Holkham development has some impact in the early stages of the event but the peak is unaffected by the extra impervious area.

8. Highway Culvert

The culvert under the highway causes large flow restrictions which impacts up into the catchment. These are exacerbated when the highway culvert is blocked by silt or other debris.
The below image shows the extent of overland flow greater than 10cm depth during the low density residential 5% event with the existing culvert.

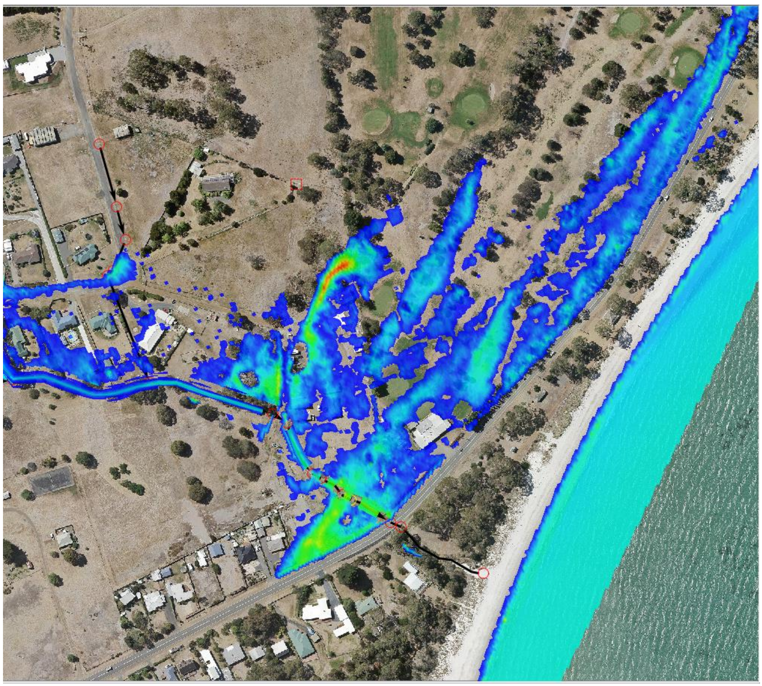

Figure 14. **5% Low Density Residential inundation areas with existing HWY culvert**

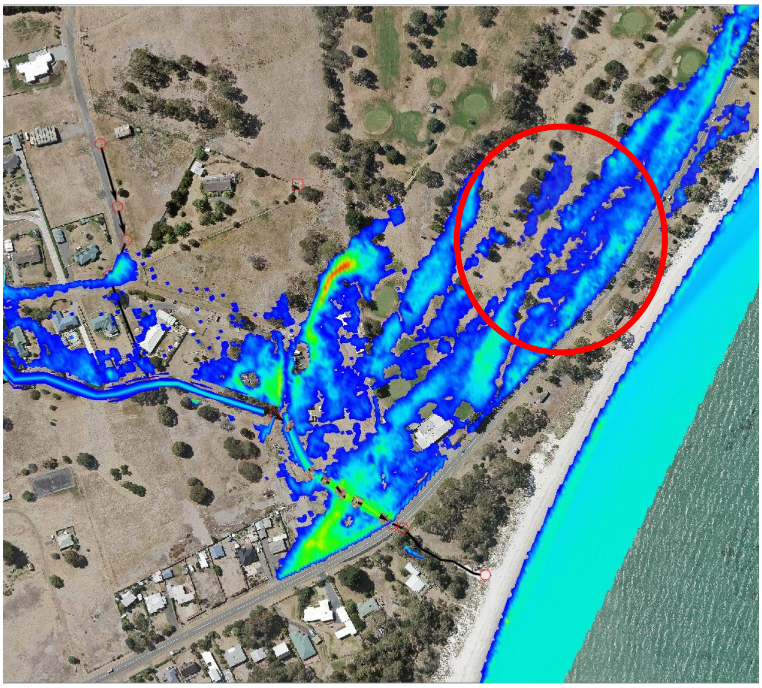

Figure 15. **5% Low Density Residential inundation area with existing HWY culvert with 30% blockage.**

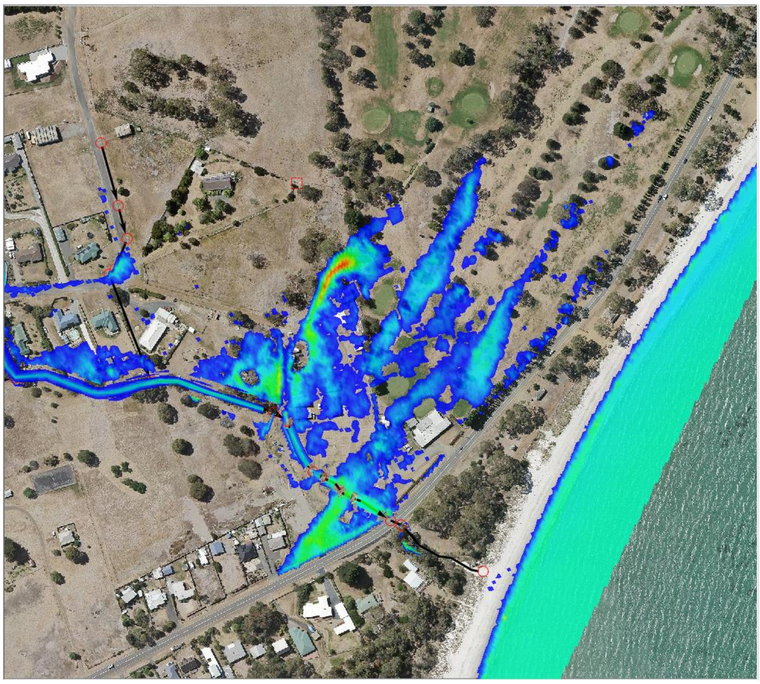

Figure 16. **5% Low Density Residential inundation area with enlarged HWY and Holkham culverts.** Note the significant decrease in inundation area.

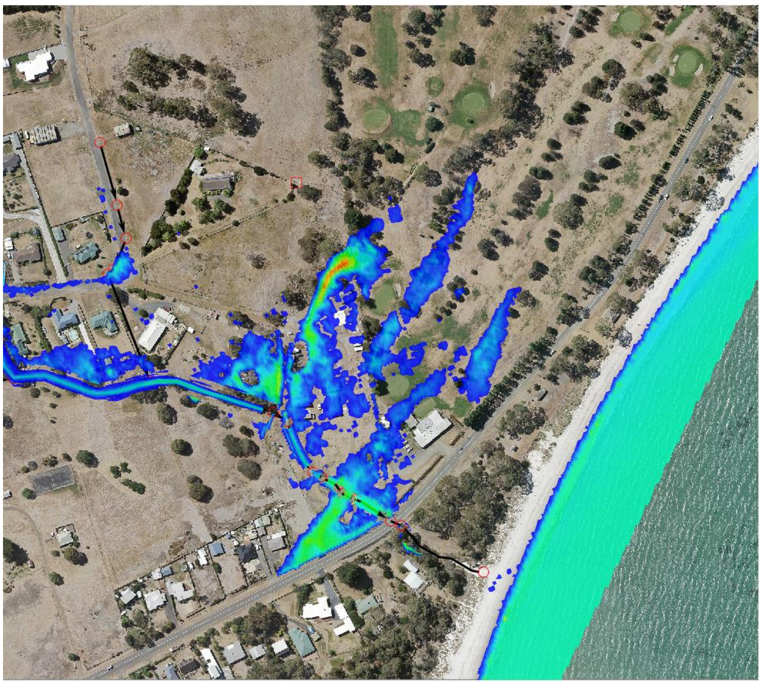

Figure 17. **5% Low Density Residential inundation area with enlarged HWY and Holkham culverts and with a bypass channel around the western boundary of the caravan park**

Recommendations.

There are a variety of short and long term works required in this catchment to reduce impacts of water flow on private property. These recommendations are general and specific design advice will be required for each job.

Minor works should generally be done to the 5pct 2hr low density residential climate change model and major works to the 1pct 4.5hr low density residential climate change model. This will ensure that works will not require upgrading as development increases.

Minor system works should aim to accommodate the 5pct event however if the 1pct event is adequately, safely and efficiently transported in the major system it may be possible to reduce the capacity of the minor system in these areas.

Works are interdependent and works that are achievable should be identified prior to undertaking any individual section of work in the lower catchment. If it is not possible to increase the highway culvert size this will impact upstream works. If this can be done expediently and combined with a diversion channel around the caravan park it will have a large effect on the amount of water that can be drained from the area.

Recommendations provided are based on modelling and lidar of the area. It is advisable to undertake specific surveys to ensure sizing and fall to accurately size infrastructure.

Recommended Actions.

Recommended actions have been divided into specific actions that may be implemented as required and long term general actions which will require further or ongoing planning.

Location	Recommendation	Possible Solution
Alma Road Culvert (Link 7)	**Increase the size of the Alma Road Culvert** to **0.66 cubic meters per second (cms)** capacity (Link 7) This will allow the low density residential 5% event to pass under Alma Road. Alma road should also have a slight redesign to allow the 1 % event to pass over Alma road and into the natural channel in a controlled manner. Alternately consider enlarging this culvert to cater for the 100 year event.	***Either 600mm pipe at 1.5% fall or a 750mm pipe at 1% for the 5% event.***
Holkham Road Central Culvert	**Increase the size of the Central Holkham Road Culvert** to **2.5 cms** capacity. This will allow the low density residential 5% event to pass under Holkham Court. Holkham Court should also have a slight redesign to allow the 1 % event to pass over Alma road and into the natural channel in a controlled manner. This may be managed by appropriate design of kerb and channel.	**1050mm pipe at 1% if depth available.**
Holkham Court	**Kerb and channel along Holkham Court**. Ensure that the driveways are not low points. This should prevent water flows into neighbouring properties. Greater than 5% flow will still pass over the road and should be directed back into the major network (the open channel) safely. This will also solve the Holkham Road entrance issues.	**Kerb and channel Holkham Court**
Caravan Park	**Create an open channel bypass around the caravan park**. Capacity should be ideally **4.5cms** for a 5% event or **6.7cms** for a 1% event. This will not prevent all the flows going through the park but will utilise the drain more efficiently causing less water to back up	**Trapezoidal drain** **Approx Dimensions for 0.5% fall** **2m base** **1m depth** **1 in 2 sides**

	around the Caravan Park and Golf Course area.	
Highway Culvert	**Increase the size of the Highway Culvert.** This culvert should be increased in size to **2.8cms** (5%) or **6.6cms** (1%) capacity to allow flows up to the 100 year event to flow under the highway**.** Increasing the size of this culvert will allow flows to escape the caravan park area more efficiently. It will also provide some protection for blockages. This will also open the area up for increases in storm surge flows into the area which have not been considered as part of this report. A non-return valve should be considered at this location.	Specific design recommended for this culvert based on a caravan park channel being constructed. Approximate dimensions of the culvert may be a 1500mm diameter culvert for the 1% event. Non return valve should be considered. Ensure that culvert design is based on flows from a caravan park channel.
Central Open Drain	**Increase the size of the open drain.** Increase the area of the open drain in locations where it is insufficient. Local knowledge will assist in providing this information. The model indicates that the area directly south of Holkham Court to is likely to require size increases. The open drains should be sized for a 1% event with capacity for **6.7 cms** capacity.	**Trapezoidal drain** **Approx Dimensions for 0.5% fall** **2m base** **1m depth** **1 in 2 sides**

Long Term Actions

Long term actions will be considered as the area is further developed.

1. **Keep the Major flow path.** A major flow route should be kept and protected through planning processes. This can either be as part of a defined channel or may be contained in constructed roads if required. Either way the Major flow route should always be designed for and protected as development increases. Development design in this area should also ensure that if the minor or major flow routes are exceeded water is not directed into private dwellings. Ensure that driveways of roads do not become low points for water entry.

2. **Design for inundation in low areas.** The low portion of the catchment is prone to inundation and storm surge. Design and development in this area should be mindful of this and be designed to accept ground water flows. The caravan park should be aware of this and manage the area accordingly and in any future development occurs here it should be designed accordingly with minimum floor heights and clear communication of the issues. The caravan park should also be prevented from placing blockages in the main flow path. The golf club may also find it advisable to do some small earth works to prevent water ingress into their building.

3. **Consider Detention or Retention options.** Detention or retention options either above ground or underground may be considered to minimise the volume of flow reaching the lower catchment. Retention would be a better option lower in the catchment, particularly if the golf course can get involved with utilising any saved water. Retention options may be a dam on the boundary of the golf course or smaller detention channels within the golf course or a detention basin further up the catchment.

Summary

Modelling has been undertaken to assess the Holkham Court catchment. The catchment is defined by an undeveloped, steep upper catchment and a lower catchment with increasing developmental pressures. It has an open drain through the centre of the catchment, large low-lying areas in the lower catchment and infrastructure of varying scope that crosses the drainage path.

There are a number of issues caused by flow paths through public property and inundation of the low lying areas. The catchment and these issues have been examined by stormwater modelling and recommendations made in this report. Some of the issues can be managed by relatively small infrastructure projects and some may be moderated by larger projects as recommended in the report. Works are unlikely to completely prevent some inundation of very low-lying areas within the caravan park.