

Esk Mapping & GIS

TASMANIAN FLOOD RECOVERY
FLOOD EXTENT PROJECT



Esk Mapping & GIS

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Project Background¹

In June 2016 Tasmania experienced recording-breaking rains which lead to widespread flooding in much of the North and North-West of Tasmania.

The Office of Security and Emergency Management, within the Department of Premier and Cabinet (DPAC) supports whole-of-government strategies to prevent, prepare for, respond to, and recover from, emergencies arising from natural disasters and as such undertook to assess the impact of the flood event.

A component of the assessment is to define the flood extent. The DPAC Tasmanian Flood Recovery Taskforce investigated a number of alternate data collection options to define the extent. A combined approach utilising both Rapid Impact Assessment (RIA) and High Water Mark (HWM) surveys was implemented.

RIA provided a rough, but timely, product that allowed the flood impacts, and infer the extent, to be mapped as they happen. In turn the HWM Survey provides the accuracy to measure the high water marks to recreate the flood soon after the event.

Project Scope

Based on the HWM Points surveyed the extent of the flood can be approximated.

A cross section, indicating a constant flood elevation, can be extrapolated for the HWM flood locations. A flood surface is interpolated and generated from the constant height flood elevations. The difference between the flood surface and Digital Elevation Model (DEM) indicates the flood extent for the areas of interest.

This project is limited to producing the flood extent polygon data for the areas of interest, based on the HWM data provided by DPAC.

Sources of Project Data

A range of initial and updated information was provided by DPAC, from these the following sources of information were utilised DPAC for the Project:

- The compiled, updated, working version of the HWM data compiled from a range of alternate sources. The data was used as the HWM locations from which the cross sections were generated - 'X_Sections_Working' Spreadsheet – supplied by DPAC, Dated 03/08/2016.

¹ Project Background sourced from: 'TasAlert - Tasmania's Official Emergency Information Source', Web: <http://www.alert.tas.gov.au/Resources/Pages/FloodRecovery.aspx>, Cited: 18/08/2016 and 'Department of Premier and Cabinet - Office of Security and Emergency Management', Web: <http://www.dpac.tas.gov.au/divisions/osem>, Cited 18/08/2016

- The initial Flood HWM and cross section data utilised for the project. The data was used as background information indicating the locations and cross sections for the initial flood mapping work which had been undertaken - 'Flood_HWM_20160706' and 'Flood_2016_Crosssections_20160706' ESRI Shapefiles - supplied by DPAC, Dated 06/07/2016.
- Additional HWM points requested by Burnie City Council - 'B16511-1' PDF and DWG data - from PDA, supplied by DPAC, Dated 09/06/2016
- The Tasmanian LiDAR DEM - 'FT_DEM_001' - supplied by DPAC.

Sources of Background Data

A range of additional LIST Open Data were used for background processing and display. These datasets are:

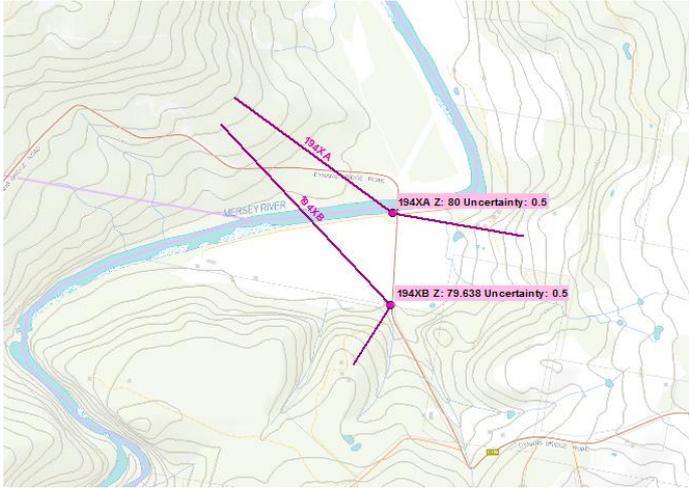
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<http://listdata.thelist.tas.gov.au/opendata/>
- *LIST Web Services - Topographic BaseMap, Web:*
<http://services.thelist.tas.gov.au/arcgis/services/Basemaps/Topographic/ImageServer>

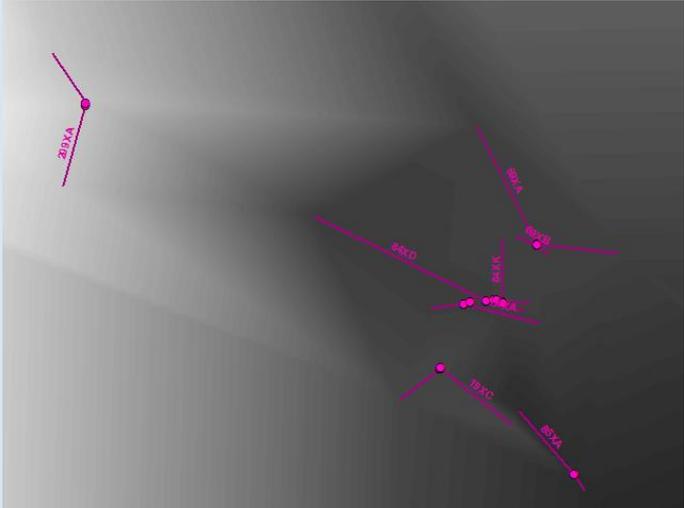
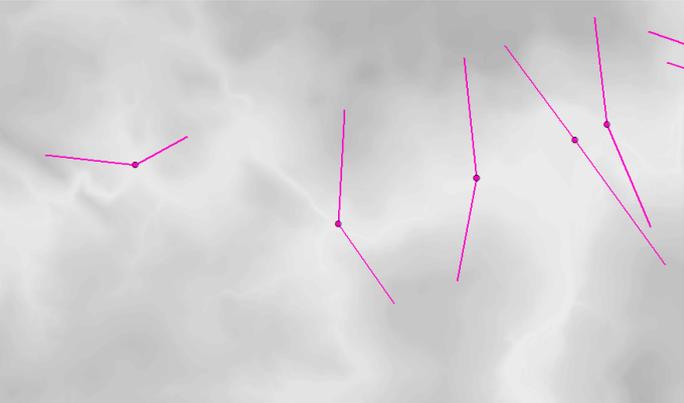
Land Tasmania is using the Creative Commons 3.0 Australia (CC 3.0 AU) license to implement its Open. The Creative Commons license: <http://creativecommons.org/licenses/by/3.0/au/>.
The data must be used in accordance with the terms and conditions -
<http://listdata.thelist.tas.gov.au/public/LISTWebServicesTermsConditions.pdf>

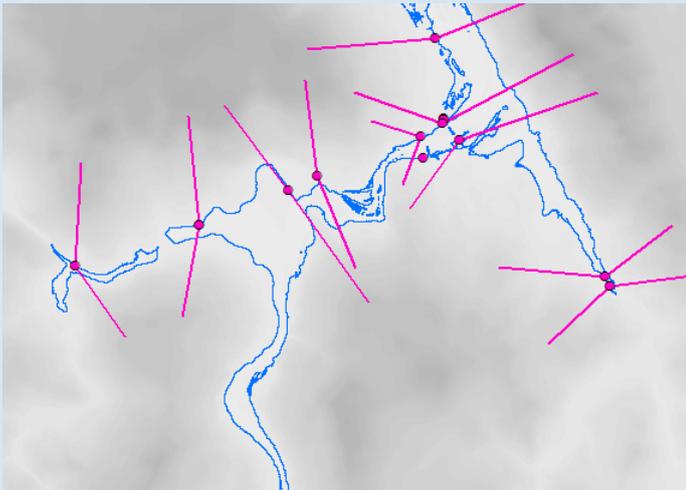
Project Methodology and Result

The Project was leveraging off the methodology established by the 'High Water Mark Survey and Flood Extent' Report.

As such the methodology and processing steps are outlined below.

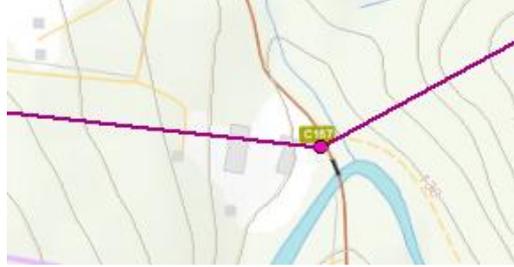
ID	Process Step	Process Description
1	Import HWM Data	The compiled and coordinated HWM Survey locations were Imported. An event theme was generated from the coordinate values, and the data was converted and saved as a point feature class.
2	Generate the Cross Sections	HWM Cross Sections were generated to provide a line of constant flood height across a lower lying area. Each Cross Section was assigned the associated HWM Survey ID and HWM Height. 
3	Create TIN Surfaces	The HWM Cross Sections were used to generate Triangular Irregular Network (TIN) Surfaces covering the required area of interest. This produces a TIN Surface of the HWM Flood Heights. 

<p>4</p>	<p>Convert to Raster GRID</p>	<p>The HWM TIN's were Converted to the Flood Raster HWM GRID Surfaces.</p> 
<p>5</p>	<p>Raster Difference</p>	<p>Raster Algebra was used to calculate the Raster Difference between the HWM Raster and DEM.</p> <p>The difference GRID has positive or negative values depicting extents where:</p> <ul style="list-style-type: none"> • The HWM Surface is above the Elevation - Areas in Flood, and • The HWM Surface is below the Elevation - Areas Not in Flood 
<p>6</p>	<p>Reclassify Raster Data</p>	<p>The Difference Raster is Reclassified to Depict the Flood Extent:</p> <ul style="list-style-type: none"> • Positive values depict where the HWM is above the Elevation, and these are Reclassified as - Areas in Flood, and • Negative valued depict where the Elevation is above the HWM and hence these are Reclassified as - Areas Not in Flood

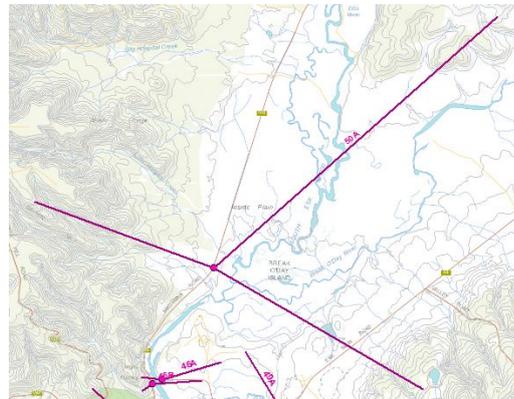
7	Convert to Vector Data	<p>The Raster is converted to Vector Data depicting the Flood Extent</p> 
8	Flood Extent Result	<p>The Resultant Polygon Data depicts the Flood Extent.</p> 

Notes and Caveats

Process Note	Note/Caveat Description
HWM Data for Processing	<ul style="list-style-type: none"> • Data is MGA Zone 55 (GDA94), AHD83. • The 03/08/2016 data contained 551 High Water Mark locations, with an additional 8 approximated and added from the PDA Survey data in Burnie. • Based on the LIST Catchments each HWM locations was assigned its associated the Catchment Number and Name.
HWM Cross Sections	<ul style="list-style-type: none"> • A total of 394 Cross Sections were generated for the Project. Each Cross Section was assigned the attributes from the associated HWM Survey location. • Cross Sections were designed to intersect the associated contours at a reasonable angle. Where practical this was generally perpendicular to the contours. The general topography and contours were used as a visual guide.

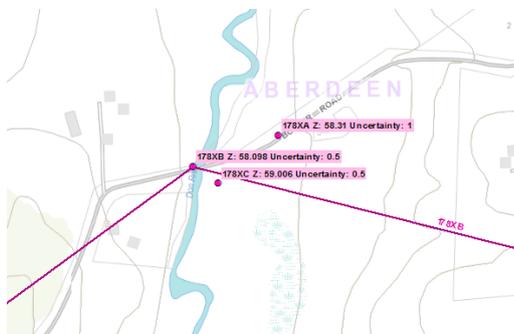


- For those upstream HWM locations at the end of the survey extent, and for larger 'flood plains' where there was minimal additional upstream HWM information HWM locations were extrapolated in multiple directions to ensure a flood elevation covered the area of interest.



For these locations a larger flat HWM flood level extent would be interpolated.

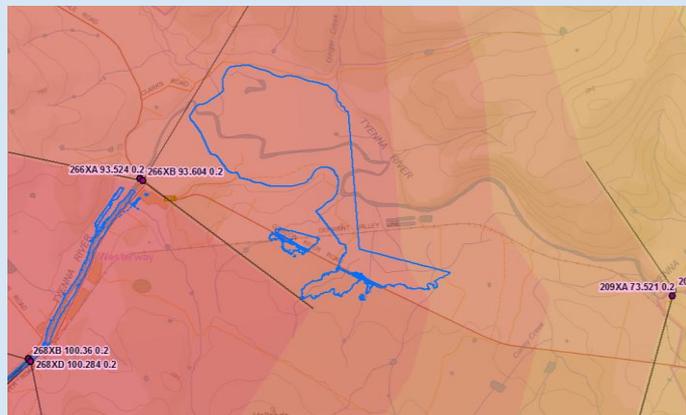
- Cross sections present different heights in similar locations feather the cross sections so that they overlap in the main stream of the flow.
- Cross Sections were not generated for all HWM Locations. Where there were a group of locations in close proximity the selection of the HWM Cross Sections was based on:
 - The number of HWM locations to choose from, and the general proximity to other HWM locations.
 - The Uncertainty assigned to the HWM location.
 - General topography and features in the area of interest.



<p>TIN and Raster Surfaces</p>	<ul style="list-style-type: none"> • The HWM Cross Sections were set as Hard Edges with the TIN generated from the HWM Height. • 2 single TIN's were generated, covering the Northern and Southern Areas of Interest. This ensured that all features and catchments within the flood extents were covered. Furthermore, and ensured a continuous boundary for any features produced from the derived Rasters. • The Raster Cell size was set to 1m to coincide with the DEM
<p>Convert to Vector Data</p>	<p>The Raster is converted to Vector Lines to depict the Flood Extent. Once produced the linear data had to be refined and tidied:</p> <ul style="list-style-type: none"> • Short lines, of less than 200m, depicting small extents were deleted from the data. • The Flood Extent was limited to areas supported by HWM Locations, and hence Lines were deleted from the data where extents had been generated due to the HWM derived surface being higher then the DEM, but not supported by HWM data. • Connectors were used to create closed extents in instances where flood extent generated exceeded the HWM locations. <p>The Vector Lines were Converted to Polygons to depict the Flood Extent.</p> <ul style="list-style-type: none"> • Small Flood Polygons were deleted from the Dataset. • Internal donut Polygons, depicting areas that were Not in Flood, were Deleted from the Dataset.
<p>Flood Extent Result</p>	<ul style="list-style-type: none"> • The Flood Extents have been generated from the Raster GRIDs and have not been smoothed or splined.  <ul style="list-style-type: none"> • The analysis is based purely off the HWM Survey locations. It does not take any other variables into account. • The Coastal and Interior extent of the Flooding are simply based on the first and last HWM location. • For numerous localities the actual DEM height is above the HWM Survey height, and hence no Flooding is shown in those areas.



- The TIN is based on an interpolation between the HWM Cross Sections. The difference between this interpolated DEM Flood surface and the Tasmanian Height DEM can lead to 'linear' edges for the Flood Extent.



Project Deliverables

The Project Deliverables are:

- HWM Survey Location Points - Point feature class of Imported locations
- HWM Flood Cross Sections - Line feature class of the Cross Sections created for the HWM Survey Points
- HWM Flood Extent - Polygon feature class of the Flood Extent Produced for the Project.
- HWM Extent Raw - Raw Linear Flood Extent data from the Raster GRID's (**This is a Raw Derived Dataset Metadata have NOT been created for this Dataset**).
- Flood Extent Metadata Document - Text document with Metadata Records.
- Tasmanian Flood Recovery - Flood Extent Project Report - Report detailing the Project and Methodology used to Generate the Flood Extent. (**This Document**).

Project Resources and Acknowledgements

Project Resources

The Project utilises some of the methodology and information set out in the following sources:

- *'Tasmanian Flood Recovery - High Water Mark Survey and Flood Extent'*, East Coast Low - Flooding, Tasmanian Flood Recovery Taskforce Report, June 2016 (Version 0.1 21/6/2016)
- *'Attn Steve - Flood Extent Analysis'*, DPAC email from Luke Roberts, Dated 25/07/2016

Report Acknowledgements

The Project Background utilises information from the following sources:

- *'TasAlert - Tasmania's Official Emergency Information Source'*, Web: <http://www.alert.tas.gov.au/Resources/Pages/FloodRecovery.aspx>, Cited: 18/08/2016
- *'Department of Premier and Cabinet - Office of Security and Emergency Management'*, Web: <http://www.dpac.tas.gov.au/divisions/osem>, Cited 18/08/2016

Project Metadata

Metadata is embedded in each of the 3 Project Feature Classes. The full Metadata Records are also included below.

HWM Survey Location Points (Flood_HWM_Survey_Locations_20160803)

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The Office of Security and Emergency Management, within the Department of Premier and Cabinet (DPAC)
supports and responds to, emergencies arising from natural disasters and as such undertook to assess the
impact of the flood event.
A component of the assessment is to define the flood extent.
The DPAC Tasmanian Flood Recovery Taskforce investigated a number of alternate data collection options to
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The 03/08/2016 data contained 551 High Water Mark locations, with an additional 8 approximated and added
from the PDA Survey data in Burnie.
Based on theLIST Catchments each HWM locations was assigned its associated the Catchment Number and
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HWM Flood Cross Sections (Flood_HWM_Cross_Sections_20160803)

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widespread flooding in much of the North and North-West of Tasmania.
The Office of Security and Emergency Management, within the Department of Premier and Cabinet (DPAC)
supports and responds to, emergencies arising from natural disasters and as such undertook to assess the
impact of the flood event.
A component of the assessment is to define the flood extent.
The DPAC Tasmanian Flood Recovery Taskforce investigated a number of alternate data collection options to
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```

This dataset is a derived produced where these HWM locations have been extrapolated to provide a constant elevation.

```
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```

Cross Sections were designed to intersect the associated contours at a reasonable angle. Where practical this was generally perpendicular to the contours. The general topography and contours were used as a visual guide.

For those upstream HWM locations at the end of the survey extent, and for larger 'flood plains' where there was minimal additional upstream HWM information HWM locations were extrapolated in multiple directions to ensure a flood elevation covered the area of interest. For these locations a larger flat HWM flood level extent would be interpolated.

Cross sections present different heights in similar locations feather the cross sections so that they overlap in the main stream of the flow.

Cross Sections were not generated for all HWM Locations. Where there were a group of locations in close proximity the selection of the HWM Cross Sections was based on:

- The number of HWM locations to choose from, and the general proximity to other HWM locations.
- The Uncertainty assigned to the HWM location.
- General topography and features in the area of interest.</gco:CharacterString>

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HWM Flood Extent (Flood_Extent_Generated_Polygons)

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and DEM gives the areas of inundation, and the Extent of the Flooding. This extent was converted to Vector
Data and polygonised. These polygons provide indicate the derived Flood Extent.</gco:CharacterString>
    </gmd:abstract>
    <gmd:purpose>
      <gco:CharacterString>In June 2016 Tasmania experienced recording-breaking rains which lead to
widespread flooding in much of the North and North-West of Tasmania.

```

The Office of Security and Emergency Management, within the Department of Premier and Cabinet (DPAC) supports and responds to, emergencies arising from natural disasters and as such undertook to assess the impact of the flood event.

A component of the assessment is to define the flood extent.

The DPAC Tasmanian Flood Recovery Taskforce investigated a number of alternate data collection options to define the extent. A combined approach utilising both Rapid Impact Assessment (RIA) and High Water Mark (HWM) surveys was implemented.

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  </gmd:lineage>
  <gmd:LI_Lineage>

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    <gmd:statement>
      <gco:CharacterString>The HWM Cross Sections were used to generate Triangular Irregular Network
      (TIN) Surfaces covering the required area of interest. This produces a TIN Surface of the HWM Flood Heights.
      The HWM TIN's were Converted to the Flood Raster HWM GRID Surfaces.
      Raster Algebra was used to calculate the Raster Difference between the HWM Raster and DEM. The difference
      GRID could be used to work out areas of inundation, and hence the Flood Extent.
      The Raster is converted to Vector Lines to depict the Flood Extent.
      Once produced the linear data had to be refined and tidied:
      - Short lines, of less than 200m, depicting small extents were deleted from the data.
      - The Flood Extent was limited to areas supported by HWM Locations, and hence Lines were deleted from the
      data where extents had been generated due to the HWM derived surface being higher then the DEM, but not
      supported by HWM data.
      - Connectors were used to create closed extents in instances where flood extent generated exceeded the
      HWM locations.
      The Vector Lines were Converted to Polygons to depict the Flood Extent.
      - Small Flood Polygons were deleted from the Dataset.
      - Internal donut Polygons, depicting areas that were Not in Flood, were Deleted from the Dataset.
    </gco:CharacterString>
  </gmd:statement>
  <gmd:processStep>
    <gmd:LI_ProcessStep>
      <gmd:description>
        <gco:CharacterString>The Flood Extents have been generated from the Raster GRIDs and have not
        been smoothed or splined.
        The analysis is based purely off the HWM Survey locations. It does not take any other variables into account.
        The Coastal and Interior extent of the Flooding are simply based on the first and last HWM location.
        For numerous localities the actual DEM height is above the HWM Survey height, and hence no Flooding is
        shown in those areas.
        The TIN is based on an interpolation between the HWM Cross Sections. The difference between this
        interpolated DEM Flood surface and the Tasmanian Height DEM can lead to 'linear' edges for the Flood Extent.
      </gco:CharacterString>
    </gmd:description>
  </gmd:LI_ProcessStep>
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</gmd:LI_Lineage>
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    <gmd:useLimitation>
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      accordance with DPAC guidelines</gco:CharacterString>
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