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Date	18 July 2016
Attention	Lindsay Callaghan
From	Clayton Johnston
Subject	**West Belconnen Hydraulic Modelling Update**

1. Background

In 2014 Jacobs developed a preliminary estimate of the 1% Annual Exceedance Probability (AEP) flood extent with one metre freeboard of Ginninderra Creek between the confluence with Gooromon Ponds Creek and Ginninderra Falls. This modelling was performed as an addendum to a broader dambreak and hydrology study of Yerrabi, Gungahlin and Ginninderra Dams. The intention of developing the 1% AEP extent, with allowance for freeboard, for this reach of Ginninderra Creek was to provide an indicative and preliminary estimate for development extents for a proposed residential development at West Belconnen prior to the completion of the full dambreak assessment.

The one-dimensional software package HEC-RAS was used to develop the preliminary 1% AEP extent. The modelling was based on the best underlying elevation data that was available at the time. This data was comprised of high-resolution LiDAR that covered the ACT side of the ACT/NSW border, and a coarser, one-second DEM data set that covered the area mostly on the NSW side of the border.

Since the completion of the 2014 modelling, new survey and LiDAR elevation data has been captured for the areas previously covered by the one-second DEM elevation data. This new data includes detailed elevation data in and around the proposed residential development in West Belconnen. As it is a major undertaking to incorporate this updated elevation data into the dambreak hydraulic model, it was considered appropriate to generate indicative flood extents using the HEC-RAS model for this current study.
Jacobs has been engaged to incorporate this newly obtained elevation data into the existing HEC-RAS model to develop an updated indicative 1% AEP flood extent. No changes other than the underlying elevation data were to be made to the HEC-RAS model. This update was not applied to the full dambreak model, hence all results are indicative only.

2. Objectives

The purpose of this short report is to outline the procedure used to update the 2014 HEC-RAS model with the newly obtained elevation data.

The key outputs of this work are GIS shapefiles of the:

- Indicative 1% AEP flood extent,
- Indicative 1% AEP flood extent + one metre of freeboard; and
- Indicative Probable Maximum Flood (PMF) design flood extent.

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3. HEC-RAS Modelling

This section will outline the key inputs to the HEC-RAS model, the method used to incorporate the updated elevation data and the model results.

3.1 Inputs

The key inputs to the hydraulic model were the inflow data, boundary conditions, Manning's values and the underlying Digital Elevation Model (DEM). This assessment includes an update to the DEM only, however each of these model components are discussed in the sections below for completeness.

3.1.1 Digital Elevation Model

In order to incorporate the newly available elevation data, the geographical information system software package Arc GIS was used. The recently captured survey data and NSW two-metre LiDAR data was combined and converted into a raster. The original LiDAR from the 2014 modelling was used where updated survey or LiDAR was not available. All three datasets were combined into one DEM.

This updated DEM was found to be similar to the original DEM in places, however significant differences did exist between the updated DEM and the previously used one-second DEM. An sample cross section taken from Ginninderra Creek is shown in Figure 1. It can be seen that in places, particularly the stream bed, the elevation data used in the 2014 model, which has been sampled in this instance from the one-second DEM, reports a different elevation than the updated 2016 data.

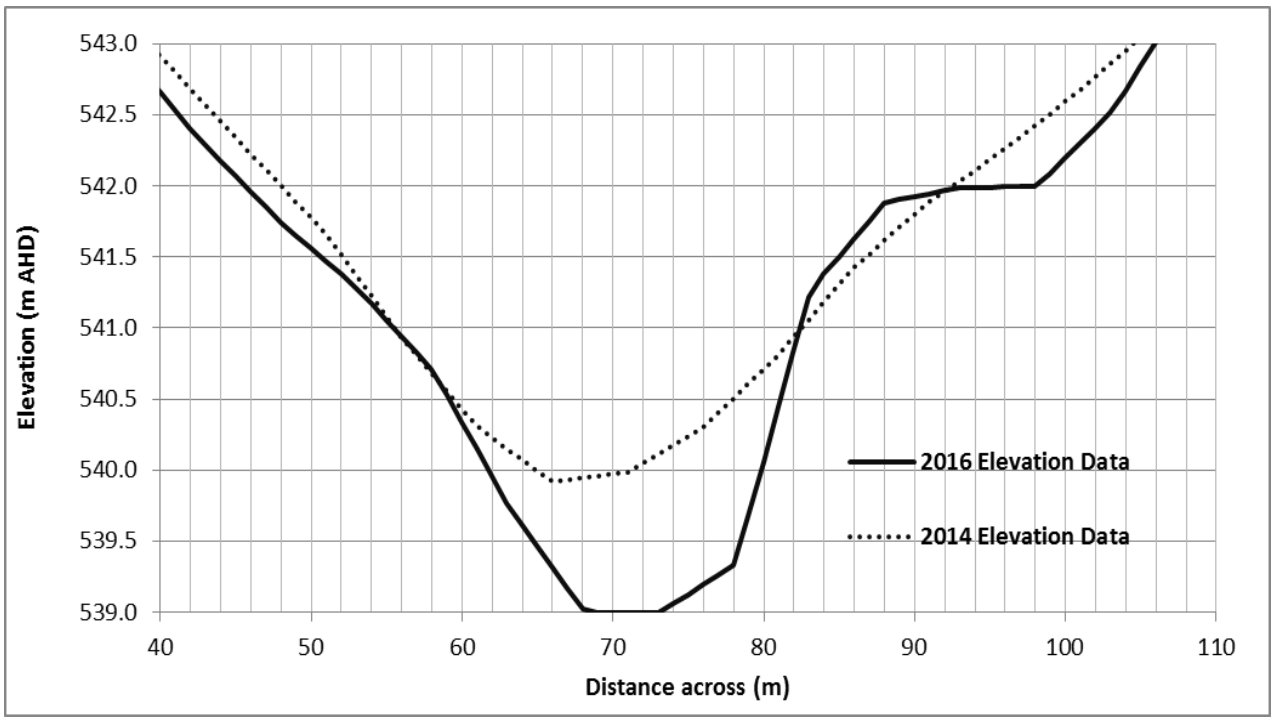

Figure 1: Comparison cross section of Ginninderra Creek

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Figure 2 displays the extents of the different elevation data sets.

The elevations of each of the HEC-RAS cross sections (as shown in Figure 1) were re-extracted from this newly compiled DEM and used as input to the hydraulic model.

3.1.2 Inflows

The HEC-RAS model requires inflows to be entered for Ginninderra Creek at approximately Osburn Drive, and at Gooromon Ponds Creek just upstream of the confluence with Ginninderra Creek.

The original 2014 modelling estimated the 1% AEP 24-hour flood on Ginninderra Creek at Osburn Drive using flood frequency analysis performed on gauge 401750.This flow was found to be 110 m^3/s.

For the Gooromon Ponds Creek inflow, the Australian Rainfall and Runoff (ARR) Regional Flood Frequency Model (ARR, 2015) was used to calculate the 1% AEP flood. This estimated an inflow of 129 m^3/s.

Both the inflow values used in the 2014 model were adopted for use in this application of the model.

The PMF inflows for Ginninderra Creek at Osburn Drive and for Gooromon Ponds Creek have been taken directly from Table 8-24 in *Ginninderra Creek Flooding and Dams Assessment – Final Project Report – Hydrology, Dambreak and Consequence Assessment (Jacobs, 2014)*. Being a dambreak study, the Jacobs 2014 report contains various estimates for the PMF. The 'Ginninderra Dam with failure' estimates were adopted for use in the current modelling. The adopted Ginninderra Creek inflow was 4,810 m^3/s and the adopted Gooromon Ponds Creek inflow was 170 m^3/s to add to a total of 4,980 m^3/s immediately downstream of the confluence.

The discharge downstream of the confluence was simply the addition of the two upstream inflows.

3.1.3 Boundary Conditions

The HEC-RAS model requires boundary conditions to be stipulated at the upstream (Ginninderra Creek and Gooromon Ponds Creek) and downstream (Ginninderra Creek at the falls). Normal depths were estimated at these locations based on the bed slope in the vicinity.

3.1.4 Manning's Roughness Values

Manning's roughness values are defined for the channel and banks of all cross sections to provide an estimate of the attenuation associated with the surface materials. For this study, Manning's 'n' values were determined using imagery of the study area in conjunction with Table 3-1 found in *HEC-RAS River Analysis System: Hydraulic Reference Manual (2010).*

For each cross section, the channel and banks were assigned the same Manning's value. The Manning's value assigned to all reaches of Ginninderra Creek (upstream and downstream of the junction) was 0.035. A Manning's value of0.040 was applied for the Gooromon Ponds Creek tributary.

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3.2 Outputs

The HEC-RAS model was re-run using the updated cross sections and other input data. The water surface levels at each cross section were extracted and overlaid on the DEM in Arc GIS to produce a flood extent contour.

Figure 3 shows the flood extents for the indicative 1% AEP, indicative 1% AEP + 1m freeboard and indicative PMF.

Figure 4 provides a comparison between the 1% AEP + 1m freeboard flood extents generated using the different underlying DEM data. As described in Section 3.1.1, there exist some differences in bed elevations between the DEM used in the 2014 model and the current DEM. These differences exist chiefly where the 2014 data is based upon one-second DEM (more coarse data) was used in the absence of LiDAR data. Most of the differences in the extents produced can be attributed to these differences in bed elevations. The 2014 HEC-RAS modelling did not estimate the PMF flood extent.

The HEC-RAS model used in this study was originally developed to provide an indicative 1% AEP flood extent prior to the completion of the full Ginninderra Creek dambreak model. The full dambreak modelling has subsequently been completed (2014) using the original DEM including the coarse one-second data for areas of NSW. As the revision of the dambreak hydraulic model is a major undertaking, for the purposes of this current study it was considered appropriate to generate indicative flood extents using the HEC-RAS model.

The current study used the HEC-RAS model to update indicative 1% AEP flood extents and to estimate the PMF extent using the latest elevation data. As such, the outputs associated with this report reflect indicative flood extents only. Greater confidence in the results would require revising the inputs and re-running the dambreak hydraulic model. For comparison, the latest HEC-RAS model PMF results are shown with the dambreak model results in Figure 5. This shows that the extent produced by the HEC-RAS modelling is similar to the extent produced by the dambreak modelling in 2014. The major differences between the two models occur near the boundaries of the modelling extent of the HEC-RAS model. This is to be expected and provides a degree of confidence to the results of the current study.

Each of the three extents generated as part of the current study has been provided as shapefiles with this memorandum.

4. References

Rahman, A., Haddah, K., Haque, M.M., Kuczera, G., Weinmann, P.E., (2015) *Revision Projects; Project 5: Regional Flood Methods – Stage 3 Report.* Australian Rainfall and Runoff (ARR), Institute of Engineers Australia, Barton, ACT, 2015.

Jacobs, (2014) *Ginninderra Creek Flooding and Dams Assessment – Final Project Report – Hydrology, Dambreak and Consequence Assessment,*

US Army Corps of Engineers, (2010) *HEC-RAS River Analysis System: Hydraulic Reference Manual (2010) Version 4.1*, Hydrologic Engineering Centre

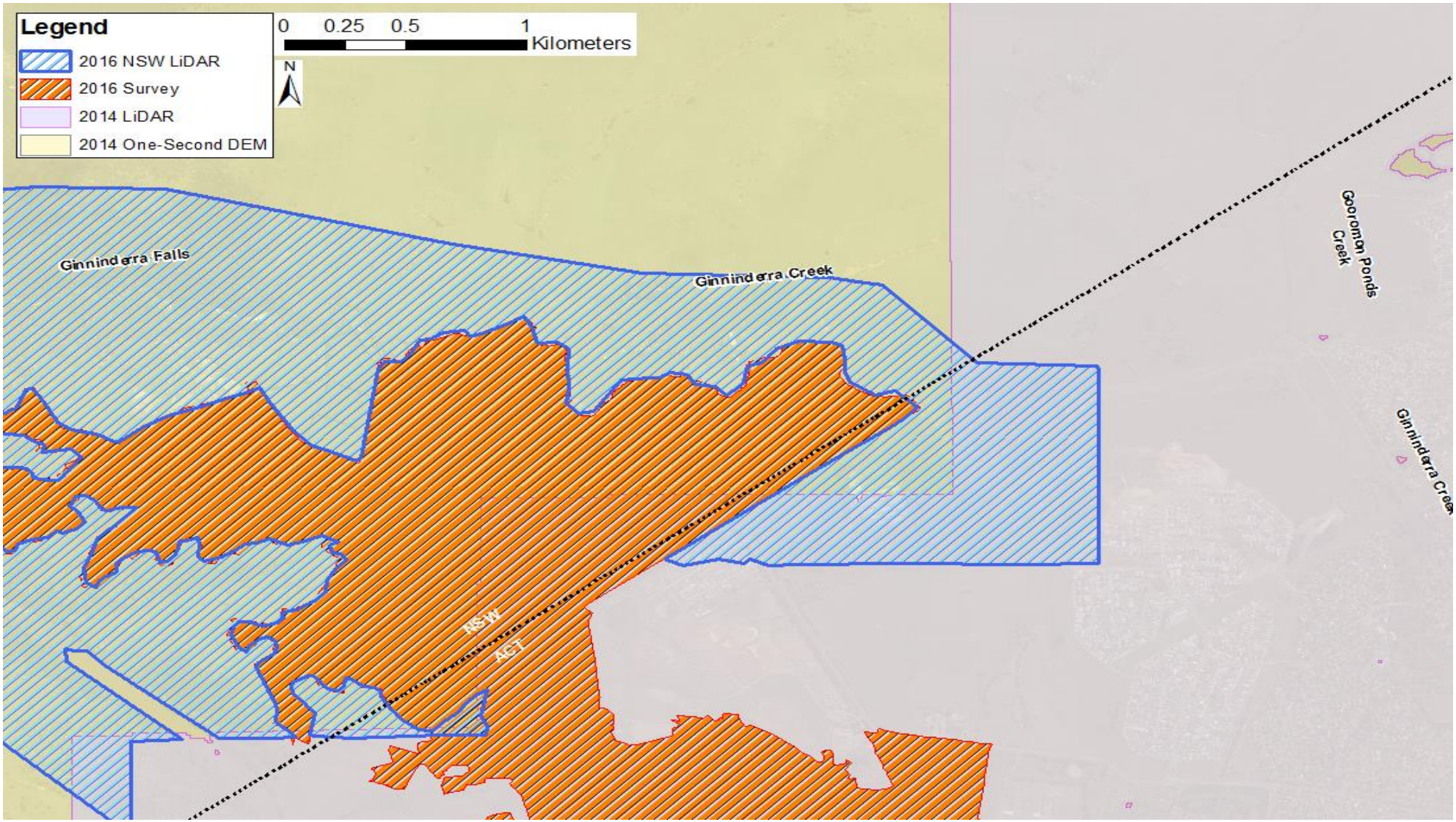

Figure 2: Extents of elevation data sets

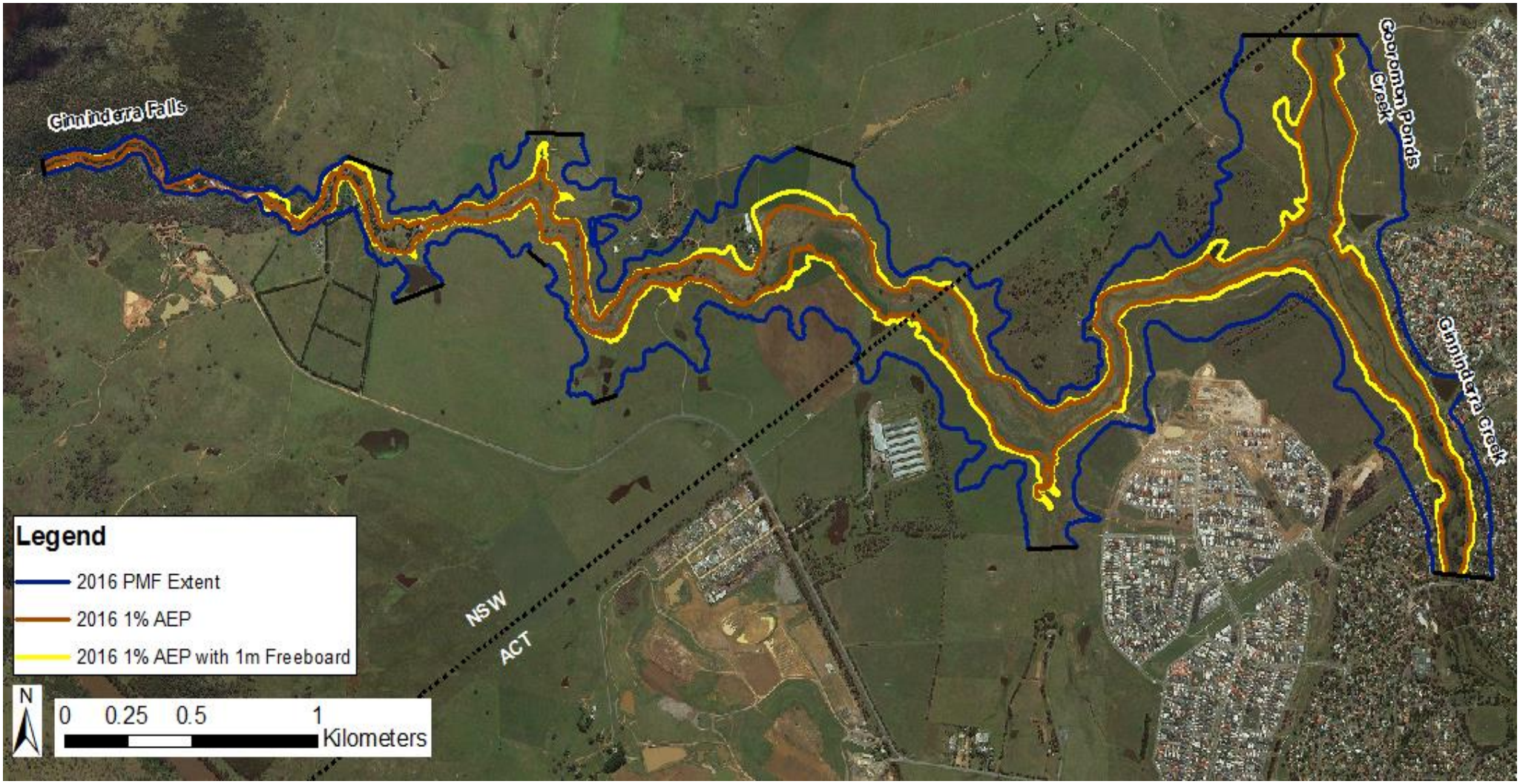

Figure 3: 1% AEP flood extent with and without 1m freeboard and PMF extent

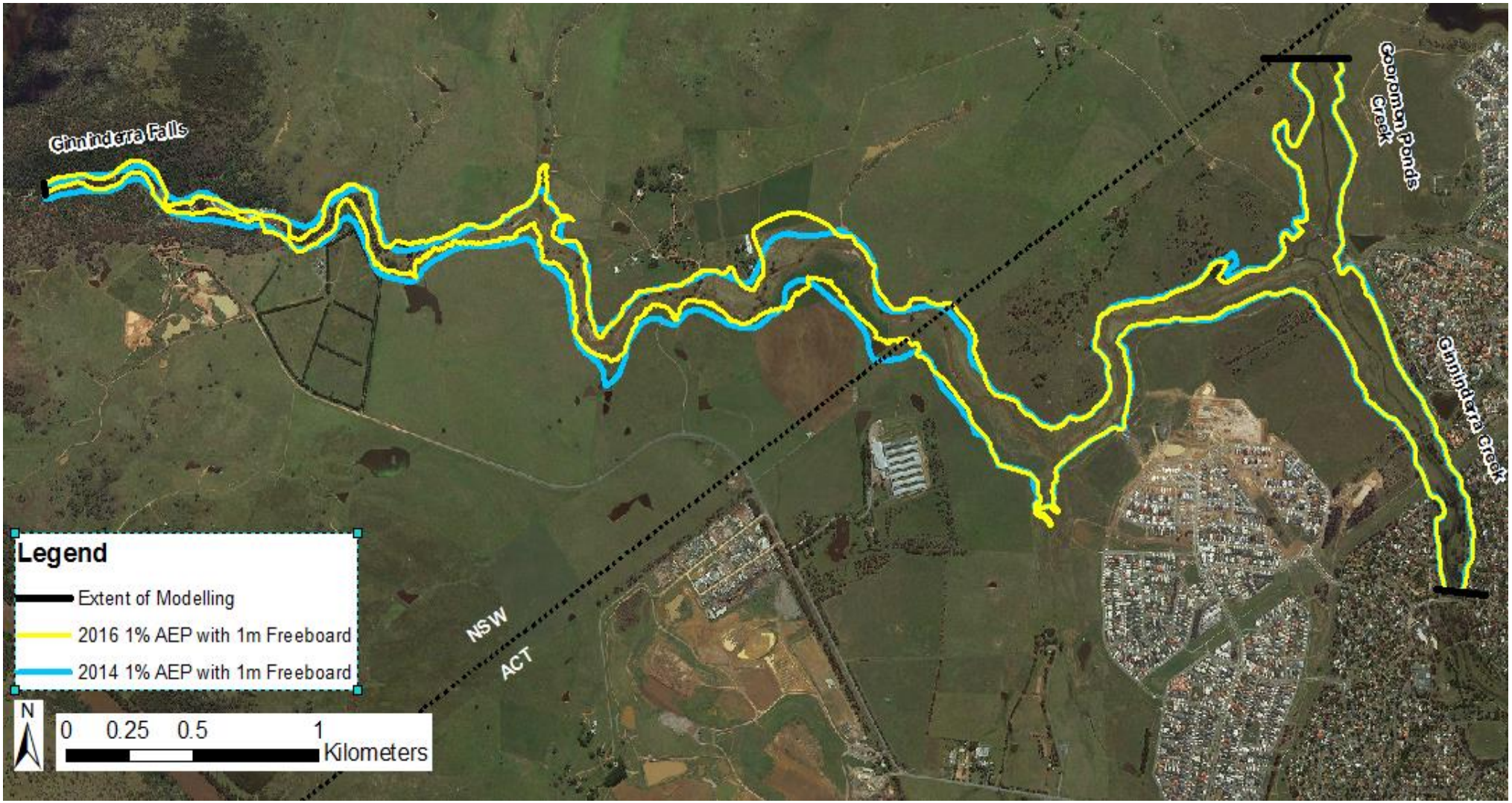

Figure 4: Comparison of 2014 and 2016 1% AEP extents with 1m freeboard

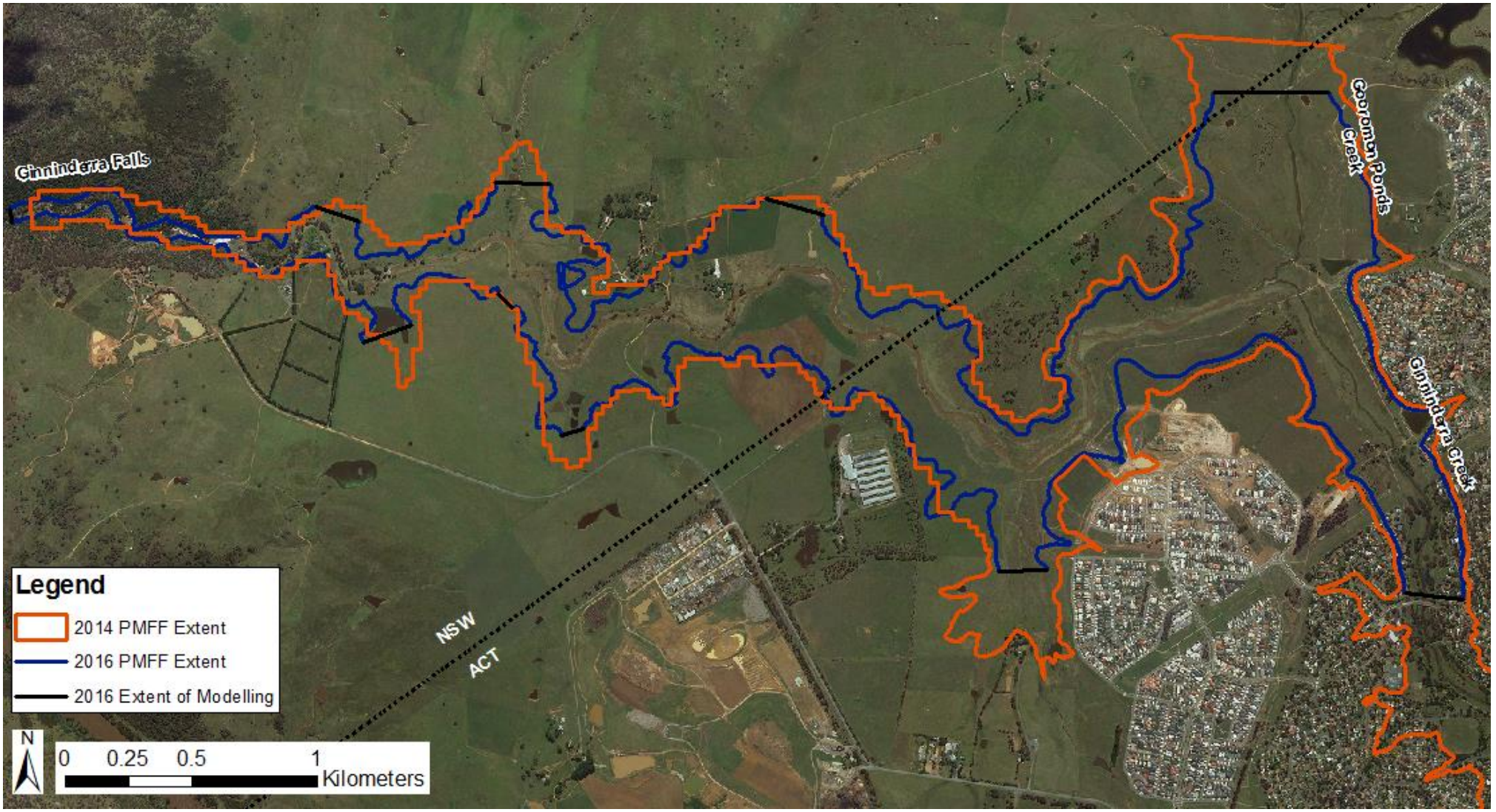

Figure 5: Comparison between 2014 and 2016 indicative PMF extents