Appendix A

Additional Relevant Policies and Guidelines

Additional Relevant Policies and Guidelines

AS/NZS 3100:2009 Risk Management – Principles and Guidelines

AS3100:2009 provides principles and generic guidelines on risk management. The principles outlined in the document can be used to assess flood risk and this standard forms the basis of the AIDR Handbook 7 approach to flood risk management.

Australian Governments Climate Change Impacts and Risk Management – A Guide for Business and Government (Department of Environment and Energy, 2006)

This guide provides a framework for considering and managing risk due to climate change. It suggests a planning horizon of 25 years to suit strategic business planning timeframes. The framework is based on AS3100:2009 and has been considered in the application of the climate change projections and the potential change to flood risk as a result of these projections (Australian Rainfall and Runoff, Geoscience Australia, 2019).

This is a national guideline for the estimation of design flood characteristics in Australia. The aim of the guide is to provide the best available information on design flood estimation in a manner suitable for use by Australian practitioners to be able to estimate the design flood problem, flood processes, and engineering hydrology. It is an important component in the provision of reliable and robust estimates of flood risk. Consistent use of Australian Rainfall and Runoff (ARR) ensures that development does not occur in high risk areas and that infrastructure is appropriately designed.

Other State guidelines

The following guidelines inform best practices approaches to incorporate climate change into flood planning:

Practical Consideration of Climate Change – Flood risk management guideline (DECC, 2007).

Technical Guide for Climate Change Adaptation for the State Road Network (RMS, in draft).

Other guidelines used to support the adopted approach and identify key sources of information to inform the flood impact assessment include:

Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Volume 2 (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (DECC, 2008).

NSW Sustainable Design Guidelines Version 4.0 (Transport for NSW, 2017).

Local Authority Guidelines and Policies

City of Penrith Local Flood Plan, State Emergency Service, 2012

The City of Penrith Local Flood Plan covers the preparedness measures, the conduct of response operations and the co-ordination of immediate recovery measures for all levels of flooding on the Nepean River within the boundaries of the Penrith City. For the study area this Plan covers some of the South Creek catchment through the suburb of St Mary's.

Penrith Development Control Plan 2014

The purpose of the Penrith Development Control Plan 2014 (DCP) is to guide development within the Penrith LGA. Section C3 outlines development guidelines with respect to all aspects of the water cycle including, natural waterways, riparian corridors, wetlands and groundwater dependent ecosystems.

Relevant objectives for this assessment include (noting a-d are not relevant):

e. to protect water catchments and environmental systems from development pressures and potential pollution sources
f. to protect and enhance natural waterways, riparian corridors, wetlands and groundwater dependent ecosystems
g. to protect, conserve and enhance surface and groundwater resources
h. to integrate water management with stormwater, drainage and flood conveyance requirements

i. to utilise principles of Water Sensitive Urban Design (WSUD) in designing new developments or infill development in existing areas.

Other relevant flooding controls include:
Flood planning level - 1% Annual Exceedance Probability (AEP) plus 0.5 m freeboard but developments that may have a significant impact on the extent of flooding will also need to consider the Probable maximum flood (PMF) when determining flood hazard.

Council will not support development obstructing overland flow paths. Developers are required to demonstrate that any overland flow is maintained for the 1%AEP overland flow.

Council will not grant consent to filling of floodways or high hazard area.

On-site Stormwater Detention shall be design and constructed to ensure that for all rainwater events up to and including the 1% AEP event, new developments do not increase stormwater peak flows in any downstream areas.

Section C3 of the DCP defines the stormwater quality requirements for all development types. For assessment purposes, the project is considered as a land use type “other” which require water quality treatment measures to be incorporated where the existing impervious area is increased by greater than 250 m^2. The applicable pollution load reduction targets are:

- 90% reduction in the post development mean annual load of total gross pollutant (greater than 5 mm)
- 85% reduction in the post development mean annual load of TSS
- 60% reduction in the post development mean annual load of TP
- 45% reduction in the post development mean annual load of TN.

Liverpool City Local Flood Plan, 2015

The Liverpool City Local Flood Plan 2015 covers the preparedness measures, the conduct of response operations and the co-ordination of immediate recovery measures for all levels of flooding in the South Creek catchment including Badgerys Creek. For the study area, the Plan covers both South Creek and Badgerys Creek upstream of Elizabeth Drive.

Liverpool Local Council Development Control Plan, 2008

The Liverpool Development Control Plan 2008 defines that the post development water quality shall be reduced to the following targets when compared to pre-development water quality:

- 45% reduction in the mean annual load of TN
- 45% reduction in the mean annual load of TP
- 80% reduction in the mean annual load of TSS.

Appendix B

Methodology Details

Flooding methodology

Details of the flooding methodology adopted for this assessment are provided below.

Hydrologic modelling

Hydrologic modelling converts the design rainfall information into flow hydrographs that are utilised by the hydraulic model to understand flood heights, depths and velocities for a range of design storms.

The existing XP-RAFTS hydrological model developed for Penrith City Council (Updated South Creek Flood Study, WP, 2015) was obtained for this assessment. Minor revisions were made to the model to update it such that it better reflects existing catchment conditions following development that has occurred within the catchment since the model was originally developed. In addition, the model was updated to incorporate the latest design rainfall information, available from the Bureau of Meteorology (BoM), which included 2016 design rainfall depths.

The initial and continuing losses adopted for the model were derived during model calibration and verification. An adopted initial loss of 30 mm and continuing loss of 2 mm/hr were adopted for the hydrologic model.

The XP-RAFTS model covers the study area for the project off-airport. The available on-airport hydrology (established through the development of a DRAINS model) developed for the Western Sydney International project was extracted from the model and used to inform the hydrologic behaviour of the Western Sydney International (on-airport) and connections to the off-airport hydrologic catchment. Based on guidance within Australian Rainfall and Runoff 2019 (ARR2019) (Ball et al 2019), the ensemble method was applied and the median peak flows to be extracted to apply within the hydraulic model.

Hydraulic modelling

Hydraulic modelling utilises the flow hydrographs and the catchment and watercourse topography to predict flood behaviour including flood levels, flood extents, flood velocities and the duration of inundation in the catchment and watercourse.

A TUFLOW one dimensional/two dimensional hydraulic model has been developed for this project to convert runoff rates into flow depths and velocities for both the existing and design scenarios. This was developed as opposed to utilising the existing RMA-2 model developed for Penrith City Council as the TUFLOW model offers more versatility and efficiency than an RMA-2 model to assess rail alignment options and cross drainage sizing. TUFLOW is a software that is widely used in Australia for hydrodynamic modelling in the public and private sector. The model has been prepared to assess the full range of flood events. This includes the 0.5 exceedances per year (EY) event (meaning an event which has a chance of occurring on average once every 2 years), the 0.2 EY (i.e. a chance of occurring once every 5 years), 5% Annual Exceedance Probability (AEP - indicating there is a 5% chance that this event could be exceeded in any one year), 1% AEP, 1% AEP including climate change and Probable maximum flood (PMF) for the existing base case conditions and the project. These events cover the full range of probable events and they have been used to inform the design of project specific elements of the drainage design.

Key features and assumptions used in development of the TUFLOW model include:

The model is based on a 10 m grid resolution with model elevations defined based on LiDAR.

Viaducts were represented as two dimensional layered flow constrictions with losses applied calculated based on Bradleys Method as presented within the *Guide to Bridge Technology Part 8 Hydraulic Design of Waterway Structures* (Austroads, 2018).

Culverts were represented as linked one dimensional elements within the model.

Initial water levels were applied to represent all storages (farm dams) as full at the start of a storm event.

Manning's n roughness values as shown in Table B.1, were used. These values represent the surface roughness or friction that ground surface applies to water flow. It is noted that buildings have been included in the model as rough areas that allow storage of floodwaters but do not block flows.

Table B.1 Adopted Manning's n roughness value

Land Use	Design Event	20% Increase Sensitivity Scenario	20% Decrease Sensitivity Scenario
Low density vegetation	0.040	0.032	0.048
Medium density vegetation	0.070	0.056	0.084
High density vegetation	0.085	0.068	0.102
Creed bed – densely vegetated	0.120	0.096	0.144
Creek bed – moderately vegetated	0.080	0.064	0.096
Lakes, farms dams	0.020	0.016	0.024
High density residential	0.050	0.040	0.060
Low density residential	0.040	0.032	0.048
Roads, carparks	0.015	0.012	0.018
Creek bed – lightly vegetated	0.030	0.036	0.024

Calibration and Validation of flood model

Calibration and validation of a model are required to ensure the adopted model adequately predicts flood behaviour. Calibration involves utilising historic flood event data (referred to as observed data) to change model inputs such as Mannings n roughness value to get the model to replicate the historic flood event. Validation then involves checking the model inputs against another historic event. Where historic data is available this is the recommended method for checking the model inputs are suitable.

The hydraulic model has been calibrated at two locations that correspond to existing NSW Water stream gauges, South Creek at Elizabeth Drive and South Creek at the Great Western Highway.

Three historical flood events have been chosen to calibrate and validate the flood model. These are:

- Calibration: June 2016 and June 1991
- Validation: August 1992.

A review of previous reports suggested that the 1991 and 1992 flood events were approximately close to a 10% AEP event, while the 2016 event was equivalent to a 5% AEP flood event (Cardno, 2017) in the upper South Creek catchment.

For the June 2016 event, the calibration of the model to observed peak flood levels was adequate at the Great Western Highway gauge but the model predicted a higher and earlier peak at the Elizabeth Drive gauge.

For the June 1991 storm event, the modelled peak flood levels were similar at both gauges but the time to peak height and duration of inundation were different to the observed data.

The validation event of August 1992 indicated the model could predict both the peak flood level and duration of inundation at the Great Western Highway gauge compared to the observed data. But the Elizabeth Drive observed data was not matched by the modelled data.

A comparison of modelled design flood extents was also made to the flood extents from Penrith City Council's adopted flood study (Penrith City Council, 2015). Both models predict similar flood extents for the three design flood presented (5%AEP, 1%AEP and PMF) along the main branch of South Creek. Differences in flood extents are most notably along minor tributaries to South Creek. The Council's flood study was developed with a focus on flood behaviour along the main branch of South Creek, Kemps Creek, Ropes Creek, part of Badgerys Creek and Thompsons Creek, while the project flood assessment has accounted for all tributaries that cross the project alignment.

A comparison of design peak flood levels was also made between the project flood model and Council's flood study at key locations. This comparison (refer Table B.2) shows that the project flood model generally predicts lower flood levels than the Council flood study.

Table B.2 Comparison project peak flood levels with Council flood study

LOCATION	DIFFERENCE IN PEAK FLOOD LEVEL (M)		
	5%AEP	1%AEP	PMF
South Creek – Downstream of Great Western Highway	-0.18	-0.53	0.01
South Creek – Upstream of Great Western Highway	-0.40	-0.61	0.13
South Creek – Upstream of M4 Motorway	-0.96	-1.22	0.13
Ephemeral tributary downstream of project tunnel portal	-0.03	-0.93	0.13
Blaxland Creek downstream of project crossing	-0.10	-0.11	0.27
Blaxland Creek upstream of project crossing	0.06	0.2	0.57
South Creek upstream of Warragamba to Prospect Water Supply Pipelines	-0.07	-0.13	0.36
Confluence of Badgerys Creek and South Creek	-0.08	-0.12	-0.06
South Creek upstream of Elizabeth Drive	0.08	0.06	0.17
Badgerys Creek upstream of Elizabeth Drive	-0.07	-0.04	0.28
South Creek near Turnbull Avenue	0.00	0.05	0.37
Badgerys Creek near Leggo Street	-0.01	0.05	0.10
South Creek near Victor Avenue	-0.01	-0.01	0.32
Confluence of Cosgroves Creek and South Creek	-0.04	-0.05	0.08
Thompson Creek downstream of project	-0.09	-0.09	0.13
South Creek downstream of Bringelly Road	-0.09	-0.07	0.09

Notes Positive value indicates peak flood level in project flood model is higher than Council's flood study

The discrepancies in peak flood levels are primarily due to the result of the application of different design temporal patterns and rainfall depths between ARR1987 and ARR2019. The methodology followed for the project hydrological assessment follows ARR2019 by enveloping the results of several critical durations found along the floodplain. Additionally, design rainfall intensities are different between both design guidelines. For this area the ARR2019 design rainfall intensities are generally lower compared to the ARR1987 design rainfall intensities. This would also result in lower peak flood levels. The adopted approach for the PMF design rainfall however has not changed from 2015 to 2019.

Further differences in flood behaviour between the project flood modelling and the Council flood study can be attributed to:

- LiDAR data
- Bed roughness values
- Hydrodynamic model software: Council adopted RMA-2 whilst TUFLOW was used for the project
- Design blockage assumptions.

Despite the differences noted, it was concluded that the flood model build was adequate for this assessment.

Flood model build features

A base case has been developed as a benchmark to determine the flood impact assessment for the project. Due to the proximity and intrinsic linkage between the designs for the project and Western Sydney International, the design for the project cannot be considered exclusive of Western Sydney International. Therefore, the Western Sydney International project (Stage 1) was incorporated into the base case as the benchmark for the flood impact assessment. The files provided by Western Sydney Airport, adopted in the base case scenario, include:

- Earthworks model - which includes the finished ground surface levels for stage 1; and
- DRAINS model – which includes the proposed drainage features for stage 1.

The method of incorporating the Western Sydney International design information has included clipping the catchment for Western Sydney International from the SMWSA XP-RAFTS model and using the hydrographs generated by the Western Sydney International DRAINS model as inflows to the TUFLOW model.

In review of the received Western Sydney International project information, several limitations were identified in the DRAINS model and have been addressed in the following ways:

1. Design Rainfalls – the model only included rainfall data for storm recurrence intervals up to the 1% AEP. To simulate flood scenarios for less frequent events, it has been necessary for the Technical Advisor (TA) for the project to provide additional design storms for the 0.05% AEP and PMF events. These design storms have been generated in accordance with ARR 2019 and BOM rainfall data.
2. Climate Change – the model has not incorporated climate change. A climate change multiplier of 1.197 has been applied to the 1%AEP storm event.
3. Bypass Flows – the model has sized infrastructure for the 1% AEP design flows only and no allowance has been made for bypass flows when simulating design events greater than the proposed infrastructure capacity. Therefore, the TA has added bypass flow links to the Drains model and assumed a point of discharge (in the TUFLOW model) based upon supplied site grading.
4. Inconsistencies between Western Sydney International documentation and model files, including:
    a. The DRAINS file excludes the Western Sydney International Detention Basin 2. The catchment draining to Detention Basin 2 is indicated to convey runoff towards Detention Basin 1. The project has adopted the model as received on the assumption that only Detention Basins 1 and 3 address excess runoff from the airport draining towards Badgerys Creek catchment.
    b. The DRAINS model (GHD, 2016) excludes Detention Basins 6 and 7.

Flood model build limitations

The project case is inclusive of the base case, as defined above. The project case has been assessed both inclusive and exclusive of climate change. Assessment of the project alignment flood immunity is required inclusive of climate change. The impact of the project on flood behaviour and other properties has been undertaken excluding climate change.

For modelling purposes and considering the level of detail required for definition design and the Environmental Impact Statement, the following assumptions have been made in preparing the project TUFLOW model:

Cut-off drains are to be provided upstream of the alignment in cutting. The cut-off drains are assumed to intercept 100 per cent of lateral runoff from adjacent catchments and connect to the inlet of the adjacent transverse culvert headwall. The cut-off drains would be designed to intercept the 1% AEP (inclusive of climate change). Flows exceeding the capacity of the cut-off drain would enter the rail corridor and be conveyed along the alignment. In the majority of cases, the ultimate point of discharge would be the same upstream transverse culvert headwall. Therefore, this approach to modelling is not anticipated to have a significant impact upon flood results.

Troughs/dives adjacent to tunnel portals are assumed to be bunded and/or provided with upstands to the intercept any local overland flows to prevent Probable Maximum Flood (PMF) flows entering the tunnel portal.

On-Site Detention basins have not been incorporated into the TUFLOW flood model. Therefore, the flood mapping results are considered conservative.

A 50/50 catchment split of the rail corridor is assumed to discharge to the upstream/downstream headwalls of transverse culverts. This is considered conservative for sizing of the transverse culvert since the track drainage is intended to capture and discharge the design event (typically 1% AEP) flows from entire rail corridor to the downstream side of the transverse culvert. The 50/50 flow split has been adopted in the TUFLOW model as it better represents the surface runoff from the rail alignment for storms event greater than the 1% AEP.

The impervious/pervious breakdown for the project alignment and stabling/maintenance facilities has not been updated from the existing conditions. This approach is considered appropriate for design storms up to the 1% AEP on the basis that on-site detention shall be provided. Typically, on site detention (OSD) is provided to limit post-development runoff to that of the existing scenario. For less frequent events (those > 1% AEP), the difference in runoff is less sensitive to catchment permeability. Therefore, this approach is also considered appropriate for the definition design/Environmental Impact Statement stage of flood modelling.

The flood model incorporates the alignment and stabling/maintenance facility location, only.

The station catchments have been included in the model but other ancillary works for the station precincts is not included in the flood model.

Viaduct track drainage (discharging at 36 linear metres into the waterway consistent with the downpipe frequency) has not been incorporated in the TUFLOW flood model as it is unlikely to alter peak flood levels due to the relatively large size of the upstream catchment compared to the viaduct drainage catchment area.

Track alignment drainage (i.e. cess drains, pit and pipes) have not be incorporated into the TUFLOW model based upon the following justification:

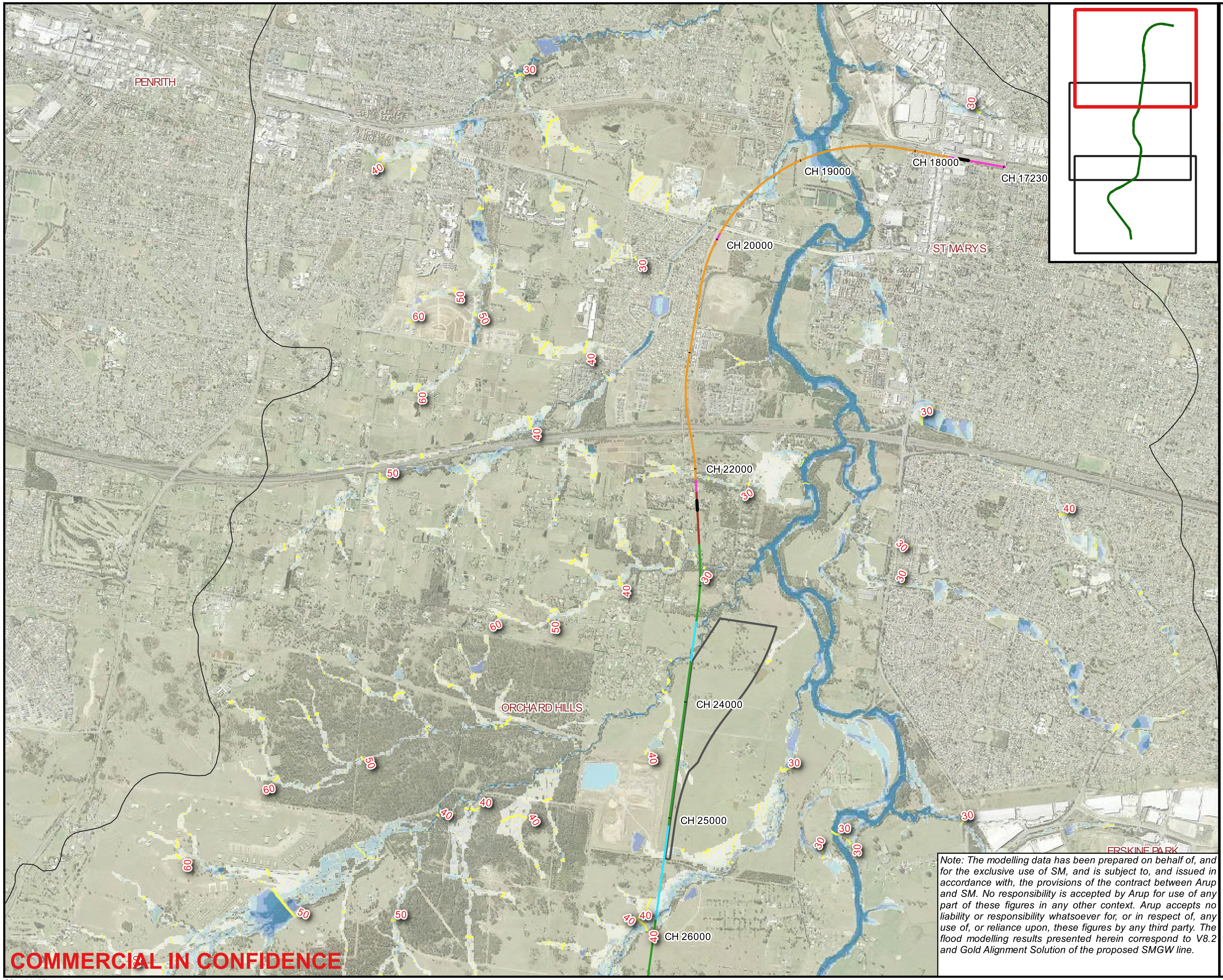
- the design is not suitably progressed
- the flood model results are not considered sensitive to the method of sizing the track drainage.

The preliminary design surface for the rail alignment and stabling/maintenance facility have been incorporated into the TUFLOW model in the project case. The following assumptions have been made with regards to incorporating stabling yards into the flood model:

The proposed earthworks for the Site 7 stabling yard cause runoff originating from a small catchment (approximately 4.5 hectares) to be diverted from its original course. In reality the proposed earthworks will need to capture the runoff from this catchment and convey it towards the north of the site. For modelling purposes it has been assumed that runoff from this small catchment has been routed through the site and conveyed outside the northern boundary of the stabling yard.

Appendix C

Base Case Flood Maps



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Legend

Peak flood levels (mAHD)

Flood depth (m)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1.0

WSI Boundary

WSI Stage 1 Construction Boundary

South Creek Catchment Boundary

At Grade

Bridge or Viaduct

Cut and Cover

Dive Structure

Driven Tunnel

Trough or Cutting

Platform

Stabling Site

Issue	Date	By	Chkd	Appd
A	01/05/20	GK	IVS	KJS

0 500 1000 1500 m

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Sydney Metro

Job Title
SMGW TA Services

Figure Title
Base Case - 0.5EY Design flood depth and levels

Scale at A3
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Figure Status
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Coordinate System
GDA 1994 MGA Zone 56

Job No
265549

Figure No
C.1 (1 of 3)

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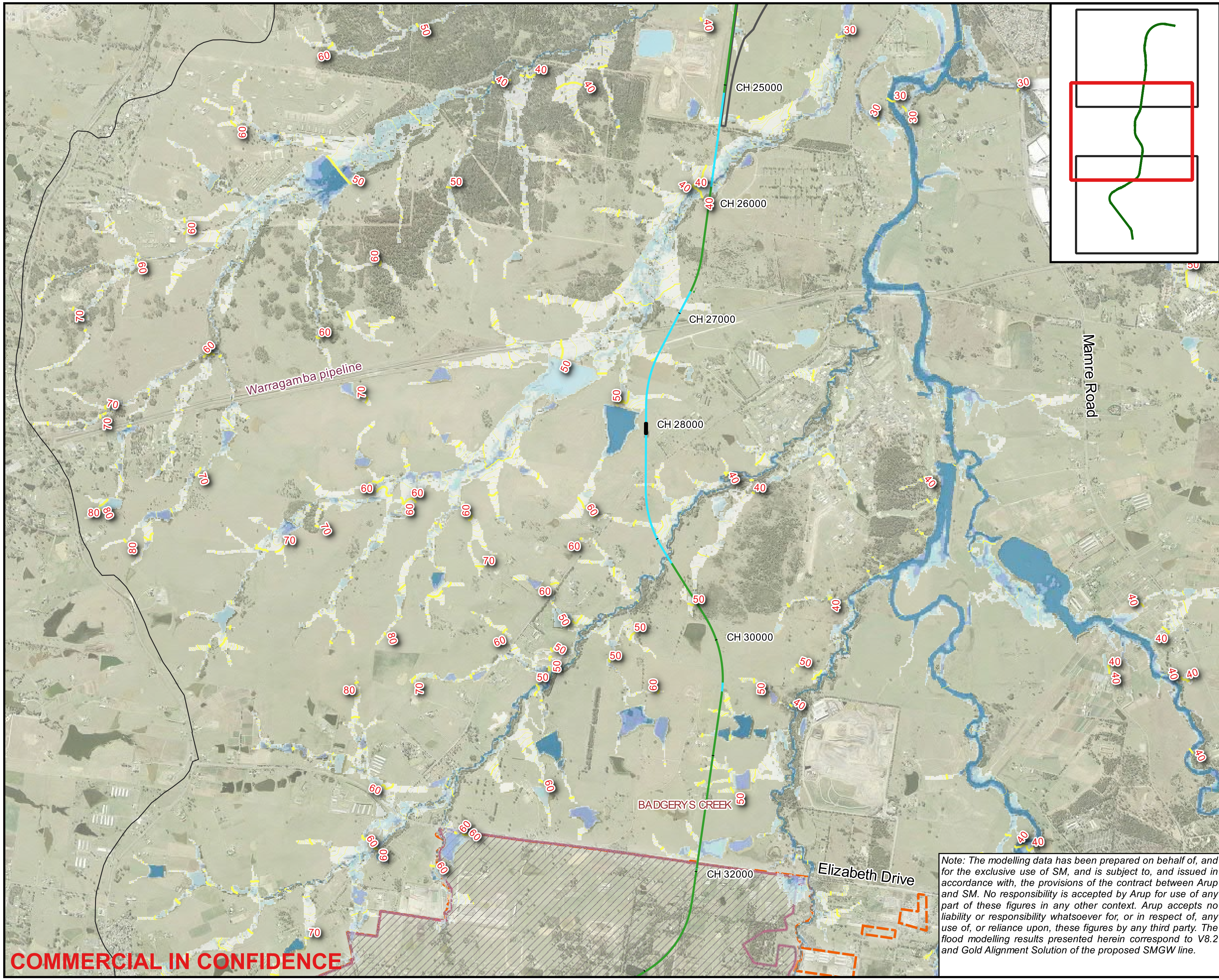

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Legend

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A	01/05/20	GK	IVS	KJS

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Coordinate System
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Job No
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Figure No
C.1 (2 of 3)

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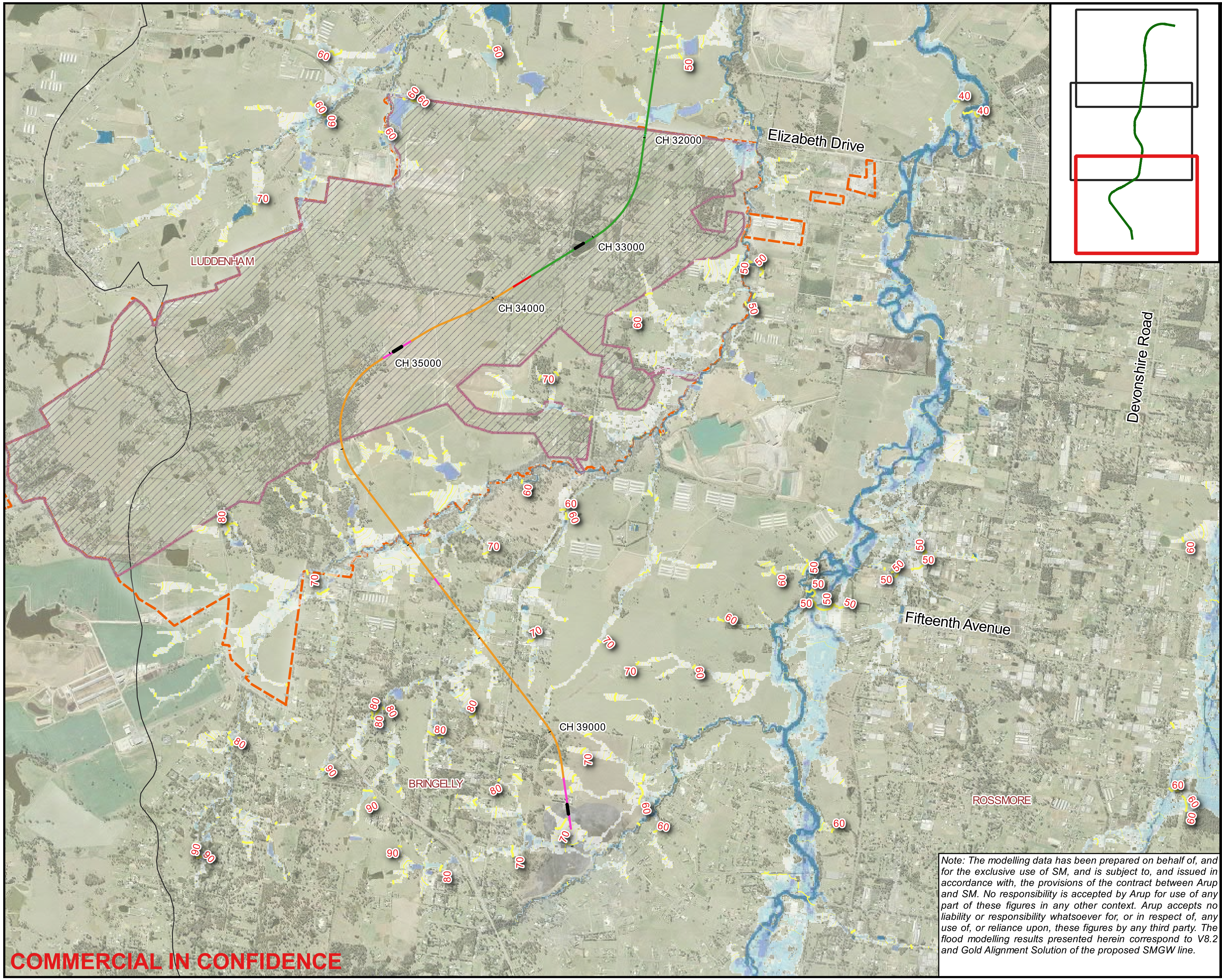

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Scale at A3	Figure Status
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Coordinate System
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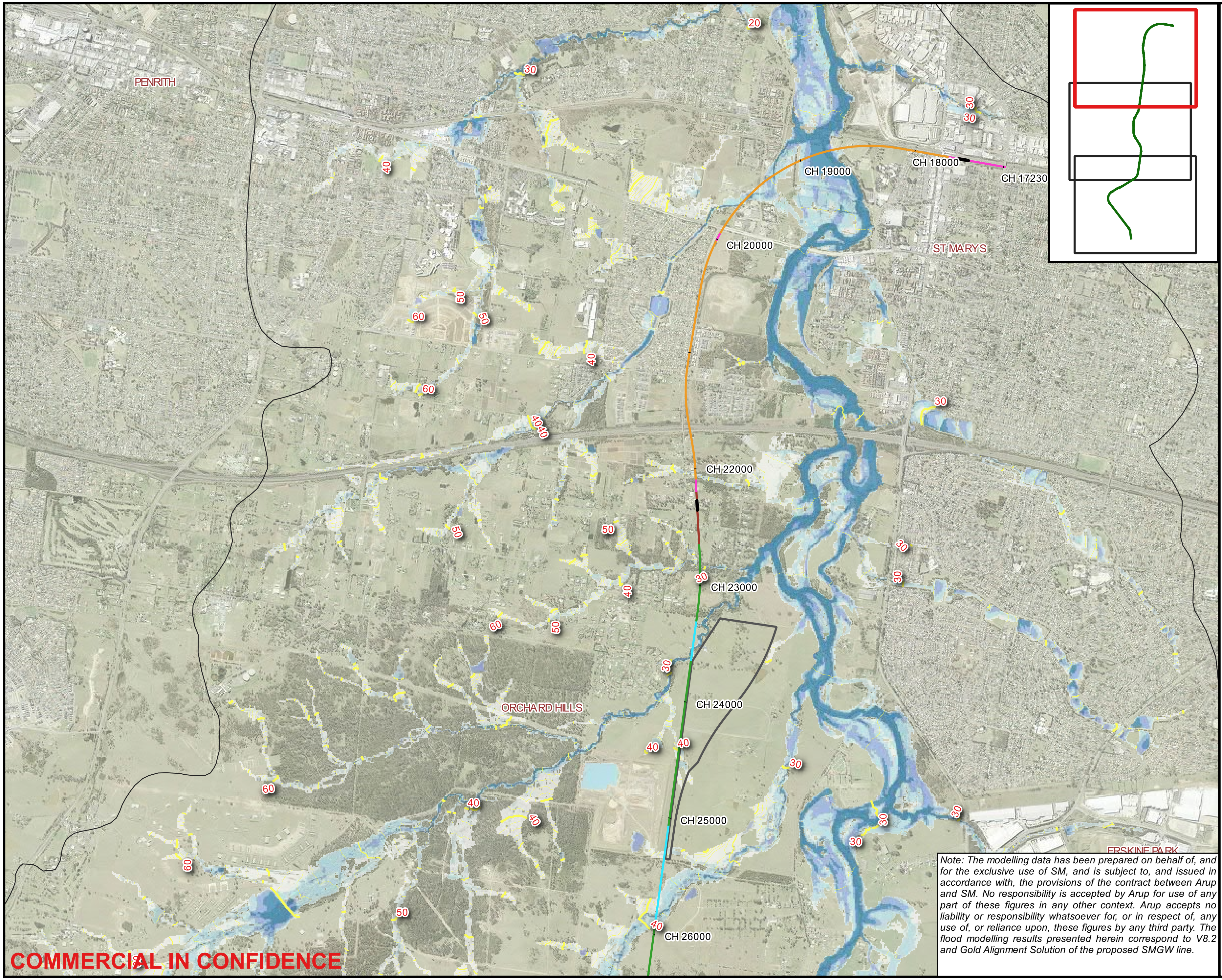

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Figure Title
Base Case - 0.2EY Design flood depth and levels

Scale at A3	Figure Status
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Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
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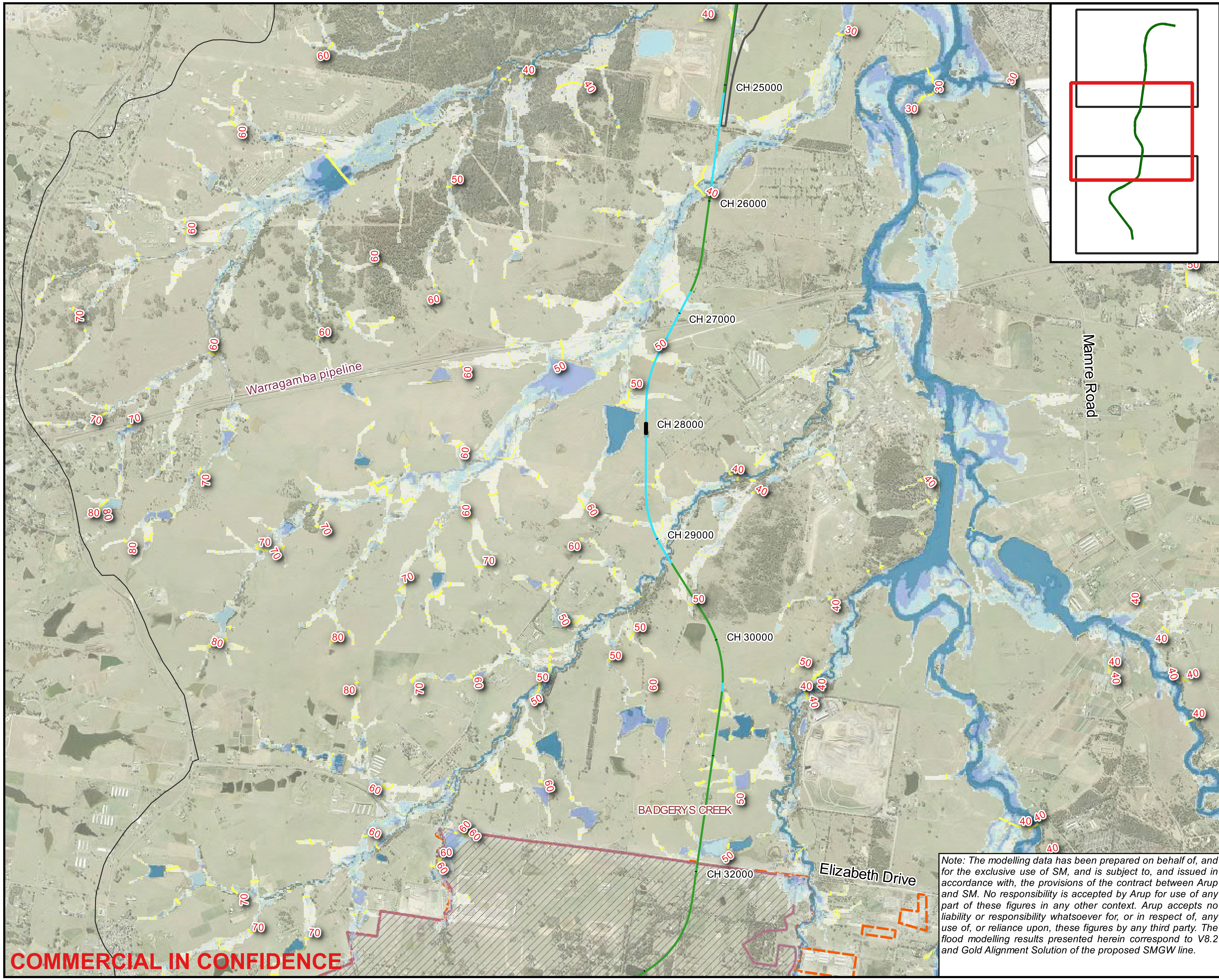

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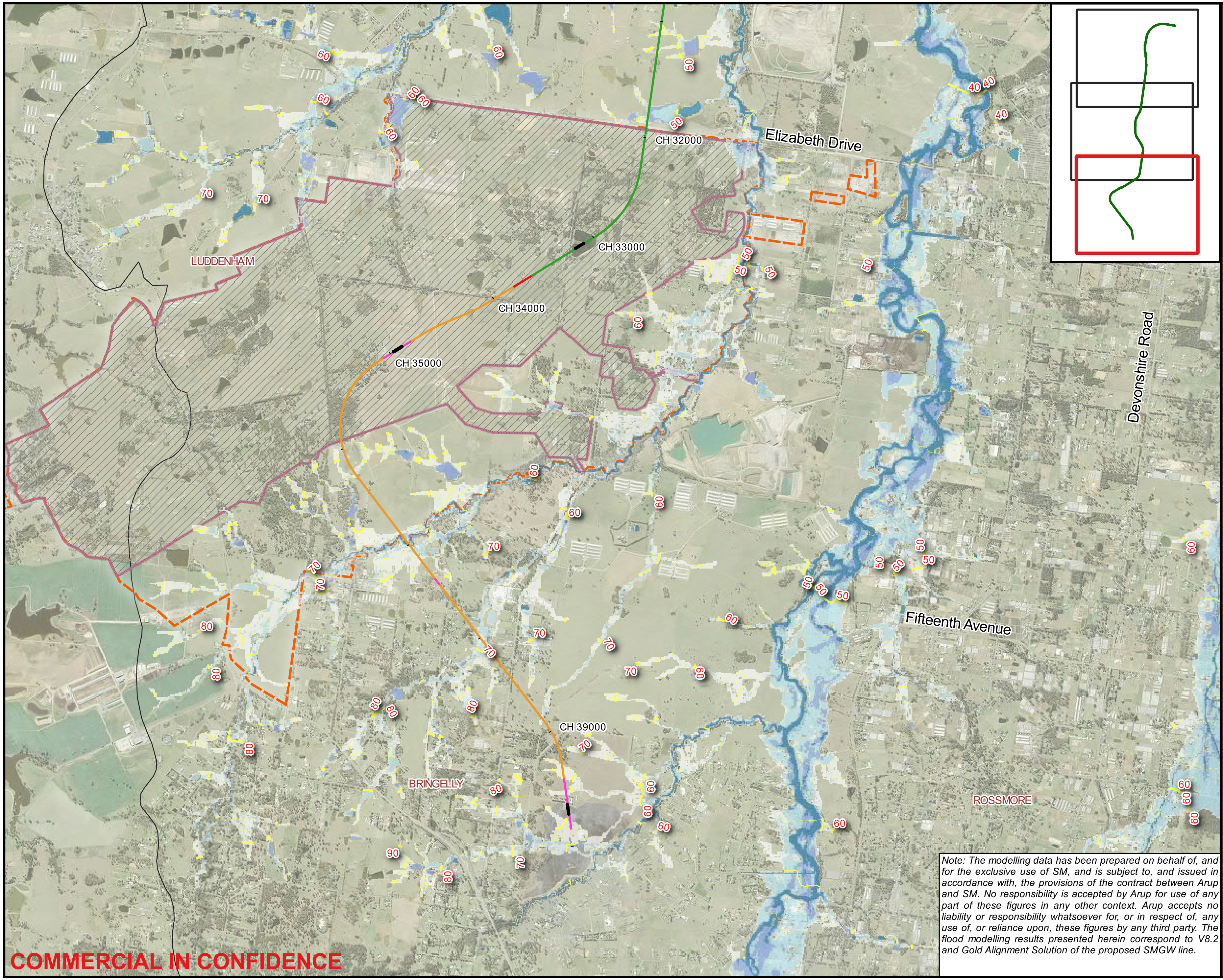

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- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1.0
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
- At Grade
- Bridge or Viaduct
- Cut and Cover
- Dive Structure
- Driven Tunnel
- Trough or Cutting
- Platform
- Stabling Site

A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

0 500 1000 1500 m

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Job Title
SMGW TA Services

Figure Title
Base Case - 0.2EY Design flood depth and levels

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.2 (3 of 3)

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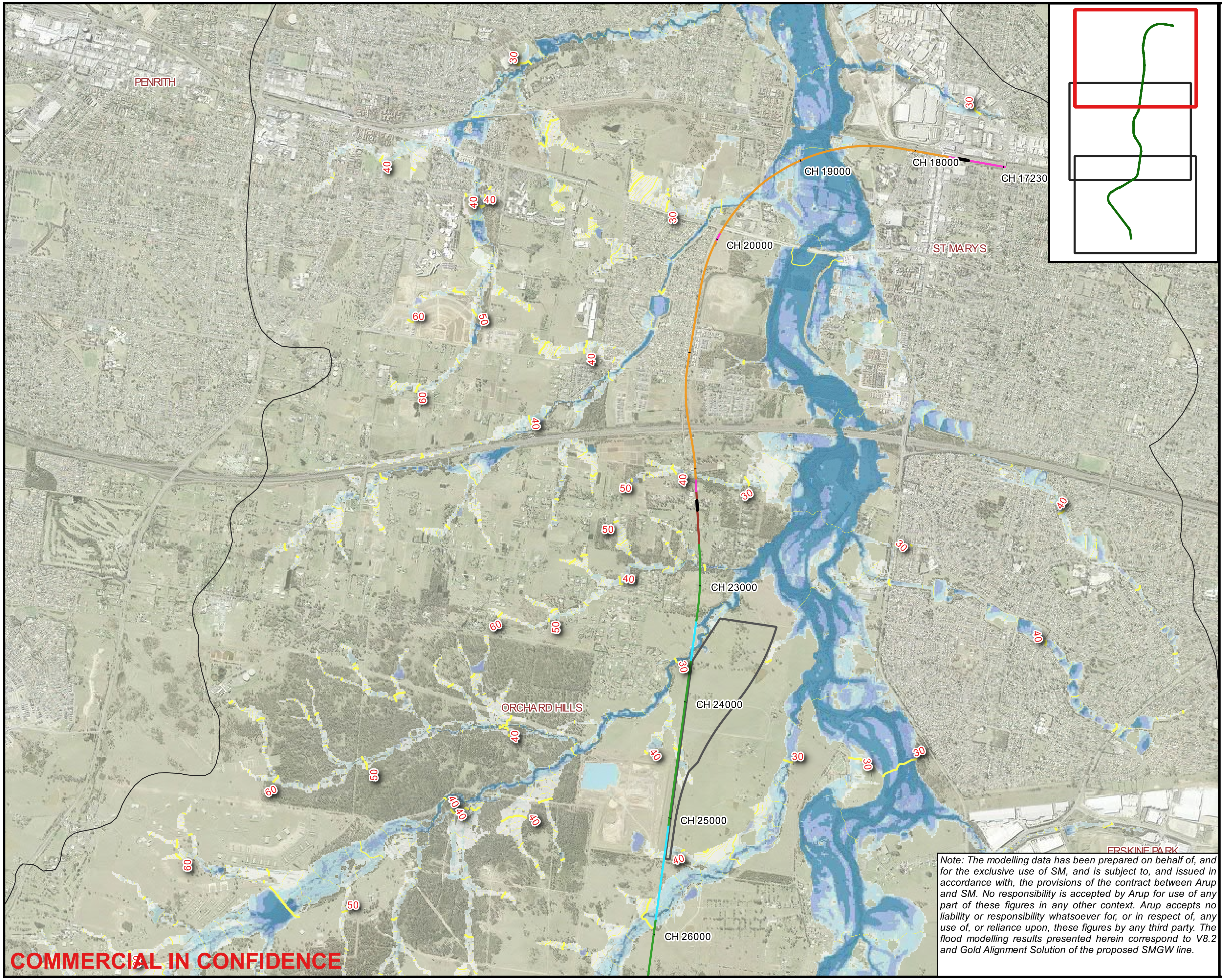

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Legend

Peak flood levels (mAHD)

Flood depth (m)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1.0

- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
- At Grade
- Bridge or Viaduct
- Cut and Cover
- Dive Structure
- Driven Tunnel
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A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

0 500 1000 1500 m

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Job Title
SMGW TA Services

Figure Title
Base Case - 5% AEP Design flood depth and levels

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.3 (1 of 3)

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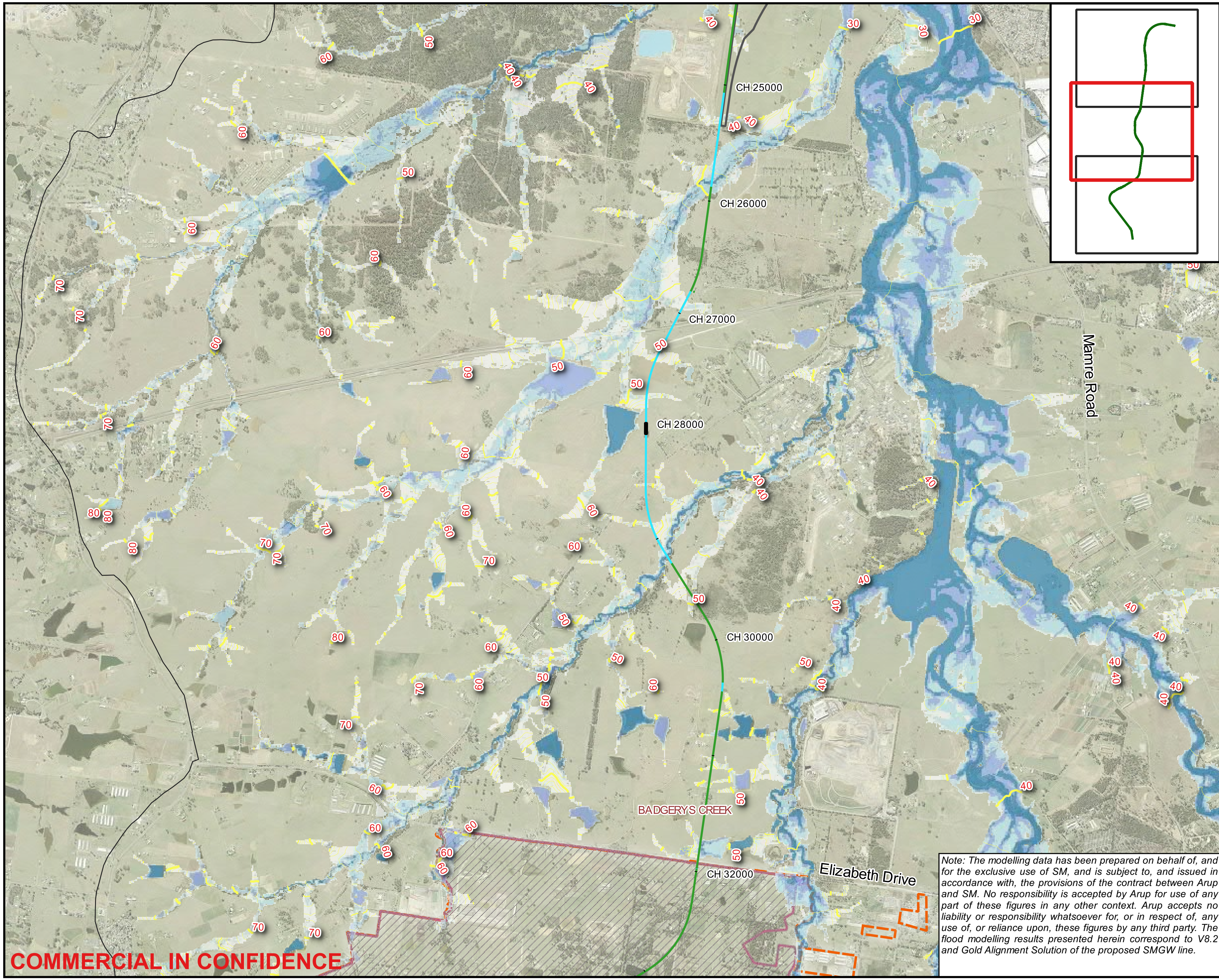

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Legend

Peak flood levels (mAHD)

Flood depth (m)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1.0

- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
- At Grade
- Bridge or Viaduct
- Cut and Cover
- Dive Structure
- Driven Tunnel
- Trough or Cutting
- Platform
- Stabling Site

A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

0 500 1000 1500 m

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Job Title
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Figure Title
Base Case - 5% AEP Design flood depth and levels

Scale at A3
1:30000

Figure Status
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Job No
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Figure No
C.3 (2 of 3)

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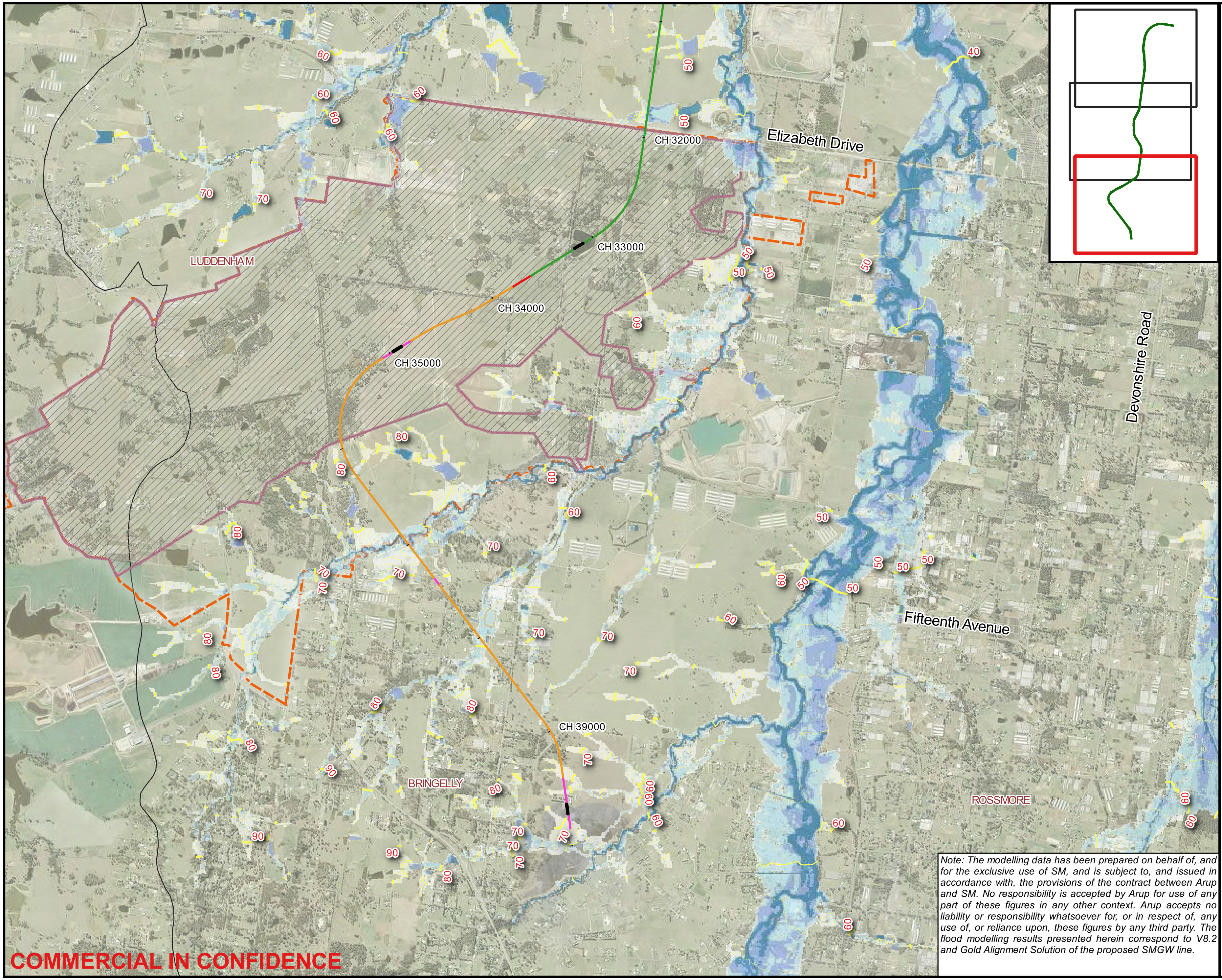

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Legend

- Peak flood levels (mAHD)

Flood depth (m)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1.0
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
- At Grade
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A	01/05/20	GK	IVS	KJS
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Figure Title
Base Case - 5% AEP Design flood depth and levels

Scale at A3
1:30000

Figure Status
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Coordinate System
GDA 1994 MGA Zone 56

Job No
265549

Figure No
C.3 (3 of 3)

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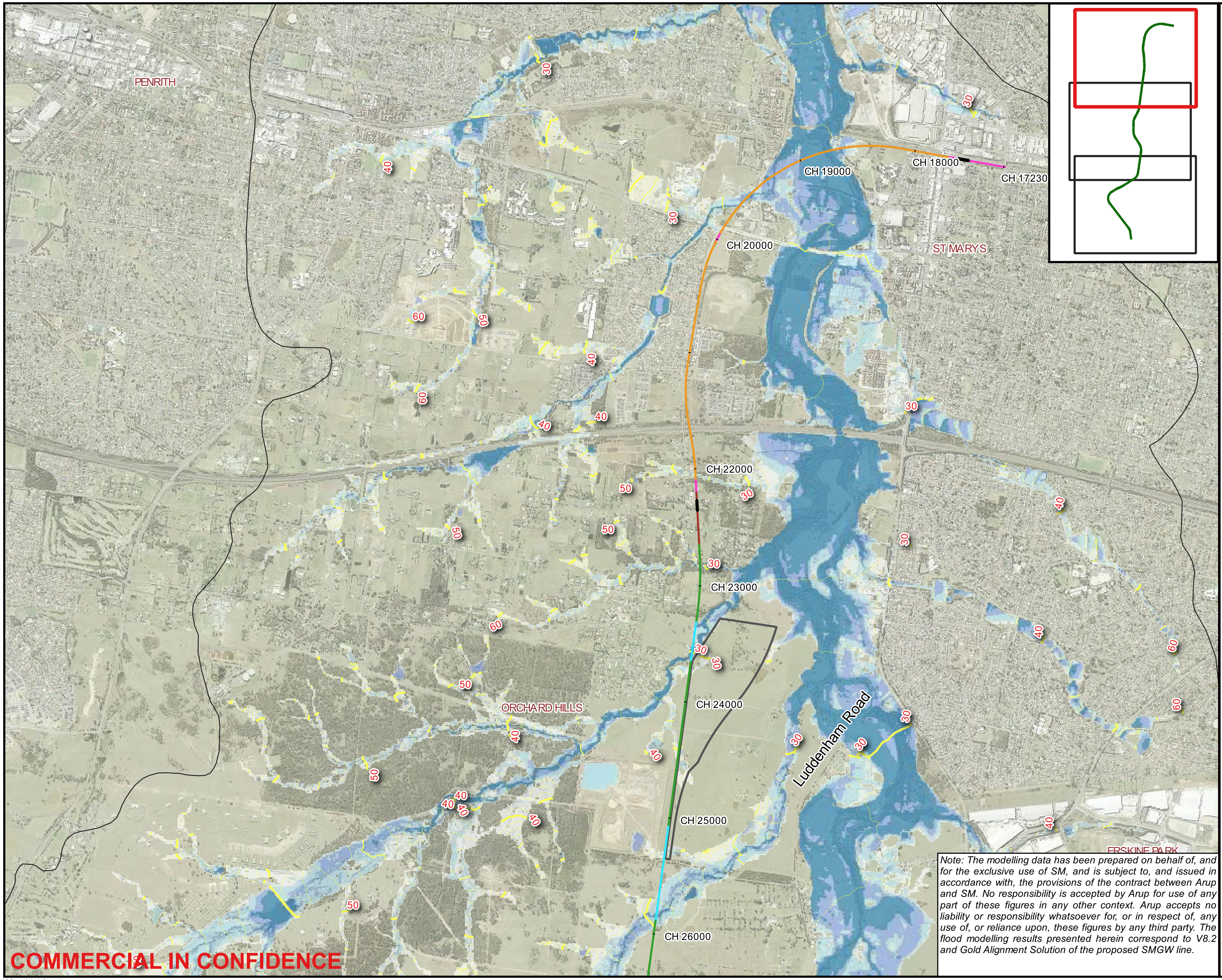

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Figure Title
Base Case - 1% AEP Design flood depth and levels

Scale at A3	Figure Status
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Coordinate System
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Job No	Figure No
265549	C.4 (1 of 3)

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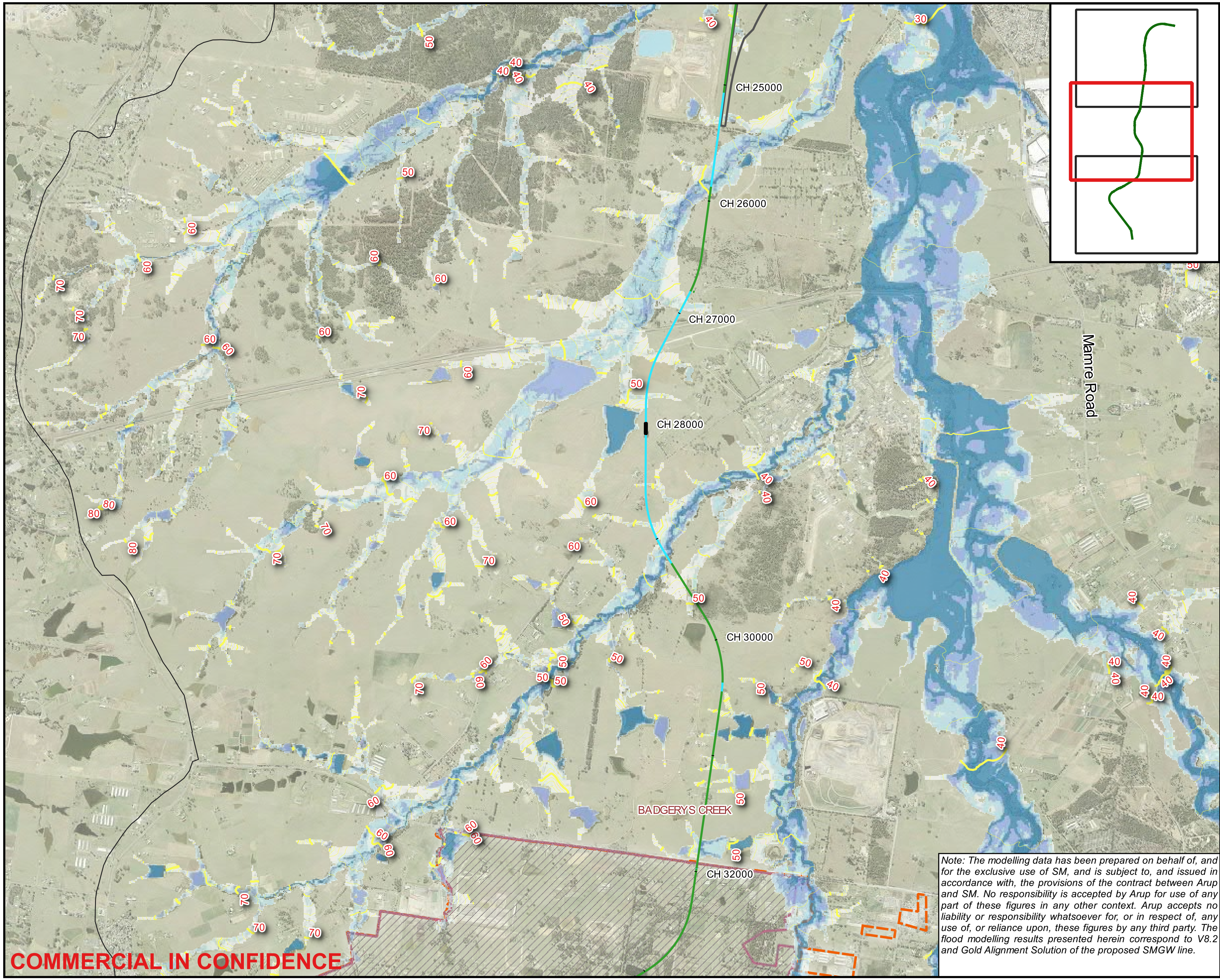

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Legend

- Peak flood levels (mAHD)

Flood depth (m)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1.0
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
- At Grade
- Bridge or Viaduct
- Cut and Cover
- Dive Structure
- Driven Tunnel
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- Platform
- Stabling Site

A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

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Figure Title
Base Case - 1% AEP Design flood depth and levels

Scale at A3	Figure Status
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Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
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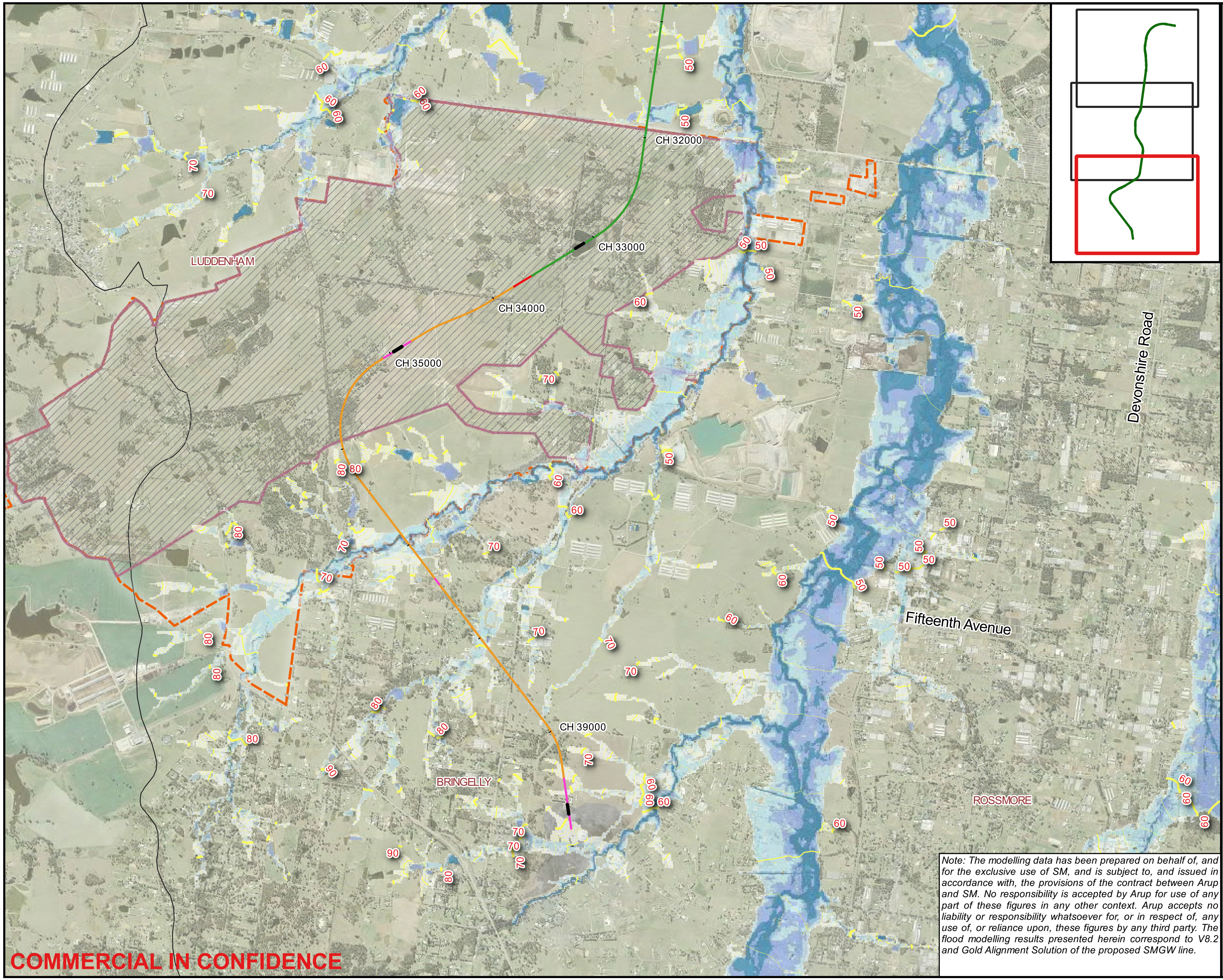

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Legend

Peak flood levels (mAHD)

Flood depth (m)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1.0

WSI Boundary
WSI Stage 1 Construction Boundary
South Creek Catchment Boundary
At Grade
Bridge or Viaduct
Cut and Cover
Dive Structure
Driven Tunnel
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Issue	Date	By	Chkd	Appd
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Base Case - 1% AEP Design flood depth and levels

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Coordinate System
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Job No
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Figure No
C.4 (3 of 3)

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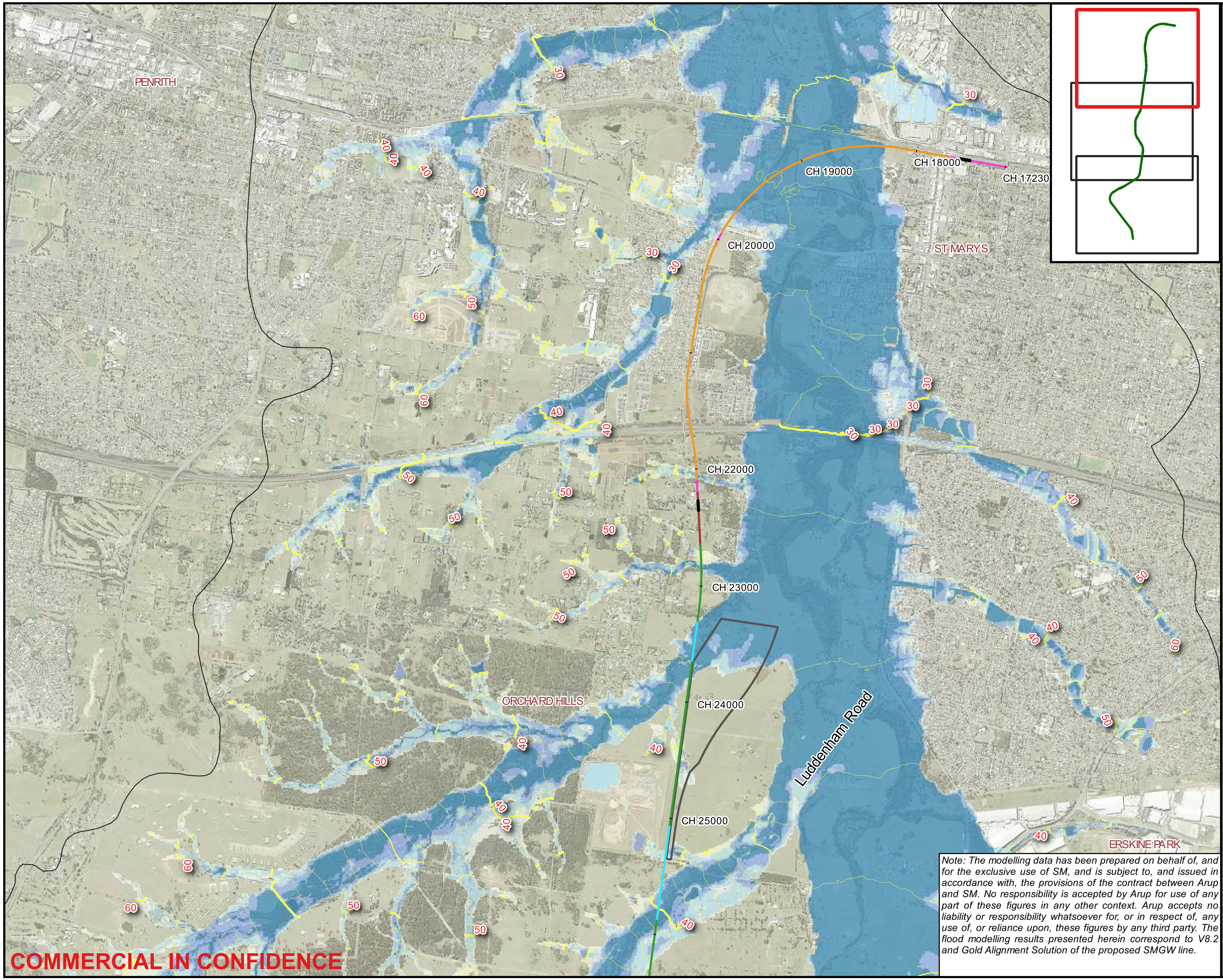

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Legend

Peak flood levels (mAHD)

Flood depth (m)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1.0

WSI Boundary
WSI Stage 1 Construction Boundary
South Creek Catchment Boundary
At Grade
Bridge or Viaduct
Cut and Cover
Dive Structure
Driven Tunnel
Trough or Cutting
Platform
Stabling Site

A	01/05/20	GK	IVS	KJS
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Job Title
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Figure Title
Base Case - PMF Design flood depth and levels

Scale at A3
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Job No
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Figure No
C.5 (1 of 3)

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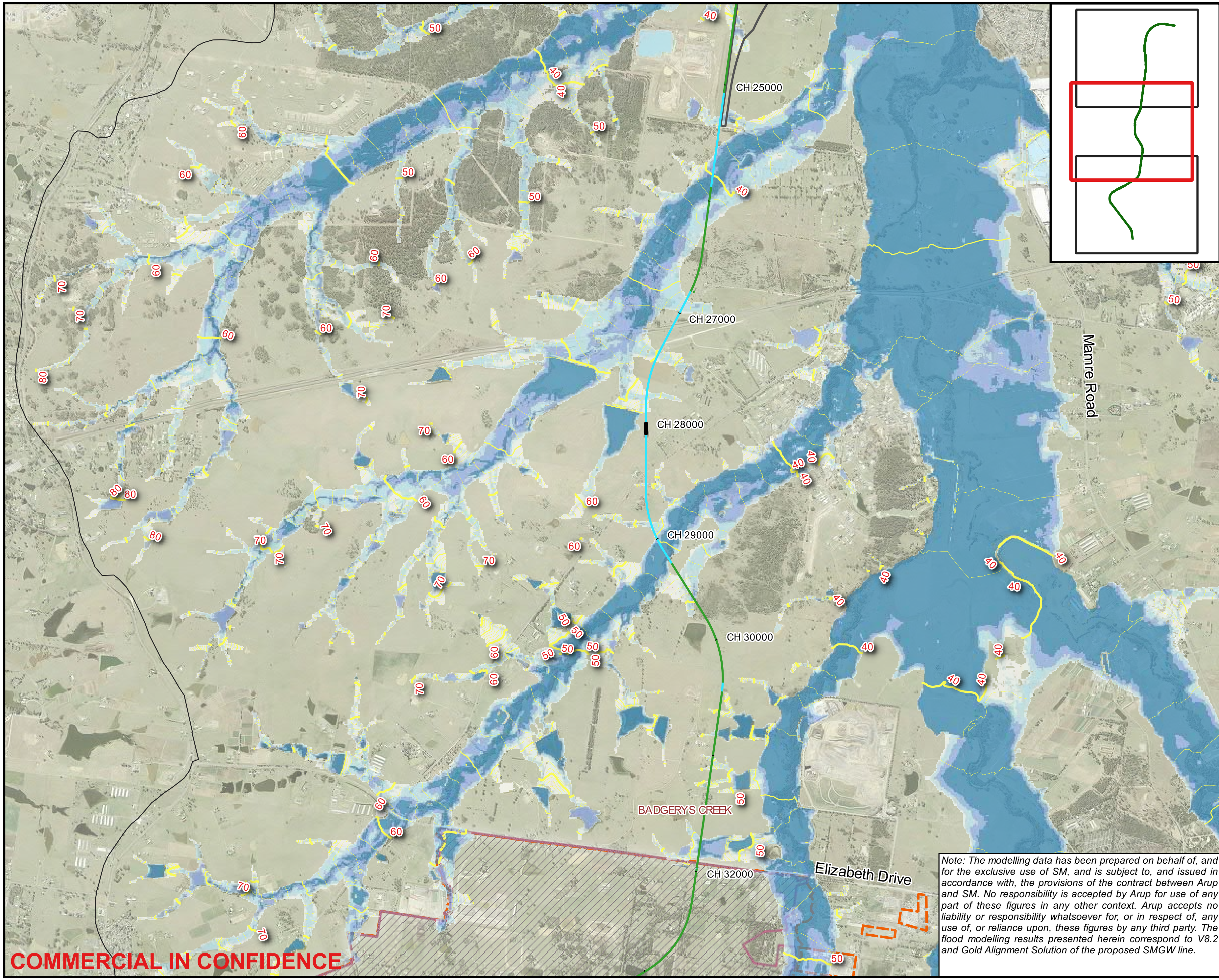

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Legend

- Peak flood levels (mAHD)

Flood depth (m)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1.0
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
- At Grade
- Bridge or Viaduct
- Cut and Cover
- Dive Structure
- Driven Tunnel
- Trough or Cutting
- Platform
- Stabling Site

Issue	Date	By	Chkd	Appd
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Job Title
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Figure Title
Base Case - PMF Design flood depth and levels

Scale at A3	Figure Status
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Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.5 (2 of 3)

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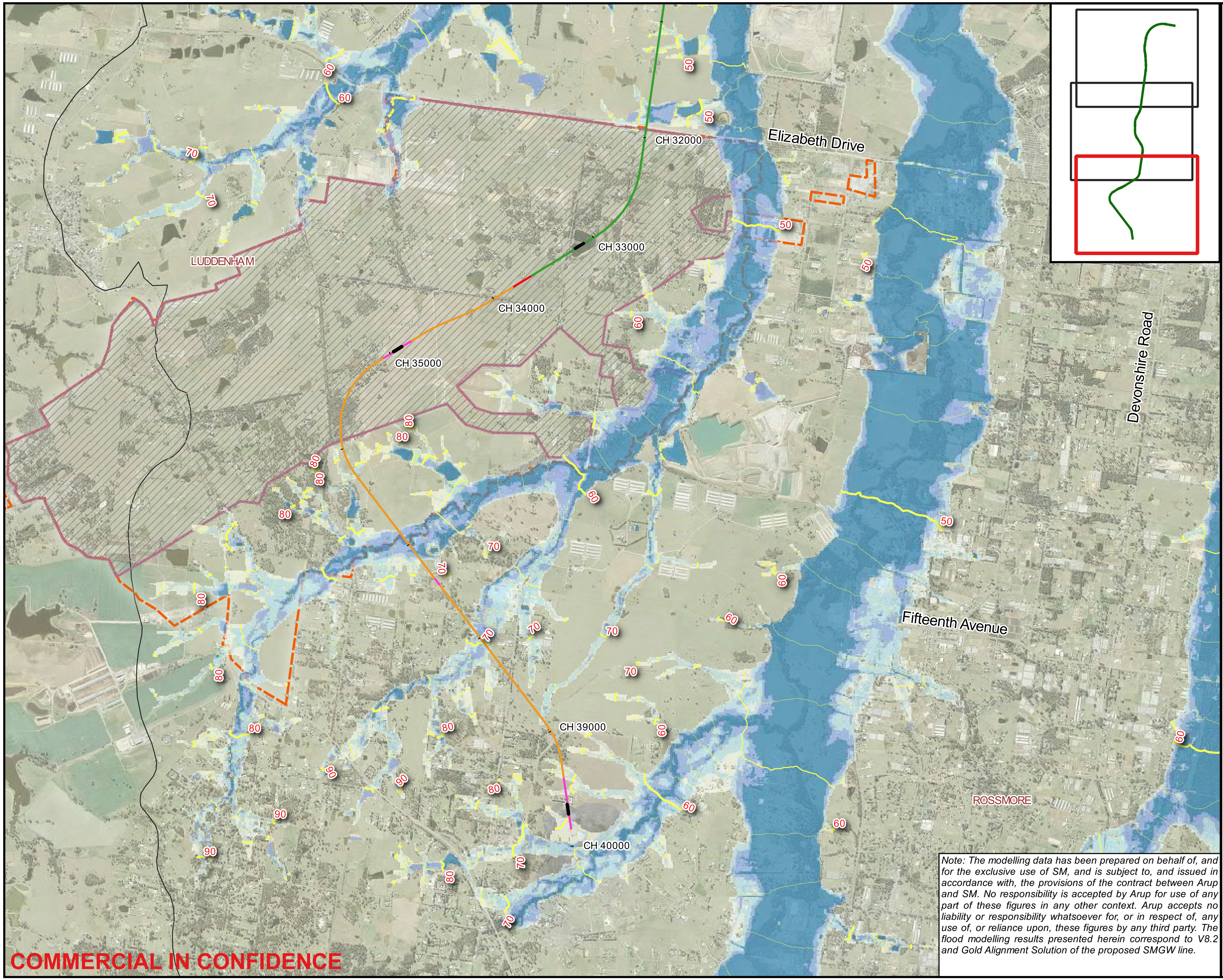

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Legend

Peak flood levels (mAHD)

Flood depth (m)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1.0

WSI Boundary

WSI Stage 1 Construction Boundary

South Creek Catchment Boundary

At Grade

Bridge or Viaduct

Cut and Cover

Dive Structure

Driven Tunnel

Trough or Cutting

Platform

Stabling Site

Issue	Date	By	Chkd	Appd
A	01/05/20	GK	IVS	KJS

0 500 1000 1500 m

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Figure Title
Base Case - PMF Design flood depth and levels

Scale at A3
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Figure Status
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Coordinate System
GDA 1994 MGA Zone 56

Job No
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Figure No
C.5 (3 of 3)

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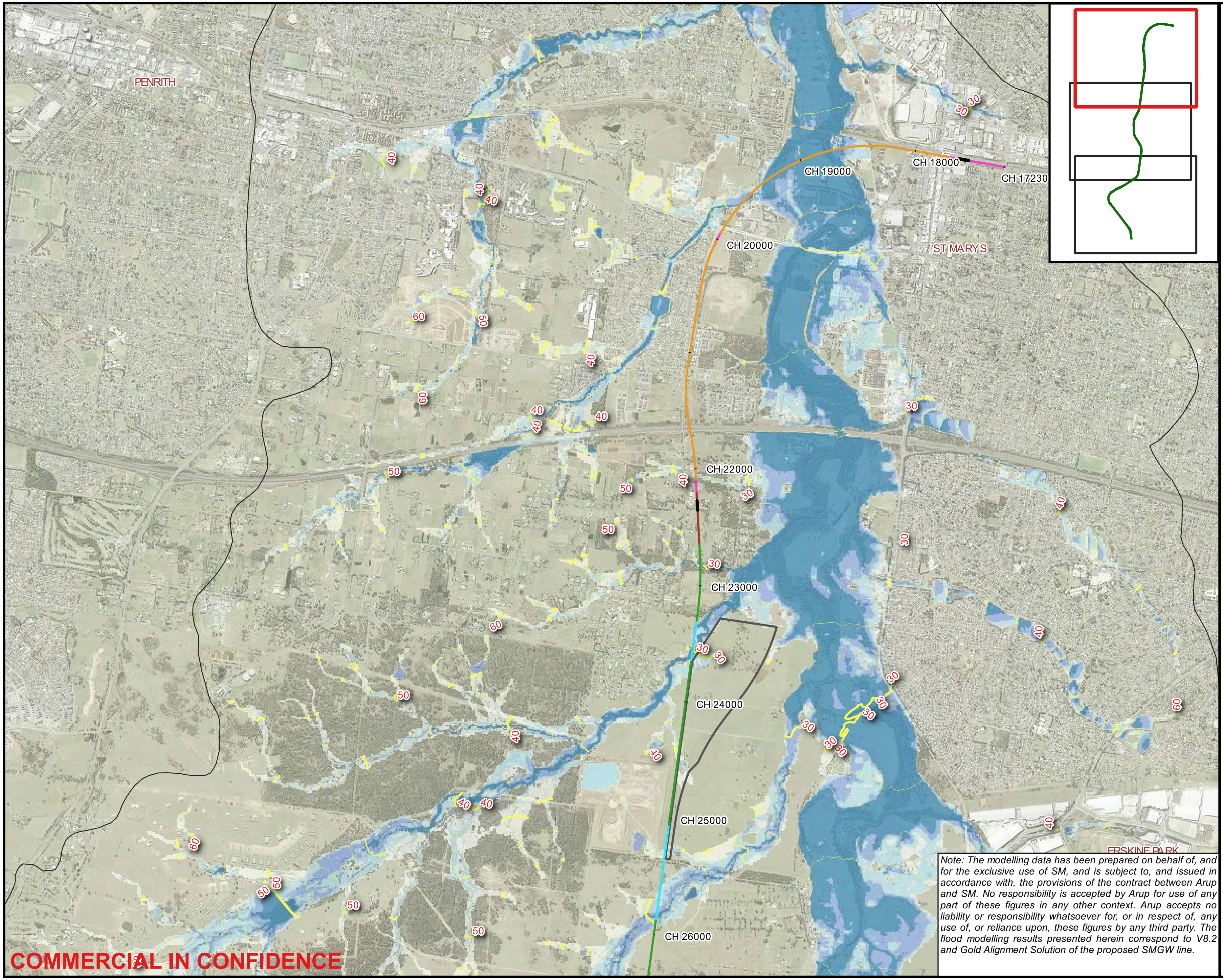

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Legend

- Peak flood levels (mAHD)

Flood depth (m)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1.0
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
- At Grade
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A	01/05/20	GK	IVS	KJS
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Job Title
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Figure Title
Base Case - 1% AEP with Climate Change Design flood depth and levels

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.6 (1 of 3)

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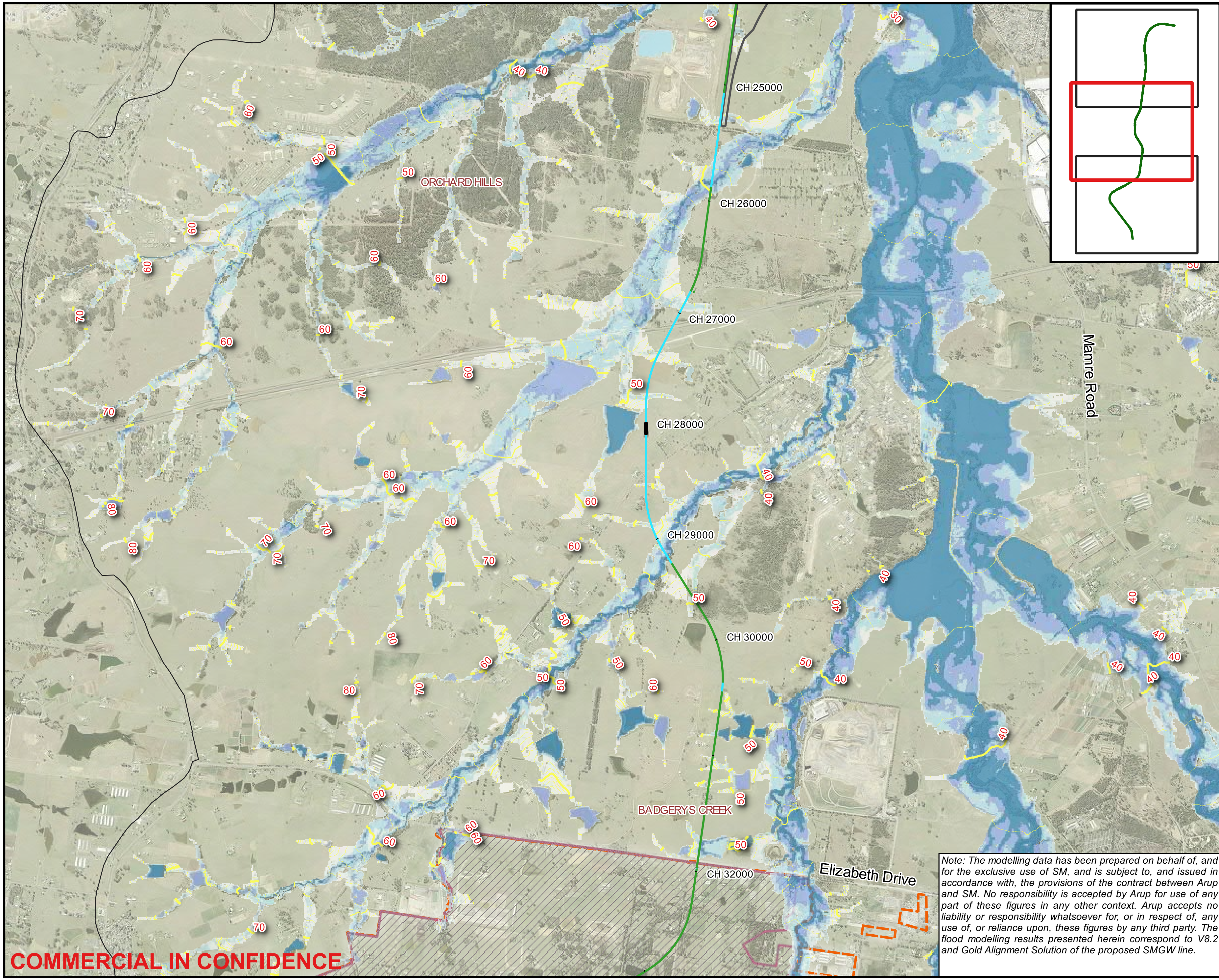

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Legend

- Peak flood levels (mAHD)

Flood depth (m)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1.0
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
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Job Title
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Figure Title
Base Case - 1% AEP with Climate Change Design flood depth and levels

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.6 (2 of 3)

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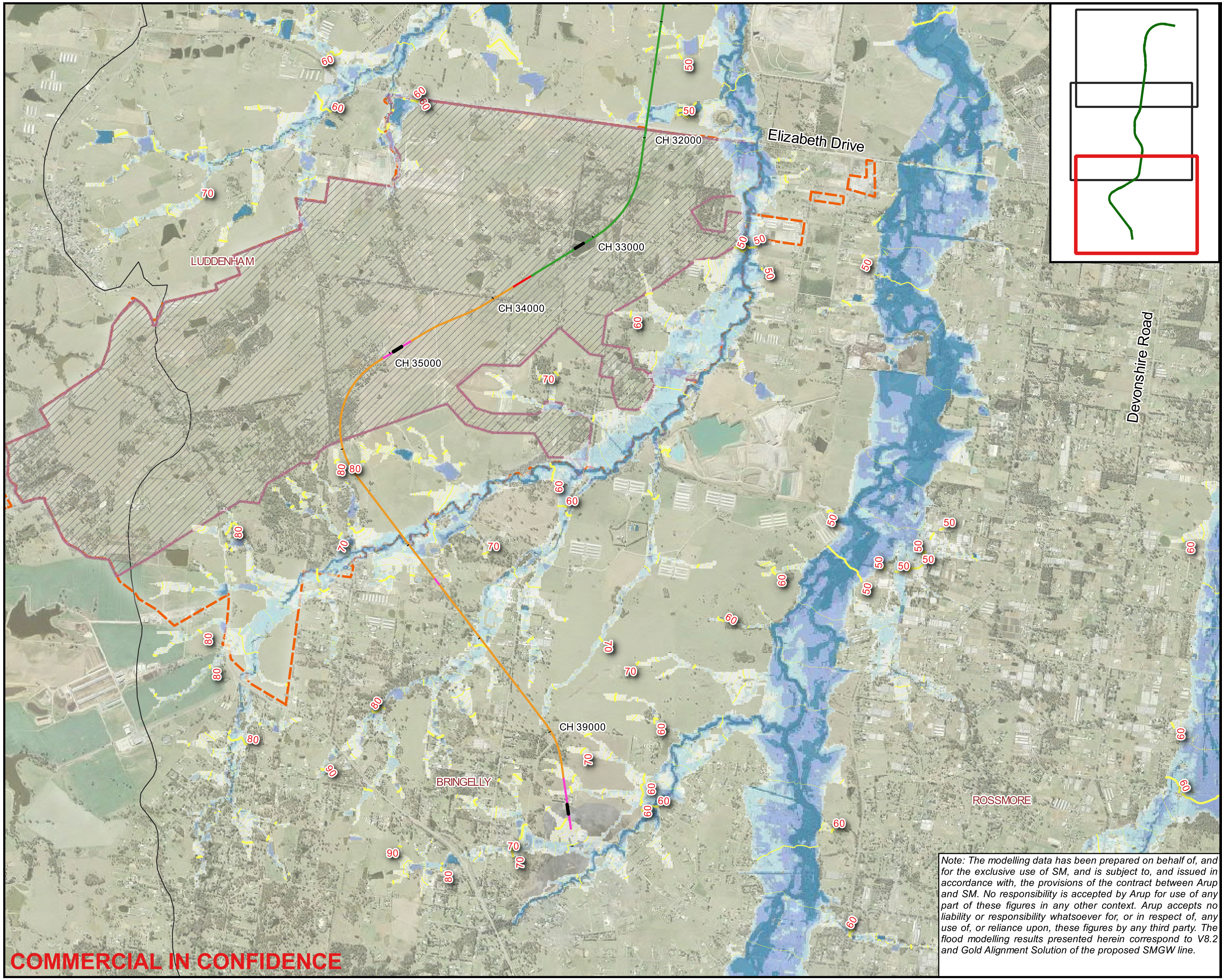

Legend

Peak flood levels (mAHD)

Flood depth (m)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1.0

WSI Boundary
WSI Stage 1 Construction Boundary
South Creek Catchment Boundary
At Grade
Bridge or Viaduct
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Figure Title
Base Case - 1% AEP with Climate Change Design flood depth and levels

Scale at A3
1:30000

Figure Status
Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No
265549

Figure No
C.6 (3 of 3)

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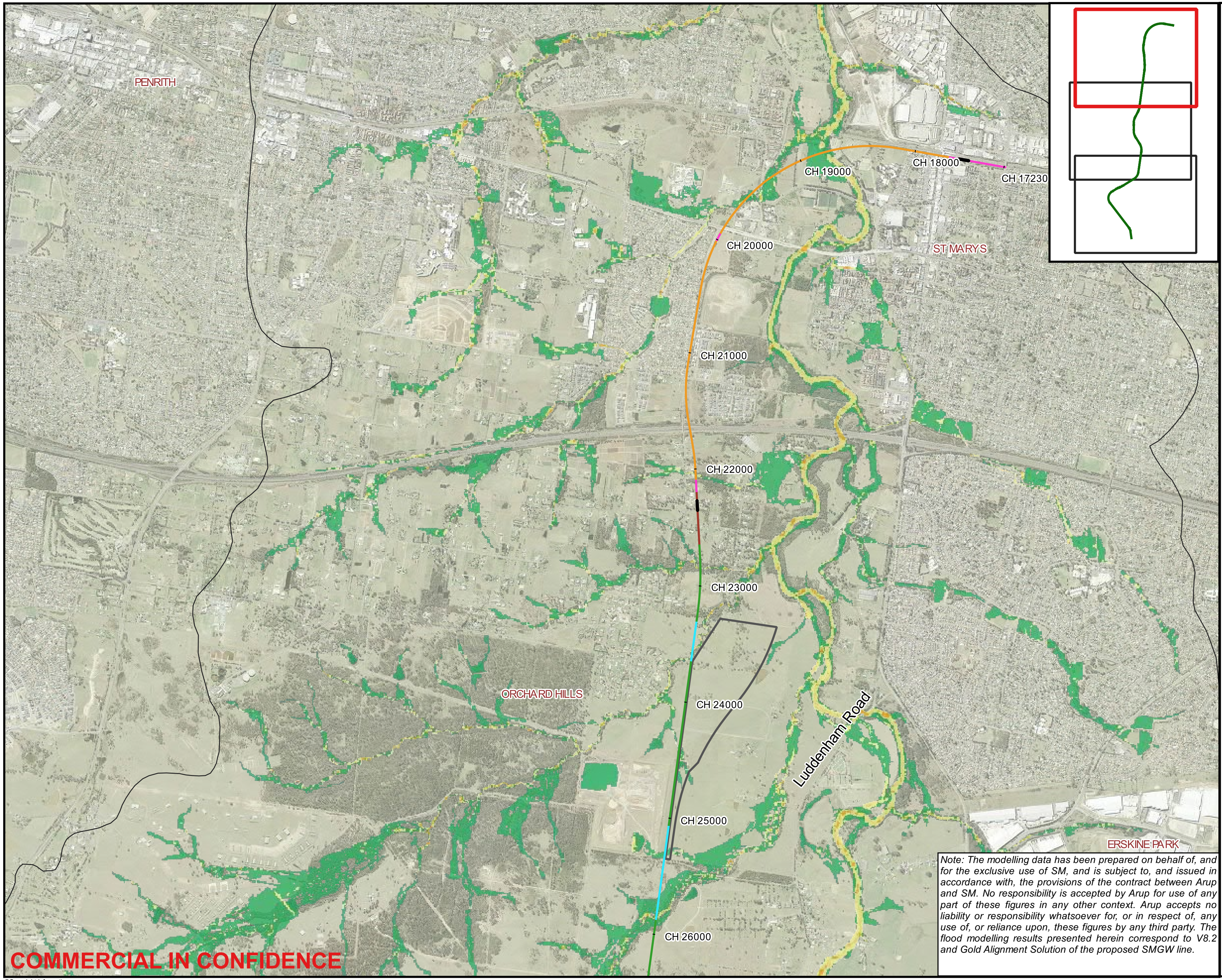

Legend

Velocity (m/s)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
- At Grade
- Bridge or Viaduct
- Cut and Cover
- Dive Structure
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Job Title
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Figure Title
Base Case - 0.5EY Design flood velocity

Scale at A3
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Figure Status
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Figure No
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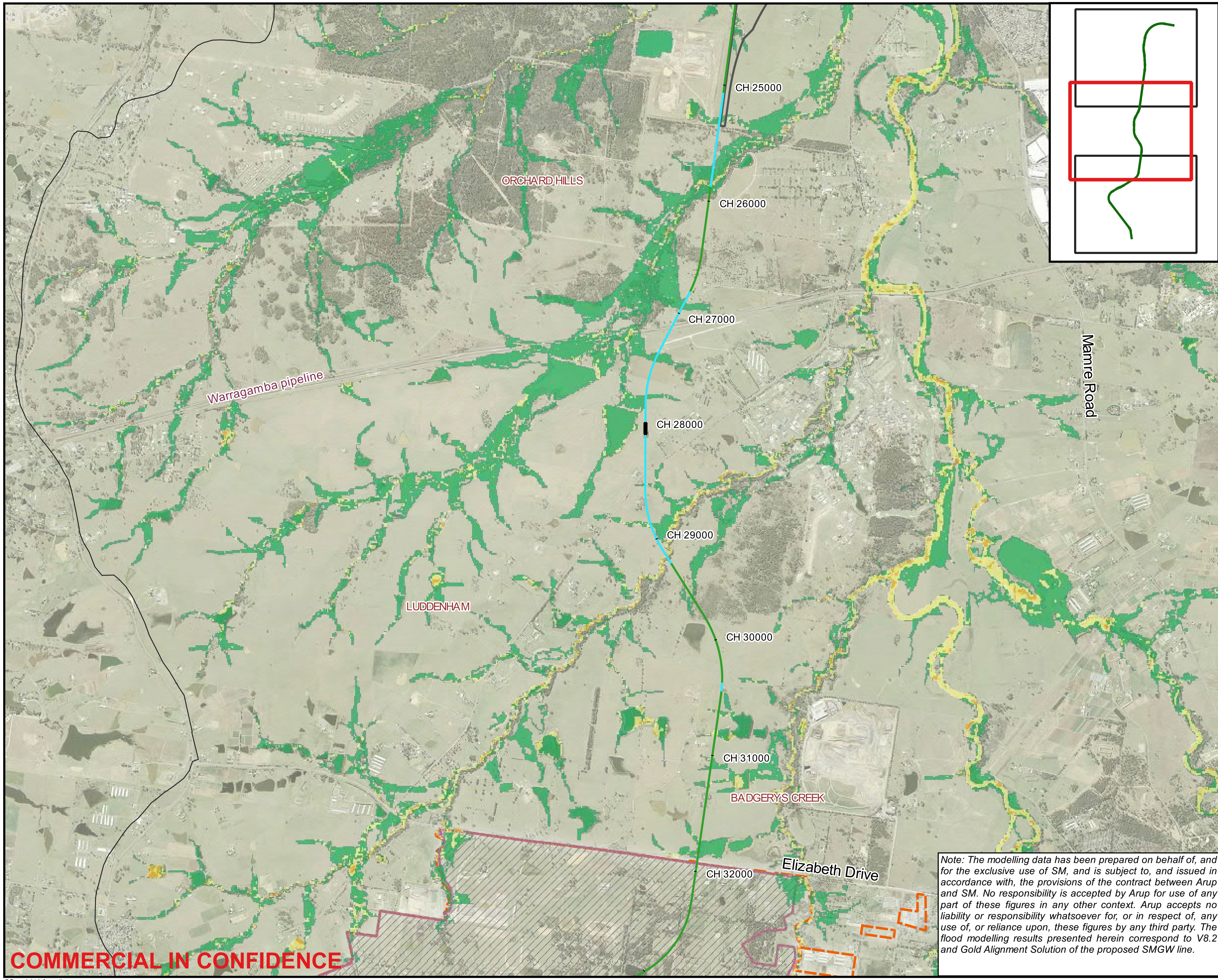

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Legend

Velocity (m/s)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
- At Grade
- Bridge or Viaduct
- Cut and Cover
- Dive Structure
- Driven Tunnel
- Trough or Cutting
- Platform
- Stabling Site

A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

0 500 1000 1500 m

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Job Title
SMGW TA Services

Figure Title
Base Case - 0.5EY Design flood velocity

Scale at A3	Figure Status
1:30000	**Issued for Information**

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	**C.7 (2 of 3)**

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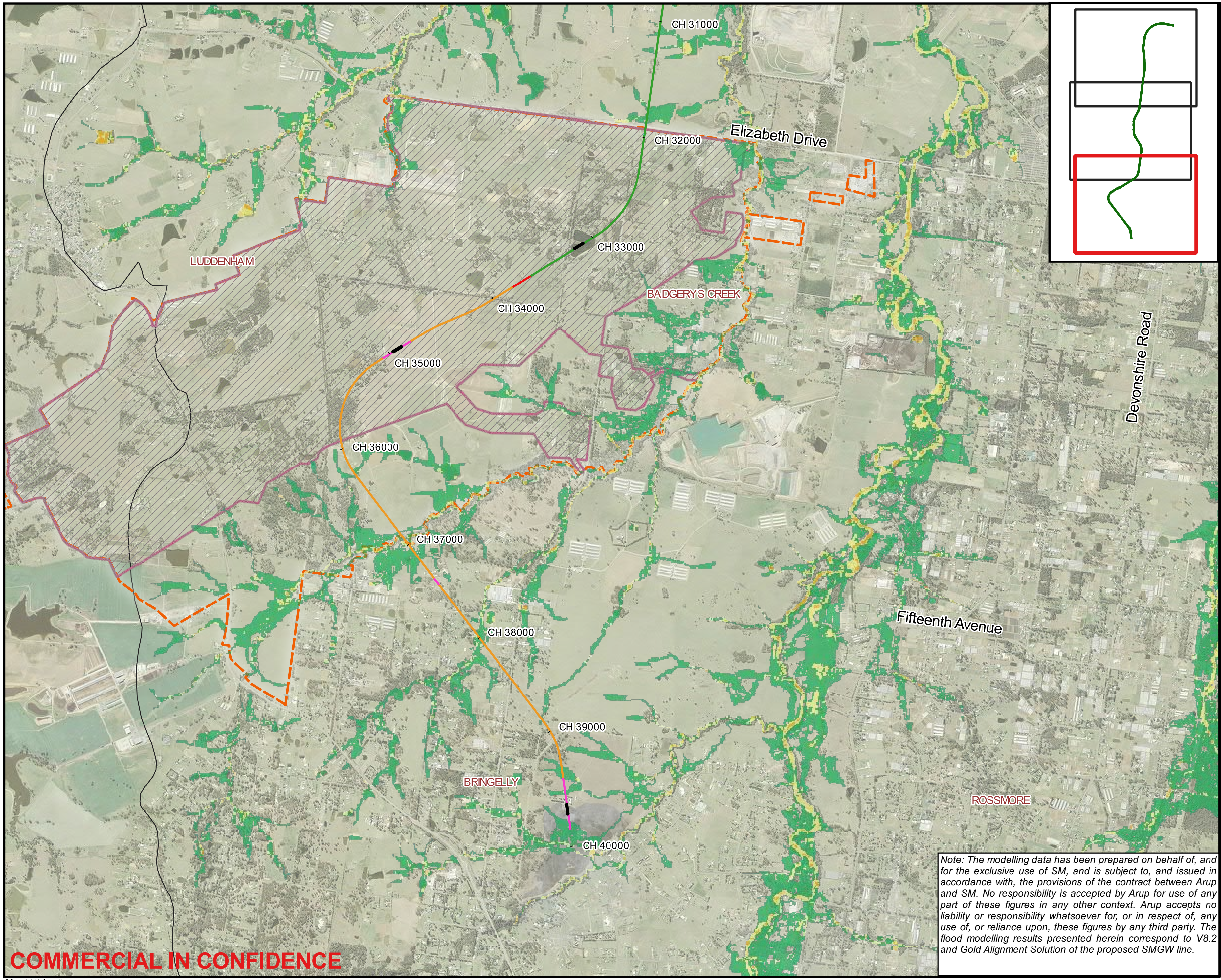

Legend

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- 0 - 0.5
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Job Title
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Figure Title
Base Case - 0.5EY Design flood velocity

Scale at A3
1:30000

Figure Status
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Coordinate System
GDA 1994 MGA Zone 56

Job No
265549

Figure No
C.7 (3 of 3)

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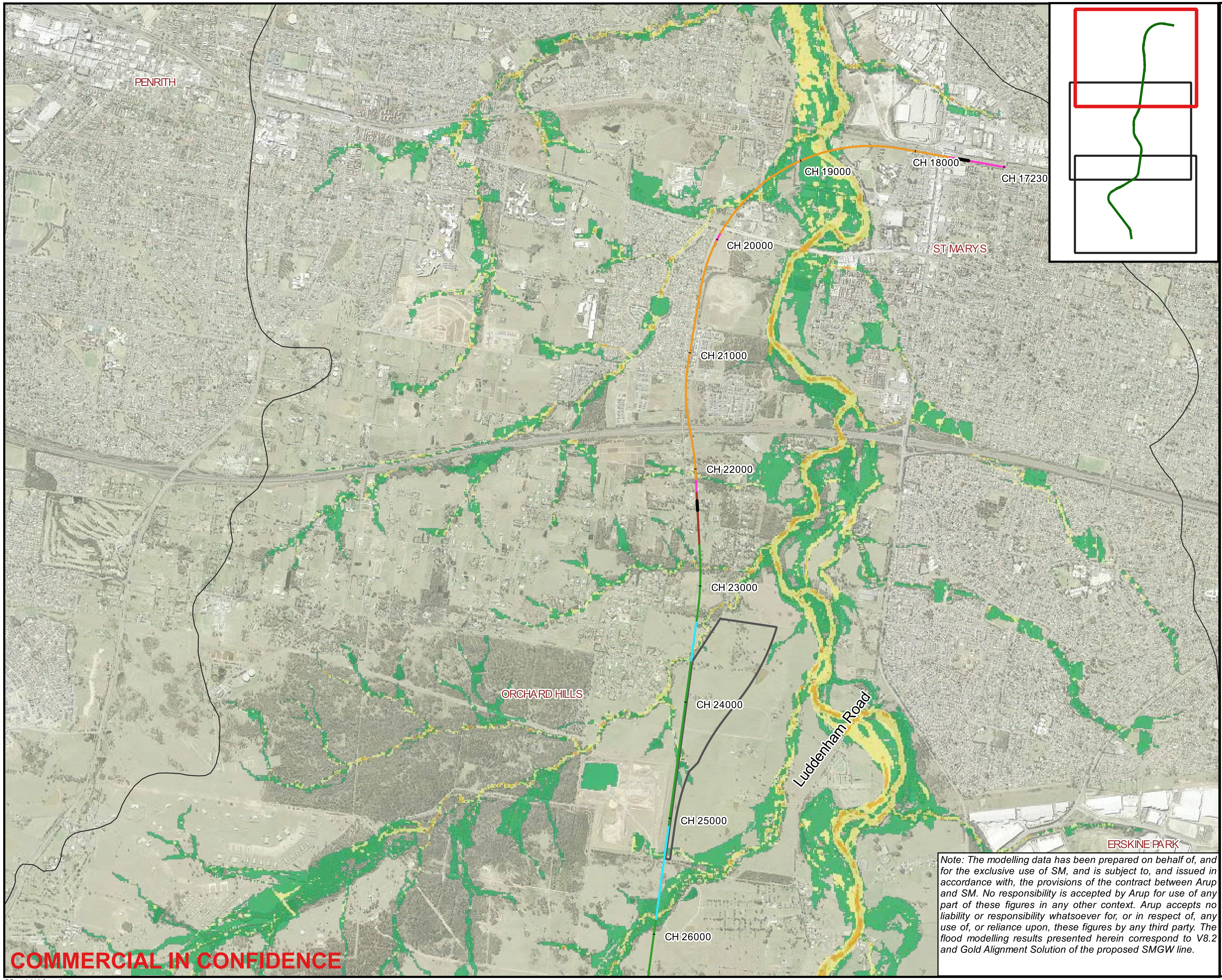

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Job Title
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Figure Title
Base Case - 0.2EY Design flood velocity

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.8 (1 of 3)

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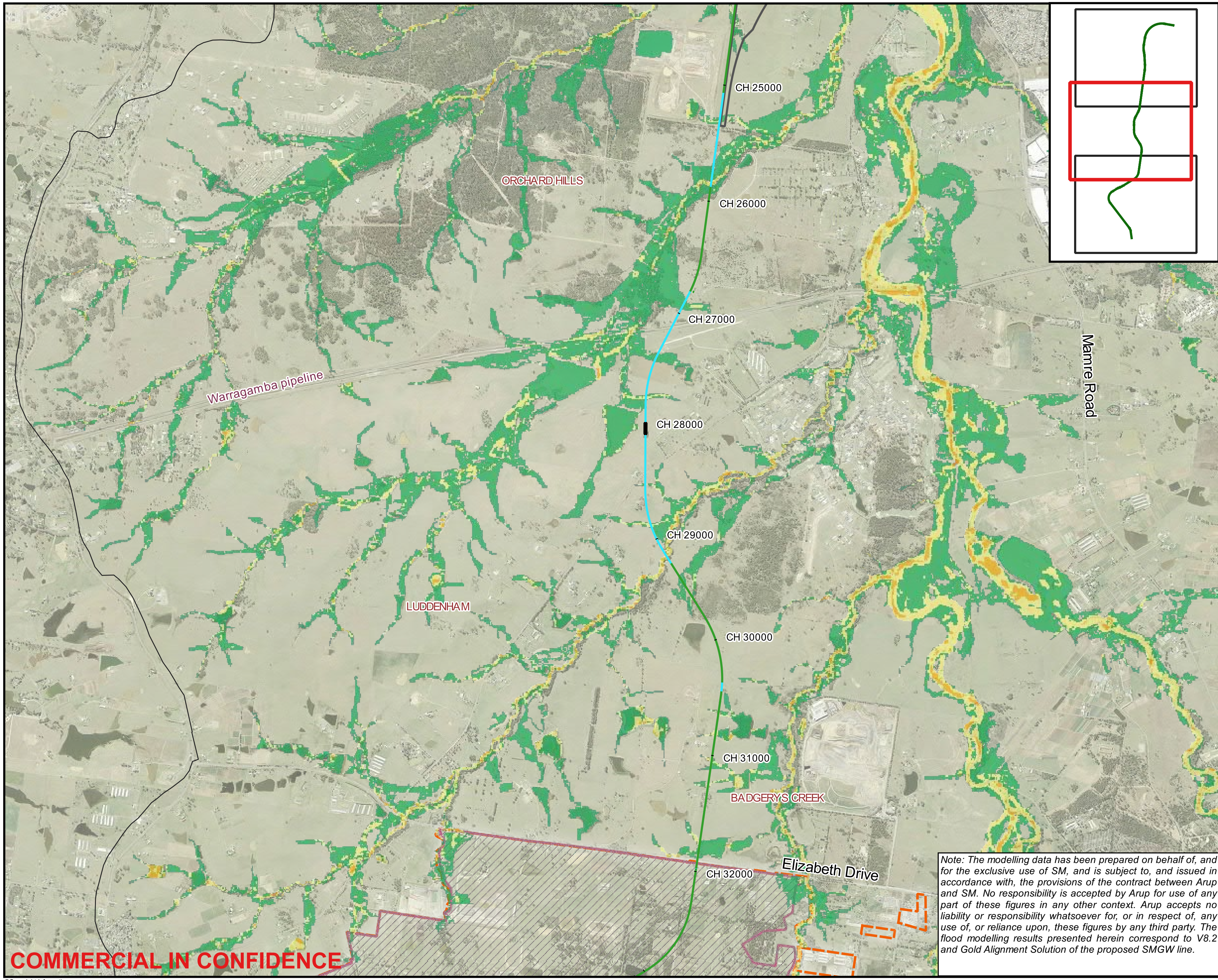

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Base Case - 0.2EY Design flood velocity

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Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.8 (2 of 3)

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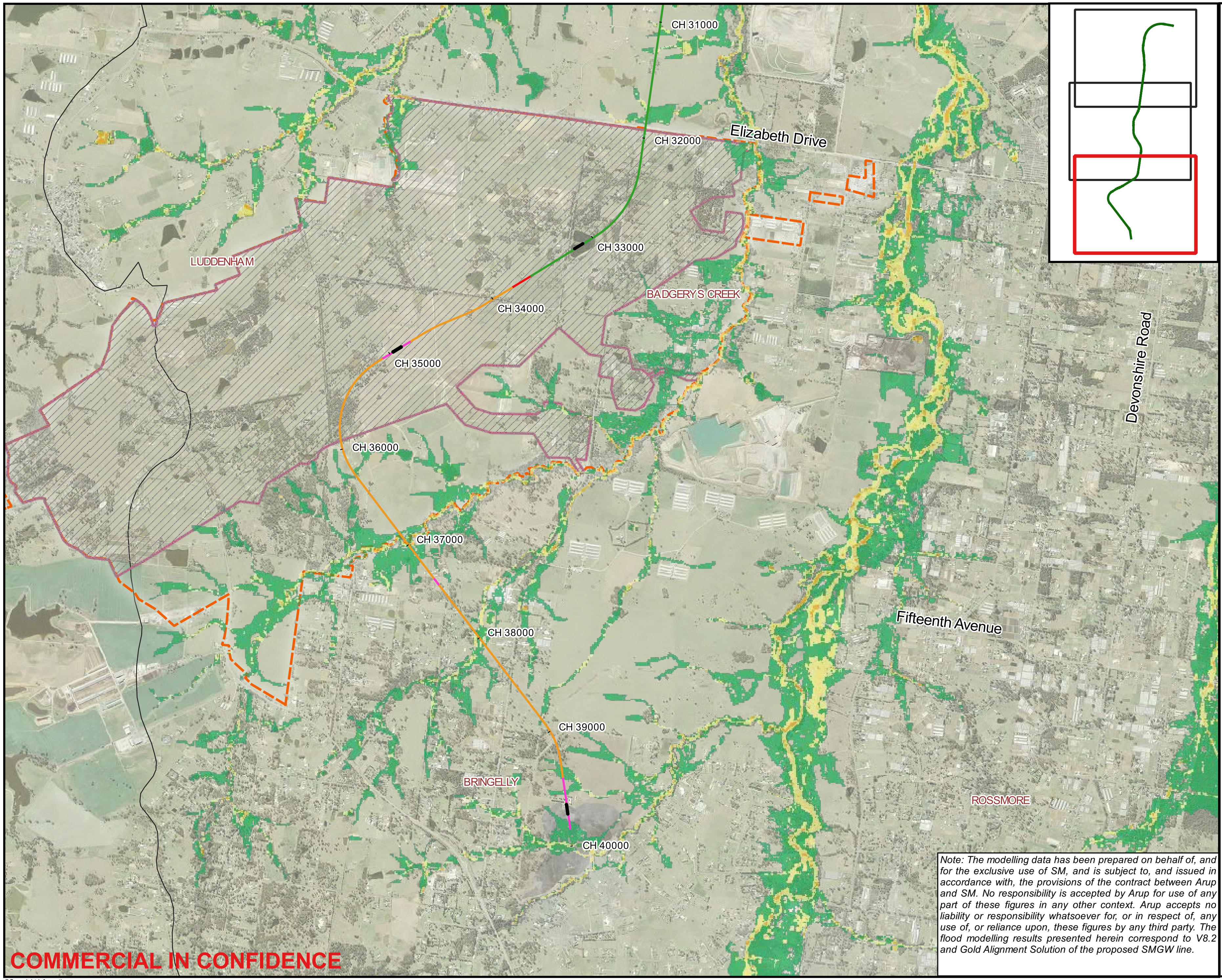

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GDA 1994 MGA Zone 56

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265549	**C.8 (3 of 3)**

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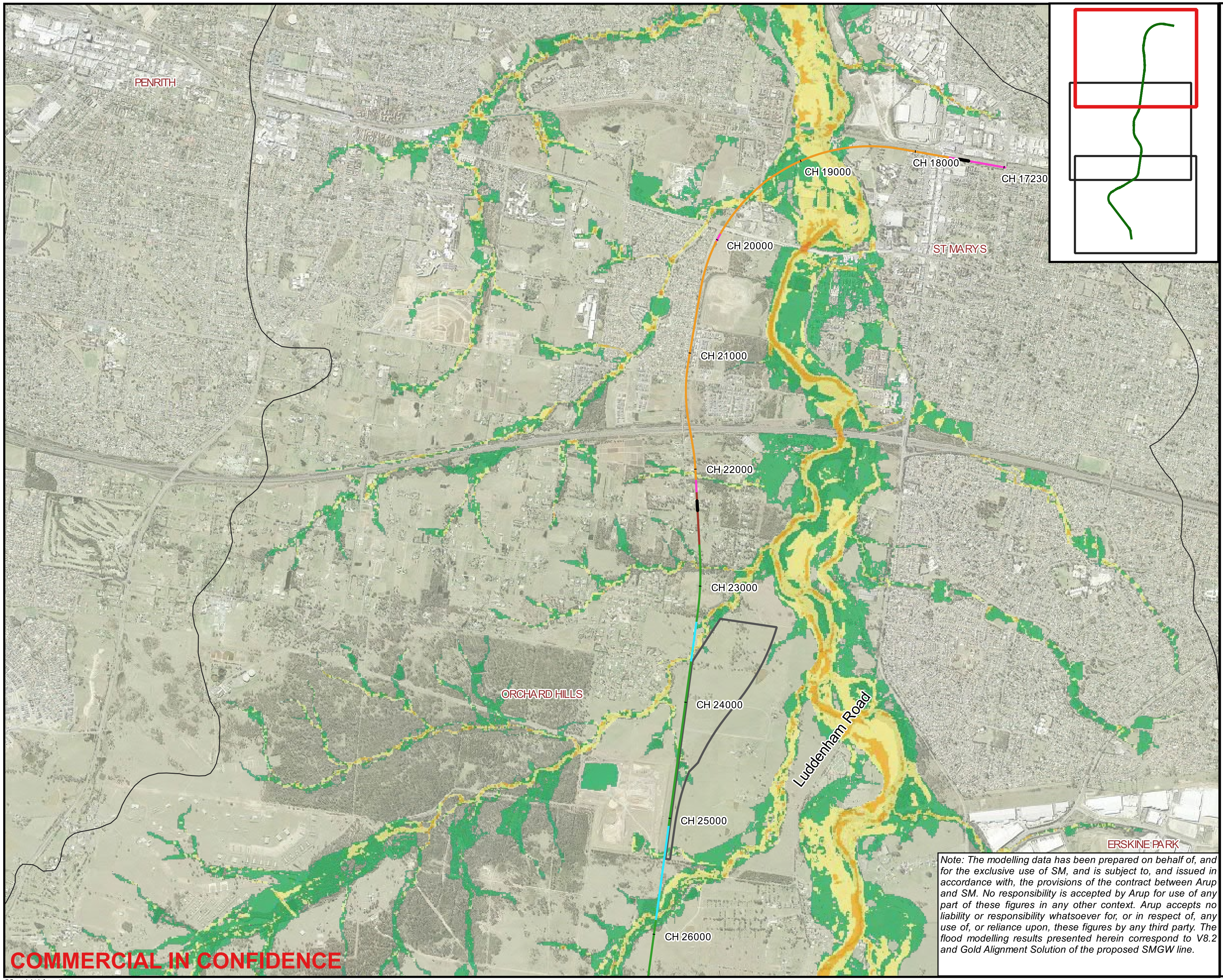

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Job Title

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Figure Title

Base Case - 5% AEP Design flood velocity

Scale at A3

1:30000

Figure Status

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Coordinate System

GDA 1994 MGA Zone 56

Job No

265549

Figure No

C.9 (1 of 3)

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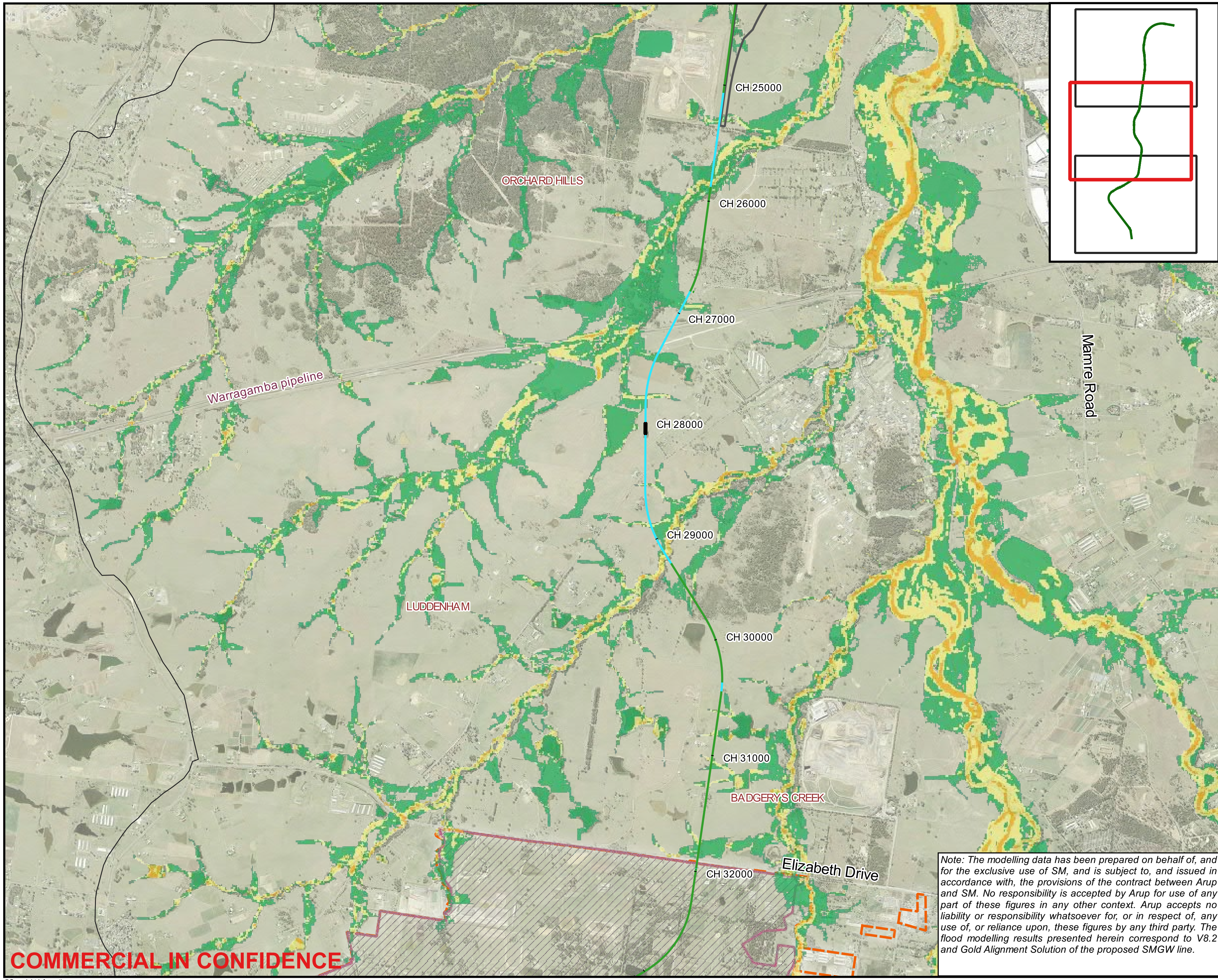

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Base Case - 5% AEP Design flood velocity

Scale at A3
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Job No
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Figure No
C.9 (2 of 3)

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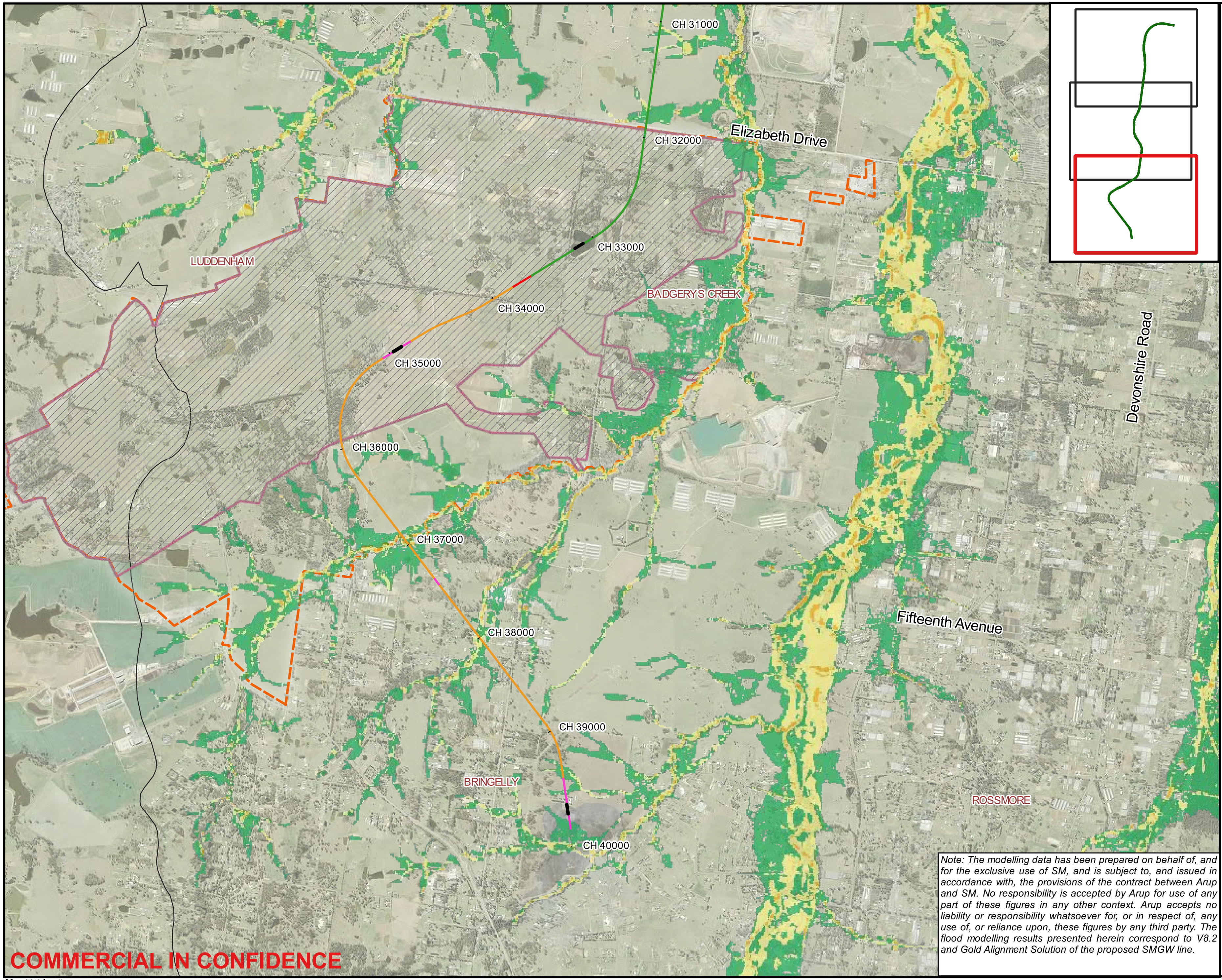

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Figure Title
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Scale at A3
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Figure Status
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Coordinate System
GDA 1994 MGA Zone 56

Job No
265549

Figure No
C.9 (3 of 3)

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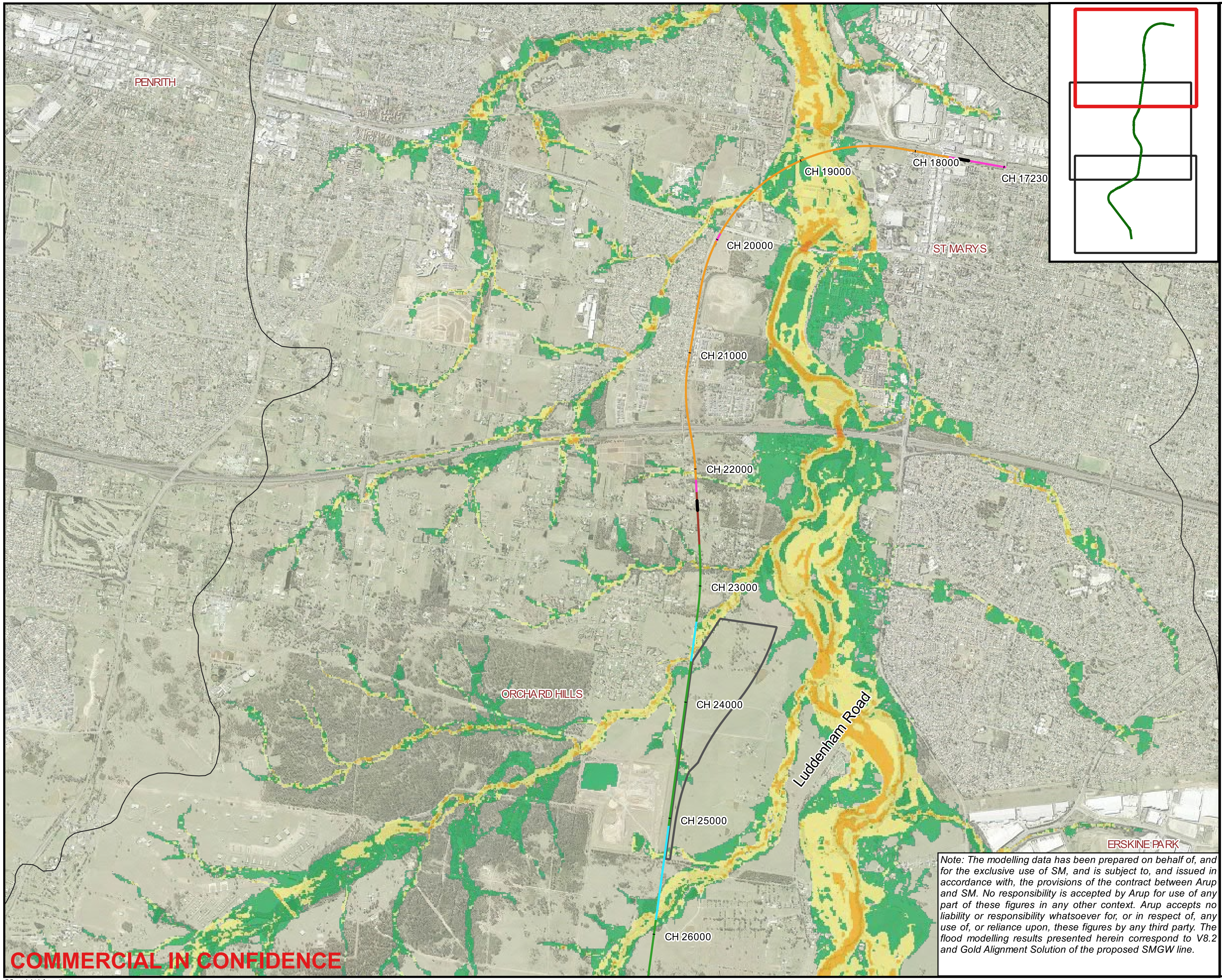

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A	01/05/20	GK	IVS	KJS
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Job Title
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Figure Title
Base Case - 1% AEP Design flood velocity

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.10 (1 of 3)

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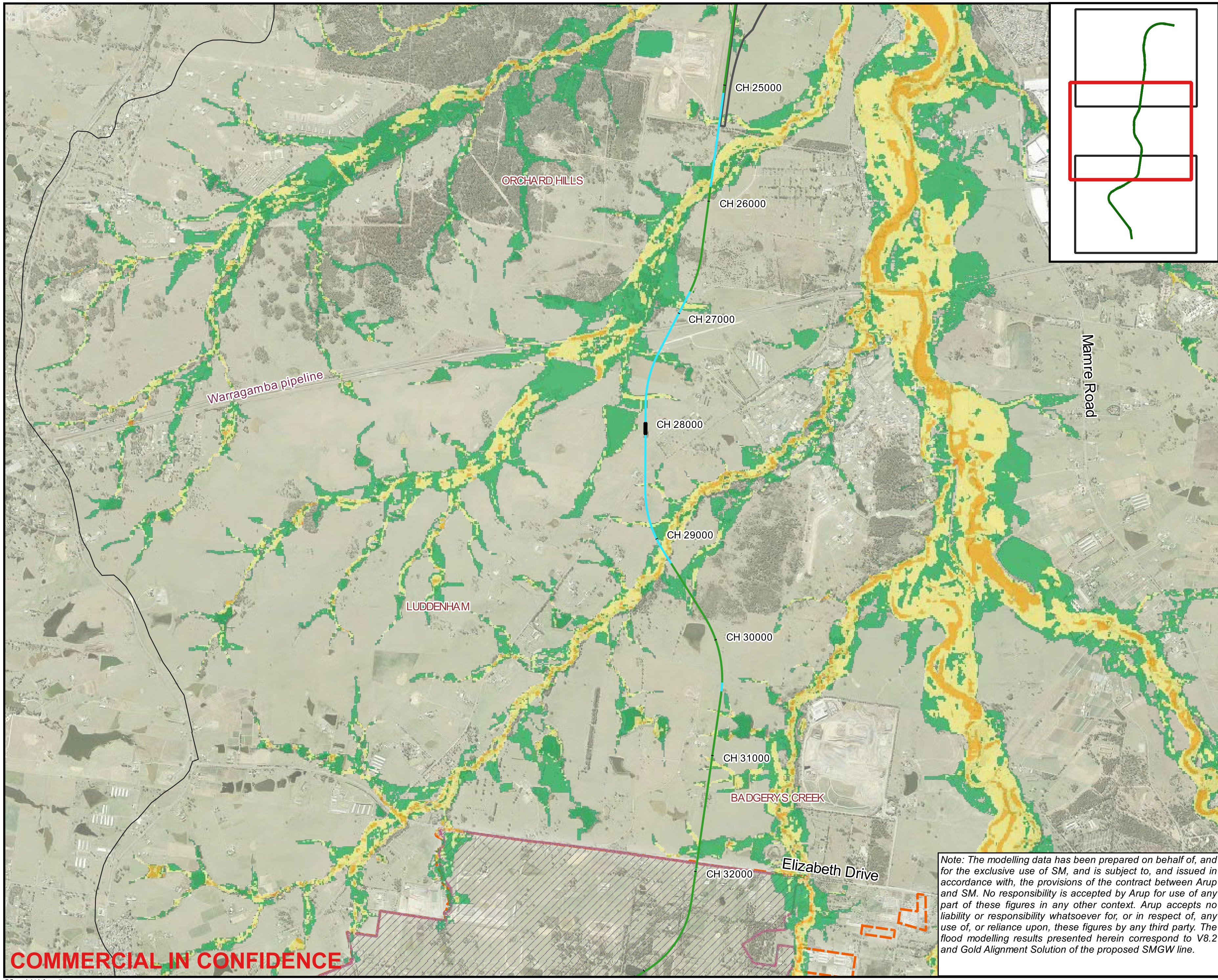

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A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

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Figure Title
Base Case - 1% AEP Design flood velocity

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.10 (2 of 3)

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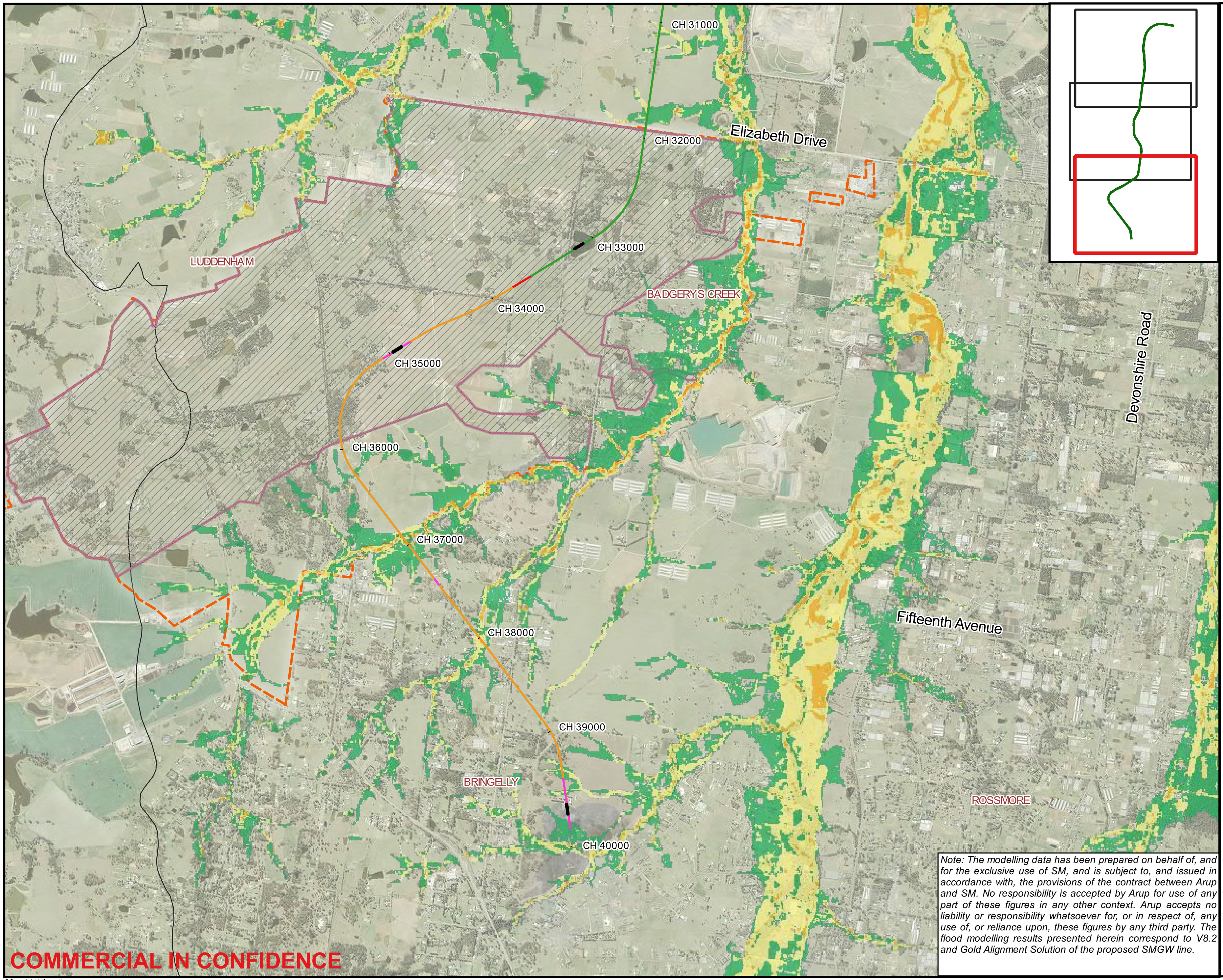

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Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
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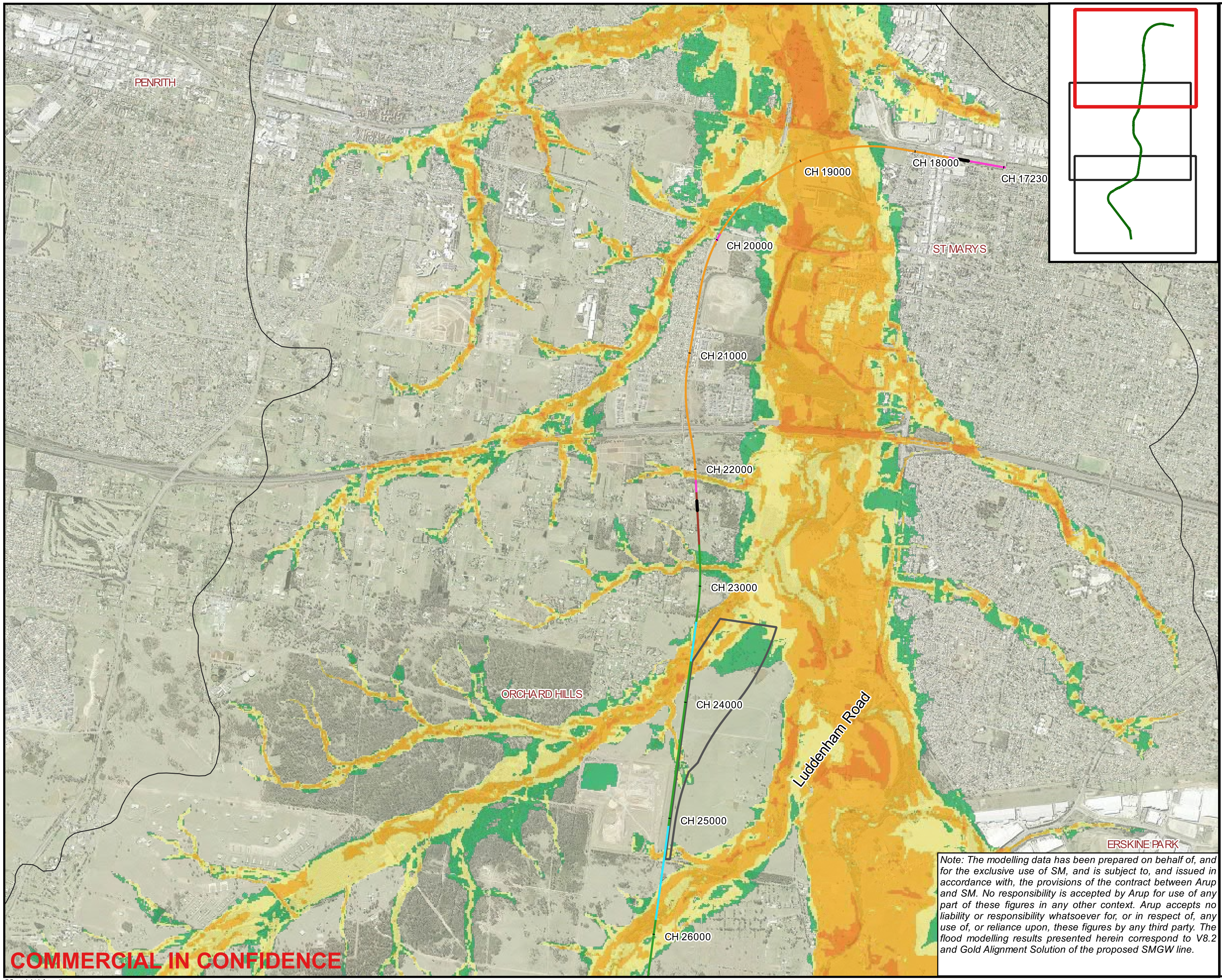

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Job Title
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Figure Title
Base Case - PMF Design flood velocity

Scale at A3	Figure Status
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Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	**C.11 (1 of 3)**

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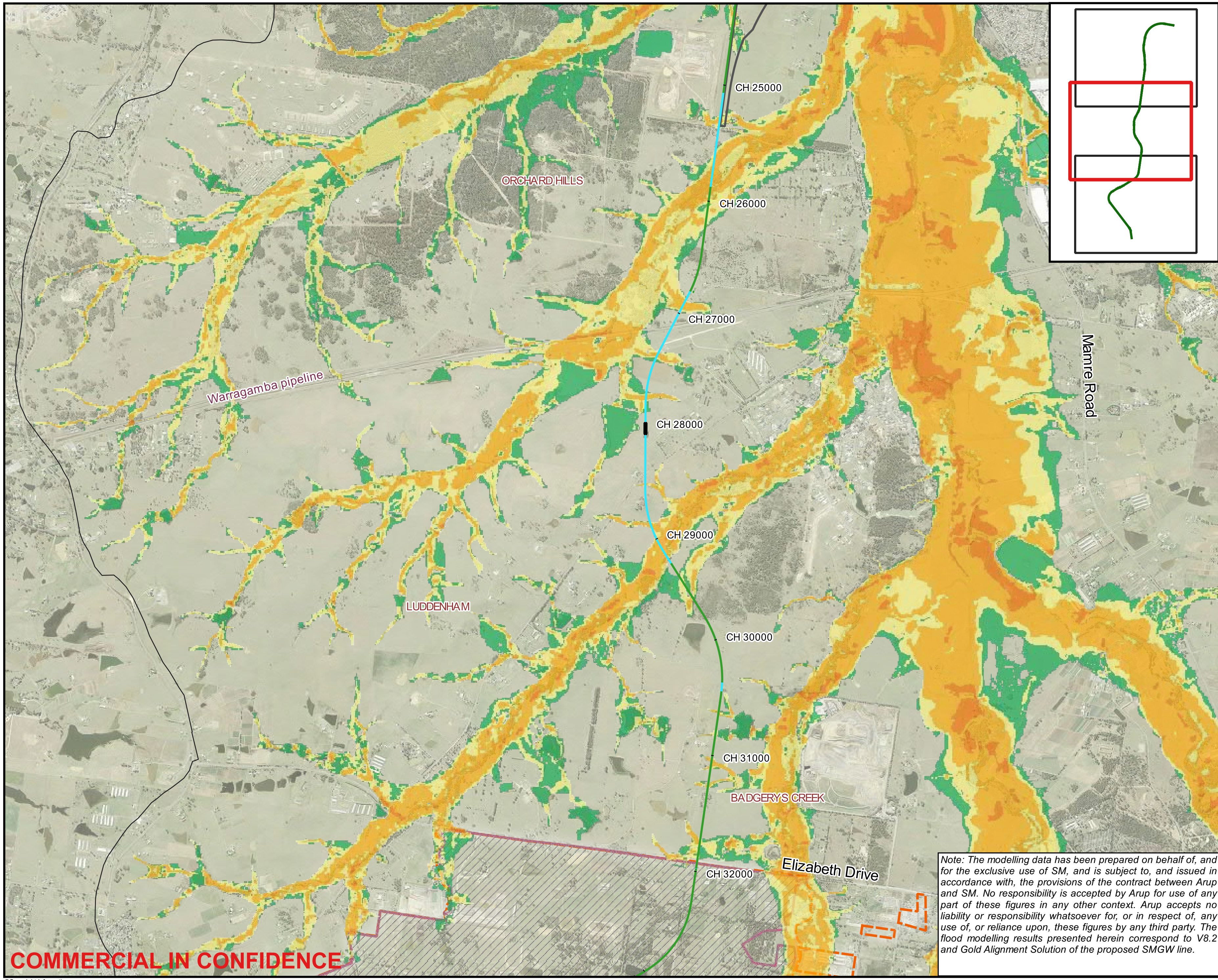

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Base Case - PMF Design flood velocity

Scale at A3
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Figure No
C.11 (2 of 3)

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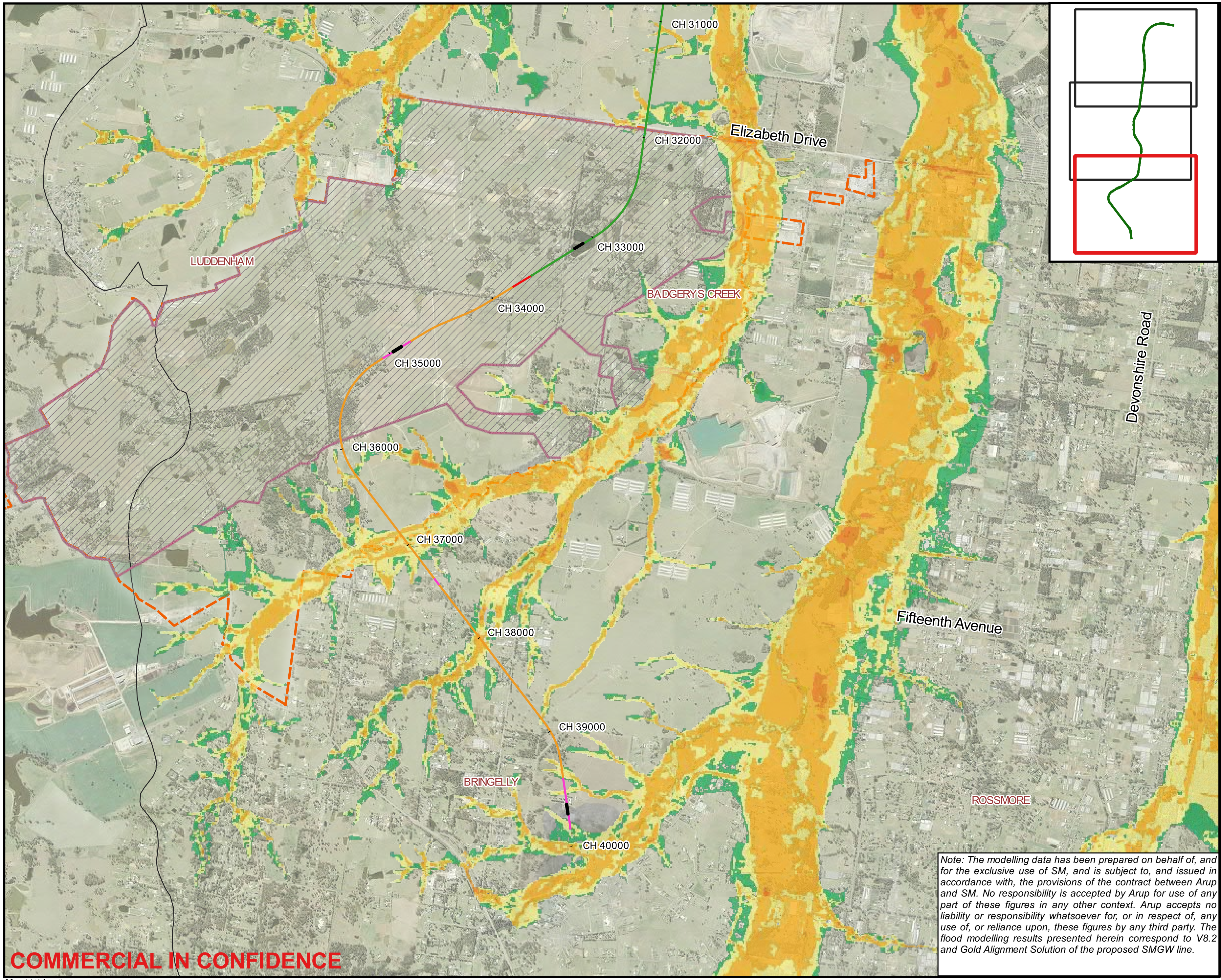

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- Cut and Cover
- Dive Structure
- Driven Tunnel
- Trough or Cutting
- Platform
- Stabling Site

Issue	Date	By	Chkd	Appd
A	01/05/20	GK	IVS	KJS

0 500 1000 1500 m

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Client: **Sydney Metro**

Job Title: **SMGW TA Services**

Figure Title: **Base Case - PMF Design flood velocity**

Scale at A3: **1:30000**

Figure Status: **Issued for Information**

Coordinate System: **GDA 1994 MGA Zone 56**

Job No: **265549**

Figure No: **C.11 (3 of 3)**

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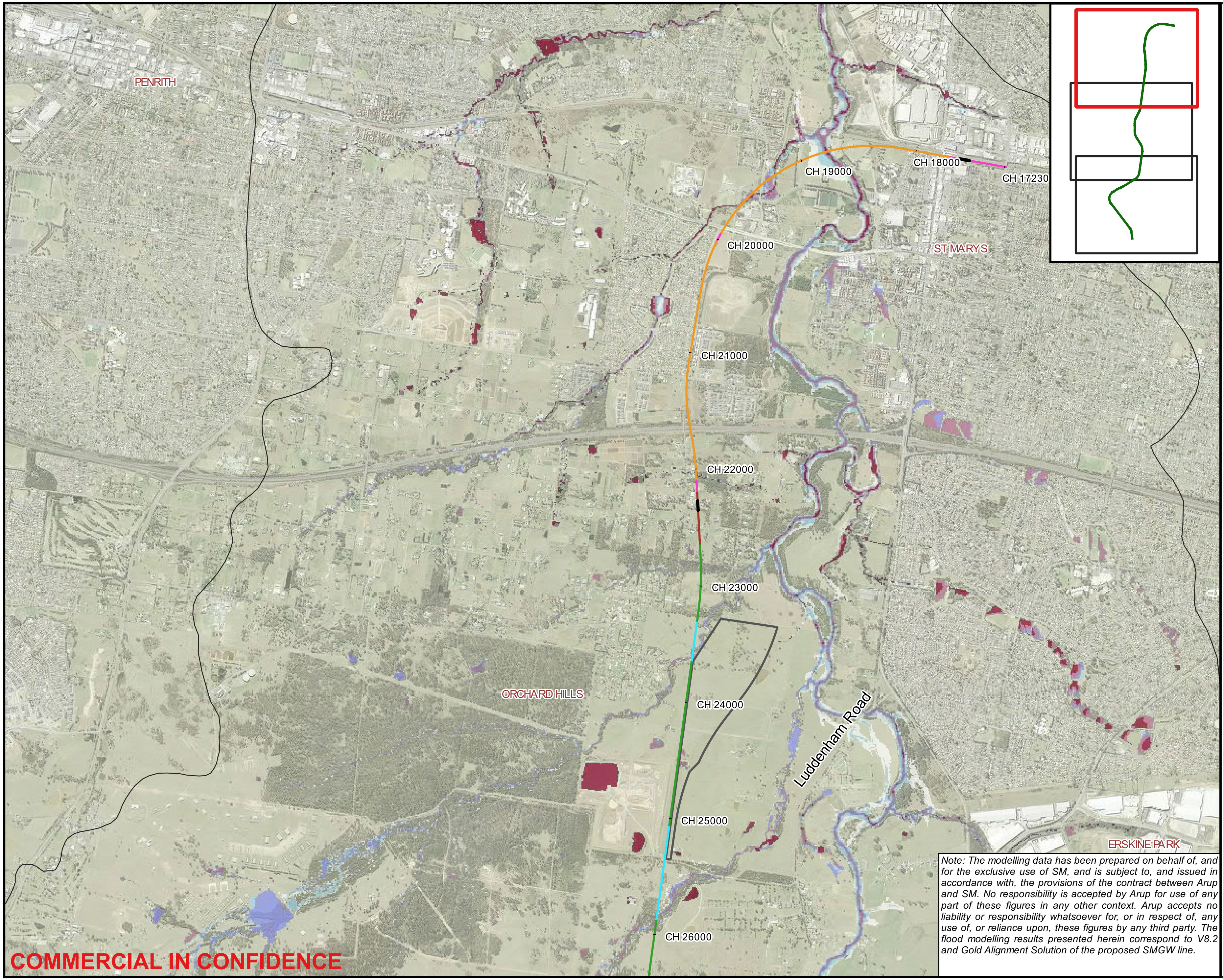

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Legend

Duration of inundation (hours)

- 0 - 6
- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 30
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
- At Grade
- Bridge or Viaduct
- Cut and Cover
- Dive Structure
- Driven Tunnel
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- Platform
- Stabling Site

A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

0 500 1000 1500 m

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Client: **Sydney Metro**

Job Title: **SMGW TA Services**

Figure Title: **Base Case - 0.5EY Duration of inundation**

Scale at A3: **1:30000**

Figure Status: **Issued for Information**

Coordinate System: **GDA 1994 MGA Zone 56**

Job No: **265549**

Figure No: **C.12 (1 of 3)**

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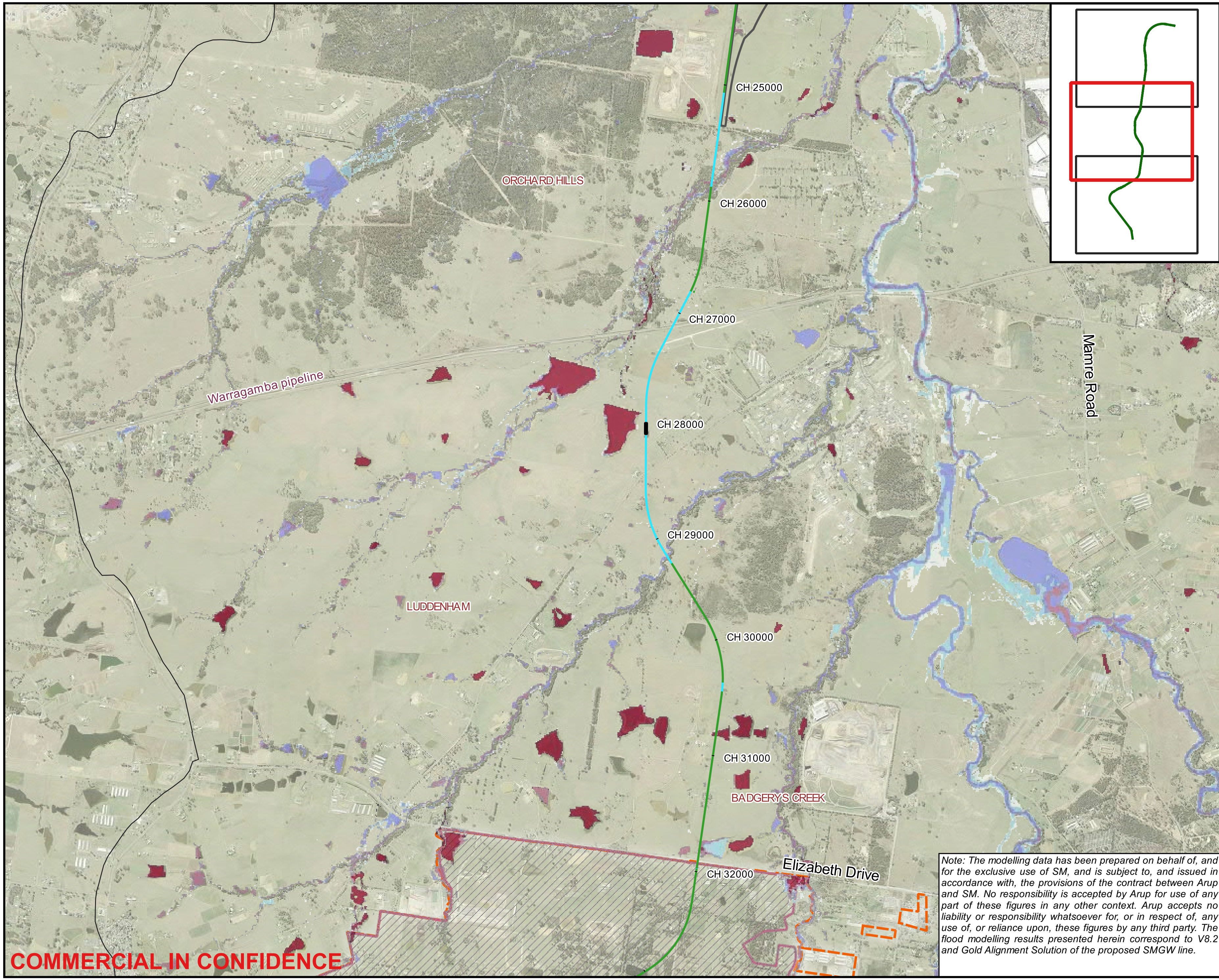

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Legend

Duration of inundation (hours)

- 0 - 6
- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 30
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
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- Stabling Site

A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

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Job Title

SMGW TA Services

Figure Title

Base Case - 0.5EY Duration of inundation

Scale at A3

1:30000

Figure Status

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Coordinate System

GDA 1994 MGA Zone 56

Job No

265549

Figure No

C.12 (2 of 3)

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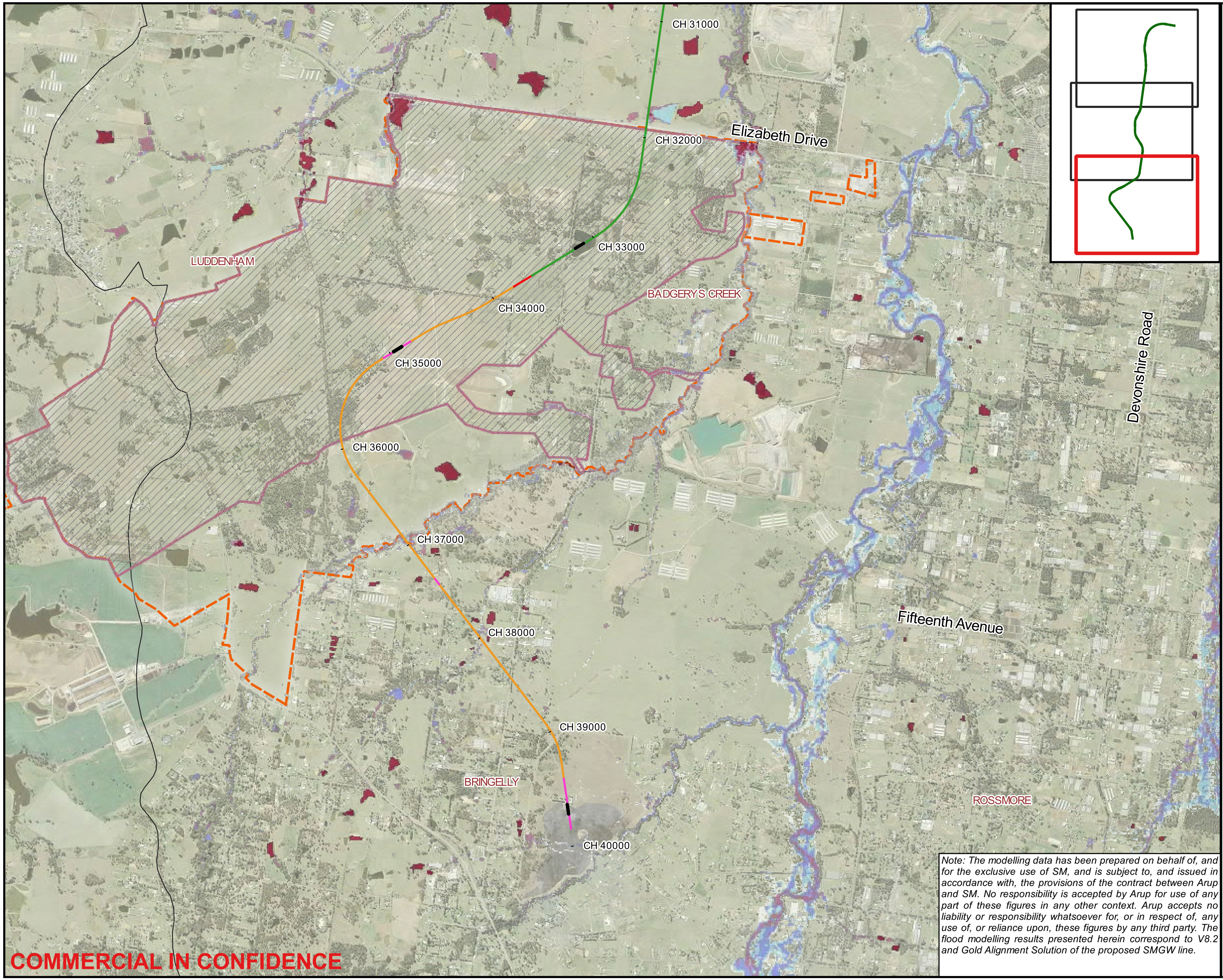

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Legend

Duration of inundation (hours)

- 0 - 6
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- WSI Stage 1 Construction Boundary
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A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

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Job Title
SMGW TA Services

Figure Title
Base Case - 0.5EY Duration of inundation

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.12 (3 of 3)

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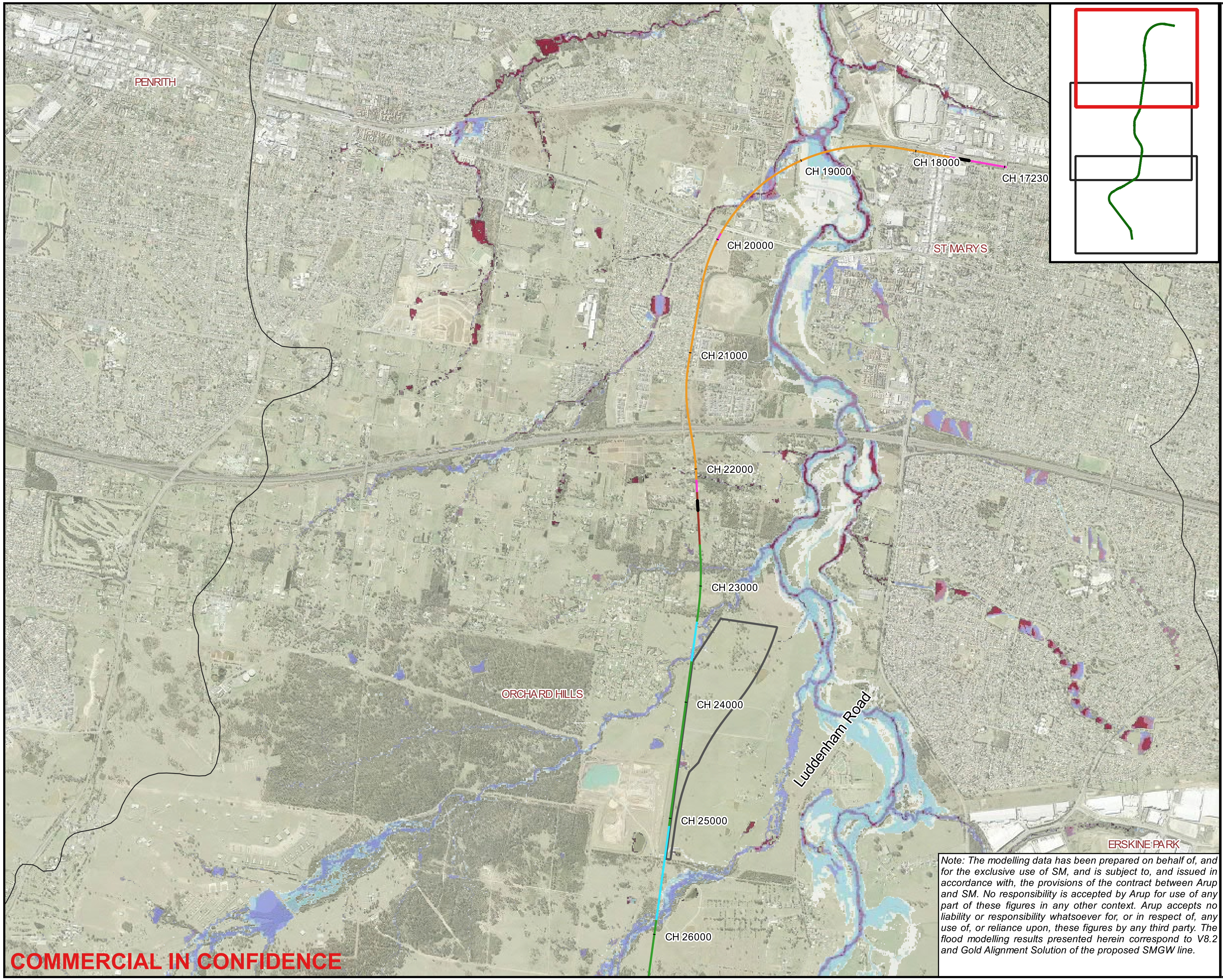

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Job Title
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Figure Title
Base Case - 0.2EY Duration of inundation

Scale at A3: 1:30000
Figure Status: Issued for Information

Coordinate System: GDA 1994 MGA Zone 56

Job No: 265549
Figure No: C.13 (1 of 3)

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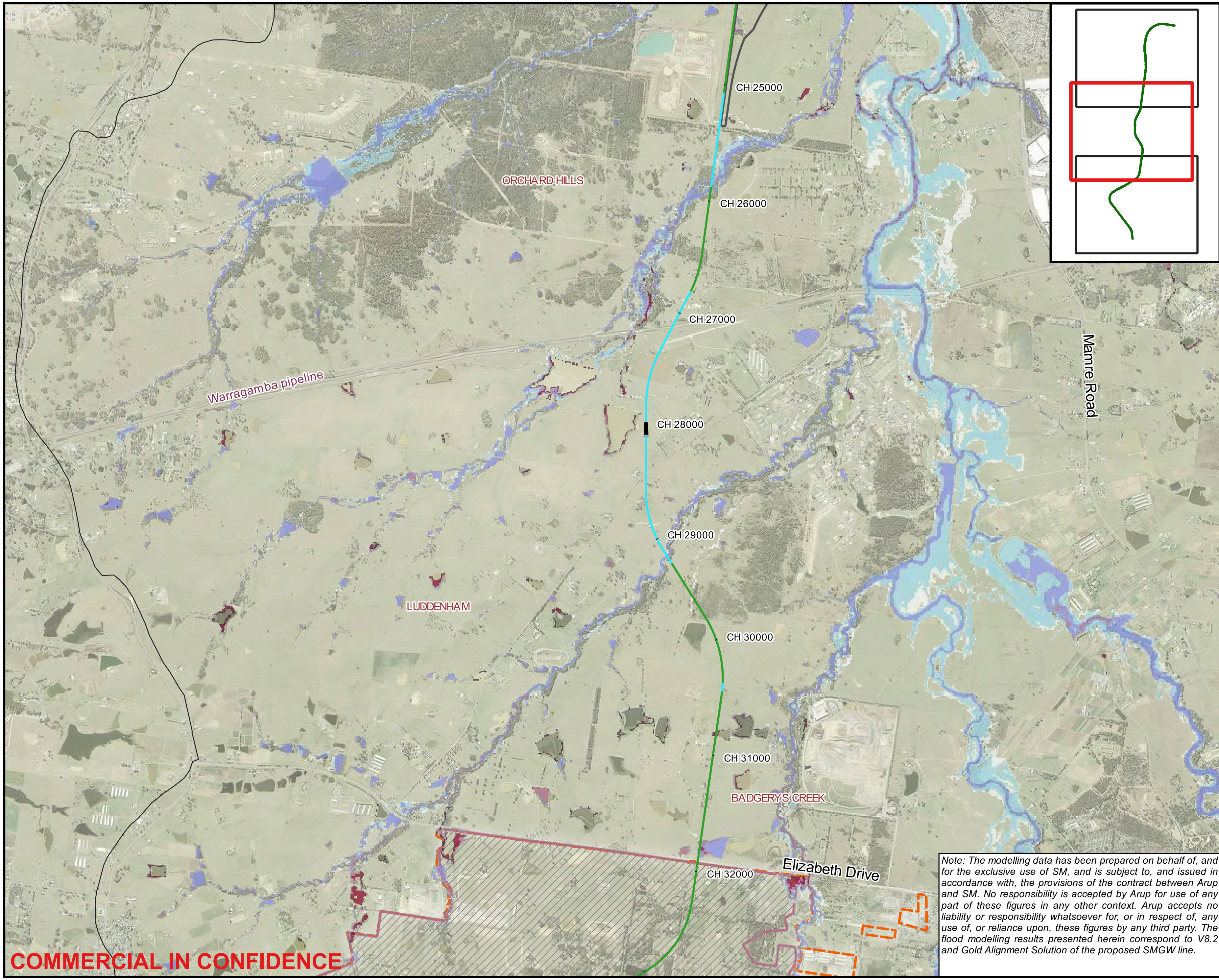

Legend

Duration of inundation (hours)

- 0 - 6
- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 30
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
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Issue	Date	By	Chkd	Appd

0 500 1000 1500 m

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Job Title
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Figure Title
Base Case - 0.2EY Duration of inundation

Scale at A3
1:30000

Figure Status
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Coordinate System
GDA 1994 MGA Zone 56

Job No
265549

Figure No
C.13 (2 of 3)

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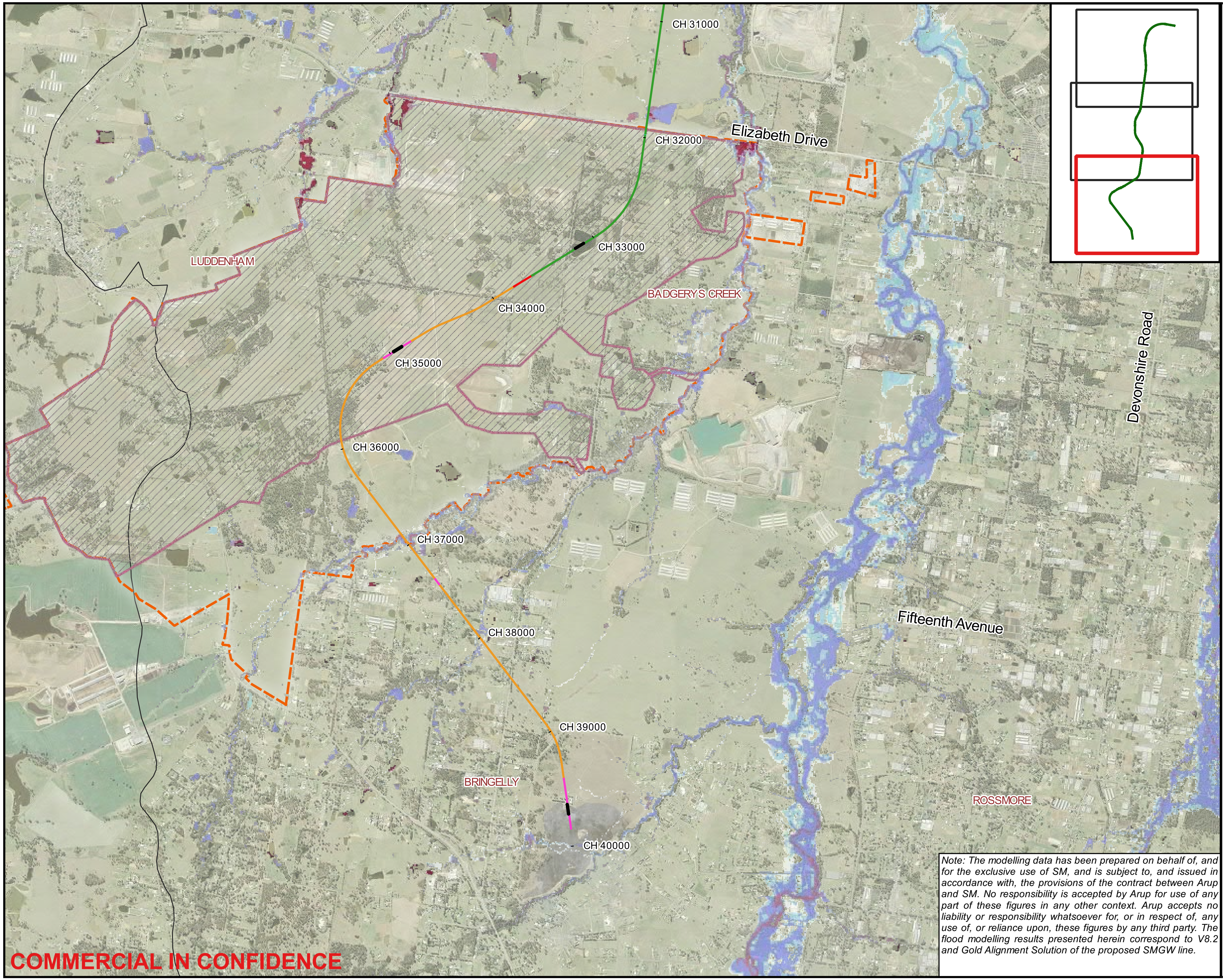

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Legend

Duration of inundation (hours)

- 0 - 6
- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 30
- WSI Boundary
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Job Title
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Figure Title
Base Case - 0.2EY Duration of inundation

Scale at A3
1:30000

Figure Status
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Coordinate System
GDA 1994 MGA Zone 56

Job No
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Figure No
C.13 (3 of 3)

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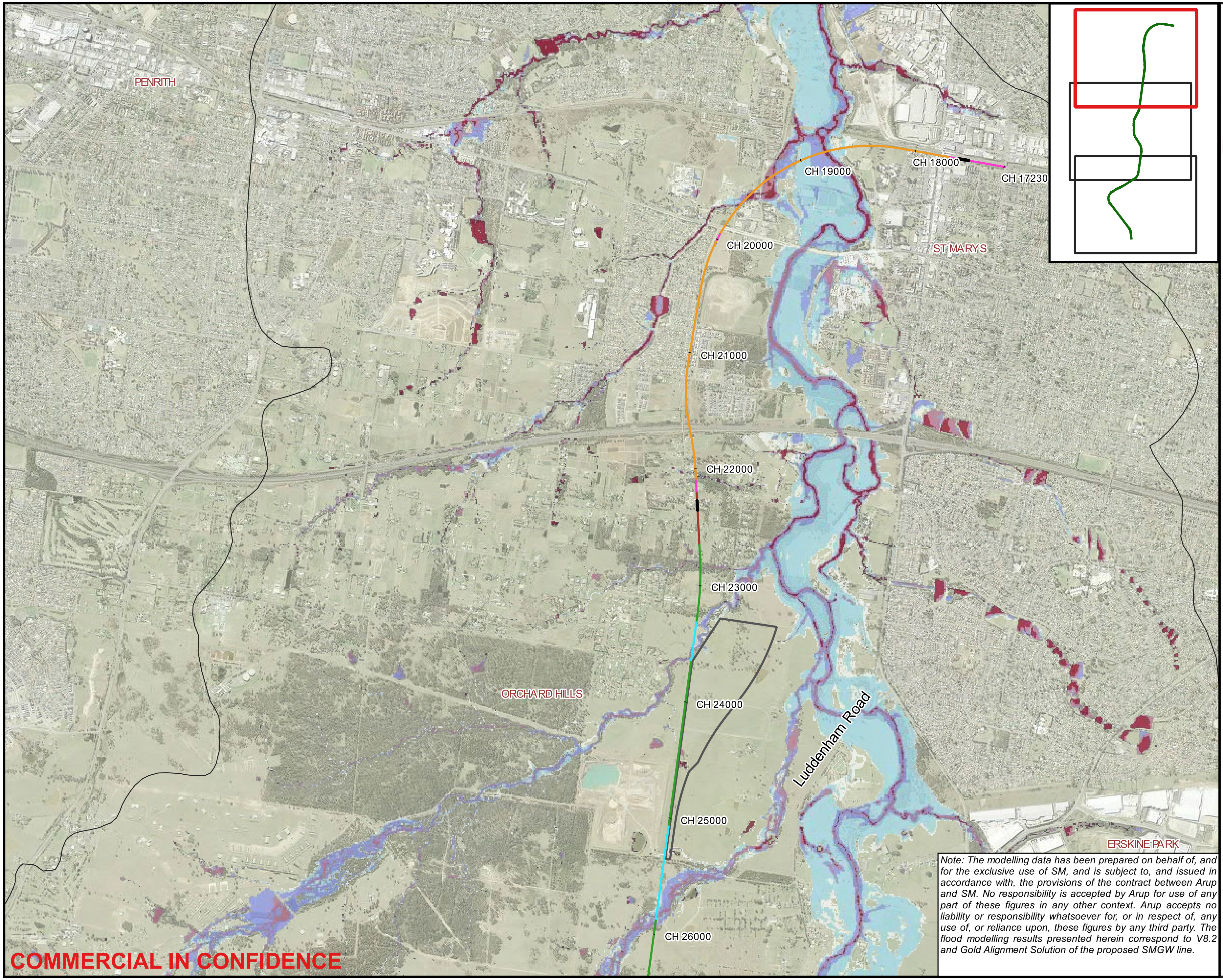

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Legend

Duration of inundation (hours)

- 0 - 6
- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 30
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
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A	01/05/20	GK	IVS	KJS
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Job Title
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Figure Title
Base Case - 5% AEP Duration of inundation

Scale at A3: **1:30000**

Figure Status: **Issued for Information**

Coordinate System
GDA 1994 MGA Zone 56

Job No: **265549**

Figure No: **C.14 (1 of 3)**

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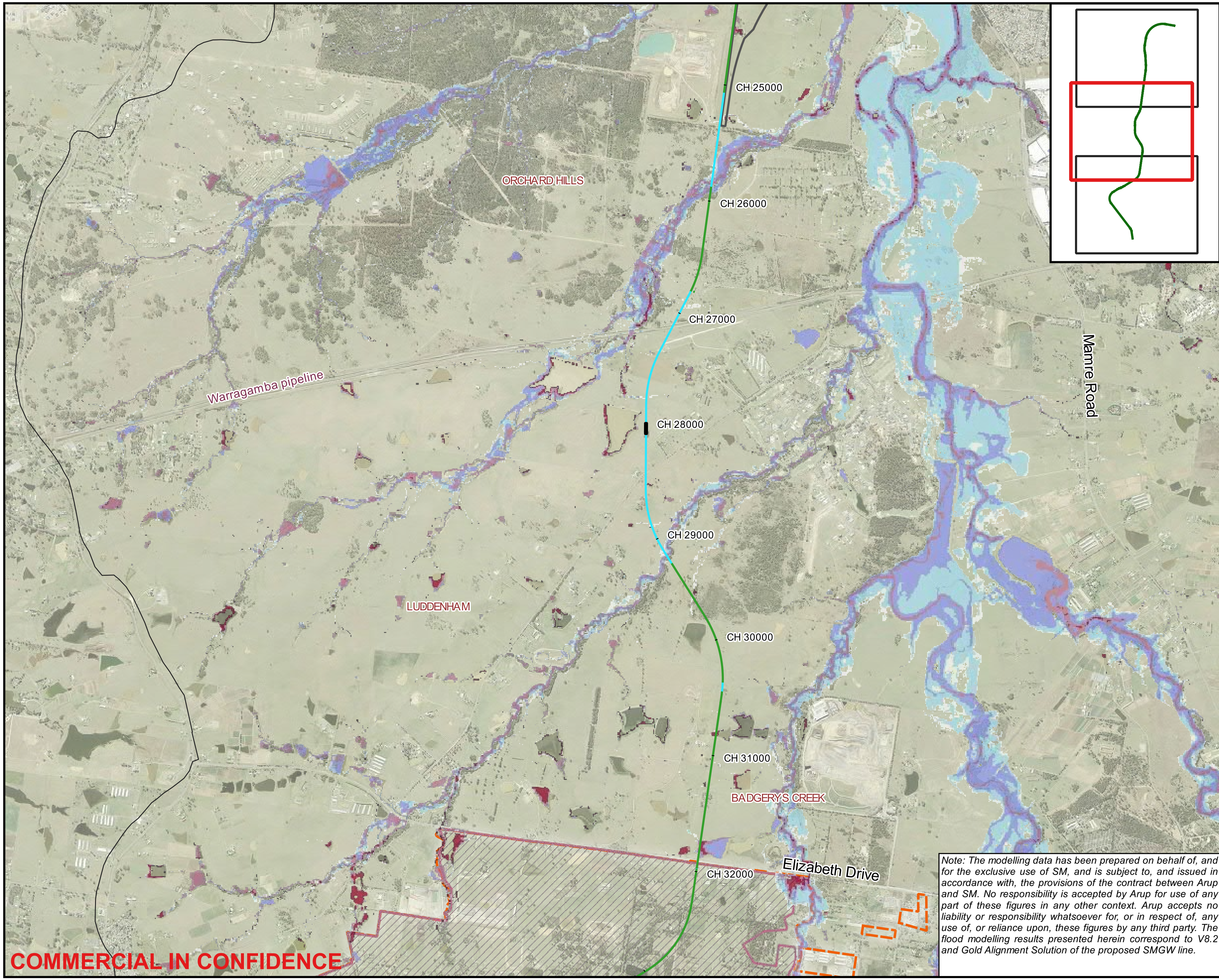

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Legend

Duration of inundation (hours)

- 0 - 6
- 6 - 12
- 12 - 18
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- WSI Stage 1 Construction Boundary
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A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

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Job Title
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Figure Title
Base Case - 5% AEP Duration of inundation

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.14 (2 of 3)

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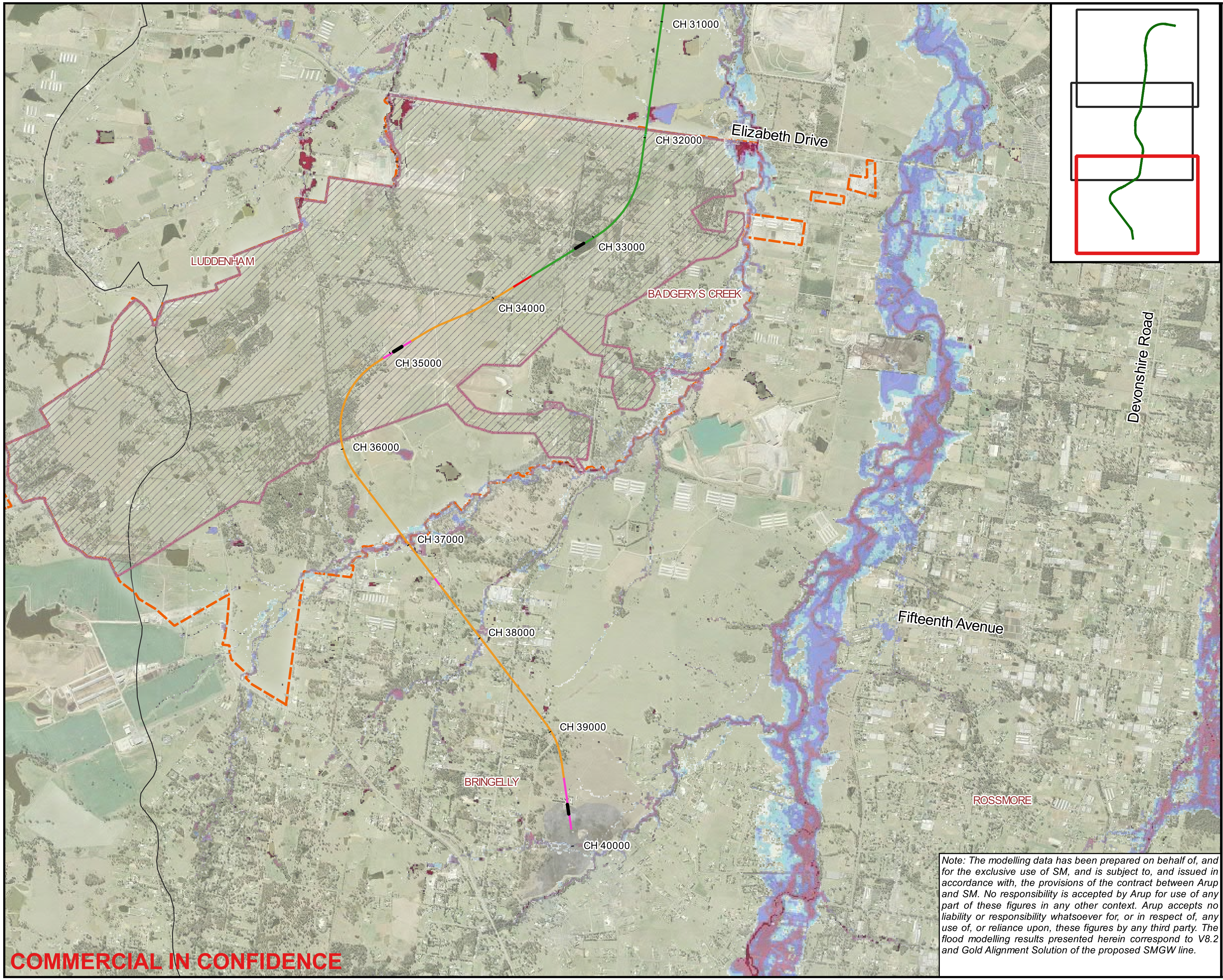

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Legend

Duration of inundation (hours)

- 0 - 6
- 6 - 12
- 12 - 18
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- WSI Boundary
- WSI Stage 1 Construction Boundary
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A	01/05/20	GK	IVS	KJS
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Job Title
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Figure Title
Base Case - 5% AEP Duration of inundation

Scale at A3	Figure Status
1:30000	**Issued for Information**

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	**C.14 (3 of 3)**

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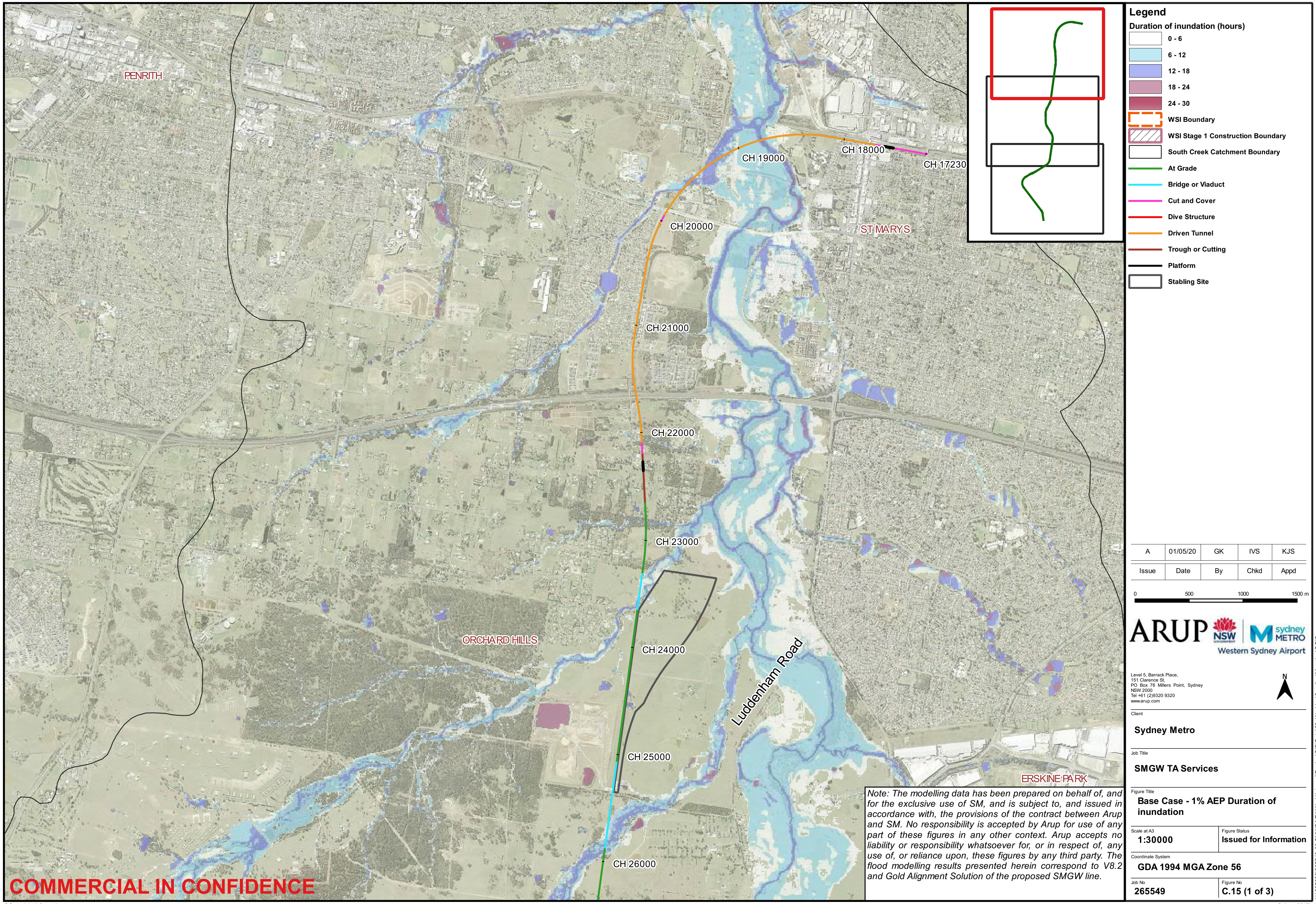

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Job Title
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Figure Title
Base Case - 1% AEP Duration of inundation

Scale at A3
1:30000

Figure Status
Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No
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Figure No
C.15 (1 of 3)

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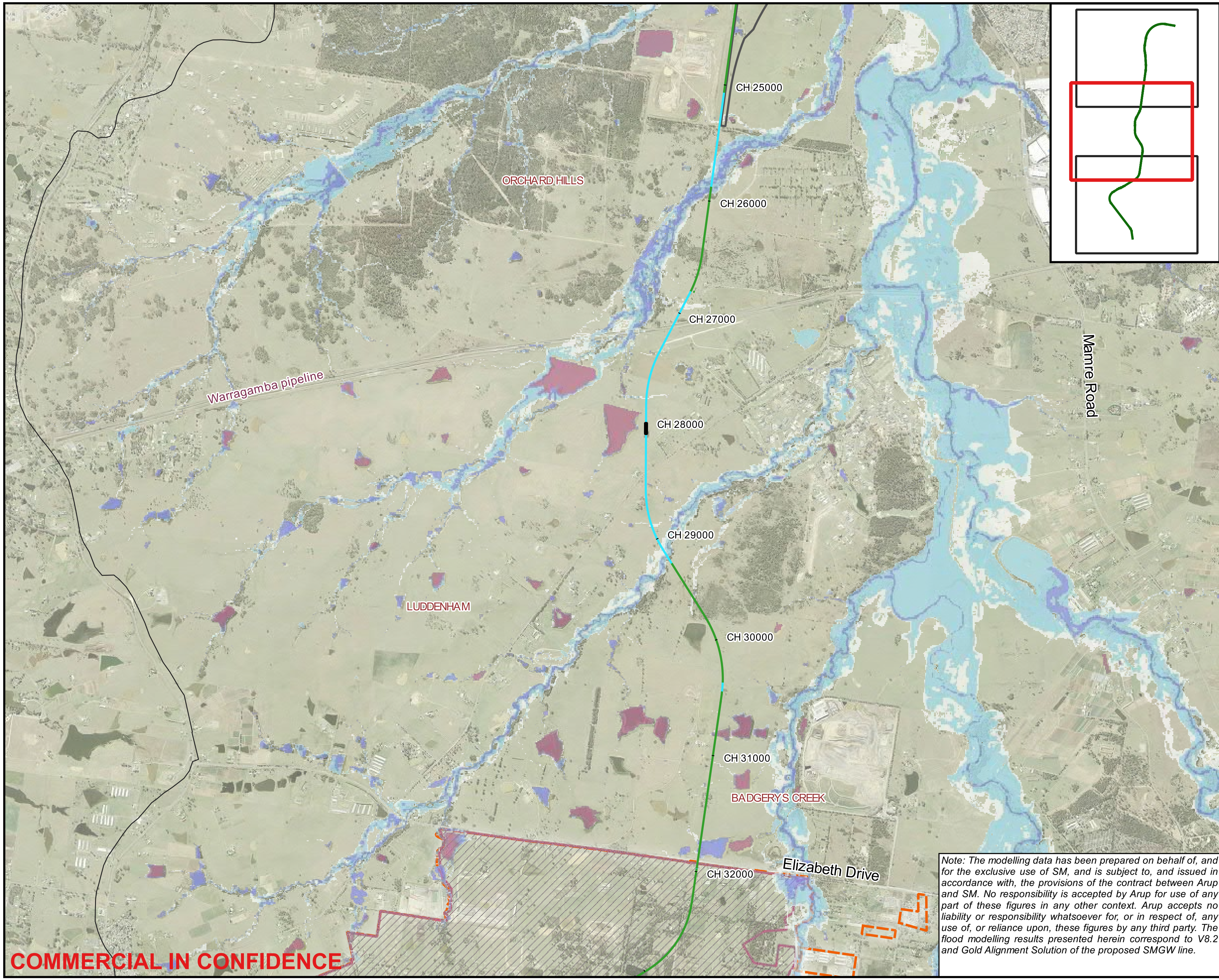

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COMMERCIAL IN CONFIDENCE

Legend

Duration of inundation (hours)

- 0 - 6
- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 30
- WSI Boundary
- WSI Stage 1 Construction Boundary
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A	01/05/20	GK	IVS	KJS
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Figure Title
Base Case - 1% AEP Duration of inundation

Scale at A3	Figure Status
1:30000	**Issued for Information**

Coordinate System
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Job No	Figure No
265549	**C.15 (2 of 3)**

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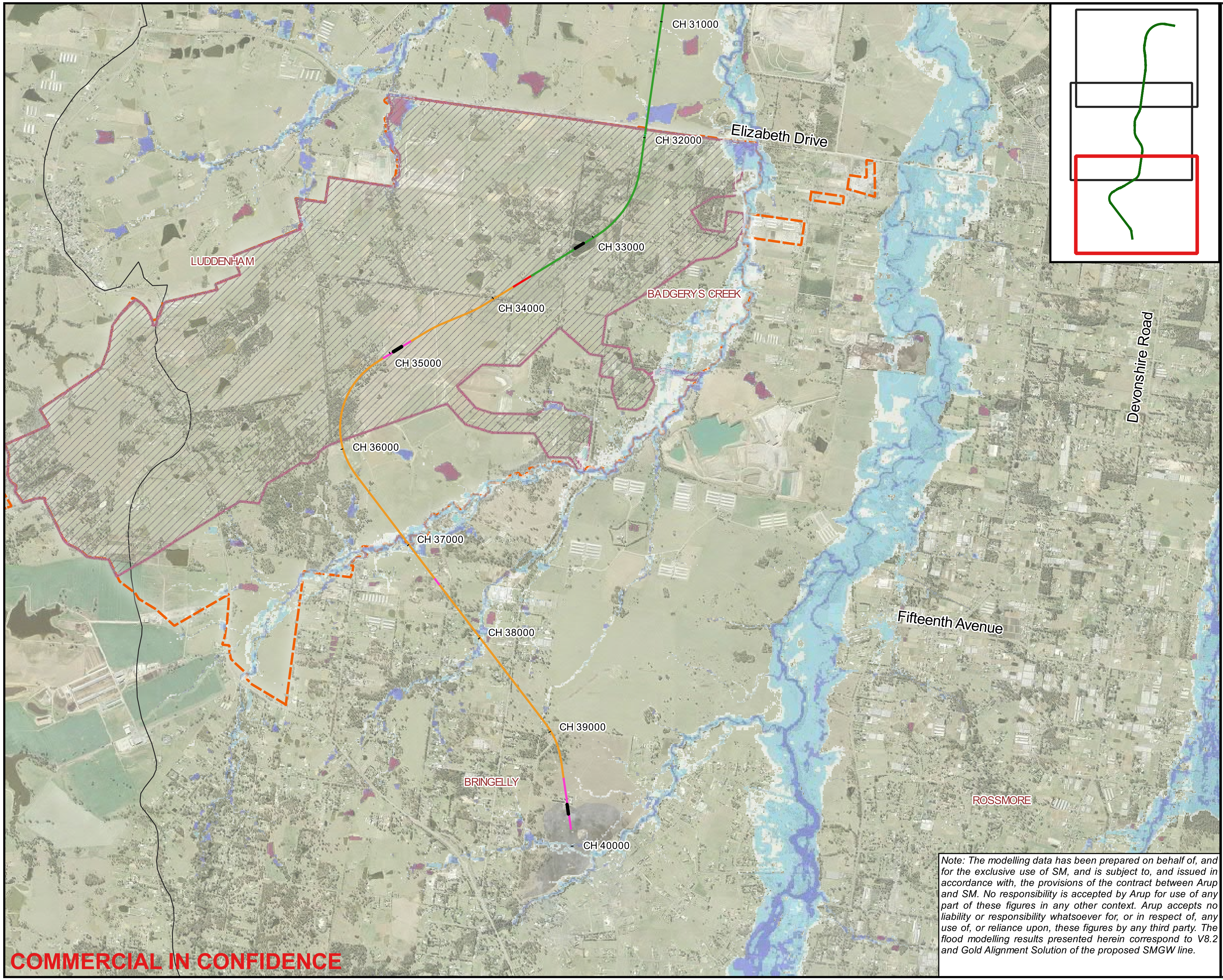

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Legend

Duration of inundation (hours)

- 0 - 6
- 6 - 12
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A	01/05/20	GK	IVS	KJS
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Figure Title
Base Case - 1% AEP Duration of inundation

Scale at A3
1:30000

Figure Status
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Coordinate System
GDA 1994 MGA Zone 56

Job No
265549

Figure No
C.15 (3 of 3)

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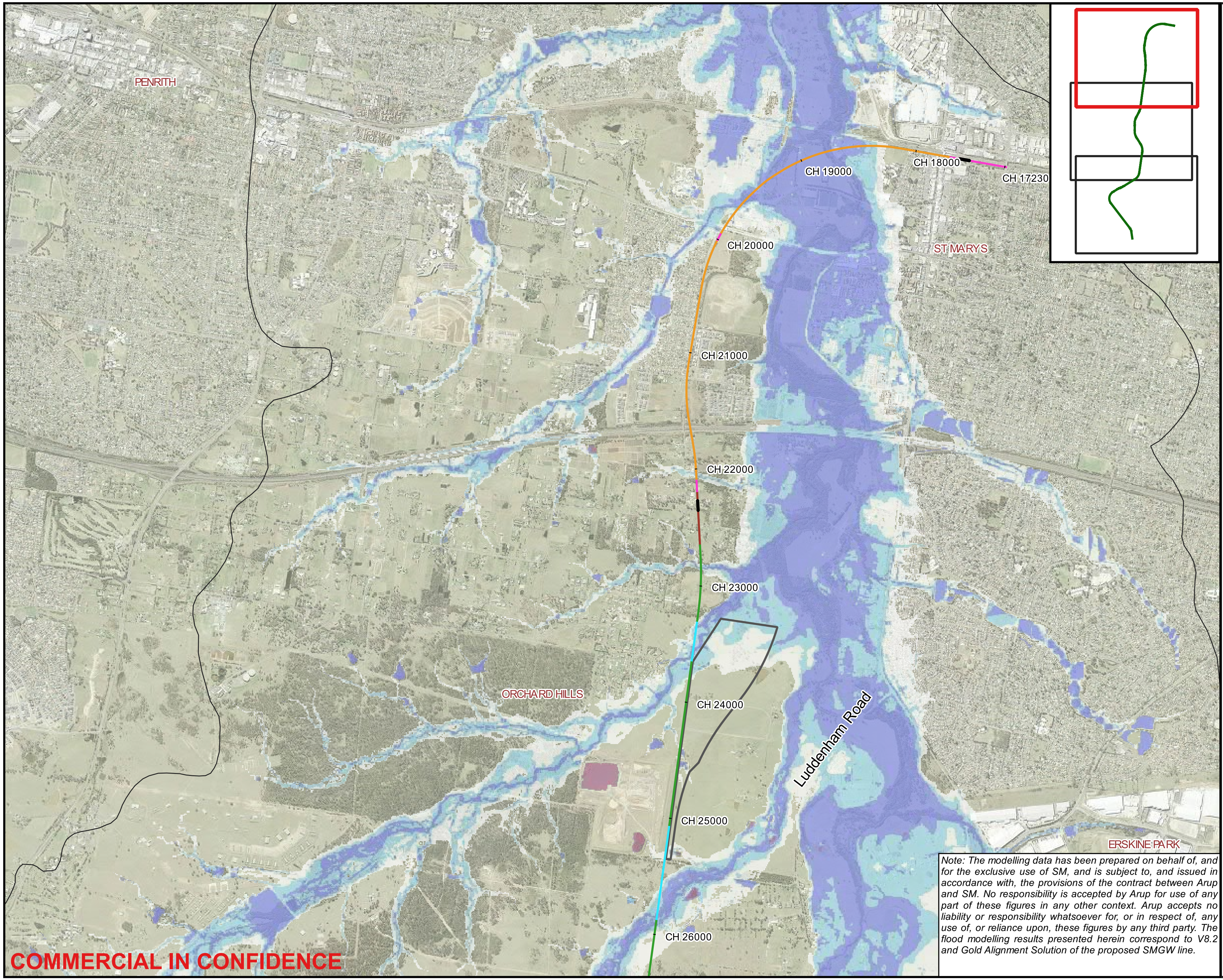

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Legend

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A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

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Job Title

SMGW TA Services

Figure Title

Base Case - PMF Duration of inundation

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System

GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.16 (1 of 3)

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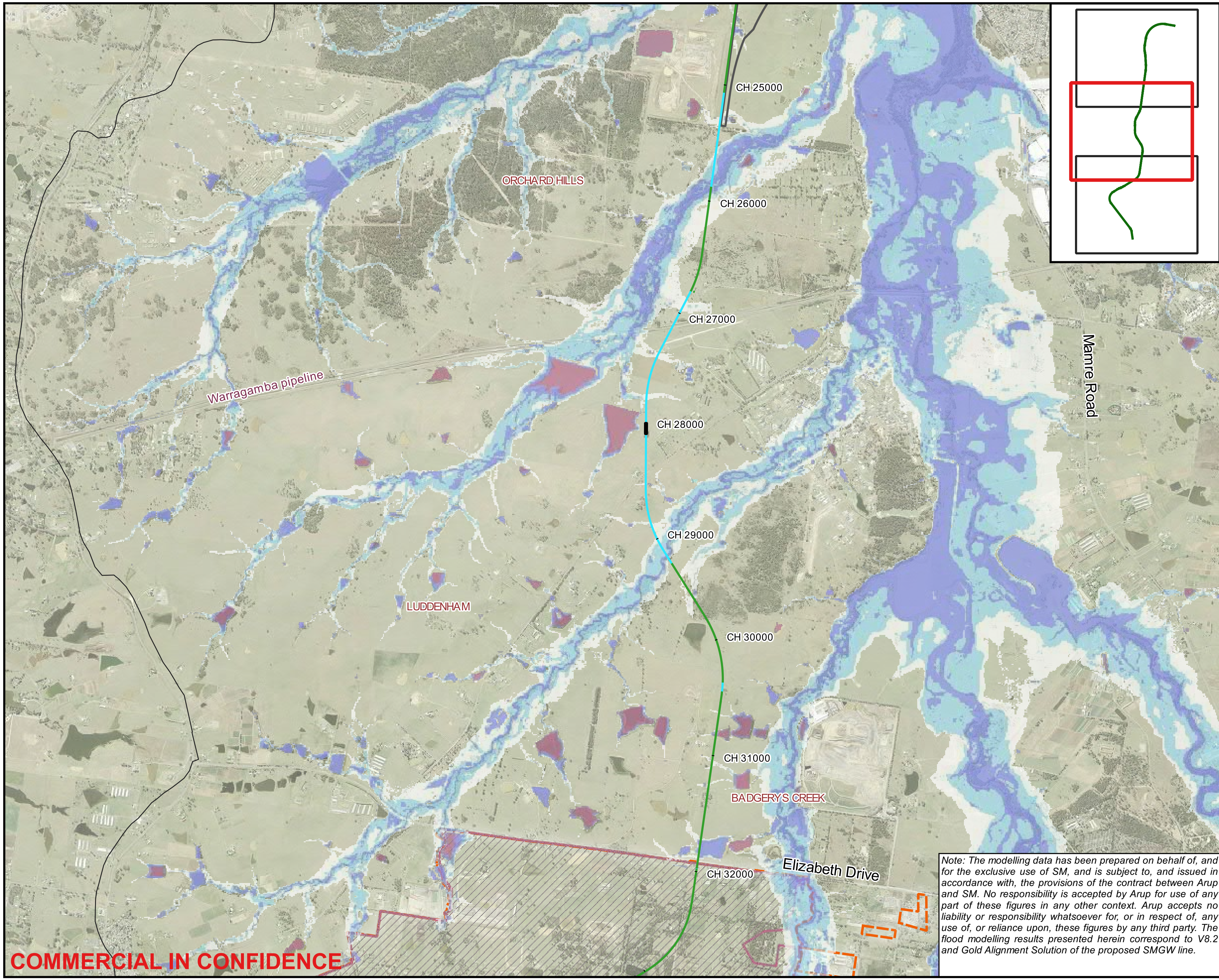

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A	01/05/20	GK	IVS	KJS
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Client
Sydney Metro

Job Title
SMGW TA Services

Figure Title
Base Case - PMF Duration of inundation

Scale at A3	Figure Status
1:30000	**Issued for Information**

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	**C.16 (2 of 3)**

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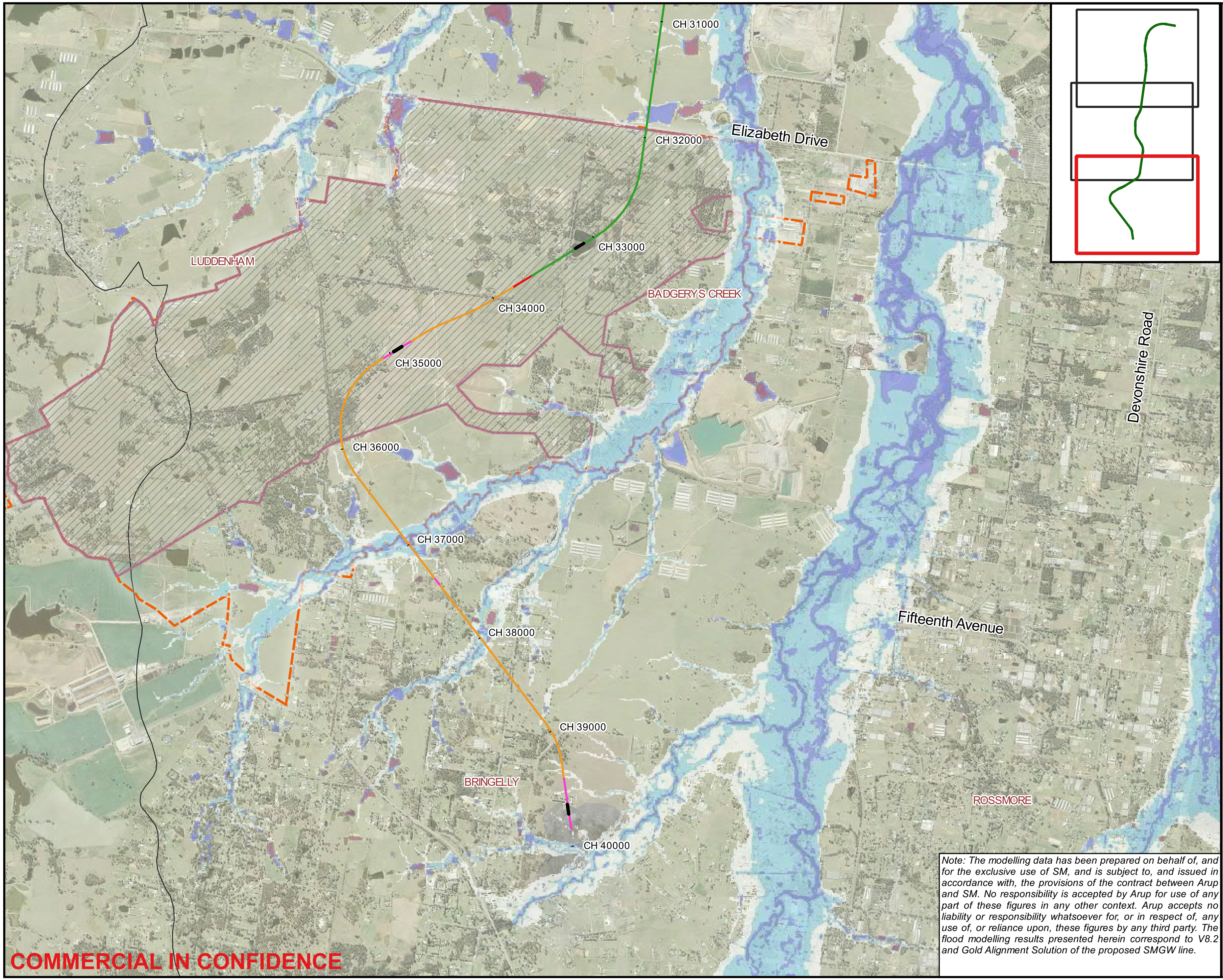

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Legend

Duration of inundation (hours)

- 0 - 6
- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 30
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
- At Grade
- Bridge or Viaduct
- Cut and Cover
- Dive Structure
- Driven Tunnel
- Trough or Cutting
- Platform
- Stabling Site

A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

0 500 1000 1500 m

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Job Title
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Figure Title
Base Case - PMF Duration of inundation

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.16 (3 of 3)

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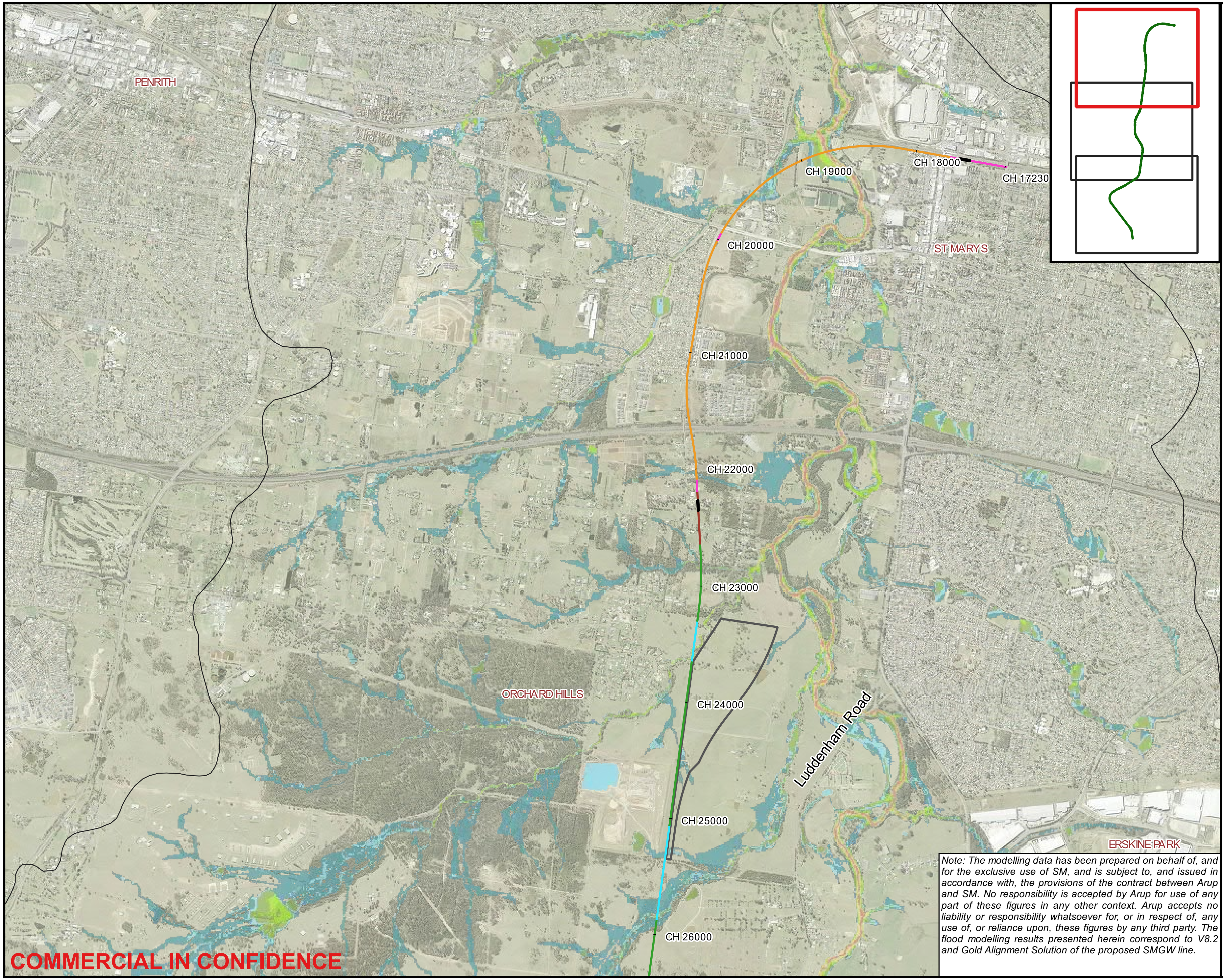

Legend

Flood hazard

- H1 - Generally safe for people, vehicles and buildings.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles, children and the elderly.
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Issue	Date	By	Chkd	Appd

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Client
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Job Title
SMGW TA Services

Figure Title
Base Case - 0.5EY Provisional flood hazard

Scale at A3: 1:30000
Figure Status: Issued for Information

Coordinate System: GDA 1994 MGA Zone 56

Job No: 265549
Figure No: C.17 (1 of 3)

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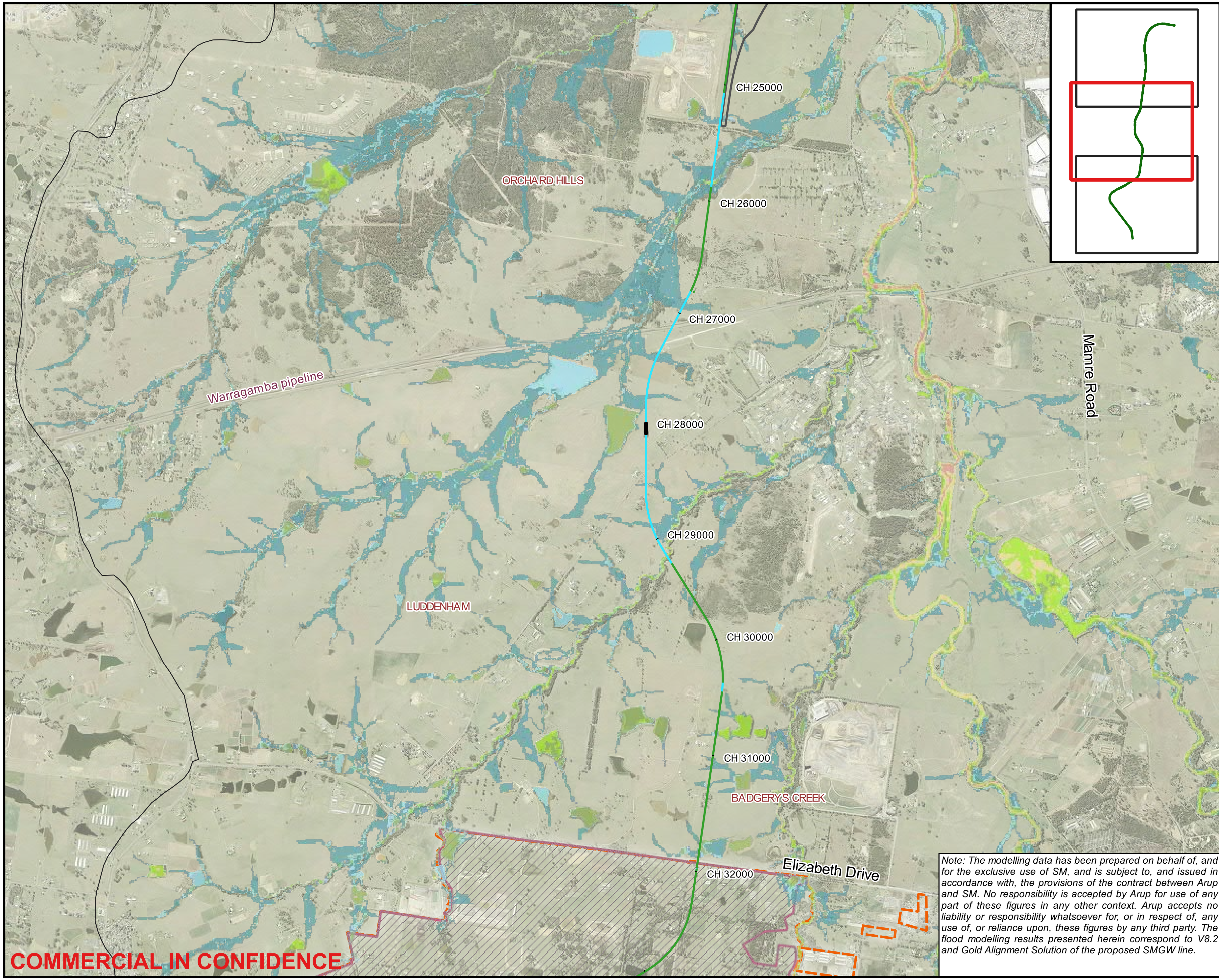

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Issue	Date	By	Chkd	Appd
A	01/05/20	GK	IVS	KJS

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Job Title
SMGW TA Services

Figure Title
Base Case - 0.5EY Provisional flood hazard

Scale at A3
1:30000

Figure Status
Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No
265549

Figure No
C.17 (2 of 3)

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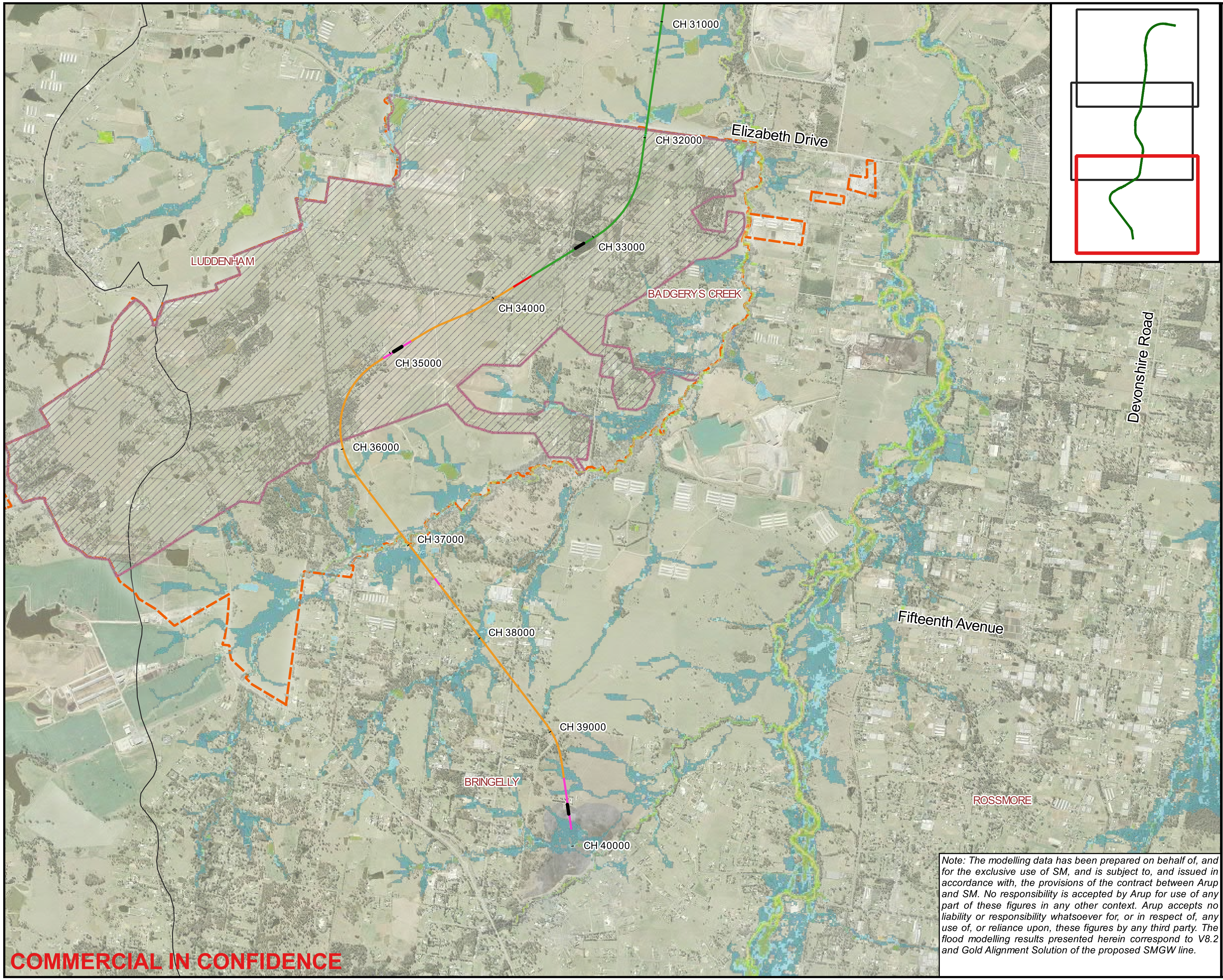

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Issue	Date	By	Chkd	Appd

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Job Title
SMGW TA Services

Figure Title
Base Case - 0.5EY Provisional flood hazard

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.17 (3 of 3)

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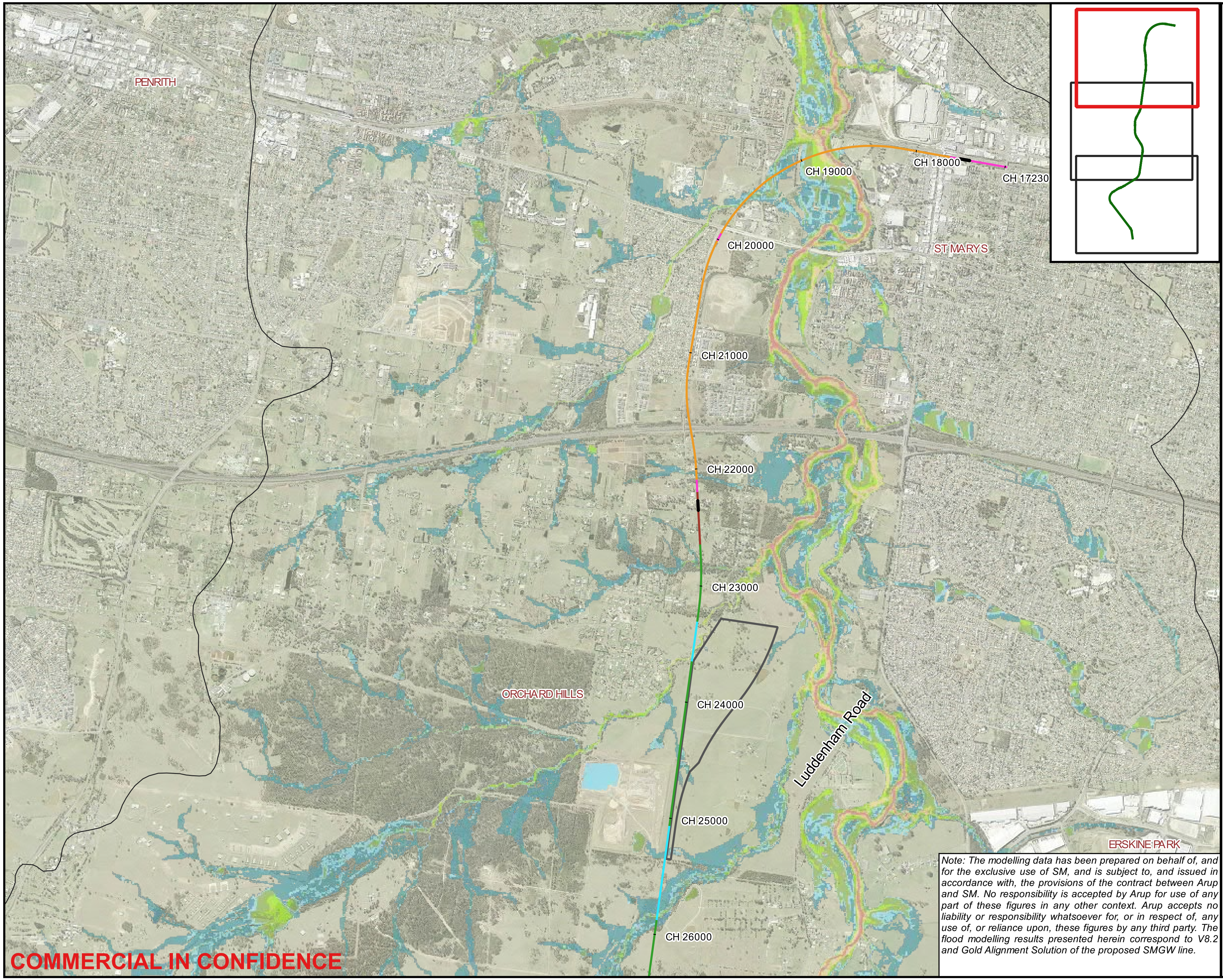

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Issue	Date	By	Chkd	Appd

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Job Title
SMGW TA Services

Figure Title
Base Case - 0.2EY Provisional flood hazard

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.18 (1 of 3)

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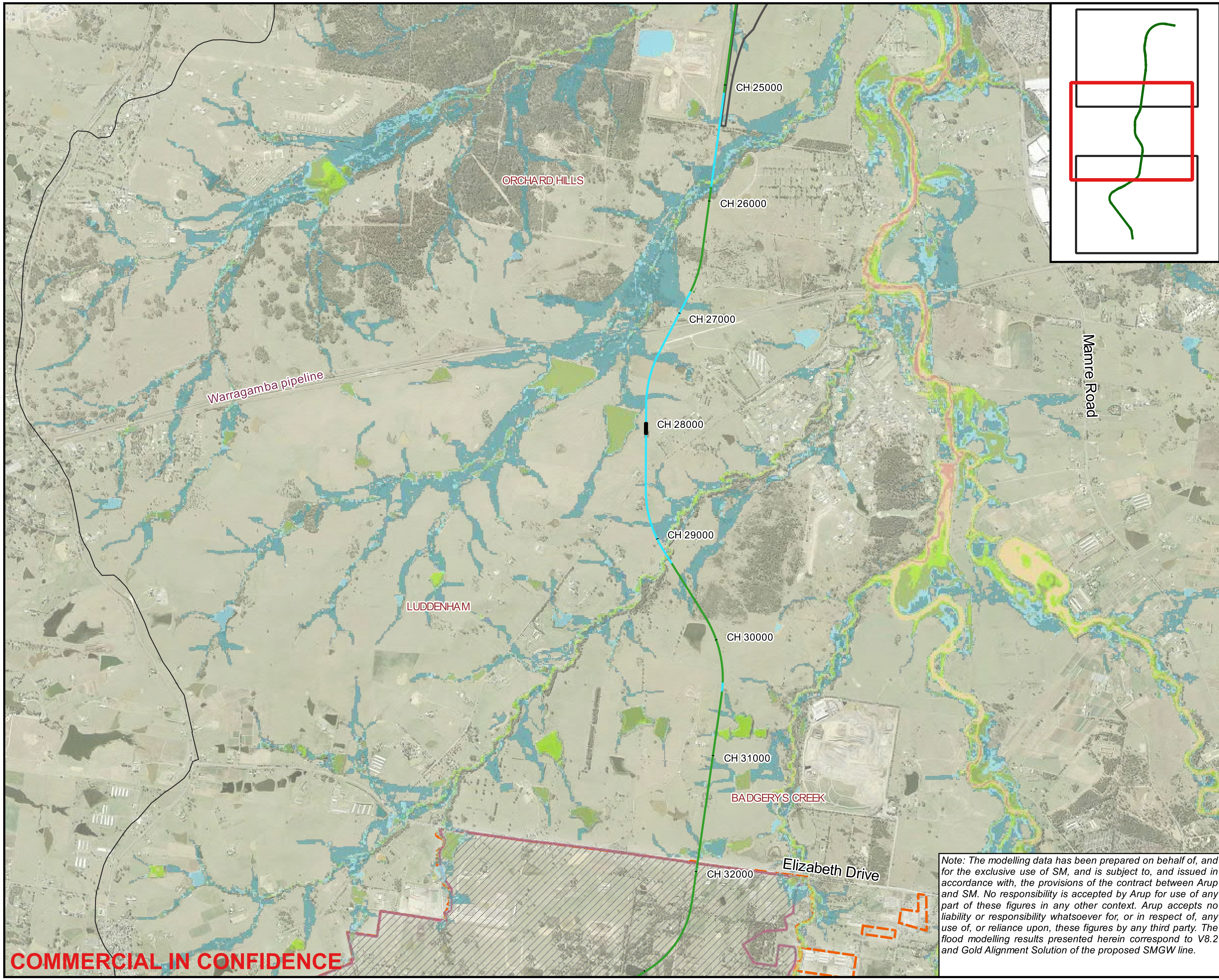

Legend

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Issue	Date	By	Chkd	Appd

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Job Title
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Figure Title
Base Case - 0.2EY Provisional flood hazard

Scale at A3: **1:30000**
Figure Status: **Issued for Information**

Coordinate System
GDA 1994 MGA Zone 56

Job No: **265549**
Figure No: **C.18 (2 of 3)**

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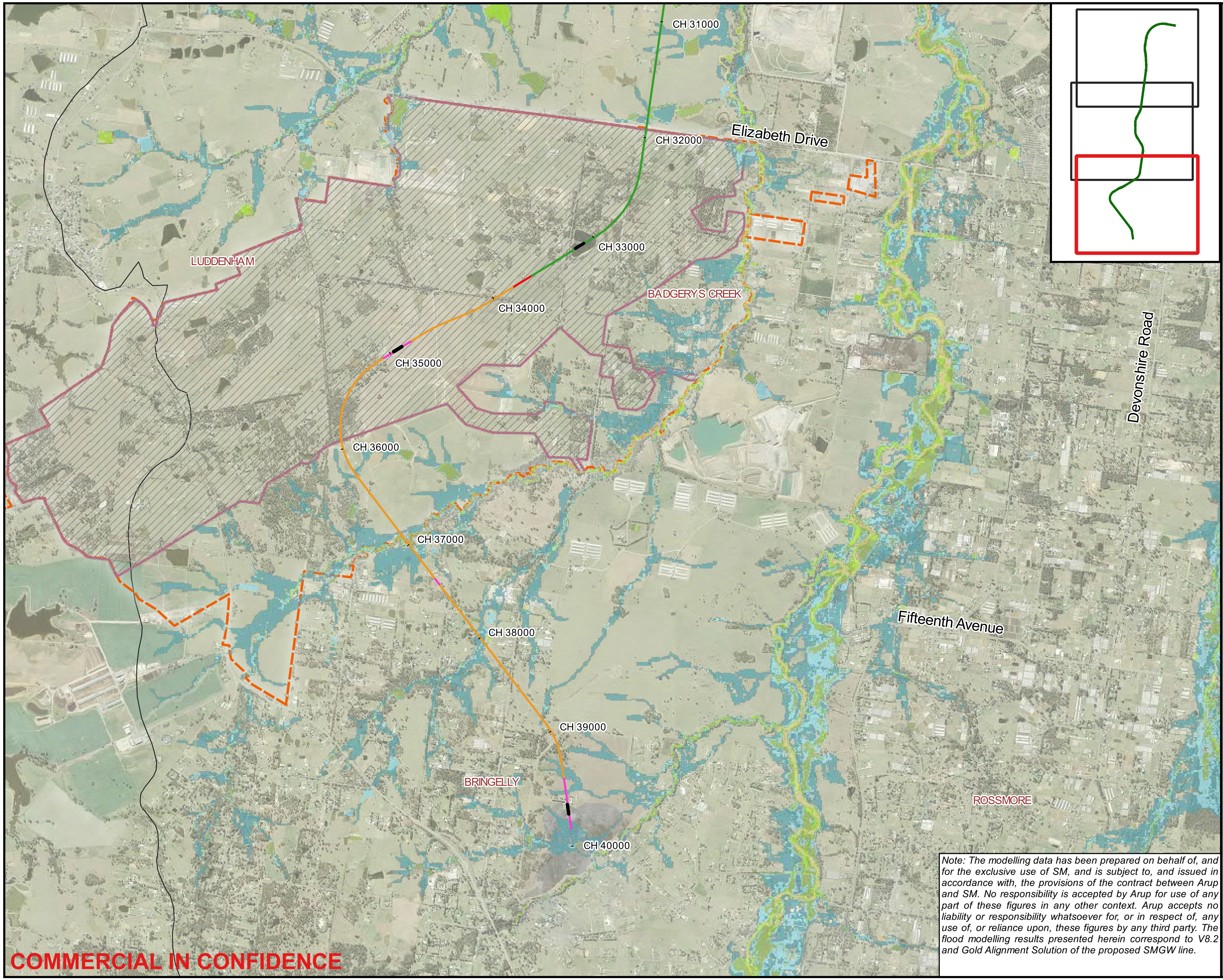

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Issue	Date	By	Chkd	Appd

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Figure Title
Base Case - 0.2EY Provisional flood hazard

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.18 (3 of 3)

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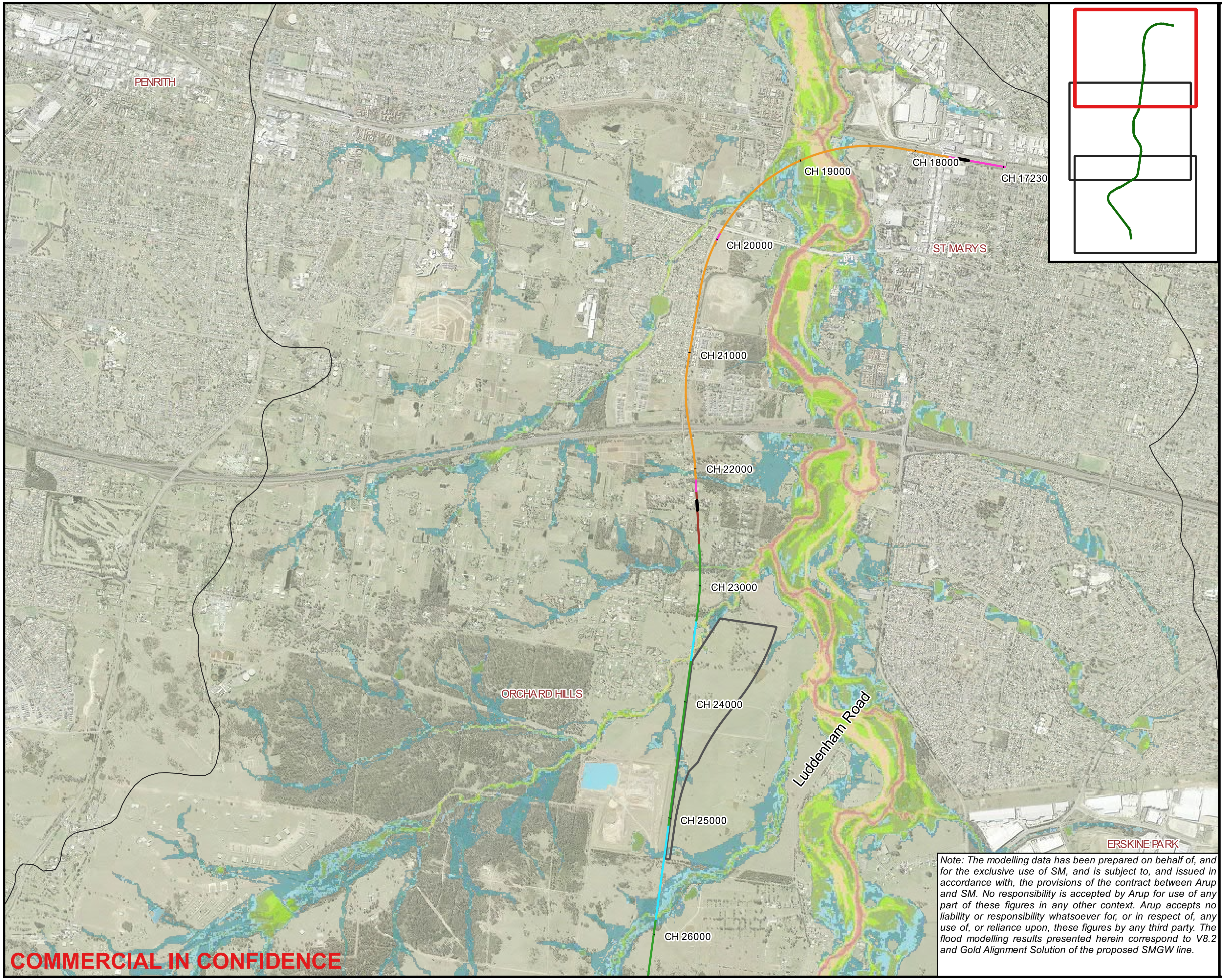

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A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

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Job Title
SMGW TA Services

Figure Title
Base Case - 5% AEP Provisional flood hazard

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.19 (1 of 3)

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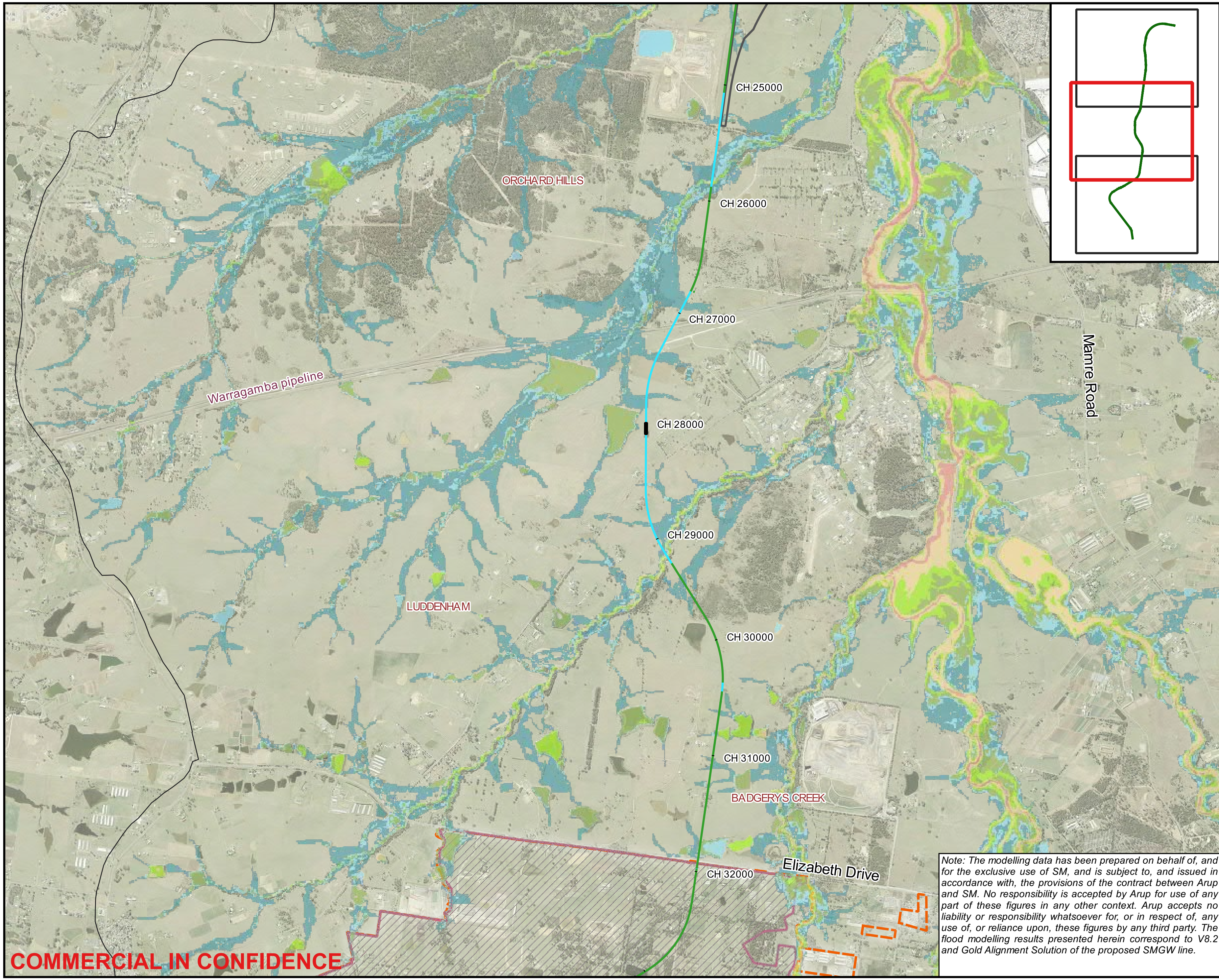

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Legend

Flood hazard

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A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

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Job Title
SMGW TA Services

Figure Title
Base Case - 5% AEP Provisional flood hazard

Scale at A3
1:30000

Figure Status
Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No
265549

Figure No
C.19 (2 of 3)

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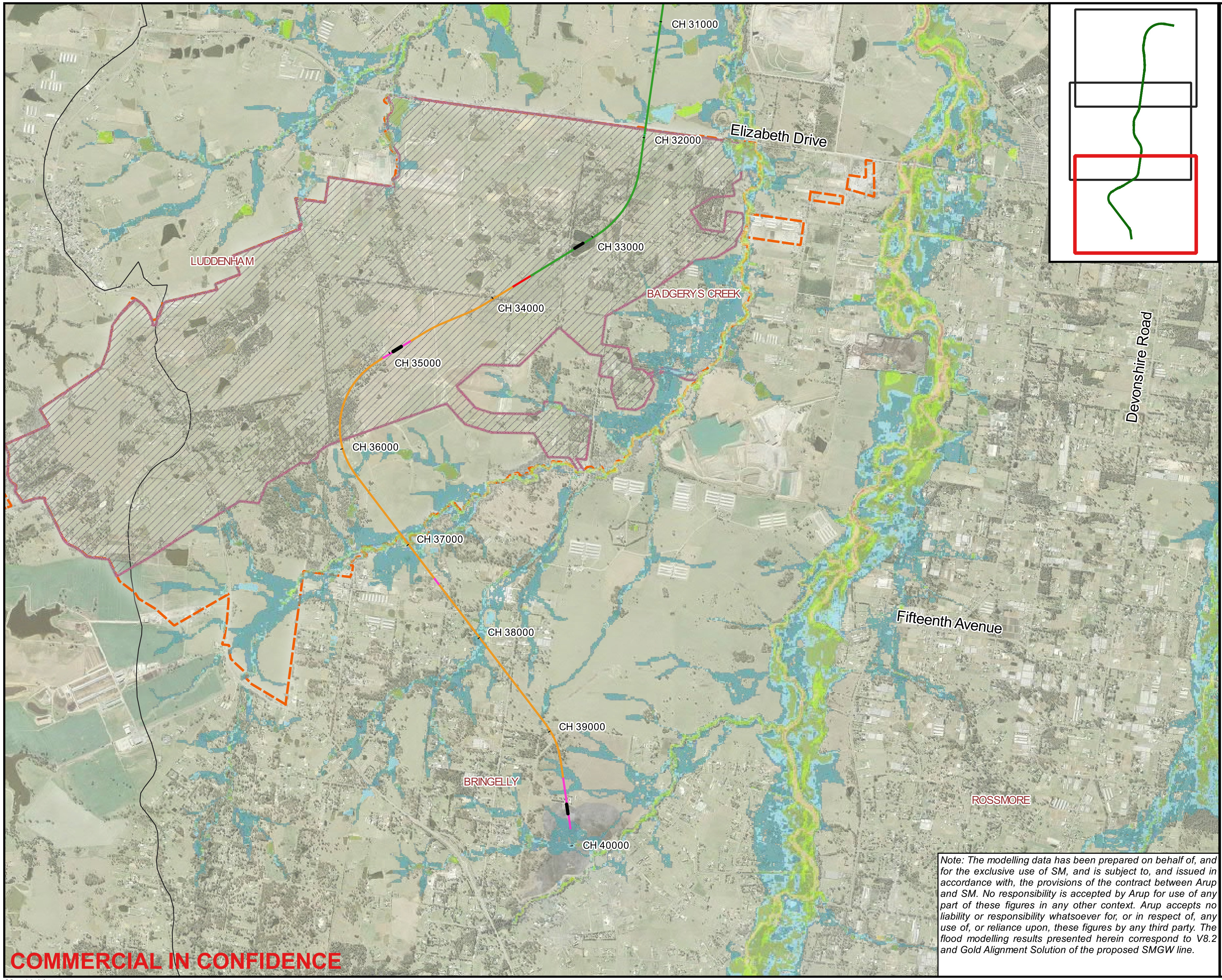

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Job Title
SMGW TA Services

Figure Title
Base Case - 5% AEP Provisional flood hazard

Scale at A3
1:30000

Figure Status
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Coordinate System
GDA 1994 MGA Zone 56

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Figure No
C.19 (3 of 3)

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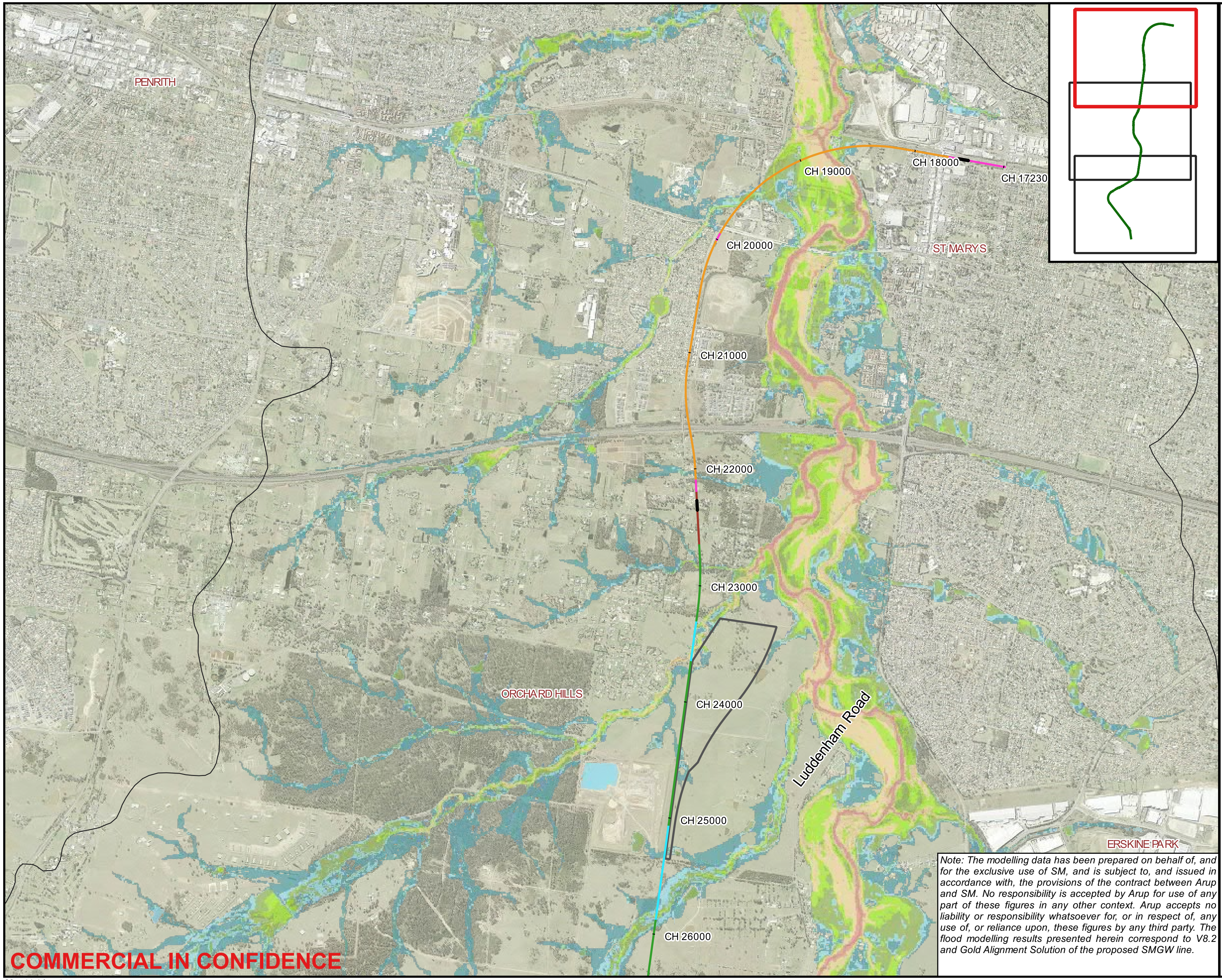

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A	01/05/20	GK	IVS	KJS
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Job Title
SMGW TA Services

Figure Title
Base Case - 1% AEP Provisional flood hazard

Scale at A3
1:30000

Figure Status
Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No
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Figure No
C.20 (1 of 3)

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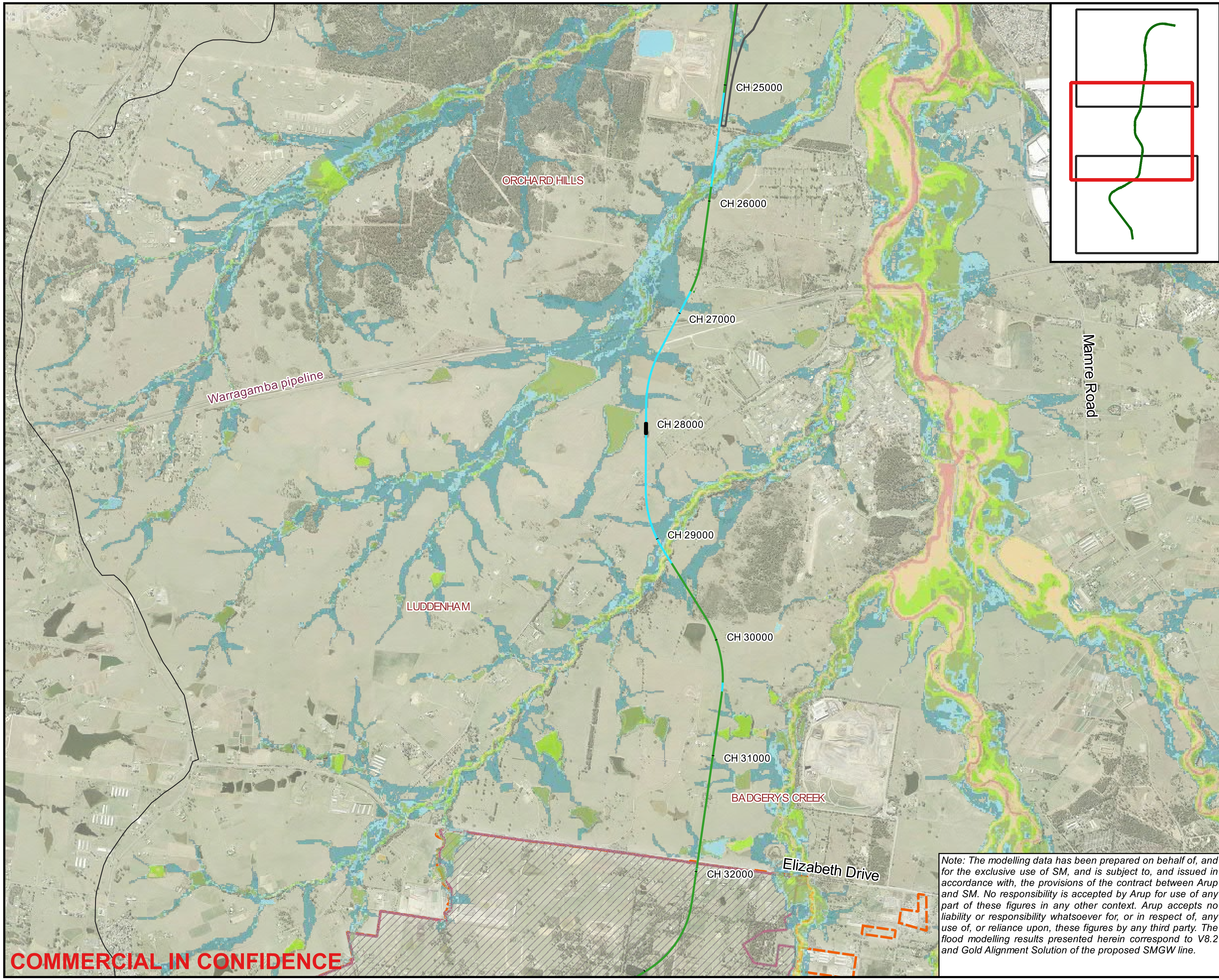

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Job Title
SMGW TA Services

Figure Title
Base Case - 1% AEP Provisional flood hazard

Scale at A3	Figure Status
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Job No	Figure No
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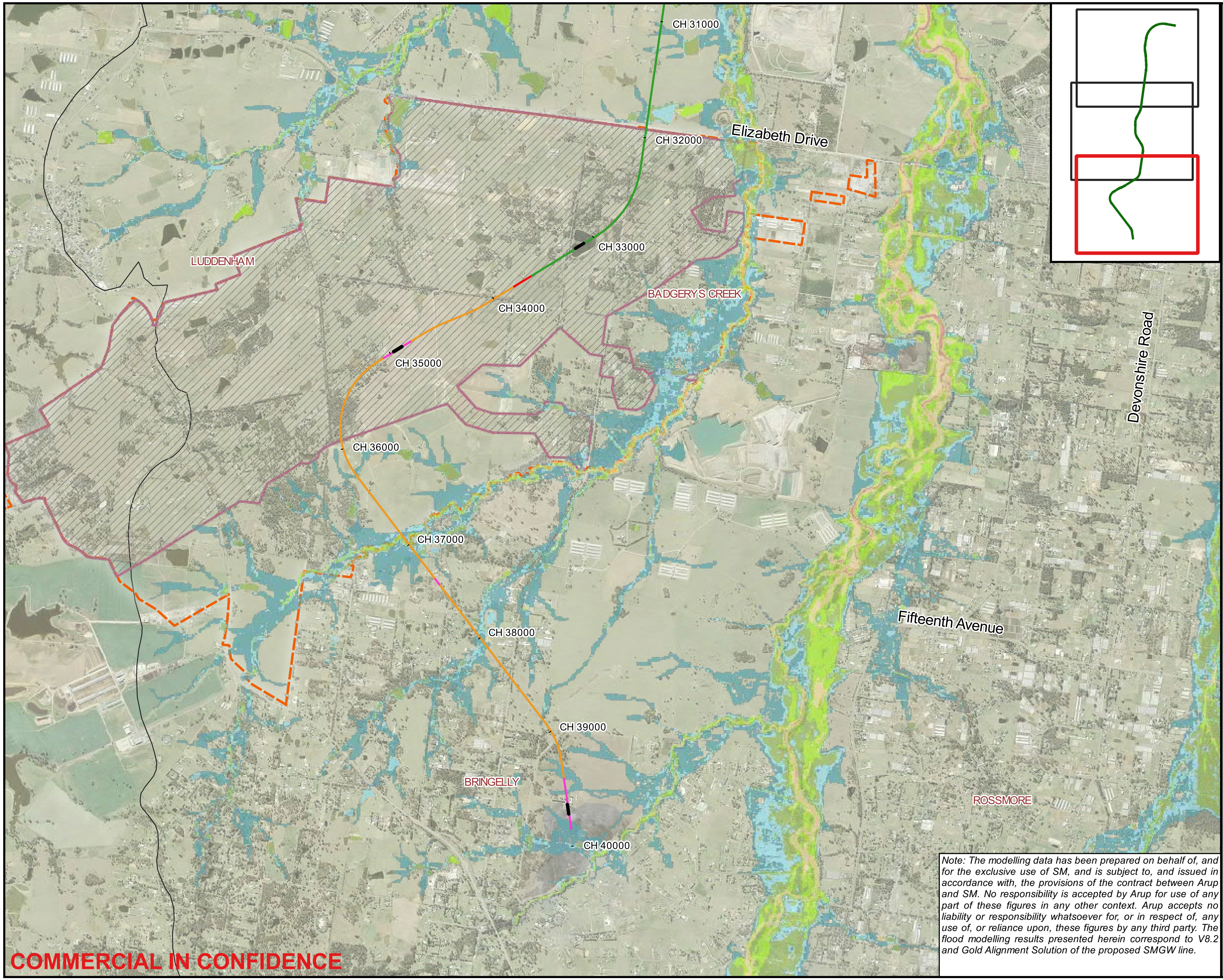

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COMMERCIAL IN CONFIDENCE

Legend

Flood hazard

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- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.
- WSI Boundary
- WSI Stage 1 Construction Boundary
- South Creek Catchment Boundary
- At Grade
- Bridge or Viaduct
- Cut and Cover
- Dive Structure
- Driven Tunnel
- Trough or Cutting
- Platform
- Stabling Site

A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

0 500 1000 1500 m

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Client
Sydney Metro

Job Title
SMGW TA Services

Figure Title
Base Case - 1% AEP Provisional flood hazard

Scale at A3
1:30000

Figure Status
Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No
265549

Figure No
C.20 (3 of 3)

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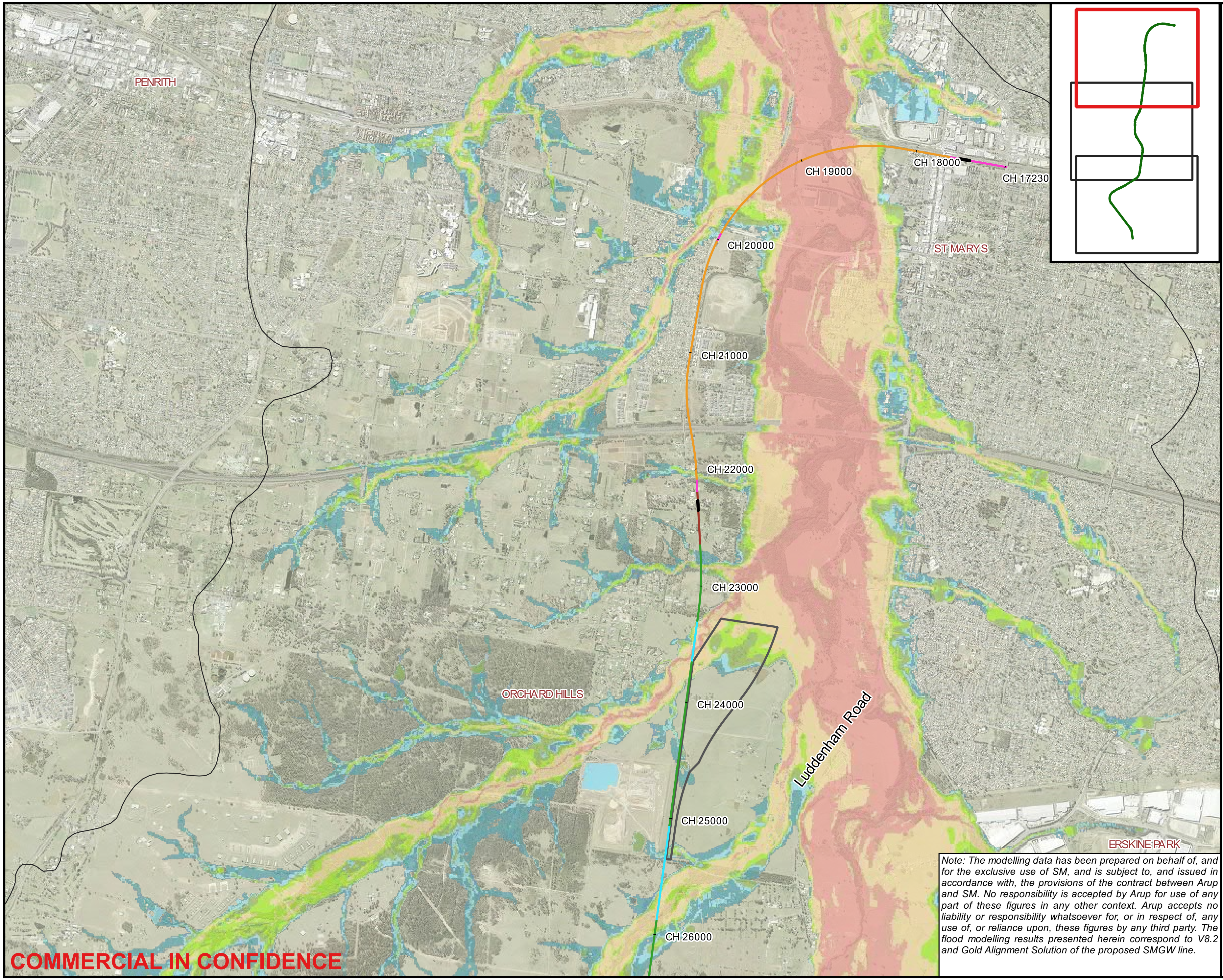

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A	01/05/20	GK	IVS	KJS
Issue	Date	By	Chkd	Appd

0 500 1000 1500 m

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Job Title
SMGW TA Services

Figure Title
Base Case - PMF Provisional flood hazard

Scale at A3
1:30000

Figure Status
Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No
265549

Figure No
C.21 (1 of 3)

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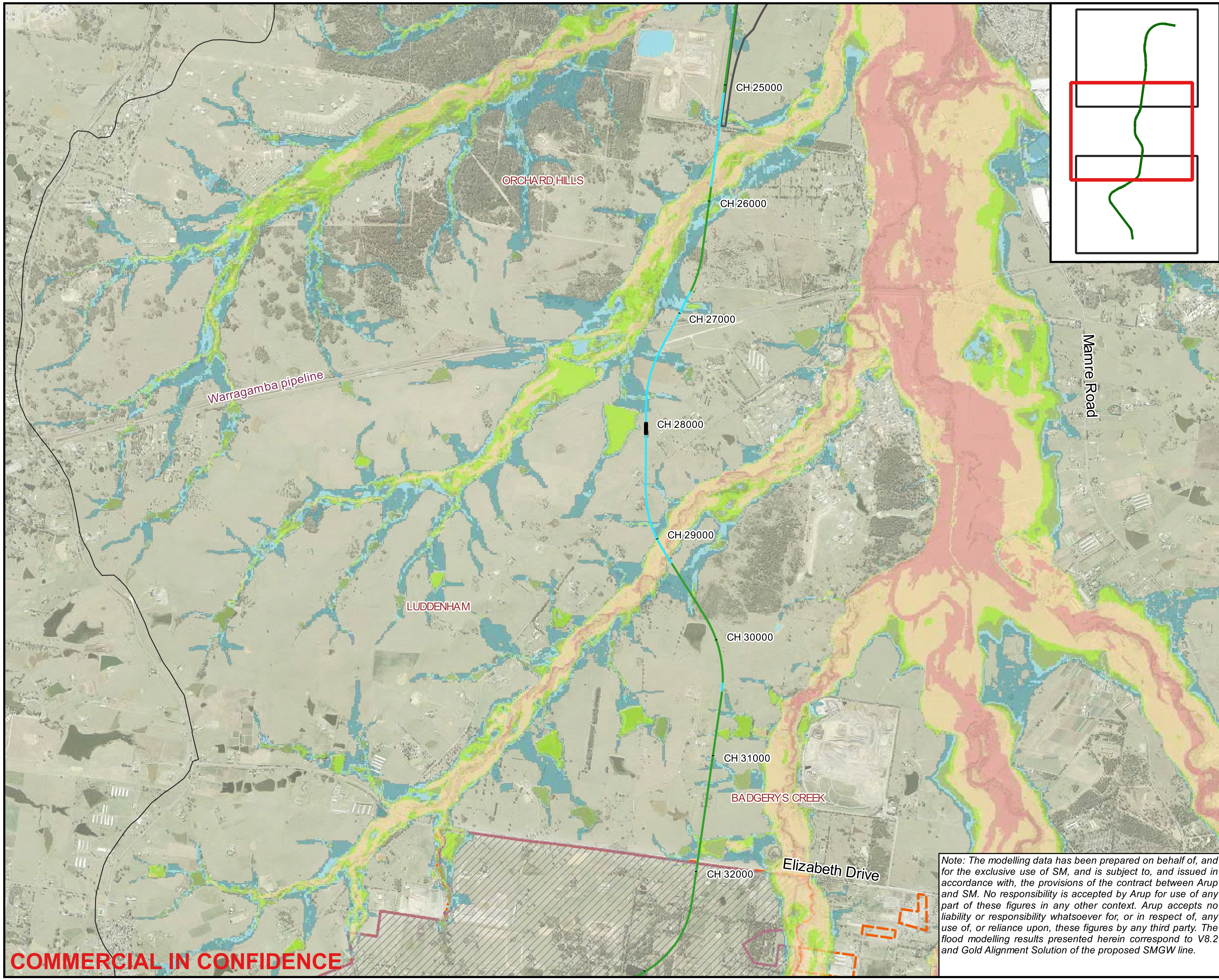

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Issue	Date	By	Chkd	Appd
A	01/05/20	GK	IVS	KJS

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Job Title
SMGW TA Services

Figure Title
Base Case - PMF Provisional flood hazard

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.21 (2 of 3)

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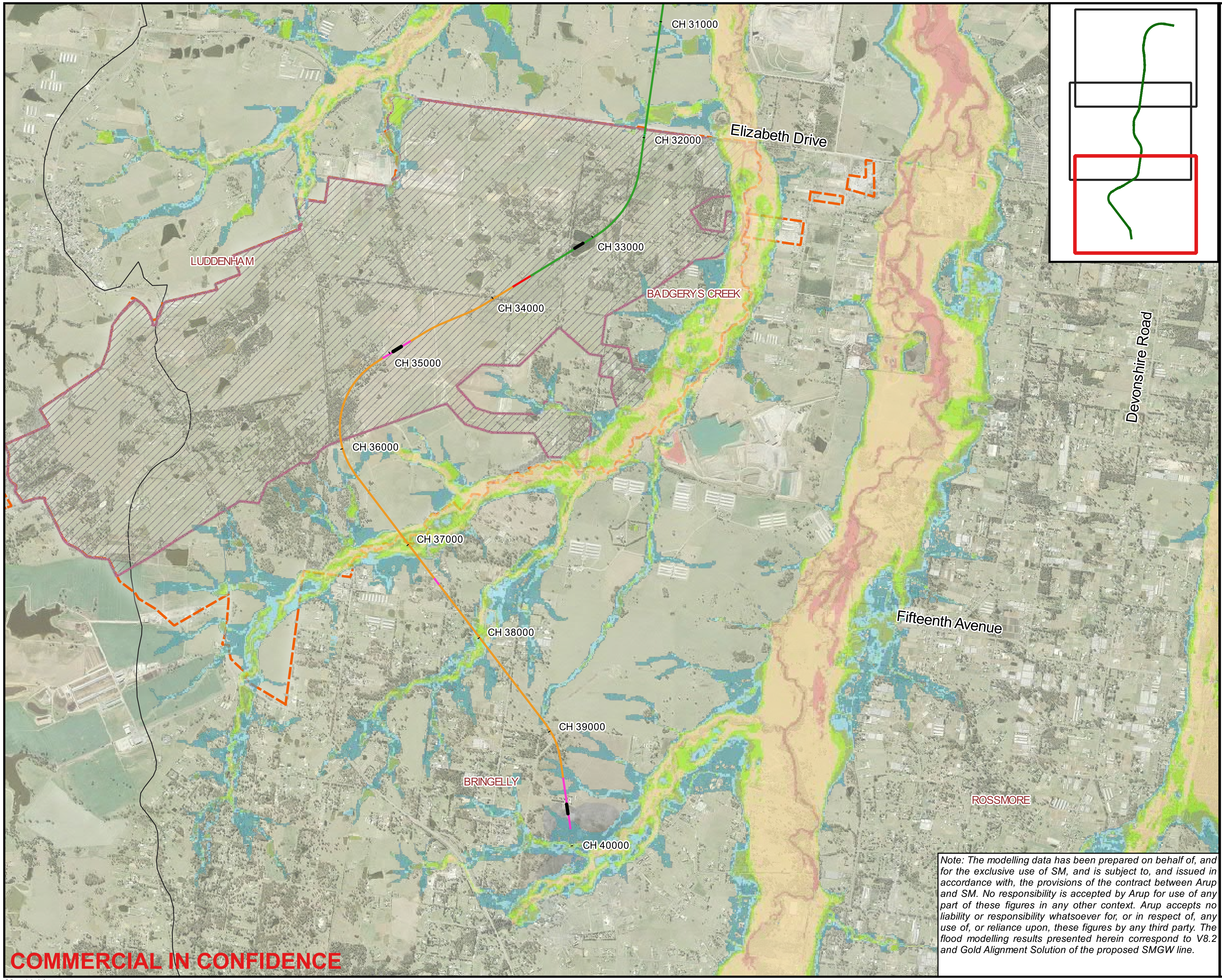

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Client
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Job Title
SMGW TA Services

Figure Title
Base Case - PMF Provisional flood hazard

Scale at A3	Figure Status
1:30000	Issued for Information

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
265549	C.21 (3 of 3)

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