UGL

COPPERSTRING FLOOD IMPACT ASSESSMENT – HUGHENDEN CAMP

DRAFT REPORT

wma water

APRIL 2024

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Project Copperstring Flood impact assessment – HUGHENDEN CAMP	**Project Number** **123061**
Client UGL	**Client's Representative** Richard Greer
Project Manager Daniel Wood, RPEQ	

Revision History

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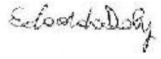
2	Draft Report	UGL	Eliza Towndrow, Edoardo Daly	Edoardo Daly	Edoardo Daly,  RPEQ No 29557	Apr 24

Photo Cover Page Taken From: https://infrastructurepipeline.org/project/copperstring

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1. INTRODUCTION

UGL proposes the development of CopperString 2032, an extra high voltage transmission system located between Mt Isa and Woodstock, near Townsville, in North Queensland, Australia (the Project) (Plate 1). The Project intends to connect the North-West Power System (NWPS) to the Powerlink network and National Electricity Market (NEM) to "reduce the cost of power supply and facilitate the large-scale development of the Hughenden wind resource and solar resourced within the North Queensland Clean Energy Hub (NQCEH)" (UGL, 2023). A key component of the Project is the development of temporary camps to provide accommodation and facilities for construction workers.

WMA Water has been engaged by UGL to provide an impact assessment for flooding on a proposed camp in Hughenden. This report summarises the methodology and results of the flood modelling undertaken for the preliminary assessment of the Camp site.

Plate 1 CopperString 2032 Proposed Transmission Lines and Substations (UGL, 2023)

2. EXISTING ENVIRONMENT

The Hughenden Camp is located within the Flinders River catchment. The local catchment of the Camp site is approximately 227 km^2. Elevations range between 480 mAHD to 315 mAHD, falling in a generally north-westerly direction, at a maximum slope of approximately 2%. The local catchment includes sections of Flinders Highway, Hughenden Muttaburra Road, and Kennedy Development Road. The Camp site is located approximately 1.4 km south from the town centre of Hughenden and 600 m upstream of the Hughenden Recreational Lake.

A review of available aerial imagery shows predominantly minimal vegetation within the local catchment, consisting of grasses and small shrubs. More dense vegetation is located within the upper reaches of the local catchment. The proposed Camp site is located adjacent to the Mount Isa rail line and Flinders Highway.

Drainage lines within the catchment area are predominantly of first and second Strahler order, with a fourth order watercourse downstream of the proposed Camp site. A non-perennial watercourse flows from the south-west, through the centre of the proposed Hughenden Camp site, towards Hughenden Recreational Lake. Runoff from the local catchment discharges into Flinders River, approximately 1.7 km north of the site.

The existing environment and proposed Hughenden Camp layout are shown in Figure 1.

Given the position of the proposed Camp, the topography, and the presence of the township of Hughenden, the Flinders River is unlikely to affect the Camp. Therefore, flooding from the Flinders River was not considered in this assessment.

3. FLOOD IMPACT ASSESSMENT

3.1. Methodology

The methodology used to model the Hughenden Camp follows the Australian Rainfall and Runoff Guidelines (2019).

3.1.1. Hydrologic and Hydraulic Models

A hydrologic and hydraulic model was established to determine the potential flooding impacts on the proposed Hughenden Camp. The hydrologic model used was the Watershed Bounded Network Model (WBNM), and the 2D hydraulic model was developed with TUFLOW.

The following steps were undertaken for the development of the hydrologic model:

1. The sub-catchments were identified for the local catchment area of the proposed Hughenden Camp.
2. A hydrologic model was developed, using WBNM, to calculate the volume of runoff generated by design rainfall events for each of the sub-catchments.
3. The WBNM was run for the 20%, 10%, 5%, 1%, and 0.5% AEP rainfall events, using 10 different temporal patterns for each of the storm durations, which ranged from 30 minutes to 48 hours.
4. The results of the WBNM included output flows for each sub-catchment to be used in the TUFLOW hydraulic model. The flow hydrographs used as input in the TUFLOW model were selected from the suite of the WBNM results following the Australian Rainfall and Runoff Guidelines (2019).

The following steps were undertaken for the development of the 2D hydraulic model:

a. A TUFLOW model was developed to determine the potential flooding impacts on the proposed Hughenden Camp:
    a. A model boundary was delineated to include the proposed Hughenden Camp (Figure 1). The area of the model is about 7 km^2.
    b. Publicly available topographic data were combined with data provided by UGL from a recent survey to define the topography within the model (see Section 3.1.2).
    c. Inflow from south-west and inflow from the east downstream of the site, as generated by the WBNM, were input into the TUFLOW model.
b. The proposed Hughenden Camp TUFLOW model was run with the inflows from the 20%, 10%, 5%, 1%, and 0.5% AEP events calculated by the WBNM.
c. The results of the TUFLOW model (Figures 2 to 21) were reviewed to determine the potential impacts of flooding on the Hughenden Camp.

3.1.2. Topography and hydraulic structures

The topography used in the hydraulic model was obtained by combining DEMs at different resolutions. A 5 m DEM was generated from a survey of an area of 0.18 km^2 where the Camp is planned to be located. The topography of the surrounding area was defined using the Copernicus GLO-30 data set, which is a digital surface model of the globe at 30 m resolution.

The Copernicus GLO-30 had higher elevations than the local survey, with an average difference

of about 1.2 m between the two DEMs. This difference was subtracted from the Copernicus GLO-30 to shift it closer to the DEM at higher resolution generated from the survey. This avoids large differences at the interface between the two DEMs and create a more realistic smooth transition between the two.

The Mount Isa line on the southern side of the camp was partially captured by the 30 m DEM, which is too coarse to identify a rail. The elevation along the line was thus modified to the assumed level of 323 mAHD. A culvert under the rail line was included in the model, using dimensions estimated from Photo 1. The culvert was included in the TUFLOW model using 4 barrels, each 2.4 m wide and 3.6 m high.

Photo 1 Culvert under the Mount Isa Line (photo provided by UGL)

A shallow culvert under Flinders Highway and a culvert under the rail line were visible from aerial images. These structures are east and downstream of the Camp. Details of these structures were not available and, therefore, they were not included in the model. This is not expected to have a large effect on the model results in the area of the Camp, and, in case, it is expected that the modelled water depths at the Camp would be overestimated because these two structures were not included in the model.

Details about the earthworks associated with the construction of the camp were not available and were not included in the model.

3.1.3. Verification

Due to the lack of gauge stations near the area of the Hughenden Camp, it is difficult to verify the results of the model. Regional Flood Frequency Estimation (RFFE) models were developed as part of the Australian Rainfall and Runoff (2019) to support the estimation of design flows in ungauged catchments up to the 1% AEP. A RFFE model has been utilised to verify the peak flows generated by the hydrologic models, to determine whether they are appropriate. Additionally, the Rational Method was used to provide a peak flow estimate to compare with the flows calculated with the WBNM. The Rational Method is an approximated method, only suitable for areas smaller than 25 km^2, that allows a rapid estimation of design flows in small rural catchments up to the 1% AEP.

3.2. Results

3.2.1. Hydrologic Verification

Peak flows up to the 1% AEP event generated for the sub-catchments used in the hydrologic models were verified with the use of a RFFE model and, for the small sub-catchment, with the Rational Method. Table 1 presents the expected peak flows and confidence limits calculated using RFFE models, and the peak flows generated by the Rational Method and the WBNM. The sub-catchment areas are shown in Figure 1.

For the large sub-catchment, peak flows calculated using the WBNM were 40% to 65% larger than the RFFE, and within the confidence limits. For the small catchment, the peak flows from WBNM were 10% to 40% smaller than the estimates from the RFFE and within the confidence limits. The Rational Method was also used for the small catchment resulting in peak flows close to those calculated with the WBNM (up to 4% difference).

These results provide confidence that the magnitudes of the peak flows from WBNM, which were used in the hydraulic model, are reasonable.

Table 1 Peak Flows – RFFE Model, Rational Method and WBNM

Location	Area (km^2)	AEP (%)	Peak Flow (m^3/s)				
			Expected Value (m^3/s)	Lower Confidence Limit (m^3/s)	Upper Confidence Limit (m^3/s)	Rational Method (m^3/s)	WBNM (m^3/s)
Area 1	212	1	526.96	262.21	1290.52	N/A	730.21
		5	360.24	187.74	764.12	N/A	508.23
		10	287.04	151.40	589.89	N/A	449.26
		20	212.08	112.59	431.00	N/A	350.92
Area 2	15	1	99.13	27.33	483.01	64.68	61.87
		5	63.02	20.67	249.27	44.08	44.20
		10	47.78	16.56	178.67	36.48	36.72
		20	33.03	11.30	128.94	29.43	29.80

3.2.2. Hydraulic Model

The resulting peak flood depths within the local catchment of the Hughenden Camp for the assessed AEP events are shown from Figure 2 to Figure 6. The peak flood velocities are shown from Figure 7 to Figure 11. The peak flood levels are shown from Figure 12 to Figure 16, and the flood hazards from Figure 17 to Figure 21.

Flow is received at the proposed Hughenden Camp from the south-west, where the culvert under the Mount Isa line is located, and flows through the Camp site, towards the Flinders River, north of the site. The Camp is divided by a defined drainage line. Channel and overland flow inundate areas of the Camp, including northern and eastern sections of the site. The flood extent in the area of the Camp does not vary considerably across the different AEP events, because the flow is driven by the presence of the rail line and the culvert under it.

Part of the Hughenden Camp site north of the drainage line is impacted by flooding for all the

considered AEP events, with maximum water depths reaching 0.6 m and 0.8 m in the 20% and 0.5% AEP, respectively. Water depths remain below 0.5 m in the part of the Camp south of the drainage line for the AEP events.

The maximum velocity in proximity to the proposed Hughenden Camp site occurs along the drainage line, with velocities above 1 m/s near the downstream end of the culvert in all the events. Table 2 details the peak flows across key cross-sections within the model for the 1% and 0.5% AEP events; the maximum velocity averaged along the cross-sections is also reported in Table 2. The cross-sections where the flow and velocity were calculated are shown in Plate 2.

In all AEP events, the hydraulic hazard reaches H3 (unsafe for all vehicles, children and the elderly) within the part of the Hughenden Camp site north of the drainage line. The hydraulic hazard increases up to H5 (unsafe for all people and all vehicles, and buildings require special engineering design and construction) along the drainage line for all AEP events except the 20% AEP, where it reaches H4 (unsafe for vehicles and people).

Table 2 Peak Flow and Maximum Velocity at Key Locations

Cross-section	Flow (m^3/s)		Velocity (m/s)	
	1% AEP	0.5% AEP	1% AEP	0.5% AEP
1	45.59	51.97	0.30	0.32
2	1.77	1.86	0.03	0.09
3	41.02	43.70	0.51	0.51
4	40.95	43.61	0.39	0.39

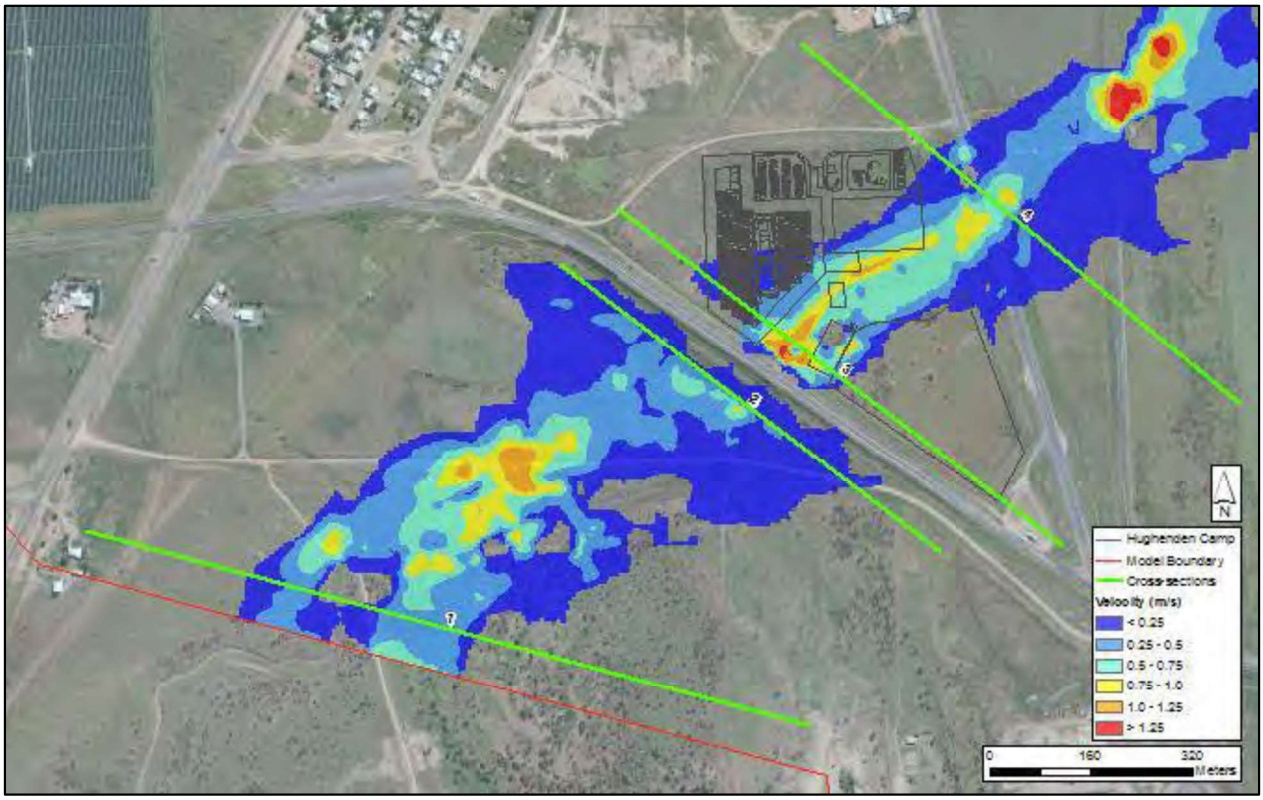


Plate 2 Flow and Velocity Analysis Locations

4. CONCLUSIONS

WMA Water has undertaken a Flood Impact Assessment for the proposed Hughenden Camp, a key component for the construction of CopperString 2032. Hydrological and hydraulic models were developed for the assessment to determine the impact of flooding on the proposed site. It is noted that earthworks for the construction of the camp were not included in the model.

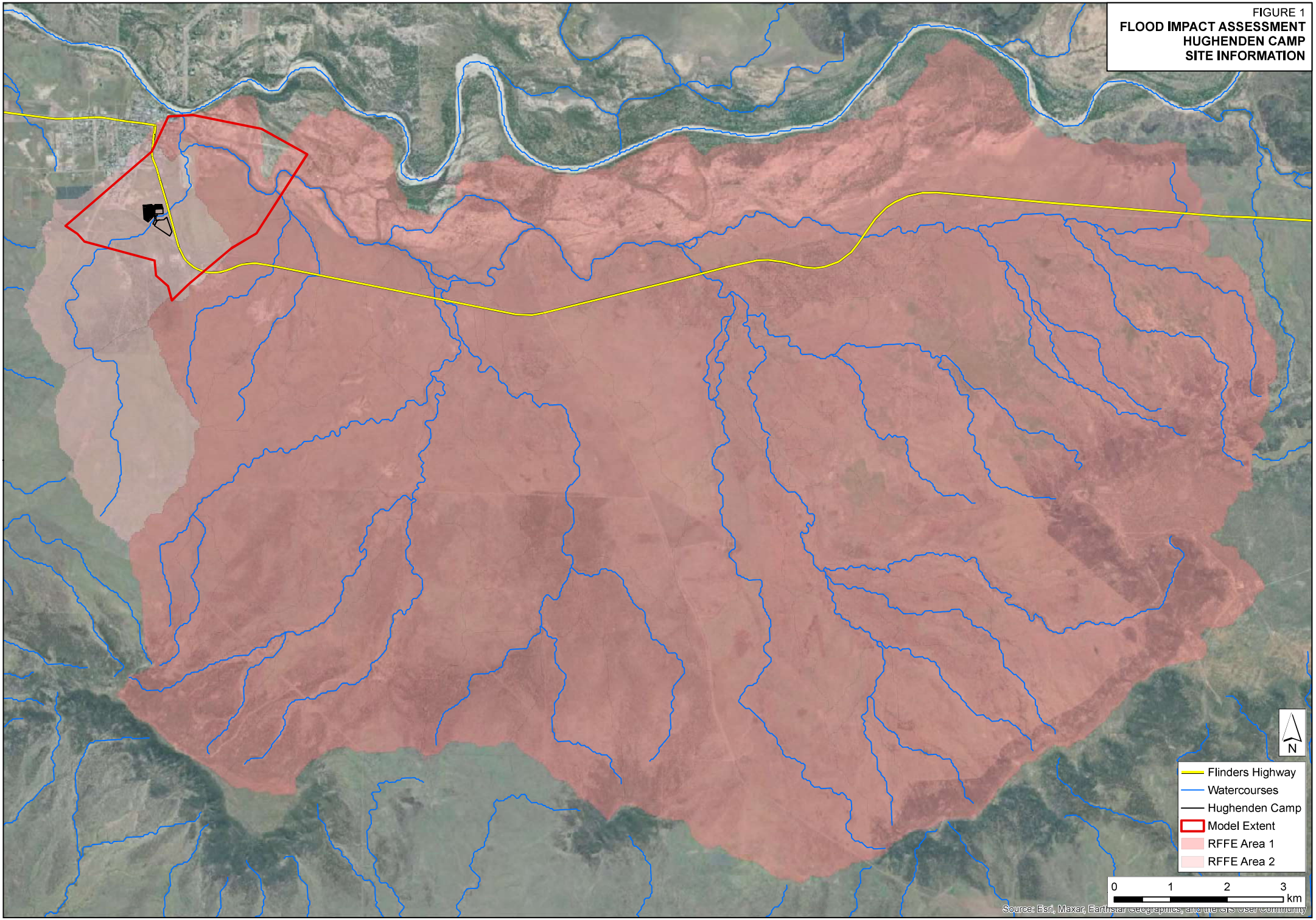
The hydrologic and hydraulic models were run for the 20%, 10%, 5%, 1% and 0.5% AEP events and identified that part of the proposed Hughenden Camp site is inundated, with water depths and velocities up to 1.2 m and 1.3 m/s along a non-perennial watercourse cutting across the camp. North of this watercourse, the water depth and velocity reach up to approximately 0.8 m and 0.6 m/s in the 0.5% AEP event.

It is highlighted that some assumptions were made to develop the model leading to uncertainties in the results:

- Two DEMs with different resolutions were combined with an imperfect transition between them. Therefore, results near the interface of the two DEMs might be inaccurate.
- The elevation of the rail line and the dimensions of the culvert under it were estimated, and hydraulic structures downstream of the Camp site were not considered.
- The presence of the Hughenden Recreational Lake was not accounted for, because details of its depth are not available.

Figures

FIGURE 1
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
SITE INFORMATION



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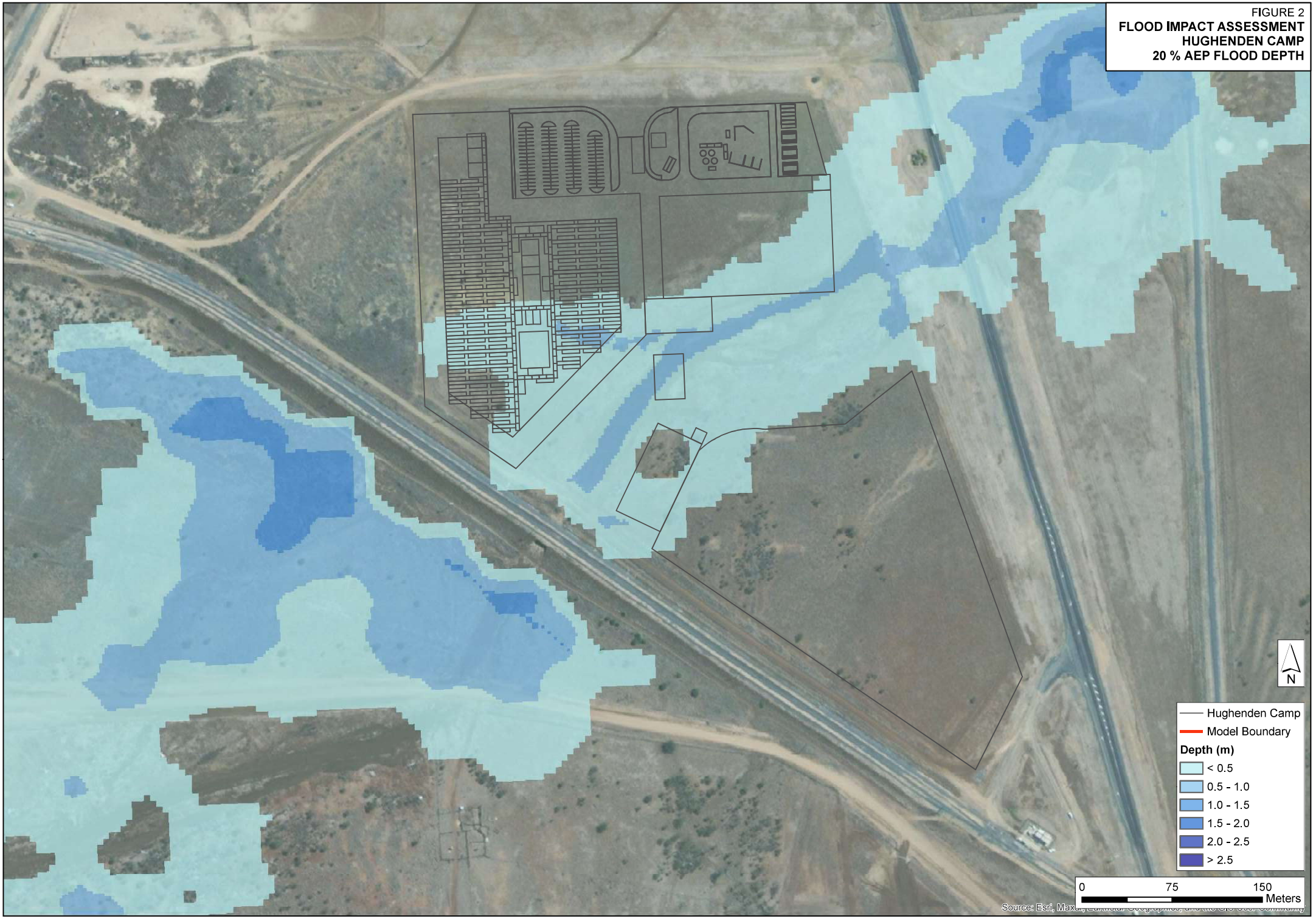
FIGURE 2
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
20 % AEP FLOOD DEPTH
N
Hughenden Camp
Model Boundary
Depth (m)
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
> 2.5
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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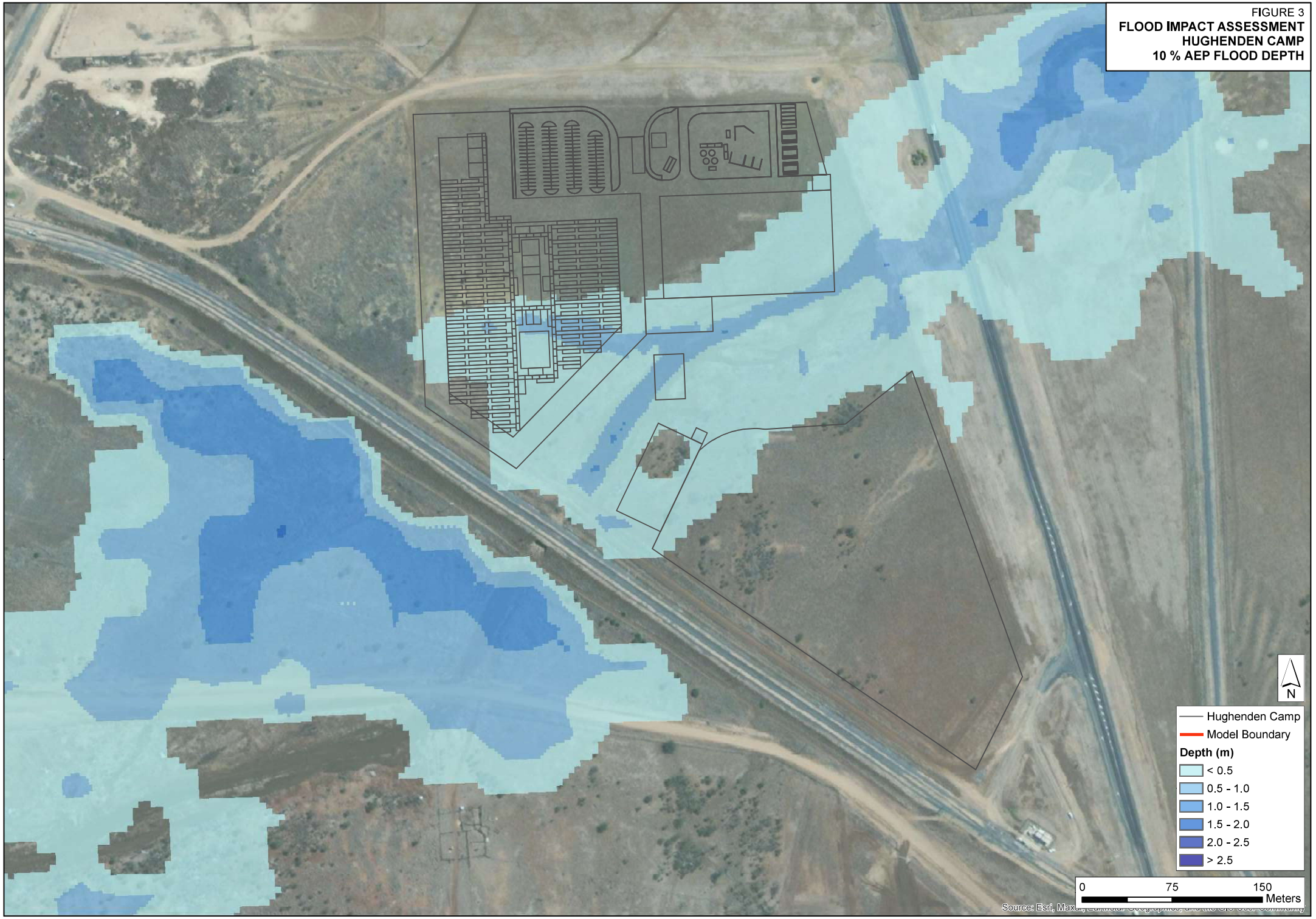
FIGURE 3
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
10 % AEP FLOOD DEPTH
N
Hughenden Camp
Model Boundary
Depth (m)
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
> 2.5
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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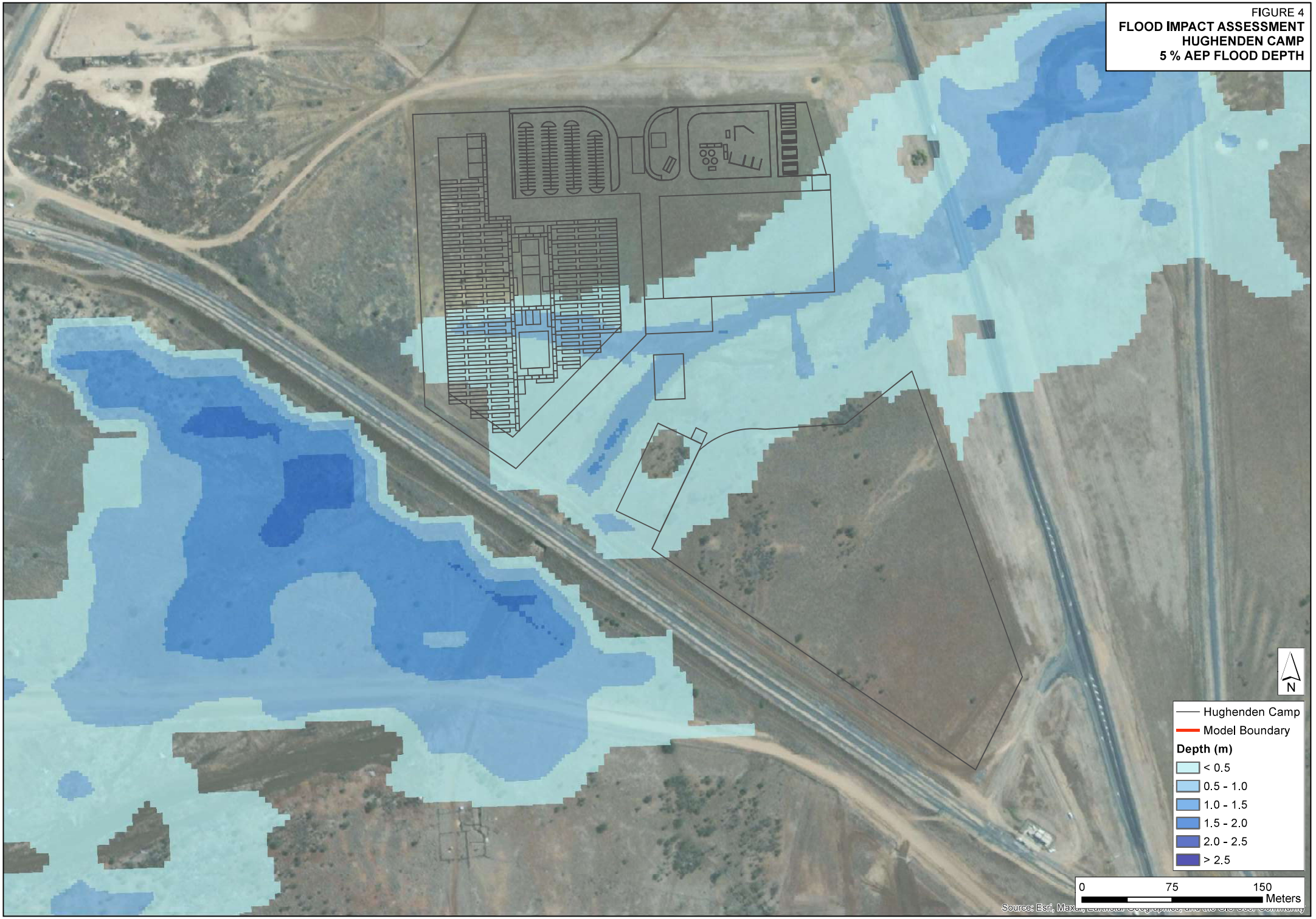
FIGURE 4
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
5 % AEP FLOOD DEPTH
N
Hughenden Camp
Model Boundary
Depth (m)
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
> 2.5
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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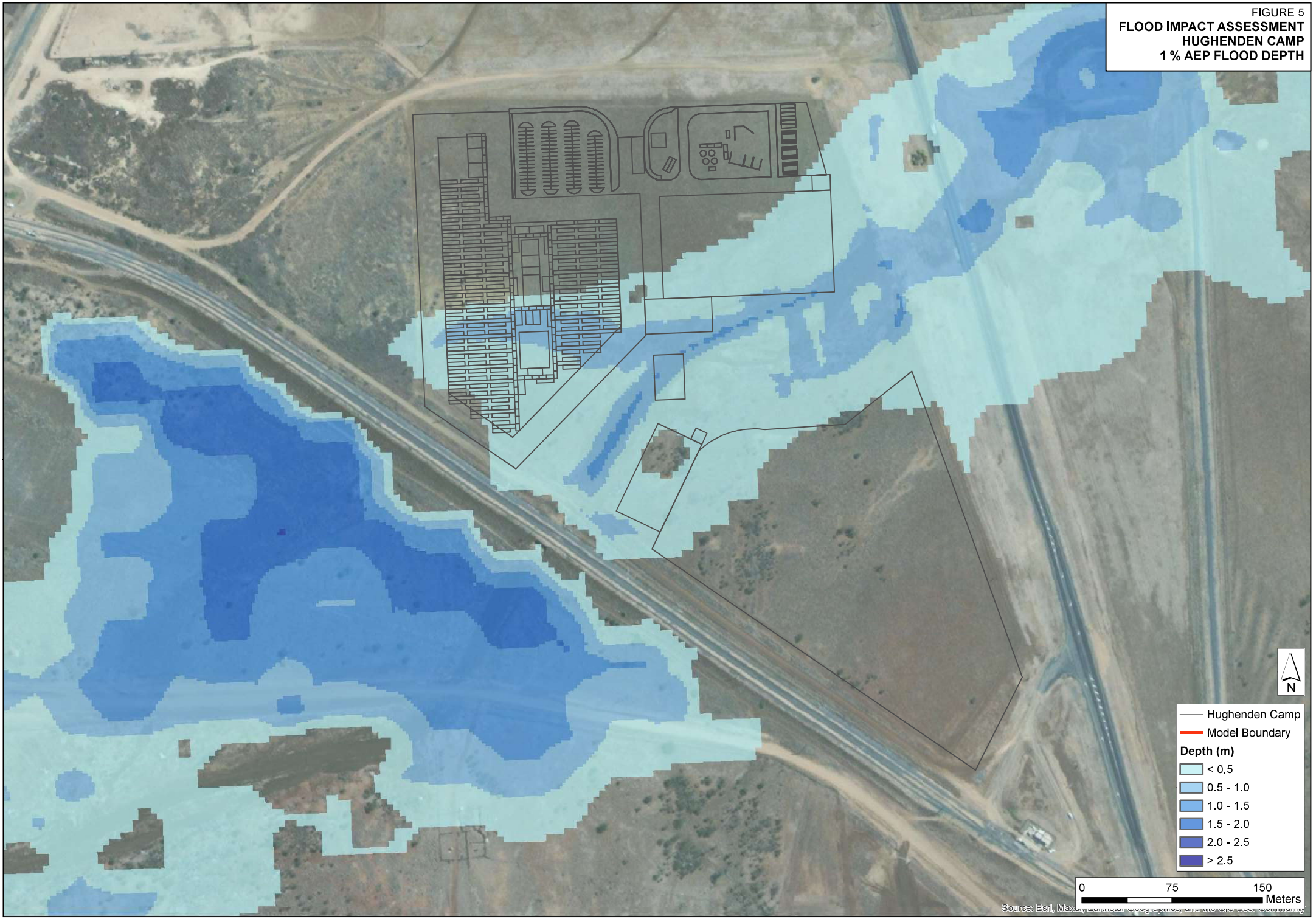
FIGURE 5
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
1 % AEP FLOOD DEPTH
N
Hughenden Camp
Model Boundary
Depth (m)
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
> 2.5
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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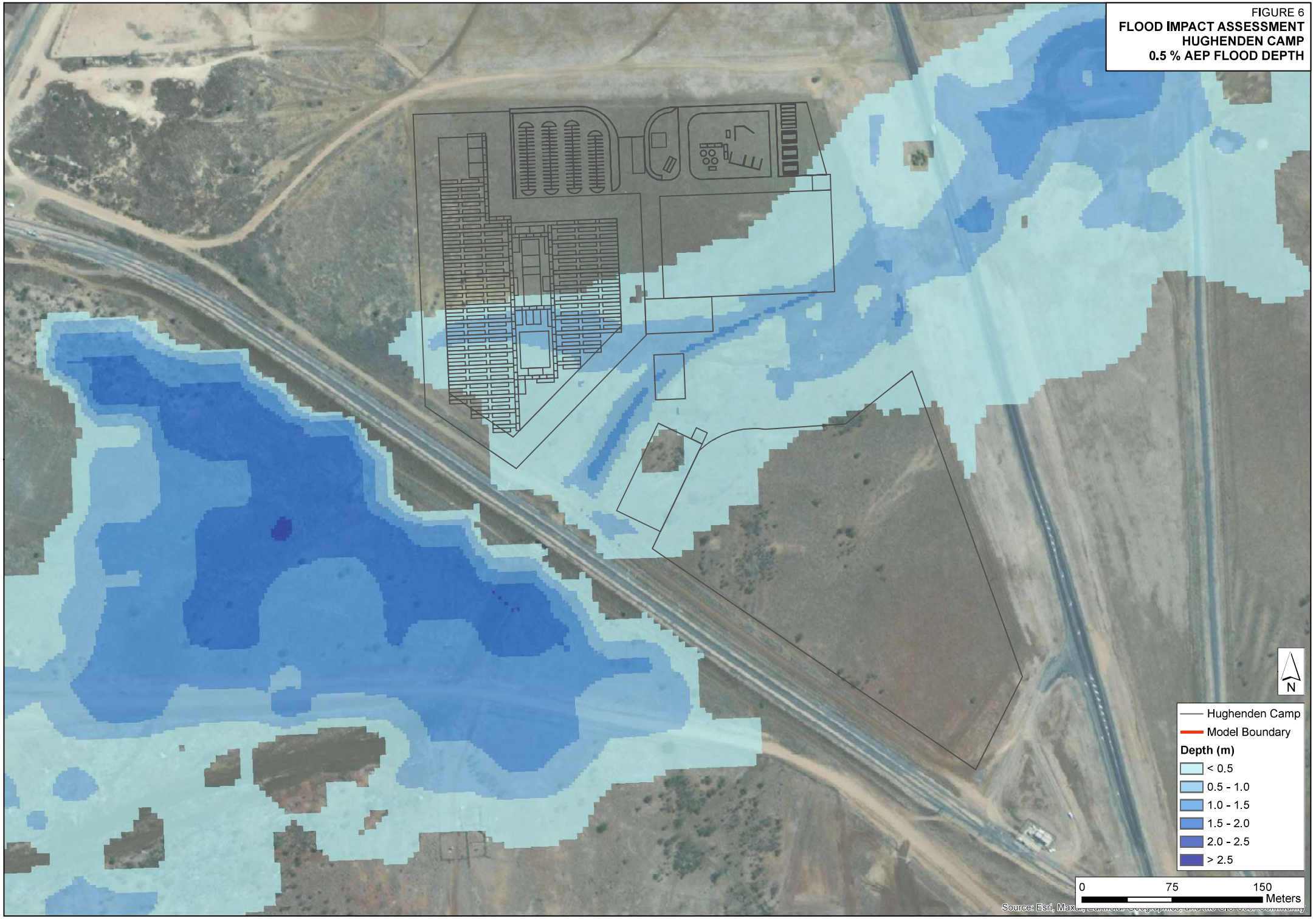
FIGURE 6
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
0.5 % AEP FLOOD DEPTH
N
Hughenden Camp
Model Boundary
Depth (m)
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
> 2.5
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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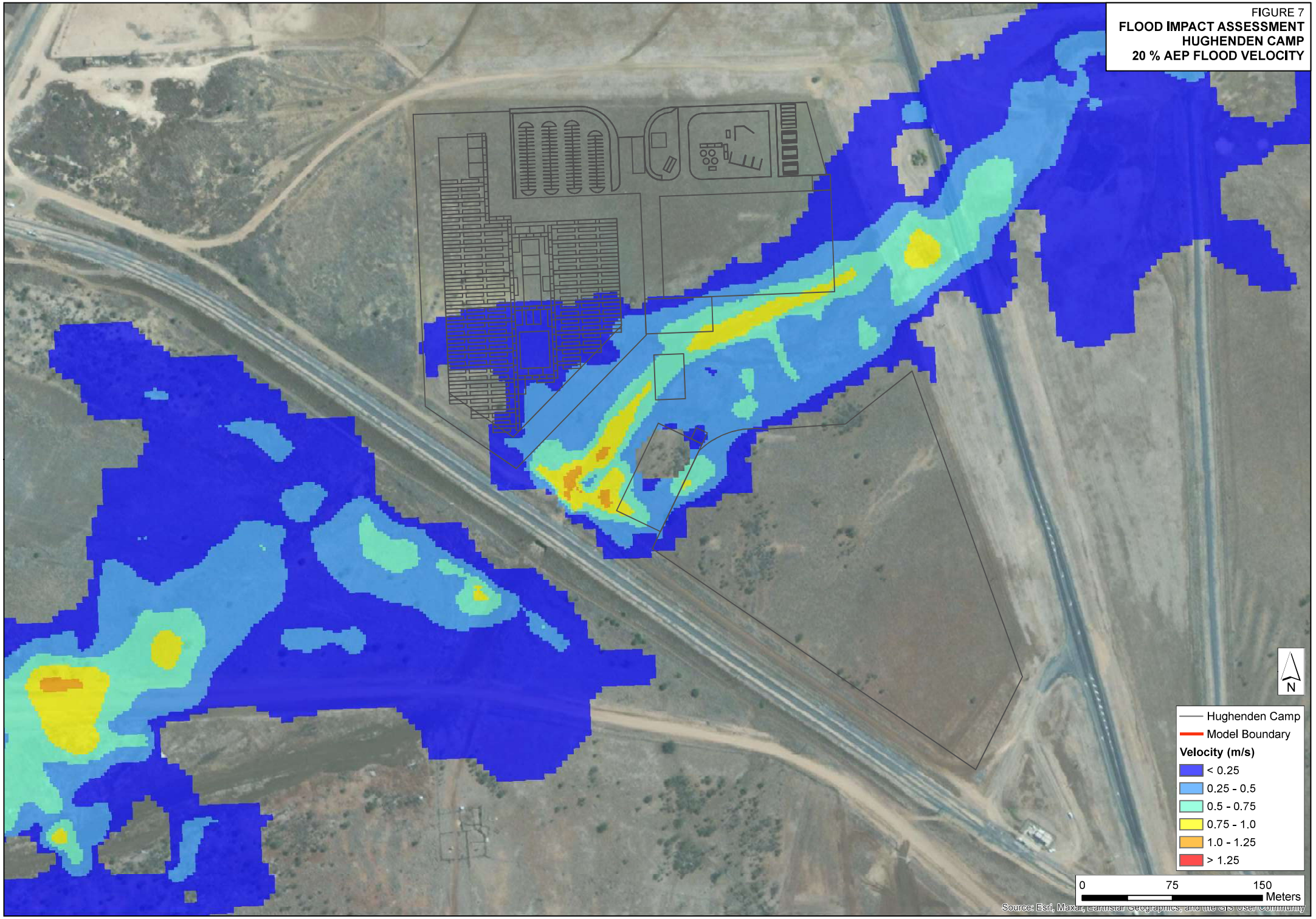
FIGURE 7
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
20 % AEP FLOOD VELOCITY
N
Hughenden Camp
Model Boundary
Velocity (m/s)
< 0.25
0.25 - 0.5
0.5 - 0.75
0.75 - 1.0
1.0 - 1.25
> 1.25
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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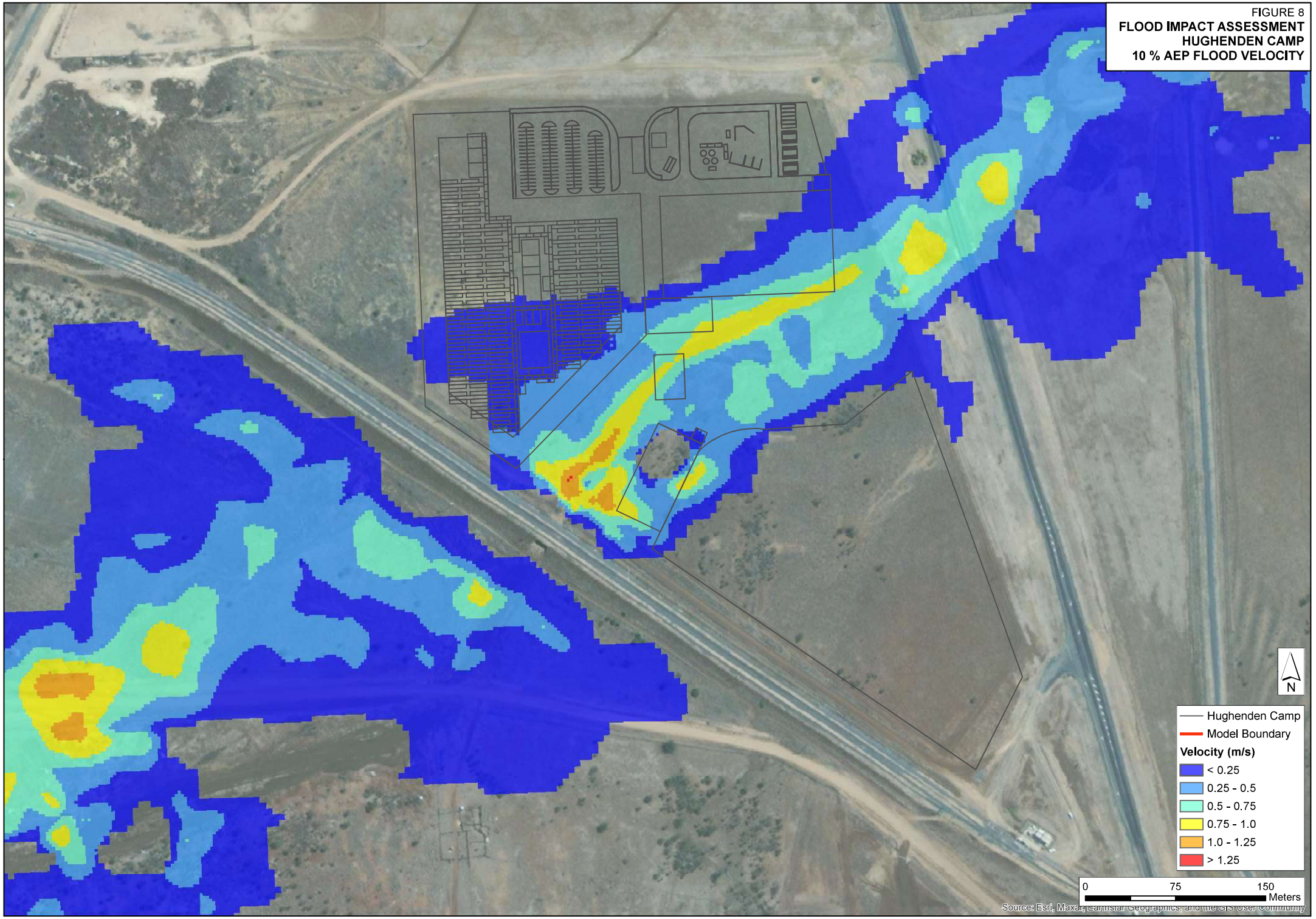
FIGURE 8
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
10 % AEP FLOOD VELOCITY



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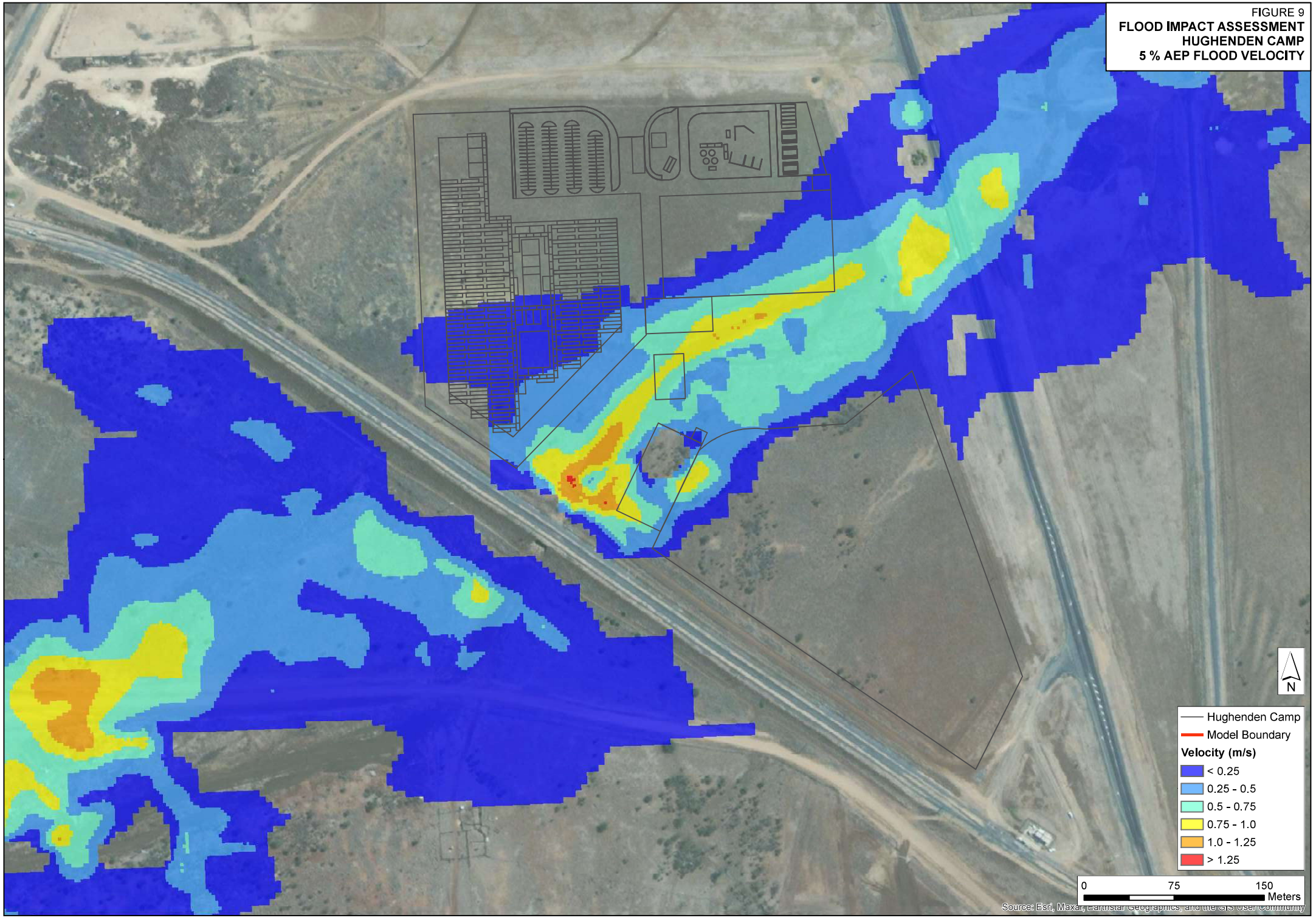
FIGURE 9
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
5 % AEP FLOOD VELOCITY
N
Hughenden Camp
Model Boundary
Velocity (m/s)
< 0.25
0.25 - 0.5
0.5 - 0.75
0.75 - 1.0
1.0 - 1.25
> 1.25
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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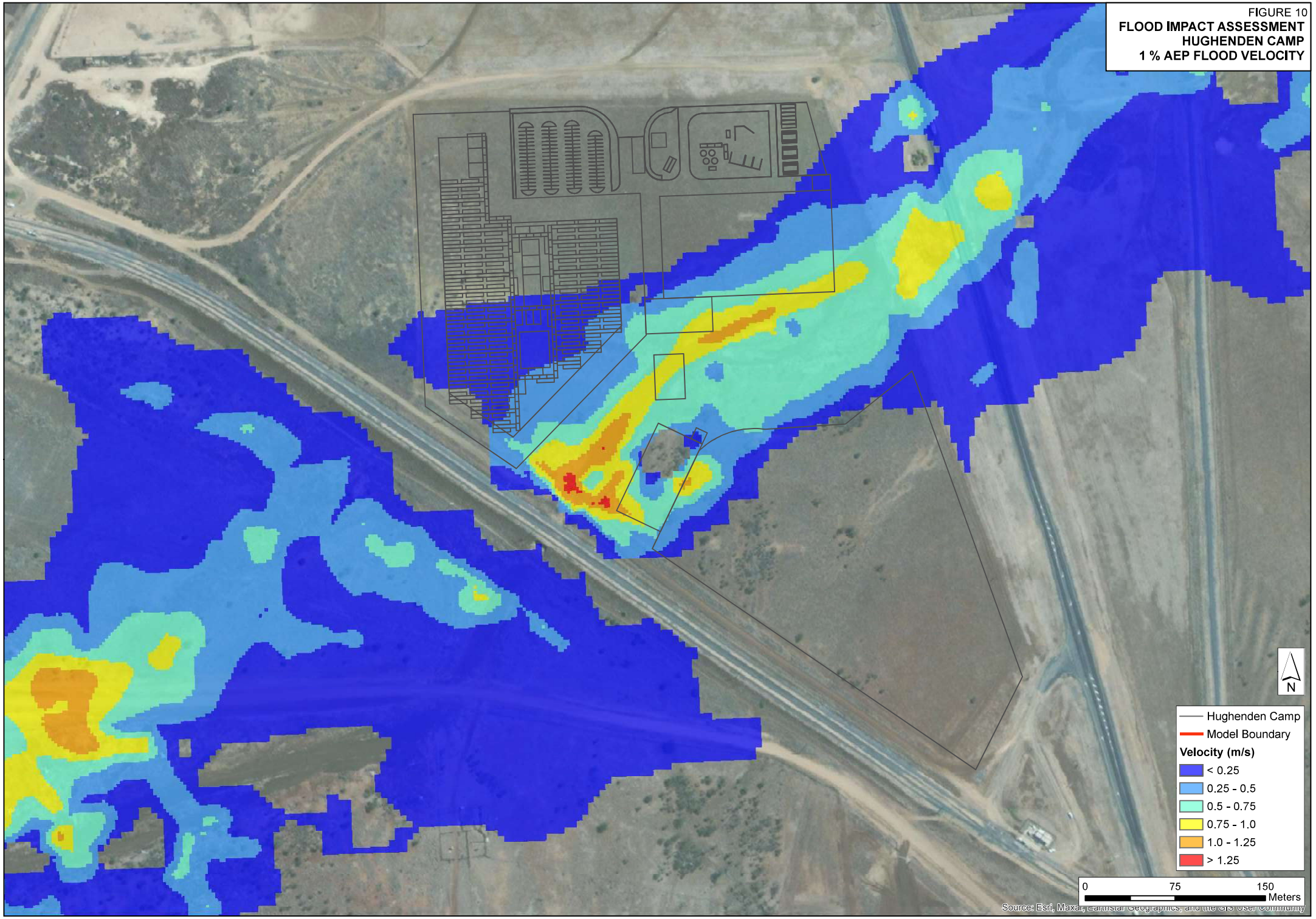
FIGURE 10
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
1 % AEP FLOOD VELOCITY
N
Hughenden Camp
Model Boundary
Velocity (m/s)
< 0.25
0.25 - 0.5
0.5 - 0.75
0.75 - 1.0
1.0 - 1.25
> 1.25
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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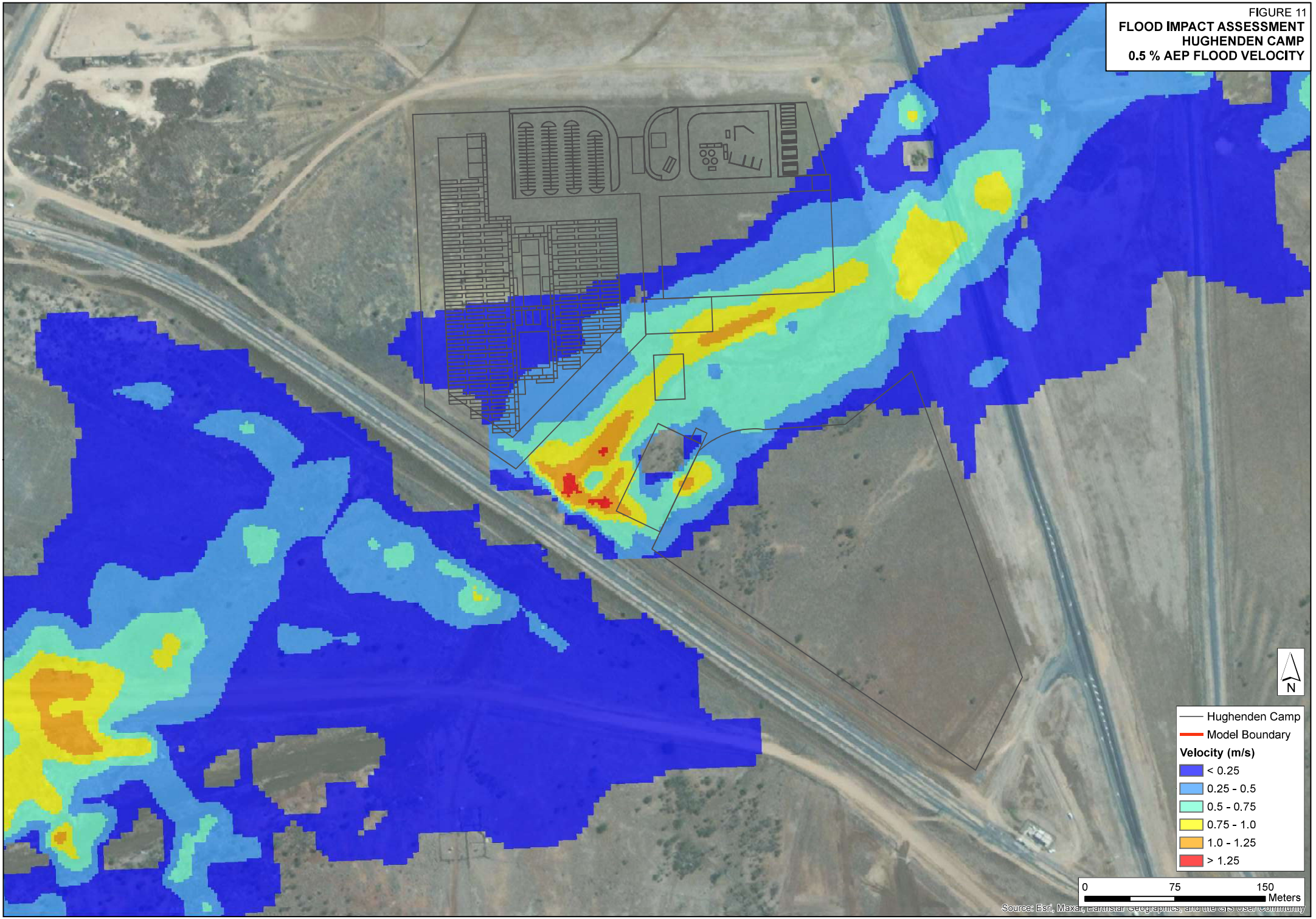
FIGURE 11
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
0.5 % AEP FLOOD VELOCITY
N
Hughenden Camp
Model Boundary
Velocity (m/s)
< 0.25
0.25 - 0.5
0.5 - 0.75
0.75 - 1.0
1.0 - 1.25
> 1.25
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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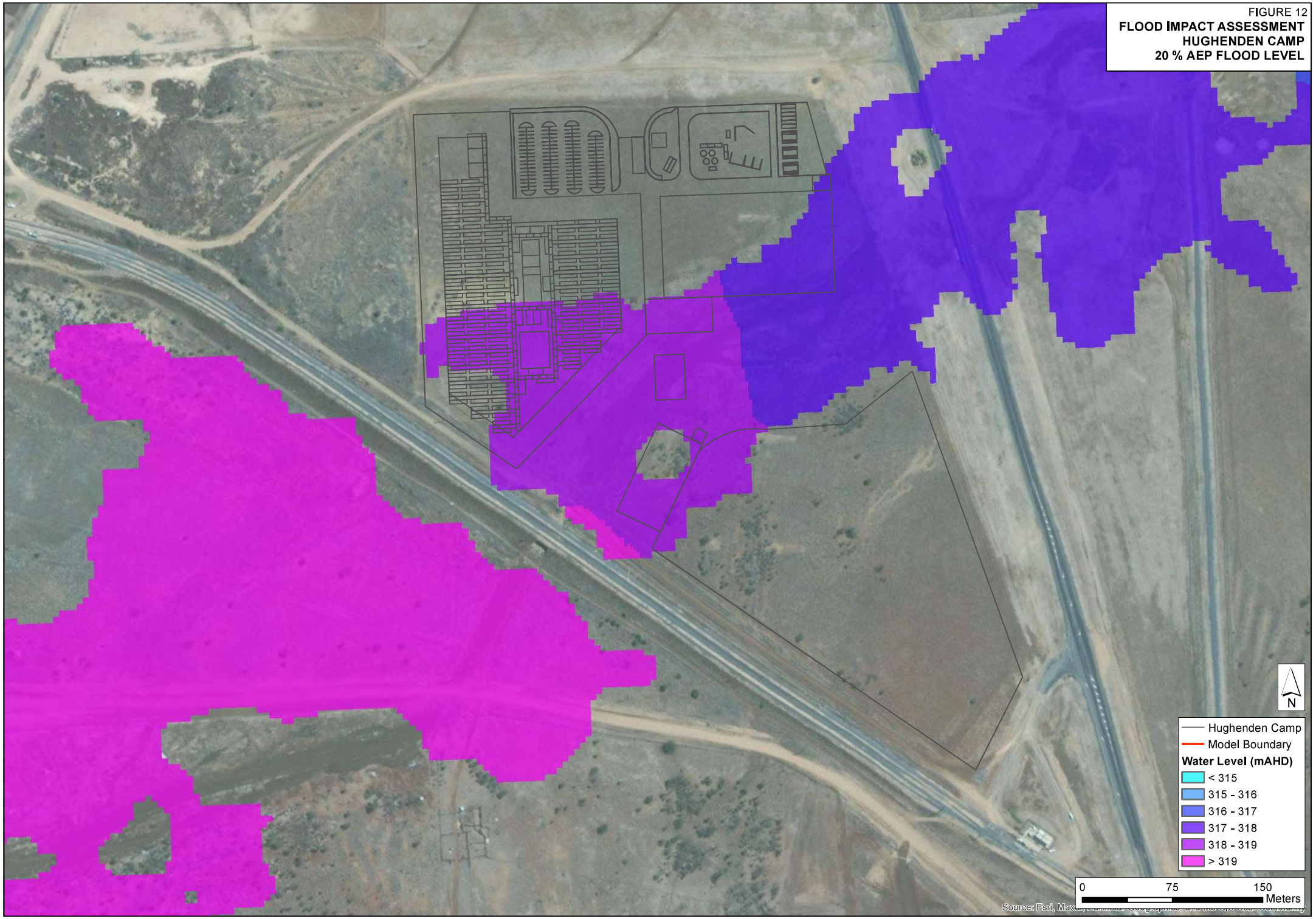
FIGURE 12
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
20 % AEP FLOOD LEVEL
N
Hughenden Camp
Model Boundary
Water Level (mAHD)
< 315
315 - 316
316 - 317
317 - 318
318 - 319
> 319
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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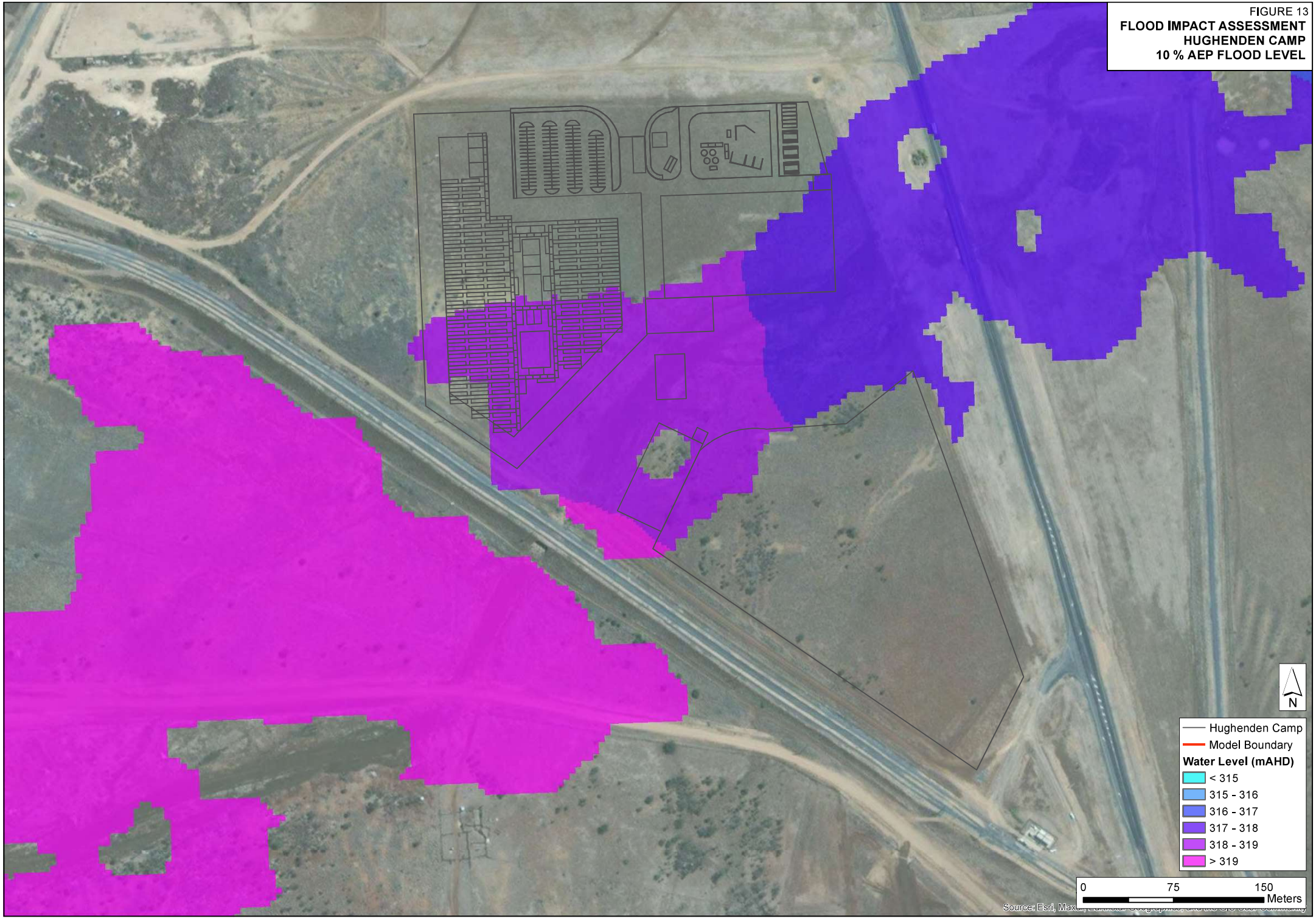
FIGURE 13
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
10 % AEP FLOOD LEVEL
N
Hughenden Camp
Model Boundary
Water Level (mAHD)
< 315
315 - 316
316 - 317
317 - 318
318 - 319
> 319
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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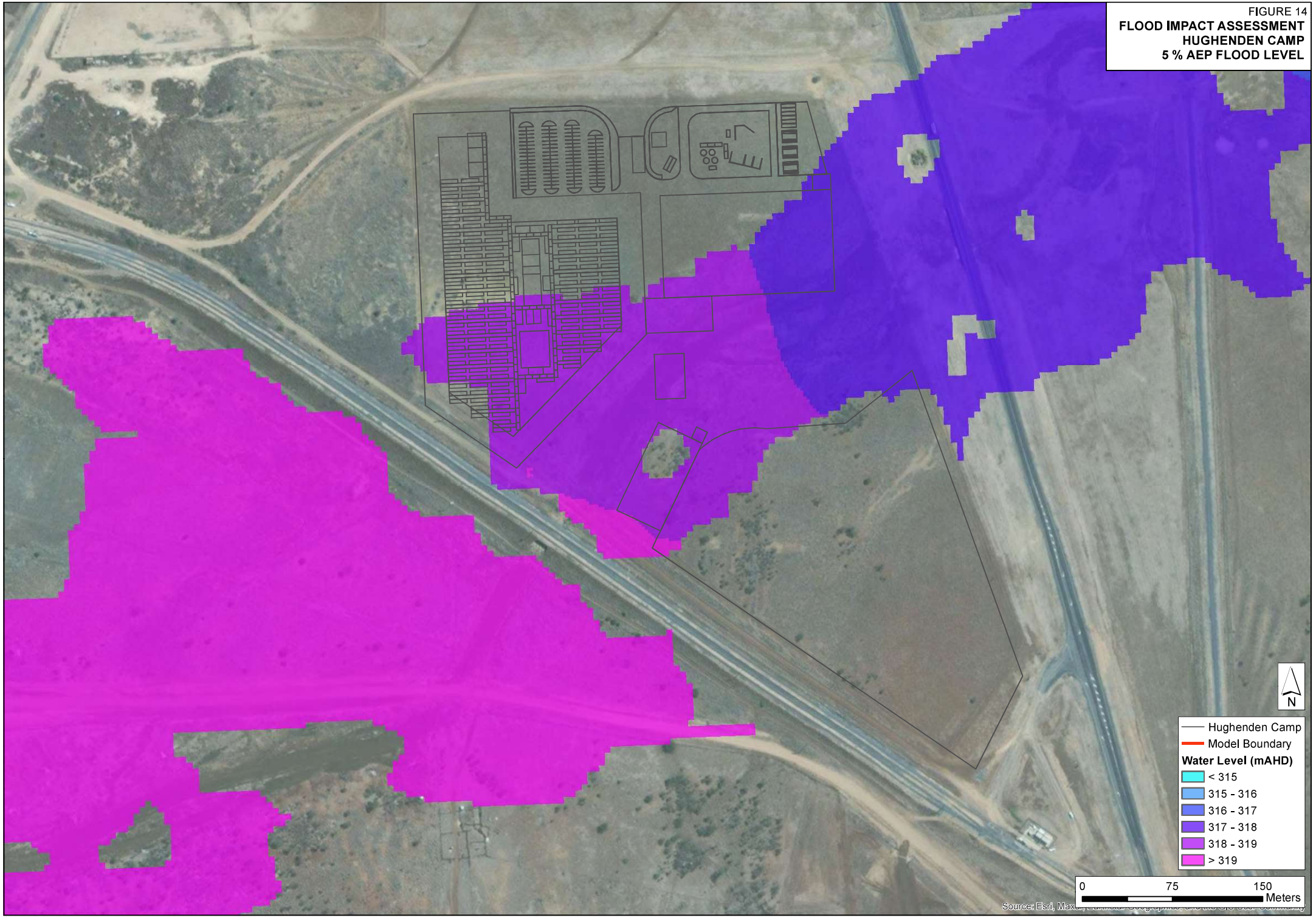
FIGURE 14
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
5 % AEP FLOOD LEVEL
N
Hughenden Camp
Model Boundary
Water Level (mAHD)
< 315
315 - 316
316 - 317
317 - 318
318 - 319
> 319
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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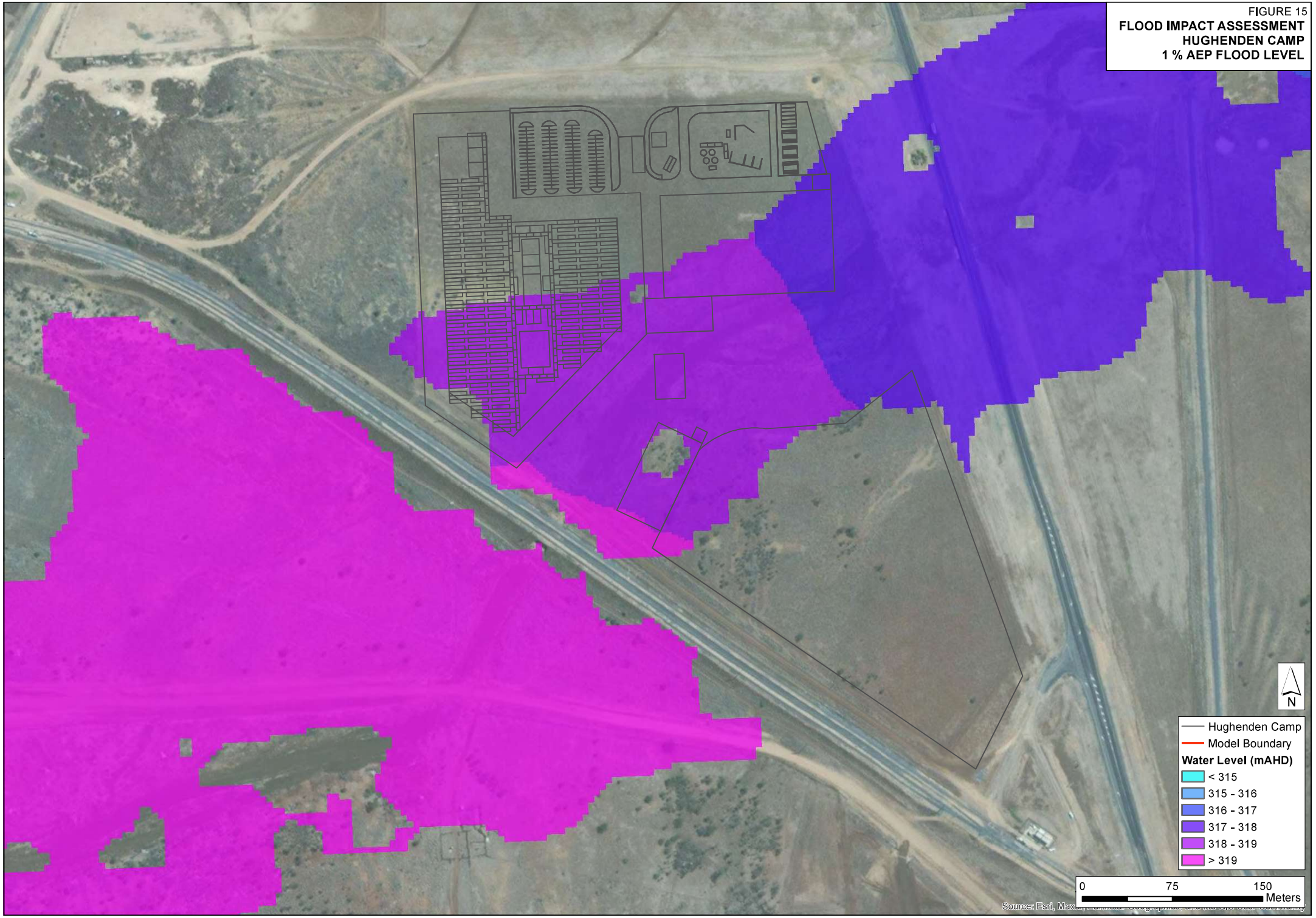
FIGURE 15
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
1 % AEP FLOOD LEVEL
N
Hughenden Camp
Model Boundary
Water Level (mAHD)
< 315
315 - 316
316 - 317
317 - 318
318 - 319
> 319
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
J:\Jobs\123061\GIS\ArcMaps\Hughenden_SS\FIG15_1%AEP_LEVEL.mxd

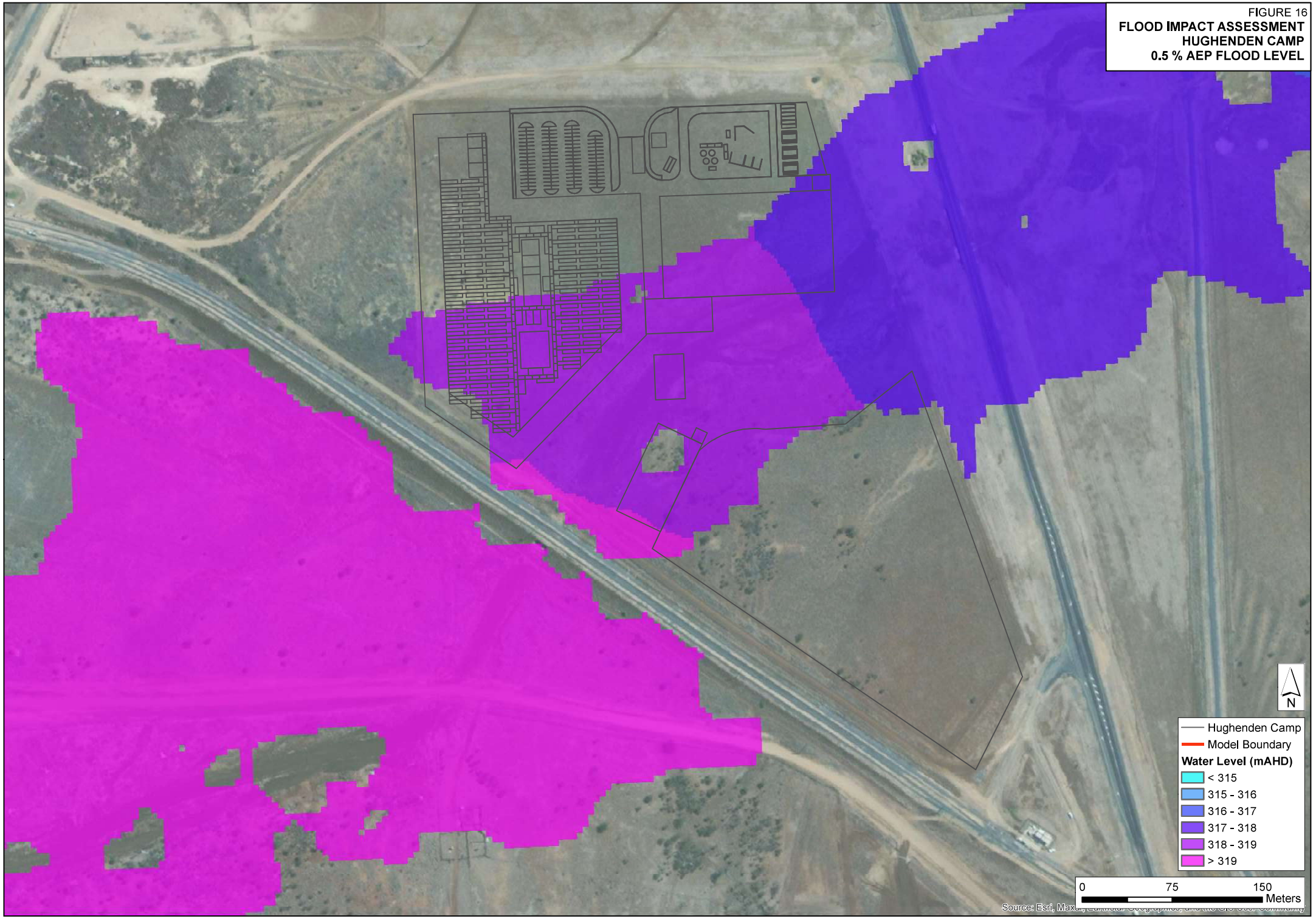
FIGURE 16
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
0.5 % AEP FLOOD LEVEL
N
Hughenden Camp
Model Boundary
Water Level (mAHD)
< 315
315 - 316
316 - 317
317 - 318
318 - 319
> 319
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
J:\Jobs\123061\GIS\ArcMaps\Hughenden_SS\FIG16_0.5%AEP_LEVEL.mxd

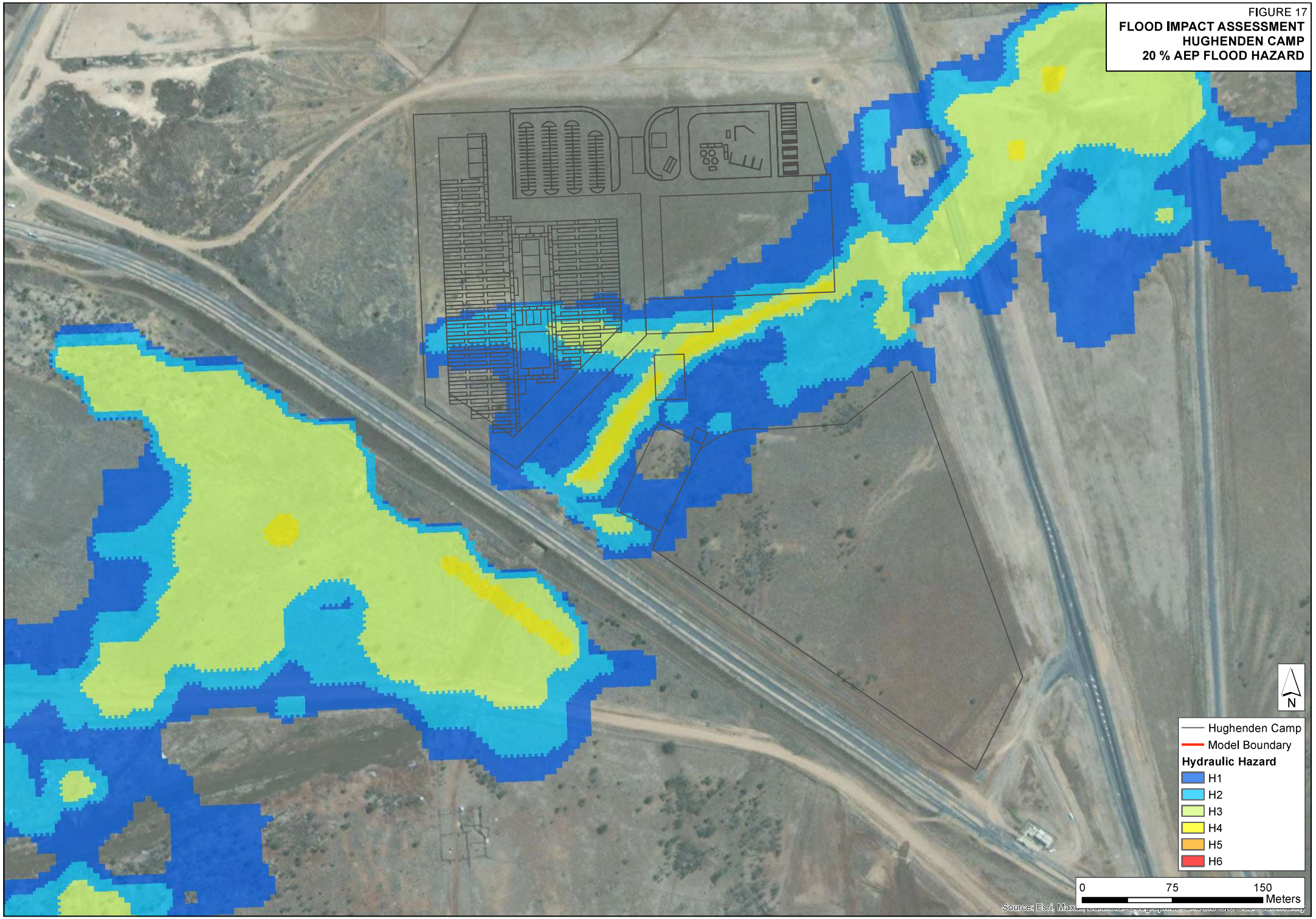
FIGURE 17
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
20 % AEP FLOOD HAZARD
N
Hughenden Camp
Model Boundary
Hydraulic Hazard
H1
H2
H3
H4
H5
H6
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
J:\Jobs\123061\GIS\ArcMaps\Hughenden_SS\FIG17_20%AEP_HAZARD.mxd

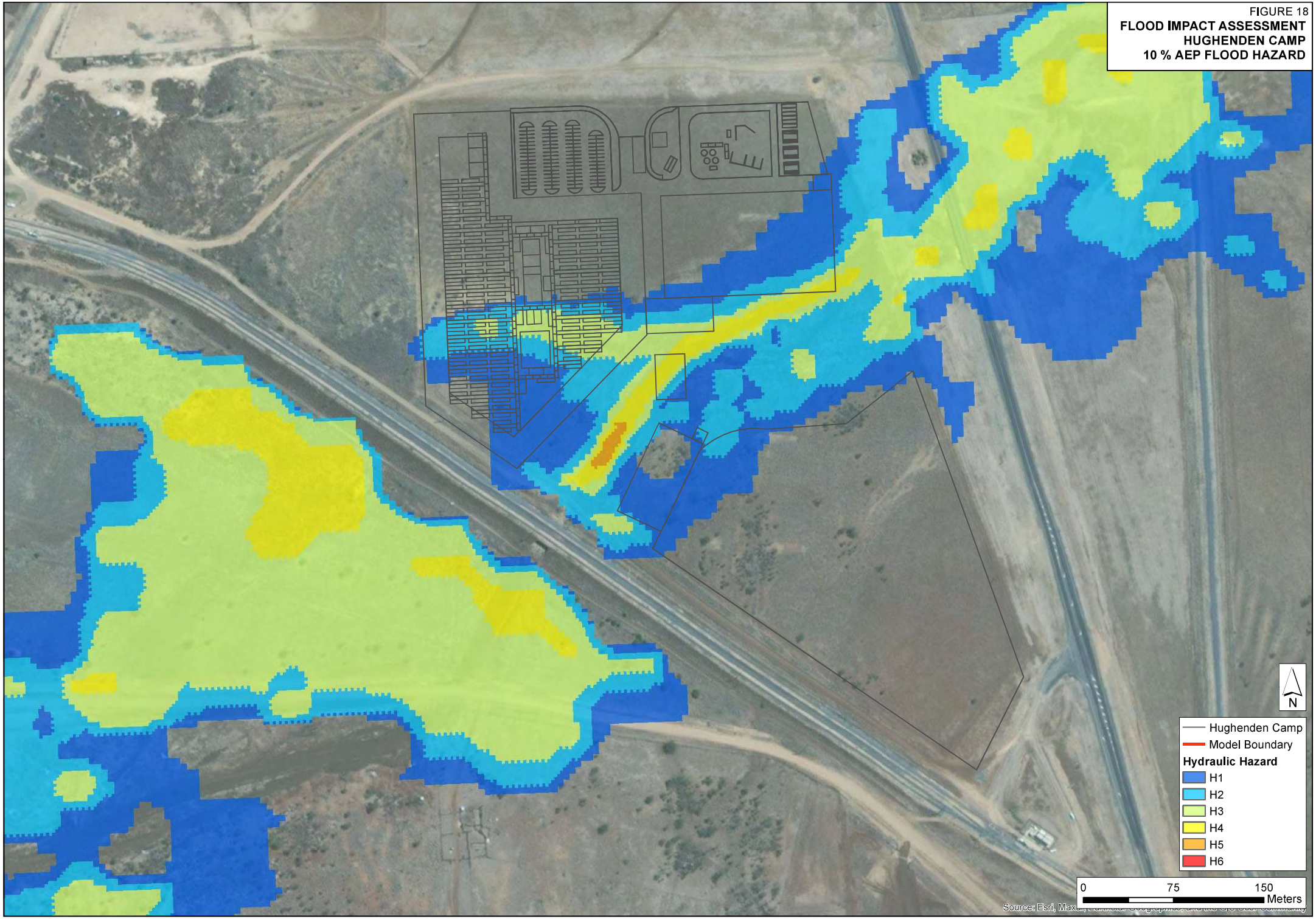
FIGURE 18
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
10 % AEP FLOOD HAZARD
N
Hughenden Camp
Model Boundary
Hydraulic Hazard
H1
H2
H3
H4
H5
H6
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
J:\Jobs\123061\GIS\ArcMaps\Hughenden_SS\FIG18_10%AEP_HAZARD.mxd

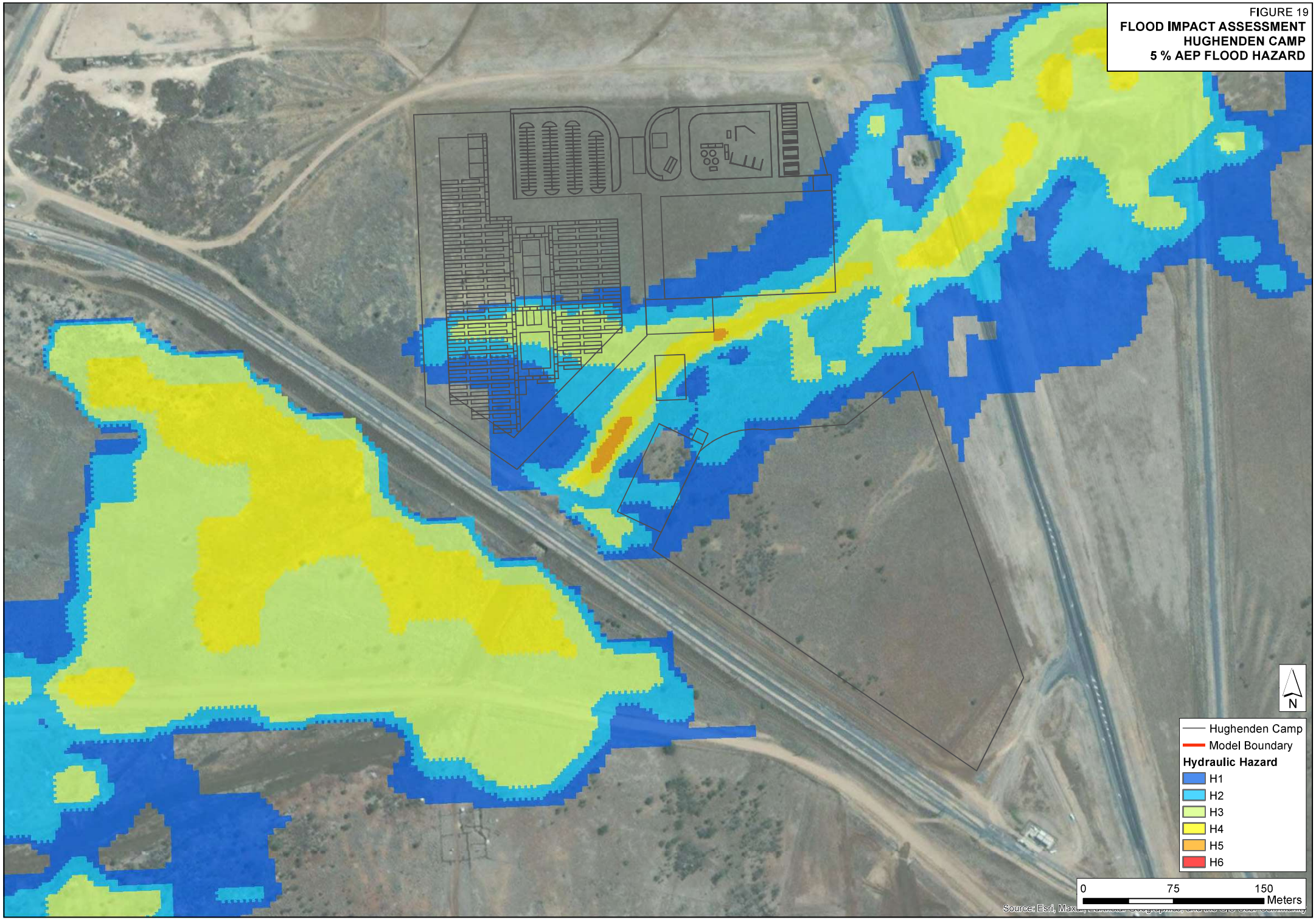
FIGURE 19
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
5 % AEP FLOOD HAZARD
N
Hughenden Camp
Model Boundary
Hydraulic Hazard
H1
H2
H3
H4
H5
H6
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
J:\Jobs\123061\GIS\ArcMaps\Hughenden_SS\FIG19_5%AEP_HAZARD.mxd

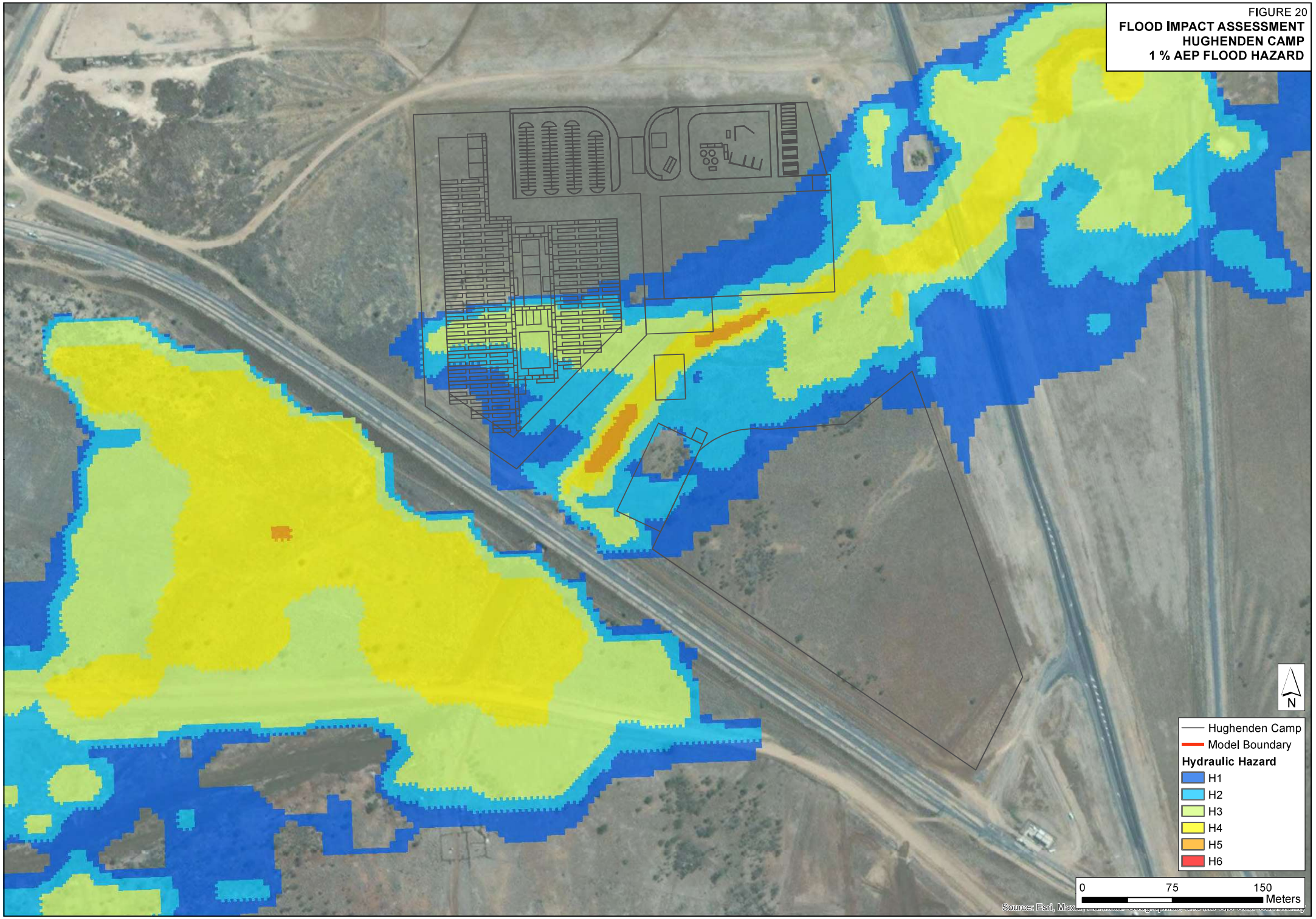
FIGURE 20
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
1 % AEP FLOOD HAZARD
N
Hughenden Camp
Model Boundary
Hydraulic Hazard
H1
H2
H3
H4
H5
H6
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
J:\Jobs\123061\GIS\ArcMaps\Hughenden_SS\FIG20_1%AEP_HAZARD.mxd

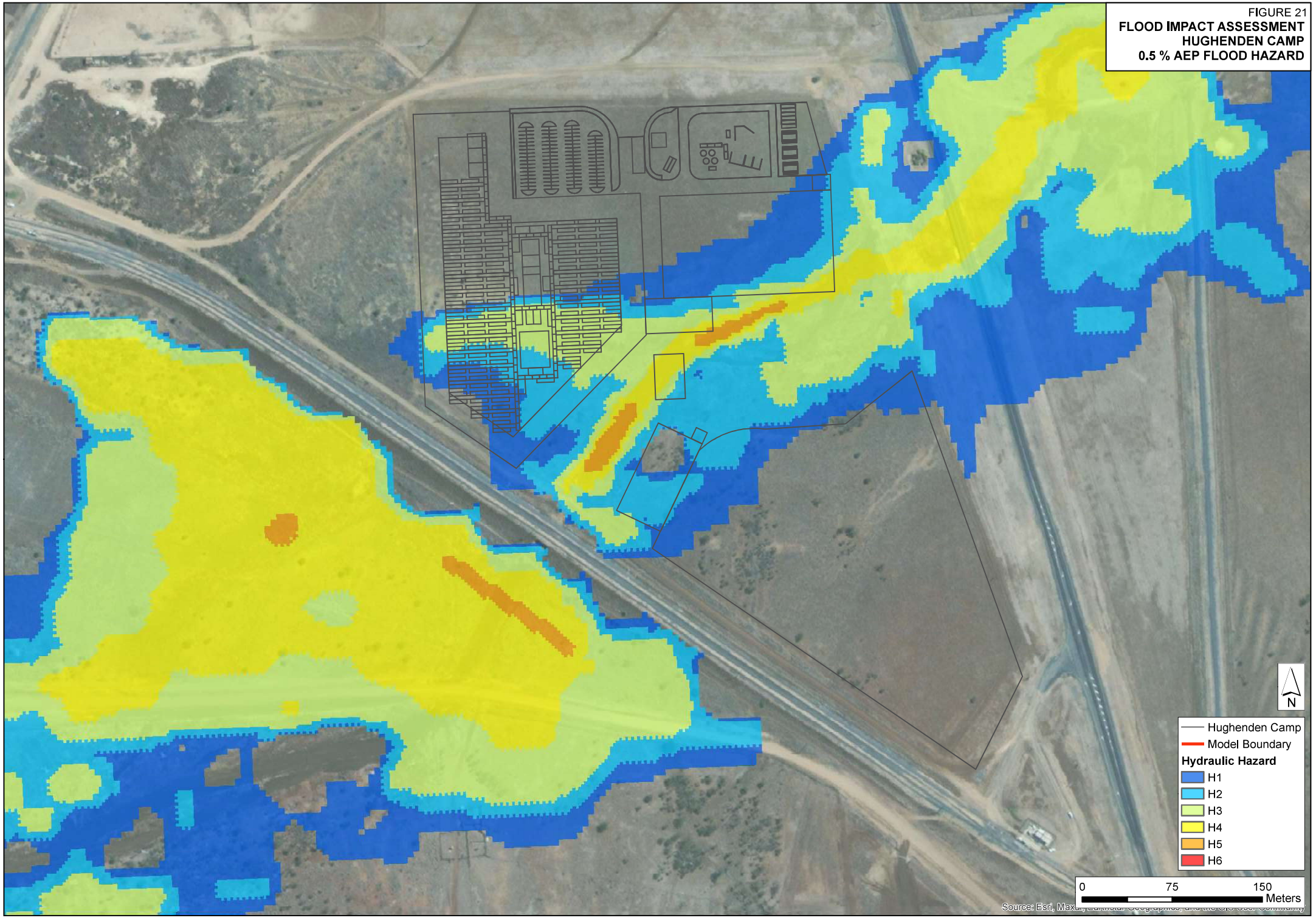
FIGURE 21
FLOOD IMPACT ASSESSMENT
HUGHENDEN CAMP
0.5 % AEP FLOOD HAZARD
N
Hughenden Camp
Model Boundary
Hydraulic Hazard
H1
H2
H3
H4
H5
H6
0
75
150
Meters
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
J:\Jobs\123061\GIS\ArcMaps\Hughenden_SS\FIG21_0.5%AEP_HAZARD.mxd