West Sussex County Council

ANGMERING FLOOD ALLEVIATION SCHEME

Modelling Technical Note



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1 BACKGROUND INFORMATION

1.1 INTRODUCTION

West Sussex County Council has commissioned WSP to further assess a Natural Flood Management (NFM) option which was initially investigated by the Environment Agency in the Angmering Flood Alleviation Scheme, Options Modelling report (4 Dec 2018).

The model that was used to inform the Environment Agency Options Modelling report has been used as the base model for this study. This is an integrated 1D-2D model in InfoWorks ICM which is reported to have been calibrated against two storm events in 2012 and 2015.

1.2 STUDY AREA

Angmering village in West Sussex lies about 2 miles north of the English Channel and the upper part of the village sits on the dip slope of the South Downs. It is prone to surface water flooding and fluvial flooding in Water Lane and along the centre of the village.

The Study Area does not only cover the Black Ditch floodplain along Water Lane in the Angmering Village. It also includes its upper reaches where the NMF measures are proposed (refer to FAS boundary highlighted in blue in Figure 1-1).

Figure 1-1 - Study Area

The Black Ditch runs from Patching Pond on the northern side of the A27 and it is predominantly groundwater fed from the South Downs. The pond discharges into the Black Ditch at restricted flows, then meanders alongside the A280 before entering the Water Lane twin culvert at Angmering. The main culvert is 500m long and 1.2m diameter and runs through the centre of Angmering. An additional high-level relief rectangular box culvert runs parallel to the main culvert for 380m before merging with the main culvert. The main culvert then drains back into open channel prior to meandering through a local golf course and joining the River Arun.

At the point that the Black Ditch enters in culvert at the Weavers Lane Trash Screen at the top of Water Lane, the catchment for the ditch extends over approximately 25km^2. The bulk of the catchment (80%) is underlain by a bedrock of chalk, but the section of the Black Ditch encompassed by the FAS comprises a bedrock of almost exclusively London Clay. The A27 effectively bisects the catchment with direct run-off north of the A27 channelling via Patching Pond. As the outfall from Patching Pond is restricted, from a pluvial perspective, run-off is predominantly restricted to south of the A27.

An initial assessment for Angmering by the Environment Agency identified four main flow paths as the main contributors towards flooding of the town, specifically:

- Water Lane - Surface water run-off running south west down Water Lane towards the
- village centre;
- Black Ditch - Fluvial flood risk overloading the Water Lane culvert;

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- Dappers Lane - Surface water run-off running south down Dappers Lane and then south
- west towards the village centre; and
- Ancient Woodland (TQ 05370) to East of Weavers Hill - surface water run-off flows north
- west down fields towards Black Ditch and Water Lane

The model takes account of all the above sources of flood risk however its hydrology focuses on the fluvial element, as the hydrographs and hyetographs in the model relate to long times to peak and therefore long storm durations.

1.3 SUMMARY OF FLUVIAL AND SURFACE WATER FLOOD RISK

In 1980, 26 properties flooded and a similar number again in 2012. The majority of these flooding incidents occurred along Water Lane, where the Black Ditch designated as a main river is culverted under the road. The Black Ditch has a catchment of a little over 24km^2 extending into the downs to the North and East. This flood risk has long been the focus of potential interventions to reduce the frequency / severity of flooding where the standard of protection is estimated as 5 years in the Environment Agency, Options Modelling Report.

1.4 HISTORY OF MODEL DEVELOPMENT

The original model for Angmering was included as a small sub-model in the Lower Tidal River Arun Strategy (LTRAS) InfoWorks RS model, which was built in 2010 by Atkins. This was later further developed by Mott MacDonald in 2015, to carry out modelling work as part of an initial assessment, to improve the model and give sufficient detail to allow high level options to be tested to understand the available benefits.

The initial assessment at the time, had the key limitation that asset data within the model was of poor quality; the model representation of the Water Lane culvert was based on readily available information at the time including a partially complete CCTV survey, and river cross sections were generated from Lidar data with manual amendments made to match observed water levels.

The model was updated for the OBC stage of the project to test options based on topographic survey and updated manhole survey. An integrated 1D- 2D model was built in InfoWorks ICM. The model utilises the InfoWorks ICM v9.0.1 modelling software, to predict flood extents based upon inputs from hydrological inflows and direct rainfall. The hydraulic modelling was previously carried out using InfoWorks ICM version 8.0.2. This model was calibrated against two storm events in 2012 and 2015.

1.5 MODEL BRIEF

The scope is summarised as follows:

- Undertake a model review;
- Check the capacity of the 1.2m diameter main carrier and the high level overflow;
- Undertake baseline model runs for 5, 20, 75 and 100 years;
- Investigate a variation of the NFM Option 1 (as identified in the Environment Agency Options modelling report) however simplified/modified based on the LLFA recommendation: LLFA Option 1 based on using the natural available storage (no excavations, refer to Figure 1.2);

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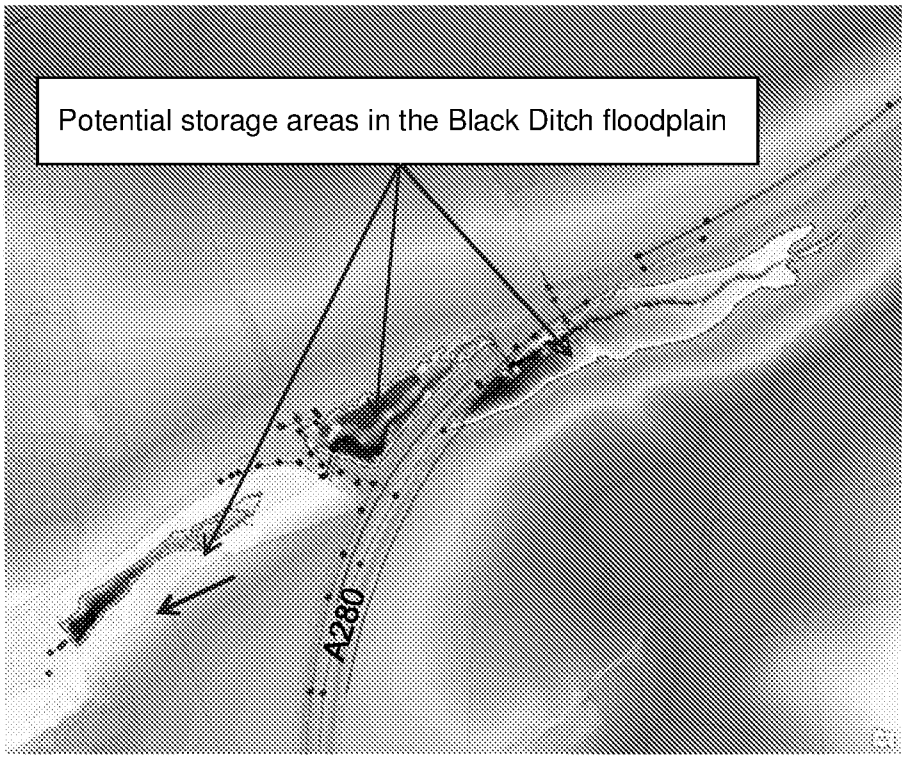


Figure 1-2 - Conceptual Attenuation areas for the Black Ditch above Water Lane

Sensitivity tests undertake:

- Change in Mannings' n values;
- Throttle on the new road crossing to limit flows as for the FAS (100+CC);
- 80% blockage of the throttle on the new road crossing;

Key Deliverables:

- Simulations of the baseline and LLFA Option 1 as set out above for 1:5; 1:75 and 1:100 and 1 in 100 + CC;
- Partial implementation of the LLFA Option 1 (refer to Section 2.2);
- Analysis of the attenuated water elevations and attenuated volumes at the eastern and western attenuation areas (100 year event);
- Flood risk plots for the LLLFA Options 1 simulation for the 100 + CC event;
- Interpretation of the modelling plots.

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2 SUMMARY OF TASKS AND OUTPUTS

2.1 MODEL REVIEW AND AMENDMENTS

The Infoworks ICM hydraulic model for the Black Ditch in Angmering was reviewed during several different stages of development, from receiving the model from the Environment Agency to the improvements made to better represent the present-day infrastructure with Angmering.

As a result of the review, a number of items have improved the representation of the different components of the model, as follows:

- Setting appropriate flags to highlight data sources in the model;
- Updating pipe roughness from the ICM default value of 1.5mm to 0.6mm which is the norm for surface water sewers;
- Checking the culverted section of the Black Ditch running under Water Lane against survey data made available by the LLFA for this study;
- Adding panel markers to river reach sections to improve conveyance curves;
- Improving the LiDAR terrain model with survey data received from Stantec and the Environment Agency, covering the reaches where the Flood Alleviation Scheme will be implemented;
- Resizing areas and shapes in the urban sub-catchments to re-distribute flows based on data provided by the LLFA;
- Improving the representation of the modelled initial conditions at Avenals Pond;
- Enlarging the width of the 1D domain at the Land South of Water Lane Development to remove model instabilities and to better represent the channel and its immediate floodplain;
- Increasing the resolution of the model by reducing the mesh triangle sizes from $50m^2$-$20m^2$ in the 'as received' model to $20m^2$- $5m^2$;
- Altering channel roughness values from 0.07 to 0.045 as these were deemed to be more sensible based on-site visit interpretation by the modeller;
- Improved the representation of the balancing pond serving the A280, near the junction with Water Lane;
- Included culvert inlets and outlets for structures along the Black Ditch watercourse;
- Included representation of building thresholds based on LiDAR levels as described below:

$$Z_{upstand} = Min\left(\left(\bar{Z}_{building} + 2\sigma + 0.3\right), \left(Max\left(Z_{building}\right) + 0.3\right)\right)$$

Where:

$Z_{upstand}$ = new height applied to all grid cells within a given building footprint

$\bar{Z}_{building}$ = mean of all "bare earth" heights within a given building footprint

σ = standard deviation of all "bare earth" heights within a given building footprint

$Z_{building}$ = set of "bare earth" heights within a given building footprint

The model takes account of surface water and fluvial sources of flood risk however its hydrology focuses on the fluvial source, as the hydrographs and hyetographs in the model relate to long storm durations.

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It would be possible to use the same model to assess surface water flood risk however the hydrology would need to be estimated for short high intensity storms and the surface water network in the village would need to be modelled in further detail.

No modelling report for the hydrology and the calibration was provided with the model (the model that informed the Environment Agency Options Modelling report) and therefore it has not been possible to verify the robustness of the assessment, without having to undertake a complete new hydrology and calibration assessment.

2.2 SCENARIOS MODELLED

The outline flood alleviation scheme (FAS) that has been modelled, comprises restrictions on peak flows as set out below (see locations A to E in Figure 1.3):

- Location A. Upstream of the access track to Ecclesden Farm to fully exploit the capacity of the existing pond;
- Location B. At the upstream side of the culvert under the A280; restriction of peak flows to $1.8m^3/s$.
- Location C. At the discharge from the balancing pond area serving the A280; restriction of peak flows to $1.8m^3/s$.
- Location D. Upstream of the proposed access road to the 'Land South of Water Lane' development; restriction of peak flows on the main culvert to $1.8m^3/s$;
- Location E. Upstream of the current access road serving Avenals Farm; restriction of peak flows to $1.5m^3/s$.

A partial implementation of the FAS has also been modelled in which the only flow restriction is at Location D. This has been modelled separately as there is an opportunity to build this structure prior to the construction of the full FAS. This opportunity has arisen as there is a proposed culverted access road into the Land to the South of Water Lane development and the inlet of this structure can accommodate the construction of the flow restriction structure. The proposed culverted access road has a 3.5m wide and 3m high culvert and the external face of the wing walls at the inlet, will be able to accommodate the flow restriction structure, which has been modelled as a weir structure with two orifice control devices beneath, as shown in Figures 1-4 and 1-5.

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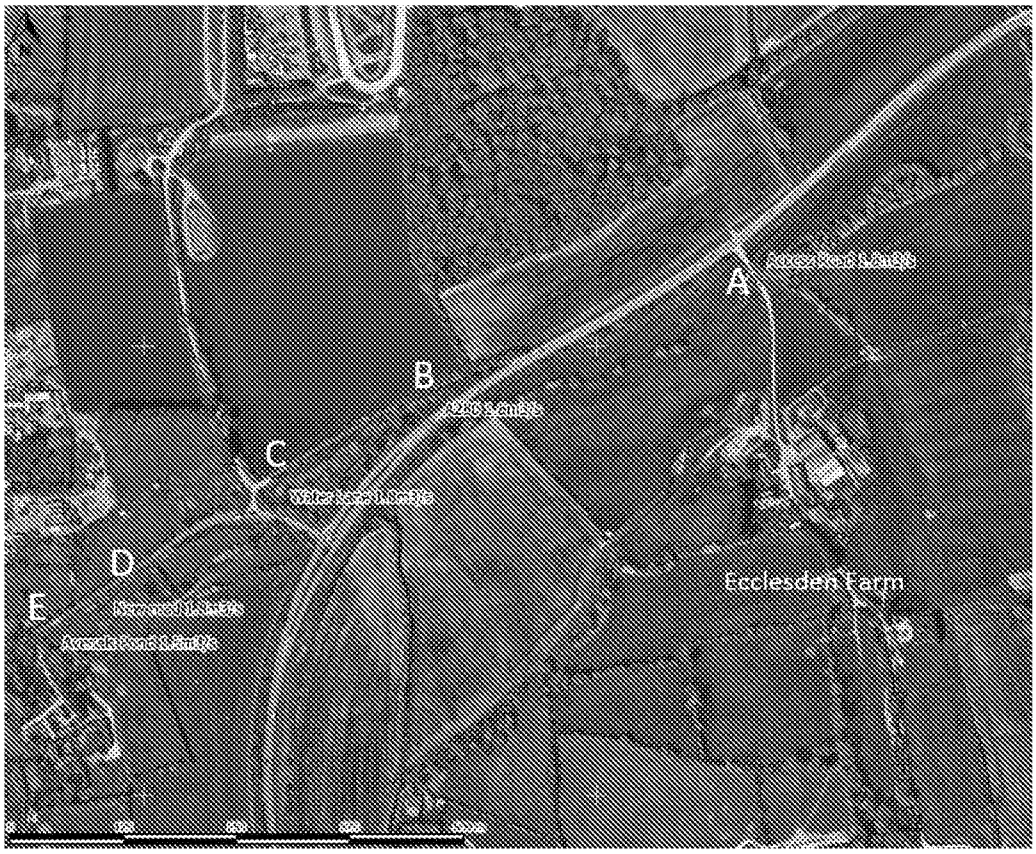


Figure 1-3 Flow Restriction Locations for the proposed FAS

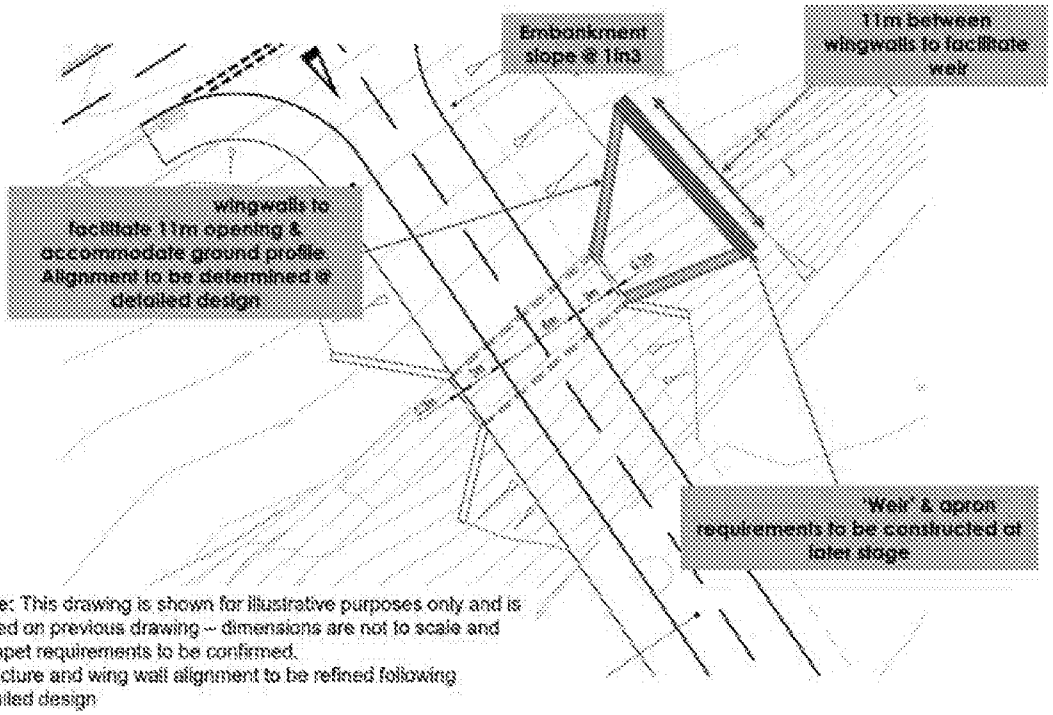


Figure 1-4 Proposed Culverted Crossing and upstream weir structure with orifice control units beneath

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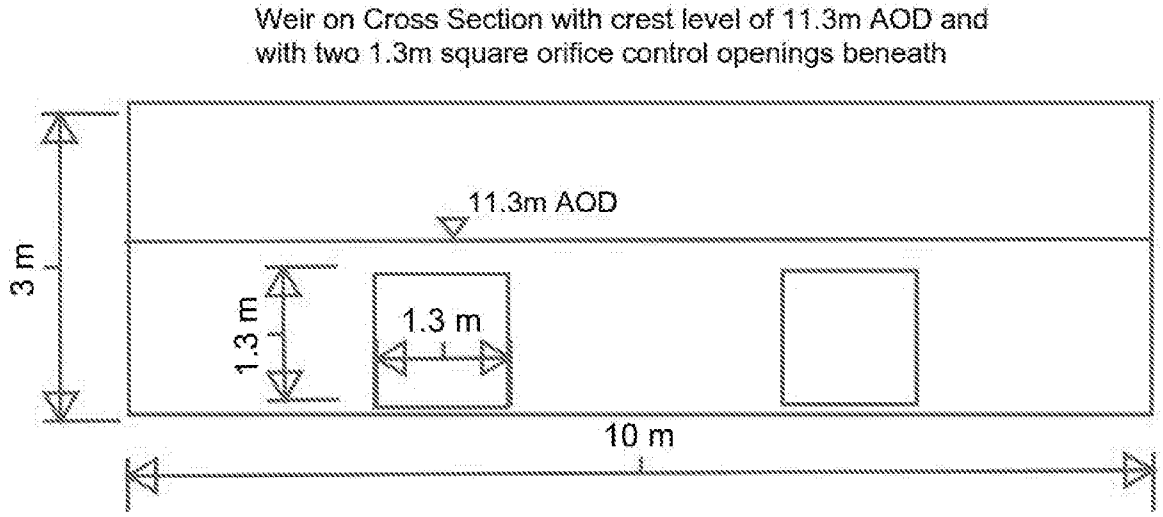


Figure 1-5 – Weir structure abutted to the culvert inlet headwalls

The scenarios modelled are therefore as follows:

- Scenario 1: Baseline (with no FAS or proposed access road to the development);
- Scenario 2: With culverted access road plus upstream weir structure (only partial implementation of the FAS);
- Scenario 3: Full FAS and culverted road access.

The return periods modelled for Scenarios 1 and 2 are: 1:5; 1:75 and 1:100 and 1 in 100 + 45% CC.

The return period for Scenarios 2 and 3 is 1 in 100 + 45% CC

It is assumed that the orifice control units at the upstream weir structure of the new access road will be open (not restricting) for the 1 in 100 + 45%CC for Scenarios 2 and 3. This is because it has been assumed at this stage, that flow attenuation will take place for lower return period events. The assumption will be reviewed as part of the detailed design modelling stage; however a sensitivity test has been undertaken to include the flow restriction also for this extreme event (see Section 2.3 below).

2.3 SENSITIVITY TESTS

Sensitivity have been undertaken to gauge the reliability of the model for key parameters such as:

1. Sensitivity of water levels as a result of variations in floodplain roughness by +/- 20%;
2. Sensitivity test in flows by comparing the results for different return period events;
3. Partial implementation of the FAS but with throttling at the proposed access road for the 1 in 100 year plus 45%CC event (Scenario 2 but with throttling of at the weir structure)
4. Full implementation of the FAS but with throttling at the proposed access road for the 1 in 100 year plus 45%CC event (Scenario 3 but with throttling of the weir structure at the proposed access road).
5. Blockage testing of the orifice controls at the proposed access road by 80%;

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Variations in water levels as a result of increasing and decreasing the surface roughness parameters by 20%. The depths vary by 0.03m between a 20% decrease and 20% increase in roughness values. Consequently, the model is not overly sensitive to variations in this parameter.

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3 MODELLING DETAILS AND OUTPUTS

3.1 FLOOD ALLEVIATION SCHEME MODEL RESULTS (LLFA OPTION 1)

The flood alleviation scheme titled LLFA Option 1 sees the introduction of a number of flow throttles at key locations in the river reaches of the Black Ditch situated upstream of the town of Angmering (refer to figure 1-3).

The outline flood alleviation scheme has been initially modelled to reduce the peak flood depths on Water Lane for a 1 in 100 year event by approximately 200mm and for the 100 year plus climate change event it could reduce up to 100mm if throttling takes place at all FAS locations, as shown in Figure 3-1.

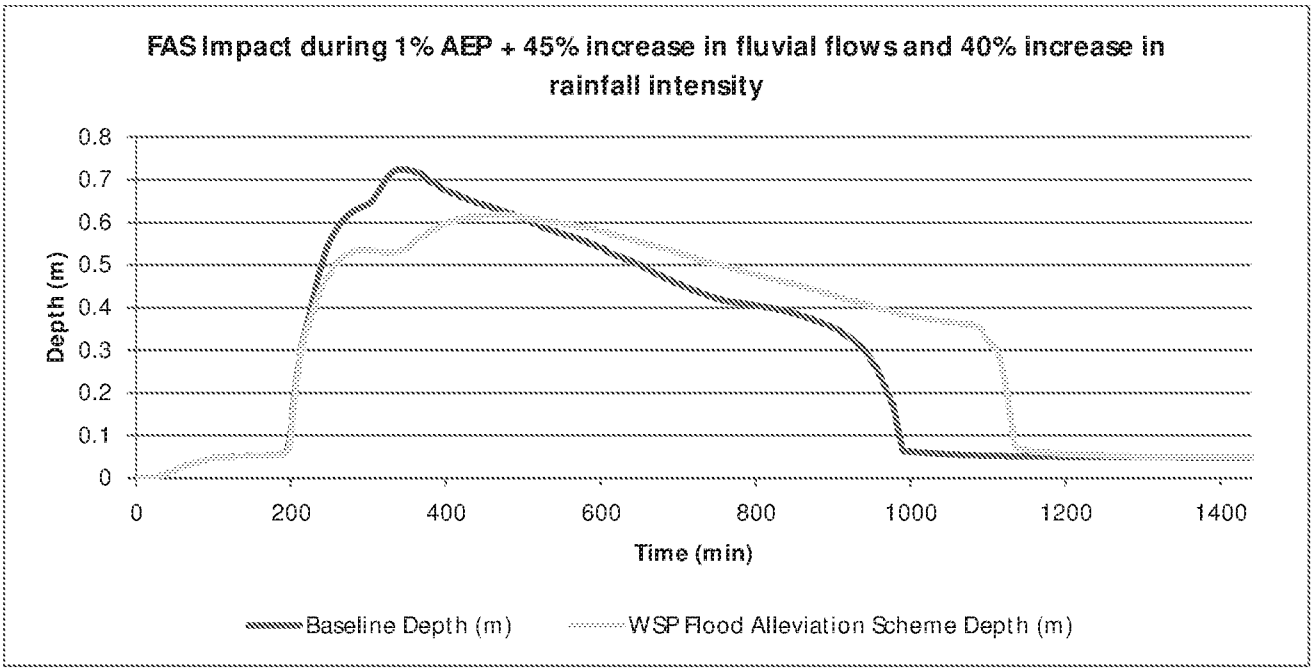


Figure 3-1 FAS Depth impact for the 100 year plus 45% event at Water Lane

3.2 ATTENUATED WATER LEVELS AND VOLUMES IN THE FLOOD ALLEVIATION SCHEME COMPONENTS

ATTENUATION UPSTREAM OF ECCLESDEN FARM ACCESS (LOCATION A IN FIGURE 1-3)

Based on the modelling runs, the maximum flow upstream of Ecclesden Farm access road is approximately 2m^3/s (Baseline). The introduction of a throttle and overflow at this location actually increases the discharge downstream, by virtue of an extra structure through which water can flow downstream. The invert level of the overflow (1.2mX1.2m rectangular culvert) is set at 16.1m AOD, while the top of the road is situated at a level of 16.7m AOD (refer to peak water level in Figure 3-2). Consequently, the invert level for the spill mechanism needs to be reviewed to allow more storage to occur in this part of the FAS. This level will have to be set to an elevation for which the discharge

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point from a wastewater treatment plant is not affected. This data was requested, but the information was not made available to support this stage of the flood alleviation scheme.

Attenuation at this location needs therefore reviewing as part of detailed modelling and could be removed. Nevertheless it is unlikely that the removal of this attenuation will affect significantly the remaining of the FAS, at it is the most upstream location.

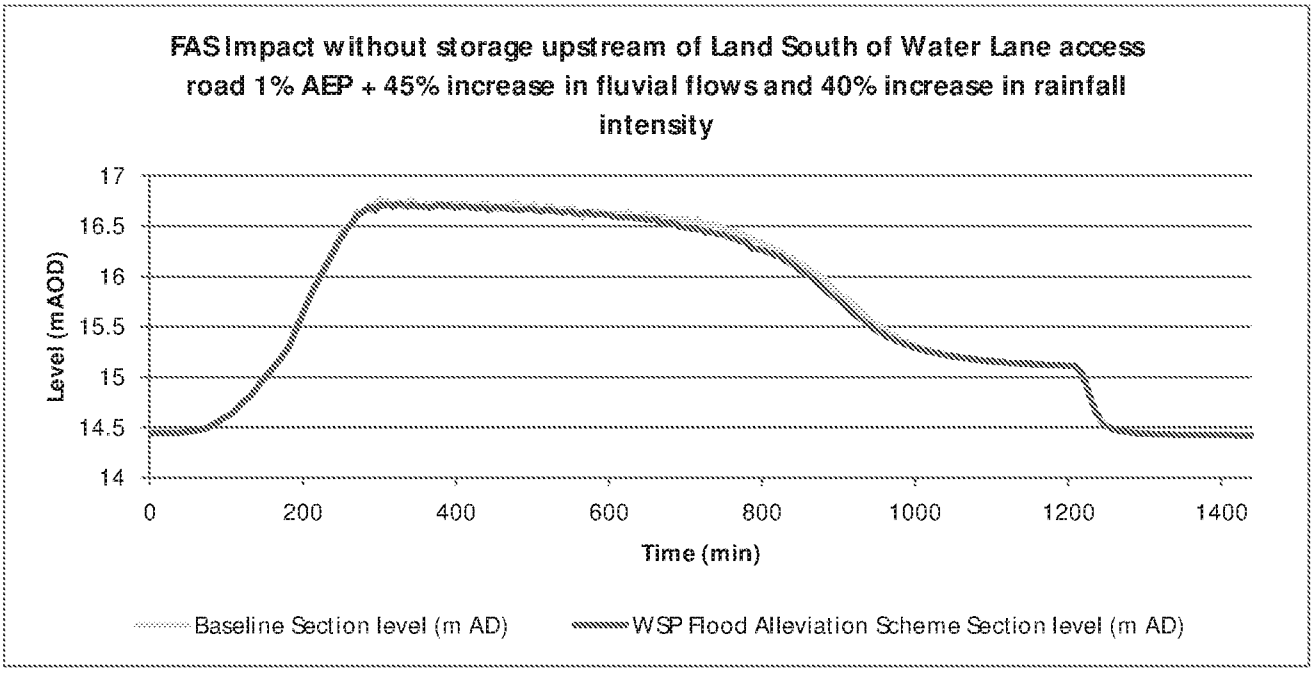


Figure 3-2 Water level hydrograph upstream of the throttling at the access road into Ecclesden Farm

UPSTREAM OF A280 (LOCATION B IN FIGURE 1-3)

The introduction of the throttle serving the flood alleviation scheme will raise water levels from 13.6m AOD (Baseline) during a 1 in 100 year plus climate change event to 14.8m AOD (refer to Figure 3-3). The volume stored here outside of the extent of the 1D domain is 12,680m^3.

Upstream of the A280, a throttle has been set to 1.8m^3/s with an overflow culvert set at 14m AOD. The overflow pipe is a 2.1mX0.8m rectangular culvert and is not sufficient in passing the necessary flows to keep water volumes under 10,000m^3, upstream of the A280. This is largely due to the overflow spilling mechanism introduced in the model and storing flows to a lower level is feasible and can be investigated as part of the detailed modelling stage.

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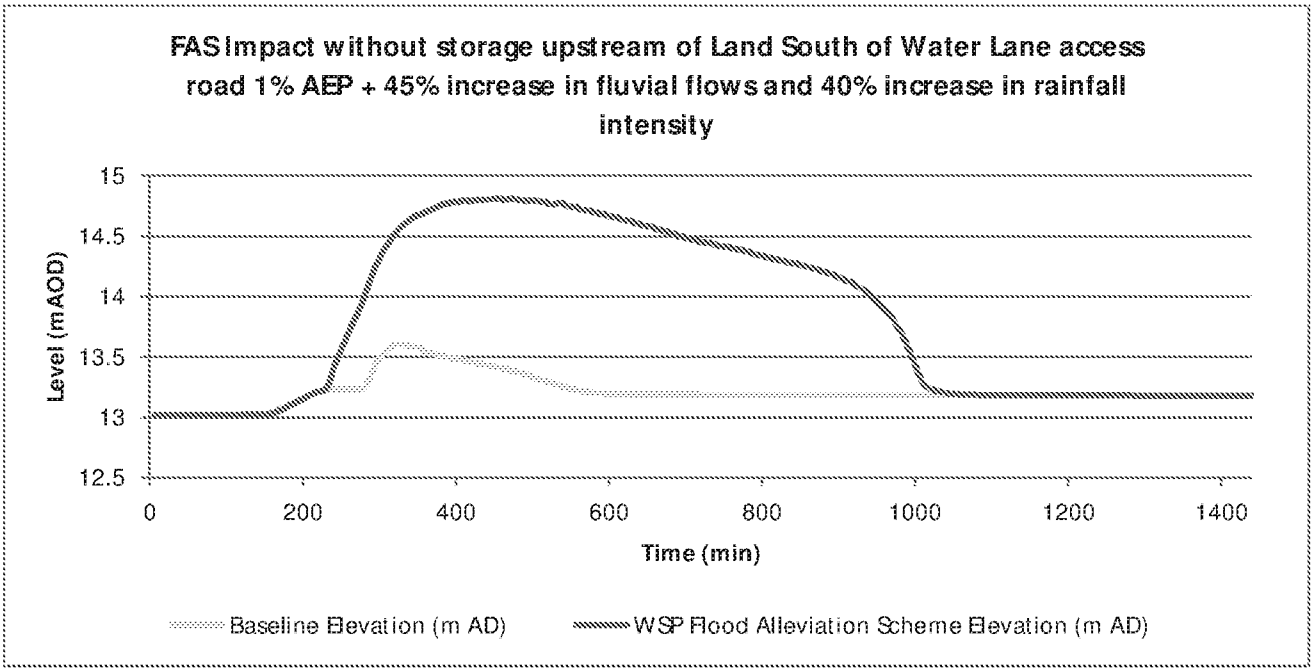


Figure 3-3 Water level hydrograph near the inlet of the A280 culvert

A280 BALANCING POND AREA (UPSTREAM OF WATER LANE, LOCATION C IN FIGURE 1-3)

The introduction of a flow 1.8m^3/s throttle upstream of the inlet of the Water Lane culvert will raise water level in the vicinity of the A280 balancing pond from 12.26m AOD to approximately 13.83m AOD (refer to figure 3-4). The overflow invert level was set to 13m AOD, however, the cross sectional area of the overflow (2.1mX0.8m rectangular culvert) was not enough to pass excess flows downstream. Consequently, the shape of the overflow will need to be slightly adjusted as part of the detailed modelling stage.

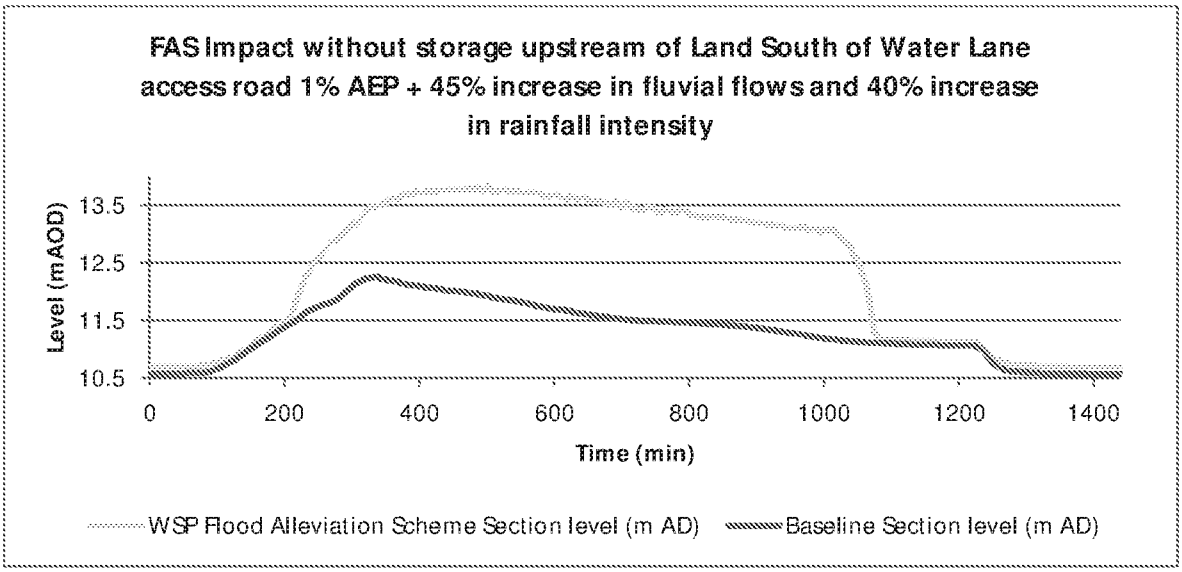


Figure 3-4 Water Level hydrograph near the inlet of the Water Lane culvert

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UPSTREAM OF ACCESS ROAD TO LAND AT SOUTH OF WATER LANE DEVELOPMENT

The throttle and spill mechanism upstream of the access road to the development known as Land South of Water Lane consists of two square 1.3m orifice controls beneath a weir structure.

These could take the form of penstocks that would have a fix setting to maximise the throttling of return period events between 5 years and 75 (or a narrow range) and be opened only for very extreme events such as the 100 year + 45%CC (refer to Figures 1-4 and 1-5). Another option is to have a fully telemetered system whereby the opening of the two penstocks change their opening depending on the storm arriving. Such control system would maximise flood risk reduction in the village however further details of how the system will operate in all conditions needs to be fully assessed. Detailed design and detailed modelling will investigate these options further. Should blockage take place on the two penstocks then the 10m long weir with a crest level of 11.3m will ensure that water levels upstream are maintained to safe levels, without affecting any dwellings or infrastructure.

The culvert beneath the access road is 3.5m wide and 3.0m high and has more than a 0.6m freeboard for the 1 in 100 year plus 45% CC event.

The combined discharge through the 2 main ingress points was set to 1.8m^3/s.

Should throttling take please for the 1 in 100 year plus 45%CC event then water levels upstream would increase to 11.7m AOD (refer to Figure 3-5). Although at this stage it has been assumed that the control gates would be open for this large event, it may be possible to keep them restricting as a level of 11.7m AOD does not affect the upstream dwellings or property, including the proposed Land South of Water Lane. A full review will be needed to ensure that the discharge from the attenuation ponds from this development will not be surcharged, prior to fully incorporating this restriction even for the 100 year plus CC event. An initial check suggested that there will only be minor surcharge.

Engineering drawings received from Stantec indicate that the invert level of the discharge basin serving the development at Land South of Water Lane is situated above the 12m AOD, as such, the impact if storing water up to an elevation of 11.3m AOD will not have a marked impact on these flows, especially when considering the different scales at which the FAS and storage basin operate.

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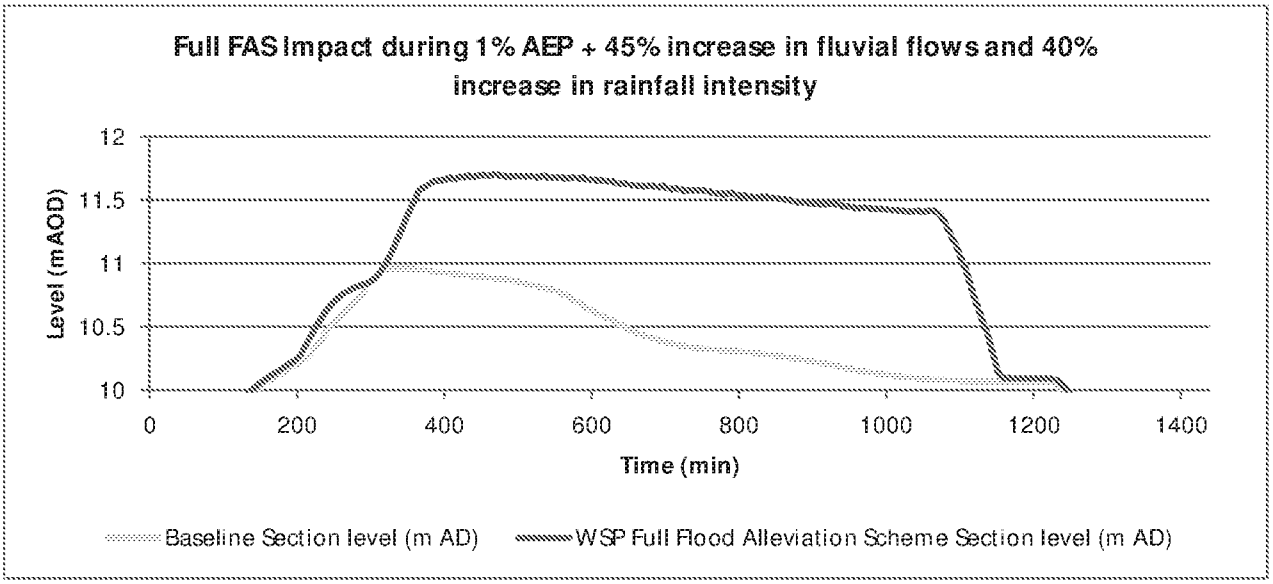


Figure 3.5 – Effect of throttling upstream of the road access to the Land South of Water Lane

UPSTREAM OF ACCESS ROAD TO AVENALS FARM

The discharge limit to the structure running underneath the access road to Avenals Farm was set 1.5m^3/s to match the capacity of the culverted section of the Black Ditch, running underneath Water Lane, before the watercourse starts surcharging the manholes along Water Lane. The overflow for this storage area has an invert level set to 10.3m AOD, while the top of the access road has an elevation of 11.3 – 11.4m AOD. The access road is not overtopped by the stored water situated immediately upstream, and there is little difference between the baseline and LLFA Option 1 during a 1 in 100 year event including the impact of climate change.

3.3 FLOOD RISK PLOTS FOR THE LLFA OPTION 1

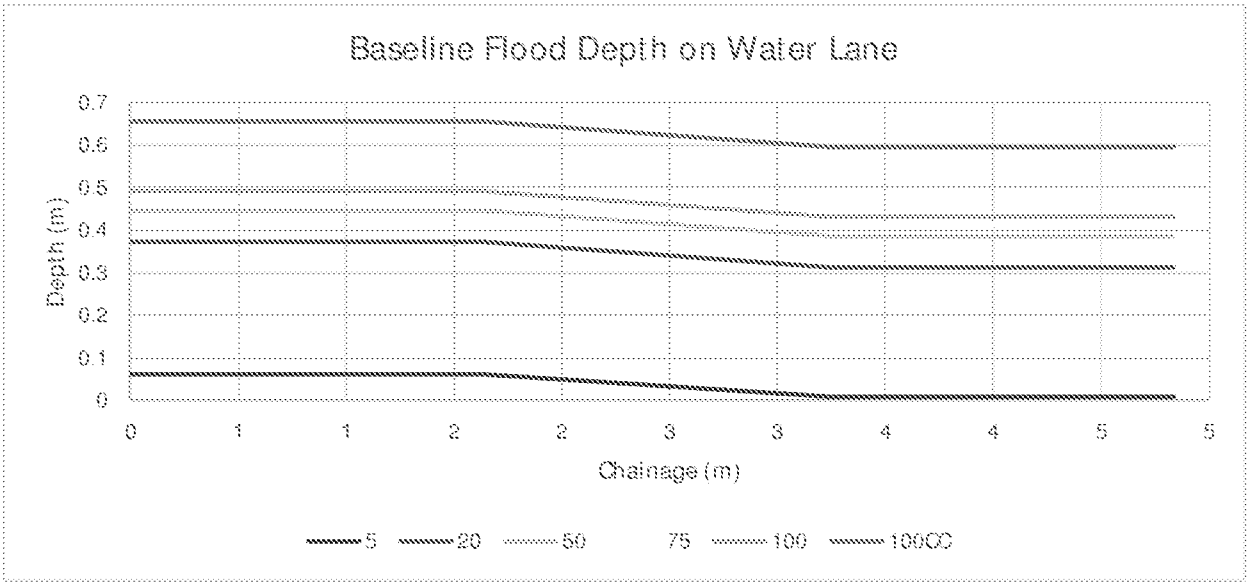
Flood depths were sampled for both the baseline and full flood alleviation scheme scenarios on water lane.

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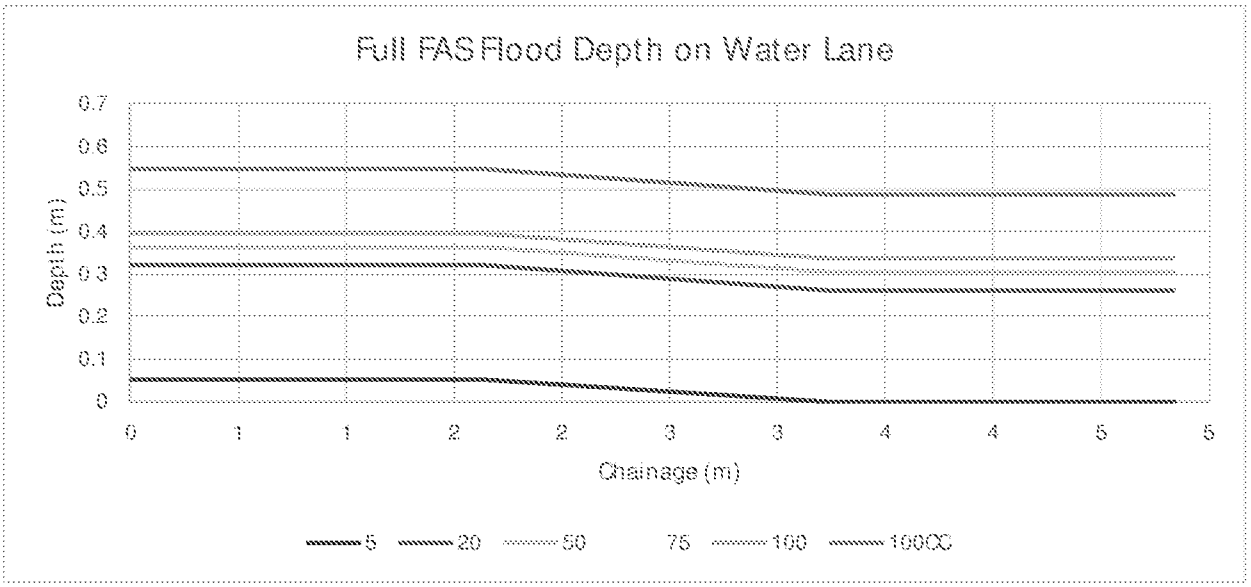
Current modelling results indicate that the reduction in flood depths obtained in the topographical depression along Water Lane are not as significant as water naturally tends to coalesce in the lowest spot.

Return Period	100CC	100	75	50	20	5
Reduction obtained as part of introducing the FAS	0.108	0.097	0.091	0.083	0.05	0.009



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Post implementation of the flood alleviation scheme, water levels on along Water Lane are expected to reduce considerably.



3.4 INTERPRETATION OF THE MODELLING PLOTS.

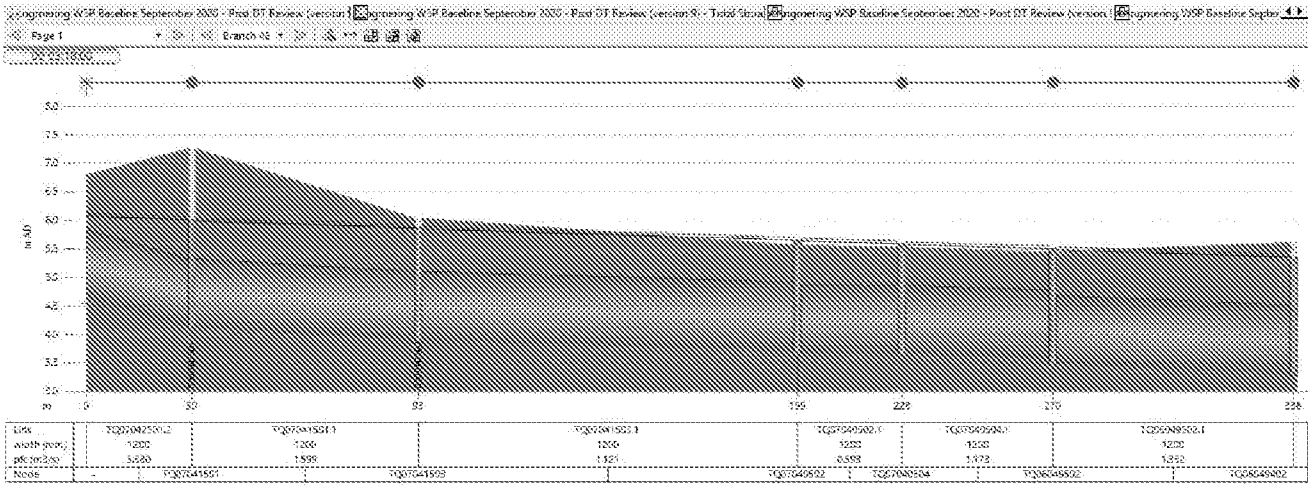
The current iteration of the Angmering flood alleviation scheme reduces flood depths for all events up to the 1 in 100-year event, including the impact of climate change. The benefits of the flood alleviation scheme could be increased by removing sediment depths from the downstream end of the Water Lane culverts. Currently, sediment removal from the pipes was not included in the current iteration of the FAS model.

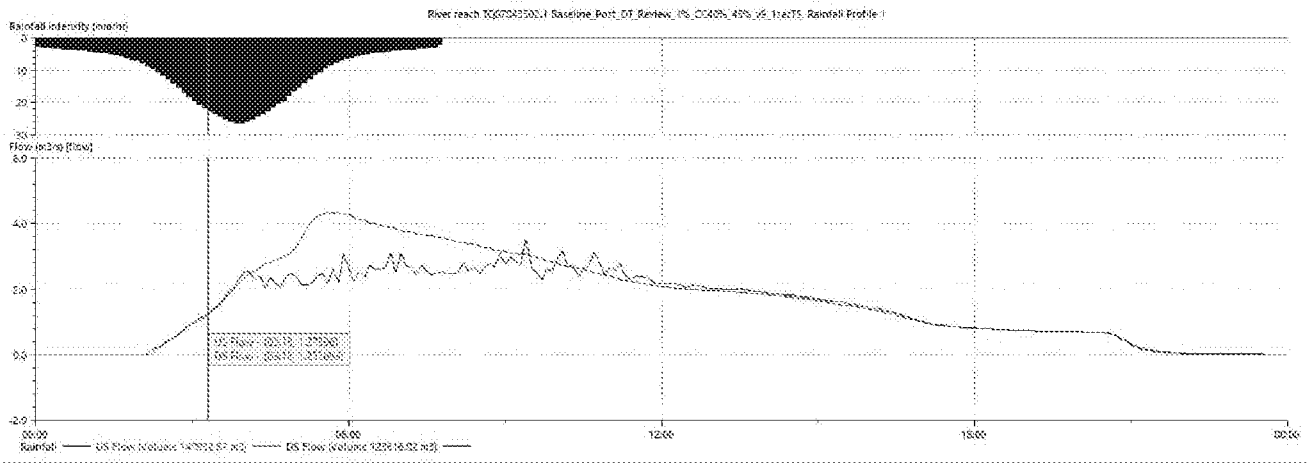
Appendix A provides a many figures from which snapshots have been created for this document, however there is also additional information in terms of return period events, which provide a comprehensive assessment of the study. The 1D part of the model is included as an area in the flood depth maps, as upstream of the proposed new road the 1D had to be widened to avoid model instability problems. This means the flood extents at this location are the addition of the 1D areas plus the 2D flood extents.

3.5 CAPACITY OF THE CULVERTED SECTION OF THE BLACK DITCH UNDER WATER LANE PRIOR TO FLOODING.

The manholes situated along Water Lane flood relatively quickly during a 1 in 100 year storm including the impacts of climate change. The manholes situated on Water Lane start to surcharge once the river channel exceeds 1.2m^3/s – 1.5m^3/s.

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4 CONCLUSION

The flood alleviation scheme has the potential to reduce fluvial flood risk in the village of Angmering by holding back flows originating via the Black Ditch watercourse so that capacity can be created in the downstream part of the culverted section of the Black Ditch running under Water Lane. Surface water flood risk will also be reduced up to certain extent as water levels along the culvert in Water Lane will be reduced.

The introduction of the flood alleviation scheme is expected to provide a reduction in flood depth along Water Lane for a range of return period events.

To progress towards the detail modelling stage, a number of items need to be refined in the current modelling:

- The modelling needs to be refined to include the removal of sediment from the culverted Water Lane section;
- The type and configuration of the FAS flow throttles needs to be assessed;
- The robustness of the calibration need to be checked;
- The robustness of the hydrological assessment needs to be checked.

This assessment confirms that the FAS will not have a detrimental effect on dwellings, including the proposed Land South of Water Lane development.

ARUN DISTRICT COUNCIL A/184/21/PL



Mountbatten House
Basing View
Basingstoke, Hampshire
RG21 4HJ

[redacted]

PUBLIC

507000

104500

N

KEY:

- 1D domain, depth results not mapped

Baseline Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

0 150 300 450 600 m

REV	DATE	DRW	DESCRIPTION	CHK	APP
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CLIENT: WEST SUSSEX COUNTY COUNCIL

ARCHITECT: -

PROJECT: ANGMERING HYDRAULIC FLOOD MODELLING

TITLE: BASELINE FLOOD RISK TO ANGMERING 1 IN 5 YEAR EVENT

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-001.qgz	1:2500	02/10/20

PROJECT No:	DRAWING No:	REV:
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N

KEY:

- 1D domain, depth results not mapped

Baseline Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

0 150 300 450 600 m

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	02/10/20	OB	FIRST ISSUE	OB	BV

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CLIENT: WEST SUSSEX COUNTY COUNCIL

ARCHITECT: -

PROJECT: ANGMERING HYDRAULIC FLOOD MODELLING

TITLE: BASELINE FLOOD RISK TO ANGMERING
1 IN 20 YEAR EVENT

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-002.qgz	1:2500	02/10/20

PROJECT No:	DRAWING No:	REV:
70072274	72274-HMR-002	B

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N

KEY:

- 1D domain, depth results not mapped

Baseline Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

0 150 300 450 600 m

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	02/10/20	OB	FIRST ISSUE	OB	BV

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ARCHITECT: -

PROJECT: ANGMERING HYDRAULIC FLOOD MODELLING

TITLE: BASELINE FLOOD RISK TO ANGMERING
1 IN 50 YEAR EVENT

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-003.qgz	1:2500	02/10/20

PROJECT No:	DRAWING No:	REV:
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N

0 150 300 450 600 m

KEY:

- 1D domain, depth results not mapped

Baseline Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	02/10/20	OB	FIRST ISSUE	OB	BV

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CLIENT: WEST SUSSEX COUNTY COUNCIL

ARCHITECT: -

PROJECT: ANGMERING HYDRAULIC FLOOD MODELLING

TITLE: BASELINE FLOOD RISK TO ANGMERING
1 IN 75 YEAR EVENT

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-004.qgz	1:2500	02/10/20

PROJECT No:	DRAWING No:	REV:
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N

KEY:

- 1D domain, depth results not mapped

Baseline Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

0 150 300 450 600 m

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	02/10/20	OB	FIRST ISSUE	OB	BV

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ARCHITECT: -

PROJECT: ANGMERING HYDRAULIC FLOOD MODELLING

TITLE: BASELINE FLOOD RISK TO ANGMERING
1 IN 100 YEAR EVENT

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
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N

0 150 300 450 600 m

KEY:

- 1D domain, depth results not mapped

Baseline Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

CLIMATE CHANGE ALLOWANCES:
45% INCREASE IN FLUVIAL FLOWS
40% INCREASE IN RAINFALL INTENSITY

REV	DATE	DRW	DESCRIPTION	CHK	APP
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CLIENT:
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ARCHITECT:
-

PROJECT:
ANGMERING HYDRAULIC FLOOD MODELLING

TITLE:
BASELINE FLOOD RISK TO ANGMERING
1 IN 100 YEAR EVENT INCLUDING CLIMATE CHANGE

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-006.qgz	1:2500	02/10/20

PROJECT No:	DRAWING No:	REV:
70072274	72274-HMR-006	B

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104500

N

KEY:

- 1D domain, depth results not mapped

Post Flood Alleviation Scheme Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

0 150 300 450 600 m

REV	DATE	DRW	DESCRIPTION	CHK	APP
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CLIENT: WEST SUSSEX COUNTY COUNCIL

ARCHITECT: -

PROJECT: ANGMERING HYDRAULIC FLOOD MODELLING

TITLE: POST FAS FLOOD RISK TO ANGMERING 1 IN 5 YEAR EVENT

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-101.qgz	1:2500	02/10/20

PROJECT No:	DRAWING No:	REV:
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ARUP DISTRIBUTED FLOOD MODEL

507000

104500

N

KEY:

1D domain, depth results not mapped

Post Flood Alleviation Scheme Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

0 150 300 450 600 m

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	02/10/20	OB	FIRST ISSUE	OB	BV

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ARCHITECT: -

PROJECT: ANGMERING HYDRAULIC FLOOD MODELLING

TITLE: POST FAS FLOOD RISK TO ANGMERING
1 IN 20 YEAR EVENT

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-102.qgz	1:2500	02/10/20

PROJECT No:	DRAWING No:	REV:
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507000

104500

N

KEY:

1D domain, depth results not mapped

Post Flood Alleviation Scheme Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

0 150 300 450 600 m

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	02/10/20	OB	FIRST ISSUE	OB	BV

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CLIENT: WEST SUSSEX COUNTY COUNCIL

ARCHITECT: -

PROJECT: ANGMERING HYDRAULIC FLOOD MODELLING

TITLE: POST FAS FLOOD RISK TO ANGMERING
1 IN 50 YEAR EVENT

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-103.qgz	1:2500	02/10/20

PROJECT No:	DRAWING No:	REV:
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KEY:

1D domain, depth results not mapped

Post Flood Alleviation Scheme Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

0 150 300 450 600 m

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A	02/10/20	OB	FIRST ISSUE	OB	BV

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CLIENT: WEST SUSSEX COUNTY COUNCIL

ARCHITECT: -

PROJECT: ANGMERING HYDRAULIC FLOOD MODELLING

TITLE: POST FAS FLOOD RISK TO ANGMERING
1 IN 75 YEAR EVENT

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-104.qgz	1:2500	02/10/20

PROJECT No:	DRAWING No:	REV:
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104500

N

0 150 300 450 600 m

KEY:

- 1D domain, depth results not mapped

Post Flood Alleviation Scheme Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	02/10/20	OB	FIRST ISSUE	OB	BV

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CLIENT: WEST SUSSEX COUNTY COUNCIL

ARCHITECT: -

PROJECT: ANGMERING HYDRAULIC FLOOD MODELLING

TITLE: POST FAS FLOOD RISK TO ANGMERING
1 IN 100 YEAR EVENT

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-105.qgz	1:2500	02/10/20

PROJECT No:	DRAWING No:	REV:
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507000

104500

N

KEY:

1D domain, depth results not mapped

Post Flood Alleviation Scheme Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

CLIMATE CHANGE ALLOWANCES:
45% INCREASE IN FLUVIAL FLOWS
40% INCREASE IN RAINFALL INTENSITY

0 150 300 450 600 m

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	02/10/20	OB	FIRST ISSUE	OB	BV

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CLIENT: WEST SUSSEX COUNTY COUNCIL

ARCHITECT: -

PROJECT: ANGMERING HYDRAULIC FLOOD MODELLING

TITLE: POST FAS FLOOD RISK TO ANGMERING
1 IN 100 YEAR EVENT INCLUDING CLIMATE CHANGE

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-106.qgz	1:2500	02/10/20

PROJECT No:	DRAWING No:	REV:
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N

KEY:

- 1D domain, depth results not mapped
- FAS Boundary

Post Flood Alleviation Scheme Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

0 150 300 m

REV	DATE	DRW	DESCRIPTION	CHK	APP
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STATUS:

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CLIENT:

WEST SUSSEX COUNTY COUNCIL

ARCHITECT:

-

PROJECT:

ANGMERING HYDRAULIC FLOOD MODELLING

TITLE:

80% BLOCKAGE AT LAND SOUTH OF WATER LANE ACCESS
1 IN 100 YEAR EVENT

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-201.qgz	1:1500	02/10/20

PROJECT No:	DRAWING No:	REV:
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ARUN DISTRICT COUNCIL

507500

N

KEY:

- 1D domain, depth results not mapped
- FAS Boundary

Post Flood Alleviation Scheme Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

CLIMATE CHANGE ALLOWANCES:
45% INCREASE IN FLUVIAL FLOWS
40% INCREASE IN RAINFALL INTENSITY

0 150 300 m

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	02/10/20	OB	FIRST ISSUE	OB	BV

STATUS:
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CLIENT:
WEST SUSSEX COUNTY COUNCIL

ARCHITECT:
-

PROJECT:
ANGMERING HYDRAULIC FLOOD MODELLING

TITLE:
80% BLOCKAGE AT LAND SOUTH OF WATER LANE ACCESS
1 IN 100 YEAR EVENT INCLUDING CLIMATE CHANGE

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-202.qgz	1:1500	02/10/20

PROJECT No:	DRAWING No:	REV:
70072274	72274-HMR-202	B

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506500
507000
507500
105000
104500
104000

N

0 150 300 m

KEY:

- 1D domain, depth results not mapped

1 in 100 Year Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	02/10/20	OB	FIRST ISSUE	OB	BV

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CLIENT:
WEST SUSSEX COUNTY COUNCIL

ARCHITECT:
-

PROJECT:
ANGMERING HYDRAULIC FLOOD MODELLING

TITLE:
SENSITIVITY TESTING
20% INCREASE IN FLOODPLAIN ROUGHNESS
1 IN 100 YEAR EVENT

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
72274-HMR-203.qgz	1:4500	02/10/20

PROJECT No:	DRAWING No:	REV:
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506500
507000
507500
105000
104500
104000

N

0 150 300 m

KEY:

- 1D domain, depth results not mapped

1 in 100 Year Depth (m)

- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00

REV	DATE	DRW	DESCRIPTION	CHK	APP
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CLIENT:
WEST SUSSEX COUNTY COUNCIL

ARCHITECT:
-

PROJECT:
ANGMERING HYDRAULIC FLOOD MODELLING

TITLE:
SENSITIVITY TESTING
20% DECREASE IN FLOODPLAIN ROUGHNESS
1 IN 100 YEAR EVENT

DRAWN:	CHECKED:	APPROVED:

QGIS FILE:	SCALE @A3:	DATE:
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PROJECT No:	DRAWING No:	REV:
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