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Sailing Quality Analysis of Calf Heath Reservoir

The West Midlands Rail Freight Interchange Order 201X

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Four Ashes Limited

West Midlands Interchange

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FOR MARINE TECHNOLOGY AND INDUSTRIAL AERODYNAMICS

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West Midlands Interchange: Sailing Quality Analysis of Calf Heath Reservoir

1 INTRODUCTION

The following report describes a programme of work to study the effects of wind environment changes as a result of potential development to the south and west of the Calf Heath Reservoir. The objective of this study is to quantity the effects that changes in the wind environment will have on sailing activities on the reservoir.

190523 RWDI Project 1901388 Wind Assessment report (referred to as 'RWDI CFD Study' in the remainder of this report), and the data used to create it, have been used as part of this sailing quality analysis. This report should be read in conjunction with the RWDI CFD Study for details of the development scenarios.

The work was conducted broadly in accordance with Wolfson Unit Proposal No. 4822, Phase 1.

2 BACKGROUND

Greensforge Sailing Club is located on the eastern side of the Calf Heath Reservoir and utilises the reservoir for dinghy sailing. Development to the south and west of the reservoir is being considered, as presented in Figure 1.

The proposed development will comprise of a number of low rise warehouse buildings with a maximum height of 30 metres and an earth bund of 7 to 8 metres in height between the development and the reservoir. The exact breakdown of development building distribution has yet to be confirmed, therefore two potential options have used in this study.

Wind directions from South-SouthEast (SSE) to West (W) will result in changes to the air flow over the reservoir due to the addition of structures upwind. RWDI carried out a Computational Fluid Dynamics (CFD) wind assessment study (RWDI CFD Study) for distinct wind directions over this range to predict the wind speed and directions over the reservoir with the existing surrounding (denoted as configuration 1) and two potential surrounding development options (denoted as configurations 2 & 3, or development options A & B) as can be seen in Figure 2.

As a result of conservative assumptions, the CFD modelled development options (C2 and C3) include some buildings that are taller than those that will be proposed, as discussed in page 4 of the RWDI CFD Study.

3 SAILING QUALITY ANALYSIS

The objective of the process is to predict and assess the effects that the adjacent development would have on the quality of the sailing environment on the reservoir in comparison to the existing site surroundings.

No adequate regulatory parameters or guidelines exist that can be used to assess the sailing quality of a particular location across a range of wind speeds, directions and durations of time. Therefore the author has used a number of criteria in order to apply some quantitative parameters to what is a relatively qualitative subject area. Particular attention has been paid to wind speed characteristics that would affect novice sailors as Royal Yachting Association (RYA) sailing courses are conducted on the reservoir. Therefore these criteria relate to the ease with which a novice sailor could sail in a particular condition. Failure to meet the criteria thresholds does not prevent sailing in the associated area or wind condition, but signifies that there will be a challenging element to sailing in that condition, and a resulting in a potential lowering of enjoyment.

The following criteria have been used as the basis for sailing quality assessments for other sailing locations with adjacent developments, such as the Former Westferry Printworks Development, Isle of Dogs, London.

https://www.london.gov.uk/sites/default/files/westferry_reg22_a3_volume.pdf

3.1 Criteria

The criteria to be satisfied are:

- Local wind speed to be within a range of 3- 9 knots
- Change of wind speed between locations of no greater than 30%

  A wind speed change of 30% between adjacent measurement locations within 20 metres
- Change of wind direction of no greater than 20˚ between adjacent points

  A direction change of 20˚ between adjacent measurement locations within 20 metres

These criteria are applied to each measurement point location and wind angle and are combined using the following method 3.2. The resulting outputs of the analysis are:

- Percentage (%) of time that 'good' sailing quality is achieved for a particular point location when the wind is in the SSE – W direction range
- Average of the point locations sailing quality (%) results for an particular area with the wind in the SSE – W direction range

A percentage time reduction of 15% (i.e. Configuration 1 (C1) (%) minus alternative configuration (%)) of good sailing quality conditions is deemed as having a 'significant' impact upon a specific sailing area.

This threshold was agreed as being reasonable following a peer review process by BRE Wind Engineering and it uses a more precautionary approach to that applied in the original work carried out as part of the Westferry Printworks Development (referenced in 3). It is important to note that the 15% threshold relates to a reduction in the time the conditions are not met, but this does not necessarily preclude the ability to sail.

3.2 Method

The reservoir has been simplified to a grid of points, with spacing 5 metres in the longitude and latitude axes and matched to data sample points in the RWDI CFD Study.

The above (3.1) criteria have been applied to each of the discrete wind angle data sets from the RWDI CFD Study and combined with wind rose data (summarised in Figure 3) to estimate the proportion of 'good' (criteria satisfied) sailing quality time, displayed as a % of total time when the wind is within the SSE to W range. Figure 5 provides a schematic breakdown of the sailing quality analysis.

A 'significant' exceedance of the combined criteria is based on a threshold of 15% (relative reduction in time when the sailing quality criteria are not met between configurations). This is applied as a quantitative measure beyond which a significant impact on sailing for novice sailing would occur.

It must be borne in mind that the wind is predicted on average to be within the SSE to W angle range 53% of time, based on an annual average (Figure 3). This study has focussed on the SSE – W directions as it is the range where the proposed development would have an aerodynamic impact on the reservoir and where the

sailing club has indicated the preferable sailing conditions. It is possible to sail across the entire range of wind directions (i.e. from West clockwise round the wind rose to South SouthEast) and the proposed development is predicted to have minimal impact at these remaining wind directions, which is for 47% of the time.

The sailing quality evaluation of a sailing area comprises of two sets of results; the first, the sailing quality at a particular point location (5 metre increments); the second, the individual increments are combined to calculate average values for the entire reservoir.

A reference wind speed height of 3 metres above the reservoir surface has been used in this analysis, this is within a representative range appropriate for single and double handed dinghies.

The sailing club have indicated areas where they tend not to sail, shown in Figure 4; these have not been included as part of the analysis.

3.3 Results

The results from the analysis have been summarised Figure 6 - Figure 8, which present the percentage of sailing quality, i.e. the percentage of time whilst the wind is in a SSE to W direction and is conforming to the 'good' sailing condition criteria, as detailed in section 3.1.

Table 1 presents the sailing quality results averaged over the reservoir and are expressed as a percentage and with the ratio of sailing quality compared to the configuration 1: existing surrounding site.

3.4 Discussion

The average sailing quality of the existing surrounding site (C1) is 19.7% which is relatively low due to surrounding tree cover which lowers the mean wind speed to the southern boundary. The increase in sailing quality towards the centre and northern areas of the reservoir can be seen in Figure 6, where the mean flow has overcome the sheltering of the trees. It has to be borne in mind that the wind environment on the existing site is "not ideal" from the perspective of clean, un-interrupted wind flow. This is not unusual for an inland sailing environment, which often have trees on the boundaries, as can be seen from the images of one such comparison, Spinnaker Sailing Club, Ringwood, Hampshire, in Figure 9.

The sailing quality is reduced for both development options (C2 and C3) with 16.5% and 15.6% average sailing quality respectively.

When compared relative to C1 there is a reduction of 3.2% and 4.1% (i.e. C1 (%) minus C2 or C3 (%)), respectively, in overall (reservoir averaged) sailing quality for the two development options (Table 1), which is the reduction in good sailing quality conditions whilst the wind is within the SSE to W direction range.

These reductions result, in general, from a combination of lower local wind speed which invokes the lower wind speed limiting criteria and greater local variation in wind speeds that invoke the change in wind change criteria.

Figure 10 and Figure 11 present the effect of the two development options (C2 & C3) respectively with respect to C1 (the existing site) and highlight the local differences (i.e. . Red signifies a reduction in quality compared to C1 (existing) and green an increase in quality for C2 or C3 (the development options). The notable differences are:

- C2 (development option A) has a reduction in the sailing quality in the central portion of the reservoir whilst showing improvements to the north and north-western zones.
- C3 (development option B) has a general reduction in sailing quality in the central/northern portions, with improvements to the west and south-western zones.

Figure 12, Figure 13 and Table 2 present the results for the area which has the most favourable sailing conditions when the wind is from a SSE – W direction. When compared relative to C1 there is an averaged reduction of 7.3% and 10.1%, respectively. This is predicted to have a noticeable effect upon this particular area, but not significant.

Both development options are predicted to result in local or point reductions in sailing quality which are significant (i.e. in excess of 15% delta) resulting from the proposed C2 or C3 options, as can be seen in Figure

14 and Figure 15. The percentage of usable sailing area affected is 11.3% and 13.5% for C2 and C3, respectively. This will make it more challenging for novice sailors to navigate those zones due to a combination of lower wind speeds making transiting slower and more difficult to assess wind direction; and larger variation in wind speed and direction during navigation that will be more onerous to react to. This will increase the demands upon a sailor, especially those new to sailing. It should be noted that despite this lowering of the sailing quality for C2 and C3, sailing will still be possible in the affected areas when the wind direction is in the SSE – W range.

Most sailing is expected to take place in the central and northern areas of the reservoir during SSE to W wind directions and this is where the most detrimental effects (from a sailing quality perspective) of the development options are predicted to occur.

The sailing quality analysis identifies the zones circled in Figure 4 as being of low quality, primarily due to low wind speeds in the SSE to W wind directions. This is supported by the experience of the sailing club which reports that these areas are avoided in SSE to W wind conditions.

A point to note is that the aerodynamic impact of the maturing existing tree line adjacent the South West edge of the reservoir will change with time. This has not been addressed in this analysis.

4 CONCLUSIONS

The analysis shows that the wind environment in the wind direction range of SSE to W over the reservoir will change as a result of either of the potential development options tested, with an overall reduction in the sailing quality. When viewed as an average over the reservoir, the sailing quality difference is predicted to be modest, with significant localised reductions predicted within the central/north portion of the reservoir. These localised changes (which can be seen in the zones highlighted in Figure 14 and Figure 15) affect 11.3% and 13.5% of the usable sailing area for C2 and C3, respectively. It will be more challenging for novice sailors to navigate those zones due to a combination of; lower wind speeds making transiting slower and more difficult to assess wind direction; and larger variation in wind speed and direction during navigation that will be more onerous to react to. Despite this lowering of the sailing quality for C2 and C3, sailing will still be possible in the affected areas when the wind direction is from the SSE – W.

Configuration 2 (development option A) has a lower impact on the sailing quality over the reservoir in comparison to Configuration 3 (development option B).

5 BIBLIOGRAPHY

RWDI. (n.d.). *190321 RWDI Project 1901388 - West Midlands Interchange - Wind Assessment (Draft).pdf.*

6 TABLES

		Sailing Quality averaged over reservoir (%)	Ratio to Config. 1
C1	Existing Site	19.70	1.000
C2	Development Option A	16.53	0.839
C3	Development Option B	15.55	0.790

Based on wind direction SSE to W range

Table 1 Sailing quality results averaged over reservoir

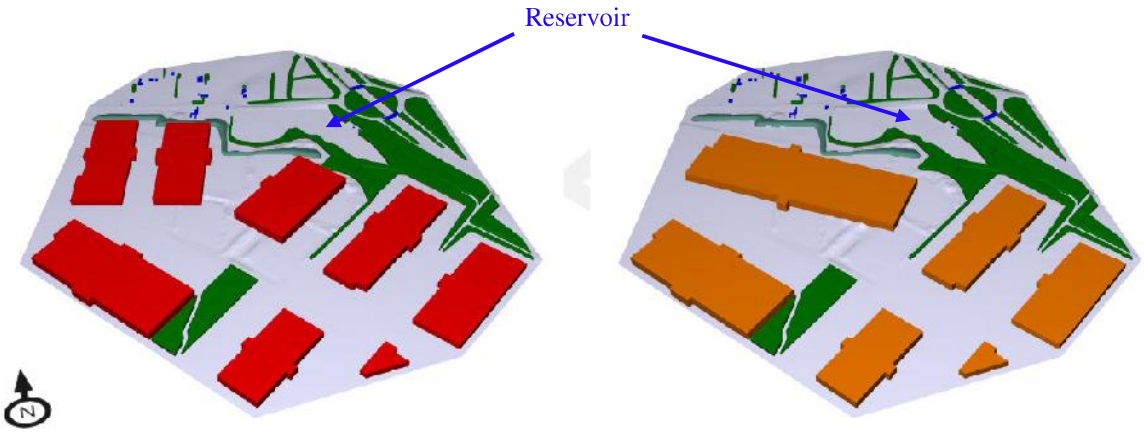
		Sailing Quality averaged over localised area (%)	Ratio to Config. 1
C1	Existing Site	38.19	1.000
C2	Development Option A	30.91	0.809
C3	Development Option B	28.07	0.735

Based on wind direction SSE to W range

Table 2 Sailing quality results averaged over localised area, as per Figure 12 and Figure 13

7 FIGURES

Figure 1: Map (and photo) of the reservoir and the proposed development zone



Option A **Option B**

Figure 2 Models of potential development scenarios (RWDI CFD Study), Development option A and B

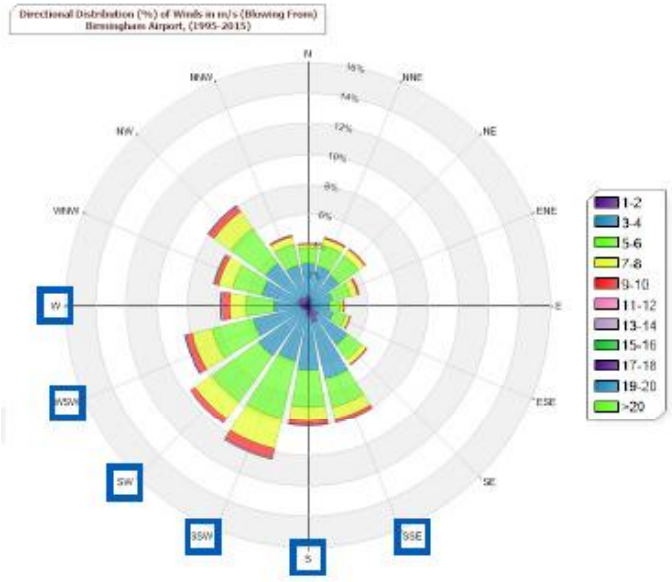


Figure 3 Wind rose: Wind distribution data from Birmingham Airport (1995-2015) (RWDI)

Figure 4 Zones typically avoided by sailors with the existing surroundings

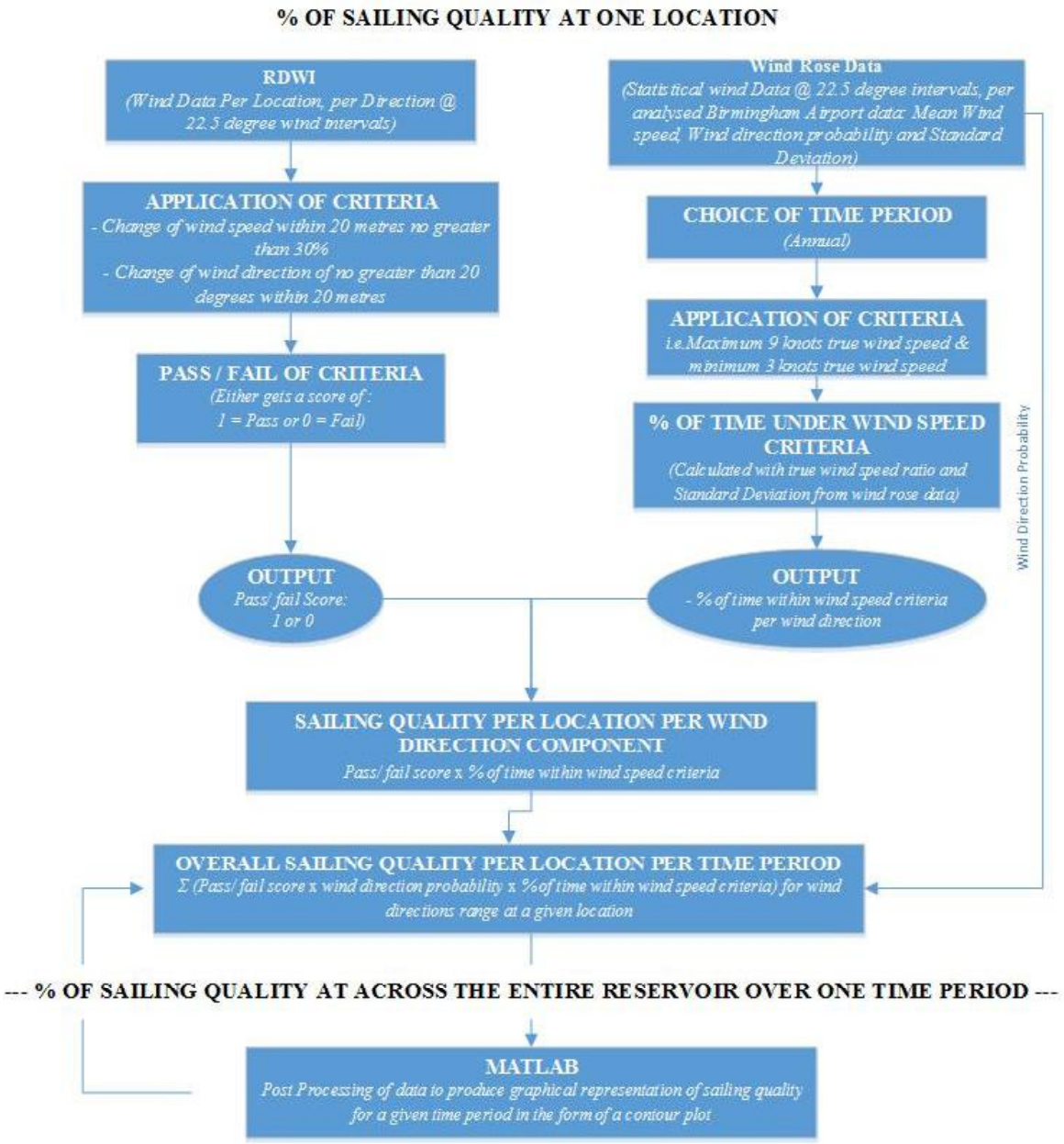


Figure 5 Breakdown of sailing analysis process

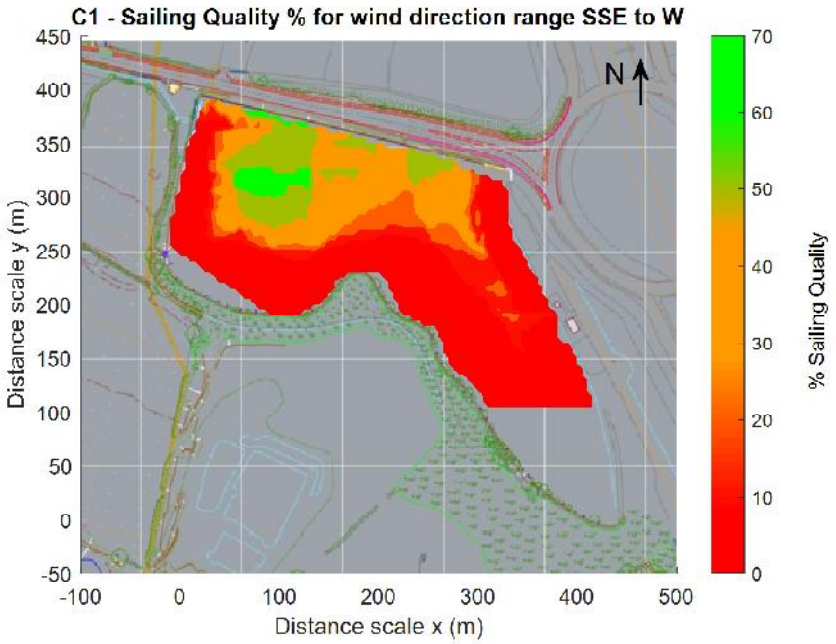


Figure 6 Configuration 1 (EXISTING SURROUNDINGS): Sailing Quality (%)

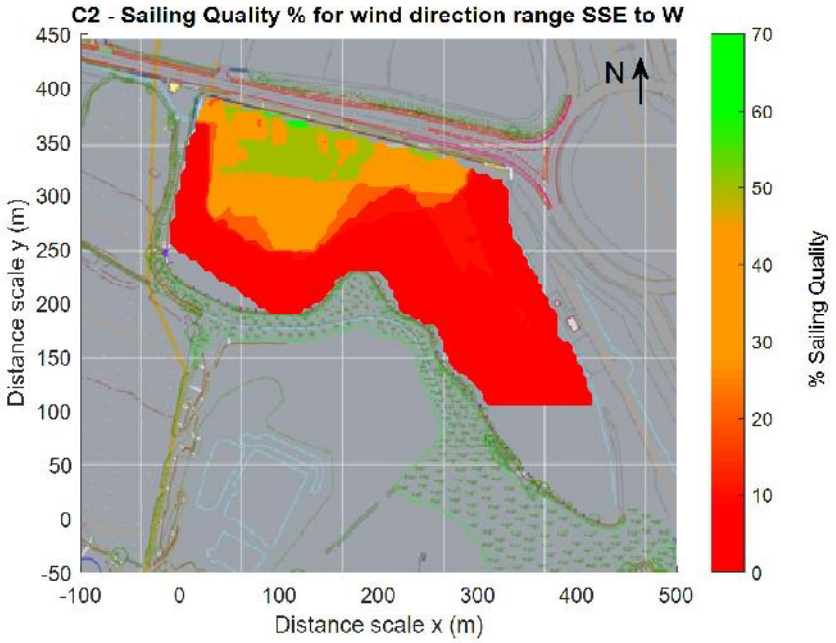


Figure 7 Configuration 2 (DEVELOPMENT OPTION A): Sailing Quality (%)

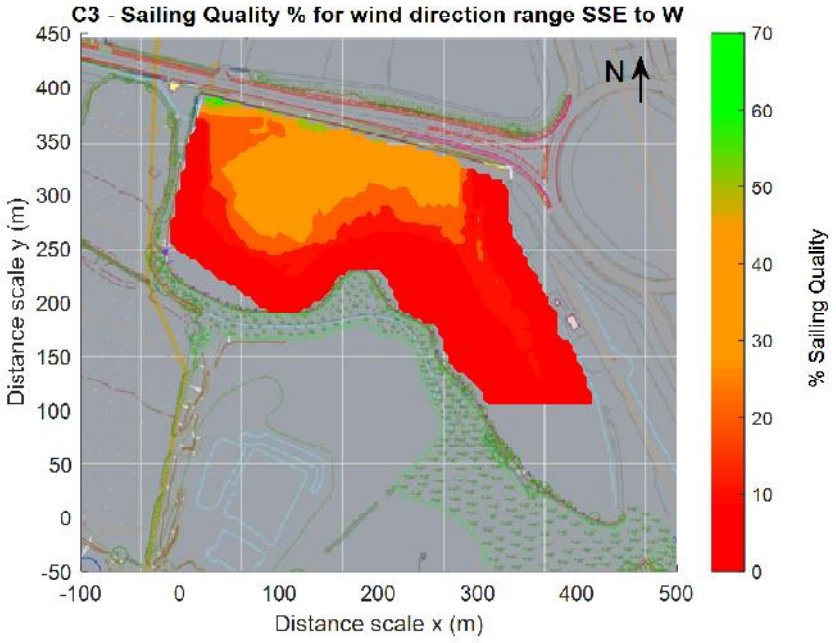


Figure 8 Configuration 3 (DEVELOPMENT OPTION B): Sailing Quality (%)

Figure 9 Example of similar inland sailing lake

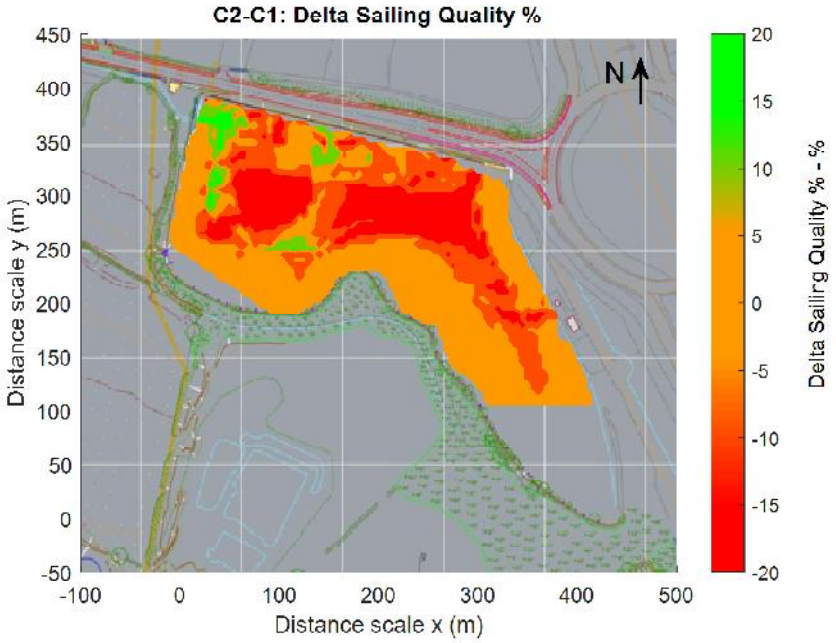


Figure 10 Effect of development option A

Configuration 2 minus Configuration 1: Delta Sailing Quality

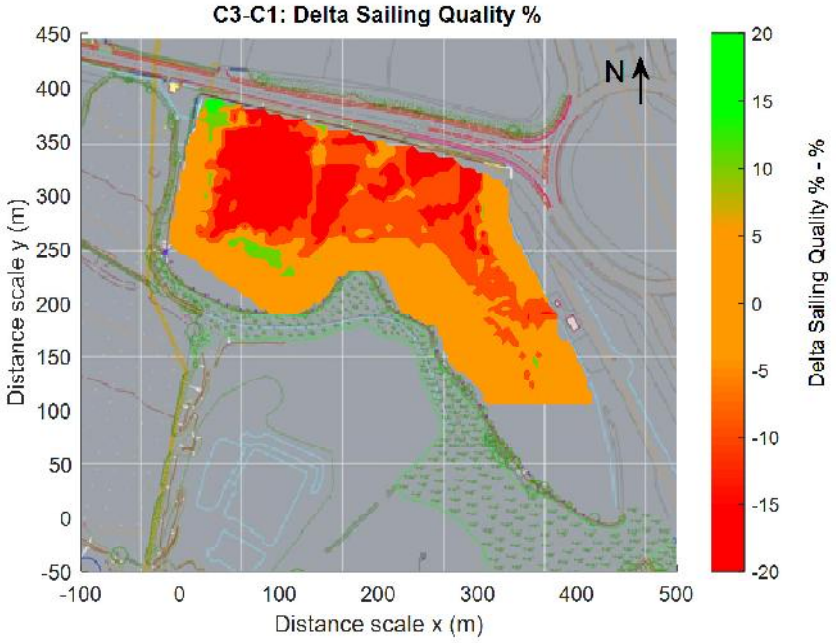


Figure 11 Effect of development option B

Configuration 3 minus Configuration 1: Delta Sailing Quality

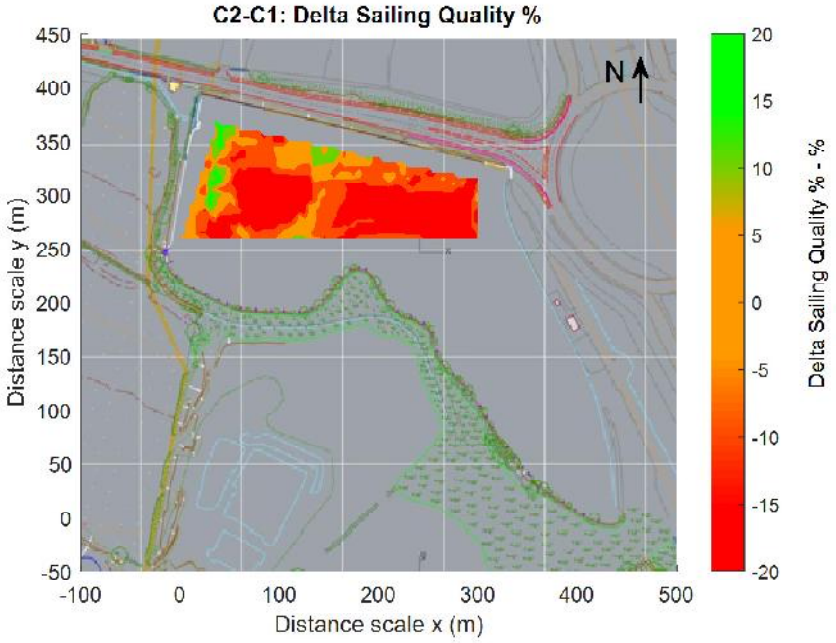


Figure 12 Effect of development option A

Localised Area: Configuration 2 minus Configuration 1: Delta Sailing Quality

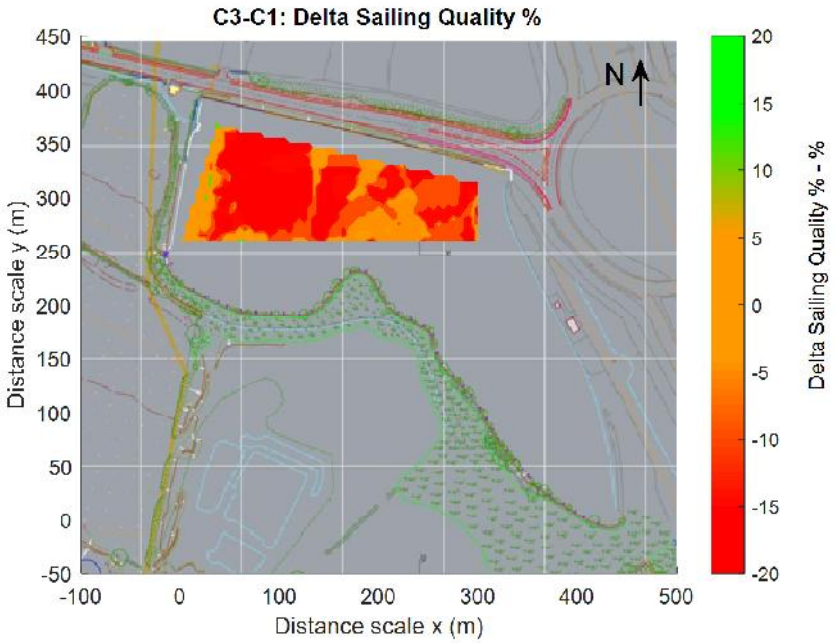


Figure 13 Effect of development option B

Localised Area: Configuration 3 minus Configuration 1: Delta Sailing Quality

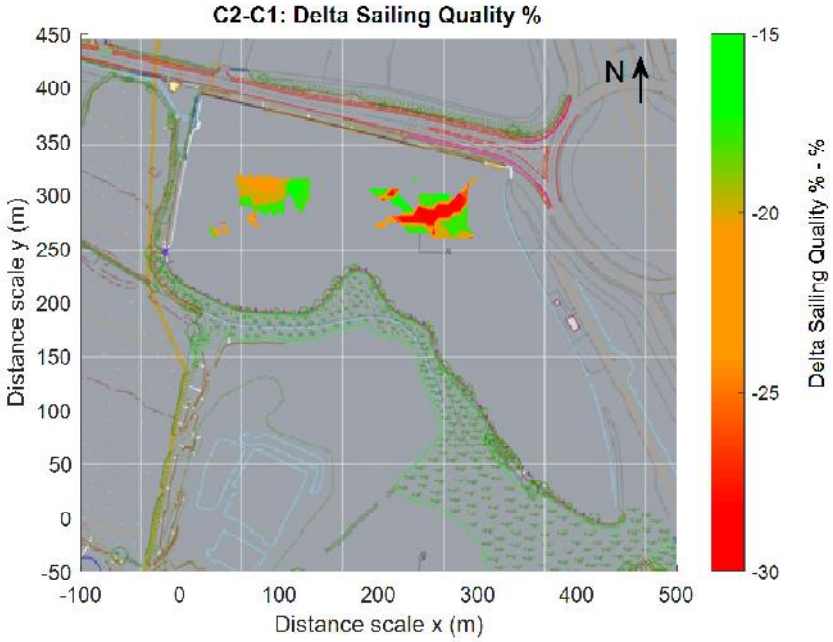


Figure 14 Effect of development option A

Zones in excess of 15% Delta: Configuration 2 minus Configuration 1: Delta Sailing Quality

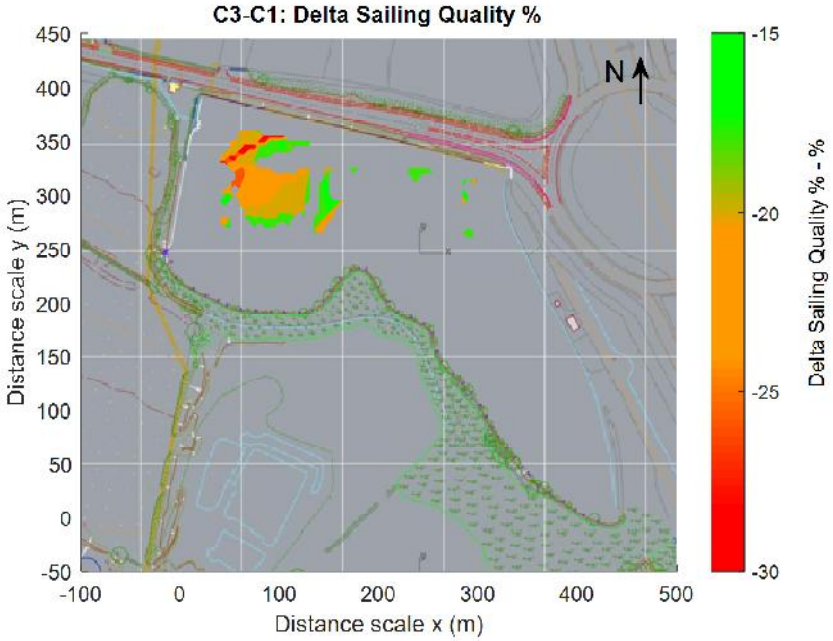


Figure 15 Effect of development option B

Zones in excess of 15% Delta: Configuration 3 minus Configuration 1: Delta Sailing Quality