Appendix C Wave Modelling

C.1 Overview

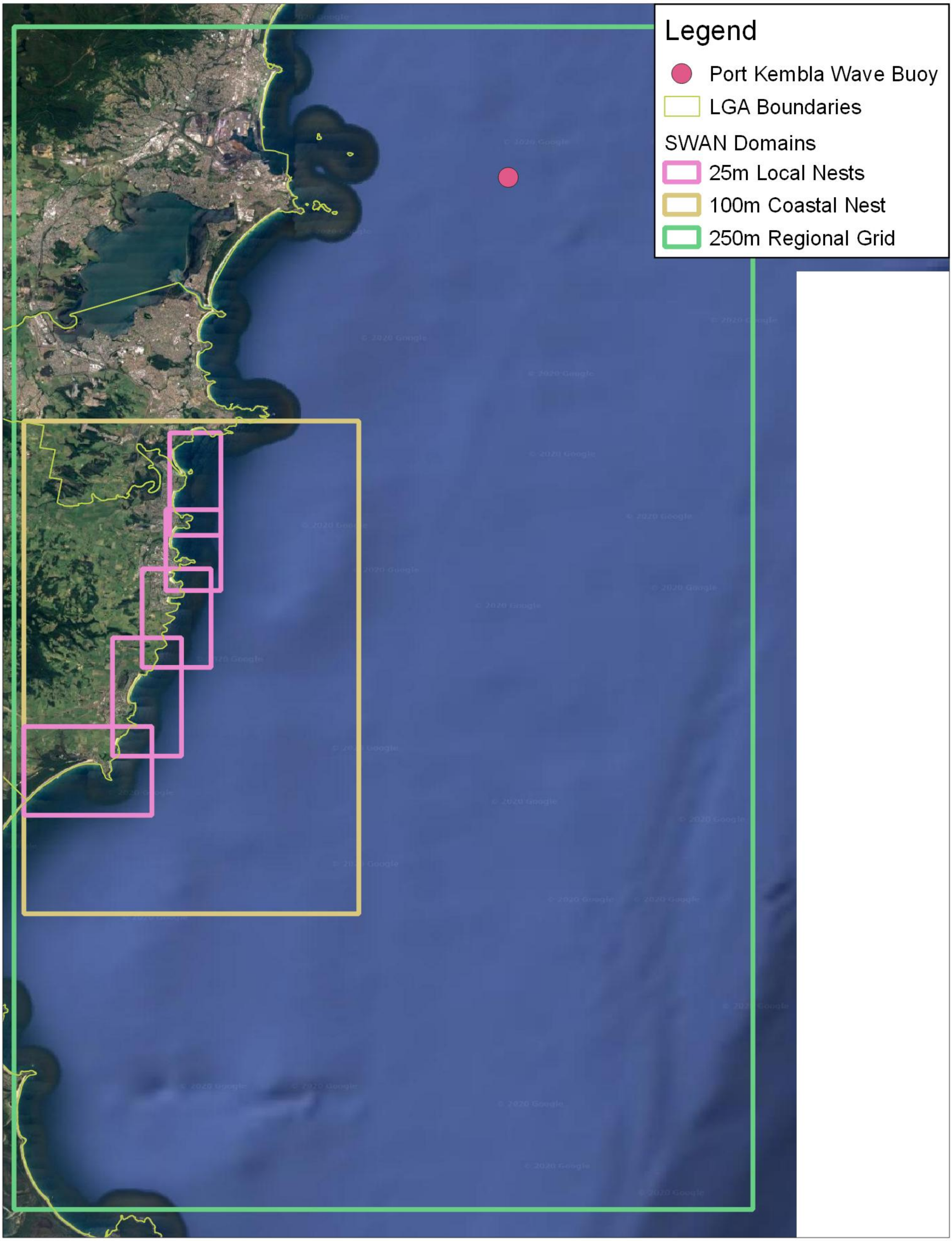
A wave model has been developed using the SWAN modelling package for the open coast Kiama area in order to translate offshore wave conditions (as recorded at the Port Kembla wave buoy) into the nearshore. SWAN (Delft University of Technology, 2006) is a third-generation spectral wave model, which can simulate the generation of waves by wind, dissipation by white-capping, depth-induced wave breaking, bottom friction and wave-wave interactions in both deep and shallow water. SWAN simulates wave/swell propagation in two-dimensions, including shoaling and refraction due to spatial variations in bathymetry and currents. This is a global industry standard modelling package that has been applied with reliable results to many investigations worldwide.

C.2 Grid Extents and Bathymetry

Several separate rectilinear grids have been developed to provide increasing resolution from offshore shelf conditions into nearshore areas. These grids are shown in Figure C-1, and span a 250m resolution regional extent, a 200m local extent, and five 25m resolution grids resolving the nearshore areas and small bays.

Bathymetry has been interpolated onto these domains based on the following sources (in order of precedence):

- NSW Marine LiDAR from 2018 (DPIE, 2018)
- Electronic Navigation Chart (ENC) Data for offshore areas, from the Australian Hydrographic Service AusENC Dataset.



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SWAN Wave Model Domains

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C.3 Simulations

Offshore wave conditions at the Port Kembla wave buoy were applied as boundary conditions to the SWAN model to transform these into nearshore conditions.

The 100-year and 20-year ARI wave conditions at the Port Kembla buoy were taken from the Extreme Value Analysis conducted by WRL (WRL, 2011). The 6-hour wave conditions were applied as they are likely to coincide with a high tide. The equivalent ARI storm tide level was applied to the SWAN model, which is likely to be a conservative estimate as the return intervals for storm tide and waves are not perfectly correlated. Wave periods were applied based on reviewing the peak periods of historical storm events as reported by WRL. The adopted offshore conditions are shown in Table C-1. The nested SWAN models were used to transfer the offshore ARI conditions inshore to the study area. The ARI conditions were applied from the offshore boundaries of the regional model domain in 22.5 degree directional increments.

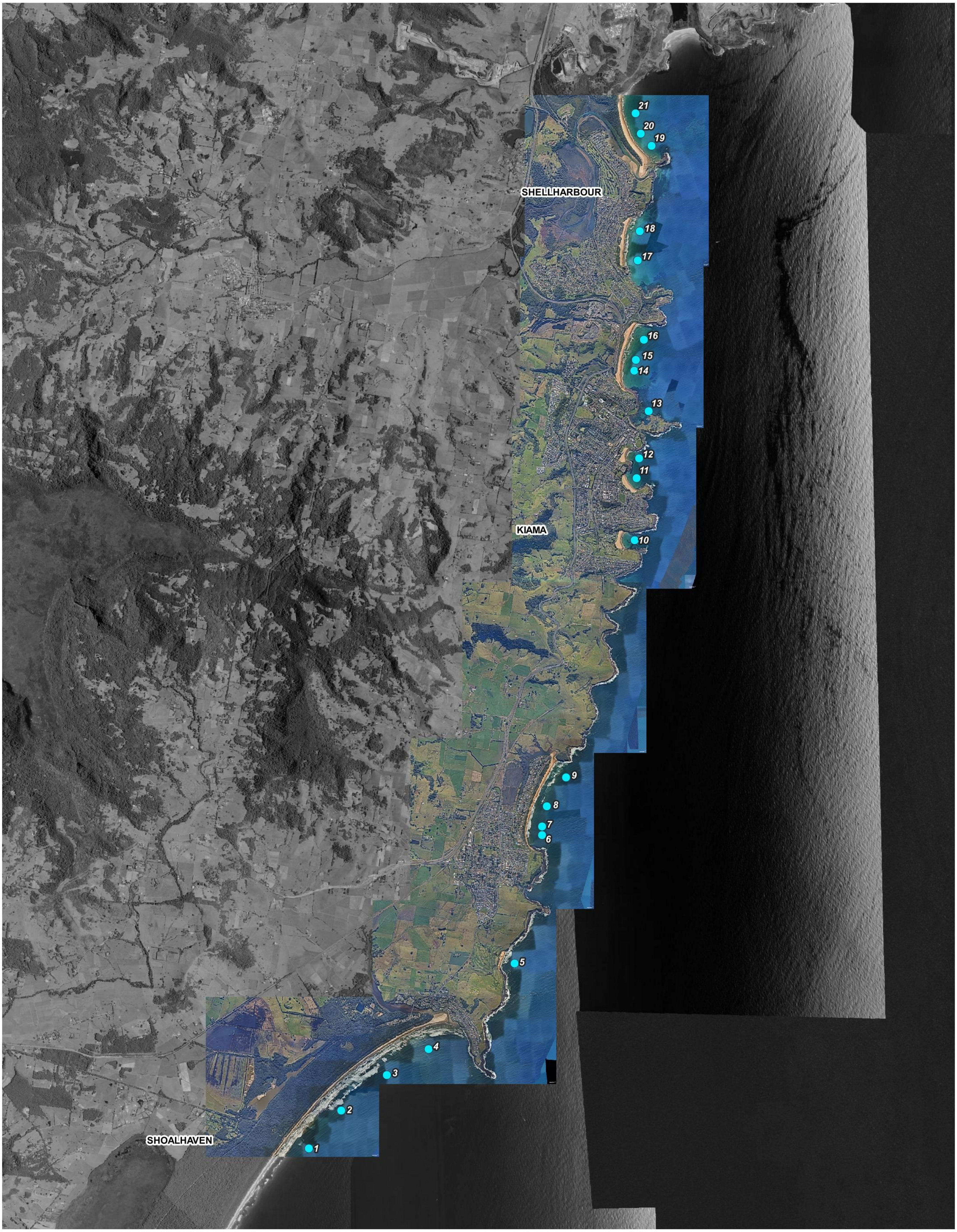
Table C-1 Modelled Offshore Wave Conditions (Port Kembla Buoy)

ARI	Significant Wave Height (m)	Peak Wave Period (s)
20-year	6.9	12.5
100-year	7.9	12.5

Directional model outputs were interrogated at the 21 inshore locations shown in Figure C-2. At each location and for each ARI, the maximum inshore wave height from across the range of offshore directional scenarios was stored. The inshore model outputs were then multiplied by directional weightings based on the percentage of incoming waves from the given directions (refer Table C-3) to develop a representative inshore wave height to use in the runup calculation.

A summary of the representative inshore wave transformation results is provided in Table C-2.

The directional wave outputs were also used to develop relative weightings of wave energy penetration (as approximated by the square of the significant wave height, H_s^2) to develop erosion scaling factors for each beach based on its exposure level. The larger of the effective weightings was adopted from the 20-year and 100-year outputs. The application of these weightings is described in Appendix A (A.2.2).



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Wave Model Output Locations

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Wave Model Output Locations

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Table C-2 Inshore Wave Transformation Results

ID	20 year ARI		100 year ARI	
	Significant Wave Height (m)	Peak Wave Period (s)	Significant Wave Height (m)	Peak Wave Period (s)
1	4.20	12.62	4.49	12.65
2	4.09	12.62	4.36	12.64
3	3.56	12.59	3.84	12.61
4	3.00	12.61	3.27	12.63
5	4.40	12.63	4.65	12.66
6	4.25	12.63	4.49	12.65
7	4.24	12.62	4.51	12.65
8	4.38	12.63	4.70	12.66
9	4.57	12.64	4.89	12.66
10	3.37	12.64	3.73	12.66
11	3.04	12.63	3.45	12.65
12	4.36	12.66	4.72	12.68
13	2.99	12.64	3.37	12.65
14	4.18	12.65	4.46	12.68
15	4.27	12.65	4.56	12.67
16	4.37	12.65	4.68	12.68
17	3.94	12.63	4.27	12.65
18	4.18	12.62	4.51	12.65
19	2.32	12.56	2.57	12.59
20	2.61	12.61	2.82	12.63
21	2.93	12.61	3.18	12.64

Table C-3 Directional Weightings

Direction	0	22.5	45	67.5	90	112.5	135	157.5
Weighting	0.296	0.174	0.083	1.213	12.725	28.837	18.923	12.352
Direction	**180**	**202.5**	**225**	**247.5**	**270**	**292.5**	**315**	**337.5**
Weighting	11.113	8.918	4.459	0.5	0.091	0.022	0.109	0.187