

# The Skerries, Anglesey

## Metocean Study

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## Summary

The Skerries, Anglesey

Metocean Study

Report EX 6000

April 2009

*Marine Current Turbines* (MCT) Ltd are proposing to build a tidal array off the north-western coast of Anglesey, North Wales and require a metocean study. The proposed tidal array site, referred to as *The Skerries*, is within an area between the Skerries islands and the north-western tip of Anglesey. The Skerries consist of a series of outcropping islands. This region is characterised by high tidal currents (in excess of 3m/s), which makes it one of the most energetic areas around the coast of Britain, with good tidal stream energy potential. The proposed tidal array will comprise up to 10 machines rated at 1.2MW, similar to the SeaGen machine installed in Strangford Lough in Northern Ireland in 2008.

This report presents detailed predictions of water level, wind and wave data for the site to support detailed design of the proposed turbine array. The following deliverables are presented:

- normal astronomical and extreme water levels
- monthly and annual wind climates
- annual directional extreme wind conditions
- monthly omni-directional extreme wind conditions
- monthly and annual wave climates
- monthly and annual individual wave climates
- annual directional extreme wave conditions
- monthly omni-directional extreme wave conditions

The tidal resource assessment is the subject of a separate document (Reference 1).

A review was carried out to determine normal astronomical and extreme water levels at the site. As an example, the 1 and 50 year extreme water levels, excluding sea level rise, were predicted as 6.61mCD and 7.21mCD.

The wind climates and extremes presented are based on the wind data from the UK Meteorological Office European wave model. As an example, the 1 and 50 year extreme wind speeds were predicted as 27.1m/s and 33.7m/s.

Wave conditions in the area of the proposed tidal array were predicted using a validated SWAN spectral wave model, which included the effects of the local bathymetry and tidal currents. As an example, extreme wave conditions for 1 and 50 years were predicted as being significant wave heights of 5.9m and 6.9m respectively. The largest waves approach from the north and from the west.



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# 1. Introduction

## 1.1 BACKGROUND

*Marine Current Turbines* (MCT) Ltd are proposing to build a tidal array off the coast of Anglesey, North Wales and require a metocean study. The tidal array will comprise up to 10 machines rated at 1.2MW, similar to the SeaGen machine installed in Strangford Lough in Northern Ireland in 2008.

The proposed tidal array site, referred to as *The Skerries*, is within an area of 8 km<sup>2</sup> between the Skerries islands and the north-western tip of Anglesey (Figure 1). The Skerries consist of a series of outcropping islands situated off the north-western coast of Anglesey, Wales. This region is characterised by high tidal currents (in excess of 3m/s), which makes it one of the most energetic areas around the coast of Britain, with good tidal in-stream energy potential.

The purpose of the study described in this report is to provide metocean data to enable the structures to be designed against both extreme loading and fatigue loading (wave and wind), and to enable the installation contractor to plan the marine operations and obtain the necessary environmental classification for the installation vessels.

The proposed locations of the tidal devices are shown in Figure 1 and their coordinates given in Table 1 and Table 2. For the purpose of this study, MCT specified a single location in the centre of the area of interest (labelled wave prediction point in Figure 5) where metocean parameters have been predicted. The easting and northing of this point are given in Table 3.

The tidal resource assessment is the subject of a separate document (Reference 1).

## 1.2 REPORT OUTLINE

Section 2 of this document reports on water level conditions at The Skerries, Section 3 reports on wind conditions and Section 4 on wave conditions. Section 5 concludes this report with recommendations, while Section 6 presents the list of references used in this study.

## 1.3 SCOPE OF WORK – DELIVERABLES

The following table lists the deliverables. For easy reference, the last column of this table refers to the relevant Tables and Figures containing the results.

| <b>Deliverable</b> | <b>Result presentation</b>   | <b>Results found in</b>  |
|--------------------|--|--|
| Water levels       | <ul style="list-style-type: none"> <li>• Tidal levels / amplitudes <ul style="list-style-type: none"> <li>○ Highest Astronomical Tide (HAT)</li> <li>○ Mean High Water Springs (MHWS)</li> <li>○ Mean High Water Neaps (MHWN)</li> <li>○ Mean Sea level (MSL)</li> <li>○ Mean Low Water Neaps (MLWN)</li> <li>○ Mean Low Water Springs (MLWS)</li> <li>○ Lowest Astronomical Tide (LAT)</li> <li>○ Mean Spring Range (MSR)</li> <li>○ Mean Neap Range (MNR)</li> </ul> </li> <li>• Extreme still water levels including tidal and surge effects <ul style="list-style-type: none"> <li>○ All-year values for return periods of 1, 5, 10, 50 and 100 years</li> <li>○ Factors to estimate month dependent extreme sea levels</li> </ul> </li> </ul> | <p>Table 6</p> <p>Table 8</p> <p>Table 9</p>   |
| Wind climates      | <ul style="list-style-type: none"> <li>• Joint frequency distribution of wind speed and direction <ul style="list-style-type: none"> <li>○ Values at 10m above still water level</li> <li>○ All-year and monthly climates</li> <li>○ All-year wind rose</li> </ul> </li> </ul>   | <p>(3-hourly values)</p> <p>Table 11 and Appendix 2<br/>Figure 2</p>                                     |
| Wind extremes      | <ul style="list-style-type: none"> <li>• Extreme wind speeds <ul style="list-style-type: none"> <li>○ Hourly-average and gust speed values at 10m above still water level</li> <li>○ All-year values for return periods of 1, 5, 10, 50 and 100 years and for N, NE, E, SE, S, SW, W, NW directions</li> <li>○ Monthly values for return periods of 1, 5, 10, 50 and 100 years (all directions)</li> </ul> </li> </ul>   | <p>(3-hourly values - adjustment factors of 1.04 and 1.55 suggested)</p> <p>Table 12</p> <p>Table 13</p> |
| Wave climates      | <ul style="list-style-type: none"> <li>• Joint frequency distribution of significant wave height and direction <ul style="list-style-type: none"> <li>○ All-year climate</li> <li>○ All-year wave rose</li> </ul> </li> <li>• Joint frequency distribution of significant wave height and absolute peak period <ul style="list-style-type: none"> <li>○ All-year and monthly climates</li> </ul> </li> <li>• Joint frequency distribution of individual wave heights and associated period, representing the number of waves in 1 year <ul style="list-style-type: none"> <li>○ All-year and monthly climates</li> </ul> </li> </ul>   | <p>Table 19<br/>Figure 18</p> <p>Table 20 and Appendix 3</p> <p>Table 21 and Appendix 4</p>              |
| Wave extremes      | <ul style="list-style-type: none"> <li>• Extreme wave criteria: significant wave height (<math>H_s</math>), mean zero-crossing period (<math>T_z</math>), peak period (<math>T_p</math>), maximum wave height (<math>H_{max}</math>), wave period associated with <math>H_{max}</math> (<math>T_{ass}</math>) <ul style="list-style-type: none"> <li>○ All-year values for return periods of 1, 5, 10, 50 and 100 years and for N, NE, E, SE, S, SW, W, NW directions</li> <li>○ Factors to estimate month dependent extreme wave heights</li> </ul> </li> </ul>   | <p>Table 22</p> <p>Table 23</p>  |

## 2. *Water levels at The Skerries*

There are two main components to the sea level. The astronomical tidal component is predictable based on analysis of earlier tide gauge records in the area. The surge component is related to weather conditions and is predictable no more than a few days in advance. Extreme sea levels are caused when a surge occurs concurrently with a high tide. These can be estimated by analysis of high and extreme levels observed in the area in the past.

All main results presented in this report relate to present-day (2009) conditions, although a recommended allowance for possible future sea level rise is discussed in Section 2.3.

### 2.1 ASTRONOMICAL TIDAL LEVELS

The tidal levels for locations on the north-facing coast of Anglesey, above local *Chart Datum* (CD), are reproduced in Table 4 from Admiralty tide tables for 2009 (Reference 2).

The levels in Table 4 were subsequently converted from CD to Ordnance Datum Newlyn to provide consistency between the different locations. The *Highest Astronomical Tide* (HAT) and *Lowest Astronomical Tide* (LAT) for the Secondary Ports were inferred by analogy with the Standard Port of Holyhead. Corresponding tidal levels between Anglesey and the Skerries Islands were calculated as the averages of those for Cemaes Bay and Holyhead. The tidal modelling results (Reference 1) suggest that this interpolation should be weighted 46% for Cemaes Bay to 54% for Holyhead, but 50/50 was used to give fractionally higher levels, as the site is about half way between Cemaes Bay and Holyhead. The results of this analysis are given in Table 5.

Table 6 summarises the tidal levels (to CD Holyhead) for the Skerries.

### 2.2 EXTREME SEA LEVELS

The Environment Agency commissioned a series of extreme sea level analyses, of which Atkins (Reference 3) covers North and Northwest Wales. Atkins reviewed a number of previous extremes analyses and made an informed choice of appropriate sources and methods for different locations. Its extreme sea level predictions for locations on the north-facing coast of Anglesey are reproduced (adding one centimetre for mean sea level rise between 2006 and 2009) in Table 7.

Again inferring levels between Anglesey and the Skerries Islands as the averages of those for Cemaes Bay and Holyhead, and estimating the 1 and 5 year return period levels by interpolation between the resulting 10 year level and HAT (from Table 6) gives the results presented in Table 8 for The Skerries.

The values given in Table 8 are irrespective of month or season. ‘Monthly’ extremes are unavailable from literature review, and there are insufficient data to derive extremes independently for each month of the year. Instead, factors to be applied to the overall extremes were derived from an assessment of the highest sea levels recorded at Holyhead over a total of about 26 years covering the period 1964-2001. The high tide values were sorted by month. The 5<sup>th</sup>/6<sup>th</sup> and 25<sup>th</sup>/26<sup>th</sup>/27<sup>th</sup> highest in each month, approximately representing return periods of 5 years and 1 year respectively, were compared with the equivalent overall values (all relative to OD). Ratios were thus

derived between extreme values conditional upon month and extreme values overall (Table 9), which should be used in conjunction with the annual extremes given in Table 8 to obtain equivalent month-dependent extreme sea levels.

## 2.3 POSSIBLE FUTURE SEA LEVEL RISE

All levels presented thus far were ‘present-day’ levels. Mean sea level, and therefore extreme sea level, is expected to rise in the future. It would be prudent to make an allowance for this in the design sea levels. Defra (Reference 4) recommends an allowance for future sea level rise as described in Table 10.

For example, projecting forward 50 years, to 2059, it is recommended to add 0.34m to all tide levels and all extreme sea levels; similarly, projecting forward 100 years, to 2109, it is recommended to add 0.99m to all levels.

## 3. *Wind conditions at The Skerries*

Long-term wind data were obtained from the *UK Meteorological Office European Wave Model* (UKMO) for a point located at 53.5°N 4.87°W. The location of this point is identified with a red cross in Figure 4. The source wind data are at 3-hourly intervals. The wind speed is nominally (nominally because it is based on numerical model assumptions) a 20-minute averaged value, which HR Wallingford usually assumes to be a 3-hourly averaged value at 10m elevation above sea level. 20-minute averages would not be systematically higher or lower than 3-hourly averages but may be more variable.

The UKMO wind record covers the period from October 1986 to March 2006 inclusive. The prediction point is in a relatively exposed location close to the proposed tidal array site and is deemed representative of conditions in this part of the Irish Sea. Although the data are predicted from a model rather than observed, they have been calibrated extensively against a wide range of measurements and are considered to be reliable.

In the absence of any site-specific wind data, wind climate and extremes were derived from the UKMO data as 3-hourly averaged values. HR Wallingford typically uses standard adjustment factors of 1.04 and 1.55 to convert 3-hourly averaged wind speeds to equivalent 1-hourly averaged and gust speed extremes with the same return periods.

Table 11 presents the annual offshore wind climate (wind speed against wind direction) at the UKMO Data Point. The data in Table 11 were distributed in 2m/s wind speed bins and in the cardinal and ordinal (or intercardinal) directions. They are expressed in parts per hundred thousand, based on the entire wind record. Appendix 2, at the end of this report, also presents monthly wind climates (wind speed against wind direction) at the UKMO Data Point, using 1m/s speed bands.

The same information is presented in Figure 2 in the form of an annual wind rose. A rose is a visual representation of the frequency of occurrence of certain conditions, lumped into directional sectors and wind speed bins. In this analysis 45° directional bins and speed intervals between 4m/s and 6m/s were used. Each ring on the rose represents a frequency of occurrence of 10%. The width of the colour bars represents the frequency of occurrence of a wind speed from a given direction and within a certain range.

Table 12 and Table 13 present the extreme wind speeds derived at the site from the UKMO data, by direction and by month respectively. As an example, the 1 and 50 year

extreme 3-hourly wind speeds were predicted as 27.1m/s and 33.7m/s. It should be remembered that these are assumed to be 3-hourly averaged values. Adjustment factors could be used to estimate corresponding 1-hourly averaged and gust speed extremes with the same return periods.

## 4. *Wave conditions at The Skerries*

Wave conditions in the area of interest were predicted using the SWAN wave spectral model. The model was initially set up and validated against a selection of the in-situ measurements. The model was then run for a wide range of conditions in order to generate look-up tables relating offshore wave and wind conditions to nearshore wave conditions. The look-up tables were generated at four tidal states and then used to generate a long-term synthetic time series of nearshore wave conditions suitable for compiling wave climates and deriving estimates of extreme values.

The following sections describe the application of the SWAN model to the Skerries. This includes the initial model validation, the generation of look-up tables, subsequent confirmation against the in-situ measurements and presentation of results.

### 4.1 WAVE MODEL OF THE SKERRIES

#### 4.1.1 *The SWAN wave transformation model*

SWAN (acronym for *Simulating WAves Nearshore*) was developed by the Technical University of Delft (TU Delft) in the Netherlands. This model is a third-generation wave model, which is the state-of-the-art in spectral wave transformation models for coastal wave modelling. This family of models solves the spectral action balance equation with sources and sinks, with no a priori restrictions on the spectral shape for the evolution of wave growth.

SWAN includes the effect of refraction and shoaling, friction, wave breaking and wave-wave interactions. The model also includes wave generation by the wind within the model area, which makes SWAN especially useful in regions where wave conditions may be equally well comprised of offshore waves and those generated by local winds, not necessarily correlated with the predominant offshore wave direction. More importantly the model also includes the effect of refraction, shoaling and blocking due to the presence of a current. SWAN therefore is well suited to the investigation of wave conditions at The Skerries.

More detailed information about SWAN can be found in References 5 and 6 and in Appendix 2, at the end of this report. Appendix 2 also includes some general information about the model verification and validation.

#### 4.1.2 *Representation of The Skerries in the numerical model*

A SWAN model of The Skerries was set up in this study to determine the wave conditions at the proposed tidal array sites. The model covers the area of interest from Penrhos Bay, south of the study area, to Cemaes Bay, east of the study area, in the approaches to The Skerries. It extends offshore as far as the closest UKMO Data Point (53.5°N 4.87°W), in relatively deep water.

Three nested rectangular grids of varying resolution were used to represent the model area. The size of the elements decreased from 480m away from the shore, to 120m and

40m at The Skerries proposed tidal array sites. Overall, the model area was represented using 3534 elements for the outer grid, 7007 elements for the middle grid and 17201 elements for the inner grid. The model area and nested grid system are shown in Figure 4 superimposed on a satellite image of the Irish Sea obtained from Google Maps.

The coordinate system used in this study was the Universal Transverse Mercator grid (UTM), zone 30, WGS84. The vertical datum was Chart Datum at Holyhead. In the remainder of this document the term *wave model* will be used to refer to this nested model system.

#### 4.1.3 Bathymetry for the wave model

The bathymetric data used to set up the hydrodynamic model (Reference 1) were used again to set up the wave model. These data consist of the most recent available information:

- Bathymetric contours and spot heights from the C-Map electronic chart database covering the Irish Sea;
- High-resolution bathymetric data collected in August 2008 by Emu Ltd, using a multi-beam sonar system and interpolated onto a 1m grid, in an area of approximately 17km<sup>2</sup> between the Skerries islands (NW), Carmel Head (SE) and Coal Rock (NE). The area around the ‘SS Castilian’ wreck was also surveyed in detail in August 2008.

A digital elevation model of the bottom elevation throughout the model area was constructed by integrating bathymetric data from these sources. The resulting bottom map is presented in Figure 5. The locations where the wave model has been calibrated and verified (see Section 4.2) are also identified in Figure 5.

#### 4.1.4 Boundary conditions for the wave model

An offshore wave climate covering almost 20 years of data (1987-2006) from the UK Meteorological Office European Wave Model was used as boundary conditions to the wave model. The offshore wave climates and wave rose are reproduced in Table 14, Table 15 and Figure 3 respectively for information.

Two-dimensional wave spectra were applied along the wave model open boundaries. For the initial model validation stage, these were computed from the wind sea and swell components predicted at the UKMO Data Point off Anglesey for the period covering the in-situ measurements.

For the look-up table model runs, the boundary conditions were based on discrete values covering the ranges predicted at the UKMO Data Point between April 1987 and March 2006. Good correlation was noted between the offshore wind sea height and period. The wind wave period was consequently assumed to be directly proportional to the wind wave height in this analysis.

The proportion of wind wave to swell will vary from condition to condition in the time series, so it is not possible to define a unique spectral shape. The approach taken in this study is therefore expected to be superior to that consisting of approximating the total wave conditions predicted at the UKMO Data Point by a JONSWAP spectrum.

In addition, equivalent winds were blown over the wave model area to represent local wave generation due to winds. This may be particularly relevant for winds blowing off the land from the east and south-east for example. Since good correlation was also noted at the UKMO Data Point between the wind sea height and the wind speed, the wind speed was derived from the wind sea height; the wind direction was the same as the wind sea direction.

## 4.2 VALIDATION OF THE WAVE MODEL OF THE SKERRIES

### 4.2.1 *Validation events*

The wave model of The Skerries was initially validated before being applied to generate the look-up tables and corresponding nearshore wave time series, climates and extremes. This validation was carried out using wave data covering 3 separate storm events with relatively high wave activity and noticeable wave-current interaction at the tidal array site:

- October 2<sup>nd</sup> 18:00 to October 3<sup>rd</sup> 6:00;
- October 23<sup>rd</sup> 2:00 to 16:00; and
- October 19<sup>th</sup> 9:00 to October 22<sup>nd</sup> 23:00.

It is important that the wave model be able to predict accurately the tidal modulations (i.e. the increase or reduction in wave height depending on the current conditions) throughout a tidal cycle. If it can be shown that the model results agree with the in-situ measurements, then it gives greater confidence in the predicted wave climates and extreme conditions.

For the validation, significant wave heights ( $H_s$ ) and mean wave periods ( $T_{m02}$ ) predicted by the wave model were compared against *Acoustic Wave and Current* (AWAC) mooring data collected by Partrac Ltd at two sites in the area of interest. The locations of these points (2 and 4) are marked by dark brown stars in Figure 5; their coordinates are given in Table 16. The instruments were located within the site boundaries at The Skerries, and were deployed in approximately 30m water depth. It should be acknowledged that Partrac Ltd also collected data at one other location (location 3), approximately 4km SW of the site, but data at this location were incomplete (no information was obtained on significant wave height) and were therefore not used in this study.

The first AWAC mooring was deployed on August 27<sup>th</sup>, 2008 at location 4 and recovered on November 5<sup>th</sup>, 2008, with only a minor interruption in the records (25.5 hours), during which time the mooring was recovered to extract the initial data and check the mooring. The other AWAC mooring was installed between September 24<sup>th</sup>, 2008 and October 24<sup>th</sup>, 2008 (location 2). There were no interruptions in the records at this location.

The wave data were collected every hour. The measured wave characteristics include (but are not limited to) significant wave height ( $H_s$ ), mean and peak wave periods ( $T_{m02}$  and  $T_p$ ), mean wave direction. An extract of the wave data at location 4 is presented in Figure 6 around a period of high waves, in relation to the current speeds measured by the instrument for the same period.

#### 4.2.2 Validation of the wave model

The wave model was validated by comparing predicted significant wave heights and mean wave periods against the wave data measured by Partrac Ltd at the site of interest in October 2008. The locations of the validation sites are marked by dark brown stars in Figure 5 and their coordinates are reported in Table 16. The wave model was run for the selected periods of the validation data using water level and flow fields predicted by the hydrodynamic model for the same periods (Reference 1). The time series of significant wave height and absolute mean period are presented in Figure 7 to Figure 12 for the three storm events. In these figures the wave model predictions are shown as crosses, while the measured data are shown as continuous lines. The data for location 2 are shown in red; the data for location 4 in blue.

It is clear from Figure 7 to Figure 12 that both the significant wave height and mean wave period are satisfactorily reproduced by the wave model. In particular the tidal modulations are well represented for the event where wave-current interactions were most evident (Figure 9 and Figure 12).

Figures 7 and 8 show that the predicted significant wave heights agree well with the measured conditions; Figure 9 shows a tendency for the model to over-predict the higher events. These differences could be attributed to deficiencies in the offshore data, the wave model or possibly inaccuracies in the measured values, or a combination of the three. The accepted accuracy of AWAC devices in measuring wave heights is of the order of a few centimetres. Overall, the results show that the wave model provides a good prediction of wave heights at the two validation sites, albeit slightly conservative.

To quantify the differences between the predictions and measurements a set of statistics were computed. These statistics were computed for both the significant wave heights and the mean wave periods. The results of this analysis are presented in Table 17 and in Table 18 for the wave height and period, respectively. Table 17 shows that the significant wave heights are predicted to within 0.3m at both locations (with a small positive bias reaffirming the observed tendency to over-predict). The corresponding root-mean-squared error in significant wave height was 0.4m. Similarly Table 18 shows that the mean wave periods are predicted to within 0.5s at both locations (with a small negative bias). The corresponding root-mean-squared error in mean wave period was 0.6s. Based on these results it is considered that the wave model will give slightly conservative results, on average.

Overall, these results indicate that the wave model provides a good prediction of wave conditions in the area of interest under a range of tidal currents and offshore wave and wind conditions. Importantly the ability of the model to simulate tidal modulations has been demonstrated in this analysis. This is expected to be critical in the prediction of wave activity in this region, which is characterized by high tidal currents.

These comparisons give confidence in the numerical model predictions. It is, however, important to recognize that model predictions may be less reliable in cases where the waves are quite small with a strong opposing current as such conditions are close to the limitations of the SWAN model. It is also expected that the waves generated locally by offshore winds, i.e. from the south-east and south, are slightly over-predicted in this study although waves from these sectors are relatively small compared to the other sectors.

## 4.3 WAVE CLIMATE AND EXTREMES AT THE SKERRIES

### 4.3.1 *Study methodology*

The UK Meteorological Office European Wave Model provides offshore data at a point off Anglesey since 1986. In order to generate a nearshore wave climate within the tidal array site, a 19 year time series of nearshore wave parameters was created by transforming these offshore wave conditions to the site using the validated wave model of The Skerries. The nearshore time series was subsequently analysed to provide a range of statistical tables.

Due to computational constraints it was not practical to run each time step of the UKMO offshore time series using the wave model directly. A look-up table approach was therefore employed. The wave model was run for a range of discrete wave and wind conditions representative of the offshore wave climate; multi-dimensional look-up tables were then created relating the offshore wave and wind conditions to nearshore wave conditions at the specified prediction point (Figure 5 and Table 3); and the look-up tables were applied to the offshore time series to provide a corresponding long-term nearshore time series within the tidal array site.

Waves are subject to the influence of ambient currents. The currents cause refraction of the waves, Doppler shifting, and in some cases (strong opposing currents) blocking of the waves. It is expected that the waves at The Skerries are significantly affected by the strong local tidal currents. The wave pattern will also be very different at different states of the tide. It was therefore a prerequisite in this study that a time series of nearshore wave conditions be produced at several states of the tide. These were then combined with a synthetic tidal level time series for The Skerries to allow interpolation of a synthetic wave time series at the prediction point.

It was determined from the in-situ measurements that peak ebb currents yield high waves at The Skerries, while peak flood currents yield lower waves. For this study the wave model was run at four states of the tide, namely high water springs (weak currents), mean water near peak ebb, low water springs (weak currents) and mean water near peak flood. The appropriate tidal current and water level fields were extracted from the calibrated hydrodynamic model for a slightly above average spring tide in October 2008. The flow modelling study is described in Reference 1.

A total of approximately 18,000 stationary runs of the wave model were carried out in order to cover all realistic combinations required to generate the look-up tables.

### 4.3.2 *Validation of the methodology*

The accuracy of the look-up table approach adopted in this study was confirmed by comparison of the computed wave time series against the wave data measured at locations 2 and 4 in October 2008. The locations of these points are marked by dark brown stars in Figure 5 and their coordinates are given in Table 16. The results of this analysis are presented in Figure 13 and Figure 14 for location 2, and in Figure 15 and Figure 16 for location 4. In these figures the look-up table predictions are shown as circles, while the measured data are shown as continuous lines.

Referring to Figure 13 to Figure 16 it is clear that both the significant wave height and mean wave period are satisfactorily reproduced by the look-up table approach including the tidal influenced modulations.

As with the initial wave model validation cases (described in Section 4.2.2) there is a tendency for the look-up tables to over-predict the high events (see Figure 13 and Figure 15). This is also illustrated in Figure 17, which shows the percentage of non-exceedance in terms of significant wave height at the two validation locations and for the full measurement period. In Figure 17, for example, a wave height of 3m is estimated to be exceeded 10% of the time at both locations 2 and 4, whereas the measurements suggest that a wave height of 3m will only be exceeded approximately 2% of the time at location 2 and 5% of the time at location 4, during the period considered.

Overall these comparisons demonstrate that the approach adopted in this study is suitable for deriving wave climates and extreme values.

### 4.3.3 Wave climates (annual and monthly)

A 19 year time series of nearshore wave conditions was derived using the look-up tables derived at one point within the area of the proposed tidal array site. The location of this point is marked by a red marker in Figure 4 and Figure 5; its coordinates are given in Table 3.

The wave climate was determined from the long-term time series at the prediction point from a weighted average of the four climate tables for each of the tidal states. Table 19 presents the annual wave climate in terms of significant wave height against mean wave direction. The mean wave directions were calculated from the wave spectrum on an energy basis. It is expected that there will be instances when the swell component will come from a very different direction to the wind sea component and the resulting mean wave direction will be a weighted average of the two.

The wave climate is also presented in Figure 18 in the form of a wave rose. This represents the frequency of occurrence of certain conditions, lumped into directional sectors and significant wave height bins. In this analysis 45° directional bins and height intervals between 0.5m and 2.0m were used. Each ring on the rose represents a frequency of occurrence of 10%. The width of the colour bars represents the frequency of occurrence of a wave condition from a given direction and within a certain range.

Table 19 and Figure 18 show that the majority of the waves come from the south-west and the highest waves come from the north and west. Smaller waves are predicted from the south-east and south as expected as the site is sheltered by Anglesey for these directions. The model has greater difficulty representing short period waves in the presence of a current, hence there is a bigger uncertainty in the waves from these directions.

The annual climate in terms of significant wave height,  $H_s$ , against absolute spectral peak wave period,  $T_p$ , is presented in Table 20. Associated monthly climates are also presented in Appendix 3.

Table 21 presents the annual wave climate at the prediction location (shown in Figure 5; Table 3) in terms of individual wave height against associated period. In this table the overall number of waves estimated in a year is quite high. This can be explained by the fact that the waves, which were already relatively short because of local generation within the Irish Sea for most of the directional sectors, also feel the effect of the currents. As a result the mean (zero-crossing) periods are rather short, which in turn yields a high number of waves per event duration.

Monthly climates of individual wave height are presented in Appendix 4. Slight differences can be noted between monthly and annual individual wave climates (the number of waves estimated in each month does not quite add up to the number of waves in a year). These differences can be largely attributed to the distribution of missing data between the months in a year and to rounding errors.

It is important to recognize that all climate tables shown in this report represent overall tidal conditions, i.e. they do not make the distinction between wave conditions in weak or strong (opposing or following) tidal currents. Preliminary analysis of the site measurements indicated a strong influence of the tidal currents on wave conditions and suggested that ebb flows result in an enhancement of wave heights at The Skerries, while flood flows result in a reduction of the wave conditions at the site.

#### 4.3.4 *Extreme waves (annual and monthly)*

Extreme wave conditions for return periods of 1, 5, 10, 50 and 100 years were estimated by fitting a Weibull distribution to the storm events identified from the 19 year nearshore wave time series at the prediction point using a peaks-over-threshold approach. These extreme conditions are presented in Table 22 by direction and in Table 23 by month. It should be noted that sometimes the waves could have both wind sea and swell components from different directions. The directional extremes are classified by the mean wave direction.

The absolute mean and peak periods corresponding to these conditions were calculated based on the predicted (mean and peak) wave steepness curves. Some variability was observed in the mean wave period. Upper and lower estimates are given in Table 22 and in Table 23 when the range in absolute mean wave period exceeded 1s.

The values for the maximum wave,  $H_{\max}$ , presented in Table 22 and in Table 23 were derived based on the British Standards (Reference 7) and assuming a 3 hour duration for the design condition. The same source suggests that the wave period associated with  $H_{\max}$  is best approximated by the peak wave period,  $T_p$ . In this study the period associated with the maximum wave was derived from the average wave steepness observed for the higher events in the nearshore wave climate presented in Table 21.

It is important to remember that all extreme values presented in this report represent overall tidal conditions.

Extreme significant wave heights for 1 and 50 years were predicted as 5.9m and 6.9m respectively. The largest waves approach from the north and west. As expected, smaller waves are predicted from the south-east and south, although these conditions may be less accurately represented in the wave model.

## 5. *Conclusions and recommendations*

This report presents detailed predictions of metocean data at the proposed Skerries tidal array site to support detailed design of the proposed turbine structures.

The following deliverables are presented:

- normal astronomical and extreme water levels
- monthly and annual wind climates

- annual directional extreme wind conditions
- monthly omni-directional extreme wind conditions
- monthly and annual wave climates
- monthly and annual individual wave climates
- annual directional extreme wave conditions
- monthly omni-directional extreme wave conditions

A review was carried out to determine normal astronomical and extreme water levels at the site. As an example, the 1 and 50 year extreme water levels, excluding sea level rise, were predicted as 6.61mCD and 7.21mCD.

The wind climates and extremes presented are based on the wind data from the UK Meteorological Office European wave model. As an example, the 1 and 50 year extreme 3-hourly wind speeds were predicted as 27.1m/s and 33.7m/s.

Wave conditions in the area of the proposed tidal array were predicted using the spectral wave model SWAN. The model was set up to represent the propagation of waves from offshore and those generated more locally, including the effects of the bathymetry and tidal currents. The model was validated against in-situ measurements of waves at two locations in the area of interest. The SWAN model was then used generate look-up tables relating offshore to nearshore wave conditions at four tidal states, from which a 19 year synthetic time series of site specific wave conditions was produced. From the nearshore time series of wave conditions the corresponding nearshore climates were compiled and estimates of extreme wave conditions were derived. As an example, extreme significant wave heights for 1 and 50 years were predicted as 5.9m and 6.9m respectively. The largest waves approach from the north and from the west.

## 6. Notations

|           |   |
|-----------|---|
| $H_s$     | Significant wave height, $H_{m0}$   |
| $H_{max}$ | Maximum wave height   |
| $T_z$     | Mean zero-crossing wave period, $T_{m02}$   |
| $T_p$     | Peak wave period  |
| CD        | Chart Datum, which is the same as the zero of the tidal predictions in all cases. By international agreement, Chart Datum is defined as a level so low that the tide will not frequently fall below it. In this study CD refers to Chart Datum at Holyhead. |
| OD        | Ordnance Datum (Newlyn). The UK land survey datum. OD is 3.05m above CD (Holyhead)  |

HAT (Highest Astronomical Tide) LAT (Lowest Astronomical Tide). The highest and lowest levels respectively which can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions; these levels will not be reached every year. HAT and LAT are not the extreme levels which can be reached, as storm surges may cause considerably higher and lower levels to occur.

MHWS (Mean High Water Springs) MLWS (Mean Low Water Springs). The height of mean high water springs is the average, throughout a year when the average maximum declination of the moon is  $23.5^\circ$ , of the heights of two successive high waters during those periods of 24 hrs (approximately once a fortnight) when the range of the tide is greatest. The height of mean low water springs is the average height obtained by the two successive low waters during the same periods.

MHWN (Mean High Water Neaps) MLWN (Mean Low Water Neaps). The height of mean high water neaps is the average, throughout a year as defined above, of the heights of two successive high waters during those periods (approximately once a fortnight) when the range of the tide is least. The height of mean low water neaps is the average height obtained from the two successive low waters during the same periods.

The values of MHWS, MHWN, MLWN and MLWS vary from year to year in a cycle of approximately 18.6 years. In general the levels are computed from at least a year's predictions and are adjusted for the long period variations to give values which are the average over the whole cycle. The values of Lowest Astronomical Tide (LAT) and Highest Astronomical Tide (HAT) are determined by inspection over a span of years.

MSL (Mean Sea Level). Mean Sea Level is the average level of the sea surface over a long period, preferably 18.6 years, or the average level which would exist in the absence of tides. MTL (Mean Tide Level) can be calculated by meaning the heights of MHWS, MHWN, MLWN and MLWS.

## 7. *References*

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## *Tables*



**Table 1 Coordinates (UTM30N, WGS84) and bed elevation in the model (mCD Holyhead) at inner turbine array locations**

|    |          |           |        |
|----|----------|-----------|--------|
| i1 | 394816.9 | 5918488.5 | -28.15 |
| i2 | 394902.3 | 5918401.5 | -29.50 |
| i3 | 394987.8 | 5918318.9 | -31.10 |
| i4 | 395067.0 | 5918227.6 | -30.00 |
| i5 | 395040.0 | 5918779.8 | -29.10 |
| i6 | 395123.7 | 5918689.5 | -28.70 |
| i7 | 395207.6 | 5918602.2 | -26.85 |
| i8 | 395304.2 | 5918513.1 | -28.10 |

**Table 2 Coordinates (UTM30N, WGS84) and bed elevation in the model (mCD Holyhead) at outer turbine array locations**

|    |          |           |        |
|----|----------|-----------|--------|
| o1 | 395383.4 | 5919938.4 | -27.10 |
| o2 | 395466.0 | 5919853.0 | -29.00 |
| o3 | 395550.3 | 5919764.5 | -26.40 |
| o4 | 395635.8 | 5919681.9 | -25.85 |
| o5 | 395716.9 | 5919590.6 | -28.65 |
| o6 | 395688.0 | 5920137.9 | -34.05 |
| o7 | 395771.7 | 5920052.6 | -31.90 |
| o8 | 395855.6 | 5919965.2 | -31.95 |
| o9 | 395939.4 | 5919881.3 | -26.85 |

**Table 3 Coordinates (UTM30N, WGS84) and bed elevation in the model (mCD Holyhead) at the wave model prediction point**

|    |           |            |        |
|----|-----------|------------|--------|
| WP | 394982.55 | 5920160.54 | -34.04 |
|----|-----------|------------|--------|

**Table 4 Tidal levels (present-day, 2009, metres above local CD) for locations on the north-facing coast of Anglesey (from UKHO, 2008)**

| Astronomical tidal level        | Trwyn<br>Dinmor<br>53°19'N<br>04°03'W | Moelfre<br>53°20'N<br>04°14'W | Amlwch<br>53°25'N<br>04°20'W | Cemaes<br>Bay<br>53°25'N<br>04°27'W | Holyhead<br>53°19'N<br>04°37'W |
|---------------------------------|---------------------------------------|-------------------------------|------------------------------|-------------------------------------|--------------------------------|
| Highest Astronomical Tide (HAT) | Not available                         |                               |                              |                                     | 6.3                            |
| Mean High Water Springs (MHWS)  | 7.5                                   | 7.5                           | 7.2                          | 6.6                                 | 5.6                            |
| Mean High Water Neaps (MHWN)    | 5.9                                   | 5.8                           | 5.7                          | 5.1                                 | 4.4                            |
| Mean Water Level (MWL)          | 4.23                                  | 4.17                          | 4.08                         | 3.67                                | 3.26                           |
| Mean Low Water Neaps (MLWN)     | 2.5                                   | 2.5                           | 2.5                          | 2.3                                 | 2.0                            |
| Mean Low Water Springs (MLWS)   | 0.9                                   | 0.9                           | 0.9                          | 0.8                                 | 0.7                            |
| Lowest Astronomical Tide (LAT)  | Not available                         |                               |                              |                                     | 0.0                            |
| Ordnance Datum (OD)             | 4.00                                  | 4.00                          | 3.90                         | 3.60                                | 3.05                           |

**Table 5 Tidal levels (present-day, 2009, metres above OD) for locations on the north-facing coast of Anglesey**

| Tidal level | Trwyn Dinmor | Moelfre | Amlwch | Cemaes Bay | Skerries | Holyhead |
|-------------|--------------|---------|--------|------------|----------|----------|
| HAT         | 4.45         | 4.45    | 4.20   | 3.83       | 3.54     | 3.25     |
| MHWS        | 3.50         | 3.50    | 3.30   | 3.00       | 2.78     | 2.55     |
| MHWN        | 1.90         | 1.80    | 1.80   | 1.50       | 1.43     | 1.35     |
| MWL         | 0.23         | 0.17    | 0.18   | 0.07       | 0.14     | 0.21     |
| MLWN        | -1.50        | -1.50   | -1.40  | -1.30      | -1.18    | -1.05    |
| MLWS        | -3.10        | -3.10   | -3.00  | -2.80      | -2.58    | -2.35    |
| LAT         | -4.05        | -4.05   | -3.90  | -3.63      | -3.34    | -3.05    |

**Table 6 Tidal levels (present-day, 2009, metres above CD Holyhead) for The Skerries**

|                           |       |
|---------------------------|-------|
| Highest Astronomical Tide | 6.59  |
| Mean High Water Springs   | 5.83  |
| Mean High Water Neaps     | 4.48  |
| Mean Water Level          | 3.19  |
| Mean Low Water Neaps      | 1.87  |
| Mean Low Water Springs    | 0.47  |
| Lowest Astronomical Tide  | -0.29 |
| Mean Spring Range         | 5.36  |
| Mean Neap Range           | 2.61  |

**Table 7 Extreme sea levels (present-day, 2009, metres above OD) for locations on the north-facing coast of Anglesey (from Atkins, 2007)**

| Return period (years) | Trwyn Dinmor | Moelfre | Amlwch | Cemaes Bay | Holyhead |
|-----------------------|--------------|---------|--------|------------|----------|
| 100                   | 5.26         | 5.30    | 5.06   | 4.64       | 4.00     |
| 50                    | 5.09         | 5.12    | 4.88   | 4.47       | 3.85     |
| 25                    | 4.99         | 5.02    | 4.78   | 4.38       | 3.77     |
| 10                    | 4.81         | 4.84    | 4.60   | 4.21       | 3.62     |

**Table 8 Extreme sea levels (present-day, 2009, metres above CD Holyhead) for The Skerries**

|                           |      |
|---------------------------|------|
| 100 year return period    | 7.37 |
| 50 year return period     | 7.21 |
| 10 year return period     | 6.97 |
| 5 year return period      | 6.85 |
| 1 year return period      | 6.61 |
| Highest Astronomical Tide | 6.59 |

**Table 9 Factors to estimate month dependent extreme sea levels (relative to CD Holyhead) from the overall extreme values given in Table 8**

| Month     | Factor |
|-----------|--------|
| January   | 0.92   |
| February  | 0.95   |
| March     | 0.94   |
| April     | 0.89   |
| May       | 0.84   |
| June      | 0.83   |
| July      | 0.86   |
| August    | 0.92   |
| September | 0.96   |
| October   | 0.95   |
| November  | 0.90   |
| December  | 0.93   |

**Table 10 Allowances for future mean sea level rise based from Defra (2006)**

|             |                 |
|-------------|-----------------|
| until 2025  | add 3.5mm/year  |
| 2025 - 2055 | add 8.0mm/year  |
| 2055 - 2085 | add 11.5mm/year |
| 2085 - 2115 | add 14.5mm/year |

**Table 11 Annual offshore wind climate (wind speed against direction) at the UKMO Data Point 53.5°N 4.87°W. Data in parts per hundred thousand, based on period Oct 1986 – Mar 2006**

| 3-hourly averaged wind speed in $m/s^{-1}$<br>$U_1$ to $U_2$ | P( $U > U_1$ ) | Centre of 45° sector |      |      |      |      |      |      |      |
|--|----------------|----------------------|------|------|------|------|------|------|------|
|  |                | N                    | NE   | E    | SE   | S    | SW   | W    | NW   |
| 0.0  | 0.98659        | 560                  | 529  | 609  | 544  | 549  | 504  | 575  | 525  |
| 2.0  | 0.94264        | 1751                 | 1495 | 1529 | 1338 | 1755 | 1842 | 1476 | 1726 |
| 4.0  | 0.81352        | 2143                 | 1667 | 1698 | 1613 | 2729 | 2935 | 2223 | 2291 |
| 6.0  | 0.64053        | 1894                 | 1331 | 1662 | 1583 | 2833 | 3538 | 2812 | 2392 |
| 8.0  | 0.46009        | 1262                 | 841  | 1059 | 1339 | 2724 | 3828 | 2665 | 1976 |
| 10.0   | 0.30316        | 807                  | 586  | 694  | 1008 | 2403 | 3582 | 2353 | 1292 |
| 12.0   | 0.17592        | 443                  | 271  | 421  | 576  | 1743 | 2428 | 1806 | 779  |
| 14.0   | 0.09127        | 221                  | 114  | 180  | 241  | 1013 | 1577 | 1125 | 372  |
| 16.0   | 0.04283        | 72                   | 69   | 32   | 97   | 625  | 770  | 586  | 175  |
| 18.0   | 0.01857        | 23                   | 17   | 19   | 37   | 323  | 365  | 304  | 78   |
| 20.0   | 0.00692        | 11                   | 8    | 6    | 20   | 98   | 145  | 114  | 28   |
| 22.0   | 0.00263        | 8                    | 2    | 0    | 10   | 45   | 45   | 51   | 6    |
| 24.0   | 0.00097        | 4                    | 0    | 2    | 4    | 15   | 11   | 23   | 4    |
| 26.0   | 0.00037        | 0                    | 0    | 0    | 0    | 4    | 4    | 15   | 0    |
| 28.0   | 0.00016        | 0                    | 0    | 0    | 0    | 0    | 4    | 2    | 0    |
| 30.0   | 0.00011        | 0                    | 0    | 0    | 0    | 0    | 4    | 0    | 0    |
| 32.0   | 0.00007        | 0                    | 0    | 0    | 0    | 0    | 0    | 4    | 0    |
| 34.0   | 0.00004        | 0                    | 0    | 0    | 0    | 0    | 4    | 0    | 0    |
| Total per thousand for each direction sector                 |                | 92                   | 69   | 79   | 84   | 169  | 216  | 161  | 116  |

<sup>1</sup> Adjustment factors of 1.04 and 1.55 respectively are considered appropriate to convert 3-hourly averaged wind speed extremes to equivalent 1-hourly averaged and gust speed extremes with the same return periods

**Table 12 Extreme 3-hourly<sup>1</sup> wind speeds (m/s) at the UKMO Data Point 53.5°N 4.87°W  
 (Month: All; Direction: Individual)**

| Return period (yr) | Centre of 45° sector |      |      |      |      |      |      |      |      |
|--------------------|----------------------|------|------|------|------|------|------|------|------|
|                    | N                    | NE   | E    | SE   | S    | SW   | W    | NW   | All  |
| 1                  | 19.1                 | 17.7 | 17.8 | 19.8 | 23.0 | 25.4 | 24.9 | 20.1 | 27.1 |
| 5                  | 22.2                 | 20.5 | 20.3 | 22.6 | 25.5 | 28.5 | 28.0 | 22.8 | 29.9 |
| 10                 | 23.4                 | 21.7 | 21.4 | 23.7 | 26.4 | 29.7 | 29.3 | 23.8 | 31.1 |
| 50                 | 26.1                 | 24.2 | 23.6 | 26.1 | 28.6 | 32.5 | 32.0 | 26.1 | 33.7 |
| 100                | 27.2                 | 25.2 | 24.5 | 27.1 | 29.4 | 33.6 | 33.1 | 27.0 | 34.7 |

**Table 13 Extreme 3-hourly<sup>1</sup> wind speeds (m/s) at the UKMO Data Point 53.5°N 4.87°W  
 (Month: Individual; Direction: All)**

| Return period (yr) | Month |      |      |      |      |      |      |      |      |      |      |      |      |
|--------------------|-------|------|------|------|------|------|------|------|------|------|------|------|------|
|                    | Jan   | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Oct  | Nov  | Dec  | All  |
| 1                  | 25.0  | 24.7 | 20.9 | 18.0 | 16.1 | 14.8 | 15.4 | 15.3 | 18.1 | 21.1 | 22.2 | 23.2 | 27.1 |
| 5                  | 28.2  | 28.0 | 23.5 | 20.1 | 18.2 | 16.6 | 17.5 | 17.1 | 20.3 | 23.4 | 24.9 | 26.0 | 29.9 |
| 10                 | 29.4  | 29.2 | 24.5 | 21.0 | 19.0 | 17.2 | 18.3 | 17.8 | 21.1 | 24.3 | 25.9 | 27.1 | 31.1 |
| 50                 | 32.1  | 32.0 | 26.8 | 22.8 | 20.8 | 18.7 | 20.1 | 19.3 | 22.9 | 26.3 | 28.2 | 29.4 | 33.7 |
| 100                | 33.2  | 33.1 | 27.7 | 23.5 | 21.5 | 19.3 | 20.8 | 19.9 | 23.7 | 27.1 | 29.1 | 30.4 | 34.7 |

**Table 14 Annual offshore wave climate ( $H_s$  against direction) at the UKMO Data Point 53.5°N 4.87°W. Data in parts per hundred thousand, based on period Oct 1986 – Mar 2006**

| Significant wave height in m $H_1$ to $H_2$  | $P(H > H_1)$ | Centre of 45° sector |      |      |      |      |      |      |      |
|--|--------------|----------------------|------|------|------|------|------|------|------|
|  |              | N                    | NE   | E    | SE   | S    | SW   | W    | NW   |
| 0.0  | 0.98561      | 1511                 | 581  | 477  | 569  | 2301 | 4688 | 1178 | 1174 |
| 0.5  | 0.86082      | 2973                 | 1211 | 1762 | 1690 | 4856 | 8303 | 2545 | 2476 |
| 1.0  | 0.60264      | 1945                 | 1065 | 1281 | 1043 | 4293 | 7145 | 2766 | 2357 |
| 1.5  | 0.38369      | 1016                 | 590  | 760  | 527  | 3258 | 5746 | 1759 | 1278 |
| 2.0  | 0.23436      | 656                  | 339  | 418  | 228  | 2405 | 4235 | 1232 | 790  |
| 2.5  | 0.13134      | 309                  | 111  | 174  | 63   | 1583 | 2689 | 686  | 407  |
| 3.0  | 0.07112      | 154                  | 65   | 37   | 35   | 911  | 1885 | 323  | 193  |
| 3.5  | 0.03508      | 72                   | 14   | 12   | 12   | 504  | 988  | 214  | 82   |
| 4.0  | 0.01609      | 23                   | 11   | 0    | 4    | 325  | 514  | 60   | 16   |
| 4.5  | 0.00658      | 12                   | 2    | 2    | 5    | 114  | 223  | 25   | 14   |
| 5.0  | 0.00262      | 4                    | 0    | 0    | 4    | 67   | 100  | 5    | 7    |
| 5.5  | 0.00075      | 0                    | 0    | 0    | 0    | 14   | 14   | 12   | 0    |
| 6.0  | 0.00035      | 0                    | 0    | 0    | 0    | 5    | 12   | 0    | 0    |
| 6.5  | 0.00018      | 0                    | 0    | 0    | 0    | 4    | 7    | 0    | 0    |
| 7.0  | 0.00007      | 0                    | 0    | 0    | 0    | 0    | 4    | 0    | 0    |
| 7.5  | 0.00004      | 0                    | 0    | 0    | 0    | 0    | 4    | 0    | 0    |
| Total per thousand for each direction sector |              | 87                   | 40   | 49   | 42   | 206  | 366  | 108  | 88   |

**Table 15 Annual offshore wave climate ( $H_s$  against  $T_z$ ) at the UKMO Data Point 53.5°N 4.87°W. Data in parts per hundred thousand, based on period Oct 1986 – Mar 2006**

| Significant wave height in m $H_1$ to $H_2$ | Mean wave period in s |       |       |       |      |      |     |      |       |       |       |       |       |       |  |
|---|-----------------------|-------|-------|-------|------|------|-----|------|-------|-------|-------|-------|-------|-------|--|
|   | 0-3                   | 3-4   | 4-5   | 5-6   | 6-7  | 7-8  | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 |  |
| 0.0   | 0                     | 8702  | 2375  | 916   | 272  | 107  | 56  | 28   | 9     | 2     | 2     | 5     | 5     | 0     |  |
| 0.5   | 0                     | 14647 | 8567  | 1896  | 537  | 123  | 47  | 2    | 0     | 0     | 0     | 0     | 0     | 0     |  |
| 1.0   | 0                     | 1115  | 17509 | 2443  | 655  | 114  | 26  | 28   | 5     | 0     | 0     | 0     | 0     | 0     |  |
| 1.5   | 0                     | 42    | 3833  | 10304 | 609  | 86   | 39  | 9    | 11    | 0     | 0     | 0     | 0     | 0     |  |
| 2.0   | 0                     | 0     | 12    | 8860  | 1329 | 72   | 26  | 4    | 0     | 0     | 0     | 0     | 0     | 0     |  |
| 2.5   | 0                     | 0     | 0     | 627   | 5357 | 32   | 7   | 0    | 0     | 0     | 0     | 0     | 0     | 0     |  |
| 3.0   | 0                     | 0     | 0     | 0     | 3324 | 276  | 4   | 0    | 0     | 0     | 0     | 0     | 0     | 0     |  |
| 3.5   | 0                     | 0     | 0     | 0     | 383  | 1516 | 0   | 0    | 0     | 0     | 0     | 0     | 0     | 0     |  |
| 4.0   | 0                     | 0     | 0     | 0     | 2    | 928  | 21  | 0    | 0     | 0     | 0     | 0     | 0     | 0     |  |
| 4.5   | 0                     | 0     | 0     | 0     | 0    | 297  | 100 | 0    | 0     | 0     | 0     | 0     | 0     | 0     |  |
| 5.0   | 0                     | 0     | 0     | 0     | 0    | 49   | 137 | 0    | 0     | 0     | 0     | 0     | 0     | 0     |  |
| 5.5   | 0                     | 0     | 0     | 0     | 0    | 0    | 35  | 5    | 0     | 0     | 0     | 0     | 0     | 0     |  |
| 6.0   | 0                     | 0     | 0     | 0     | 0    | 0    | 16  | 2    | 0     | 0     | 0     | 0     | 0     | 0     |  |
| 6.5   | 0                     | 0     | 0     | 0     | 0    | 0    | 7   | 4    | 0     | 0     | 0     | 0     | 0     | 0     |  |
| 7.0   | 0                     | 0     | 0     | 0     | 0    | 0    | 4   | 0    | 0     | 0     | 0     | 0     | 0     | 0     |  |
| 7.5   | 0                     | 0     | 0     | 0     | 0    | 0    | 0   | 4    | 0     | 0     | 0     | 0     | 0     | 0     |  |
| Total per thousand                          | 0                     | 245   | 323   | 250   | 125  | 36   | 5   | 1    | 0     | 0     | 0     | 0     | 0     | 0     |  |

**Table 16 Coordinates (UTM30N, WGS84) and bed elevation in the model (mCD Holyhead) at AWAC / ADCP locations**

|                   |          |           |        |
|-------------------|----------|-----------|--------|
| location 1 (ADCP) | 394863.8 | 5919942.0 | -28.55 |
| location 2 (AWAC) | 396346.5 | 5920969.0 | -29.55 |
| location 3 (AWAC) | 390283.7 | 5916350.0 | -28.45 |
| location 4 (AWAC) | 394593.6 | 5919669.5 | -29.20 |
| location 5 (ADCP) | 394842.4 | 5920007.5 | -29.05 |

**Table 17 Wave model validation results, comparison of significant wave height predictions**

|   | location 2 | location 4 |
|---|------------|------------|
| Mean Absolute Error<br>MAE (m)            | 0.3        | 0.3        |
| Bias<br>BIAS (m)                          | 0.2        | 0.2        |
| Root Mean Squared Error<br>RMSE (m)       | 0.4        | 0.4        |
| Standard deviation of errors<br>StDev (m) | 0.3        | 0.4        |
| Scatter Index<br>SI                       | 0.3        | 0.3        |
| Overprediction ratio<br>Ro                | 0.7        | 0.6        |

**Table 18 Wave model validation results, comparison of mean wave period predictions**

|   | location 2 | location 4 |
|---|------------|------------|
| Mean Absolute Error<br>MAE (s)            | 0.5        | 0.5        |
| Bias<br>BIAS (s)                          | -0.2       | -0.1       |
| Root Mean Squared Error<br>RMSE (s)       | 0.6        | 0.6        |
| Standard deviation of errors<br>StDev (s) | 0.6        | 0.6        |
| Scatter Index<br>SI                       | 0.2        | 0.2        |
| Overprediction ratio<br>Ro                | 0.3        | 0.4        |

**Table 19 Annual wave climate ( $H_s$  against mean direction) at the site: 5920160. N 394982. E. Data in parts per hundred thousand, based on period Apr 1987 – Mar 2006**

| Significant wave height<br>in m<br>$H_1$ to $H_2$ | $P(H > H_1)$ | Centre of 45° sector |      |      |      |      |      |      |      |
|---|--------------|----------------------|------|------|------|------|------|------|------|
|   |              | N                    | NE   | E    | SE   | S    | SW   | W    | NW   |
| 0.0   | 1.00000      | 2912                 | 2620 | 3393 | 2997 | 2538 | 8981 | 6902 | 2899 |
| 0.5   | 0.66757      | 3299                 | 2883 | 1478 | 1063 | 864  | 8155 | 6166 | 3470 |
| 1.0   | 0.39380      | 1879                 | 1759 | 364  | 162  | 63   | 5133 | 4438 | 2667 |
| 1.5   | 0.22916      | 949                  | 887  | 93   | 23   | 4    | 3243 | 2858 | 1422 |
| 2.0   | 0.13436      | 641                  | 412  | 21   | 0    | 0    | 2196 | 1848 | 767  |
| 2.5   | 0.07551      | 348                  | 189  | 2    | 0    | 0    | 1491 | 1158 | 443  |
| 3.0   | 0.03920      | 204                  | 68   | 1    | 0    | 0    | 941  | 683  | 222  |
| 3.5   | 0.01803      | 101                  | 40   | 0    | 0    | 0    | 500  | 347  | 106  |
| 4.0   | 0.00708      | 45                   | 15   | 0    | 0    | 0    | 205  | 161  | 44   |
| 4.5   | 0.00239      | 18                   | 7    | 0    | 0    | 0    | 59   | 51   | 11   |
| 5.0   | 0.00092      | 14                   | 3    | 0    | 0    | 0    | 8    | 23   | 6    |
| 5.5   | 0.00038      | 6                    | 0    | 0    | 0    | 0    | 6    | 17   | 1    |
| 6.0   | 0.00007      | 2                    | 0    | 0    | 0    | 0    | 1    | 3    | 0    |
| 6.5   | 0.00001      | 0                    | 0    | 0    | 0    | 0    | 0    | 1    | 0    |
| 7.0   | 0.00000      | 0                    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 7.5   | 0.00000      | 0                    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Total per thousand for each direction sector      |              | 102                  | 87   | 53   | 42   | 34   | 304  | 243  | 119  |

**Table 20 Annual wave climate ( $H_s$  against absolute  $T_p$ ) at the site: 5920160. N 394982. E. Data in parts per hundred thousand, based on period Apr 1987 – Mar 2006**

| Significant wave height in m $H_1$ to $H_2$ | Absolute spectral peak wave period in s |      |      |      |      |      |      |      |       |       |       |       |       |       |  |  |
|---|---|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|--|--|
|   | 0-3                                     | 3-4  | 4-5  | 5-6  | 6-7  | 7-8  | 8-9  | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-16 | 16-18 |  |  |
| 0.0   | 3458                                    | 4187 | 4840 | 3712 | 3080 | 1982 | 1543 | 1544 | 5851  | 3025  | 13    | 5     | 3     | 1     |  |  |
| 0.5   | 4                                       | 216  | 3330 | 7926 | 6707 | 3067 | 1243 | 399  | 3077  | 1363  | 30    | 12    | 5     | 0     |  |  |
| 1.0   | 0                                       | 5    | 79   | 3019 | 8507 | 3551 | 521  | 76   | 532   | 166   | 8     | 1     | 0     | 0     |  |  |
| 1.5   | 0                                       | 0    | 0    | 109  | 3523 | 5060 | 628  | 25   | 105   | 29    | 0     | 0     | 0     | 0     |  |  |
| 2.0   | 0                                       | 0    | 0    | 0    | 281  | 3597 | 1890 | 92   | 22    | 3     | 0     | 0     | 0     | 0     |  |  |
| 2.5   | 0                                       | 0    | 0    | 0    | 0    | 758  | 2621 | 236  | 12    | 3     | 1     | 0     | 0     | 0     |  |  |
| 3.0   | 0                                       | 0    | 0    | 0    | 0    | 12   | 1401 | 692  | 9     | 1     | 3     | 0     | 0     | 0     |  |  |
| 3.5   | 0                                       | 0    | 0    | 0    | 0    | 0    | 289  | 783  | 21    | 2     | 0     | 0     | 0     | 0     |  |  |
| 4.0   | 0                                       | 0    | 0    | 0    | 0    | 0    | 10   | 412  | 46    | 0     | 0     | 0     | 0     | 0     |  |  |
| 4.5   | 0                                       | 0    | 0    | 0    | 0    | 0    | 0    | 75   | 69    | 2     | 0     | 0     | 0     | 0     |  |  |
| 5.0   | 0                                       | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 44    | 10    | 0     | 0     | 0     | 0     |  |  |
| 5.5   | 0                                       | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 17    | 14    | 0     | 0     | 0     | 0     |  |  |
| 6.0   | 0                                       | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1     | 5     | 0     | 0     | 0     | 0     |  |  |
| 6.5   | 0                                       | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0     | 1     | 0     | 0     | 0     | 0     |  |  |
| 7.0   | 0                                       | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0     | 0     | 0     | 0     | 0     | 0     |  |  |
| 7.5   | 0                                       | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0     | 0     | 0     | 0     | 0     | 0     |  |  |
| Total per thousand                          | 35                                      | 44   | 82   | 148  | 221  | 180  | 101  | 43   | 98    | 46    | 1     | 0     | 0     | 0     |  |  |

**Table 21 Annual wave climate (H against absolute T) at the site: 5920160. N 394982. E. Data in number of waves in a year, based on period  
Apr 1987 – Mar 2006**

|      |      |         |       |        |         |         |         |         |         |        |        |        |        |       |       |      |      |     |    |    |   |   |   |
|------|------|---------|-------|--------|---------|---------|---------|---------|---------|--------|--------|--------|--------|-------|-------|------|------|-----|----|----|---|---|---|
| 0.0  | 0.5  | 7904900 | 77024 | 701606 | 1553981 | 1816422 | 1103249 | 712809  | 581324  | 501447 | 394466 | 259098 | 133419 | 51884 | 14687 | 2967 | 438  | 60  | 14 | 4  | 1 | 0 | 0 |
| 0.5  | 1.0  | 2102270 | 0     | 0      | 1628    | 232286  | 895853  | 531020  | 167048  | 71349  | 56965  | 56262  | 46415  | 27641 | 11585 | 3392 | 691  | 109 | 18 | 5  | 2 | 1 | 0 |
| 1.0  | 1.5  | 746886  | 0     | 0      | 0       | 390     | 65763   | 396345  | 207050  | 41775  | 11196  | 7460   | 7243   | 5552  | 2862  | 961  | 237  | 43  | 7  | 2  | 1 | 0 | 0 |
| 1.5  | 2.0  | 316341  | 0     | 0      | 0       | 0       | 158     | 48131   | 190302  | 63676  | 8620   | 1858   | 1405   | 1125  | 687   | 287  | 75   | 15  | 3  | 1  | 0 | 0 | 0 |
| 2.0  | 2.5  | 147184  | 0     | 0      | 0       | 0       | 0       | 139     | 48391   | 81380  | 14771  | 1509   | 365    | 318   | 195   | 85   | 24   | 5   | 1  | 0  | 0 | 0 | 0 |
| 2.5  | 3.0  | 71953   | 0     | 0      | 0       | 0       | 0       | 1       | 1648    | 41750  | 25469  | 2606   | 270    | 95    | 71    | 30   | 11   | 3   | 0  | 0  | 0 | 0 | 0 |
| 3.0  | 3.5  | 36051   | 0     | 0      | 0       | 0       | 0       | 0       | 3       | 7010   | 23490  | 5042   | 395    | 63    | 28    | 13   | 4    | 2   | 2  | 0  | 0 | 0 | 0 |
| 3.5  | 4.0  | 18278   | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 163    | 9953   | 7424   | 652    | 56    | 19    | 8    | 2    | 0   | 0  | 0  | 2 | 0 | 0 |
| 4.0  | 4.5  | 9317    | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 1      | 1744   | 6234   | 1242   | 76    | 9     | 6    | 2    | 0   | 0  | 0  | 0 | 1 | 0 |
| 4.5  | 5.0  | 4759    | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 51     | 2848   | 1729   | 116   | 10    | 2    | 2    | 1   | 0  | 0  | 0 | 1 | 0 |
| 5.0  | 5.5  | 2434    | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 1      | 647    | 1548   | 224   | 10    | 1    | 1    | 1   | 0  | 0  | 0 | 0 | 0 |
| 5.5  | 6.0  | 1246    | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 0      | 39     | 863    | 327   | 15    | 1    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 6.0  | 6.5  | 640     | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 0      | 0      | 272    | 337   | 30    | 1    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 6.5  | 7.0  | 330     | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 0      | 0      | 38     | 239   | 51    | 1    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 7.0  | 7.5  | 171     | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 0      | 0      | 1      | 106   | 61    | 3    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 7.5  | 8.0  | 89      | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 0      | 0      | 0      | 29    | 54    | 7    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 8.0  | 8.5  | 47      | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 0      | 0      | 0      | 2     | 35    | 10   | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 8.5  | 9.0  | 25      | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 0      | 0      | 0      | 0     | 14    | 10   | 1    | 0   | 0  | 0  | 0 | 0 | 0 |
| 9.0  | 9.5  | 13      | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 0      | 0      | 0      | 0     | 4     | 8    | 1    | 0   | 0  | 0  | 0 | 0 | 0 |
| 9.5  | 10.0 | 7       | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 0      | 0      | 0      | 0     | 0     | 5    | 2    | 0   | 0  | 0  | 0 | 0 | 0 |
| 10.0 | 10.5 | 4       | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 0      | 0      | 0      | 0     | 0     | 2    | 1    | 0   | 0  | 0  | 0 | 0 | 0 |
| 10.5 | 11.0 | 2       | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 0      | 0      | 0      | 0     | 0     | 1    | 1    | 0   | 0  | 0  | 0 | 0 | 0 |
| 11.0 | 11.5 | 1       | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 0      | 0      | 0      | 0     | 0     | 0    | 1    | 0   | 0  | 0  | 0 | 0 | 0 |
| 11.5 | 12.0 | 1       | 0     | 0      | 0       | 0       | 0       | 0       | 0       | 0      | 0      | 0      | 0      | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
|      |      |         | 77024 | 701606 | 1555609 | 2049098 | 2065024 | 1688444 | 1195766 | 808550 | 546725 | 351028 | 195857 | 88189 | 30425 | 7800 | 1495 | 240 | 46 | 13 | 5 | 2 | 1 |

**Table 22 Extreme wave conditions at the site: 5920160. N 394982. E (Month: All; Direction: Individual)**

|                      | $H_s$<br>(m) | absolute $T_z$<br>(s) <sup>2</sup> | absolute $T_p$<br>(s) <sup>2</sup> | $H_{max}$<br>(m) <sup>3</sup> | absolute $T_{ass}$<br>(s) <sup>4</sup> |
|----------------------|--------------|------------------------------------|------------------------------------|-------------------------------|--|
| Sector centred on N  |              |                                    |                                    |                               |  |
| 1                    | 4.7          | 7.1                                | 9.8                                | 9.3                           | 12.2                                   |
| 5                    | 5.9          | 7.5                                | 10.9                               | 11.7                          | 13.8                                   |
| 10                   | 6.2          | 7.6                                | 11.2                               | 12.3                          | 14.1                                   |
| 50                   | 6.8          | 7.7                                | 11.6                               | 13.5                          | 14.7                                   |
| 100                  | 7.0          | 7.8                                | 11.8                               | 13.9                          | 15.0                                   |
| Sector centred on NE |              |                                    |                                    |                               |  |
| 1                    | 4.6          | 7.2                                | 9.7                                | 9.1                           | 12.1                                   |
| 5                    | 5.3          | 7.5                                | 10.3                               | 10.4                          | 13.0                                   |
| 10                   | 5.5          | 7.7                                | 10.6                               | 10.9                          | 13.3                                   |
| 50                   | 6.1          | 7.9                                | 11.0                               | 12.0                          | 13.9                                   |
| 100                  | 6.3          | 8.0                                | 11.2                               | 12.5                          | 14.2                                   |
| Sector centred on E  |              |                                    |                                    |                               |  |
| 1                    | 2.2          | 4.1                                | 10.0                               | 4.6                           | 8.6                                    |
| 5                    | 2.7          | 4.6                                | 10.0                               | 5.5                           | 9.4                                    |
| 10                   | 2.9          | 4.8                                | 10.0                               | 5.9                           | 9.8                                    |
| 50                   | 3.4          | 5.3                                | 10.0                               | 7.0                           | 10.6                                   |
| 100                  | 3.7          | 5.4                                | 10.0                               | 7.4                           | 10.9                                   |
| Sector centred on SE |              |                                    |                                    |                               |  |
| 1                    | 1.7          | 4.0                                | 10.7                               | 3.6                           | 7.6                                    |
| 5                    | 2.0          | 4.0                                | 10.7                               | 4.0                           | 8.1                                    |
| 10                   | 2.0          | 4.0                                | 10.7                               | 4.2                           | 8.2                                    |
| 50                   | 2.2          | 4.0                                | 10.7                               | 4.5                           | 8.5                                    |
| 100                  | 2.2          | 4.0                                | 10.7                               | 4.6                           | 8.6                                    |
| Sector centred on S  |              |                                    |                                    |                               |  |
| 1                    | 1.4          | 4.4                                | 10.8                               | 2.9                           | 6.8                                    |
| 5                    | 1.6          | 4.4                                | 11.0                               | 3.3                           | 7.3                                    |
| 10                   | 1.7          | 4.4                                | 11.0                               | 3.4                           | 7.4                                    |
| 50                   | 1.8          | 4.4                                | 11.1                               | 3.7                           | 7.7                                    |
| 100                  | 1.9          | 4.4                                | 11.1                               | 3.8                           | 7.8                                    |
| Sector centred on SW |              |                                    |                                    |                               |  |
| 1                    | 5.0          | 7.0                                | 10.5                               | 9.9                           | 12.6                                   |
| 5                    | 6.0          | 7.1                                | 11.4                               | 11.9                          | 13.9                                   |
| 10                   | 6.2          | 7.1                                | 11.5                               | 12.3                          | 14.1                                   |
| 50                   | 6.5          | 7.2                                | 11.8                               | 13.0                          | 14.5                                   |
| 100                  | 6.6          | 7.2                                | 11.8                               | 13.1                          | 14.6                                   |
| Sector centred on W  |              |                                    |                                    |                               |  |
| 1                    | 5.7          | 7.7                                | 10.9                               | 11.3                          | 13.5                                   |
| 5                    | 6.2          | 8.0                                | 11.5                               | 12.3                          | 14.1                                   |
| 10                   | 6.4          | 8.2                                | 11.7                               | 12.7                          | 14.3                                   |
| 50                   | 6.8          | 8.4                                | 12.2                               | 13.4                          | 14.7                                   |
| 100                  | 7.0          | 8.5                                | 12.3                               | 13.8                          | 14.9                                   |

<sup>2</sup> These are average wave periods. The expected variability is  $\pm 1s$

<sup>3</sup> This sea-state  $H_{max}$  was computed based on Reference 7

<sup>4</sup>  $T_{ass}$  was computed based on an average steepness of 0.04, derived from individual wave height climate

|                      | $H_s$<br>(m) | absolute $T_z$<br>(s) <sup>2</sup> | absolute $T_p$<br>(s) <sup>2</sup> | $H_{max}$<br>(s) <sup>3</sup> | absolute $T_{ass}$<br>(s) <sup>4</sup> |
|----------------------|--------------|------------------------------------|------------------------------------|-------------------------------|--|
| Sector centred on NW |              |                                    |                                    |                               |  |
| 1                    | 4.7          | 6.4                                | 10.2                               | 9.3                           | 12.3                                   |
| 5                    | 5.5          | 6.8                                | 11.0                               | 11.0                          | 13.3                                   |
| 10                   | 5.7          | 6.9                                | 11.1                               | 11.4                          | 13.6                                   |
| 50                   | 6.1          | 7.0                                | 11.5                               | 12.2                          | 14.0                                   |
| 100                  | 6.3          | 7.1                                | 11.6                               | 12.5                          | 14.2                                   |
| All directions       |              |                                    |                                    |                               |  |
| 1                    | 5.9          | 7.5                                | 11.2                               | 11.7                          | 13.7                                   |
| 5                    | 6.4          | 7.5                                | 11.7                               | 12.7                          | 14.3                                   |
| 10                   | 6.6          | 7.5                                | 11.8                               | 13.0                          | 14.5                                   |
| 50                   | 6.9          | 7.5                                | 12.2                               | 13.8                          | 14.9                                   |
| 100                  | 7.1          | 7.5                                | 12.3                               | 14.1                          | 15.1                                   |

**Table 23 Factors to estimate month dependent extreme wave heights from the overall extreme values given in Table 22**

| Month     | Factor |
|-----------|--------|
| January   | 0.96   |
| February  | 0.94   |
| March     | 0.76   |
| April     | 0.76   |
| May       | 0.63   |
| June      | 0.54   |
| July      | 0.61   |
| August    | 0.53   |
| September | 0.65   |
| October   | 0.81   |
| November  | 0.80   |
| December  | 0.97   |



## *Figures*



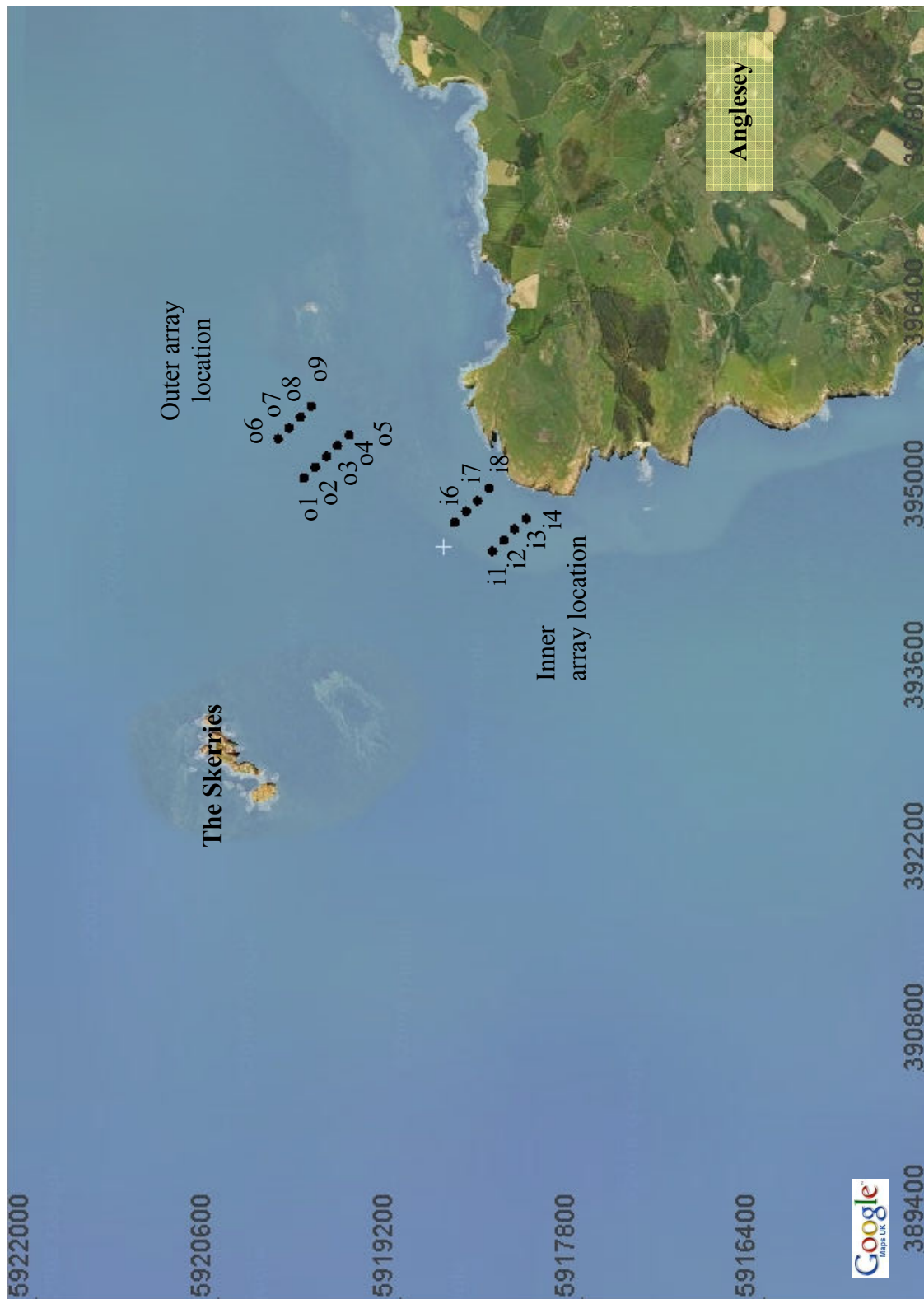


Figure 1 Aerial view of The Skerries, Anglesey and proposed turbine array locations

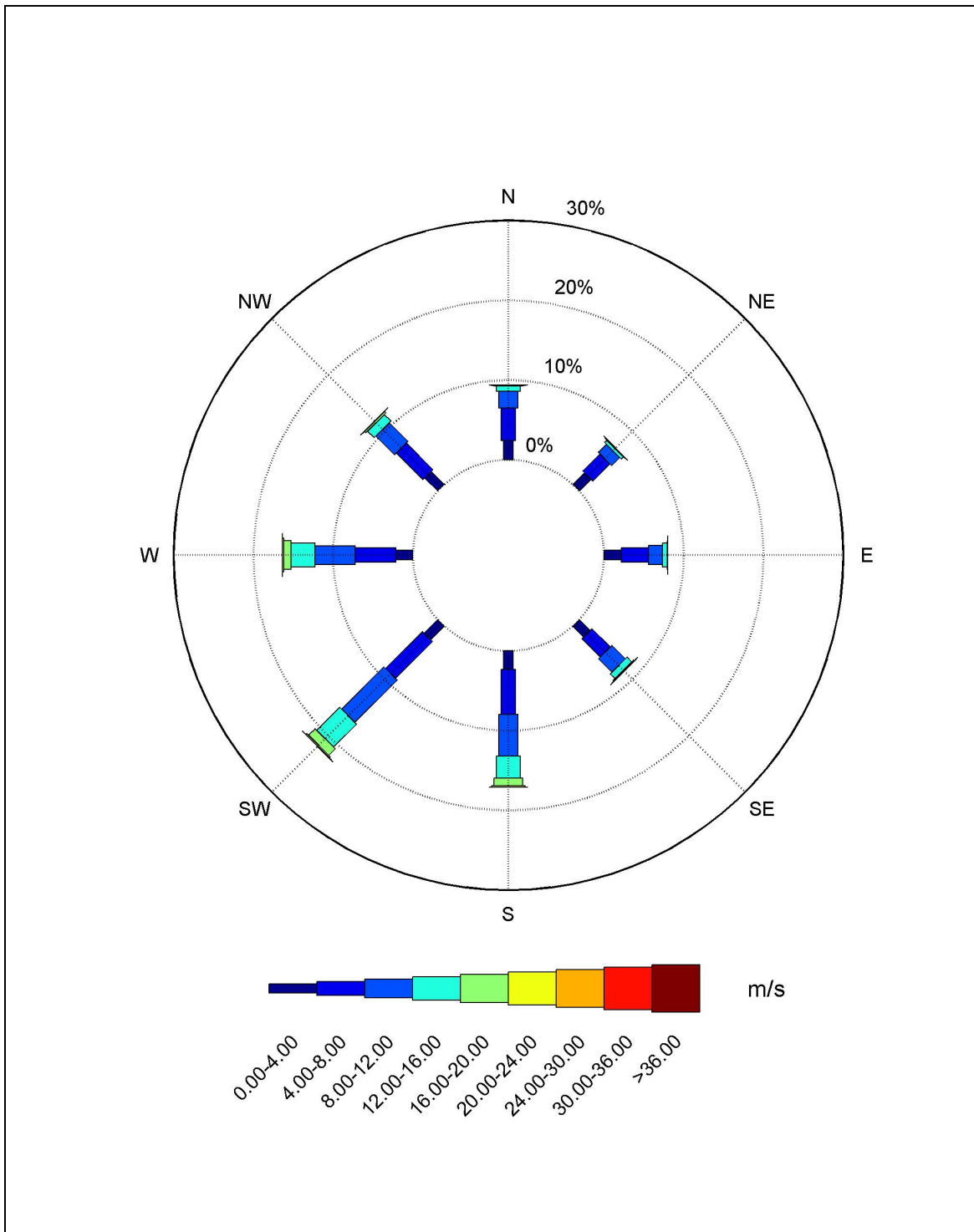


Figure 2 Offshore wind rose at the UK Met Office European Model Data Point 53.5°N 4.87°W

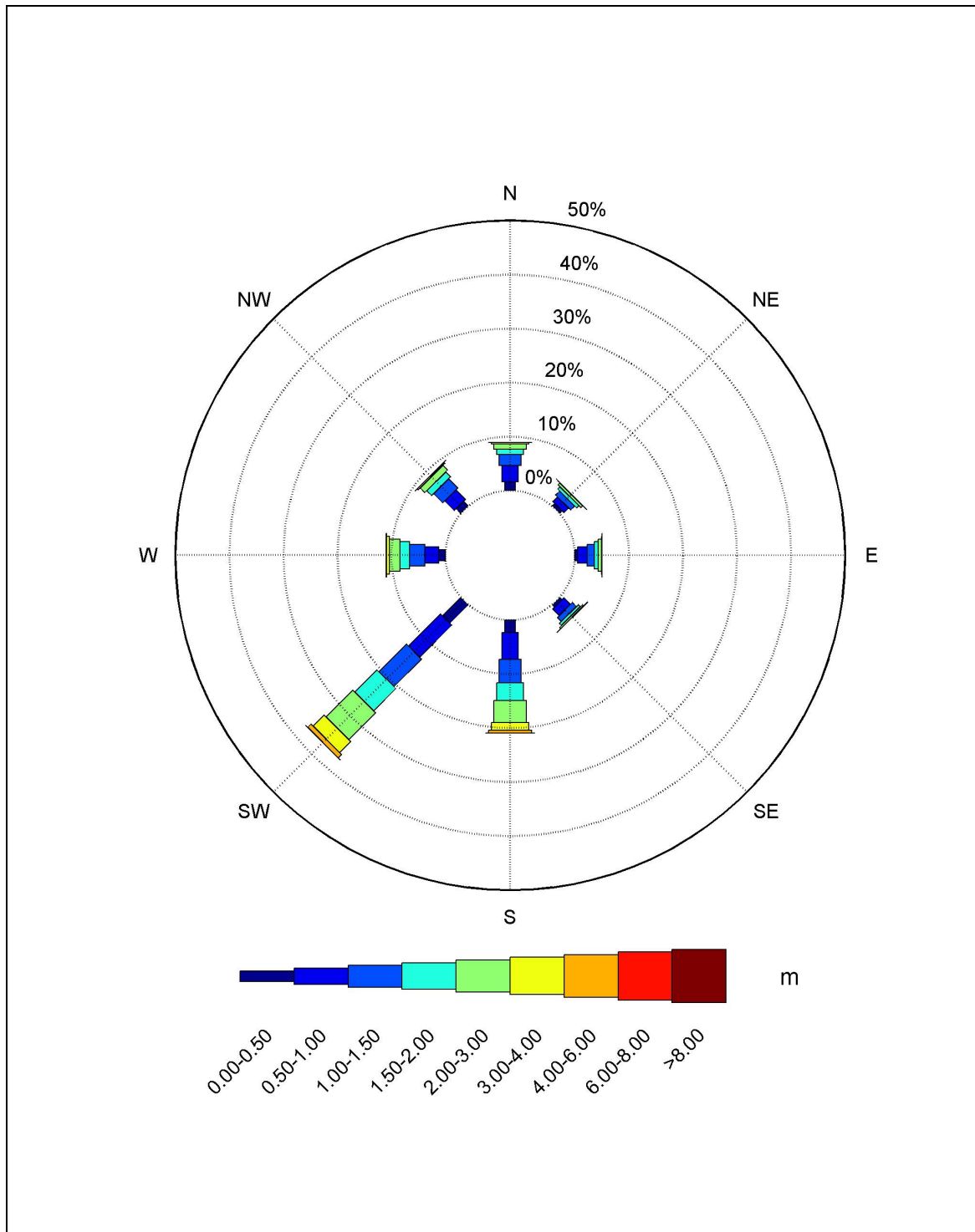


Figure 3 Offshore wave rose at the UK Met Office European Model Data Point 53.5°N 4.87°W



Figure 4 Extent and grid resolution of the wave model of The Skerries

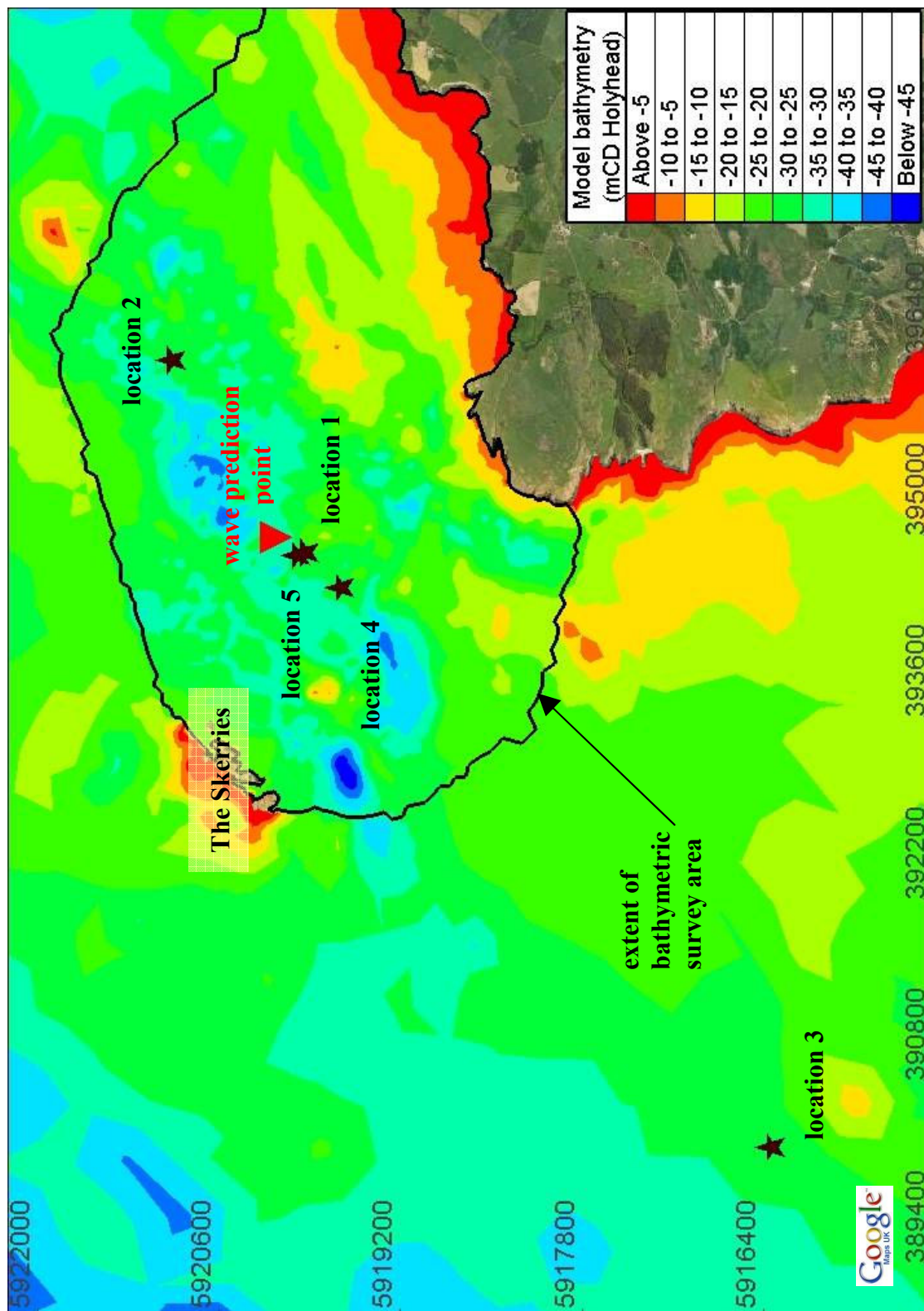


Figure 5 Representation of the bathymetry around The Skerries in the wave model

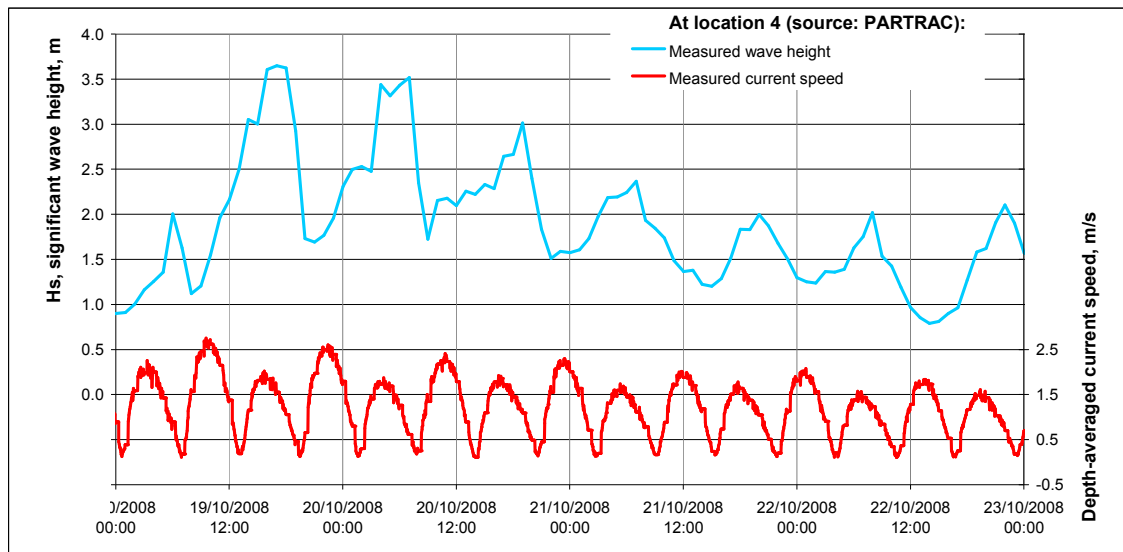
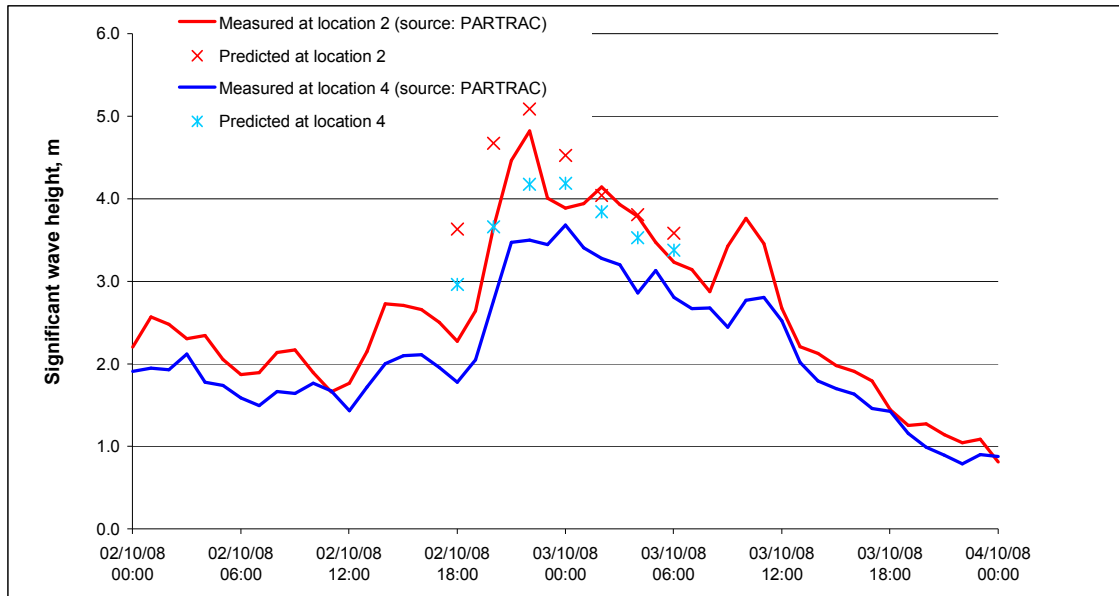
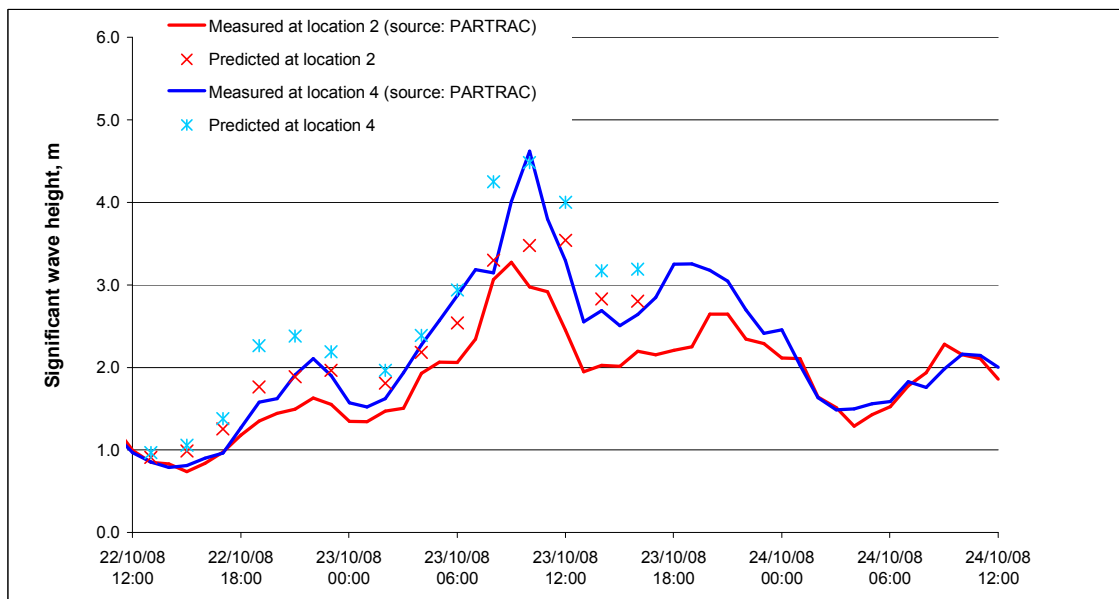


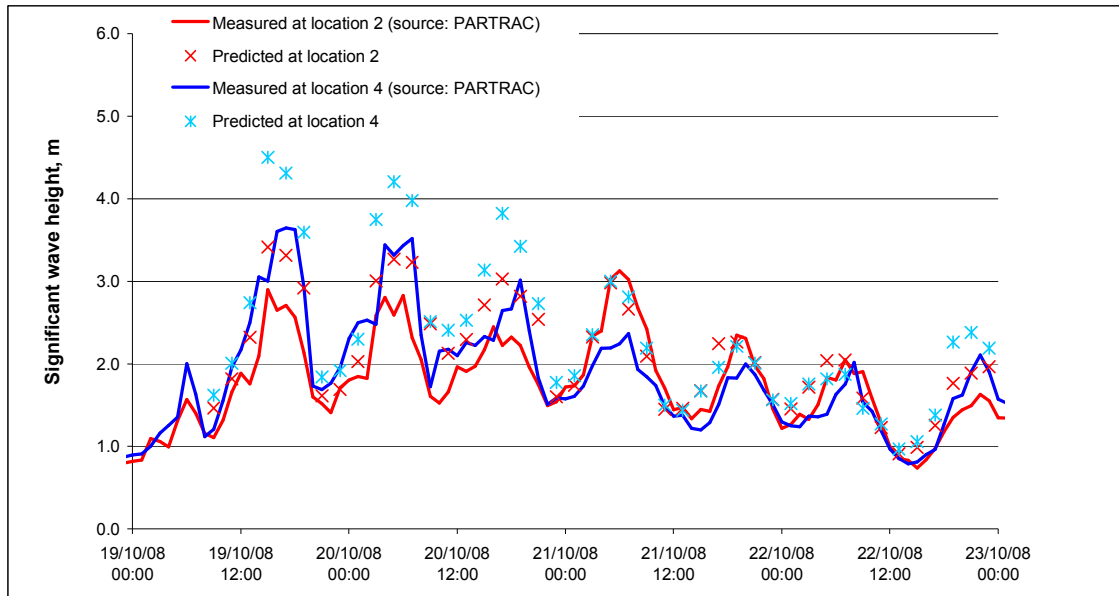
Figure 6 Extract of the measured data at location 4 around a period of high waves



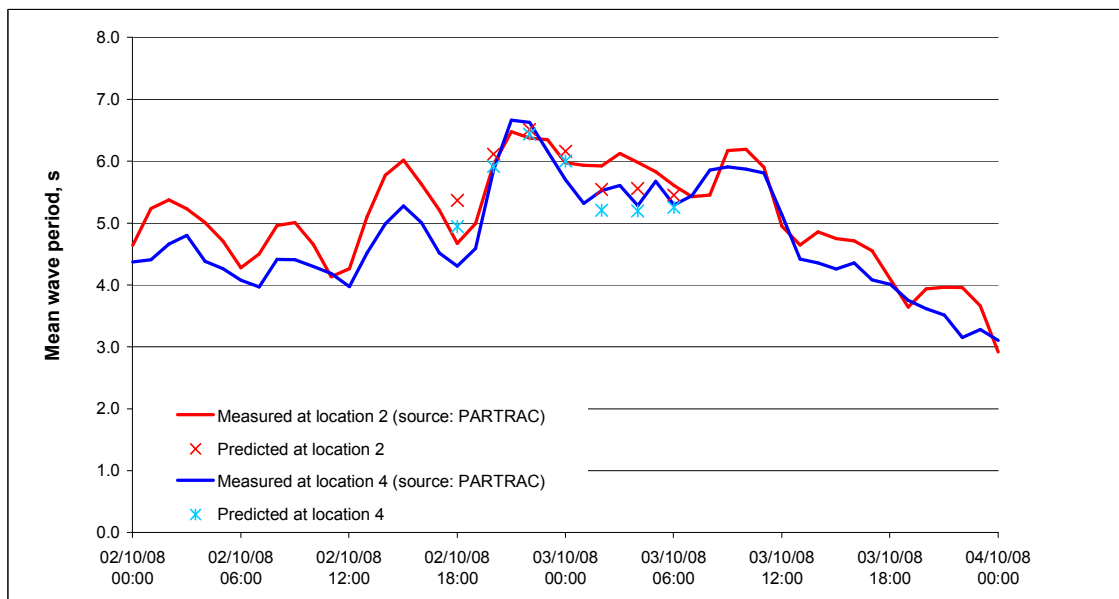
**Figure 7 Validation of the wave model: Significant wave height at locations 2 and 4, October 2 to October 4, 2008**



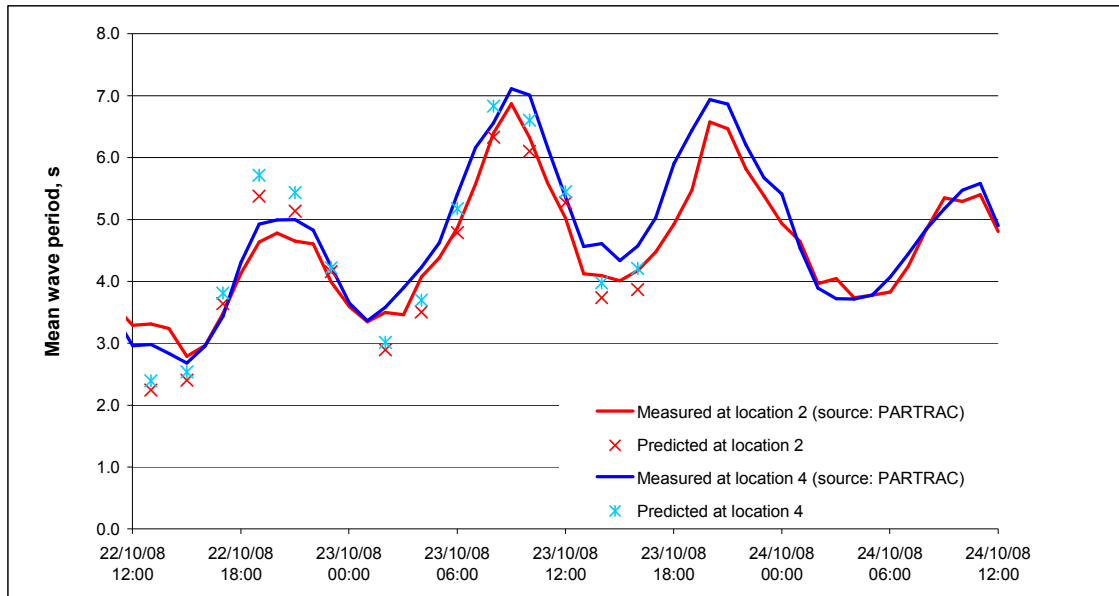
**Figure 8 Validation of the wave model: Significant wave height at locations 2 and 4, October 22 to October 24, 2008**



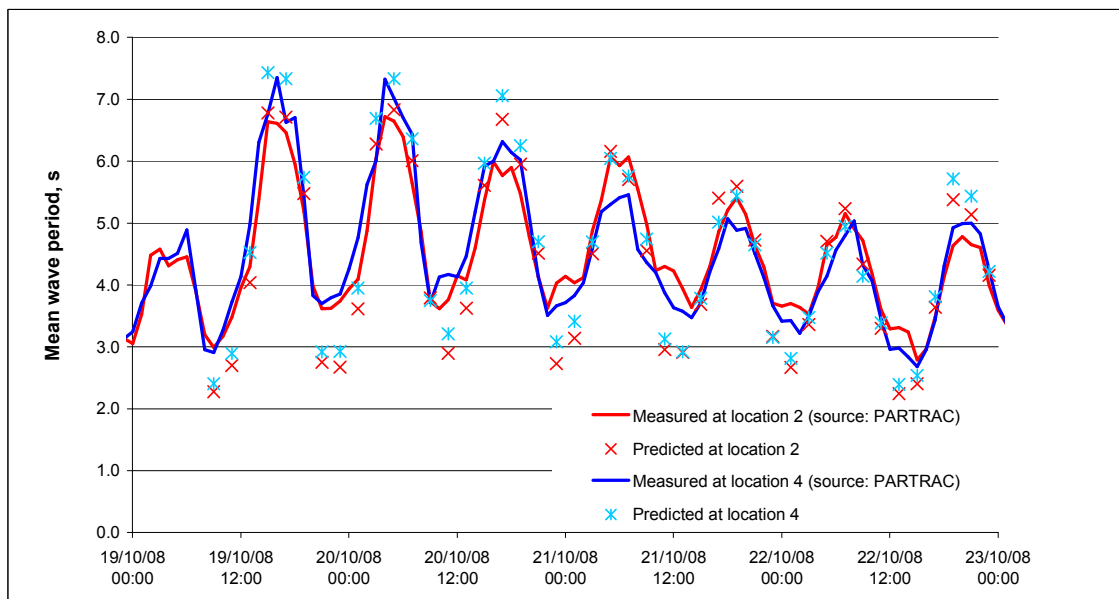
**Figure 9 Validation of the wave model: Significant wave height at locations 2 and 4, October 19 to October 23, 2008**



**Figure 10 Validation of the wave model: Mean wave period at locations 2 and 4, October 2 to October 4, 2008**



**Figure 11 Validation of the wave model: Mean wave period at locations 2 and 4, October 22 to October 24, 2008**



**Figure 12 Validation of the wave model: Mean wave period at locations 2 and 4, October 19 to October 23, 2008**

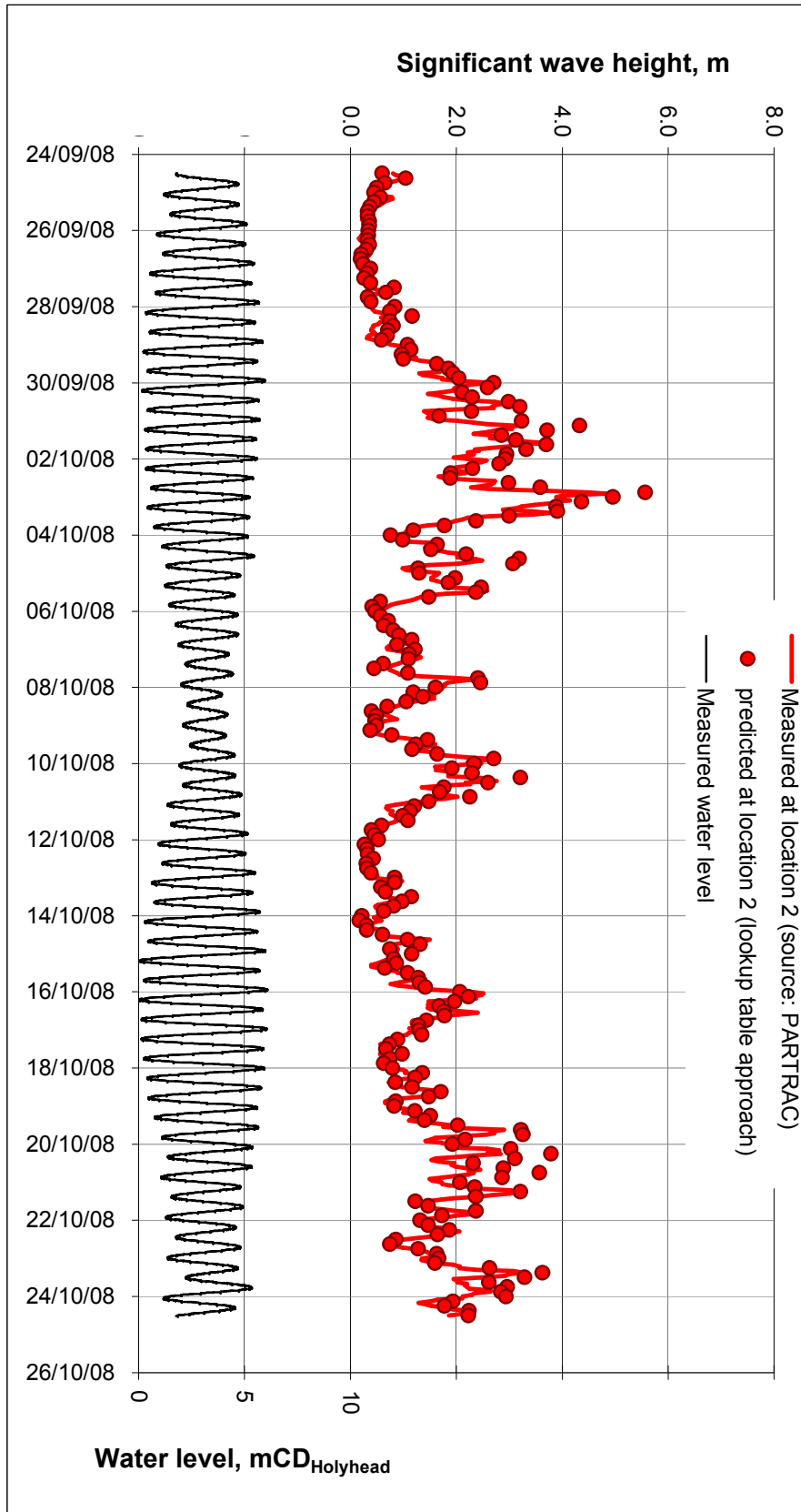


Figure 13 Validation of the methodology: Significant wave height at location 2, September 24 to October 24, 2008

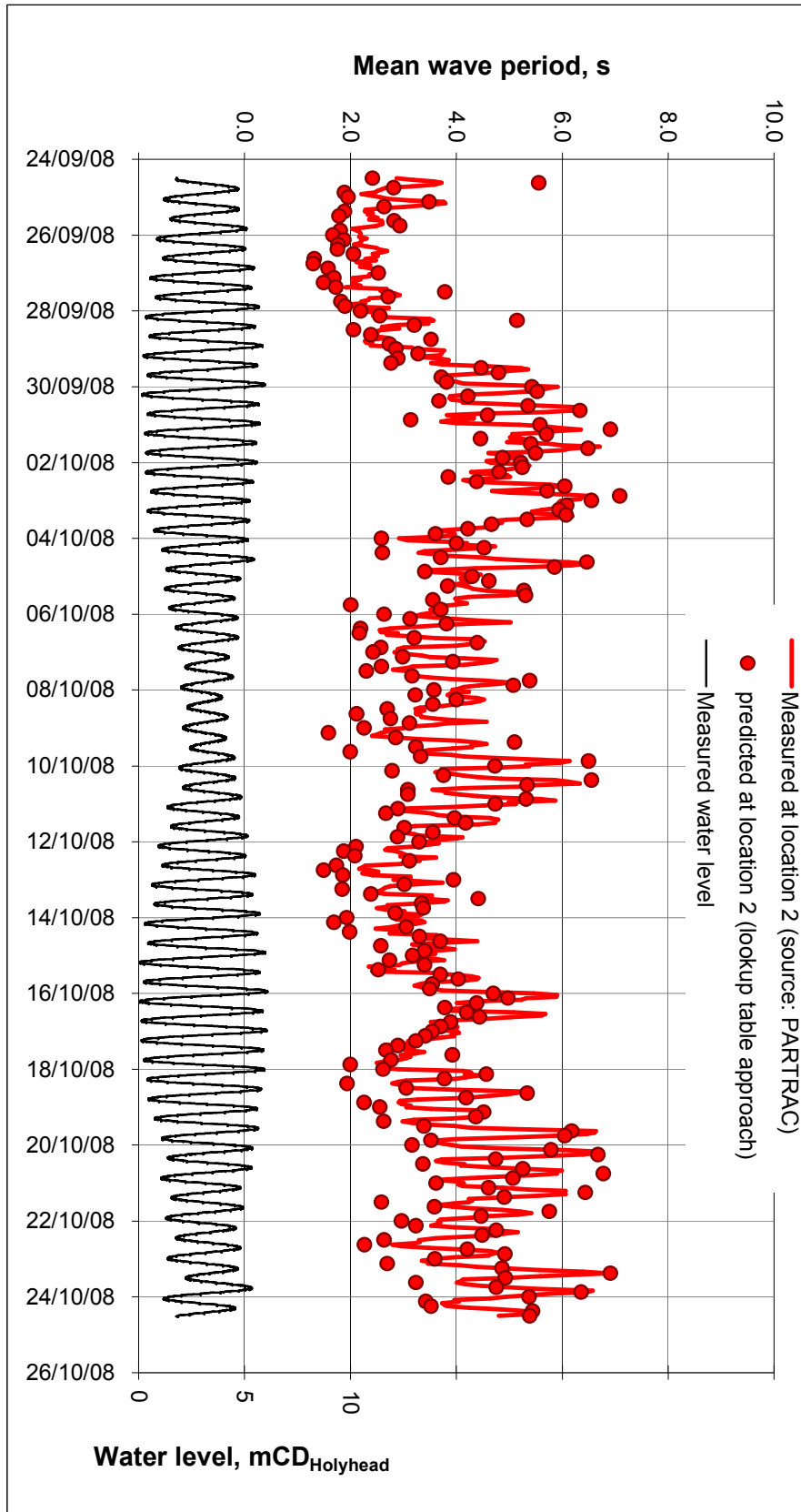
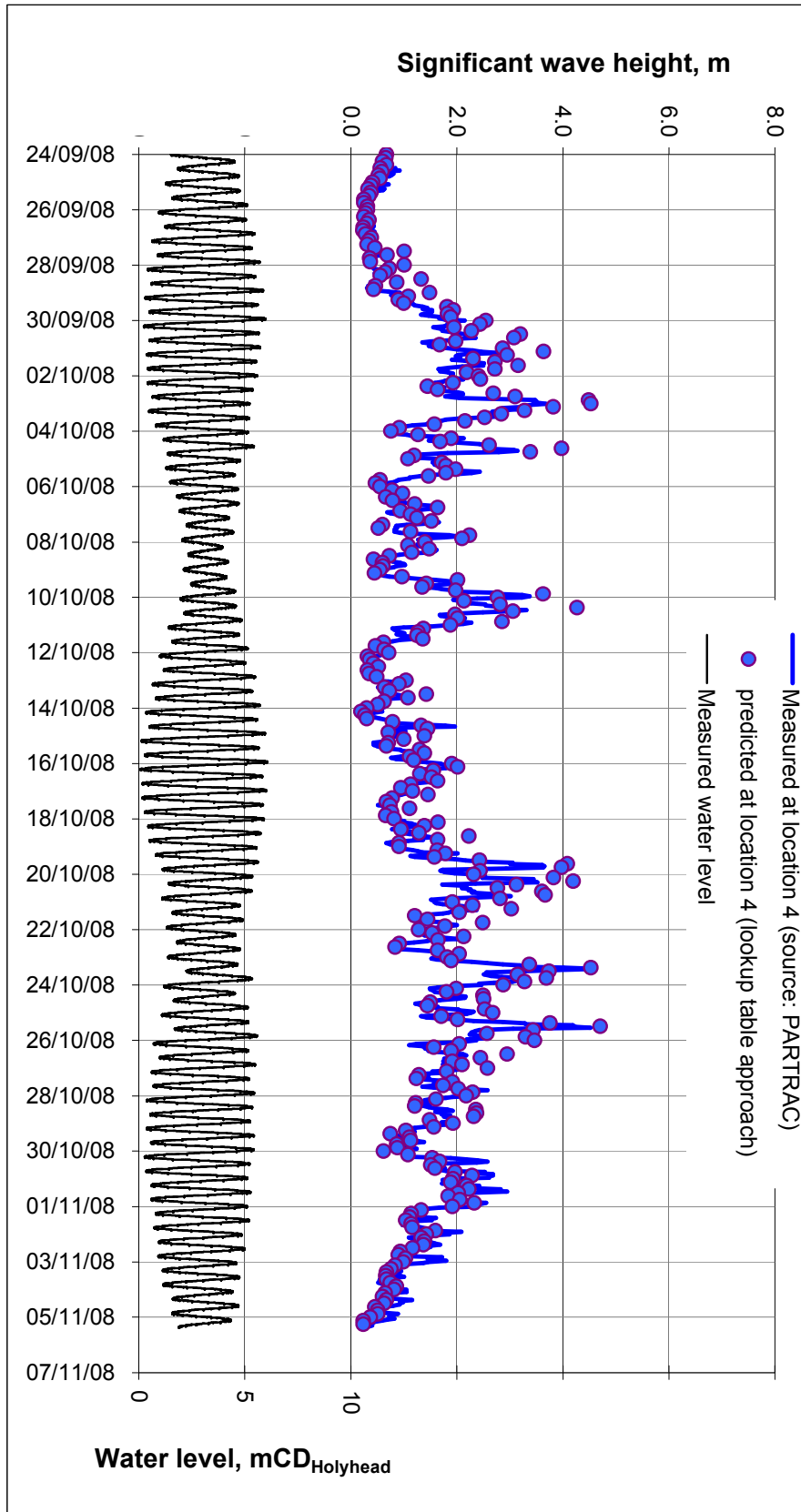


Figure 14 Validation of the methodology: Mean wave period at location 2, September 24 to October 24, 2008



**Figure 15 Validation of the methodology: Significant wave height at location 4, September 24 to November 5, 2008**

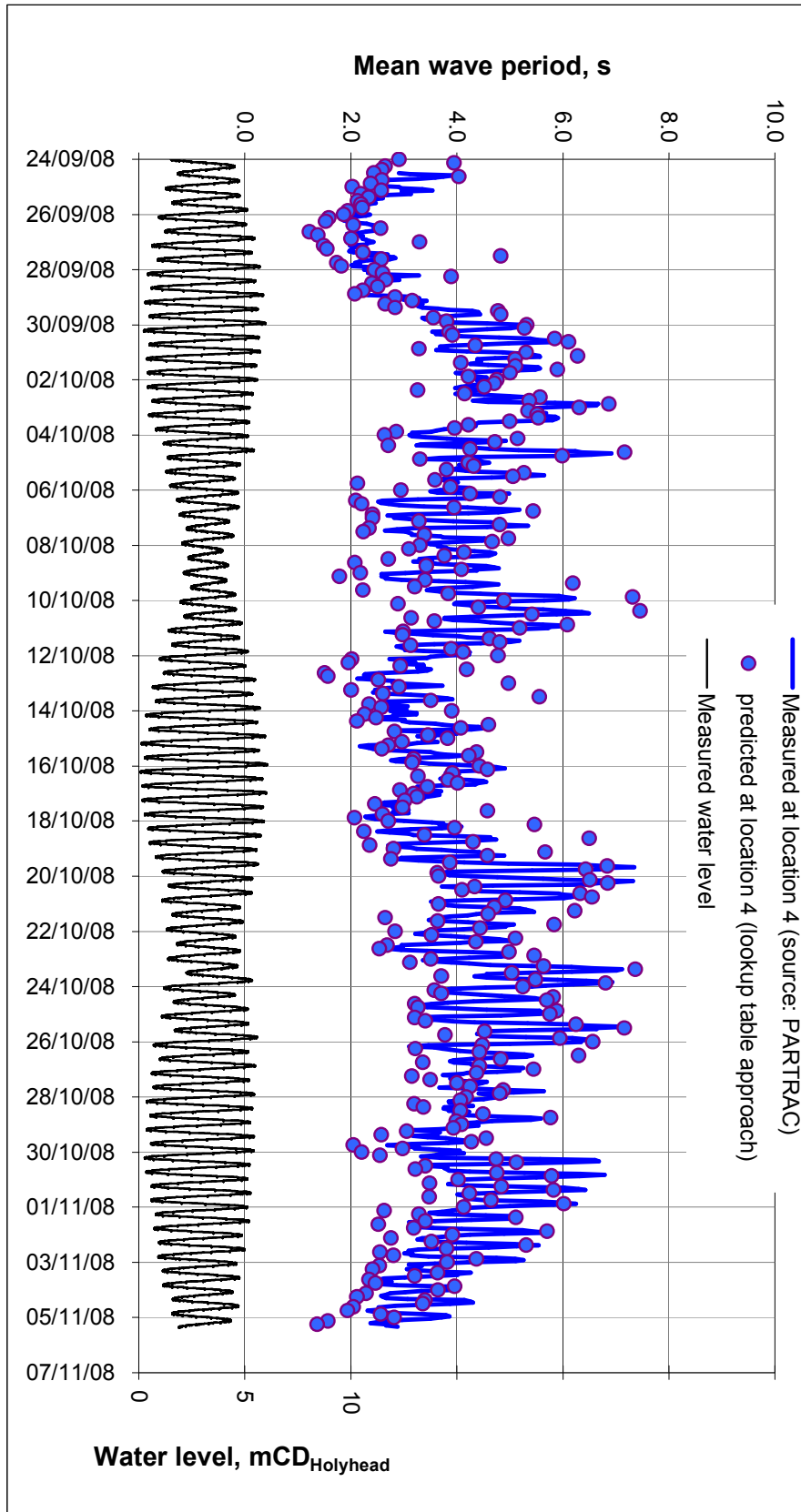
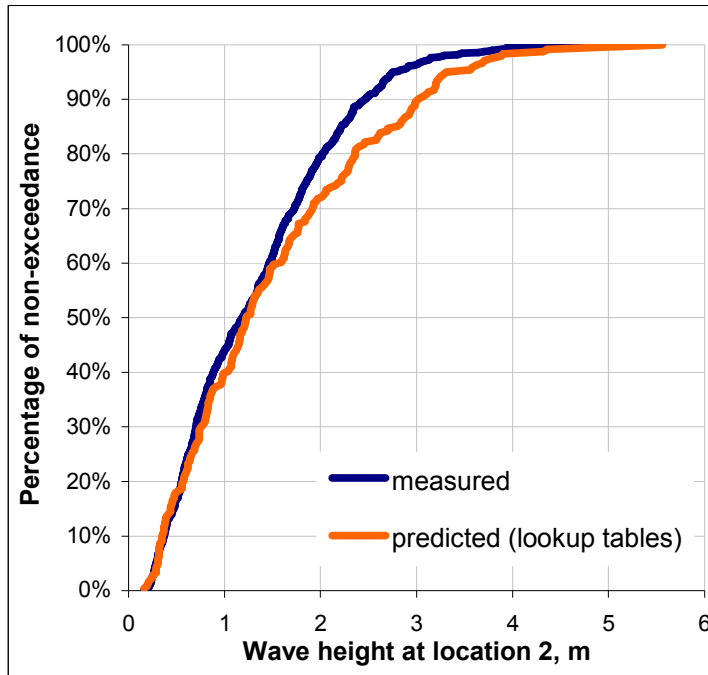


Figure 16 Validation of the methodology: Mean wave period at location 4, September 24 to November 5, 2008

a)



b)

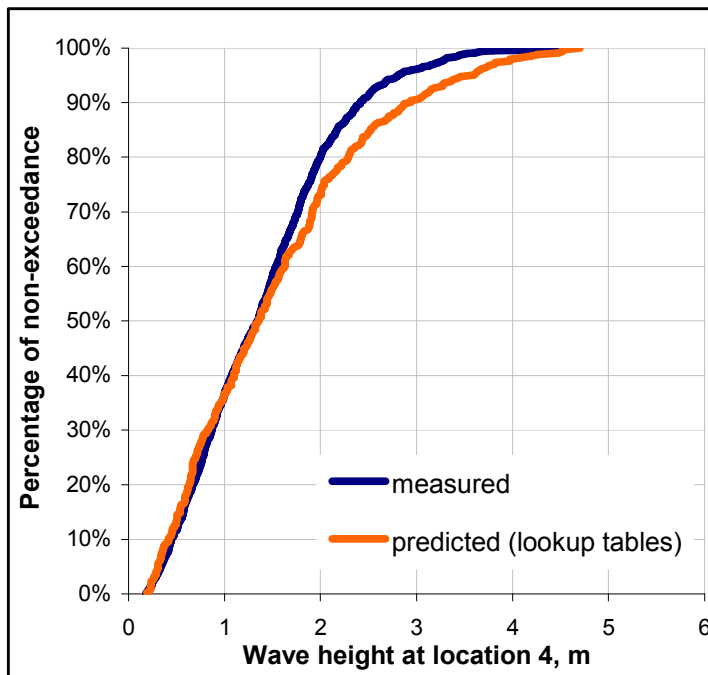
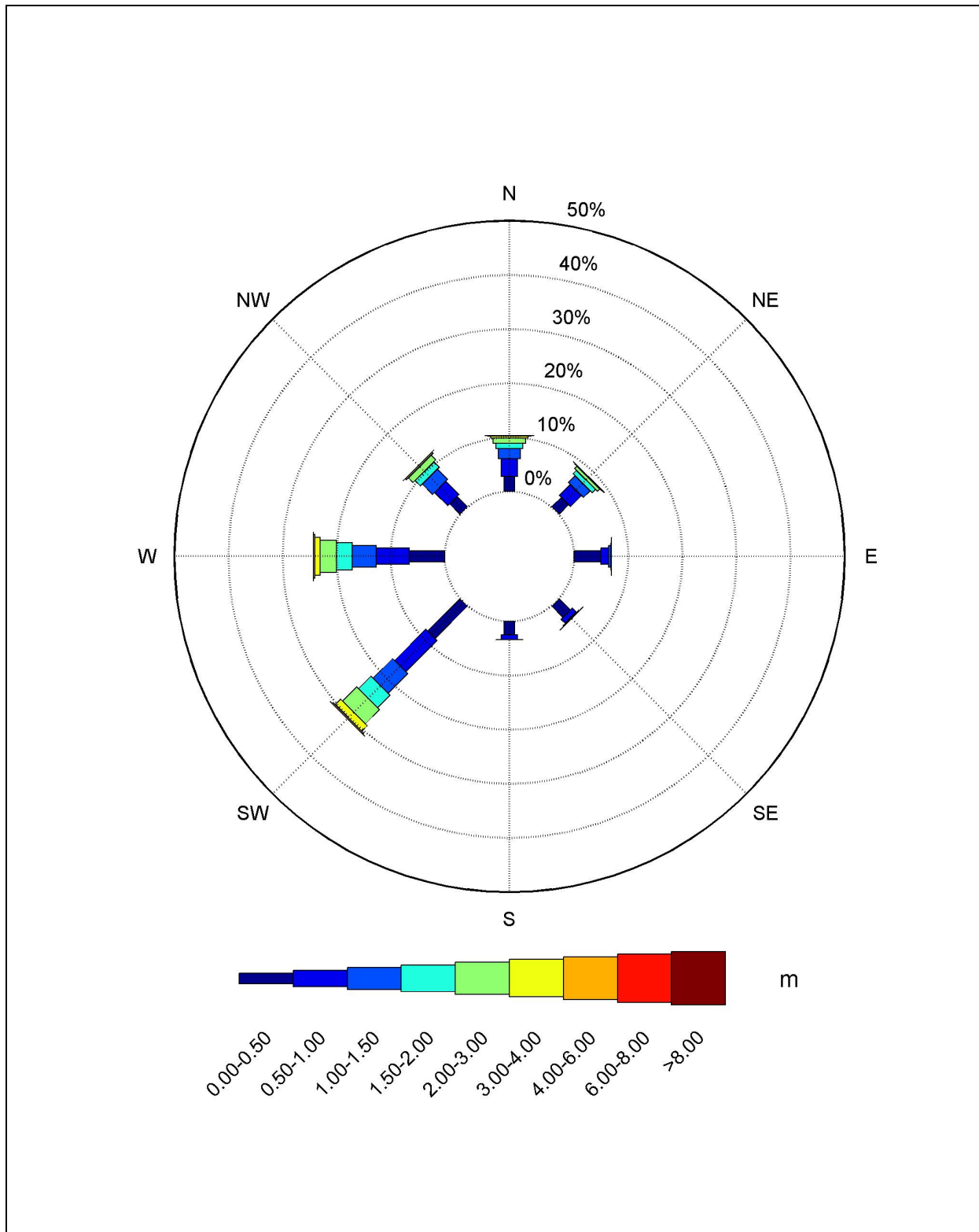


Figure 17 Validation of the methodology: Percentage of non-exceedance of significant wave height predicted by the wave model a) at location 2 and b) at location 4



**Figure 18** Wave rose at the site: 5920160. N 394982. E



## *Appendices*



## Appendix 1 *The SWAN wave transformation model*

### Introduction

SWAN is a computational spectral wave transformation model. It can be used to obtain realistic estimates of wave parameters in coastal areas, lakes and estuaries from given wind, seabed, and current conditions. The model has been developed by the Technical University of Delft (TU Delft).

SWAN is based on a fully spectral representation of the wave action balance equation (or energy balance in the absence of currents) with all physical processes modelled explicitly. No a priori limitations are imposed on the spectral evolution. This makes SWAN (Simulating WAVes Nearshore) a third-generation wave model.

The model has been used successfully at numerous sites around the UK and in other parts of the world. It is designed to represent the following wave propagation processes:

- refraction due to spatial variations in seabed and current,
- shoaling due to spatial variations in seabed and current,
- blocking and reflections by opposing currents,
- transmission through, blockage by or reflection from obstacles (such as coastlines or breakwaters).

The following wave generation and dissipation processes are also represented in SWAN:

- generation by wind,
- dissipation by whitecapping,
- dissipation by depth-induced wave breaking,
- dissipation by seabed friction,
- wave-wave interactions (quadruplets and triads),
- obstacles.

Diffraction is not represented in SWAN, so the model should not be used in areas where variations in wave height are large within a horizontal scale of a few wavelengths. Because of this, the wave field computed by SWAN will generally not be accurate in the immediate vicinity of obstacles.

The SWAN wave model has been conceived to be a computationally feasible third-generation spectral wave model for waves in shallow water (including the surf zone) with ambient currents.

### The SWAN wave model

The SWAN model represents the waves in terms of the two-dimensional wave action density spectrum  $N(\sigma, \vartheta)$ , even when nonlinear phenomena dominate (e.g., in the surf zone). The independent variables are the relative frequency  $\sigma$  (as observed in a frame of reference moving with the action propagation velocity) and the wave direction  $\vartheta$  (the direction normal to the wave crest of each spectral component). The action density is equal to the energy density divided by the relative frequency:  $N(\sigma, \vartheta) = E(\sigma, \vartheta) / \sigma$ .

In SWAN the two-dimensional wave action density spectrum may vary in time and space. Its evolution is described by the spectral action balance equation, which for Cartesian coordinates is (e.g. Hasselmann et al., 1973):

$$\frac{\partial}{\partial t} N + \frac{\partial}{\partial x} C_x N + \frac{\partial}{\partial y} C_y N + \frac{\partial}{\partial \sigma} C_\sigma N + \frac{\partial}{\partial \vartheta} C_\vartheta N = \frac{S(\sigma, \vartheta)}{\sigma} \quad (1)$$

The first term in the left-hand side represents the local rate of change of action density in time. The second and third term represent propagation of action in geographical  $x$ - and  $y$ -space (with propagation velocities  $C_x$  and  $C_y$ , respectively). The fourth term represents shifting of the relative frequency due to variations in depths and currents in time (with propagation velocity  $C_\sigma$  in  $\sigma$ -space). The fifth term represents propagation of action in  $\vartheta$ -space (depth-induced and current-induced refraction) with propagation velocity  $C_\vartheta$ . The expressions for these propagation speeds are taken from linear wave theory. The term  $S(\sigma, \vartheta)$  at the right hand side of the action balance equation is the source term representing the effects of generation, dissipation and non-linear wave-wave interactions.

The formulations for the generation, the dissipation and the quadruplet wave-wave interactions are taken from the WAM model (WAM Cycle3, WAMDI group, 1988, and optionally WAM Cycle4, Komen et al., 1994). These are supplemented with a spectral version of the dissipation model for depth-induced breaking of Battjes and Janssen (1978) and a more recently formulated discrete interaction approximation for the triad wave-wave interactions (Eldeberky and Battjes, 1995).

#### Transfer of wind energy to the waves

The transfer of wind energy to the waves is described in SWAN with a resonance mechanism (Phillips, 1957) and a feed-back mechanism (Miles, 1957). The corresponding source term for these mechanisms is commonly described as the sum of linear and exponential growth:

$$S_{in}(\sigma, \vartheta) = A + B \times E(\sigma, \vartheta) \quad (2)$$

in which  $A$  and  $B$  depend on wave frequency and direction, and wind speed and direction. The effects of currents are accounted for in SWAN by using the apparent local wind speed and direction. The expression for the term  $A$  is due to Cavaleri and Malanotte-Rizzoli (1981, revised by Tolman, 1992). Two optional expressions for the coefficient  $B$  are used in the model. The first is due to Snyder et al. (1981), re-scaled in terms of friction velocity by Komen et al. (1984). The second expression is due to Janssen (1991) and accounts explicitly for the interaction between the wind and the waves by considering atmospheric boundary layer effects and the roughness length of the sea surface.

#### Whitecapping

Whitecapping is primarily controlled by the steepness of the waves. In presently operating third-generation wave models (including SWAN) the whitecapping formulations are based on a pulse-based model (Hasselmann, 1974), as adapted by the WAMDI group (1988):

$$S_{ds,w}(\sigma, \vartheta) = -\Gamma \frac{\tilde{\sigma}}{\tilde{k}} E(\sigma, \vartheta) \quad (3)$$

where  $\Gamma$  is a steepness dependent coefficient,  $k$  is wave number and  $\tilde{\sigma}$  and  $\tilde{k}$  denote a mean frequency and a mean wave number, respectively (cf. the WAMDI group, 1988). The value of  $\Gamma$  depends on the wind input formulation that is used. Since two expressions are used for the wind input in SWAN, two values for  $\Gamma$  are used. The first is due to Komen et al. (1984), and

is used in SWAN when the wind input coefficient of Komen et al. (1984) is used. The second expression is an adaptation of this expression based on Janssen (1991). It is used when the wind input term of Janssen (1991) is used.

### Depth-induced dissipation

Depth induced-dissipation may be caused by seabed friction, by seabed motion, by percolation or by back-scattering on seabed irregularities. For continental shelf seas with sandy seabeds, the dominant mechanism appears to be seabed friction, which can generally be represented as:

$$S_{ds,b}(\sigma, \vartheta) = -c_{bed} \frac{\sigma^2}{g^2 \sinh^2(kd)} E(\sigma, \vartheta) \quad (4)$$

in which  $c_{bed}$  is a seabed friction coefficient. A large number of models has been proposed. Hasselmann et al. (JONSWAP, 1973) suggested use of an empirically obtained constant. This seems to perform well in many different conditions as long as a suitable value is chosen (typically different for swell and wind sea; Bouws and Komen, 1983). A nonlinear formulation based on drag has been proposed by Hasselmann and Collins (1968), which was later simplified by Collins (1972), and is also implemented in SWAN. More complicated, eddy viscosity models have been developed by Madsen et al. (1988). The effect of a mean current on the wave energy dissipation due to seabed friction is not taken into account in SWAN.

### Depth-induced wave breaking

Although the process of depth-induced wave breaking is still poorly understood and little is known about its spectral modelling, the total dissipation (i.e. integrated over the spectrum) can be well modelled with the dissipation of a bore applied to the breaking waves in a random field. And laboratory observations show that the shape of initially uni-modal spectra propagating across simple (barred) beach profiles is fairly insensitive to depth-induced breaking. This has led Eldeberky and Battjes (1995) to formulate a spectral version of the bore model of Battjes and Janssen (1978) which conserves the spectral shape. Their expression has been expanded in the SWAN model to include direction:

$$S_{ds,br}(\sigma, \vartheta) = \frac{D_{tot}}{E_{tot}} E(\sigma, \vartheta) \quad (5)$$

in which  $E_{tot}$  is the total wave energy and  $D_{tot}$  (which is negative) is the rate of dissipation of the total energy due to wave breaking according to Battjes and Janssen (1978). The value of  $D_{tot}$  depends critically on the breaking parameter  $\gamma = H_{max} / d$  (in which  $H_{max}$  is the maximum possible individual wave height in the local water depth  $d$ ). In SWAN  $\gamma$  has a constant value (default is 0.73 corresponding to the mean value of the data set of Battjes and Stive, 1985).

### Wave transmission

SWAN can estimate wave transmission through a structure such as a breakwater. Since obstacles usually have a plan area that is too small to be resolved by the bathymetric grid, in SWAN, an obstacle is modelled as a line. The transmission coefficient is defined as the ratio of the (significant) wave height at the downwave side of the breakwater over the (significant) wave height at the upwave side. If the crest of the breakwater is such that waves can pass over, the transmission coefficient is taken from Goda et al. (1967) and is expressed as a function of wave height and freeboard (difference in crest level and water level).

Note that a change in wave frequency is to be expected as well as a change in wave height, since often the process above the breakwater is highly non-linear. But given the little information available, SWAN assumes that the frequencies remain unchanged over an obstacle (only the energy scale of the spectrum is affected and not the spectral shape).

### **Nonlinear wave-wave interactions**

In deep water, quadruplet wave-wave interactions dominate the evolution of the spectrum. They transfer wave energy from the spectral peak to lower frequencies (thus moving the peak frequency to lower values) and to higher frequencies (where the energy is dissipated by whitecapping). In very shallow water, triad wave-wave interactions transfer energy from lower frequencies to higher frequencies often resulting in higher harmonics (Beji and Battjes, 1993; low-frequency energy generation by triad wave-wave interactions is not considered here).

A full computation of the **quadruplet wave-wave interactions** is extremely time consuming and not convenient in any operational wave model. A number of techniques, based on parametric methods or other types of approximations have been proposed to improve computational speed. In SWAN the computations are carried out with the Discrete Interaction Approximation (DIA) of Hasselmann et al. (1985). Eldeberky and Battjes (1995) introduced a discrete triad approximation (DTA) for co-linear waves, obtained by considering only the dominant self-self **triad interactions**. Their model has been verified with flume observations of long-crested, random waves breaking over a submerged bar (Beji and Battjes, 1993) and over a barred beach (Arcilla et al., 1994). A slightly different version, the Lumped Triad Approximation (LTA) was later derived by Eldeberky (1996) and is used in SWAN.

Cycle III of SWAN is stationary and optionally non-stationary, formulated in Cartesian (recommended only for small scales) or spherical (small scales and large scales) coordinates. The stationary mode should be used only for waves with a relatively short residence time in the computational area under consideration (i.e. small travel time of the waves through the region compared to the time scale of the geophysical conditions: wave boundary conditions, wind, tides and storm surge). A quasi-stationary approach can be taken with stationary SWAN computations in a time-varying sequence of stationary conditions.

The current version of SWAN can be used on any scale relevant for wind generated surface gravity waves, as the model now uses more accurate numerical propagation schemes and can compute on spherical co-ordinates (longitude, latitude), allowing calculations in laboratory situations, coastal regions, shelf seas and oceans. However, SWAN is specifically developed for coastal applications, which would usually not require such flexibility in scale. And it must be emphasized that on oceanic scales SWAN is certainly less efficient on oceanic scales than WAVEWATCH III and probably also less efficient than WAM.

Fully implicit numerical schemes are used in the SWAN model for propagation in both geographic and spectral spaces (an iterative, forward-marching, four-sweep technique due to Ris et al., 1994). This scheme is unconditionally stable in contrast with the explicit schemes of conventional spectral wave models.

### **Typical results**

- (i) Colour contour plots of significant wave height,  $H_s$ , and vector plots of mean wave direction over the model area.
- (ii) Tables of  $H_s$ ,  $T_z$ ,  $T_p$  and mean direction at a selection of inshore locations. For example the model can be used to investigate which offshore wave conditions lead to the worst inshore wave heights at a particular site.
- (iii) SWAN also calculates fields of wave-induced forces per unit surface area, wave orbital velocities, and a variety of other parameters. Such results can be used directly as input into a sediment transport model.

- (iv) 2D (frequency and direction) spectrum at a selection of inshore location. Information of this type would normally be required as input to a numerical harbour model or a mathematical model of beach processes. In addition this information would also be needed at the wave paddle positions in a physical model in order to generate the correct random wave sequence for design studies.

## Validation

SWAN has been extensively validated by the developers and user community for a range of academic, laboratory and field cases. The results have appeared in peer reviewed journal papers, for example, Holthuijsen *et al* (1997, 1998), Booij *et al* (1999), Ris *et al* (1999, 2002) and Hsu *et al* (2005).

SWAN is used by many government authorities, research institutes and consultants worldwide to simulate spectral wave transformations for both large-scale deep water and small-scale shallow water applications. At HR Wallingford, the model has been extensively used since 2000.

Whilst the extensive validation and wide usage indicates that SWAN is a robust and accurate model, accurate predictions are reliant on accurate boundary conditions, e.g. the bathymetry, the offshore waves and wind forcing. Where possible it is recommended that SWAN is calibrated and validated against a local source of field measurements.

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## Appendix 2 Monthly wind climates (wind speed against wind direction) at the UK Met Office European Model Data Point 53.5°N 4.87°W

January

Data in parts per hundred thousand

|  |       |         | N   | NE  | E   | SE  | S    | SW   | W    | NW  |
|--|-------|---------|-----|-----|-----|-----|------|------|------|-----|
| 0.00                                     | 1.00  | 0.99254 | 60  | 81  | 101 | 60  | 60   | 81   | 40   | 121 |
| 1.00                                     | 2.00  | 0.98649 | 302 | 262 | 202 | 343 | 302  | 242  | 504  | 141 |
| 2.00                                     | 3.00  | 0.96351 | 363 | 605 | 645 | 484 | 645  | 383  | 323  | 202 |
| 3.00                                     | 4.00  | 0.92702 | 383 | 444 | 625 | 524 | 706  | 343  | 544  | 464 |
| 4.00                                     | 5.00  | 0.88669 | 504 | 423 | 544 | 887 | 665  | 504  | 746  | 524 |
| 5.00                                     | 6.00  | 0.83871 | 524 | 383 | 544 | 927 | 726  | 726  | 706  | 665 |
| 6.00                                     | 7.00  | 0.78669 | 806 | 544 | 988 | 685 | 1028 | 766  | 685  | 806 |
| 7.00                                     | 8.00  | 0.72359 | 685 | 403 | 585 | 484 | 1532 | 1028 | 706  | 585 |
| 8.00                                     | 9.00  | 0.66351 | 544 | 665 | 544 | 685 | 1653 | 1552 | 907  | 504 |
| 9.00                                     | 10.00 | 0.59294 | 464 | 444 | 302 | 565 | 1835 | 1956 | 1371 | 544 |
| 10.00                                    | 11.00 | 0.51815 | 403 | 524 | 363 | 645 | 1996 | 2500 | 1472 | 524 |
| 11.00                                    | 12.00 | 0.43387 | 363 | 343 | 282 | 605 | 1633 | 2177 | 1452 | 504 |
| 12.00                                    | 13.00 | 0.36028 | 282 | 423 | 363 | 444 | 2137 | 2440 | 1794 | 363 |
| 13.00                                    | 14.00 | 0.27782 | 141 | 141 | 403 | 645 | 1794 | 2056 | 1109 | 323 |
| 14.00                                    | 15.00 | 0.21169 | 121 | 141 | 242 | 343 | 1310 | 2218 | 1028 | 242 |
| 15.00                                    | 16.00 | 0.15524 | 40  | 60  | 20  | 161 | 968  | 1976 | 907  | 282 |
| 16.00                                    | 17.00 | 0.11109 | 81  | 20  | 0   | 202 | 867  | 1290 | 645  | 202 |
| 17.00                                    | 18.00 | 0.07802 | 40  | 0   | 0   | 20  | 524  | 1169 | 605  | 60  |
| 18.00                                    | 19.00 | 0.05383 | 20  | 0   | 0   | 121 | 423  | 847  | 585  | 141 |
| 19.00                                    | 20.00 | 0.03246 | 20  | 0   | 0   | 0   | 343  | 544  | 302  | 40  |
| 20.00                                    | 21.00 | 0.01996 | 0   | 0   | 0   | 20  | 242  | 524  | 202  | 0   |
| 21.00                                    | 22.00 | 0.01008 | 0   | 0   | 0   | 20  | 81   | 222  | 101  | 20  |
| 22.00                                    | 23.00 | 0.00565 | 0   | 0   | 0   | 0   | 81   | 101  | 60   | 0   |
| 23.00                                    | 24.00 | 0.00323 | 0   | 0   | 0   | 0   | 0    | 20   | 20   | 0   |
| 24.00                                    | 25.00 | 0.00282 | 0   | 0   | 0   | 0   | 20   | 20   | 40   | 0   |
| 25.00                                    | 26.00 | 0.00202 | 0   | 0   | 0   | 0   | 40   | 0    | 40   | 0   |
| 26.00                                    | 27.00 | 0.00121 | 0   | 0   | 0   | 0   | 0    | 20   | 0    | 0   |
| 27.00                                    | 28.00 | 0.00101 | 0   | 0   | 0   | 0   | 0    | 0    | 20   | 0   |
| 28.00                                    | 29.00 | 0.00081 | 0   | 0   | 0   | 0   | 0    | 0    | 0    | 0   |
| 29.00                                    | 30.00 | 0.00081 | 0   | 0   | 0   | 0   | 0    | 20   | 20   | 0   |
| 30.00                                    | 31.00 | 0.00040 | 0   | 0   | 0   | 0   | 0    | 0    | 0    | 0   |
| 31.00                                    | 32.00 | 0.00040 | 0   | 0   | 0   | 0   | 0    | 0    | 0    | 0   |
| 32.00                                    | 33.00 | 0.00040 | 0   | 0   | 0   | 0   | 0    | 0    | 0    | 0   |
| 33.00                                    | 34.00 | 0.00040 | 0   | 0   | 0   | 0   | 0    | 0    | 0    | 0   |
| 34.00                                    | 35.00 | 0.00040 | 0   | 0   | 0   | 0   | 0    | 40   | 0    | 0   |
| Parts per thousand<br>for each direction |       |         | 61  | 59  | 68  | 89  | 216  | 258  | 169  | 73  |

February

Data in parts per hundred thousand

|  |       |         | N   | NE  | E   | SE  | S    | SW   | W    | NW   |
|--|-------|---------|-----|-----|-----|-----|------|------|------|------|
| 0.00                                     | 1.00  | 0.98739 | 22  | 66  | 44  | 88  | 111  | 22   | 66   | 22   |
| 1.00                                     | 2.00  | 0.98296 | 265 | 288 | 221 | 177 | 420  | 199  | 177  | 288  |
| 2.00                                     | 3.00  | 0.96261 | 509 | 376 | 221 | 332 | 442  | 465  | 376  | 465  |
| 3.00                                     | 4.00  | 0.93075 | 597 | 420 | 332 | 354 | 553  | 841  | 642  | 442  |
| 4.00                                     | 5.00  | 0.88894 | 664 | 531 | 398 | 310 | 841  | 819  | 619  | 1018 |
| 5.00                                     | 6.00  | 0.83695 | 465 | 509 | 575 | 819 | 796  | 1217 | 996  | 996  |
| 6.00                                     | 7.00  | 0.77323 | 863 | 465 | 288 | 553 | 996  | 1416 | 1062 | 929  |
| 7.00                                     | 8.00  | 0.70752 | 553 | 420 | 310 | 996 | 1062 | 1527 | 1460 | 973  |
| 8.00                                     | 9.00  | 0.63451 | 575 | 288 | 376 | 642 | 1062 | 1704 | 1527 | 841  |
| 9.00                                     | 10.00 | 0.56438 | 686 | 442 | 243 | 752 | 973  | 2478 | 1549 | 619  |
| 10.00                                    | 11.00 | 0.48695 | 686 | 487 | 155 | 708 | 1106 | 2699 | 1549 | 774  |
| 11.00                                    | 12.00 | 0.40531 | 929 | 487 | 155 | 730 | 1195 | 2920 | 1549 | 686  |
| 12.00                                    | 13.00 | 0.31881 | 553 | 243 | 177 | 487 | 1040 | 2478 | 1504 | 597  |
| 13.00                                    | 14.00 | 0.24801 | 288 | 354 | 177 | 221 | 1150 | 2279 | 1350 | 442  |
| 14.00                                    | 15.00 | 0.18540 | 155 | 88  | 88  | 177 | 774  | 1748 | 1615 | 376  |
| 15.00                                    | 16.00 | 0.13518 | 199 | 133 | 0   | 0   | 420  | 1283 | 819  | 155  |
| 16.00                                    | 17.00 | 0.10509 | 44  | 22  | 0   | 44  | 487  | 1128 | 796  | 199  |
| 17.00                                    | 18.00 | 0.07788 | 111 | 88  | 0   | 22  | 509  | 951  | 575  | 133  |
| 18.00                                    | 19.00 | 0.05398 | 44  | 66  | 0   | 22  | 465  | 642  | 597  | 111  |
| 19.00                                    | 20.00 | 0.03451 | 66  | 0   | 0   | 0   | 442  | 465  | 310  | 22   |
| 20.00                                    | 21.00 | 0.02146 | 0   | 0   | 0   | 44  | 177  | 177  | 199  | 88   |
| 21.00                                    | 22.00 | 0.01460 | 0   | 0   | 0   | 66  | 177  | 88   | 66   | 22   |
| 22.00                                    | 23.00 | 0.01040 | 0   | 0   | 0   | 22  | 111  | 88   | 155  | 22   |
| 23.00                                    | 24.00 | 0.00642 | 44  | 0   | 0   | 22  | 44   | 66   | 66   | 22   |
| 24.00                                    | 25.00 | 0.00376 | 0   | 0   | 0   | 22  | 22   | 44   | 44   | 0    |
| 25.00                                    | 26.00 | 0.00243 | 0   | 0   | 0   | 0   | 0    | 22   | 44   | 0    |
| 26.00                                    | 27.00 | 0.00177 | 0   | 0   | 0   | 0   | 0    | 0    | 44   | 0    |
| 27.00                                    | 28.00 | 0.00133 | 0   | 0   | 0   | 0   | 0    | 0    | 44   | 0    |
| 28.00                                    | 29.00 | 0.00088 | 0   | 0   | 0   | 0   | 0    | 0    | 0    | 0    |
| 29.00                                    | 30.00 | 0.00088 | 0   | 0   | 0   | 0   | 0    | 0    | 0    | 0    |
| 30.00                                    | 31.00 | 0.00088 | 0   | 0   | 0   | 0   | 0    | 44   | 0    | 0    |
| 31.00                                    | 32.00 | 0.00044 | 0   | 0   | 0   | 0   | 0    | 0    | 0    | 0    |
| 32.00                                    | 33.00 | 0.00044 | 0   | 0   | 0   | 0   | 0    | 0    | 44   | 0    |
| 33.00                                    | 34.00 | 0.00000 | 0   | 0   | 0   | 0   | 0    | 0    | 0    | 0    |
| 34.00                                    | 35.00 | 0.00000 | 0   | 0   | 0   | 0   | 0    | 0    | 0    | 0    |
| Parts per thousand<br>for each direction |       |         | 83  | 58  | 38  | 76  | 154  | 278  | 198  | 102  |

March

Data in parts per hundred thousand

|  |       |         | N   | NE  | E    | SE  | S    | SW   | W    | NW   |
|--|-------|---------|-----|-----|------|-----|------|------|------|------|
| 0.00                                     | 1.00  | 0.98145 | 121 | 60  | 40   | 81  | 20   | 40   | 121  | 20   |
| 1.00                                     | 2.00  | 0.97641 | 282 | 262 | 323  | 161 | 161  | 302  | 282  | 141  |
| 2.00                                     | 3.00  | 0.95726 | 262 | 645 | 302  | 444 | 423  | 403  | 484  | 665  |
| 3.00                                     | 4.00  | 0.92097 | 444 | 363 | 726  | 706 | 948  | 585  | 1028 | 766  |
| 4.00                                     | 5.00  | 0.86532 | 484 | 484 | 746  | 867 | 1431 | 1069 | 968  | 1129 |
| 5.00                                     | 6.00  | 0.79355 | 706 | 726 | 948  | 968 | 1109 | 1290 | 1411 | 1089 |
| 6.00                                     | 7.00  | 0.71109 | 585 | 544 | 1028 | 927 | 1532 | 1653 | 1391 | 1069 |
| 7.00                                     | 8.00  | 0.62379 | 665 | 746 | 766  | 968 | 1593 | 2056 | 1512 | 1129 |
| 8.00                                     | 9.00  | 0.52944 | 484 | 484 | 464  | 988 | 1673 | 2117 | 1532 | 1613 |
| 9.00                                     | 10.00 | 0.43589 | 464 | 423 | 645  | 645 | 1613 | 2480 | 1190 | 1028 |
| 10.00                                    | 11.00 | 0.35101 | 504 | 363 | 585  | 383 | 1452 | 2560 | 1149 | 1089 |
| 11.00                                    | 12.00 | 0.27016 | 363 | 141 | 363  | 464 | 1331 | 1996 | 1653 | 645  |
| 12.00                                    | 13.00 | 0.20060 | 222 | 81  | 383  | 222 | 907  | 1694 | 1190 | 645  |
| 13.00                                    | 14.00 | 0.14718 | 282 | 60  | 222  | 343 | 927  | 1552 | 1048 | 403  |
| 14.00                                    | 15.00 | 0.09879 | 222 | 0   | 282  | 242 | 746  | 1250 | 948  | 262  |
| 15.00                                    | 16.00 | 0.05927 | 40  | 0   | 101  | 202 | 806  | 625  | 444  | 222  |
| 16.00                                    | 17.00 | 0.03488 | 20  | 0   | 40   | 101 | 363  | 323  | 444  | 81   |
| 17.00                                    | 18.00 | 0.02117 | 0   | 0   | 20   | 20  | 242  | 181  | 222  | 121  |
| 18.00                                    | 19.00 | 0.01310 | 0   | 0   | 60   | 40  | 101  | 81   | 121  | 81   |
| 19.00                                    | 20.00 | 0.00827 | 0   | 0   | 20   | 0   | 121  | 60   | 60   | 20   |
| 20.00                                    | 21.00 | 0.00544 | 0   | 0   | 0    | 20  | 20   | 81   | 101  | 40   |
| 21.00                                    | 22.00 | 0.00282 | 0   | 0   | 0    | 0   | 20   | 0    | 20   | 81   |
| 22.00                                    | 23.00 | 0.00161 | 0   | 0   | 0    | 40  | 0    | 20   | 0    | 20   |
| 23.00                                    | 24.00 | 0.00081 | 0   | 0   | 0    | 0   | 0    | 20   | 20   | 0    |
| 24.00                                    | 25.00 | 0.00040 | 0   | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 25.00                                    | 26.00 | 0.00040 | 0   | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 26.00                                    | 27.00 | 0.00040 | 0   | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 27.00                                    | 28.00 | 0.00040 | 0   | 0   | 0    | 0   | 0    | 0    | 40   | 0    |
| 28.00                                    | 29.00 | 0.00000 | 0   | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 30.00                                    | 31.00 | 0.00000 | 0   | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 31.00                                    | 32.00 | 0.00000 | 0   | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 32.00                                    | 33.00 | 0.00000 | 0   | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 33.00                                    | 34.00 | 0.00000 | 0   | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 34.00                                    | 35.00 | 0.00000 | 0   | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| Parts per thousand<br>for each direction |       |         | 61  | 54  | 81   | 88  | 175  | 224  | 174  | 124  |

April

Data in parts per hundred thousand

|  |       |         | N    | NE   | E    | SE   | S    | SW   | W    | NW   |
|--|-------|---------|------|------|------|------|------|------|------|------|
| 0.00                                     | 1.00  | 0.99298 | 285  | 154  | 197  | 219  | 154  | 175  | 110  | 197  |
| 1.00                                     | 2.00  | 0.97807 | 592  | 570  | 702  | 482  | 592  | 482  | 329  | 417  |
| 2.00                                     | 3.00  | 0.93640 | 724  | 789  | 1009 | 724  | 636  | 1009 | 482  | 789  |
| 3.00                                     | 4.00  | 0.87478 | 1623 | 1031 | 1118 | 548  | 965  | 965  | 833  | 1031 |
| 4.00                                     | 5.00  | 0.79364 | 1667 | 1053 | 1118 | 877  | 1513 | 1469 | 811  | 1009 |
| 5.00                                     | 6.00  | 0.69846 | 1206 | 1031 | 1118 | 1140 | 1798 | 1601 | 1075 | 899  |
| 6.00                                     | 7.00  | 0.59978 | 1184 | 1053 | 1118 | 1228 | 1776 | 1996 | 1425 | 702  |
| 7.00                                     | 8.00  | 0.49496 | 921  | 921  | 1053 | 1118 | 2105 | 1776 | 1118 | 855  |
| 8.00                                     | 9.00  | 0.39627 | 1009 | 768  | 965  | 921  | 1557 | 1601 | 987  | 768  |
| 9.00                                     | 10.00 | 0.31053 | 1009 | 439  | 614  | 680  | 1272 | 1711 | 987  | 592  |
| 10.00                                    | 11.00 | 0.23750 | 746  | 570  | 439  | 526  | 1250 | 1623 | 921  | 614  |
| 11.00                                    | 12.00 | 0.17061 | 526  | 417  | 219  | 417  | 1404 | 1250 | 987  | 395  |
| 12.00                                    | 13.00 | 0.11447 | 395  | 241  | 373  | 154  | 899  | 1053 | 877  | 285  |
| 13.00                                    | 14.00 | 0.07171 | 395  | 175  | 88   | 197  | 548  | 395  | 833  | 285  |
| 14.00                                    | 15.00 | 0.04254 | 197  | 110  | 44   | 110  | 307  | 329  | 395  | 285  |
| 15.00                                    | 16.00 | 0.02478 | 263  | 88   | 66   | 88   | 110  | 219  | 175  | 132  |
| 16.00                                    | 17.00 | 0.01338 | 44   | 88   | 0    | 0    | 241  | 66   | 88   | 132  |
| 17.00                                    | 18.00 | 0.00680 | 44   | 88   | 0    | 22   | 66   | 44   | 88   | 0    |
| 18.00                                    | 19.00 | 0.00329 | 0    | 22   | 0    | 0    | 22   | 44   | 22   | 22   |
| 19.00                                    | 20.00 | 0.00197 | 0    | 22   | 0    | 22   | 22   | 22   | 0    | 22   |
| 20.00                                    | 21.00 | 0.00088 | 0    | 0    | 0    | 0    | 22   | 0    | 22   | 0    |
| 21.00                                    | 22.00 | 0.00044 | 0    | 22   | 0    | 0    | 0    | 0    | 0    | 0    |
| 22.00                                    | 23.00 | 0.00022 | 0    | 22   | 0    | 0    | 0    | 0    | 0    | 0    |
| 23.00                                    | 24.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 24.00                                    | 25.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 25.00                                    | 26.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 26.00                                    | 27.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 27.00                                    | 28.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 28.00                                    | 29.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 30.00                                    | 31.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 31.00                                    | 32.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 32.00                                    | 33.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 33.00                                    | 34.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 34.00                                    | 35.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Parts per thousand<br>for each direction |       |         | 128  | 97   | 102  | 95   | 173  | 178  | 126  | 94   |

May

Data in parts per hundred thousand

|  |       |         | N    | NE   | E    | SE  | S    | SW   | W    | NW   |
|--|-------|---------|------|------|------|-----|------|------|------|------|
| 0.00                                     | 1.00  | 0.98918 | 170  | 127  | 233  | 106 | 64   | 106  | 276  | 297  |
| 1.00                                     | 2.00  | 0.97538 | 806  | 806  | 828  | 446 | 594  | 531  | 658  | 382  |
| 2.00                                     | 3.00  | 0.92487 | 1549 | 1188 | 1379 | 764 | 828  | 1188 | 849  | 1125 |
| 3.00                                     | 4.00  | 0.83616 | 1931 | 2313 | 1655 | 785 | 1104 | 1316 | 976  | 1528 |
| 4.00                                     | 5.00  | 0.72008 | 2547 | 2165 | 1549 | 891 | 1210 | 1464 | 1061 | 1634 |
| 5.00                                     | 6.00  | 0.59486 | 2037 | 1740 | 1634 | 722 | 1677 | 1740 | 849  | 1167 |
| 6.00                                     | 7.00  | 0.47920 | 1740 | 1422 | 1952 | 785 | 1252 | 1507 | 997  | 1528 |
| 7.00                                     | 8.00  | 0.36736 | 1252 | 997  | 1486 | 382 | 1295 | 1634 | 849  | 1082 |
| 8.00                                     | 9.00  | 0.27759 | 637  | 552  | 997  | 700 | 1210 | 1422 | 573  | 849  |
| 9.00                                     | 10.00 | 0.20819 | 382  | 573  | 531  | 276 | 934  | 1337 | 764  | 870  |
| 10.00                                    | 11.00 | 0.15153 | 212  | 509  | 573  | 233 | 828  | 1295 | 488  | 891  |
| 11.00                                    | 12.00 | 0.10123 | 212  | 233  | 276  | 255 | 1082 | 997  | 615  | 467  |
| 12.00                                    | 13.00 | 0.05985 | 212  | 42   | 127  | 276 | 679  | 679  | 382  | 212  |
| 13.00                                    | 14.00 | 0.03374 | 149  | 42   | 64   | 64  | 467  | 509  | 170  | 212  |
| 14.00                                    | 15.00 | 0.01698 | 0    | 42   | 127  | 21  | 149  | 318  | 42   | 85   |
| 15.00                                    | 16.00 | 0.00913 | 42   | 0    | 21   | 21  | 233  | 233  | 42   | 0    |
| 16.00                                    | 17.00 | 0.00318 | 0    | 0    | 0    | 0   | 106  | 64   | 0    | 0    |
| 17.00                                    | 18.00 | 0.00149 | 0    | 0    | 0    | 0   | 0    | 42   | 0    | 0    |
| 18.00                                    | 19.00 | 0.00106 | 0    | 0    | 0    | 0   | 42   | 64   | 0    | 0    |
| 19.00                                    | 20.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 20.00                                    | 21.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 21.00                                    | 22.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 22.00                                    | 23.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 23.00                                    | 24.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 24.00                                    | 25.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 25.00                                    | 26.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 26.00                                    | 27.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 27.00                                    | 28.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 28.00                                    | 29.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 30.00                                    | 31.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 31.00                                    | 32.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 32.00                                    | 33.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 33.00                                    | 34.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 34.00                                    | 35.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| Parts per thousand<br>for each direction |       |         | 139  | 128  | 134  | 67  | 138  | 164  | 96   | 123  |

June

Data in parts per hundred thousand

|  |       |         | N    | NE   | E    | SE   | S    | SW   | W    | NW   |
|--|-------|---------|------|------|------|------|------|------|------|------|
| 0.00                                     | 1.00  | 0.99408 | 307  | 132  | 263  | 132  | 219  | 88   | 263  | 351  |
| 1.00                                     | 2.00  | 0.97654 | 482  | 680  | 1075 | 811  | 702  | 439  | 746  | 658  |
| 2.00                                     | 3.00  | 0.92061 | 1228 | 1162 | 1075 | 1009 | 1162 | 1118 | 746  | 1184 |
| 3.00                                     | 4.00  | 0.83377 | 1535 | 1491 | 965  | 987  | 1601 | 2061 | 1162 | 2061 |
| 4.00                                     | 5.00  | 0.71513 | 1513 | 1250 | 811  | 746  | 2105 | 1930 | 1382 | 2127 |
| 5.00                                     | 6.00  | 0.59649 | 1579 | 1053 | 636  | 636  | 1667 | 2741 | 1579 | 1732 |
| 6.00                                     | 7.00  | 0.48026 | 1513 | 768  | 417  | 680  | 1469 | 2697 | 1645 | 1864 |
| 7.00                                     | 8.00  | 0.36974 | 1053 | 461  | 395  | 329  | 1711 | 2851 | 1601 | 1732 |
| 8.00                                     | 9.00  | 0.26842 | 1228 | 285  | 241  | 285  | 1579 | 2697 | 1075 | 1469 |
| 9.00                                     | 10.00 | 0.17982 | 614  | 197  | 22   | 110  | 1579 | 2281 | 1009 | 1009 |
| 10.00                                    | 11.00 | 0.11162 | 285  | 197  | 88   | 219  | 965  | 1491 | 504  | 680  |
| 11.00                                    | 12.00 | 0.06732 | 219  | 88   | 88   | 66   | 702  | 1140 | 482  | 329  |
| 12.00                                    | 13.00 | 0.03618 | 197  | 110  | 44   | 22   | 724  | 592  | 154  | 197  |
| 13.00                                    | 14.00 | 0.01579 | 154  | 66   | 0    | 66   | 154  | 241  | 110  | 44   |
| 14.00                                    | 15.00 | 0.00746 | 44   | 0    | 0    | 0    | 197  | 88   | 44   | 44   |
| 15.00                                    | 16.00 | 0.00329 | 88   | 0    | 0    | 0    | 66   | 0    | 44   | 0    |
| 16.00                                    | 17.00 | 0.00132 | 0    | 0    | 0    | 0    | 44   | 22   | 0    | 22   |
| 17.00                                    | 18.00 | 0.00044 | 0    | 0    | 0    | 0    | 44   | 0    | 0    | 0    |
| 18.00                                    | 19.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 19.00                                    | 20.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 20.00                                    | 21.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 21.00                                    | 22.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 22.00                                    | 23.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 23.00                                    | 24.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 24.00                                    | 25.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 25.00                                    | 26.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 26.00                                    | 27.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 27.00                                    | 28.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 28.00                                    | 29.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 30.00                                    | 31.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 31.00                                    | 32.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 32.00                                    | 33.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 33.00                                    | 34.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 34.00                                    | 35.00 | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Parts per thousand<br>for each direction |       |         | 120  | 79   | 61   | 61   | 167  | 225  | 125  | 155  |

July

Data in parts per hundred thousand

|  |       |         | N    | NE  | E    | SE  | S    | SW   | W    | NW   |
|--|-------|---------|------|-----|------|-----|------|------|------|------|
| 0.00                                     | 1.00  | 0.99469 | 149  | 191 | 191  | 297 | 170  | 340  | 233  | 340  |
| 1.00                                     | 2.00  | 0.97559 | 615  | 467 | 764  | 722 | 531  | 743  | 637  | 785  |
| 2.00                                     | 3.00  | 0.92296 | 1231 | 764 | 1082 | 828 | 1379 | 1295 | 1210 | 997  |
| 3.00                                     | 4.00  | 0.83510 | 1167 | 679 | 679  | 976 | 2334 | 2419 | 1401 | 1401 |
| 4.00                                     | 5.00  | 0.72453 | 1443 | 700 | 828  | 913 | 2738 | 2398 | 2016 | 1677 |
| 5.00                                     | 6.00  | 0.59741 | 1528 | 828 | 828  | 849 | 2016 | 2907 | 1783 | 2165 |
| 6.00                                     | 7.00  | 0.46838 | 1379 | 615 | 679  | 637 | 1889 | 2377 | 2143 | 2377 |
| 7.00                                     | 8.00  | 0.34741 | 743  | 552 | 488  | 615 | 1401 | 2568 | 1570 | 1889 |
| 8.00                                     | 9.00  | 0.24915 | 764  | 191 | 424  | 170 | 1401 | 2695 | 1570 | 1295 |
| 9.00                                     | 10.00 | 0.16405 | 403  | 21  | 191  | 106 | 1146 | 2080 | 1592 | 997  |
| 10.00                                    | 11.00 | 0.09868 | 42   | 85  | 233  | 64  | 722  | 1167 | 1082 | 531  |
| 11.00                                    | 12.00 | 0.05942 | 21   | 85  | 85   | 42  | 722  | 637  | 764  | 297  |
| 12.00                                    | 13.00 | 0.03289 | 21   | 127 | 0    | 0   | 467  | 446  | 318  | 255  |
| 13.00                                    | 14.00 | 0.01655 | 64   | 21  | 0    | 0   | 170  | 297  | 149  | 149  |
| 14.00                                    | 15.00 | 0.00806 | 21   | 0   | 21   | 0   | 64   | 170  | 64   | 42   |
| 15.00                                    | 16.00 | 0.00424 | 21   | 42  | 0    | 0   | 0    | 85   | 42   | 0    |
| 16.00                                    | 17.00 | 0.00233 | 0    | 0   | 0    | 0   | 0    | 42   | 21   | 0    |
| 17.00                                    | 18.00 | 0.00170 | 0    | 64  | 0    | 0   | 0    | 21   | 0    | 21   |
| 18.00                                    | 19.00 | 0.00064 | 0    | 0   | 0    | 0   | 21   | 0    | 0    | 0    |
| 19.00                                    | 20.00 | 0.00042 | 0    | 0   | 0    | 0   | 21   | 21   | 0    | 0    |
| 20.00                                    | 21.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 21.00                                    | 22.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 22.00                                    | 23.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 23.00                                    | 24.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 24.00                                    | 25.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 25.00                                    | 26.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 26.00                                    | 27.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 27.00                                    | 28.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 28.00                                    | 29.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 30.00                                    | 31.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 31.00                                    | 32.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 32.00                                    | 33.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 33.00                                    | 34.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| 34.00                                    | 35.00 | 0.00000 | 0    | 0   | 0    | 0   | 0    | 0    | 0    | 0    |
| Parts per thousand<br>for each direction |       |         | 96   | 54  | 65   | 62  | 172  | 227  | 166  | 152  |

August

Data in parts per hundred thousand

|  |       |         | N    | NE  | E    | SE   | S    | SW   | W    | NW   |
|--|-------|---------|------|-----|------|------|------|------|------|------|
| 0.00                                     | 1.00  | 0.99618 | 191  | 170 | 212  | 276  | 233  | 297  | 170  | 191  |
| 1.00                                     | 2.00  | 0.97878 | 700  | 615 | 615  | 806  | 806  | 806  | 806  | 722  |
| 2.00                                     | 3.00  | 0.91999 | 1188 | 743 | 785  | 934  | 1401 | 1592 | 976  | 1231 |
| 3.00                                     | 4.00  | 0.83149 | 1358 | 891 | 1061 | 1082 | 1570 | 2271 | 1443 | 1655 |
| 4.00                                     | 5.00  | 0.71817 | 1698 | 658 | 700  | 658  | 1910 | 2674 | 1549 | 1974 |
| 5.00                                     | 6.00  | 0.59996 | 1273 | 658 | 637  | 700  | 2292 | 3014 | 1783 | 1252 |
| 6.00                                     | 7.00  | 0.48387 | 1104 | 446 | 806  | 403  | 1804 | 2865 | 2356 | 1486 |
| 7.00                                     | 8.00  | 0.37118 | 1019 | 361 | 806  | 361  | 1273 | 2653 | 2250 | 1592 |
| 8.00                                     | 9.00  | 0.26804 | 722  | 318 | 340  | 467  | 1316 | 2568 | 1740 | 934  |
| 9.00                                     | 10.00 | 0.18400 | 361  | 255 | 149  | 318  | 955  | 1931 | 1082 | 891  |
| 10.00                                    | 11.00 | 0.12458 | 170  | 212 | 233  | 403  | 785  | 1613 | 955  | 594  |
| 11.00                                    | 12.00 | 0.07492 | 127  | 64  | 106  | 149  | 637  | 1316 | 594  | 424  |
| 12.00                                    | 13.00 | 0.04075 | 42   | 21  | 0    | 64   | 573  | 615  | 403  | 276  |
| 13.00                                    | 14.00 | 0.02080 | 0    | 0   | 0    | 42   | 149  | 488  | 382  | 85   |
| 14.00                                    | 15.00 | 0.00934 | 0    | 0   | 0    | 0    | 64   | 170  | 149  | 21   |
| 15.00                                    | 16.00 | 0.00531 | 0    | 0   | 0    | 21   | 149  | 64   | 64   | 42   |
| 16.00                                    | 17.00 | 0.00191 | 0    | 0   | 0    | 42   | 21   | 21   | 42   | 0    |
| 17.00                                    | 18.00 | 0.00064 | 0    | 0   | 0    | 0    | 0    | 21   | 0    | 0    |
| 18.00                                    | 19.00 | 0.00042 | 0    | 0   | 0    | 0    | 21   | 21   | 0    | 0    |
| 19.00                                    | 20.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 20.00                                    | 21.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 21.00                                    | 22.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 22.00                                    | 23.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 23.00                                    | 24.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 24.00                                    | 25.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 25.00                                    | 26.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 26.00                                    | 27.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 27.00                                    | 28.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 28.00                                    | 29.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 30.00                                    | 31.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 31.00                                    | 32.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 32.00                                    | 33.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 33.00                                    | 34.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 34.00                                    | 35.00 | 0.00000 | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| Parts per thousand<br>for each direction |       |         | 100  | 54  | 65   | 67   | 160  | 250  | 167  | 134  |

September

Data in parts per hundred thousand

|  |       |         | N    | NE   | E    | SE  | S    | SW   | W    | NW   |
|--|-------|---------|------|------|------|-----|------|------|------|------|
| 0.00                                     | 1.00  | 0.99912 | 197  | 175  | 110  | 66  | 219  | 154  | 263  | 88   |
| 1.00                                     | 2.00  | 0.98640 | 373  | 439  | 482  | 417 | 548  | 285  | 461  | 373  |
| 2.00                                     | 3.00  | 0.95263 | 1118 | 724  | 702  | 680 | 1009 | 724  | 789  | 921  |
| 3.00                                     | 4.00  | 0.88596 | 1031 | 1184 | 1294 | 789 | 1009 | 1118 | 943  | 965  |
| 4.00                                     | 5.00  | 0.80263 | 921  | 1228 | 1031 | 614 | 1382 | 1557 | 1228 | 1294 |
| 5.00                                     | 6.00  | 0.71009 | 1338 | 899  | 1009 | 987 | 1491 | 2083 | 1228 | 899  |
| 6.00                                     | 7.00  | 0.61075 | 1732 | 1118 | 965  | 899 | 1228 | 1601 | 1754 | 1447 |
| 7.00                                     | 8.00  | 0.50329 | 1031 | 746  | 899  | 789 | 1952 | 1930 | 1469 | 1031 |
| 8.00                                     | 9.00  | 0.40482 | 833  | 768  | 526  | 548 | 1338 | 1864 | 1425 | 1557 |
| 9.00                                     | 10.00 | 0.31623 | 526  | 461  | 329  | 307 | 1667 | 1667 | 1360 | 1206 |
| 10.00                                    | 11.00 | 0.24101 | 614  | 417  | 329  | 417 | 1469 | 1864 | 746  | 899  |
| 11.00                                    | 12.00 | 0.17346 | 197  | 241  | 329  | 373 | 1228 | 1118 | 1162 | 789  |
| 12.00                                    | 13.00 | 0.11908 | 175  | 88   | 241  | 241 | 855  | 1140 | 987  | 658  |
| 13.00                                    | 14.00 | 0.07522 | 44   | 44   | 44   | 88  | 395  | 965  | 702  | 197  |
| 14.00                                    | 15.00 | 0.05044 | 0    | 132  | 44   | 88  | 373  | 724  | 351  | 154  |
| 15.00                                    | 16.00 | 0.03180 | 44   | 175  | 0    | 44  | 241  | 439  | 241  | 154  |
| 16.00                                    | 17.00 | 0.01842 | 0    | 110  | 0    | 44  | 219  | 219  | 219  | 88   |
| 17.00                                    | 18.00 | 0.00943 | 0    | 44   | 0    | 44  | 88   | 154  | 66   | 88   |
| 18.00                                    | 19.00 | 0.00461 | 0    | 0    | 0    | 66  | 110  | 44   | 0    | 44   |
| 19.00                                    | 20.00 | 0.00197 | 0    | 0    | 0    | 0   | 44   | 66   | 22   | 0    |
| 20.00                                    | 21.00 | 0.00066 | 0    | 0    | 0    | 0   | 0    | 22   | 0    | 0    |
| 21.00                                    | 22.00 | 0.00044 | 0    | 0    | 0    | 0   | 0    | 22   | 22   | 0    |
| 22.00                                    | 23.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 23.00                                    | 24.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 24.00                                    | 25.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 25.00                                    | 26.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 26.00                                    | 27.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 27.00                                    | 28.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 28.00                                    | 29.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 30.00                                    | 31.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 31.00                                    | 32.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 32.00                                    | 33.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 33.00                                    | 34.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| 34.00                                    | 35.00 | 0.00000 | 0    | 0    | 0    | 0   | 0    | 0    | 0    | 0    |
| Parts per thousand<br>for each direction |       |         | 102  | 90   | 83   | 75  | 169  | 198  | 154  | 129  |

October

Data in parts per hundred thousand

|  |       |         | N   | NE  | E    | SE   | S    | SW   | W    | NW   |
|--|-------|---------|-----|-----|------|------|------|------|------|------|
| 0.00                                     | 1.00  | 0.96875 | 60  | 141 | 81   | 0    | 20   | 40   | 60   | 60   |
| 1.00                                     | 2.00  | 0.96411 | 181 | 181 | 222  | 242  | 121  | 242  | 302  | 181  |
| 2.00                                     | 3.00  | 0.94738 | 363 | 444 | 403  | 444  | 302  | 383  | 524  | 403  |
| 3.00                                     | 4.00  | 0.91472 | 665 | 524 | 544  | 645  | 484  | 524  | 565  | 605  |
| 4.00                                     | 5.00  | 0.86915 | 786 | 766 | 706  | 867  | 968  | 544  | 867  | 867  |
| 5.00                                     | 6.00  | 0.80544 | 726 | 806 | 827  | 927  | 1069 | 1109 | 1048 | 585  |
| 6.00                                     | 7.00  | 0.73448 | 484 | 625 | 847  | 685  | 1230 | 1250 | 1129 | 1129 |
| 7.00                                     | 8.00  | 0.66069 | 907 | 706 | 948  | 1411 | 1270 | 1169 | 1250 | 927  |
| 8.00                                     | 9.00  | 0.57480 | 806 | 504 | 1008 | 1331 | 1230 | 1633 | 1371 | 1109 |
| 9.00                                     | 10.00 | 0.48488 | 605 | 625 | 1109 | 1210 | 1028 | 1794 | 1613 | 927  |
| 10.00                                    | 11.00 | 0.39577 | 302 | 383 | 625  | 1149 | 1452 | 1976 | 1855 | 746  |
| 11.00                                    | 12.00 | 0.31089 | 343 | 222 | 444  | 786  | 1512 | 2137 | 1230 | 343  |
| 12.00                                    | 13.00 | 0.24073 | 181 | 181 | 343  | 544  | 1431 | 1431 | 1008 | 585  |
| 13.00                                    | 14.00 | 0.18367 | 81  | 81  | 282  | 282  | 1593 | 1472 | 1008 | 706  |
| 14.00                                    | 15.00 | 0.12863 | 0   | 60  | 181  | 242  | 1149 | 1210 | 1270 | 464  |
| 15.00                                    | 16.00 | 0.08286 | 20  | 0   | 242  | 101  | 786  | 847  | 927  | 202  |
| 16.00                                    | 17.00 | 0.05161 | 0   | 0   | 40   | 60   | 524  | 504  | 403  | 40   |
| 17.00                                    | 18.00 | 0.03589 | 20  | 0   | 20   | 40   | 464  | 484  | 262  | 20   |
| 18.00                                    | 19.00 | 0.02278 | 20  | 0   | 40   | 0    | 222  | 262  | 403  | 40   |
| 19.00                                    | 20.00 | 0.01290 | 20  | 0   | 0    | 0    | 141  | 141  | 141  | 141  |
| 20.00                                    | 21.00 | 0.00706 | 0   | 0   | 0    | 0    | 101  | 60   | 81   | 40   |
| 21.00                                    | 22.00 | 0.00423 | 0   | 0   | 0    | 0    | 60   | 20   | 60   | 20   |
| 22.00                                    | 23.00 | 0.00262 | 0   | 0   | 0    | 0    | 40   | 20   | 121  | 0    |
| 23.00                                    | 24.00 | 0.00081 | 0   | 0   | 0    | 0    | 0    | 0    | 40   | 0    |
| 24.00                                    | 25.00 | 0.00040 | 0   | 0   | 0    | 0    | 0    | 0    | 20   | 0    |
| 25.00                                    | 26.00 | 0.00020 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 20   |
| 26.00                                    | 27.00 | 0.00000 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 27.00                                    | 28.00 | 0.00000 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 28.00                                    | 29.00 | 0.00000 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 30.00                                    | 31.00 | 0.00000 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 31.00                                    | 32.00 | 0.00000 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 32.00                                    | 33.00 | 0.00000 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 33.00                                    | 34.00 | 0.00000 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| 34.00                                    | 35.00 | 0.00000 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    |
| Parts per thousand<br>for each direction |       |         | 66  | 63  | 89   | 110  | 172  | 193  | 176  | 102  |

November

Data in parts per hundred thousand

|  |       |         | N   | NE  | E   | SE   | S    | SW   | W    | NW   |
|--|-------|---------|-----|-----|-----|------|------|------|------|------|
| 0.00                                     | 1.00  | 0.94771 | 42  | 104 | 63  | 104  | 63   | 83   | 83   | 42   |
| 1.00                                     | 2.00  | 0.94187 | 208 | 146 | 104 | 250  | 313  | 271  | 167  | 375  |
| 2.00                                     | 3.00  | 0.92354 | 688 | 250 | 354 | 313  | 313  | 333  | 354  | 708  |
| 3.00                                     | 4.00  | 0.89042 | 563 | 354 | 500 | 333  | 688  | 417  | 583  | 688  |
| 4.00                                     | 5.00  | 0.84917 | 688 | 479 | 521 | 521  | 750  | 625  | 667  | 1208 |
| 5.00                                     | 6.00  | 0.79458 | 750 | 542 | 542 | 875  | 708  | 729  | 1250 | 708  |
| 6.00                                     | 7.00  | 0.73354 | 646 | 563 | 542 | 917  | 1021 | 1229 | 1833 | 1083 |
| 7.00                                     | 8.00  | 0.65521 | 792 | 292 | 396 | 1021 | 896  | 1333 | 1479 | 1042 |
| 8.00                                     | 9.00  | 0.58271 | 479 | 229 | 354 | 813  | 1083 | 1563 | 2104 | 1083 |
| 9.00                                     | 10.00 | 0.50563 | 604 | 292 | 375 | 917  | 1292 | 1500 | 2083 | 1250 |
| 10.00                                    | 11.00 | 0.42250 | 854 | 229 | 396 | 938  | 1542 | 2271 | 1917 | 875  |
| 11.00                                    | 12.00 | 0.33229 | 646 | 188 | 188 | 938  | 1167 | 1833 | 1958 | 771  |
| 12.00                                    | 13.00 | 0.25542 | 604 | 208 | 63  | 833  | 1313 | 1521 | 1354 | 563  |
| 13.00                                    | 14.00 | 0.19083 | 313 | 167 | 83  | 667  | 917  | 1229 | 1021 | 500  |
| 14.00                                    | 15.00 | 0.14187 | 604 | 125 | 42  | 313  | 1271 | 1167 | 875  | 313  |
| 15.00                                    | 16.00 | 0.09479 | 188 | 63  | 21  | 271  | 521  | 792  | 604  | 229  |
| 16.00                                    | 17.00 | 0.06792 | 208 | 83  | 0   | 125  | 771  | 542  | 417  | 271  |
| 17.00                                    | 18.00 | 0.04375 | 125 | 146 | 21  | 83   | 729  | 417  | 375  | 21   |
| 18.00                                    | 19.00 | 0.02458 | 63  | 42  | 0   | 104  | 333  | 146  | 83   | 21   |
| 19.00                                    | 20.00 | 0.01667 | 0   | 42  | 21  | 63   | 188  | 146  | 104  | 63   |
| 20.00                                    | 21.00 | 0.01042 | 0   | 21  | 21  | 21   | 63   | 125  | 42   | 21   |
| 21.00                                    | 22.00 | 0.00729 | 0   | 21  | 42  | 21   | 104  | 83   | 42   | 0    |
| 22.00                                    | 23.00 | 0.00417 | 0   | 0   | 0   | 0    | 21   | 63   | 0    | 0    |
| 23.00                                    | 24.00 | 0.00333 | 0   | 0   | 0   | 42   | 83   | 0    | 42   | 0    |
| 24.00                                    | 25.00 | 0.00167 | 0   | 0   | 21  | 0    | 83   | 0    | 42   | 0    |
| 25.00                                    | 26.00 | 0.00021 | 0   | 0   | 0   | 21   | 0    | 0    | 0    | 0    |
| 26.00                                    | 27.00 | 0.00000 | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    |
| 27.00                                    | 28.00 | 0.00000 | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    |
| 28.00                                    | 29.00 | 0.00000 | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    |
| 30.00                                    | 31.00 | 0.00000 | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    |
| 31.00                                    | 32.00 | 0.00000 | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    |
| 32.00                                    | 33.00 | 0.00000 | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    |
| 33.00                                    | 34.00 | 0.00000 | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    |
| 34.00                                    | 35.00 | 0.00000 | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    |
| Parts per thousand<br>for each direction |       |         | 91  | 46  | 47  | 105  | 162  | 184  | 195  | 118  |

December

Data in parts per hundred thousand

|  |       |         | N   | NE  | E    | SE   | S    | SW   | W    | NW  |
|--|-------|---------|-----|-----|------|------|------|------|------|-----|
| 0.00                                     | 1.00  | 0.99698 | 81  | 20  | 40   | 60   | 40   | 40   | 20   | 20  |
| 1.00                                     | 2.00  | 0.99375 | 282 | 262 | 282  | 242  | 222  | 81   | 181  | 161 |
| 2.00                                     | 3.00  | 0.97661 | 323 | 282 | 484  | 665  | 302  | 202  | 262  | 282 |
| 3.00                                     | 4.00  | 0.94859 | 423 | 444 | 524  | 746  | 423  | 423  | 323  | 323 |
| 4.00                                     | 5.00  | 0.91230 | 464 | 726 | 988  | 847  | 887  | 585  | 323  | 484 |
| 5.00                                     | 6.00  | 0.85927 | 444 | 504 | 1149 | 766  | 1190 | 766  | 847  | 585 |
| 6.00                                     | 7.00  | 0.79677 | 544 | 504 | 1069 | 706  | 1411 | 1411 | 948  | 827 |
| 7.00                                     | 8.00  | 0.72258 | 685 | 746 | 1048 | 1371 | 1331 | 1411 | 1230 | 746 |
| 8.00                                     | 9.00  | 0.63690 | 444 | 565 | 988  | 1512 | 1411 | 1210 | 1129 | 827 |
| 9.00                                     | 10.00 | 0.55605 | 585 | 282 | 847  | 948  | 1815 | 2157 | 1391 | 948 |
| 10.00                                    | 11.00 | 0.46633 | 504 | 302 | 766  | 827  | 1250 | 2137 | 1673 | 968 |
| 11.00                                    | 12.00 | 0.38206 | 444 | 262 | 887  | 645  | 1270 | 2097 | 1290 | 645 |
| 12.00                                    | 13.00 | 0.30665 | 343 | 222 | 847  | 544  | 786  | 1431 | 1996 | 605 |
| 13.00                                    | 14.00 | 0.23891 | 181 | 101 | 625  | 363  | 625  | 1895 | 1613 | 685 |
| 14.00                                    | 15.00 | 0.17802 | 323 | 81  | 242  | 262  | 726  | 1431 | 1210 | 444 |
| 15.00                                    | 16.00 | 0.13085 | 20  | 40  | 323  | 121  | 504  | 1270 | 1008 | 262 |
| 16.00                                    | 17.00 | 0.09536 | 81  | 40  | 202  | 141  | 685  | 847  | 907  | 323 |
| 17.00                                    | 18.00 | 0.06310 | 40  | 40  | 20   | 121  | 383  | 565  | 746  | 262 |
| 18.00                                    | 19.00 | 0.04133 | 0   | 20  | 60   | 0    | 464  | 363  | 504  | 81  |
| 19.00                                    | 20.00 | 0.02641 | 20  | 0   | 20   | 0    | 282  | 343  | 323  | 60  |
| 20.00                                    | 21.00 | 0.01593 | 40  | 20  | 0    | 0    | 40   | 161  | 242  | 0   |
| 21.00                                    | 22.00 | 0.01089 | 81  | 0   | 0    | 20   | 60   | 121  | 141  | 0   |
| 22.00                                    | 23.00 | 0.00665 | 40  | 0   | 0    | 0    | 141  | 101  | 60   | 0   |
| 23.00                                    | 24.00 | 0.00323 | 0   | 0   | 0    | 0    | 20   | 40   | 20   | 0   |
| 24.00                                    | 25.00 | 0.00242 | 40  | 0   | 0    | 0    | 0    | 20   | 20   | 20  |
| 25.00                                    | 26.00 | 0.00141 | 0   | 0   | 0    | 0    | 0    | 20   | 20   | 0   |
| 26.00                                    | 27.00 | 0.00101 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0   |
| 27.00                                    | 28.00 | 0.00101 | 0   | 0   | 0    | 0    | 40   | 20   | 20   | 0   |
| 28.00                                    | 29.00 | 0.00020 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0   |
| 29.00                                    | 30.00 | 0.00020 | 0   | 0   | 0    | 0    | 0    | 20   | 0    | 0   |
| 30.00                                    | 31.00 | 0.00000 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0   |
| 31.00                                    | 32.00 | 0.00000 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0   |
| 32.00                                    | 33.00 | 0.00000 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0   |
| 33.00                                    | 34.00 | 0.00000 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0   |
| 34.00                                    | 35.00 | 0.00000 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0   |
| Parts per thousand<br>for each direction |       |         | 64  | 55  | 114  | 109  | 163  | 212  | 184  | 96  |

*Appendix 3 Monthly wave climates ( $H_s$  against  
absolute spectral  $T_p$ ) at the site: 5920160. N 394982. E*

January

Data in parts per hundred thousand

|                                    | 0.0  | 1.0     | 2.0     | 3.0  | 4.0 | 5.0 | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 |   |
|------------------------------------|------|---------|---------|------|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|
| 0.00                               | 0.50 | 1.00    | 1.00000 | 1358 | 16  | 324 | 1316 | 1501 | 1422 | 1353 | 1533 | 1188 | 1141 | 4303 | 2531 | 11   | 11   | 0    | 0    | 0 |
| 0.50                               | 1.00 | 0.81993 | 0       | 0    | 0   | 196 | 1321 | 4361 | 4658 | 2838 | 1846 | 615  | 5581 | 2621 | 64   | 58   | 5    | 0    | 0    | 0 |
| 1.00                               | 1.50 | 0.57826 | 0       | 0    | 0   | 11  | 111  | 2181 | 7704 | 4568 | 987  | 154  | 1242 | 446  | 64   | 16   | 0    | 0    | 0    | 0 |
| 1.50                               | 2.00 | 0.40344 | 0       | 0    | 0   | 0   | 0    | 159  | 3518 | 7656 | 1215 | 42   | 223  | 69   | 0    | 0    | 0    | 0    | 0    | 0 |
| 2.00                               | 2.50 | 0.27462 | 0       | 0    | 0   | 0   | 0    | 0    | 249  | 5587 | 3947 | 255  | 32   | 5    | 0    | 0    | 0    | 0    | 0    | 0 |
| 2.50                               | 3.00 | 0.17386 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 854  | 5544 | 737  | 21   | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 3.00                               | 3.50 | 0.10229 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 21   | 2961 | 1952 | 42   | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 3.50                               | 4.00 | 0.05253 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 5    | 642  | 2472 | 37   | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 4.00                               | 4.50 | 0.02096 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 5    | 11   | 1289 | 143  | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 4.50                               | 5.00 | 0.00647 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 276  | 175  | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 5.00                               | 5.50 | 0.00196 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 69   | 27   | 0    | 0    | 0    | 0    | 0 |
| 5.50                               | 6.00 | 0.00101 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 27   | 37   | 0    | 0    | 0    | 0    | 0 |
| 6.00                               | 6.50 | 0.00037 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 5    | 16   | 5    | 0    | 0    | 0    | 0 |
| 6.50                               | 7.00 | 0.00011 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 5    | 5    | 0    | 0    | 0    | 0 |
| 7.00                               | 7.50 | 0.00000 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 7.50                               | 8.00 | 0.00000 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| Total per thousand for each period |      |         | 14      | 0    | 3   | 15  | 29   | 81   | 175  | 231  | 183  | 89   | 119  | 58   | 1    | 1    | 0    | 0    | 0    | 0 |

February

Data in parts per hundred thousand

|                    | 0.0  | 1.0     | 2.0     | 3.0  | 4.0 | 5.0 | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 |   |
|--------------------|------|---------|---------|------|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|
| 0.00               | 0.50 | 1.00    | 1.00000 | 1443 | 6   | 186 | 1373 | 2066 | 1862 | 1583 | 1013 | 914  | 937  | 4108 | 2549 | 23   | 0    | 0    | 0    | 0 |
| 0.50               | 1.00 | 0.81937 | 0       | 0    | 0   | 52  | 1874 | 5633 | 5005 | 2491 | 1519 | 1519 | 762  | 3381 | 1490 | 52   | 0    | 0    | 0    | 0 |
| 1.00               | 1.50 | 0.59678 | 0       | 0    | 0   | 0   | 41   | 2368 | 8811 | 4213 | 791  | 791  | 151  | 594  | 209  | 0    | 0    | 0    | 0    | 0 |
| 1.50               | 2.00 | 0.42499 | 0       | 0    | 0   | 0   | 0    | 87   | 4423 | 7734 | 1077 | 1077 | 70   | 209  | 76   | 0    | 0    | 0    | 0    | 0 |
| 2.00               | 2.50 | 0.28823 | 0       | 0    | 0   | 0   | 0    | 0    | 617  | 6093 | 3847 | 256  | 81   | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 2.50               | 3.00 | 0.17929 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 1234 | 5720 | 681  | 17   | 6    | 0    | 0    | 0    | 0    | 0    | 0 |
| 3.00               | 3.50 | 0.10213 | 0       | 0    | 0   | 0   | 0    | 0    | 23   | 2782 | 1990 | 35   | 6    | 29   | 0    | 0    | 0    | 0    | 0    | 0 |
| 3.50               | 4.00 | 0.05348 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 628  | 2095 | 93   | 12   | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 4.00               | 4.50 | 0.02520 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 29   | 1234 | 163  | 6    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 4.50               | 5.00 | 0.01088 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 268  | 308  | 12   | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 5.00               | 5.50 | 0.00500 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 256  | 64   | 0    | 0    | 0    | 0    | 0 |
| 5.50               | 6.00 | 0.00180 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 87   | 81   | 0    | 0    | 0    | 0    | 0 |
| 6.00               | 6.50 | 0.00012 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 12   | 0    | 0    | 0    | 0    | 0 |
| 6.50               | 7.00 | 0.00000 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 7.00               | 7.50 | 0.00000 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 7.50               | 8.00 | 0.00000 | 0       | 0    | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| Total per thousand |      |         | 14      | 0    | 2   | 14  | 40   | 100  | 204  | 228  | 173  | 84   | 94   | 45   | 1    | 0    | 0    | 0    | 0    | 0 |
| for each period    |      |         |         |      |     |     |      |      |      |      |      |      |      |      |      |      |      |      |      |   |

March

Data in parts per hundred thousand

|                                    | 0.0     | 1.0  | 2.0 | 3.0 | 4.0  | 5.0  | 6.0       | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 |
|------------------------------------|---------|------|-----|-----|------|------|-----------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.00                               | 0.00    | 1.00 | 117 | 865 | 2175 | 2823 | 2027      | 1868 | 1289 | 1369 | 1512 | 6192 | 3279 | 0    | 0    | 5    | 16   | 11   | 0    |
| 0.50                               | 0.74289 | 0    | 0   | 0   | 133  | 2250 | 6919      | 6839 | 3778 | 1629 | 684  | 3268 | 1475 | 21   | 0    | 32   | 0    | 0    | 0    |
| 1.00                               | 0.47262 | 0    | 0   | 0   | 5    | 90   | 252510845 | 4642 | 875  | 127  | 605  | 244  | 5    | 0    | 0    | 0    | 0    | 0    | 0    |
| 1.50                               | 0.27297 | 0    | 0   | 0   | 0    | 0    | 111       | 3889 | 6786 | 897  | 5    | 133  | 21   | 0    | 0    | 0    | 0    | 0    | 0    |
| 2.00                               | 0.15455 | 0    | 0   | 0   | 0    | 0    | 0         | 377  | 4462 | 2525 | 48   | 5    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 2.50                               | 0.08038 | 0    | 0   | 0   | 0    | 0    | 0         | 0    | 997  | 3173 | 170  | 11   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 3.00                               | 0.03687 | 0    | 0   | 0   | 0    | 0    | 0         | 0    | 32   | 1655 | 631  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 3.50                               | 0.01369 | 0    | 0   | 0   | 0    | 0    | 0         | 0    | 0    | 371  | 584  | 16   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 4.00                               | 0.00398 | 0    | 0   | 0   | 0    | 0    | 0         | 0    | 0    | 16   | 287  | 16   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 4.50                               | 0.00080 | 0    | 0   | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 32   | 32   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 5.00                               | 0.00016 | 0    | 0   | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 16   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 5.50                               | 0.00000 | 0    | 0   | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 6.00                               | 0.00000 | 0    | 0   | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 6.50                               | 0.00000 | 0    | 0   | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 7.00                               | 0.00000 | 0    | 0   | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 7.50                               | 0.00000 | 0    | 0   | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Total per thousand for each period | 22      | 1    | 9   | 23  | 52   | 116  | 238       | 220  | 125  | 41   | 103  | 50   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |

April

Data in parts per hundred thousand

|                                    | 0.0  | 1.0      | 2.0  | 3.0 | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 |   |
|------------------------------------|------|----------|------|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|---|
| 0.00                               | 0.50 | 1.000000 | 1031 | 389 | 1930 | 4737 | 5016 | 3651 | 2928 | 1968 | 1502 | 1870 | 7851 | 4002 | 5    | 0    | 0    | 0    | 0    | 0 |
| 0.50                               | 1.00 | 0.63120  | 0    | 0   | 11   | 307  | 3240 | 8136 | 7248 | 3882 | 1826 | 658  | 2999 | 1195 | 11   | 0    | 0    | 0    | 0    | 0 |
| 1.00                               | 1.50 | 0.33607  | 0    | 0   | 0    | 5    | 93   | 3394 | 7412 | 3410 | 548  | 44   | 285  | 66   | 0    | 0    | 0    | 0    | 0    | 0 |
| 1.50                               | 2.00 | 0.18350  | 0    | 0   | 0    | 0    | 0    | 175  | 3788 | 4402 | 433  | 0    | 66   | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 2.00                               | 2.50 | 0.09485  | 0    | 0   | 0    | 0    | 0    | 0    | 323  | 3717 | 943  | 16   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 2.50                               | 3.00 | 0.04485  | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 1047 | 1420 | 33   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 3.00                               | 3.50 | 0.01985  | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 22   | 1086 | 175  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 3.50                               | 4.00 | 0.00702  | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 208  | 285  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 4.00                               | 4.50 | 0.00208  | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 5    | 132  | 11   | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 4.50                               | 5.00 | 0.00060  | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 33   | 11   | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 5.00                               | 5.50 | 0.00016  | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 11   | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 5.50                               | 6.00 | 0.00005  | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 5    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 6.00                               | 6.50 | 0.00000  | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 6.50                               | 7.00 | 0.00000  | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 7.00                               | 7.50 | 0.00000  | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 7.50                               | 8.00 | 0.00000  | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| Total per thousand for each period |      |          | 10   | 4   | 19   | 50   | 83   | 154  | 217  | 184  | 80   | 32   | 112  | 53   | 0    | 0    | 0    | 0    | 0    | 0 |

May

Data in parts per hundred thousand

|                                    | 0.0  | 1.0     | 2.0     | 3.0  | 4.0 | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 |   |
|------------------------------------|------|---------|---------|------|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|---|
| 0.00                               | 0.50 | 1.00    | 0.00000 | 2021 | 520 | 3162 | 7369 | 7518 | 5104 | 4414 | 2701 | 1809 | 2032 | 5698 | 2579 | 0    | 0    | 0    | 0    | 0 |
| 0.50                               | 1.00 | 0.55072 | 0       | 0    | 0   | 244  | 5470 | 9258 | 7327 | 2907 | 2907 | 1231 | 345  | 1730 | 674  | 0    | 0    | 0    | 0    | 0 |
| 1.00                               | 1.50 | 0.25886 | 0       | 0    | 0   | 5    | 58   | 3942 | 7470 | 2791 | 334  | 334  | 32   | 244  | 58   | 0    | 0    | 0    | 0    | 0 |
| 1.50                               | 2.00 | 0.10951 | 0       | 0    | 0   | 0    | 0    | 64   | 2838 | 3258 | 324  | 5    | 5    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 2.00                               | 2.50 | 0.04457 | 0       | 0    | 0   | 0    | 0    | 0    | 170  | 1692 | 950  | 16   | 16   | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 2.50                               | 3.00 | 0.01629 | 0       | 0    | 0   | 0    | 0    | 0    | 0    | 350  | 690  | 5    | 5    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 3.00                               | 3.50 | 0.00584 | 0       | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 255  | 143  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 3.50                               | 4.00 | 0.00186 | 0       | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 42   | 106  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 4.00                               | 4.50 | 0.00037 | 0       | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 37   | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 4.50                               | 5.00 | 0.00000 | 0       | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 5.00                               | 5.50 | 0.00000 | 0       | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 5.50                               | 6.00 | 0.00000 | 0       | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 6.00                               | 6.50 | 0.00000 | 0       | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 6.50                               | 7.00 | 0.00000 | 0       | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 7.00                               | 7.50 | 0.00000 | 0       | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| 7.50                               | 8.00 | 0.00000 | 0       | 0    | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0 |
| Total per thousand for each period |      |         | 20      | 5    | 32  | 76   | 130  | 184  | 222  | 137  | 56   | 27   | 77   | 33   | 0    | 0    | 0    | 0    | 0    | 0 |

June

Data in parts per hundred thousand

|                    |      |          |      |     |      |      |           |      |      |      |      |      |      |      |     |    |    |   |   |   |
|--------------------|------|----------|------|-----|------|------|-----------|------|------|------|------|------|------|------|-----|----|----|---|---|---|
| 0.00               | 0.50 | 1.000000 | 1700 | 718 | 2758 | 6239 | 7500      | 5970 | 4605 | 2467 | 1880 | 1782 | 4002 | 2007 | 49  | 44 | 16 | 0 | 0 | 0 |
| 0.50               | 1.00 | 0.58262  | 0    | 0   | 0    | 334  | 514811711 | 9002 | 3969 | 318  | 1080 | 318  | 1135 | 652  | 197 | 66 | 22 | 0 | 0 | 0 |
| 1.00               | 1.50 | 0.24627  | 0    | 0   | 0    | 5    | 82        | 3893 | 7944 | 3152 | 252  | 49   | 203  | 49   | 16  | 0  | 0  | 0 | 0 | 0 |
| 1.50               | 2.00 | 0.08980  | 0    | 0   | 0    | 0    | 0         | 154  | 2681 | 2714 | 291  | 33   | 11   | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 2.00               | 2.50 | 0.03098  | 0    | 0   | 0    | 0    | 0         | 0    | 181  | 1360 | 620  | 11   | 0    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 2.50               | 3.00 | 0.00927  | 0    | 0   | 0    | 0    | 0         | 0    | 0    | 345  | 400  | 11   | 0    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 3.00               | 3.50 | 0.00170  | 0    | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 121  | 16   | 0    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 3.50               | 4.00 | 0.00033  | 0    | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 16   | 16   | 0    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 4.00               | 4.50 | 0.00000  | 0    | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 4.50               | 5.00 | 0.00000  | 0    | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 5.00               | 5.50 | 0.00000  | 0    | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 5.50               | 6.00 | 0.00000  | 0    | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 6.00               | 6.50 | 0.00000  | 0    | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 6.50               | 7.00 | 0.00000  | 0    | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 7.00               | 7.50 | 0.00000  | 0    | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| 7.50               | 8.00 | 0.00000  | 0    | 0   | 0    | 0    | 0         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0   | 0  | 0  | 0 | 0 | 0 |
| Total per thousand |      |          | 17   | 7   | 28   | 66   | 127       | 217  | 244  | 140  | 47   | 22   | 54   | 27   | 3   | 1  | 0  | 0 | 0 | 0 |
| for each period    |      |          |      |     |      |      |           |      |      |      |      |      |      |      |     |    |    |   |   |   |

July

Data in parts per hundred thousand

|                                       | 0.0 | 1.0 | 2.0  | 3.0  | 4.0  | 5.0   | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 |
|---------------------------------------|-----|-----|------|------|------|-------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.00                                  | 865 | 573 | 2706 | 7762 | 8844 | 7051  | 5433 | 3093 | 2425 | 1830 | 4642 | 1841 | 21   | 0    | 0    | 0    | 0    | 0    | 0    |
| 0.50                                  | 0   | 0   | 11   | 302  | 4966 | 11264 | 8760 | 3093 | 743  | 170  | 653  | 180  | 16   | 16   | 5    | 0    | 0    | 0    | 0    |
| 1.00                                  | 0   | 0   | 0    | 5    | 106  | 3523  | 8250 | 3056 | 133  | 11   | 27   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 1.50                                  | 0   | 0   | 0    | 0    | 0    | 48    | 2218 | 2197 | 159  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 2.00                                  | 0   | 0   | 0    | 0    | 0    | 0     | 42   | 1369 | 414  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 2.50                                  | 0   | 0   | 0    | 0    | 0    | 0     | 0    | 292  | 520  | 27   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 3.00                                  | 0   | 0   | 0    | 0    | 0    | 0     | 0    | 0    | 196  | 32   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 3.50                                  | 0   | 0   | 0    | 0    | 0    | 0     | 0    | 0    | 16   | 80   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 4.00                                  | 0   | 0   | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 16   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 4.50                                  | 0   | 0   | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 5.00                                  | 0   | 0   | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 5.50                                  | 0   | 0   | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 6.00                                  | 0   | 0   | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 6.50                                  | 0   | 0   | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 7.00                                  | 0   | 0   | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 7.50                                  | 0   | 0   | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Total per thousand<br>for each period | 9   | 6   | 27   | 81   | 139  | 219   | 247  | 131  | 46   | 22   | 53   | 20   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |



September

Data in parts per hundred thousand

|                                    | 0.0 | 1.0 | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 |
|------------------------------------|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.0                                | 0   | 439 | 2188 | 5855 | 5943 | 4666 | 3788 | 2133 | 1623 | 2133 | 6014 | 3109 | 22   | 5    | 0    | 0    | 0    | 0    | 0    |
| 1.0                                | 0   | 0   | 11   | 291  | 4211 | 9221 | 7067 | 2549 | 713  | 214  | 2072 | 861  | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 1.50                               | 0   | 0   | 0    | 0    | 77   | 3668 | 8673 | 3246 | 263  | 5    | 329  | 44   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 2.00                               | 0   | 0   | 0    | 0    | 0    | 104  | 3520 | 4709 | 439  | 16   | 49   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 2.50                               | 0   | 0   | 0    | 0    | 0    | 0    | 280  | 3432 | 1277 | 66   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 3.00                               | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 543  | 1875 | 82   | 5    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 3.50                               | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 5    | 806  | 307  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 4.00                               | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 154  | 291  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 4.50                               | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 5    | 49   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 5.00                               | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 5    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 5.50                               | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 6.00                               | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 6.50                               | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 7.00                               | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 7.50                               | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 8.00                               | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Total per thousand for each period | 5   | 4   | 22   | 61   | 102  | 177  | 233  | 166  | 72   | 32   | 85   | 40   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |

October

Data in parts per hundred thousand

|                                    | 0.0  | 1.0 | 2.0 | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 |
|------------------------------------|------|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.00                               | 0.00 | 154 | 897 | 2552 | 2876 | 2403 | 1990 | 1390 | 1051 | 1252 | 8176 | 4441 | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 0.50                               | 1.00 | 0   | 5   | 191  | 2441 | 5926 | 5926 | 2929 | 1337 | 308  | 5337 | 2377 | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 1.00                               | 1.50 | 0   | 0   | 5    | 111  | 2812 | 8998 | 3693 | 621  | 74   | 796  | 202  | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 1.50                               | 2.00 | 0   | 0   | 0    | 5    | 133  | 4271 | 6043 | 875  | 21   | 106  | 58   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 2.00                               | 2.50 | 0   | 0   | 0    | 0    | 0    | 244  | 4367 | 2467 | 117  | 21   | 21   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 2.50                               | 3.00 | 0   | 0   | 0    | 0    | 0    | 0    | 934  | 3587 | 287  | 16   | 16   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 3.00                               | 3.50 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 1677 | 828  | 5    | 5    | 5    | 0    | 0    | 0    | 0    | 0    | 0    |
| 3.50                               | 4.00 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 287  | 891  | 16   | 11   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 4.00                               | 4.50 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 11   | 387  | 53   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 4.50                               | 5.00 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 53   | 53   | 5    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 5.00                               | 5.50 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 27   | 11   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 5.50                               | 6.00 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 5    | 5    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 6.00                               | 6.50 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 6.50                               | 7.00 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 7.00                               | 7.50 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 7.50                               | 8.00 | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Total per thousand for each period |      | 8   | 2   | 9    | 27   | 54   | 113  | 214  | 194  | 119  | 42   | 146  | 72   | 0    | 0    | 0    | 0    | 0    | 0    |

November

Data in parts per hundred thousand

|                                    | 0.0     | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 |
|------------------------------------|---------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.00                               | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.50                               | 0.73037 | 0    | 5    | 115  | 2078 | 6075 | 5872 | 2478 | 954  | 181  | 5066 | 2325 | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 1.00                               | 0.47889 | 0    | 0    | 11   | 66   | 2440 | 9501 | 3498 | 499  | 93   | 970  | 329  | 5    | 0    | 0    | 0    | 0    | 0    | 0    |
| 1.50                               | 0.30477 | 0    | 0    | 0    | 0    | 99   | 4901 | 5828 | 877  | 33   | 263  | 82   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 2.00                               | 0.18394 | 0    | 0    | 0    | 0    | 0    | 461  | 4841 | 2067 | 154  | 49   | 5    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 2.50                               | 0.10817 | 0    | 0    | 0    | 0    | 0    | 0    | 1283 | 3427 | 428  | 11   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 3.00                               | 0.05669 | 0    | 0    | 0    | 0    | 0    | 0    | 27   | 2182 | 822  | 16   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 3.50                               | 0.02621 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 565  | 1124 | 22   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 4.00                               | 0.00910 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 16   | 647  | 33   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 4.50                               | 0.00214 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 132  | 55   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 5.00                               | 0.00027 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 27   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 5.50                               | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 6.00                               | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 6.50                               | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 7.00                               | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 7.50                               | 0.00000 | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Total per thousand for each period | 56      | 0    | 6    | 20   | 42   | 103  | 226  | 196  | 117  | 48   | 125  | 60   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |

December

Data in parts per hundred thousand

|                                    | 0.0 | 1.0 | 2.0 | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 |
|------------------------------------|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0.0                                | 424 | 42  | 239 | 1448 | 1905 | 1873 | 1931 | 1061 | 1220 | 1310 | 8584 | 4361 | 11   | 0    | 0    | 0    | 0    | 0    | 0    |
| 1.0                                | 0   | 0   | 0   | 149  | 1761 | 5656 | 4711 | 2483 | 1215 | 435  | 4876 | 2181 | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 2.0                                | 0   | 0   | 0   | 0    | 37   | 2143 | 8738 | 3740 | 833  | 149  | 1019 | 340  | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 3.0                                | 0   | 0   | 0   | 0    | 0    | 69   | 3857 | 6749 | 775  | 74   | 191  | 42   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 4.0                                | 0   | 0   | 0   | 0    | 0    | 0    | 366  | 5184 | 3072 | 175  | 74   | 5    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 5.0                                | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 1056 | 4680 | 398  | 21   | 5    | 5    | 0    | 0    | 0    | 0    | 0    | 0    |
| 6.0                                | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 11   | 3019 | 1395 | 16   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 7.0                                | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 552  | 1512 | 69   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 8.0                                | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 32   | 907  | 138  | 0    | 0    | 0    | 0    | 0    | 5    | 0    | 0    |
| 9.0                                | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 117  | 207  | 11   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 10.0                               | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 133  | 27   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 11.0                               | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 85   | 48   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 12.0                               | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 5    | 27   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 13.0                               | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 5    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 14.0                               | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 15.0                               | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 16.0                               | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 17.0                               | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 18.0                               | 0   | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Total per thousand for each period | 4   | 0   | 2   | 16   | 37   | 97   | 196  | 203  | 154  | 65   | 154  | 71   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |



*Appendix 4 Monthly wave climates (H against absolute T) at the site: 5920160.54 N 394982.55 E*



| January | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|
| 0.0     | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 0.5     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 1.0     | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 1.5     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 2.0     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 2.5     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.0     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.5     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 4.0     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 4.5     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 5.0     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 5.5     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 6.0     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 6.5     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 7.0     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 7.5     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 8.0     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 8.5     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 9.0     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 9.5     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 10.0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 10.5    | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 11.0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 11.5    | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 12.0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |

1745 22810 69122 117481 148222 146368 118835 85097 56608 34922 18960 8472 2956 785 163 30 6 1 0 0 0 0

| February | 1      | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11   | 12   | 13  | 14  | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|----------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|-----|-----|----|----|----|----|----|----|----|
| 0.0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 0.5      | 1      | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10   | 11   | 12  | 13  | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 1.0      | 174029 | 21403 | 68270 | 95802 | 55356 | 37149 | 32258 | 28684 | 22478 | 14212 | 6938 | 2468 | 617 | 107 | 11 | 1  | 0  | 0  | 0  | 0  | 0  |
| 1.5      | 82444  | 0     | 0     | 20749 | 77219 | 41412 | 11715 | 5646  | 4819  | 4901  | 3931 | 2317 | 946 | 259 | 49 | 6  | 0  | 0  | 0  | 0  | 0  |
| 2.0      | 42680  | 0     | 0     | 16    | 8099  | 45205 | 21930 | 3839  | 1178  | 765   | 640  | 447  | 223 | 78  | 19 | 3  | 0  | 0  | 0  | 0  | 0  |
| 2.5      | 22752  | 0     | 0     | 0     | 6     | 6951  | 25731 | 8302  | 1046  | 251   | 182  | 119  | 63  | 24  | 5  | 1  | 0  | 0  | 0  | 0  | 0  |
| 3.0      | 12247  | 0     | 0     | 0     | 0     | 22    | 7655  | 12401 | 2263  | 263   | 68   | 44   | 24  | 10  | 2  | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.5      | 3587   | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 4312  | 457   | 77   | 23   | 9   | 4   | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| 4.0      | 6618   | 0     | 0     | 0     | 0     | 0     | 0     | 1342  | 4211  | 950   | 77   | 29   | 8   | 2   | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| 4.5      | 1949   | 0     | 0     | 0     | 0     | 0     | 0     | 41    | 1924  | 1453  | 141  | 13   | 11  | 3   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 5.0      | 1062   | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 383   | 1267  | 273  | 18   | 4   | 4   | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| 5.5      | 579    | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 14    | 630   | 383  | 29   | 3   | 1   | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| 6.0      | 317    | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 158   | 361  | 57   | 3   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 6.5      | 173    | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 11    | 216  | 85   | 4   | 1   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 7.0      | 95     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 72   | 92   | 9   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 7.5      | 52     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 11   | 67   | 16  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 8.0      | 28     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 31   | 20  | 1   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 8.5      | 15     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 8    | 17  | 3   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 9.0      | 8      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 1    | 11  | 4   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 9.5      | 4      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 4   | 4   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 10.0     | 2      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 1   | 3   | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| 10.5     | 1      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 2   | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| 11.0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 1   | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| 11.5     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 12.0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |

1605 21403 68329 116568 140681 130740 99624 67282 42628 25318 13369 5849 1994 508 94 13 1 0 0 0 0 0

| March | 0    | 1      | 2    | 3     | 4     | 5      | 6     | 7     | 8     | 9     | 10    | 11    | 12    | 13   | 14   | 15  | 16 | 17 | 18 | 19 | 20 |   |
|-------|------|--------|------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|------|------|-----|----|----|----|----|----|---|
| 0.0   | 0.5  | 559501 | 4003 | 38288 | 96651 | 127319 | 78880 | 53496 | 46426 | 41434 | 33234 | 22171 | 11482 | 4473 | 1265 | 277 | 63 | 23 | 11 | 4  | 1  | 0 |
| 0.5   | 1.0  | 199248 | 0    | 0     | 157   | 19831  | 83773 | 52107 | 16641 | 7511  | 5802  | 5264  | 4189  | 2477 | 1073 | 325 | 72 | 23 | 11 | 5  | 3  | 1 |
| 1.0   | 1.5  | 76415  | 0    | 0     | 0     | 56     | 6048  | 39727 | 22293 | 4541  | 1263  | 793   | 751   | 563  | 271  | 84  | 20 | 3  | 3  | 1  | 0  | 0 |
| 1.5   | 2.0  | 32208  | 0    | 0     | 0     | 0      | 24    | 4514  | 19344 | 6884  | 875   | 193   | 148   | 116  | 69   | 31  | 7  | 1  | 0  | 0  | 0  | 0 |
| 2.0   | 2.5  | 14514  | 0    | 0     | 0     | 0      | 0     | 15    | 4519  | 8265  | 1501  | 126   | 27    | 30   | 20   | 8   | 3  | 1  | 0  | 0  | 0  | 0 |
| 2.5   | 3.0  | 6778   | 0    | 0     | 0     | 0      | 0     | 0     | 150   | 3827  | 2550  | 222   | 15    | 4    | 6    | 3   | 1  | 0  | 0  | 0  | 0  | 0 |
| 3.0   | 3.5  | 3211   | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 598   | 2117  | 466   | 25    | 2    | 1    | 1   | 0  | 0  | 0  | 0  | 0  | 0 |
| 3.5   | 4.0  | 1524   | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 14    | 788   | 671   | 48    | 3    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 4.0   | 4.5  | 720    | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 130   | 481   | 105   | 3    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 4.5   | 5.0  | 338    | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 4     | 191   | 134   | 8    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 5.0   | 5.5  | 157    | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 40    | 100   | 25   | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 5.5   | 6.0  | 72     | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 3     | 48    | 21   | 1    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 6.0   | 6.5  | 33     | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 13    | 18   | 2    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 6.5   | 7.0  | 15     | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 2     | 11   | 3    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 7.0   | 7.5  | 7      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 4     | 4    | 2    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 7.5   | 8.0  | 3      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 1     | 1    | 2    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 8.0   | 8.5  | 1      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 1    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 8.5   | 9.0  | 1      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 9.0   | 9.5  | 0      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 9.5   | 10.0 | 0      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 10.0  | 10.5 | 0      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 10.5  | 11.0 | 0      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 11.0  | 11.5 | 0      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |
| 11.5  | 12.0 | 0      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0 |

4003 38288 96651 127319 78880 53496 46426 41434 33234 22171 11482 4473 1265 277 63 23 11 4 1 0 0

| April | 1    | 2      | 3    | 4     | 5      | 6      | 7     | 8     | 9     | 10    | 11    | 12    | 13    | 14   | 15   | 16  | 17 | 18 | 19 | 20 | 21 |
|-------|------|--------|------|-------|--------|--------|-------|-------|-------|-------|-------|-------|-------|------|------|-----|----|----|----|----|----|
| 0.0   | 0.5  | 695315 | 6076 | 61497 | 134355 | 149821 | 94714 | 62494 | 52534 | 47320 | 38998 | 26625 | 13825 | 5272 | 1461 | 280 | 38 | 3  | 0  | 0  | 0  |
| 0.5   | 1.0  | 166970 | 0    | 0     | 155    | 19622  | 67691 | 41839 | 15272 | 6397  | 4083  | 3850  | 3807  | 2626 | 1188 | 360 | 70 | 9  | 1  | 0  | 0  |
| 1.0   | 1.5  | 53923  | 0    | 0     | 0      | 39     | 5975  | 28713 | 13708 | 3206  | 881   | 487   | 370   | 306  | 161  | 58  | 15 | 3  | 0  | 0  | 0  |
| 1.5   | 2.0  | 21175  | 0    | 0     | 0      | 0      | 21    | 4142  | 12600 | 3607  | 554   | 87    | 68    | 47   | 31   | 14  | 4  | 1  | 0  | 0  | 0  |
| 2.0   | 2.5  | 8974   | 0    | 0     | 0      | 0      | 0     | 12    | 3685  | 4489  | 688   | 70    | 5     | 13   | 4    | 3   | 1  | 0  | 0  | 0  | 0  |
| 2.5   | 3.0  | 3964   | 0    | 0     | 0      | 0      | 0     | 0     | 99    | 2672  | 1089  | 95    | 6     | 0    | 2    | 1   | 0  | 0  | 0  | 0  | 0  |
| 3.0   | 3.5  | 1798   | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 462   | 1164  | 160   | 11    | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 3.5   | 4.0  | 829    | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 5     | 557   | 252   | 14    | 1    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 4.0   | 4.5  | 385    | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 88    | 269   | 27    | 27    | 1    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 4.5   | 5.0  | 180    | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 2     | 127   | 127   | 49    | 1    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 5.0   | 5.5  | 84     | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 26    | 54    | 4    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 5.5   | 6.0  | 39     | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 2     | 30    | 7    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 6.0   | 6.5  | 18     | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 9     | 9    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 6.5   | 7.0  | 9      | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 1     | 6    | 1    | 0   | 0  | 0  | 0  | 0  | 0  |
| 7.0   | 7.5  | 4      | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 3    | 1    | 0   | 0  | 0  | 0  | 0  | 0  |
| 7.5   | 8.0  | 2      | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1    | 1    | 0   | 0  | 0  | 0  | 0  | 0  |
| 8.0   | 8.5  | 1      | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 8.5   | 9.0  | 0      | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 9.0   | 9.5  | 0      | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 9.5   | 10.0 | 0      | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 10.0  | 10.5 | 0      | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 10.5  | 11.0 | 0      | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 11.0  | 11.5 | 0      | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 11.5  | 12.0 | 0      | 0    | 0     | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |

| May  | 0    | 1      | 2     | 3      | 4      | 5      | 6      | 7     | 8     | 9     | 10    | 11    | 12    | 13   | 14   | 15  | 16 | 17 | 18 | 19 | 20 | 21 |
|------|------|--------|-------|--------|--------|--------|--------|-------|-------|-------|-------|-------|-------|------|------|-----|----|----|----|----|----|----|
| 0.0  | 0.5  | 835357 | 11599 | 98048  | 187421 | 193332 | 112379 | 68868 | 51555 | 41947 | 32123 | 21040 | 11030 | 4428 | 1290 | 257 | 36 | 4  | 0  | 0  | 0  | 0  |
| 0.5  | 1.0  | 161197 | 0     | 0      | 120    | 19243  | 71210  | 41581 | 13548 | 4920  | 3077  | 2843  | 2338  | 1437 | 632  | 202 | 41 | 5  | 0  | 0  | 0  | 0  |
| 1.0  | 1.5  | 44198  | 0     | 0      | 0      | 33     | 3600   | 23280 | 13032 | 2689  | 594   | 266   | 290   | 234  | 42   | 42  | 9  | 1  | 0  | 0  | 0  | 0  |
| 1.5  | 2.0  | 14143  | 0     | 0      | 0      | 0      | 11     | 1926  | 8288  | 3343  | 432   | 56    | 23    | 25   | 11   | 11  | 3  | 0  | 0  | 0  | 0  | 0  |
| 2.0  | 2.5  | 4983   | 0     | 0      | 0      | 0      | 0      | 3     | 1459  | 2822  | 636   | 52    | 4     | 1    | 3    | 2   | 1  | 0  | 0  | 0  | 0  | 0  |
| 2.5  | 3.0  | 1882   | 0     | 0      | 0      | 0      | 0      | 0     | 29    | 991   | 775   | 81    | 5     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.0  | 3.5  | 743    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 119   | 475   | 142   | 7     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.5  | 4.0  | 302    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 1     | 148   | 139   | 14    | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 4.0  | 4.5  | 125    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 16    | 85    | 23    | 1    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 4.5  | 5.0  | 53     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 28    | 23    | 1    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 5.0  | 5.5  | 22     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 4     | 15    | 3    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 5.5  | 6.0  | 9      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 6     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 6.0  | 6.5  | 4      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 1     | 2    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 6.5  | 7.0  | 2      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 7.0  | 7.5  | 1      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 7.5  | 8.0  | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 8.0  | 8.5  | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 8.5  | 9.0  | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 9.0  | 9.5  | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 9.5  | 10.0 | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 10.0 | 10.5 | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 10.5 | 11.0 | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 11.0 | 11.5 | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 11.5 | 12.0 | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
|      |      | 11599  | 98048 | 187540 | 212608 | 187200 | 135659 | 87912 | 56833 | 38275 | 24736 | 13778 | 6138  | 2079 | 515  | 91  | 11 | 1  | 0  | 0  | 0  | 0  |

| June | 0     | 1     | 2      | 3      | 4      | 5      | 6     | 7     | 8     | 9     | 10    | 11   | 12   | 13  | 14  | 15 | 16 | 17 | 18 | 19 | 20 |
|------|-------|-------|--------|--------|--------|--------|-------|-------|-------|-------|-------|------|------|-----|-----|----|----|----|----|----|----|
| 0.0  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 0.5  | 1     | 1     | 2      | 3      | 4      | 5      | 6     | 7     | 8     | 9     | 10    | 11   | 12   | 13  | 14  | 15 | 16 | 17 | 18 | 19 | 20 |
| 1.0  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 1.5  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 2.0  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 2.5  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.0  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.5  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 4.0  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 4.5  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 5.0  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 5.5  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 6.0  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 6.5  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 7.0  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 7.5  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 8.0  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 8.5  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 9.0  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 9.5  | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 10.0 | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 10.5 | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 11.0 | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 11.5 | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 12.0 | 0     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
|      | 10880 | 90487 | 178977 | 215311 | 192786 | 133828 | 78859 | 45984 | 28946 | 18202 | 10142 | 4636 | 1675 | 481 | 119 | 30 | 8  | 2  | 1  | 0  | 0  |

| July | 0    | 1      | 2     | 3      | 4      | 5      | 6      | 7     | 8     | 9     | 10    | 11    | 12   | 13   | 14  | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|------|------|--------|-------|--------|--------|--------|--------|-------|-------|-------|-------|-------|------|------|-----|----|----|----|----|----|----|----|
| 0.0  | 0.5  | 899911 | 10585 | 205501 | 224508 | 134082 | 75467  | 51532 | 38728 | 28342 | 18461 | 9764  | 3992 | 1211 | 258 | 39 | 4  | 0  | 0  | 0  | 0  | 0  |
| 0.5  | 1.0  | 158346 | 0     | 127    | 16201  | 71833  | 47440  | 14450 | 3908  | 1446  | 865   | 866   | 682  | 356  | 133 | 32 | 5  | 1  | 0  | 0  | 0  | 0  |
| 1.0  | 1.5  | 38307  | 0     | 0      | 13     | 2501   | 19811  | 12445 | 2860  | 470   | 90    | 42    | 34   | 25   | 10  | 4  | 2  | 1  | 0  | 0  | 0  | 0  |
| 1.5  | 2.0  | 10707  | 0     | 0      | 0      | 5      | 1250   | 6480  | 2520  | 398   | 44    | 5     | 2    | 1    | 1   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 2.0  | 2.5  | 3478   | 0     | 0      | 0      | 0      | 2      | 1009  | 2038  | 387   | 38    | 3     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 2.5  | 3.0  | 1287   | 0     | 0      | 0      | 0      | 0      | 4     | 752   | 487   | 41    | 2     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.0  | 3.5  | 512    | 0     | 0      | 0      | 0      | 0      | 0     | 66    | 364   | 78    | 3     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.5  | 4.0  | 209    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 112   | 89    | 7     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 4.0  | 4.5  | 86     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 6     | 68    | 12    | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 4.5  | 5.0  | 35     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 19    | 15    | 1    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 5.0  | 5.5  | 14     | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 1     | 12    | 1    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 5.5  | 6.0  | 6      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 4     | 2    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 6.0  | 6.5  | 2      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 2    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 6.5  | 7.0  | 1      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 1    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 7.0  | 7.5  | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 7.5  | 8.0  | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 8.0  | 8.5  | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 8.5  | 9.0  | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 9.0  | 9.5  | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 9.5  | 10.0 | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 10.0 | 10.5 | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 10.5 | 11.0 | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 11.0 | 11.5 | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 11.5 | 12.0 | 0      | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|      |      | 10585  | 97436 | 205628 | 240722 | 208421 | 143971 | 85921 | 50872 | 32014 | 19794 | 10735 | 4716 | 1594 | 402 | 76 | 11 | 2  | 0  | 0  | 0  | 0  |

| August | 0    | 1      | 2     | 3      | 4      | 5      | 6      | 7      | 8     | 9     | 10    | 11    | 12    | 13   | 14   | 15  | 16 | 17 | 18 | 19 | 20 | 21 |
|--------|------|--------|-------|--------|--------|--------|--------|--------|-------|-------|-------|-------|-------|------|------|-----|----|----|----|----|----|----|
| 0.0    | 0.5  | 886016 | 11905 | 100208 | 205486 | 223446 | 127950 | 71251  | 48636 | 36735 | 27392 | 18047 | 9592  | 3912 | 1176 | 243 | 35 | 3  | 0  | 0  | 0  | 0  |
| 0.5    | 1.0  | 154882 | 0     | 0      | 121    | 15917  | 71054  | 44425  | 13601 | 4223  | 1613  | 1159  | 1217  | 910  | 450  | 154 | 33 | 5  | 0  | 0  | 0  | 0  |
| 1.0    | 1.5  | 38813  | 0     | 0      | 0      | 14     | 2713   | 20332  | 12482 | 2493  | 454   | 133   | 71    | 64   | 37   | 15  | 5  | 1  | 0  | 0  | 0  | 0  |
| 1.5    | 2.0  | 11401  | 0     | 0      | 0      | 0      | 4      | 1318   | 6819  | 2841  | 344   | 41    | 18    | 8    | 4    | 3   | 1  | 0  | 0  | 0  | 0  | 0  |
| 2.0    | 2.5  | 3680   | 0     | 0      | 0      | 0      | 0      | 1      | 937   | 2204  | 497   | 32    | 2     | 4    | 2    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 2.5    | 3.0  | 1271   | 0     | 0      | 0      | 0      | 0      | 0      | 11    | 632   | 565   | 60    | 2     | 0    | 1    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.0    | 3.5  | 455    | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 49    | 309   | 92    | 5     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 3.5    | 4.0  | 164    | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 63    | 93    | 8     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 4.0    | 4.5  | 58     | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 5     | 38    | 14    | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 4.5    | 5.0  | 20     | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 7     | 12    | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 5.0    | 5.5  | 6      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 1     | 4     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 5.5    | 6.0  | 2      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 1     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 6.0    | 6.5  | 1      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 6.5    | 7.0  | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 7.0    | 7.5  | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 7.5    | 8.0  | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 8.0    | 8.5  | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 8.5    | 9.0  | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 9.0    | 9.5  | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 9.5    | 10.0 | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 10.0   | 10.5 | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 10.5   | 11.0 | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 11.0   | 11.5 | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
| 11.5   | 12.0 | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  | 0  |
|        |      |        | 11905 | 100208 | 205607 | 239377 | 201721 | 137327 | 82487 | 49177 | 31242 | 19703 | 10945 | 4903 | 1670 | 415 | 73 | 9  | 1  | 0  | 0  | 0  |

| September | 0    | 1      | 2    | 3     | 4      | 5      | 6      | 7      | 8     | 9     | 10    | 11    | 12    | 13   | 14   | 15  | 16  | 17 | 18 | 19 | 20 | 21 |
|-----------|------|--------|------|-------|--------|--------|--------|--------|-------|-------|-------|-------|-------|------|------|-----|-----|----|----|----|----|----|
| 0.0       | 0.5  | 743170 | 9466 | 76725 | 155865 | 170716 | 97904  | 62107  | 50003 | 43330 | 34615 | 23213 | 12372 | 5024 | 1475 | 304 | 45  | 5  | 0  | 0  | 0  | 0  |
| 0.5       | 1.0  | 167559 | 0    | 0     | 115    | 20290  | 77492  | 42894  | 11831 | 4068  | 2897  | 2958  | 2493  | 1559 | 695  | 217 | 44  | 6  | 1  | 0  | 0  | 0  |
| 1.0       | 1.5  | 55429  | 0    | 0     | 0      | 11     | 4641   | 30708  | 15641 | 2839  | 523   | 276   | 326   | 258  | 145  | 48  | 12  | 2  | 0  | 0  | 0  | 0  |
| 1.5       | 2.0  | 21288  | 0    | 0     | 0      | 0      | 5      | 2931   | 13300 | 4305  | 549   | 75    | 43    | 36   | 29   | 13  | 3   | 1  | 0  | 0  | 0  | 0  |
| 2.0       | 2.5  | 8836   | 0    | 0     | 0      | 0      | 0      | 5      | 2681  | 5142  | 894   | 86    | 11    | 9    | 5    | 2   | 1   | 0  | 0  | 0  | 0  | 0  |
| 2.5       | 3.0  | 3791   | 0    | 0     | 0      | 0      | 0      | 0      | 44    | 2172  | 1414  | 146   | 12    | 2    | 1    | 1   | 0   | 0  | 0  | 0  | 0  | 0  |
| 3.0       | 3.5  | 1647   | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 236   | 1151  | 236   | 22    | 1    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 3.5       | 4.0  | 717    | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 3     | 359   | 327   | 26    | 3    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 4.0       | 4.5  | 311    | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 37    | 227   | 44    | 3    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 4.5       | 5.0  | 133    | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 1     | 70    | 59    | 3    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 5.0       | 5.5  | 56     | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 9     | 41    | 6    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 5.5       | 6.0  | 23     | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 14    | 8    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 6.0       | 6.5  | 9      | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 3     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 6.5       | 7.0  | 4      | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 1    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 7.0       | 7.5  | 1      | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 1    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 7.5       | 8.0  | 0      | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 8.0       | 8.5  | 0      | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 8.5       | 9.0  | 0      | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 9.0       | 9.5  | 0      | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 9.5       | 10.0 | 0      | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 10.0      | 10.5 | 0      | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 10.5      | 11.0 | 0      | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 11.0      | 11.5 | 0      | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
| 11.5      | 12.0 | 0      | 0    | 0     | 0      | 0      | 0      | 0      | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0   | 0  | 0  | 0  | 0  | 0  |
|           |      |        | 9466 | 76725 | 155980 | 191017 | 180043 | 138645 | 93501 | 62093 | 42437 | 27623 | 15465 | 6921 | 2354 | 586 | 104 | 13 | 1  | 0  | 0  | 0  |

| October | 0    | 1      | 2    | 3     | 4     | 5      | 6     | 7     | 8     | 9     | 10    | 11    | 12    | 13   | 14   | 15  | 16 | 17 | 18 | 19 | 20 |
|---------|------|--------|------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|------|------|-----|----|----|----|----|----|
| 0.0     | 0.5  | 617377 | 4359 | 40554 | 97417 | 123478 | 80678 | 61191 | 57610 | 54468 | 44810 | 29794 | 15256 | 5832 | 1583 | 305 | 39 | 3  | 0  | 0  | 0  |
| 0.5     | 1.0  | 190671 | 0    | 0     | 245   | 20888  | 76563 | 43912 | 14029 | 7049  | 7124  | 7975  | 6745  | 3982 | 1617 | 445 | 84 | 11 | 1  | 0  | 0  |
| 1.0     | 1.5  | 73351  | 0    | 0     | 0     | 71     | 6448  | 38909 | 19687 | 3948  | 1115  | 858   | 950   | 761  | 422  | 145 | 32 | 4  | 0  | 0  | 0  |
| 1.5     | 2.0  | 32486  | 0    | 0     | 0     | 0      | 30    | 4623  | 19734 | 6497  | 946   | 221   | 168   | 130  | 89   | 37  | 10 | 2  | 0  | 0  | 0  |
| 2.0     | 2.5  | 15271  | 0    | 0     | 0     | 0      | 0     | 19    | 4662  | 8715  | 1561  | 181   | 55    | 44   | 22   | 9   | 3  | 1  | 0  | 0  | 0  |
| 2.5     | 3.0  | 7395   | 0    | 0     | 0     | 0      | 0     | 0     | 141   | 4159  | 2747  | 281   | 33    | 18   | 11   | 4   | 1  | 0  | 0  | 0  | 0  |
| 3.0     | 3.5  | 3622   | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 563   | 2462  | 536   | 44    | 8    | 6    | 2   | 1  | 0  | 0  | 0  | 0  |
| 3.5     | 4.0  | 1777   | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 17    | 872   | 805   | 71    | 7    | 3    | 1   | 0  | 0  | 0  | 0  | 0  |
| 4.0     | 4.5  | 869    | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 135   | 597   | 125   | 9    | 1    | 1   | 0  | 0  | 0  | 0  | 0  |
| 4.5     | 5.0  | 423    | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 6     | 220   | 183   | 2    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 5.0     | 5.5  | 205    | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 46    | 136   | 1    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 5.5     | 6.0  | 99     | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 3     | 61    | 2    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 6.0     | 6.5  | 48     | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 17    | 3    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 6.5     | 7.0  | 23     | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 2     | 5    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 7.0     | 7.5  | 11     | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 1     | 6    | 1    | 0   | 0  | 0  | 0  | 0  | 0  |
| 7.5     | 8.0  | 5      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1    | 3    | 1   | 0  | 0  | 0  | 0  | 0  |
| 8.0     | 8.5  | 2      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 2    | 1    | 0   | 0  | 0  | 0  | 0  | 0  |
| 8.5     | 9.0  | 1      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 1   | 0  | 0  | 0  | 0  | 0  |
| 9.0     | 9.5  | 1      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 9.5     | 10.0 | 0      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 10.0    | 10.5 | 0      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 10.5    | 11.0 | 0      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 11.0    | 11.5 | 0      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |
| 11.5    | 12.0 | 0      | 0    | 0     | 0     | 0      | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0    | 0    | 0   | 0  | 0  | 0  | 0  | 0  |

4359

40554

97662

144438

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| Month    | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | 15     | 16     | 17     | 18     | 19     | 20     | 21     |
|----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| November | 0      | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | 15     | 16     | 17     | 18     | 19     | 20     |
| 0.0      | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    |
| 492186   | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 | 181631 |
| 2433     | 29452  | 80053  | 105711 | 67064  | 49193  | 45753  | 42052  | 33576  | 21377  | 10489  | 3817   | 997    | 191    | 191    | 26     | 2      | 0      | 0      | 0      | 0      | 0      |
| 0        | 0      | 99     | 20835  | 74140  | 41749  | 12619  | 6330   | 6656   | 7588   | 6250   | 3552   | 1384   | 357    | 357    | 62     | 7      | 1      | 0      | 0      | 0      | 0      |
| 1.0      | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    | 1.5    |
| 73378    | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  | 73378  |
| 33740    | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  | 33740  |
| 2.0      | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    |
| 16436    | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  | 16436  |
| 8237     | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   | 8237   |
| 3.0      | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    | 3.5    |
| 4186     | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   | 4186   |
| 2136     | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   | 2136   |
| 4.0      | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    | 4.5    |
| 1085     | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   | 1085   |
| 5.0      | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    | 5.5    |
| 270      | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    | 270    |
| 6.0      | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    | 6.5    |
| 132      | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    | 132    |
| 7.0      | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    | 7.5    |
| 63       | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     | 63     |
| 8.0      | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    |
| 14       | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     | 14     |
| 9.0      | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    | 9.5    |
| 3        | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      | 3      |
| 10.0     | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   | 10.5   |
| 1        | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 1      |
| 11.0     | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   | 11.5   |
| 0        | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |
| 12.0     | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   | 12.0   |
| 0        | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |
| 2433     | 29452  | 80152  | 126574 | 148903 | 136036 | 103142 | 72576  | 50450  | 33125  | 18808  | 8565   | 2962   | 748    | 134    | 17     | 1      | 0      | 0      | 0      | 0      | 0      |

