SEPA
Scottish Environment Protection Agency

Attachment VIII

Site and Hydrographic Survey Requirements

Version 2.7

31st October 2008

Scope

This guidance is for those involved in the submission and evaluation of environmental data for the predictive modelling assessment of fish farm impacts. These data include:

- position fixing;
- depth measurements;
- wind speed and direction, and;
- current flow.

Such data are required in support of applications for discharge licenses under The Water Environment (Controlled Activities) (Scotland) Regulations 2005, commonly referred to as 'CAR'.

The guidance is intended for those experienced in using the necessary specialised apparatus such as current meters, GPS navigation equipment and water level recorders. Analysis of the data entails trigonometric transformations and is assisted greatly by competence in the use of spreadsheet functions.

The guidance includes standards and examples of how to collect and present the data.

Contents

Tables and Figures

1 Introduction

Current data collected at a fish farm site are used to characterise the local flow field. This information is essential for assessing the impact from fish farm discharges. In particular, current data are used in the modelling of dispersion of dissolved and solid substances. Subject to the topography, the tidal currents may be modified by the wind, so concurrent wind data are required.

Other important information includes the local topography and accurate position fixing of the cages and current meters. This enables correct location of cages against the bathymetry and allows SEPA to check the suitability of the current meter deployment site.

An application to discharge from a marine cage fish farm (made under CAR, 2005) needs to be supported by a report that summarises and qualifies the data required by SEPA (see below for details). The report will be held on SEPA's Public Register.

This document provides guidance on:

- what data are required;
- how to gather and process the data; and
- ways to present the data in a report.

SEPA's requirements are set out in separate boxes and for each topic there is background information.

2 Site Survey

The effective dispersion of discharged materials and the rate of accumulation of solids beneath a farm depend on the cage size and location, and the depth of water below the cage group.

Collect positional and depth information for the corners of each cage group.

Relative position errors can be minimised by doing this at the same time as the current meter deployment.

2.1 Position Fixing

Determine cage corner positions and the current meter deployment position using an electronic satellite navigation technique with an accuracy of <25m.

Typically, this entails the use of GPS (Global Positioning System) or DGPS (Differential GPS), although GLONASS and Galileo may be alternatives.

The quality of information from GPS/DGPS can be improved by:

- allowing the system to 'see' a greater number of satellites;
- holding the position for longer. For example, 1 minute is better than 10 seconds.

Therefore, it is important to log the number of satellites in view and the length of the fix as a measure of the likely quality of the data. Record this information alongside the position data.

Report the datum of the positioning system (preferably WGS84/ETRS89) and convert the measured positions to Ordnance Survey National Grid references (NGR relative to OSGB36 datum) via a recognised transformation algorithm.

For the preceding task - WGS84/ETRS89 to OSGB36 – OSTN02 is the most accurate currently available method.

It is good practice, when embarking on position fixing, to calibrate the positioning equipment at a known reference point, such as a jetty or pier light. This also provides an opportunity to check the time needed to obtain a good position fix. Do a similar exercise at the end of the survey to assess the precision of the equipment and method over the survey period. Record the results of all such tests in the report.

Resources:

OSTN02-enabled conversion software, Grid InQuest, is available as freeware from Quest Geo Solutions from the downloads page of their website: www.qgsl.com

For further information about GPS, geodetics and datum transformations refer to the Ordnance Survey National GPS website: www.gps.gov.uk.

2.2 Depth Soundings

Collect depth measurements at the cage corner positions, to an accuracy of ±0.5m.

Acoustic sounders typically return depths to ±0.1m; for manually obtained data, the reported depth should be an average of at least five soundings during the position fix period.

In shallow water (<25m), a plumb line is a reasonable alternative. Care should be taken that depths are not over-estimated because of the line's drifting in strong currents.

Record or convert the times of the position fixes and depth measurements to GMT. Correct the depths to chart datum (CD) by subtracting the local tidal height as predicted from Admiralty Tide Tables (ATT) or an equivalent electronic method (many such tools exist, some of which are freely available via the Internet).

In areas poorly represented in Admiralty (UKHO) bathymetric charts, obtain a minimum of four additional depth measurements.

Ideally, additional depth measurements should characterise the bathymetry 150m from the cages in at least the cardinal directions (the four main points of the compass). Where this cannot be achieved, because of insufficient draught, the shallowest achievable depth should be recorded with a further measurement taken at an intermediate point. Collect supplementary measurements, as required, to resolve pertinent topographic features, such as channels, reefs, and embayments. More detailed studies may use continuous logging of DGPS position and depth, usually to a dedicated survey computer.

2.3 Data Reporting

In the report, present a bathymetric contour plot of a one km square area centred on the cages. This should be overlain by OS-National Grid 100m graticules (grid lines) and the locations of the:

- ***cage group corners (with depths);***
- ***current meter (with depth);***
- ***meteorological station;***
- ***any other depth soundings (marked and clearly labelled).***

Correct all depths to chart datum.

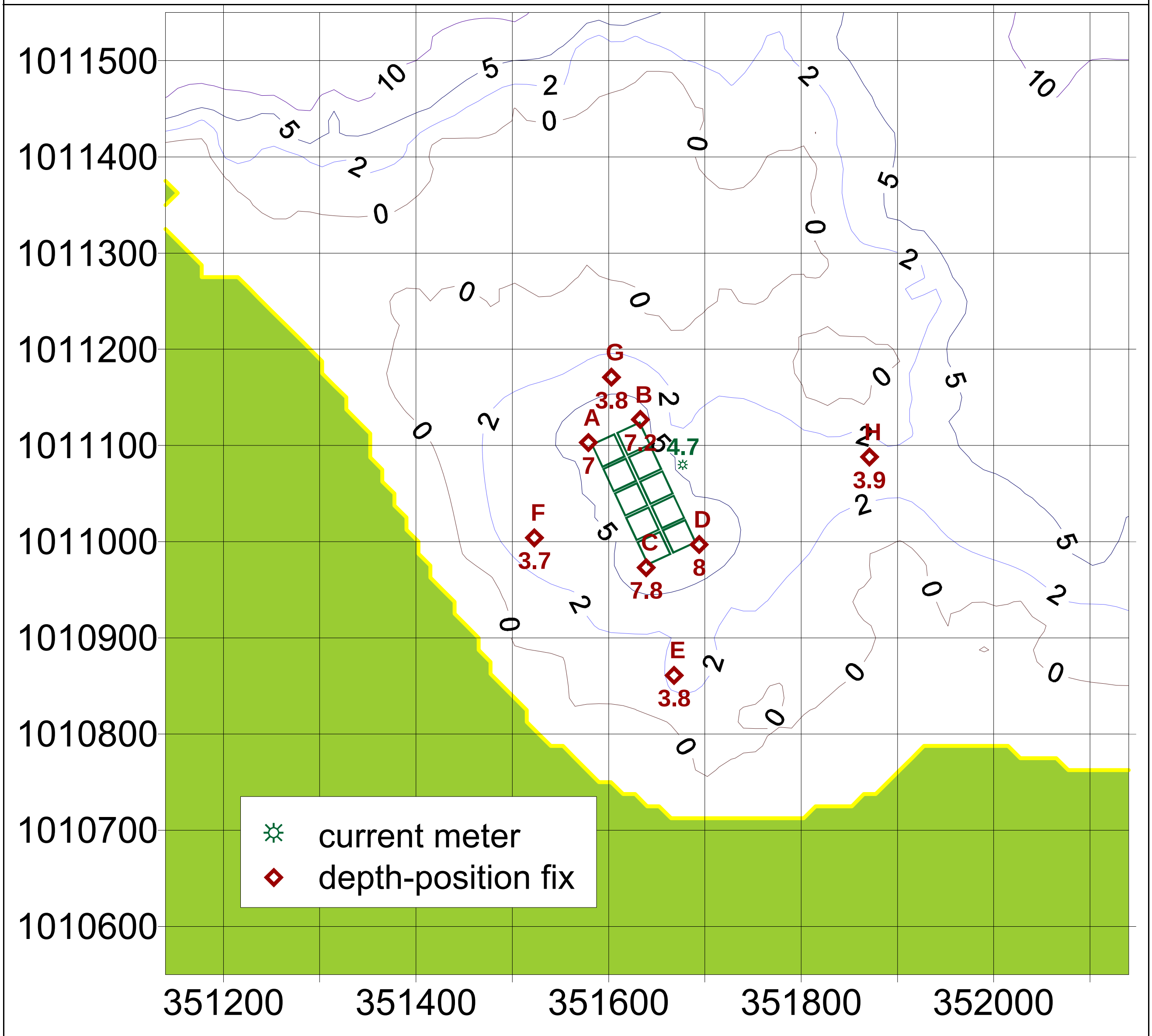
An example is provided in Figure 2-1.

Report the date of the depth survey.

Present the data as a table on the same or the facing page of the report in the format specified in Table 2.1

Continuous logging bathymetric surveys can produce vast quantities of data; the raw data (usually lat/long positions and depth soundings), the tidal corrections, the corrected depths, and the conversions of positions to NGRs should be supplied electronically in a single ASCII format file. Include a plot of the survey track, and select representative individual soundings corresponding to the 'additional depth measurements' described in section 2.2 above, for inclusion in the cage and bathymetry diagram.

Figure 2-1 Example cage survey and bathymetry diagram



Notes: depths in m below chart datum; positions in OSGB36 eastings and northings.

Table 2.1 Extract of example survey report table

Soundings collected on 24th April, 2008.

Label	Time[1] GMT	Predicted Tidal Height[2] (m)	Depth (m) sounding	Depth (m) (CD)	Position WGS84	Position NGR	No. of Sat[3]	Duration of Fix[4] (mins)
A	13:42	2.7	9.7	7	58° 59.058'N 2° 50.649'W	351579 1011103	7	5
B	13:48	2.6	9.8	7.2	58° 59.072'N 2° 50.593'W	351633 1011127	8	4
C	13:55	2.6	10.4	7.8	58° 58.989'N 2° 50.585'W	351639 1010973	8	4
…	…	…	…	…	…	…	…	…

Notes:

1- present the soundings in chronological order; this highlights any errors in the predicted tidal height values.

2 - the predicted tidal height at the time when a fix/sounding is made may be obtained from Admiralty Tide Tables or other tidal data sources; the source employed should be reported.

3 - the number of GPS satellites visible to the receiver at the time of fix/sounding. This may entail accessing a different receiver menu than that used to display co-ordinates.

4 - the length of time, spent at the fix/sounding location to achieve the final fix/sounding. This is not required for a continuous logging bathymetric survey.

3 Current Data

3.1 Duration and Resolution

For robust assessment of the local current conditions, deploy meters for at least a half-lunar cycle (15 days).

Longer deployments may allow clearer determination of tidal components, should data repair be necessary (see section 3.7). Use whole multiples of the half-lunar period (i.e., an exact 15 day record) to derive the analysis and indices discussed in section 3.10.

The lowest acceptable temporal resolution is 20 minutes.

This value is specified so as to capture minimum and maximum currents; a lower temporal resolution (longer interval between samples) is more likely to miss a short slack-water period. Table 3.1 shows the number of data records required for a complete 15-day dataset at typical recording frequencies:

Table 3.1 Current data duration and resolution (minimum requirement)

Resolution (interval between records) (minutes)	Frequency (records per hour)	Number of records
1	60	21601
2	30	10801
3	20	7201
5	12	4321
6	10	3601
10	6	2161
12	5	1801
15	4	1441
20	3	1081

3.2 Water depth

Collect a record of water depth simultaneously with the current record, at the same or a higher frequency.

This enables SEPA to corroborate the deployment depth, timing, and duration. Water depth may be recorded with a pressure sensor fitted to the device on or nearest to the seabed, or by deployment of a separate bed-mounted tide gauge at the bottom of the current meter mooring.

3.3 Equipment

SEPA's current flow data requirements may be met by a variety of different technologies. These can be divided into two broad categories: instruments that return data from the point of deployment (Discrete Measuring Devices); and those that return data from a range of depths local to the device (Profiling Devices).

3.3.1 Discrete measuring devices.

These include mechanical, electro-magnetic and acoustic devices. In all cases, current velocity is determined by relating measurement of current speed to the orientation of the device. The orientation is most often determined by an on-board electro-magnetic compass.

- Mechanical meters typically employ impellors that complete a calibrated number of revolutions, during the specified sampling period, in response to water flow. They therefore return an average of the flow speed during the sampling period. The impellor usually has a minimum starting speed below which it will not turn; at speeds lower than this threshold, no current is recorded. To minimise the effect of short-term turbulent fluctuations in the flow, the sampling period should be more than 30 seconds. To reduce biasing by sub-threshold speeds, the sampling period should be less than 2 minutes.
- Electro-magnetic meters determine current speed by measuring the voltage generated across pairs of orthogonally aligned electrodes when water moves through the magnetic field applied by the device. They are therefore not as susceptible to fouling and have a very low threshold speed, giving valid readings from near zero to their full scale. However, they are sensitive to the conductance of the water in which they are immersed; this is not normally a problem in seawater but can lead to difficulty in low salinity waters; consequently, care should be taken at sites in proximity to river discharges. The data returned are instantaneous and therefore sub-sampling and averaging are required to describe the average flow-field rather than the detailed turbulent fluctuations. The averaging is normally done internally by use of appropriate instrument settings.
- Acoustic meters transmit sound pulses at a specific acoustic frequency. They then measure the Doppler shift in the return signal echoing from particles entrained in the water: this frequency shift depends on the speed of the entrained particles. Orthogonal current components are determined by resolving the signals from two or more transducers aligned with specific divergent beam angles. The recorded speed is an average of a large number of estimates of the entrained particles' velocity. The precision of these values reflects the number of estimates and the sampled volume of water; a useful target for configuring such instruments is that speed precision should approximate to 10% of the mean of the dataset.

3.3.2 Profiling devices

Acoustic devices may be employed, utilising the same technology as for the discrete devices described above. These determine average currents across adjacent depth 'cells', or 'bins', through the water column.

Where profiling instruments are used, they must be fitted with suitable ancillary sensors and set up carefully with respect to averaging interval, number of 'pings', cell size and deployment depth, to ensure that the following criteria are met in addition to those specified in Table 3.2:

- ***the height of the transducers above the bed, blanking distance and cell size should be set such that the centre of the first cell meets the near-bottom depth criterion defined in section 3.6;***
- ***the near-bottom depth bin or cell size should not exceed 3m;***
- ***sound-speed should be determined in real-time from measured temperature and an appropriate salinity;***
- ***during deployment the device should not tilt away from the vertical to an extent that would invalidate the flow estimates – this angle is device specific;***
- ***the horizontal speed precision should not exceed 10% of the mean;***
- ***the acoustic frequency of the device should be chosen to return reliable flow estimates through the full deployment depth.***

N.B.: In areas of weak current flow an acoustic instrument may be unable to deliver sufficient precision for a reliable estimate of flow. Similarly, in situations with low turbidity (high clarity) such as during the winter, when phytoplankton concentrations are at their lowest, there may be insufficient scatterers in the ensonified sampling volume to provide adequate echoes from which the instrument can determine reliable flow estimates. In such cases, an alternative means of measurement is advised. If the data have been collected with equipment slightly outwith the specifications in Table 3.2 they may still be acceptable. In this instance, applicants are strongly advised to seek SEPA's opinion before using the data for modelling purposes.

3.4 Data Quality Assurance

All instruments should be selected to achieve the specifications in Table 3.2 as a minimum.

Record the specifications of the instruments in a format similar to Table 3.2. Include any additional sensors for which data are to be presented. Report any device-specific set-up parameters such as sampling interval or number of averaged samples.

Include calibration certificates, or evidence of calibration tests, as appendices to the survey report.

Table 3.2 Equipment specifications

	Accuracy[1]	Precision[2]	Resolution[3]	Range
Speed[4]	≤ 1 cm/s	≤ 2 cm/s	≤ 1 cm/s	≥ 3 cm/s
Direction	≤ 5°	≤ 3°	≤ 1°	0° to 360°
Pressure	≤ 0.05 dBar	≤ 0.02 dBar	≤ 0.01 dBar	≥ 0 dBar
acoustic instruments should also include:				
Tilt/Roll	≤ 0.5°	≤ 0.5°	≤ 0.1°	0° to ≥ 20°
Temperature	≤ 0.5°	≤ 0.5°C	≤ 0.1°C	≤ 0° to >25°C

Notes:

[1] - ‘accuracy’ is the measure of the discrepancy between the value returned by a sensor and the true value;

[2] - ‘precision’ is the measure of the variability of the values returned by a sensor for any true value, calculated as standard deviation;

[3] - ‘resolution’ is the measure of the smallest interval that a sensor can determine.

[4] - this is horizontal speed; some instruments provide estimates of 3D speed precision which may be biased by the generally higher precision of the vertical speed component; the manufacturer should be contacted for clarification.

The specifications stipulated in Table 3.2 may be relaxed where it can be shown that the noise in the current measurement is sufficiently low relative to the current itself that the resulting modelling predictions are not significantly altered. This is to say that the uncertainty in the value returned by a sensor is so small, in relation to the currents, that derived predictions are altered insignificantly by increasing or decreasing the data by the uncertainty.

As an example, where a resuspension threshold of 9.5 cm/s is applied in the modelling of particle-bound in-feed anti-parasitic chemicals, a current speed of 20 cm/s recorded with a precision of 2.5 cm/s rather than 2 cm/s will result in little difference in the deposition predictions. This is because the data is highly unlikely to be incorrect by more than 7.5 cm/s (three standard deviations) and still therefore remains above the threshold value.

Where an instrument has been deployed that fails to meet the requirements specified in Table 3.2, arguments for the validity of the resultant data - quantifying the likely impact on any subsequent modelling results - should be documented and submitted for approval by SEPA before any further use.

3.5 Deployment Position

The location of the meter is inevitably a compromise between the goal of returning a representative dataset and practical considerations, particularly with regard to obstruction by natural features or farm equipment such as moorings.

With the forgoing in mind, the deployment should meet the following criteria:

- ***To obtain data representing flow in the vicinity of the cages, the meter should be in a similar depth. A desirable target is ±5m of the mean depth of the cage corners (c.f. section 2.2);***
- ***The meter should be within 150m of the centre of the cage group it represents. Adjacent groups may be represented by a single deployment so long as the 150m criterion is met for each. Sites composed of many or large cage groups – where the total site extends for more than 500m – should be covered by multiple deployments;***
- ***The mooring should be sited to avoid local currents associated with topographic features such as reefs, skerries, points and the cages themselves.***

Where any of these criteria are compromised by site-specific limitations, the report should include the rationale behind the selection of the mooring site and an assessment of the degree to which the data represent current around the cage groups.

Please refer to section 2.1 for details of position fixing requirements.

Applicants, or their contractors, are invited to contact SEPA **before** deployment to discuss any uncertainties regarding the suitability of current meter sites. Enquiries of this nature can be sent to the e-mail address: mailto:FFModelling@sepa.org.uk

3.6 Depth of Data Retrieval

At sites with chart depths in excess of 15m, collect data at three depths:

- ***Sub-surface currents - from a depth 5m below the lowest predicted spring tide during the deployment period.***
- ***Cage-bottom currents - at a depth corresponding to the bottom of the cages at mean sea level ±1m.***
- ***Near-bottom currents - as close to the bed as is practicable, typically 1-2m above the bed. 3m is the maximum permissible distance from the bed for near-bottom data.***

For profiling devices, the above measurement depths should be the centres of data collection cells (bins). The sub-surface bin should be of sufficient depth that it does not suffer from effects such as wave breaking or side-lobe interference.

At sites with mean charted depths of less than 15m, only the above-defined sub-surface and near-bottom datasets are required.

Applicants, or their contractors, are invited to contact SEPA **before** deployment to discuss any uncertainties regarding the suitability of current meter deployment depths. Enquiries of this nature can be sent to the e-mail address: FFModelling@sepa.org.uk

3.7 Meteorological Data

Provide meteorological data, concurrent with the current meter deployment. Make measurements at a location representative of the cage groups (i.e. not subject to topographic modification of the wind).

Record wind speed and direction at least 3 times a day, evenly spread during daylight hours. Manual measurements should be the average of 5 observations at one minute intervals. Automatically logged records may be hourly averages with hourly maximum gust values.

During the period of observation there must be at least 3 consecutive days with mean daily wind speeds less than 10 m/s (19.3 knots) for the current flow measurements to be acceptable.

In some instances, it may be necessary to extend the period of measurement to ensure that the quiescence criterion is met. This stipulation may be relaxed if it can be demonstrated by modelling, or otherwise, that the current data include a period when the flow field is not significantly modified by wind forcing. For example, this may apply when the wind is blowing across, rather than along, a loch, correspondingly reducing the effect of the wind on the water movement.

3.8 Numerical Data

Supply current data from each depth on electronic media, (floppy disk or CD-ROM) in two forms:

1. ***the raw data as downloaded from the instrument including all file headers and additional parameters, with conversion to engineering units where appropriate – this may include binary data files for some instruments;***
2. ***separate processed data ASCII text files (or sheets in a spreadsheet file) of all retrieved data records for each depth, uncorrected and formatted to the specification detailed in Table 3.3****Error! Reference source not found.****.**

Supply meteorological data numerically on electronic media, formatted as in Table 3.3*Error! Reference source not found.****.**

Table 3.3 Data file format

Hydrographic data

MINIMUM REQUIREMENT				ADDITIONAL PARAMETERS				
date & time[1] GMT	speed m/s	direction °Magnetic	depth[2] m	east m/s	north m/s	pressure dBar	salinity PSU	temperature °C
11/2/02 13:15	0.035	234	17.51					
11/2/02 13:25	0.042	245	17.47					
…	…	…	…	…	…	…	…	…

Meteorological data

MINIMUM REQUIREMENT			ADDITIONAL PARAMETERS
date & time[1] GMT	mean speed m/s	direction °Magnetic	maximum gust m/s
11/2/02 13:15	3.7	155	7.4
11/2/02 14:15	4.2	153	9.6
…	…	…	…

Notes:

[1] - ‘date & time’ are in a single column and should be delimited as such in tab or comma separated text file formats;

[2] - depth should be corrected for the height of the sensor above the bed; report this correction.

3.9 Data Processing

SEPA accepts that there may be data loss during a current meter deployment because of various technical and environmental factors. Every effort should be made to minimise this.

SEPA will accept the repair of up to 6 hours of data in any submitted 15-day data set.

SEPA will assess the scientific robustness of any synthesis technique to repair missing or erroneous data and may reject data deemed unlikely to represent the flow field. It should be noted that data from sites with weak tidal currents relative to other influences are difficult to repair satisfactorily.

Where the processing of current data involves the removal of spikes, filtering or the repair of missing records, the affected records should be identified and the repair method should be described in the report.

Correct all times to GMT (equivalent to UTC or GPS time).

Correct all bearings – current data and meteorological data – from Magnetic to Grid or True North, prior to performing statistical analyses. Report the values of magnetic variation and grid convergence that have been used.

N.B. True North is slightly different from Grid North and this difference varies across the country. Local magnetic and grid correction information is included on Ordnance Survey maps. Grid convergence corrections may also be obtained from the Ordnance Survey’s GPS website, via:
www.ordnancesurvey.co.uk/oswebsite/gps/docs/ProjectionandTransformationCalculations.xls; a grid convergence function is also included in SEPA’s current meter/wind data analysis tool, available from the SEPA website via the Aquaculture Modelling pages.

3.10 Data Analysis

Analyse a 15-day subset of the data returned from the deployment of meters to derive the following statistical and descriptive values for each depth:

1. ***mean speed;***
2. ***ranked percentage of the mean speed within the 15 day record;***
3. ***3.0cm.s^{-1}, 4.5cm.s^{-1}, and 9.5cm.s^{-1} as ranked percentages within the 15 day record;***
4. ***residual current speed and direction;***
5. ***identification of the major axis of any tidal current ellipse - in tidally dominated current regimes this may be determined by inspection of the direction frequency analysis or the scatter plot of vector components;***
6. ***decomposition of residual current speed into orthogonal vector components relative to the tidal ellipse major axis;***
7. ***calculation of tidal current amplitude as orthogonal vector components relative to the tidal ellipse major axis – this may be achieved by the assumption of a sinusoidal approximation of tidal variation in current speed and the application of the relationship in Equation 3.1***
8. ***calculate the ratio of the orthogonal tidal current amplitude components (the anisotropy), longitudinal over lateral.***

Report the start and finish date and time, and the resulting number of data records, for the period analysed.

N.B. all of these requirements can be satisfied by applying SEPA's hydrographic data analysis tool (currently HGdata_analysis_v7.xls) and submitting the 'Summary' sheet.

$$A = \sigma\sqrt{2}$$ ***Equation 3.1***

where: A is the amplitude of a sinusoidally varying dataset

σ is the standard deviation of the dataset

from: **Gillibrand P A and Turrell W R 1999.** A management model to predict the dispersion of soluble pesticides from marine fish farms. Marine Laboratory, Aberdeen Report 2/99 SOAEFD

Present the data from each depth in a number of graphical formats (see section 3.11). These require a number of prior manipulations:

- ***decomposition of current speed and direction into orthogonal easterly and northerly vector components (where these are not directly available from the instrument or any interface software),***
- ***frequency analysis of direction and***
- ***quantile analysis of speed, as specified in Table 3.4.***

Table 3.4 Current data analysis measures								
Current direction should be analysed for frequency and percentage of occurrence in the following bin ranges:								
0°≤ 10°	10°≤20°	20°≤30°	30°≤40°	40°≤50°	50°≤60°	60°≤70°	70°≤80°	80°≤90°
90°≤100°	100°≤110°	110°≤120°	120°≤130°	130°≤140°	140°≤150°	150°≤160°	160°≤170°	170°≤180°
180°≤190°	190°≤200°	200°≤210°	210°≤220°	220°≤230°	230°≤240°	240°≤250°	250°≤260°	260°≤270°
270°≤280°	280°≤290°	290°≤300°	300°≤310°	310°≤320°	320°≤330°	330°≤340°	340°≤350°	350°≤360°

Current speed should be analysed to derive the following percentile values:										
0 (minimum)	1	5	10	25	50 (median)	75	90	95	99	100 (maximum)

3.11 Graphical Presentation

The hydrographic data report should present the data from each surveyed depth in the following graphical formats, of which examples are provided in Figure 3-1 to Figure 3-8 below:

Either:

1. ***A time-series plot of speed and water depth. In addition, where spike removal, filtering or repair has been undertaken, a similar plot of time-series of unprocessed speed and water depth is required;***
2. ***A time-series plot of direction and water depth. In addition, where spike removal, filtering or repair has been undertaken, a similar plot of time-series of unprocessed direction and water depth is required;***

Or:

3. ***A time-series plot of longitudinal and lateral current vector components, with respect to the identified major axis, and water-depth. In addition, where spike removal, filtering or repair has been undertaken, a similar plot of time-series of unprocessed speed and water depth is required;***

And:

4. ***A scatter plot of east and north vector components;***
5. ***A plot of current speed against percentile;***
6. ***A bar chart of direction frequency analysis;***
7. ***A time-series plot of wind speed and direction.***

N.B. Requirements 3, 4, 5, and 6 can be satisfied by submitting the 'Summary' sheet of SEPA's hydrographic data analysis tool (currently HGdata_analysis_v7.xls); see Figure 3-6.

Additional parameters:

8. ***A time-series plot of heading, pitch, and roll, for acoustic profiling instruments.***

Figure 3-1: Time-series of speed and water depth

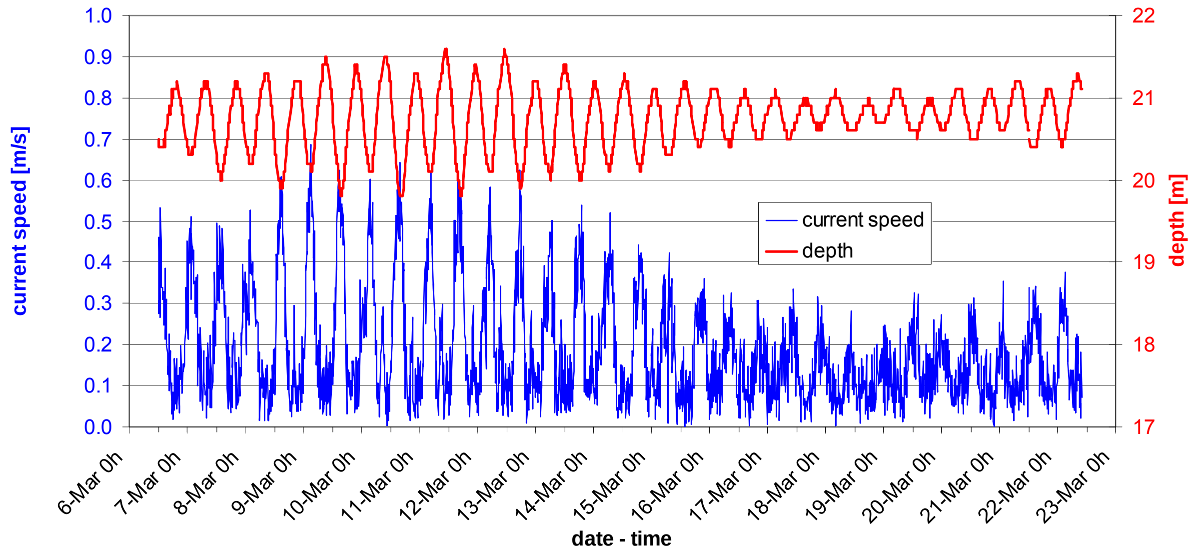


Figure 3-2: Time-series of direction and water depth

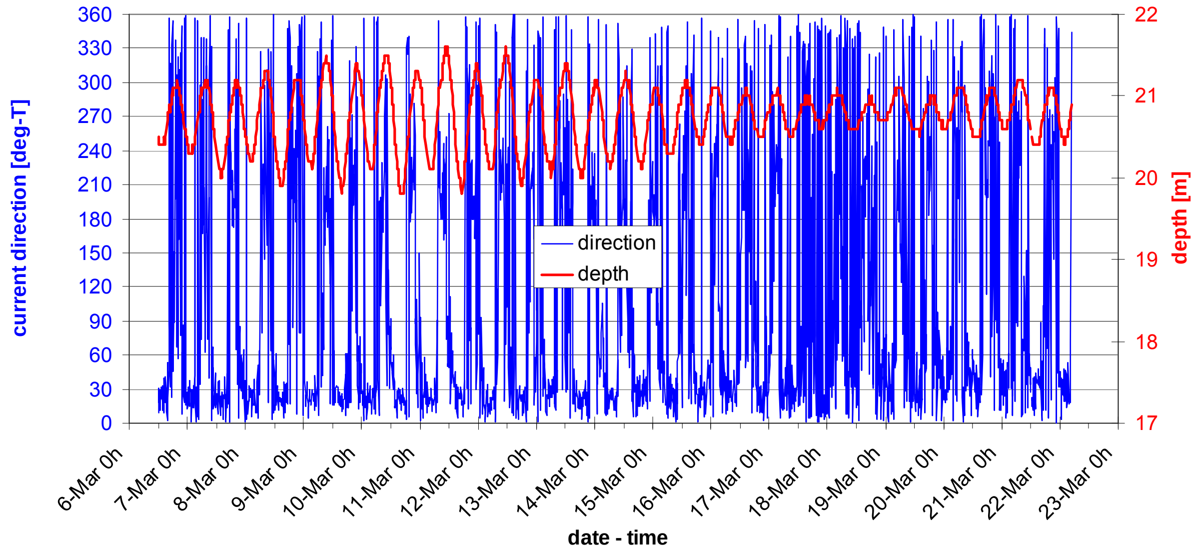
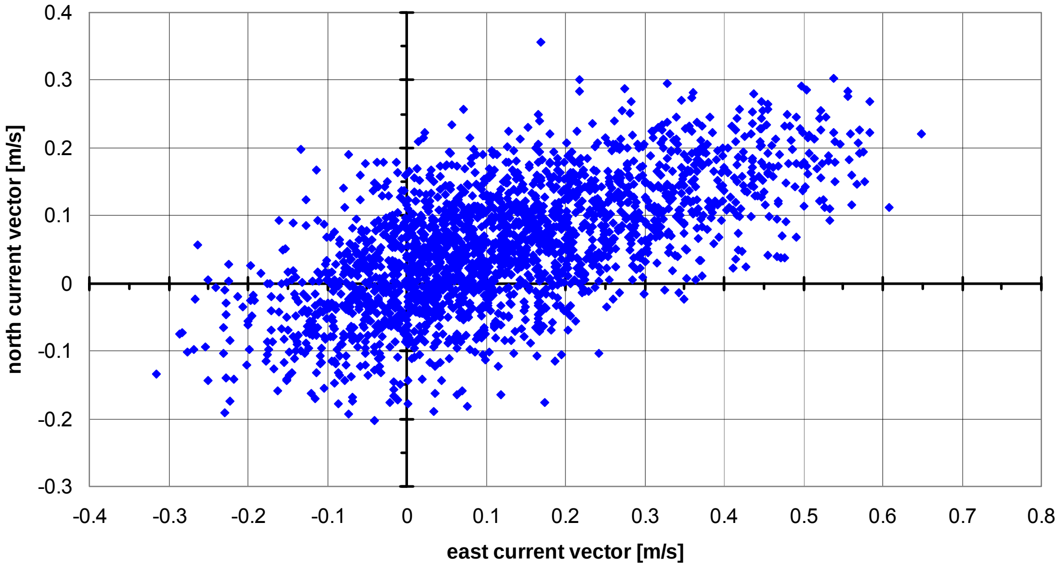


Figure 3-3: Scatter plot of east and north vector components



N.B. this should be presented on an orthogonal isometric scale (i.e. the axes should be to the same scale).

Figure 3-4: Bar chart (histogram) of direction frequency analysis

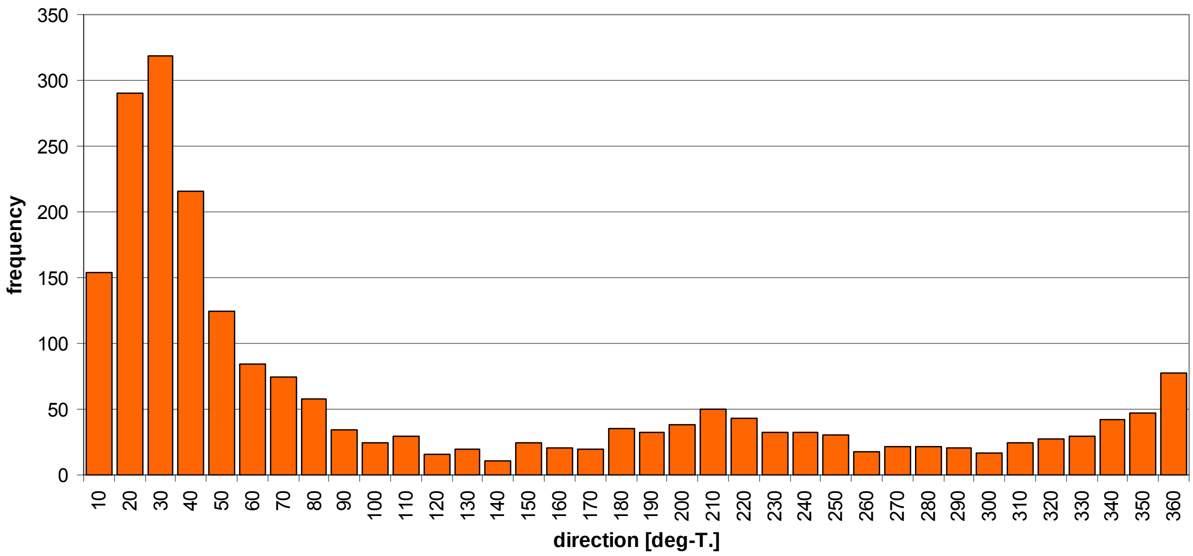


Figure 3-5: Current speed against percentile

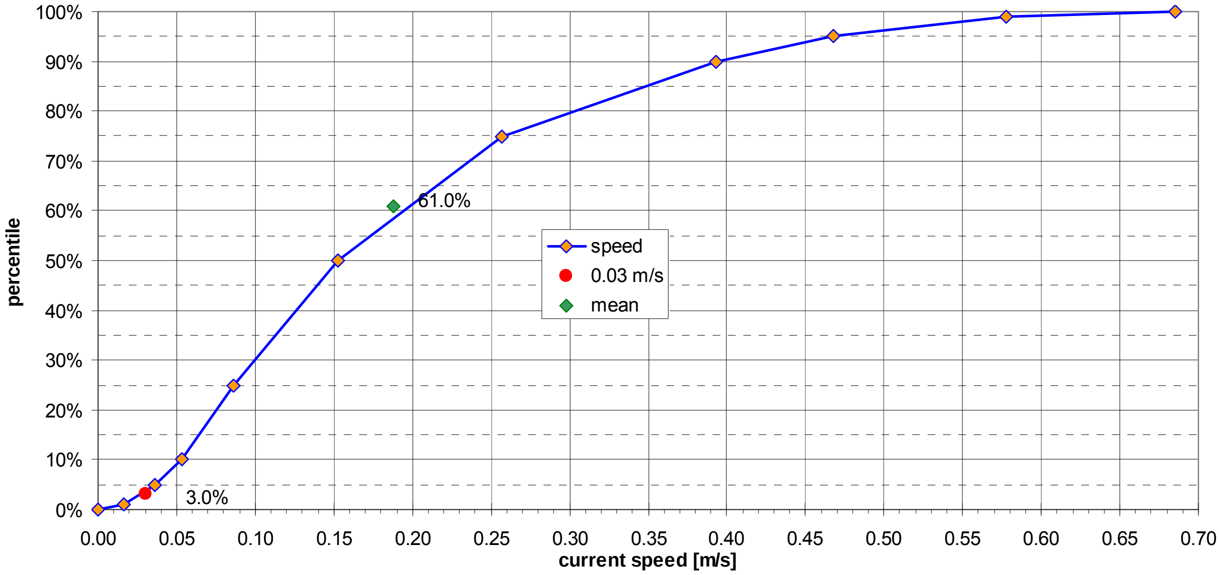


Figure 3-6: Current meter data summary statistics and plots

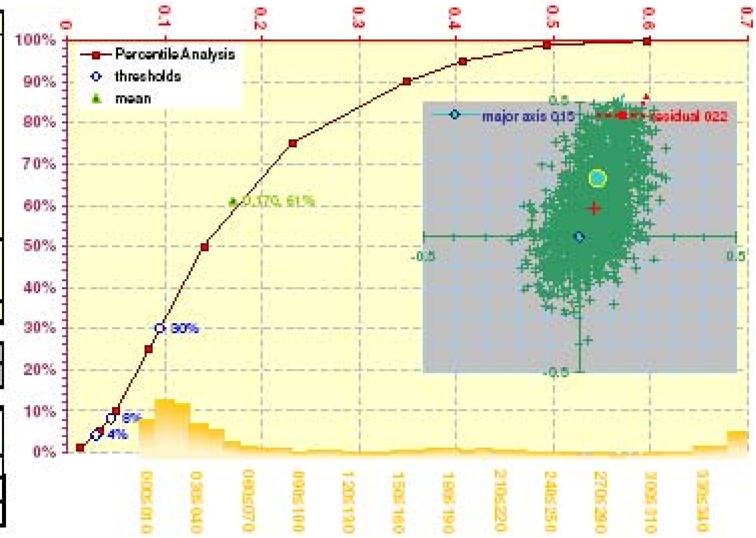
Current meter ID :	sitename - 2.7 m				436690mE	1126920mN
variation:	-5.5	convergence:	-		heading:	(Deg-G)
Period of measurement :	6/3/01 12:00	to	21/3/01 12:00	15 days	0 hrs	0 mins

Depth/ Pressure		
	Max:	21.60
	Mean:	20.74
	Min:	19.80

Percentiles	Current Speed	
1%	0.013 m/s	percentile analysis
5%	0.034 m/s	
10%	0.050 m/s	
25%	0.084 m/s	
50%	0.140 m/s	
75%	0.231 m/s	
90%	0.349 m/s	
95%	0.406 m/s	
99%	0.493 m/s	
100%	0.597 m/s	
4%	0.030 m/s	threshold values
8%	0.045 m/s	
30%	0.095 m/s	
61%	0.170 m/s	mean

Major axis :	015 deg		0.222 m/s
Residual current :	0.116 m/s	at	022 deg

	Residual	Tidal amplitude
Longitudinal (U) :	0.115 m/s	0.222 m/s
Lateral (V) :	0.015 m/s	0.092 m/s
Anisotropy (long'l/lat'l) :	7.61	2.41



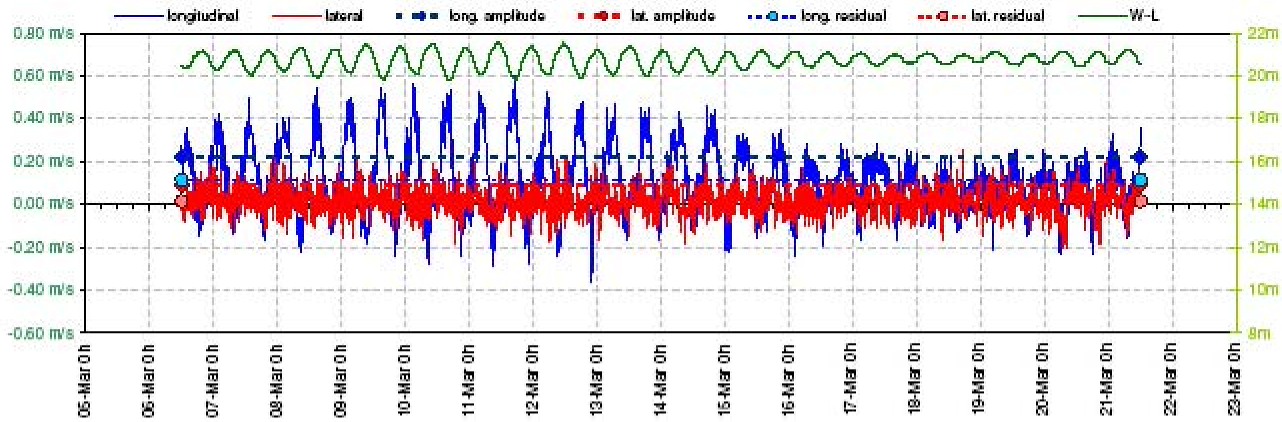


Figure 3-7: Time-series plot of wind speed and direction

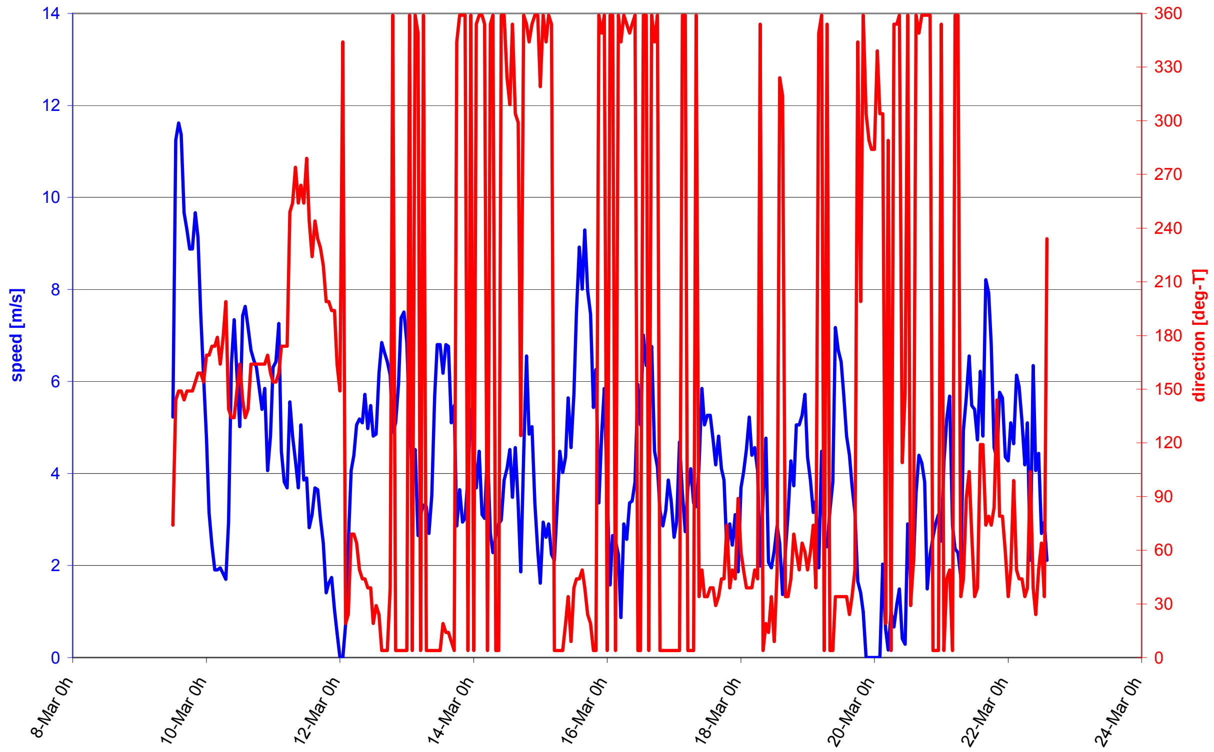
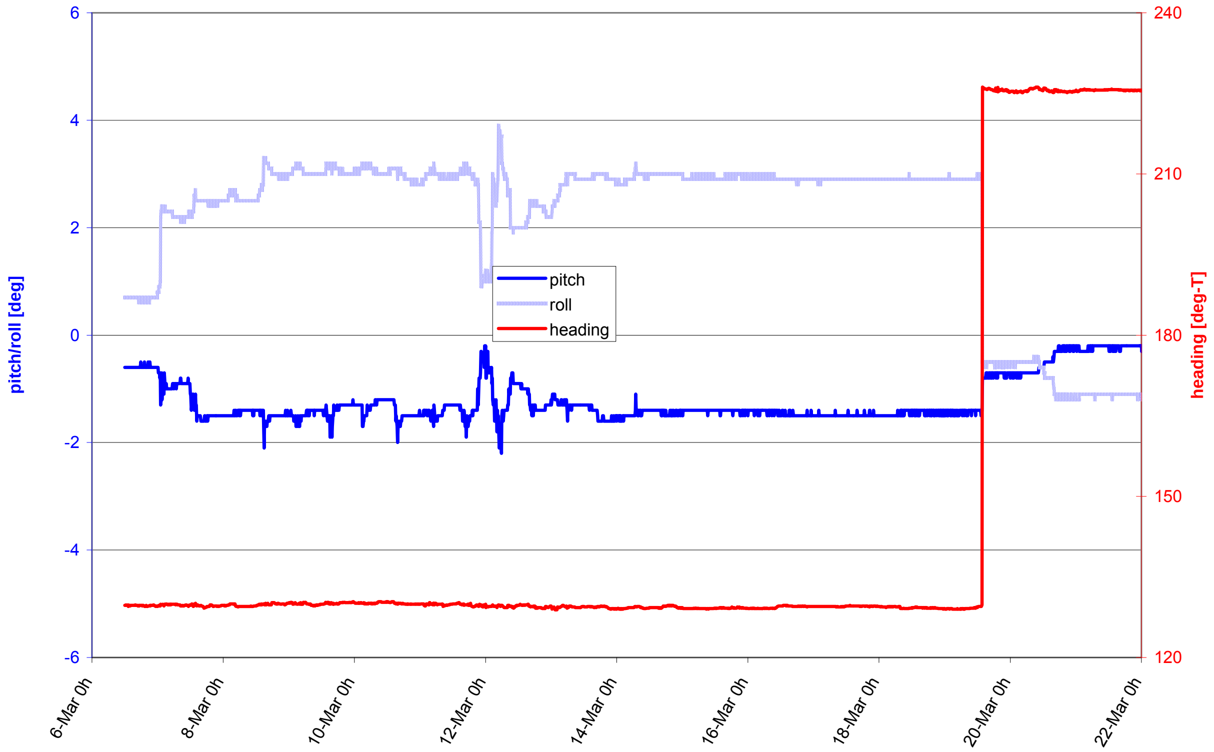


Figure 3-8: Time-series plot of heading, pitch, and roll



N.B. the scales of this plot have been adjusted such that both the maximum range and the fine detail of variation during the deployment are clear.

3.12 Qualitative Summary

Provide a brief descriptive summary of the key characteristics of the observed data, e.g. tidal influence, wind influence, topographic influence, variation with depth, any anomalous features.

It may be possible to deduce the likely behaviour of solute and particulate emissions from the site, with respect to their dispersion, transport, and fate; these may be offered as part of the summary.

3.13 Quality Control

A suitably qualified person must check that the submitted hydrographic data are representative of the flow at the farm site. Include a statement in the report that this has been carried out. Include evidence of compliance with any in-house quality assurance procedures.

4 Report Structure

There follows a skeleton list of sections that should be included in the site location and hydrographic survey report:

- Site description;
- Survey programme;
- Methods (sampling, data processing, discussion of site-specific survey details, description of instrument mooring system);
- Cage survey plot;
- Cage survey summary table;
- Hydrographic data Quality Assurance statement;
- Hydrographic data summary statistics;
- Hydrographic and met. data plots;
- Equipment list, specifications and set-up parameters;
- Survey log sheets;
- Calibration reports.

A checklist of these sections and their contents is attached at Appendix

5 References

Gillibrand P A and Turrell W R (1999) A management model to predict the dispersion of soluble pesticides from marine fish farms. Marine Laboratory, Aberdeen Report 2/99 SOAEFD

Glossary

A glossary of acronyms used in the text.

ASCII	American Standard Code for Information Interchange
ATT	Admiralty Tide Tables
CD	Chart Datum
CD-ROM	Compact Disc Read Only Memory
DGPS	Differential Global Positioning System
ETRS89	European Terrestrial Reference System 1989
Galileo	European Global Navigation Satellite System under development
GLONASS	Global Navigation satellite system – a Russian system with less coverage than GPS
GMT	Greenwich Mean Time
GPS	Global Positioning System
NGR	National Grid Reference
OS	Ordnance Survey
OSGB36	Ordnance Survey Great Britain 1936 - the national standard coordinate system for topographic mapping
OSTN97	Ordnance Survey National Grid Transformation 1997
OSTN02	Ordnance Survey National Grid Transformation 2002
UKHO	United Kingdom Hydrographic Office
WGS84	World Geodetic System 1984
UTC	Universal Time Coordinated – equivalent to GMT

Appendix I

Hydrographic and Site Survey Report checklist

Site description		
	setting and site history	
	development status (proposed/established/relocated)	
	cage group details (dimensions, spacing, layout, orientation)	
Survey programme		
Methods		
	sampling	
	instrument specification and configuration	
	data processing	
	description of calculations	
	description of site-specific survey details	
	description of mooring system	
Site Survey Results		
	Cage survey plot	
	cage group corners, with labels	
	current meter	
	met. station	
	(additional spot depths, with labels)	
	Cage survey summary table	
	survey date	
	label	
	time (GMT)	
	tide height	
	sounded depth	
	corrected depth	
	position fix	
	satellite information	
Hydrographic Survey Results		
	deployment/retrieval dates and times	
	record duration & period analyzed	
	Quality Assurance statement	
	qualitative summary	
	Summary statistics	
	mean speed	
	ranked percentage mean speed	
	ranked percentage of 9cm/s	
	residual current speed & direction	
	major axis of tidal ellipse	
	vector components of current residual	
	vector components of tidal current amplitude	
	tidal current amplitude anisotropy (longitudinal/lateral)	
	Plots	
	time-series of speed and water depth	
	(time-series of unrepaired speed and water depth)	
	time-series of direction and water depth	
	(time-series of unrepaired direction and water depth)	
	time-series of orthogonal current components and water depth	

	scatter plot of east and north vector components	
	bar chart of direction frequency analysis	
	current speed against percentile	
	time-series plot of wind speed, rolling 24hr mean speed, and direction	
	time-series plot of heading, pitch, and roll, for acoustic (profiling and 'in-line' moored) instruments	
Appendices		
	Survey log sheets	
	Calibration reports	
Electronic data submission (CD-ROM)		
	raw data files (binary and/or ASCII format)	
	Hydrographic and Site Survey Report (MS Word or PDF format)	