Appendix A.1 – GPS Drifter Validation and Background on Lagrangian Surf Zone Studies

A.1(i) Previous Lagrangian measurements of current flow in the surf zone

A.1(i).1 Dye tracer studies

Numerous studies have been conducted in Australia and around the globe using dye to track rip currents in the surf zone (Sonu, 1972, Huntley et al., 1988, Brander, 1999, Brander and Short, 2001, Haas et al., 2002, MacMahan et al., 2009, MacMahan et al., 2010). Other studies have applied dye tracers to the surf zone to measure surf zone diffusivity (Spydell et al., 2009, Spydell and Feddersen, 2009, Feddersen, 2013, Hally-Rosendahl et al., 2014); land runoff and beach contamination (Clarke et al., 2007); and sediment transport (Jamaluddin, 1983). The most important studies to note are those conducted in Australia by Andrew Short, Rob Brander and Kevin Haas.

Rip tracer dye is both cheaper than expensive and problematic field equipment, as well as having minimal legal or health related issues (Jamaluddin, 1983). Huntley et al. (1988) also found dye tracking techniques to be more accurate than surface floats and drogues for measuring rip current velocities. Dye tracers represent a ‘true’ Lagrangian measurement of water movement and as such are the most accurate indication of rip current flow (MacMahan et al., 2009). Using dye to study rip currents is valuable as the dye tracks the current flow out through surf zone, through the breaking waves. The dye is also not influenced wind stress. By adding dye to inshore currents (alongshore and cross-shore) an increased understanding of the nature of surf zone circulation and expulsion can be obtained. Images of dyed rips are also very effective as an educational tool (Figure A.1). However, there is generally a negative public perception of the use of dye in coastal environments, as they associate it with pollution, and this raises logistical and legal issues, which may make the use of dye unsuitable in certain areas, such as the Gold Coast open beaches.
A.1(i). 2 Video-image techniques

Photo and video techniques have been used in coastal studies since the 1980’s (Williams, 2009). Coastal observations using a video process however, is a relatively new phenomenon in coastal management and only a few places in the world have systemised video surveillance of coastlines (Williams, 2009). Recent studies of rip currents have utilised video-image and satellite technology (Murray et al., 2003, Murray, 2004, Ranasinghe et al., 2004, MacMahan et al., 2005, da Silva et al., 2006, Turner et al., 2007, MacMahan et al., 2008, Slattery, 2010, Murray et al., 2013, Castelle et al., 2014). The use of video-imagery allows for continuous and sometimes long term data collection without the complications of deploying field equipment. From rectified images it is possible to accurately measure location, spacing, duration and geometry of surf zone currents.

A.1(i). 3 Theodolite tracking of drogues

The simplest way of measuring surf zone current velocities is by drogues (also known as drifters), which are visible floats that offer more drag to the water than to the wind so that their velocity is a good measure of the velocity of the surrounding water (Nielsen, 2009). Traditionally drifters were tracked with two theodolites and position of the drifter was triangulated. The introduction of total stations has made this technique
easier to carry out, with only one person required. Oranges, buoys and even humans have been used as visual drogues for surf zone studies.

A.1(i).4 GPS drifters in the study of surf zone currents

In the last decade the use of Global Positioning System (GPS) and Lagrangian drifters has become more prominent in the study of nearshore surf zone hydrodynamics. The use of low cost but accurate GPS drifters in the study of surf zone currents is becoming increasingly important. Several studies have assessed nearshore surf zone circulation in recent years using relatively cost-effective and small GPS units (Schmidt et al., 2003, Johnson et al., 2003, Johnson and Pattiaratchi, 2004, Spydell et al., 2007, Bruneau et al., 2009a, Bruneau et al., 2009b, MacMahan et al., 2009, Spydell and Feddersen, 2009, Spydell et al., 2009, Austin et al., 2010, MacMahan et al., 2010, Bruneau et al., 2011, Sabet and Barani, 2011, Spydell and Feddersen, 2012, Winter et al., 2012, Austin et al., 2013, McCarroll et al., 2013a, McCarroll et al., 2013c, Austin et al., 2014, Castelle et al., 2014, McCarroll et al., 2014a, McCarroll et al., 2014c, Scott et al., 2014, Winter et al., 2014). The low-cost of such units allow for simultaneous deployments to augment data returns. The use of Lagrangian drifters in surf zone studies in the field are extremely valuable for elucidating the detailed structure of circulation and associated hazards.

A.1(i).5 Background on GPS

Global Positioning System (GPS) is a worldwide radio navigation system which employs a constellation of up to 24 satellites; up to eight are used at any one time to determine the position of the receiver (Johnson et al., 2003; Sabet and Barani, 2011). Until May of 2000 the U.S. Government employed ‘Selective Availability’ (SA) on the publicly available GPS signal, reducing the positional error to around 100 m. This was done for military purposes. The removal of SA now allows for absolute positional accuracy on the order of 10 to 15 m to be resolved with non differential GPS (Table 3.1).

In recent years the introduction of ‘Satellite Based Augmentation System’ (SBAS) networks has improved the accuracy of non differential GPS units to the order of 1 to 3 m. Currently there are several SBAS networks set up around the world for different regions; WAAS in North America, EGNOS in Europe, MSAS in Japan, GAGAN in Indian, SDCM in Russia and COMPASS in China. The SBAS systems were initially
designed to aid in aviation and in theory all these networks work in the same way and are compatible with one another.

The SBAS networks act similarly to differential GPS (DGPS) in that they provide real-time corrections to the receiver GPS unit. These real-time corrections are provided via geostationary satellites, which receive their error corrections from a network of receiver base stations. This is used instead of having a DGPS base station at the study site. Unfortunately at the moment SBAS networks have not been established specifically for Australia and reliability of SBAS enabled GPS data is questionable in the region.

There are more expensive and more accurate real-time kinematic (RTK) GPS systems available, but for measuring the surf zone current field the study aims to show that cheap and compact non-differential GPS systems can provide a very good estimation of Lagrangian current flow, both in the cross-shore and alongshore directions.

A.1(i).6 Handheld GPS characteristics

The GPS units need be small enough to be attached to the surf zone drifters. The handheld GPS units use internal patch antennas, which are low cost as they are small and inexpensive. Unfortunately internal patch-antennas result in decreased positional accuracy and reliability because signals are weak with respect to the multipathing noise and they can cause cycle slips (Saeki and Hori, 2006). Recently, one handheld GPS company provided the option for internal recording of the carrier phase information in a small (mobile phone size), self contained, inexpensive package, the Delorme Earthmate Blue Logger (MacMahan et al., 2009). The unit records the carrier phase information and outputs in a RINEX (Receiver Independent Exchange) format (MacMahan et al., 2009). This is required for accurate post-processing of absolute positional data to sub-metre accuracies (MacMahan et al., 2009). To date the Delorme Earthmate Bluelogger is the only low-cost handheld GPS unit that provides this function. Unfortunately the company has discontinued this product and they are in scarce supply from third parties. As a result less accurate GPS techniques are utilised to measure surf zone currents in the present study.

The main source of errors for GPS positioning are summarised in Table A.1. The individual values are not constant values, but are subject to variances. Combined the approximate error of non-differential GPS receivers is ± 10 – 15 m, with Selective
Availability ‘switched off’ (Table A.1). SBAS systems can reduce this error to around ± 1 to 3 m.

Table A.1: Approximate values (in metres) of GPS positioning errors

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Measurement Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ionospheric effects</td>
<td>± 5 metres</td>
</tr>
<tr>
<td>Shifts in the satellite orbits</td>
<td>± 2.5 metres</td>
</tr>
<tr>
<td>Clock errors of the satellites’ clocks</td>
<td>± 2 metres</td>
</tr>
<tr>
<td>Multipath effect</td>
<td>± 1 metre</td>
</tr>
<tr>
<td>Tropospheric effects</td>
<td>± 0.5 metres</td>
</tr>
<tr>
<td>Calculation and rounding errors</td>
<td>± 1 metre</td>
</tr>
</tbody>
</table>

A.1(i).7 Human floater experiments

Tracking human floaters in the surf zone has been conducted in previous rip studies (Short and Hogan, 1994, Brander and Short, 2000, Bruneau et al., 2009b, MacMahan et al., 2010, Miloshis and Stephenson, 2011, McCarroll et al., 2013c, McCarroll et al., 2013a, Castelle and Coco, 2013, Castelle et al., 2013, McCarroll et al., 2014c, McCarroll et al., 2014a, Castelle et al., 2014) to obtain Lagrangian information of surface flow circulation and velocities. The earlier studies of Short and Hogan (1994) and Brander and Short (2000) involved theodolite tracking of a human floater in a rip current to understand the circulation pattern of the current and to measure the velocity. The more recent studies listed above have involved waterproof GPS units being attached to the human floaters in order to increase the density of rip current data. Castelle et al. (2014) used human floaters to measure rip currents. Miloshis and Stephenson (2011) and McCarroll (2013-2014) used human floaters to assess 'escape strategies' from rip currents.
A.1(ii) Human Rip Float Experiment

A.1(ii).1 Aim
To compare non-differential GPS and more accurate theodolite survey techniques for measuring human drifter position in the field (surf zone).

A.1(ii).2 Study site
Palm Beach, Gold Coast (Figure A.2) was selected as the study site for the human rip float experiments. It is a 4 km long, north-east facing beach bordered by Tallebudgera Creek and Burleigh Headland to the north andCurrumbin Point and Currumbin Creek to the south (Short, 2000). The Study site for this experiment was around 4th Ave (Figure A.2). The modal beach state at the study site is a Low Tide Terrace / Transverse Bar Rip (LTT/TBR) inner bar and a Longshore Bar Trough (LBT) outer bar (Short, 2000).

Figure A.2: 4th Avenue, Palm Beach study site for Human Rip Floats (July 27, 2010).Currumbin and Tallebudgera Creek – Burleigh Heads study sites for trialling and testing of GPS drifters (Source: Google Earth®).
A.1(ii).3 Human rip float methods

The rip float study took place on the ebb tide between 9 am and 1 pm on July 27th, 2010. Two theodolite stations were set up approximately 100 m apart along the beach, either side of a weak rip channel (Figure A.3). Distance between the stations was measured with a tape measure. Theodolites were zeroed on one another. This was achieved by setting the Horizontal angle \((H_a)\) to zero by sighting the opposing theodolite station. This is done in order to take an angle reading of floater position through time, away from the horizontal of zero, for post-processing (Figure A.4).

Human drifters were deployed in the quasi-steady longshore current and floated ‘shallow and freely’ with the current allowing waves to push them back to shore if required (Figure A.3). A waypoint was taken by the floater on the GPS unit at the commencement of the float and then every thirty seconds until the end of the ‘float’. Each time a waypoint was taken, the floater signaled to the beach and the two theodolite stations took an angle reading, away from zero, on the floater. Contact between the theodolite stations was maintained by CB radio. When post-processing the theodolite data, trigonometry is used to calculate floater position through time (Figure A.4). The GPS unit used was a Garmin GPS 76 unit, with a comparable receiver chip to the AMOD AGL 3080. At the time of the experiment the more accurate AMOD AGL 3080 units had not been obtained.

The recorded GPS tracks were correlated with Theodolite tracks. Positions of Theodolites, GPS waypoints and human float theodolite recordings were converted into Universal Transverse Mercator coordinates (Easting and Northings) for a mathematical analysis of the data and comparison. This was carried out in Google Earth® and all points were referenced into the World Geodetic System of 1984 (WGS84) datum for comparison.

An Acoustic Doppler Current Profiler (ADCP) was deployed on the inner bar within the surf zone for the duration of the experiment to record current speeds (Figure A.3). The ADCP was deployed in 2 m water depth and sampled at 0.5 m bins averaging over 300 seconds.
A.1(ii).4 Post Processing of Human Theodolite Drifter Tracks

1) Use law of sines to calculate unknown sides of a triangle from each station for each point.

\[
a / \sin a = b / \sin b = c / \sin c
\]

2) a) Figure out the distance \( x \) (m) from one of the stations (i.e. the south station) to where the floater point would intersect the zero line at a 90° angle.
   - Using same law of sines rule for \( x_1 \) and \( x_2 \)
   (e.g. \( b / \sin 90 = x_1 / \sin \text{calculated unknown angle} \))
   - Unknown angle calculated from 180° – 90° – known angle from station (make sure in radians).

b) figure out the distance \( y \) (m) from the zero line at the 90° intersection to the floater position.
   - Using same law of sines rule for \( y_1 \) and \( y_2 \)
   (e.g. \( y_1 / \sin \text{known station angle} = b / \sin 90 \))
   - \( \sin 90 = 1 \)
e.g. (a)

\[ \frac{83.92}{\sin 90} = x_1 / \sin 59 \text{ (degrees)} \]

\[ \frac{83.92}{1} = x_1 / \sin 1.03 \text{ (radians)} \]

\[ x_1 = 83.92 \sin 1.03 \]

\[ x_1 = 71.93 \text{ m} \]

\[ \frac{86.24}{1} = x_2 / \sin 1.012 \text{ (radians)} \]

\[ x_2 = 86.24 \sin 1.01 \]

\[ x_2 = 73.13 \text{ m} \]

\[ x_2 - x_1 = 1.20 \text{ m in the x direction in 30 seconds.} \]

e.g. (b)

\[ \frac{y_1}{\sin 1.30} = \frac{83.92}{\sin 90} \]

\[ y_1 = 83.92 \sin 1.30 \text{ (radians)} \]

\[ y_1 = 81.06 \text{ m} \]

\[ \frac{y_2}{\sin 1.31} = \frac{86.24}{\sin 90} \]

\[ y_2 = 86.24 \sin 1.31 \text{ (radians)} \]

\[ y_2 = 83.30 \text{ m} \]

\[ y_2 - y_1 = 2.54 \text{ m in the y direction in 30 seconds.} \]

c) do for progressive (i.e. advancing) drifter positions (e.g. 1 & 2 etc.)

3) a) Once step two a) is done you can subtract the \( x_2 \) from \( x_1 \) and figure out the distance moved in the x direction.

b) Once step two b) is done you can subtract \( y_2 \) from \( y_1 \) and figure out the distance moved in the y direction.

4) Using simple Pythagorean theorem you can calculate the distance moved in the z (not vertical, but the hypotenuse) direction.

\[ a^2 = b^2 + c^2 \]
5) Once z directional movement (x, y) is calculated; then divide by the time taken between points (i.e. every 30 s) to determine speed in m/s.

A.1(ii).5 Results and Discussion:

A.1(ii).5.1 Qualitative description of drifters

Experiments were conducted under low wave energy conditions on the Gold Coast (Figure A.5) and a LTT/TBR (tending toward more of a LTT) beach state at the study site. A weak northerly flowing longshore current prevailed. There was some evidence of weak cross-shore flows on the low tide (not recorded in GPS data – Figure A.3).
Figure A.5: $H_{\text{sig}}$ (m) and $T_p$ (s) for July 27, 2010 (Gold Coast Seaway Waverider Buoy, cf. Chapter 3 for buoy location).

The theodolite tracking and GPS unit held by the floater both recorded a northward floater drift (Figures A.3). On three of the inshore drifts (Floats 1, 3 & 5), the floater was pushed back to shore by the small surf (Figures A.3). Floats 4, 6 and 8 were conducted further offshore where the floater was picked up in the longshore current and drifted slowly northward (between approximately 0.1 – 0.4 m.s$^{-1}$) (Figure A.3).

Floats 4 and 5 highlight the greatest amount of cross-shore movement (Figure A.3). Float 5 was conducted shoreward of an inner surf zone gutter and there is slight movement offshore, before being pushed back shoreward again by small waves (Figure A.3). Float 4 was undertaken further offshore and again there is some slight cross-shore movement of the floater in a weak rip current, before being moved fairly steadily northward in the longshore current (Figure A.3). The longshore current remains dominant in both floats.
A.1(ii).5.2 Quantitative comparison of floater position recorded by theodolite triangulation and a non-differential GPS unit.

Floats omitted from statistical analysis are Float 2 and Float 7 due to lack of confidence in the recovered data set. Floats 1, 3, 4, 5, 6 and 8 are discussed below to compare the recording of relative position using a simple GPS and the theodolite total station system (Figures A.6 – A.11). Trends in current velocity are analysed for Floats 3, 5, 6 and 8. Gaps in the data set and difficulties in matching waypoint location and time for the other float tracks on the day prohibit an analysis of current velocities for those floats.

The relative positions of the floater measured from a stationary reference point show an acceptable correlation between those points recorded from the handheld GPS and those points inferred from triangulating drifter position using two stationary theodolites (Figures A.6 – A.11). The figures show the two measurement techniques follow a similar track, depicting current flow and position in the surf zone (Figures A.6 – A.11). The error in absolute geographical position between the two lines is on the order of a couple of metres (generally < 5 m but no more than 10 m). This is understandable as accuracies of non-differential GPS units are on the order of 5 to 15 m. There is a high correlation between GPS position and theodolite position in the more steady longshore current floats (Figures A.6 – A.11). This supports the literature in that the GPS errors are increased on circular paths (Witte and Wilson, 2004, Sabet and Barani, 2011).
Figure A.6: Comparison of theodolite and GPS recorded position, Float 1 (9:20am - 9:21am). Arrows represent current vectors (every 30 s).

Figure A.7: Comparison of theodolite and GPS recorded position, Float 3 (9:36am - 9:41am). Arrows represent current vectors (every 30 s). Dashed lines represent missing data points.
Figure A.8: Comparison of theodolite and GPS recorded position, Float 4 (9:49am - 9:58am). Arrows represent current vectors (every 30 s). Dashed lines represent missing data points. Only an initial and final reading were obtained from the GPS data (with a large gap in the data set).

Figure A.9: Comparison of theodolite and GPS recorded position, Float 5 (11:11am - 11:17am). Arrows represent current vectors (every 30 s). Dashed lines represent missing data points.
Figure A.10: Comparison of theodolite and GPS recorded position, Float 6 (11:20am - 11:32am). Arrows represent current vectors (every 30 s).

Figure A.11: Comparison of theodolite and GPS recorded position, Float 8 (12:44am - 12:57am). Arrows represent current vectors (every 30 s).
A.1(ii).5.3 Current speeds

There are significant differences in recorded current speeds over the 30 second intervals between the GPS unit data and theodolite recorded data. This is explained by errors in the methodology outlined in Section A.1(ii).6 below. Whilst $r^2$ values are low for the comparison of GPS and theodolite recorded current speeds (indicating a poor correlation), the velocity recorded by the GPS and theodolite tracking techniques appear to overall follow similar trends (Figures A.12 – A.15). There is a large standard deviation in the current speeds, which may be attributed to different surf zone processes moving the floaters around, such as (but not limited to): waves pushing floaters shoreward and lower frequency pulses of currents. When averaging the speed over each individual drift track, there is a high correlation of current speed (Table A.3). It is concluded from this that applying averaging to the raw GPS data, such as moving average filters, will improve results by smoothing out noise and removing outliers.

Figure A.12: Float 3 (9:36am - 9:41am) current speed for the GPS (black) and theodolite (grey) recordings ($r^2 = 0.6848$).
Figure A.13: Float 5 (11:11am - 11:17am) current speed for the GPS (black) and theodolite (grey) recordings ($r^2 = 0.0751$).

Figure A.14: Float 6 (11:20am - 11:32am) current speed for the GPS (black) and theodolite (grey) recordings ($r^2 = 0.1244$).
Figure A.15: Float 8 (12:44am - 12:57am) current speed for the GPS (black) and theodolite (grey) recordings ($r^2 = 0.0006$).

Table A.3: Average speed (cm/s) (+s.d.) for Floats 3, 6 and 8. The other floats were excluded for this analysis due to gaps in the data set ($r^2 = 0.9644$).

<table>
<thead>
<tr>
<th></th>
<th>GPS</th>
<th>Theodolite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Float 3</td>
<td>34.57 (27.74)</td>
<td>33.80 (27.10)</td>
</tr>
<tr>
<td>Float 6</td>
<td>27.30 (11.88)</td>
<td>25.22 (5.64)</td>
</tr>
<tr>
<td>Float 8</td>
<td>21.24 (5.37)</td>
<td>21.78 (4.99)</td>
</tr>
</tbody>
</table>

The higher recorded current speeds obtained in Float 3 and Float 6 (> 0.7 m.s$^{-1}$) are attributed to floaters being moved around the surf zone rapidly by waves (Figures A.12 & A.14). These larger values do not represent the mean current velocity, rather surf ‘noise’. The current speed values measured by the GPS on July 27, 2010 are thought to be acceptable, based on the low energy conditions observed on the day. An ADCP deployed in the surf zone nearby, measured similar current speeds to that of the GPS and theodolite tracking (Figure A.16).
Figure A.16: Five minute-averaged current speeds recorded by an ADCP in approximately 2 m water depth (July 27, 2010). Average GPS measured velocities and average theodolite tracked drifter speeds are presented for Floats 5, 6 & 8, which were also measuring the dominant longshore current.

**A.1(ii) Errors in methodology**

Theodolite surveys are expected to have sub metre accuracy (and sub decimetre accuracy with experienced operators). Comparatively non-differential GPS has absolute positional accuracies of 5 to 15 m. By comparing the two techniques the study aims to show that both techniques give a good estimation of surf zone current trajectories and velocities.

It was noted that a one degree error in recording of position in Google Earth® (data not shown) will generate a couple of metres difference in drifter location when plotting in Google Earth®. Great care was taken when plotting drifter position in Google Earth®. Error in measuring drifter position in Google Earth® from the south or north theodolite station is less than one metre. Due to the methodology used and the fact that a floater is greater than one metre in length, this error is seen as minimal in determining floater position and as such drifter position was measured from the south station. Theodolite tracked floater position was measured to the nearest 0.1 m in Google Earth®.
There is a small amount of human error in comparing the GPS and theodolite positions and velocities as data points were not taken at the exact same time. There is also a small loss of accuracy in the post-processing methodologies.

**A.1(ii).7 Conclusions**
This study compares the traditional technique (theodolite tracking of drifters) and a recently developed technique (GPS tracked human drifters) for measuring rip current trajectories and estimating rip current velocities. The study shows that non-differential GPS will give a reasonable estimate of rip current velocities and drifter tracks. As such an assessment of a small and low-cost non-differential GPS data logger was undertaken, to determine its positional accuracy for use in measuring surf zone currents (cf. Section 3.3 in thesis).

**A.1(iii) Further Assessment of non-differential GPS accuracy**

**A.1(iii).1 Satellite acquisition and geometry**
Further data was collected on satellite acquisition and geometry from the stationary GPS experiment (cf. Section 3.3 in thesis) to assess the accuracy of the GPS units for use in Lagrangian surf zone current studies. The AMOD AGL outputs a NMEA 0183 data stream, which includes information on Dilution of Precision (DOP). When GPS satellites are in close proximity, the geometry is said to be weak and the DOP value is correspondingly high. When GPS satellites are far apart the geometry is strong and DOP value is low. The NMEA 0183 data stream outputs data on Horizontal Dilution of Precision (HDOP), Vertical Dilution of Precision (VDOP) and Positional Dilution of Precision (PDOP). DOP values of 0 to 1 are ideal and indicate the highest possible confidence level of satellite geometry and positional accuracy. Values between 1 and 5 are reasonable for navigation and values less than 2 are deemed acceptable for this study. HDOP will be examined to determine the effects of satellite geometry on positional errors. Satellite fix will also be examined to determine its effects on positional errors.

Both stationary units (i.e. Drifters) recorded modal and average HDOP values below one, indicating a high reliability in the positional data (Figure A.18). 99% of measured values of HDOP for Drifter 2 were less than two, which are acceptable for this study (Figure A.17). 100% of measured values of HDOP for Drifter 1 were less than two (Figure A.17).
Figure A.17: Distribution of HDOP for stationary Drifter 1 (n = 3066 s) (black) and stationary Drifter 2 (n = 3051 s) (blue)

A.1(iii).2 Satellite fixes
Satellite fixes of 7 or more were recorded more than 99% of the time for stationary Drifter 1 and more than 97% of the time for stationary Drifter 2 (Figure A.18). Modal number of satellites fixed was 9 and 8 for stationary units (i.e. Drifters) 1 and 2 respectively (Figure A.19). Satellite fixes for Drifter 2 dropped as low as 4, whilst Drifter 1 recorded data from 6 or more satellites for the duration of the experiment (Figure A.18).
By examining the HDOP data against number of satellites fixed, it is concluded that when the GPS units are recording 6 or more satellites the data is of acceptable accuracy for analysis of relative position and velocity (Figures A.19 & A.20). Drifter 2 (Figures A.19 & A.20) obtained a greater percentage of lower satellite fixes and thus a higher HDOP value. 100% of HDOP values are classified as ‘ideal’ (less than or equal to one) when 8 or more satellites are fixed upon (Figures A.19 & A.20). Stationary unit 1 (i.e. Drifter 1) held a higher number of satellites and thus produced lower HDOP values for the duration of the study (Figures A.19 & A.20). As a result the AMOD AGL 3080 was accepted for use in the surf zone drifter study (cf. Chapter 4).
Figure A.19: HDOP vs. Number of Satellites for stationary Drifter 1.

Figure A.20: HDOP vs. Number of Satellites for stationary Drifter 2.
A.1(iv) GPS drifter validation in the surf zone

GPS drifters were tested for efficacy, in the surf zone, around headlands and in the creeks at Currumbin and Tallebudgera-Burleigh Heads on six days in May – June, 2011 (Figure A.2). The full dataset is displayed in Figures A.21 – A.26.

Figure A.21: Drifter tracks overlayed in Google Earth® (Currumbin 18 May 2011, ebb tide)

Figure A.22: Drifter tracks overlayed in Google Earth® (Currumbin 25 May 2011, flood tide)
Figure A.23: Drifter tracks overlayed in Google Earth® (Currumbin 27 May 2011)

Figure A.24: Drifter tracks overlayed in Google Earth® (Tallebudgera May 24, 2011)

Figure A.25: Drifter tracks overlayed in Google Earth® (Tallebudgera May 19, 2011)

Figure A.26: Drifter tracks overlayed in Google Earth® Tallebudgera – Burleigh Heads, June 1, 2011.
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