CURRENT MEASUREMENTS IN PORT MOUTON BAY

1. DROGUES TRACKED FOR A TIDAL-CYCLE, MARCH 13th, 2007

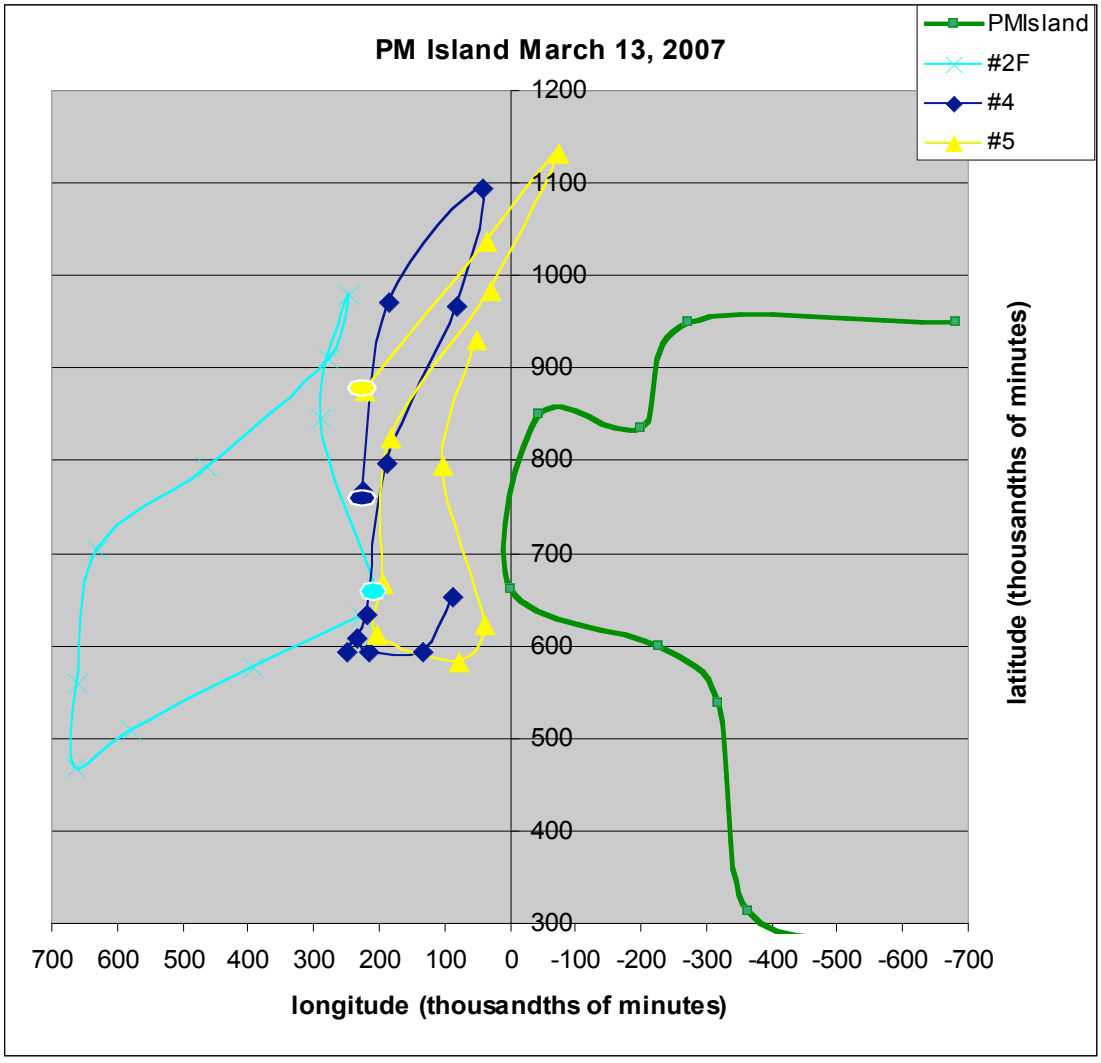

Figure 1. A chart showing the northwest shoreline of Port Mouton Island (green) together with the drift paths of three drogues with their sails at 3 m depth. The drogues, released from the dot symbols near the island during ebbing tide, and drifting N and NE initially, were tracked for the 12 hour tide cycle. Average drogue speeds were 4 to 5 centimetres per second.

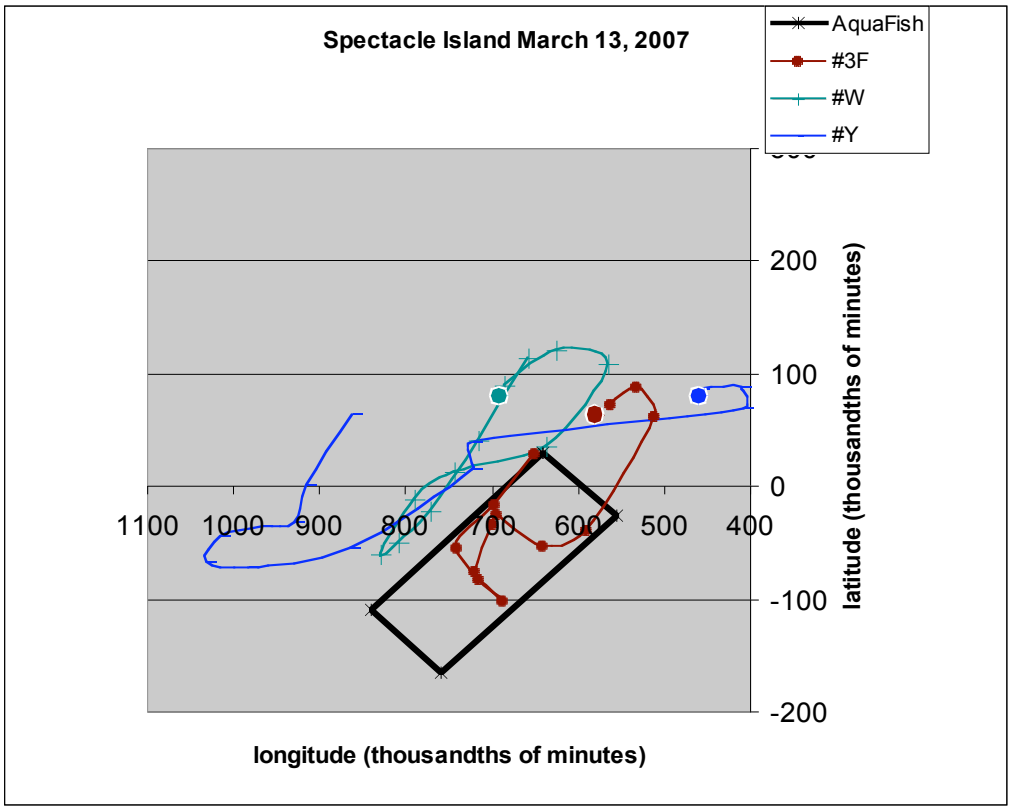

Figure 2. Tracks of three similar drogues released on the same March 13th tide cycle off the salmon farm (black) near Spectacle Island, Port Mouton Bay. These drogues drifted NE or E initially, starting from the dot symbols. Average drogue speeds were 1.5 to 2.5 centimetres per second.

From these drogue current trajectories, tracked over a tidal cycle by Brian Fisher and Robin Fisher, fishermen and Ron Loucks, oceanographer, on March 13th, 2007:

- Drogue drift speeds were low – 1.5 to 2.5 cm/s at Spectacle Island. At Port Mouton Island the 2-day average current speed from the 2002 moored current meter was 4 cm/s as was the average drogue drift speed on March 13th, 2007. The

Spectacle Island site is known to be depositional. Based on current meter and this drogue data, the proposed Port Mouton Island site is expected to be depositional whenever winds are light or blocked from the sheltered location.

- At the conclusion of the tidal cycle, five of the six drogues had returned to the vicinity of their release points, indicating re-circulation of the same water rather than new water being exposed to fish farm loads, i.e., tidal flushing did not occur within the tide cycle.
- The scale of the drogues' paths through the 12 hour tidal cycle was 500 to 1100 m. These trajectories are approximately the same scale as the proposed farm. Therefore, even on a calm day, the tidal trajectory could carry suspended particulates beyond the farm site.
- On a day when winds are strong and effective, wastes in suspension in the water column from a fish farm on either of these sites can be expected to be transported to the far-field.

2. ANALYSIS OF 2002 CURRENT METER DATA FOR PORT MOUTON BAY

2.1 Objective

Utilize the current meter data available, two days of data (January 31-February 1, 2002) (Dominator Marine Services Inc., Baseline Environmental Assessment, January 31, 2002) from a mooring near Port Mouton Island, at mid-depth in the 11-metre water column, to obtain information about the dispersion and transport of pollutants from the proposed aquaculture farm.

2.2 Approach

Using the current meter data in the Environmental Impact Statement, the bearings were adjusted from magnetic to true direction, the current speeds at ten-minute intervals were converted to virtual drift distances. Finally the resulting speed and bearing vectors were (vector) added cumulatively to obtain the direction and distance of net drift past the current meter. Two related charts are given showing the wind travel and the mid-column drift travel.

In consultation with fishermen and to check that the current meter data were being interpreted correctly for direction, two drogues were released on January 5, 2007, close to where the current meter was moored on January 31 to February 2, 2002, and tracked with GPS for two hours.

2.3 Results

2.3.1 Drogue Data, as a check

When the current meter results were first discussed with fishermen knowledgeable about the Port Mouton Island area, they described the effects of currents on hoisted lobster traps as sometimes varying in direction with depth as well as some question about whether the

current direction would be northward during an ebb tide. In order to check this, two drogues were released in January, 2007, near the location of the current meter mooring five years previously. The tides were similar to those at the beginning of the record on January 31, 2002 – starting at the time of high water, large vertical tide and light winds. The drogues were rigged with sails at 3m depth to correspond approximately with the current meter.

The drogues (Figure 3 and 4) drifted to the east and north, with approximately the same direction as indicated in Ebb01 of the current meter record (Figure 5).

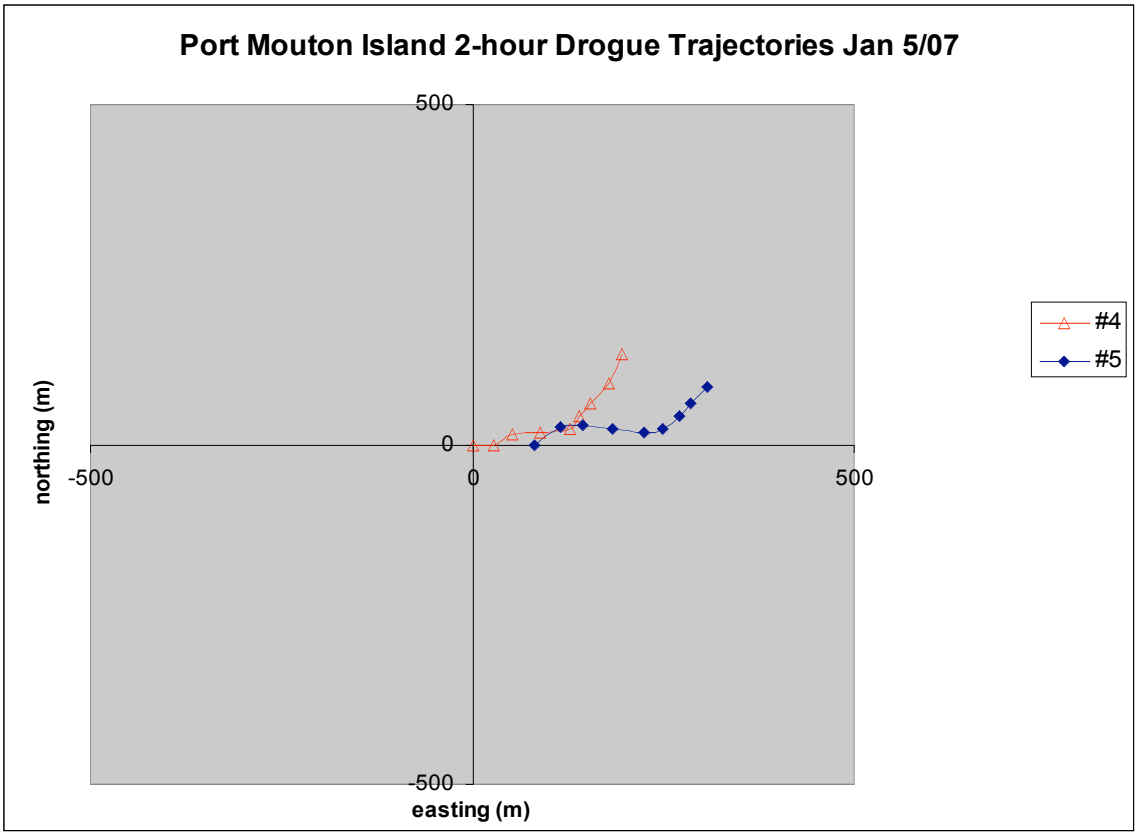

Figure 3. Drogue positions released from near the site of the earlier current meter mooring and tracked between 0908 and 1058 hours around high water (0917 hours) on Jan 5 2007.

In Figure 4, the northwest shore of Port Mouton Island is sketched in (green).

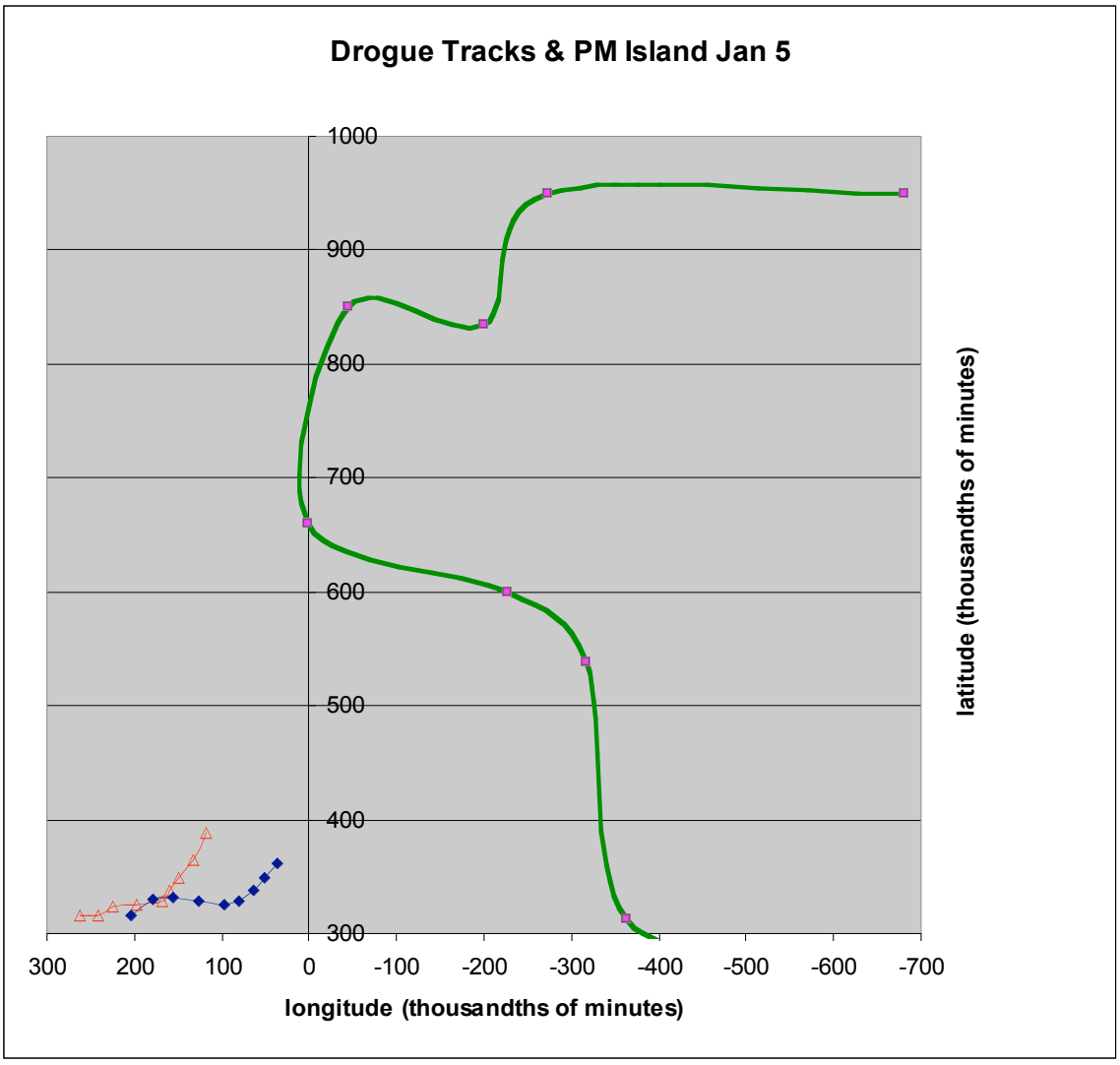

Figure 4. Drogue positions between 0908 and 1058 on January 5, 2007 in relation to the northwest shoreline of Port Mouton Island.

As mentioned, the circumstances on January 5, 2007 corresponded reasonably well with those of the morning of January 31, 2002, when a current meter was installed at the proposed aquaculture site off Port Mouton Island – in both cases, deployment was just after high water, with large tides and light winds. The current meter was a few metres lower in the water column than the sail of the drogue. The two hours of January 2007 drogue data of Figures 3 can be compared with the corresponding two hours of 2002 current meter data in Figure 5.

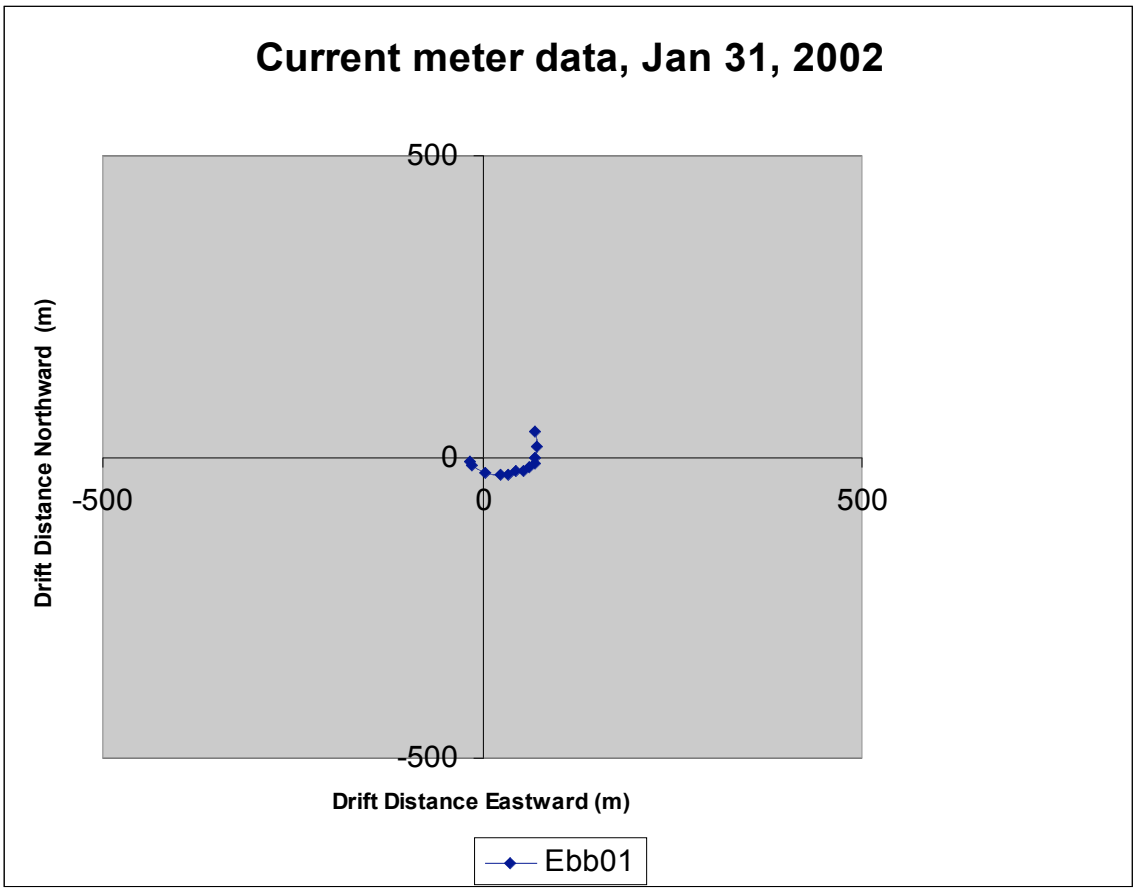

Figure 5. Inferred drift from current meter data the time of high water until high water plus 2 hours on January 31, 2002.

The two tracks – from 2002 current meter and from 2007 drogues - correspond reasonably well in direction. The drift speeds indicated by the drogues in March 2007, 3 cm/s, were larger than indicated by the current meter in January, 2002, though still relatively weak. Consistent with the fishermen's experience who describe this location as a collection zone, the proposed salmon farm site is indeed one with periods of weak currents where deposition would be expected to occur. In the case of these drogues, they drifted toward the nearby Port Mouton Island Back Beach.

2.3.2 Winds and Current Meter Data over the period, Jan 31 to Feb 2, 2002:

From Figure 6 below, the Western Head wind travel totaled about 700 km in 48 hours or 14 km/h average – not particularly strong winds, and the net travel was about 200 km.

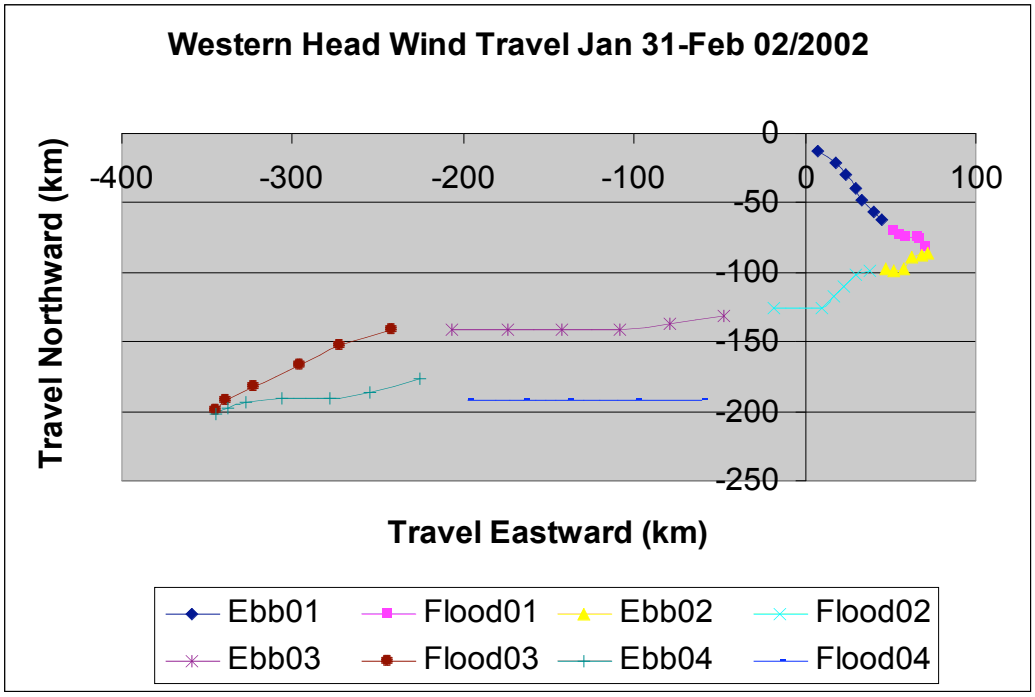

Figure 6. Wind travel, Western Head, Jan 31 to Feb 2, 2002.

The wind travel (Figure 6) is color-coded by half-tide cycle to correspond with the current meter data below. The Ebb01 period extends from high tide on the morning of January 31, 2002 to low tide late afternoon that day; Flood01 extends from the time of that low tide to the time of high tide early in the morning of February 1, 2002, etc. for 48 hours.

The drift currents respond to the tidal force and the bathymetry as well as the winds. The chart of cumulative current drift (Figure 7) shows a northwest / southeast orientation with travel totaling about six kilometres in these particular two days.

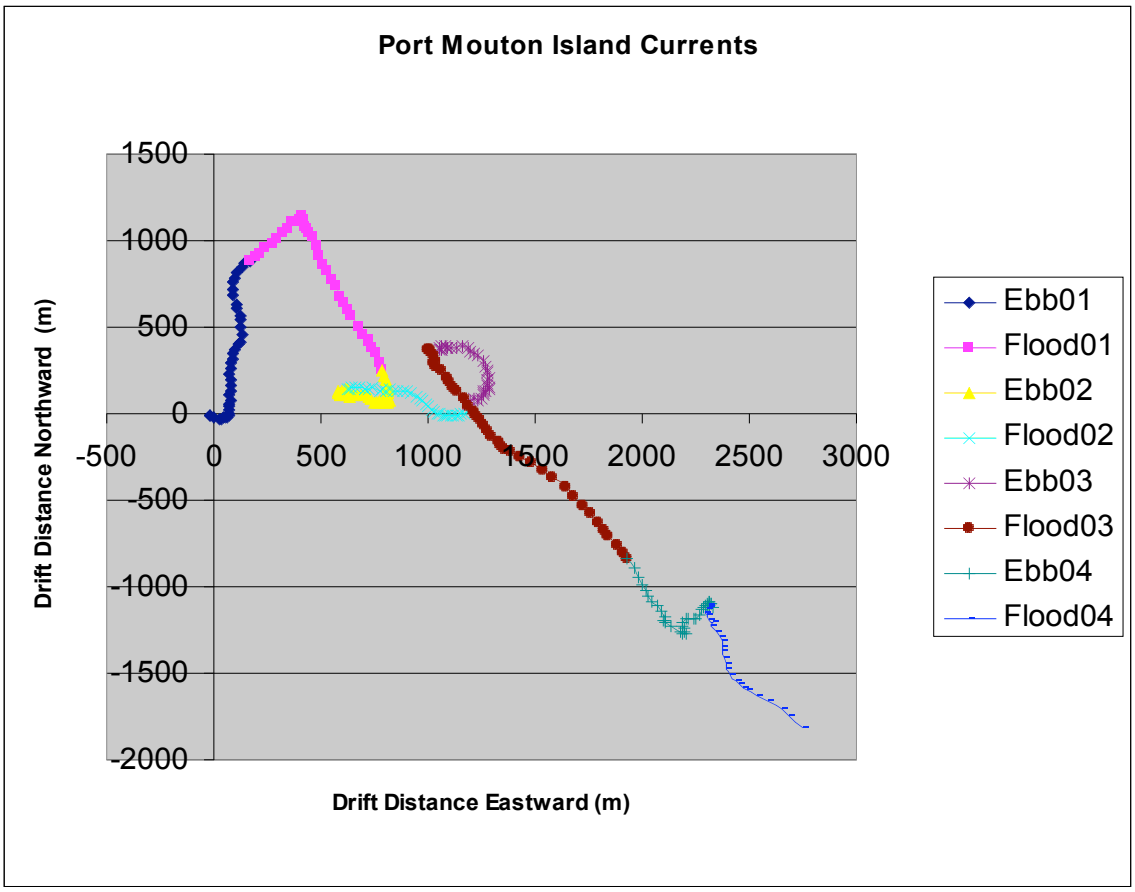

Figure 7. Inferred drift trajectory, January 31 to February 2, 2002, from moored current meter data (AMEC report).

A description and interpretation of the 2002 information on currents is given in Table 1 below..

During this two-day period, January 31 to February 2, 2002, overall average current speeds were weak, about 3 cm/s. The net drift, inferred from the moored current meter over the two days, was approximately 4 kilometres, far enough to reach nearby beaches, but not enough to exchange the water in Port Mouton Bay which has a length scale of approximately 8 km. A unidirectional current of 30 to 40 cm/s for half a tide cycle would move water approximately 8 km – enough to exchange the water in the Bay in that tide cycle – but from Figure 8 below, the observed currents were much weaker than 30 cm/s.

Table 1. Measured currents and wind influences during ebbing and flooding tides.

Period of Record	Tide Tendency	Average Wind Tendency	Description
Ebb01	Northward	Winds light, 11 km/h, from NW	Currents flowed N at 4 cm/s. The displacement Ebb01 to Ebb02 is ~700 m.
Flood01 (pink)	Southward	Light winds, 5 km/h	Currents flowed SE at 4 cm/s
Ebb02 (yellow)	Northward	Light NE winds (Shearwater data substituted for missing Western Head data)	Currents stalled, 1 cm/s. The displacement Ebb02 to Ebb03 is ~ 500 m.
Flood02 (aqua)	Southward	Winds from E at ~14 km/h, some observations missing	Weak currents , 3 cm/s, southward
Ebb03 (purple)	Northward	Winds from the E at 31 km/h	Currents were weak, 1 cm/s, northward and then eastward. Presumably these waters are sheltered from east winds by Port Mouton Island. Displacement Ebb03 to Ebb04 is ~1800 m.
Flood03 (brown)	Southward	Moderate, 19 km/h, from NE.	Current flowed SE at 7 cm/s. Again, these waters may be sheltered from direct effect of NE winds.
Ebb04 (green)	Northward	Winds 24 km/h from the west	Currents initially flowed SE, then stalled as tide opposed winds, average speed 2 cm/s.
Flood04 (blue)	Southward	Winds 22 km/h from the west	Currents flowed toward SE, average speed, 4 cm/s.

The record showed that at the mooring location current speeds were very weak for the Ebb02 / Flood02 / Ebb03 period even though substantial E winds occurred. The highest speeds, rising to 7 cm/s average over a 6 hour period occurred with NE winds during the Flood03 period. The frequency distribution of 10-minute average speeds from the current meter is shown in Figure 8.

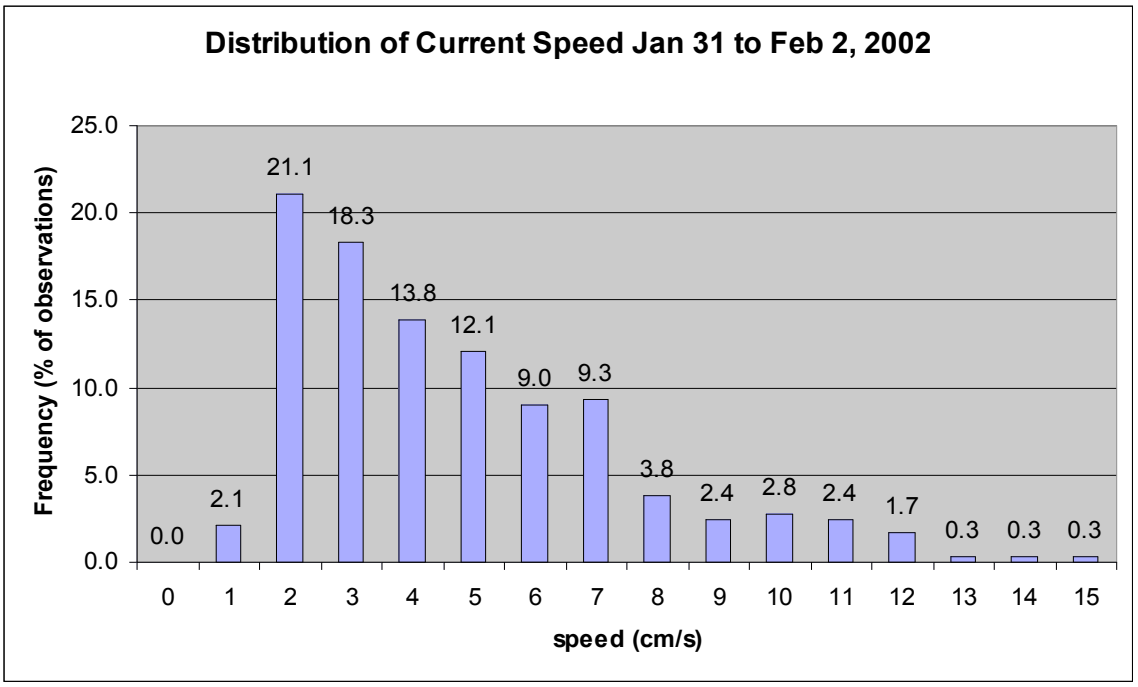

Figure 8. Frequency Distribution of current speeds from the two days of record. The numerical labels give the percentage occurrence of readings at each speed class. E.g., 21% of the current meter readings (10-minute averages) showed speeds between 1.5 and 2.5 cm/s. The median speed is 4 cm/s.

3. CONCLUSIONS TO DATE:

The current meter results and the drogue results are complementary and support a consistent description of the situation. The current meter data give coverage for one location over several tide cycles and, we understand that a current meter mooring was deployed for a few weeks in December 2007. The drogues give the actual path of a drifting parcel of water over for a limited time period.

The composite picture is that with calm winds the tide takes the water around a pattern from 500 to 1100 m in 'length scale' in twelve hours. For most drogues this path ends close to the release point, indicating that recirculation is occuring..

With strong winds from exposed and effective directions, flushing is expected to be faster.

When the December, 2006, current meter data becomes available, then, by relating currents to the Western Head wind data, it should be possible to estimate approximately how many recirculation episodes are likely to occur per year. During these episodes, the area on the west side of Port Mouton Island is indicated to be in a depositional state.