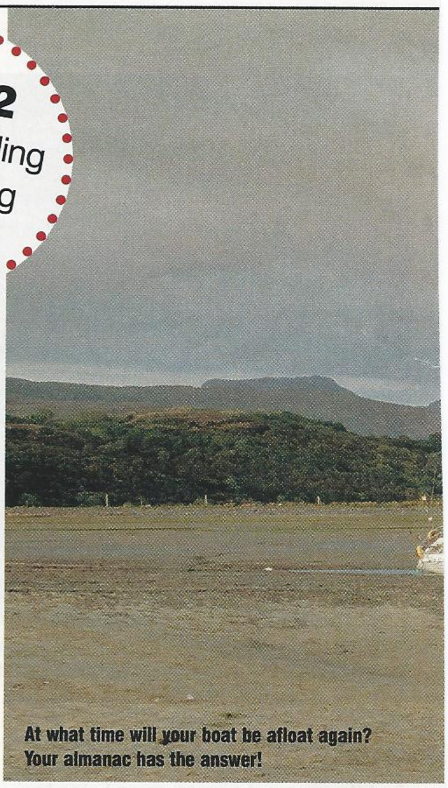
Practical Navigation

Part 2
Understanding and dealing with tides


At what time will your boat be afloat again? Your almanac has the answer!

PPL

Roger Seymour continues our series aimed at helping people attending Royal Yachting Association night school classes. Roger, an RYA instructor and examiner, includes extra tips and hints about parts of the course he knows students find difficult

Sailors since the beginning of time have always marvelled at the effect of the tides. Followers of King Canute thought he could control their ebb and flow until he proved them wrong by getting his feet wet! Even today we try and hold back the tide with lock gates or great engineering projects like the Thames Barrier. As yachtsmen we will never harness all of its power but, as with the weather, a wary eye needs to be kept on it.

All sailors need to know the times of high water and on most passages in coastal waters, the height of tide. This knowledge will enable you to avoid going aground or watching the lock gates close leaving you shut outside for the night.

Causes of tide

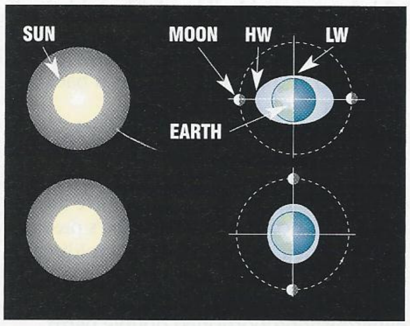
The tides are primarily caused by the gravitational pull of the sun and moon and the positioning of the earth between them. The moon, although tiny in comparison to the sun, has a greater effect than the sun because it is much closer. The gravitational pull of the sun is only about 45% of that of the moon.

There is an excellent working diagram of this on the RNLI website, look for 'e-learning' on their 'sea safety' pages.

Springs/Neaps

When the sun and moon are in line this causes maximum pull and is called a Spring tide (about one and a half days after a full or new moon). Neap tides are when there is minimum pull (half moon).

The moon rotates around the earth every 27.5 days. This is of great benefit to navigators because no matter where you are the time of highwater today will be approximately the same in a fortnight's time. The time of highwater progresses an hour a day (actually, closer to 50 minutes).



Spring tides are when the sun and moon line up. Neap tides occur when they are at right angles

Of course this is a very simplistic view of the universe but all the other cycles that affect the tides are over a longer time period – up to 18½ years in some cases. All of these, such as the distance of the sun and moon from the earth and their angle of orbit (declination), are predictable.

One such cycle is when the largest tides of the year occur around the March and September equinoxes when the sun crosses the equator, the infamous Equinoctial Springs.

All of this so far assumes the earth is covered in water to an even depth in which case the range of the tide would be far less than a metre. Place irregular pieces of land on it and things become much more interesting. The tidal bulge now tends to behave more like a wave getting steeper and higher as it approaches shallow water, and the reflecting waves causing a series of oscillations. England has some of the widest tidal ranges in the world. The Bristol Channel has a tide of over 15m at Springs yet my home port of Poole often has a range of less than 1m.

The largest tides occur in the Bay of Fundy's Minas Basin in Nova Scotia, Canada. The tide can rise up to 16m above low water. During the six-hour cycle 14 cubic kilometres or 14 billion tonnes of water are moved – enough weight to bend Nova Scotia's tectonic plate.

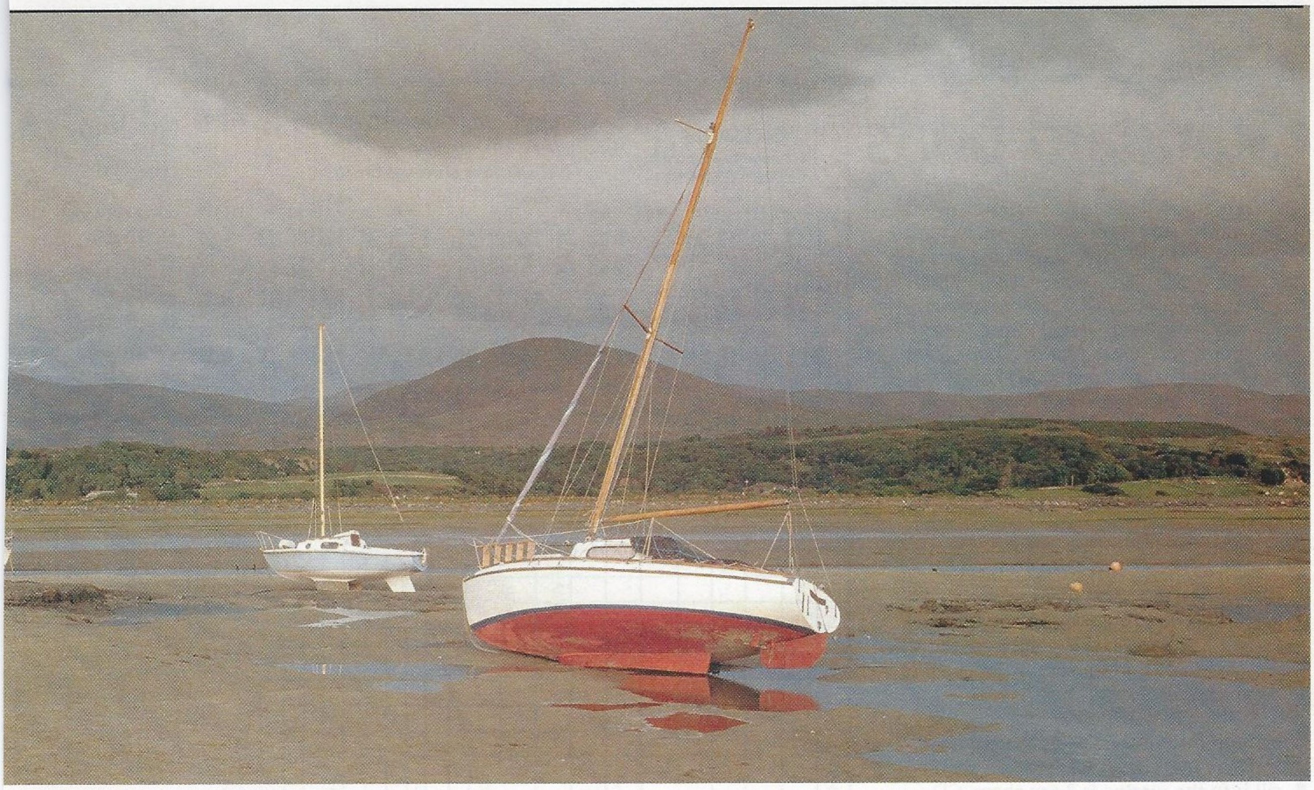
Tide tables

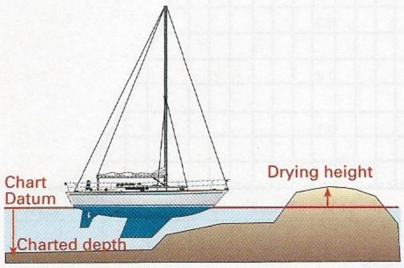
Publications containing tidal information were first published by the Hydrographic Office in 1833 and since 1938 the tidal predictions have been based on harmonic analysis of tidal flows.

The Admiralty Tide Tables are published each year and contain predictions for the time and height of high and low water for every standard port in the world, and tables of constants for intermediate (secondary) ports.

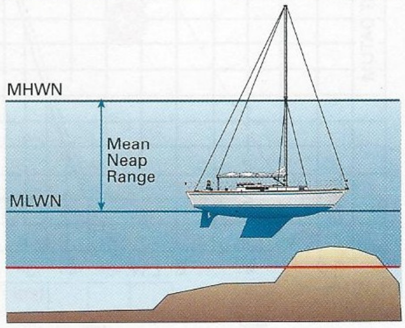
Most yachts are unlikely to carry Admiralty Tide Tables and are better served by using an Almanac designed for small boats because they contain lots of other useful information.

The new PBO Almanac comes out each Christmas and makes an ideal present, but all I carry on board our family dayboat when sailing in Poole Harbour is a pocket-sized locally-produced tide table.

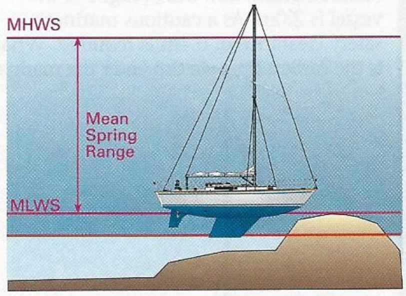




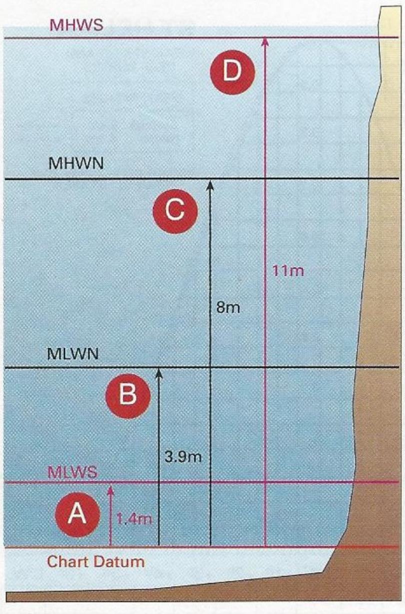
We saw last month that a chart shows the lowest amount of water we are ever likely to encounter

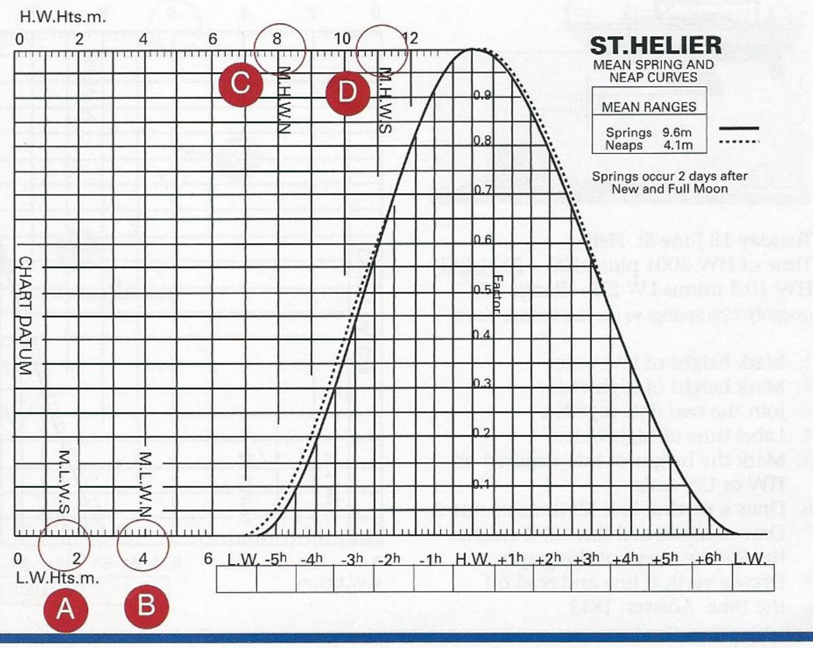


The range of Neap tides is not extreme so we might be able to get over that rock at LW Neaps



Spring tides have high HW and low LW so there is not enough water to get over the rock at LW Springs





Tidal data from RYA Practice Navigation Tables for Yachtsmen

Standard ports

Looking up tide times is straightforward, but always double check you are using the correct port and date, and to add an hour if applying British Summer Time (BST).

If using a French port remember they are always an hour ahead (Time Zone -0100) therefore subtract one hour for Greenwich Mean Time (GMT) or Universal Time (UT). This information should be transferred to the logbook where it can easily be retrieved. The range of the tide (height of HW minus height of LW) should always be worked out at the same time. This then tells you how close to Springs or Neaps it is.

We need to be able to work out the height of tide at any given time to ensure we can anchor safely in Tranquil Bay, or the earliest time to safely get over the sill into Costalot Harbour or pass over those drying banks.

It's the afternoon of 18 June and the ice has run out for the G&Ts, therefore it is imperative to re-victual in St. Helier. The sill into the marina is 3.6m above CD (Chart Datum) and the draught of the vessel is 2.0m. As a cautious mariner a safety clearance of 0.4m is required. What is the earliest time we can enter the marina?

CHANNEL ISLANDS - ST. HELIER

TIME ZONE (UT)
For Summer Time add ONE hour in non-shaded areas

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

MAY

Day	Time	m	Day	Time	m
1	0448	9.6	16	0538	10.3
	1126	2.1		1218	1.5
W	1715	10.0	TH	1757	10.5
	2348	1.9			
2	0532	10.3	17	0043	1.5
	1212	1.6		0621	10.6
TH	1756	10.6	F	1303	1.4
			●	1837	10.8
3	0034	1.4	18	0126	1.3
	0613	10.8		0701	10.6
F	1256	1.2	SA	1342	1.4
O	1834	11.0		1914	10.8
4	0117	1.0	19	0202	1.4
	0653	11.1		0738	10.5
SA	1337	1.0	SU	1416	1.6
	1913	11.3		1948	10.7

JUNE

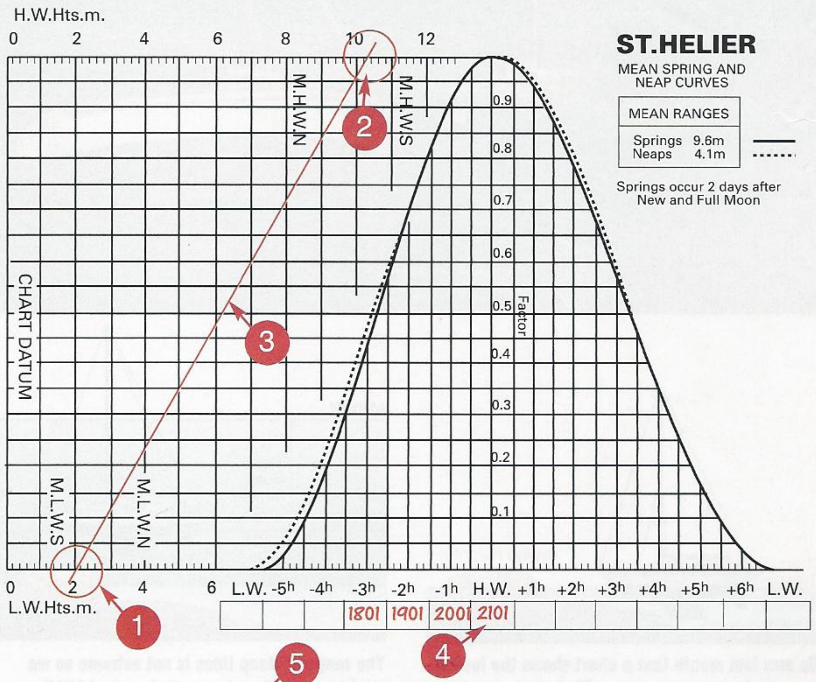
Day	Time	m	Day	Time	m
1	0006	1.6	16	0101	2.0
	0549	10.5		0640	10.1
SA	1231	1.4	SU	1317	2.0
O	1813	11.0	●	1852	10.4
2	0056	1.1	17	0139	1.9
	0636	11.0		0718	10.2
SU	1318	1.1	M	1352	2.0
	1857	11.3		1928	10.5
3	0144	0.8	18	0213	1.9
	0721	11.2		0753	10.1
M	1404	1.0	TU	1425	2.1
	1941	11.5		2001	10.3
4	0230	0.8	19	0245	2.1
	0807	11.2		0826	9.9
TU	1449	1.1	W	1456	2.3
	2026	11.3		2033	10.0

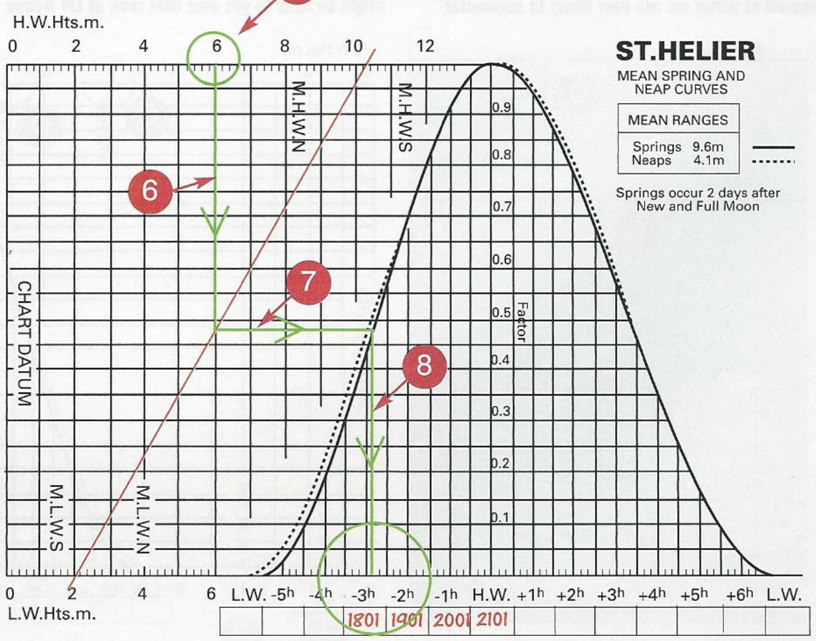
JULY

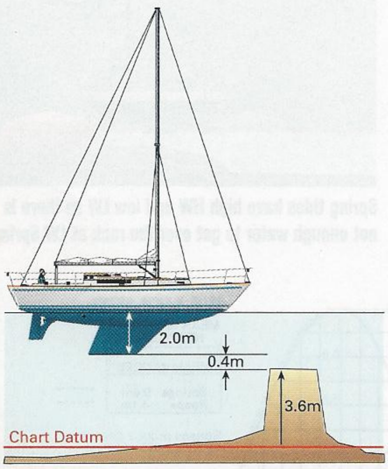
Day	Time	m	Day	Time	m
1	0039	1.2	16	0115	2.1
	0623	10.8		0657	10.1
M	1305	1.2	TU	1329	2.1
O	1846	11.4		1907	10.5
2	0132	0.8	17	0151	2.0
	0713	11.3		0732	10.2
TU	1355	0.9	W	1405	2.0
	1933	11.7		1942	10.5
3	0221	0.6	18	0226	1.9
	0800	11.4		0806	10.1
W	1442	0.8	TH	1438	2.0
	2019	11.7		2014	10.3
4	0309	0.6	19	0258	2.0
	0845	11.3		0838	9.9
TH	1528	1.0	F	1509	2.2
	2104	11.5		2045	10.1

Day	Time	m	Day	Time	m
1	0209	0.3	16	0202	1.7
	0747	11.7		0741	10.4
TH	1430	0.4	F	1416	1.7
	2005	12.0		1951	10.6
2	0254	0.3	17	0235	1.7
	0830	11.7		0813	10.3
F	1513	0.6	SA	1447	1.8
	2047	11.8		2021	10.4
3	0336	0.5	18	0303	1.9
	0911	11.4		0841	10.1
SA	1554	1.0	SU	1516	2.0
	2128	11.3		2049	10.2
4	0416	1.1	19	0330	2.1
	0951	10.8		0909	9.8
SU	1633	1.7	M	1544	2.3
	2209	10.6		2119	9.9

18 0126 1.3
0701 10.6
SA 1342 1.4
1914 10.8







Tuesday 18 June St. Helier
Time of HW 2001 plus 0100 = 2101 BST
HW 10.3 minus LW 2.1 = Range 8.2
(roughly 75% Springs so use the Springs curve)

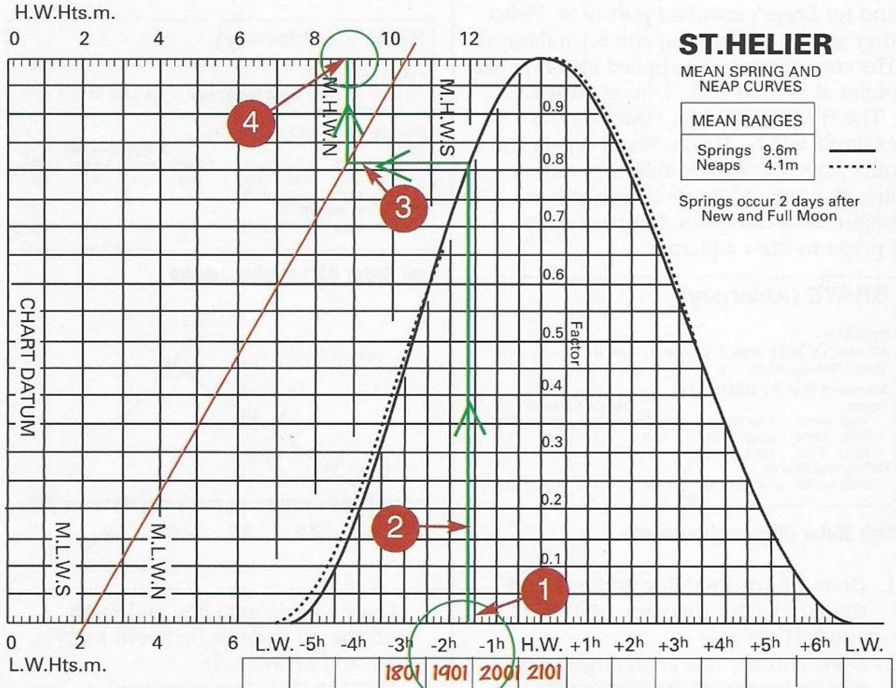
1. Mark height of low water
2. Mark height of high water
3. Join the two dots together
4. Label time of high water
5. Mark the height of tide required on HW or LW scale
6. Draw a vertical line till it meets line 3
7. Draw a horizontal line till it reaches the Springs curve of the graph
8. Draw a vertical line and read off the time. Answer: 1811

An extreme example but this happened at Neaps – there would be even less water at Low Water Springs

If the height of tide is required for a given time then the graph can be used in reverse. What is the height of tide at 1921 BST?

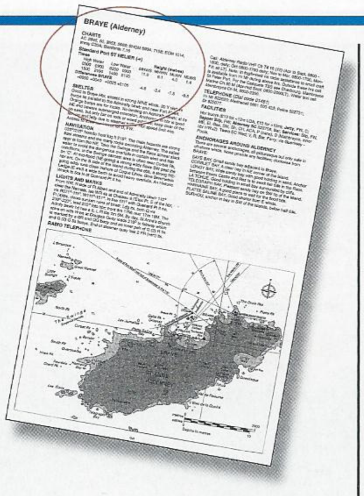
1. Mark time required on bottom of graph
2. Draw a vertical line till it touches the tidal curve
3. Draw a horizontal line till it meets line between HW and LW
4. Draw a vertical line to the height scale
5. Read the result

Height of tide from graph at 1921 BST was 8.8m.



This graph can be drawn before you depart for a day's sail or in preparation for next summer's cruise. Remember most tidal curves are based around six hours before to six hours after the time of high water, and be careful to use the dotted curve for a neap tide. Always use a pencil to mark your curves – you'll need to rub your calculations out to use the curve next time

Secondary ports



Secondary ports are the ones most yachtsmen visit – the smaller, more picturesque, less crowded, non commercial, unspoilt harbours for which daily tide tables by the Admiralty are not published.

So how do you work out tide times for secondary ports? Let's assume our friends will not get to St. Helier in time to join us for cocktails, but intend to drop their anchor in Braye Harbour instead.

To use a graph for a secondary port you must first apply the differences to the standard port information. One way of achieving this is to break it down into steps

1. **Work out the time of high water in Braye**
2. **Work out the height of high water**
3. **Work out the height of low water**
4. **Plot the times and heights for Braye on the St. Helier graph**

Step 1: Work out the time of high water in Braye

Secondary port differences should be calculated on the existing tidal information for the standard port before corrections for zone or summertime are made.

BRAYE (Alderney)

CHARTS
AC *2845, 60, 3653, 2669;* SHOM 6934, 7158; ECM 1014; Imray C33A; Stanfords 7,16

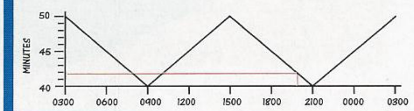
Standard Port ST HELIER (→)

Times				Height (metres)			
High Water		Low Water		MHWS	MHWN	MLWN	MLWS
0300	0900	0200	0900	11.0	8.1	4.0	1.4
1500	2100	1400	2100				
Differences BRAYE							
+0050	+0040	+0025	+0105	-4.8	-3.4	-1.5	-0.5

Look at the times of high water at St. Helier and the differences at Braye. The left hand column is telling you that if HW at St. Helier is at 0300 or 1500 then HW at Braye is 50 minutes later (0350 or 1550). The right hand column says if HW at St. Helier is at 0900 or 2100 then HW Braye is 40 minutes later (0940 or 2140).

In our example HW St. Helier is 2001. The difference to be applied must be between +50 minutes and +40 minutes. The difference can be interpolated by eye, by calculator, or graphically.

1. By eye: 2100 minus 1500 = 6 hours 50 minus 40 = 10 minutes. The difference of 10 minutes spread over 6 hours equates to slightly more than 1.6 minutes an hour. Round that up to 2 and your correction becomes roughly +42 minutes.
2. By calculator: unable to find it, it got wet, the kids took the batteries!
3. Graphically.



Therefore:

HW St. Helier	=	2001 UT
Correction	=	+0042
Summertime	=	+0100
HW Braye	=	2143 BST

Step 2: Work out the height of high water

Now we must look at the HW columns. As the names suggest MHWS (Mean High Water Springs) and MHWN (Mean High Water Neaps) are the average HW heights and for Braye's standard port of St. Helier they are 11.0m (Springs) and 8.1m (Neaps). The corrections to be applied for Braye are -4.8m at Springs and -3.4m at Neaps.

The HW height at St. Helier for our example will be 10.3m. Bookkeepers and quiz players might be able to work out Braye's corrected figure by eye, others might use a calculator, but personally I prefer to draw a picture.

BRAYE (Alderney)

CHARTS
AC *2845, 60, 3653, 2669;* SHOM 6934, 7158; ECM 1014; Imray C33A; Stanfords 7,16

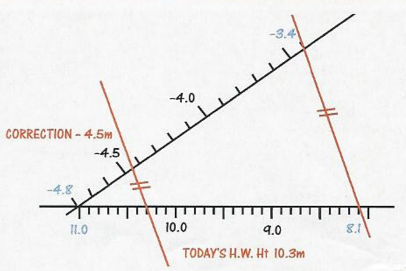
Standard Port ST HELIER (→)

Times				Height (metres)			
High Water		Low Water		MHWS	MHWN	MLWN	MLWS
0300	0900	0200	0900	11.0	8.1	4.0	1.4
1500	2100	1400	2100				
Differences BRAYE							
+0050	+0040	+0025	+0105	-4.8	-3.4	-1.5	-0.5

High Water (HW) heights column

1. Draw a horizontal line and mark off the 1st variable (between MHWS 11.0 and MHWN 8.1)
2. Draw another line at an angle to the first and mark off the 2nd variable (heights between -4.8 and -3.4)

The angle between the lines does not matter and neither do the scales for the



two variables as long as the two lines are of similar length.

Caution

Double check that you have got your variables around the correct way, Springs to Springs and Neaps to Neaps.

3. Draw the third side of the triangle between 8.1 and -3.4.
4. Then carefully move the plotter to today's HW height and draw a line parallel to the first.
5. Read the correction off the top line and apply to today's HW height.

Therefore:

HW St Helier	=	10.3m
Correction	=	-4.5m
HW Braye	=	5.8m

Step 3: Work out the height of low water

The same method can be used to find the height for LW Braye.

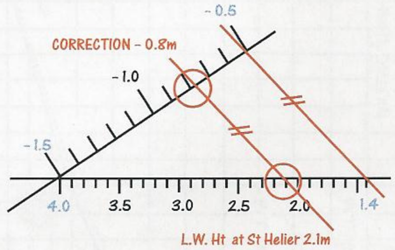
BRAYE (Alderney)

CHARTS
AC *2845, 60, 3653, 2669;* SHOM 6934, 7158; ECM 1014; Imray C33A; Stanfords 7,16

Standard Port ST HELIER (→)

Times				Height (metres)			
High Water		Low Water		MHWS	MHWN	MLWN	MLWS
0300	0900	0200	0900	11.0	8.1	4.0	1.4
1500	2100	1400	2100				
Differences BRAYE							
+0050	+0040	+0025	+0105	-4.8	-3.4	-1.5	-0.5

Low Water (LW) heights column



1. Draw a horizontal line and mark off the 1st variable (between MLWN 4.0 and MLWS 1.4).
2. Draw another line at an angle to the first and mark off the 2nd variable (heights between -1.5 and -0.5).
3. Draw the third side of the triangle.
4. Then carefully move the plotter to

today's LW height and draw a line parallel to the first.

5. Read the correction off the top line and apply to today's HW height.

Therefore:
LW St Helier = 2.1m
Correction = -0.8m

LW Braye = 1.3m

Step 4: Plot the times and heights for Braye on the St. Helier curve

Apply corrected heights for Braye to the St. Helier curve.

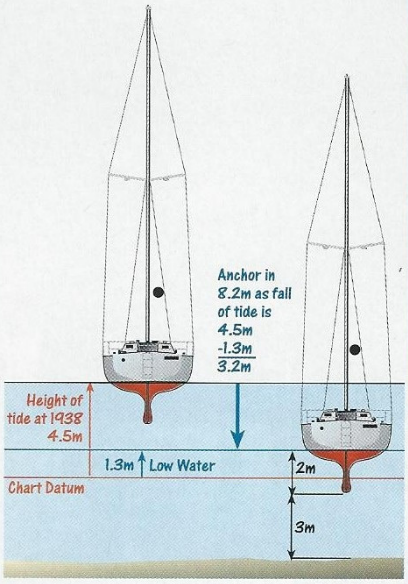
Our friends, having arrived in Braye Harbour and finding all the visitor moorings occupied, decide to anchor in a sheltered corner and want to ensure there is a minimum of 3.0m under their keel at the next low water. The draught of their vessel is 2.0m. They will drop their anchor at 1938 BST.

What is the depth of water they need to anchor in?

1. Find the height of tide at 1938 from the graph.
2. Work out the height of the next LW at Braye.

The height of tide from the graph at 1938 BST is 4.5m.

Fortunately the LW height at St. Helier at 0245 UT on the 19th remains 2.1m.

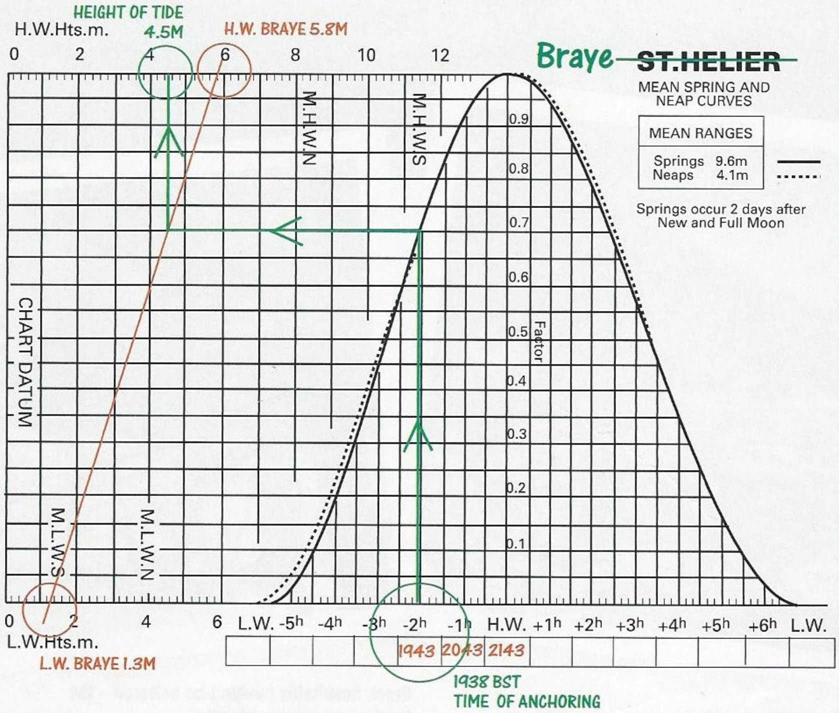


With most of these tidal problems the fall of tide is required and drawing a sketch will make it a lot clearer.

The boat will need 5.0m (clearance plus draught) at LW.

The tide will fall 3.2m (height of tide minus height of LW)

The depth of water required to anchor is therefore 8.2m.



Conclusion

This may seem an awful lot of work. It is! Therefore it is best done before you ever leave the dock or better still before you leave home.

Finding a method that suits you and practising it is the key to success.

On the water it is better to produce an accurate workmanlike answer quickly than to spend hours sweating at the chart table attempting to get answers to multiple decimal places and getting it wrong.

How accurate?

In the classroom you'll need to work out heights to within 0.1m and time to within just a few minutes.

On the water times to 10 minutes and, if possible, heights to 0.1 or 0.2 of a metre are practical. Remember, though, the figures you work out are only predictions, and other influences can affect the height of tides – most notably the weather.

If during the summer months a high pressure sits over the UK for any length of time it can depress the height of tide by up to 0.3m.

A strong wind blowing down an estuary will depress the water level dramatically. Most major ports will have a meteorological correction. With a north wind of F5 blowing down Southampton Water a correction of -0.2m is required and a F10 produces a fall of a full half metre. It is normally the increase in the height of the tide that causes all the damage with a low pressure of 965mb raising the level by 0.6m. Storm surges coming down the North Sea and up the Thames estuary worry Parliament. In Holland it's the flooding rivers coming from Germany, and in the Baltic the melting ice that affect tides.

The modern navigator

The modern navigator can get his tidal prediction from a number of sources other than local tide tables.

THE INTERNET. Admiralty Easy Tide (www.easytide.ukho.gov.uk) is a very reliable source and will give free predictions for up to seven days of all standard ports and many of the popular secondary ports. Many commercial companies produce tidal software for PCs and palm-sized computers. These are getting cheaper and most are very user-friendly.

CHART PLOTTERS. Most will contain a tidal program. Just find the 'T' on the chart and a graph miraculously appears. You can always check the height of tide as you pass a position with a charted depth, or listen to the local VTS or harbour control. You could also call the harbour master and ask for a depth reading if you consider there is a risk of grounding.

There will always be a difference between the results produced by pen and paper and electronics, perhaps because of the thickness of your pencil on the graph, or the source of the electronic data. So use your common sense – and make sure your depth sounder is accurate.