13. TIDES

Water levels vary in tidal and non-tidal waters: sailors should be aware that the depths shown on the charts do not always represent the actual amount of water under the boat.

13.1 Tidal waters

In **tidal waters**, tides are caused by the relative pull of the gravity of the Moon (70%) and of the Sun (30%). When the Sun and Moon are in line with the Earth, either on the same side (New Moon) or opposite sides (Full Moon), the effect of their gravity is maximum, and the tides are highest; these are called **Spring** tides. When the Moon and Sun are at right angles, i.e. at the time of the first or last Quarter Moon, the effects on the tides are minimal; these are **Neap** tides. Tides are also affected, to a much lesser degree, by wind and barometric pressure.

Stronger tide currents are naturally associated with Spring tides. The inside of the back cover of the *Canadian Tide and Current Tables,* published annually by Fisheries and Oceans Canada, shows the days of each month when the Moon is full or new, or at first or last quarter. This helps in planning passages through narrow areas where tide currents can be dangerous.

The daily rotation of the Earth translates into typically semi-diurnal tides: two high tides, and two low tides per interval of 24 hours. The time interval between a high (low) tide and the next high (low) tide is slightly more than 12 hours (close to 12.5 hours) because the Moon orbits around the Earth towards the East, in the same direction as the Earth's spin, so that it takes a little more than a full spin of the Earth for a point on Earth to return under the Moon again. The usual time elapsed between a high tide and the following low tide, or vice-versa, is typically a little more then six hours.

By definition, high tides alternate with low tides, although the difference in heights can be barely noticeable. The usual two high tides, each day, have different heights: one is a **High water**, the other is a **Higher high water**. There are usually also two low tides: one is a **Low water**, the other is a **Lower low water**. This concept is important to understand how to use the reference levels for measuring depths and tide heights, as well as the reference levels used for measuring elevations above water.

Tides are measured above a plane of reference called the **vertical datum**. In Canada, it is the **lowest normal low water**. This is the same as saying the **lowest normal lower water**. The use of this reference level means that all depths marked on the chart, also counted from the same vertical datum, are normally the minimum depths which a boat might expect: any tide, even a small low tide, will add to the amount of water depth shown on the chart. However, the datum is set on the lowest **normal** tides. Once in a few years, an abnormally low tide will occur, which might be very slightly lower than the datum. At that time, the tide is negative, and the actual amount of water below the keel will be a little less than the depth shown on the charts.

In the US, the vertical datum is set at the **Mean lower low water**. Each month, many low tides are negative, during which a boat has less water under its keel than that shown on the chart.

The calculations of tide levels under various circumstances are conducted from tables contained in the *Canadian Tide and Current Tables* and are described in this chapter.

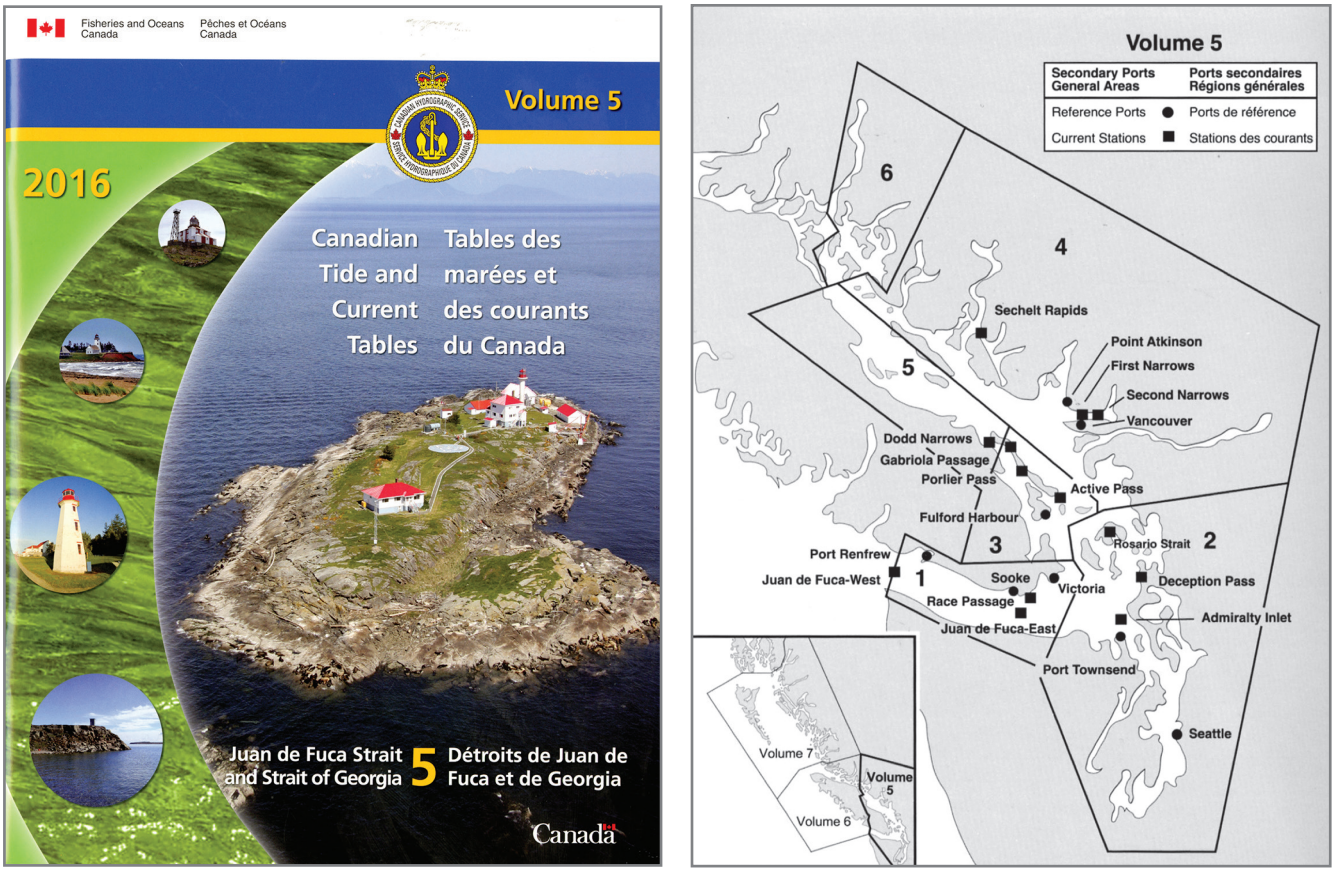

Fig.13.1 Volume 5 of the *Canadian Tide and Current Tables* describes the tides and the currents along the West Coast.

13.2 Non-tidal waters

In **non-tidal waters**, for instance lakes and rivers, the depth is not always indicated on the chart. On lakes, the level is directly related to the precipitation and thus usually varies with the seasons. The depth around large lakes can also be affected by wind. River depths are affected by precipitation and by the movements of muddy bottoms.

13.3 Canadian Tide and Current Tables

While there are numerous electronic resources for tides and currents, it is important to understand how to use the official printed documents.

The *Canadian Tide and Current Tables* are published annually, and describe the tides and the currents along the Canadian shores. Volumes 1, 2 and 3 cover the East Coast; and Volume 4 the Arctic.

The tides and currents of Georgia and Juan de Fuca Straits are described in Volume 5 of the *Canadian Tide and Current Tables* (Fig. 13.1, left). Those around Vancouver Island and further north are given in Volume 6; and the tides and currents in the Queen Charlotte area are forecast in Volume 7 (Fig. 13.1, right).

Canadian Tide and Current Tables

Contents

These tables are published under the authority of the Canadian Hydrographic Service.

Table des matières

Ces tables sont publiées avec l'autorisation du Service hydrographique du Canada.

3

Fig.13.2 The two main sections of the *Canadian Tide and Current Tables (2016)* are the "Tide Tables" (pages 14 to 57) and the "Current Tables" (pages 58 to 109).

The inside front cover of the *Canadian Tide and Current Tables* shows the location of the **Reference Ports** where the **High and Low tides** are predicted for each day of the year (Fig. 13.1, right). The reference ports are shown with round black dots. For instance, the reference port for the Gulf Islands is Fulford Harbour. The reference ports are listed in the table of contents (Fig. 13.2, top, "Tide Tables").

The inside front cover also shows the **Current Stations** where the current is forecast (Fig. 13.1, right). The data include the speed and times of **maximum currents**, and the times of the **turns**, when the speed of the current is very low or nil, i.e. the current is "light and variable" (Fig. 14.1, p. 100). The current stations are shown as black squares; they are along frequently-used passes (Fig. 13.1, right). The current stations are listed in the table of contents (Fig. 13.2, middle, "Current Tables").

TABLE DES MARÉES **2016** **FULFORD HARBOUR** HNP Z+8

April-avril

Day	Time	Metres	Feet	jour	heure	mètres	pieds
1	0055	3.0	9.8	16	0138	3.2	10.5
	0656	2.5	8.2		0811	2.0	6.6
FR	0934	2.6	8.5	SA	1242	2.4	7.9
VE	1729	1.1	3.6	SA	1852	1.4	4.6
2	0144	3.1	10.2	17	0218	3.1	10.2
	0749	2.4	7.9		0850	1.8	5.9
SA	1108	2.5	8.2	SU	1409	2.4	7.9
SA	1832	1.1	3.6	DI	1949	1.5	4.9
3	0224	3.1	10.2	18	0252	3.1	10.2
	0822	2.2	7.2		0921	1.6	5.2
SU	1240	2.6	8.5	MO	1517	2.5	8.2
DI	1931	1.1	3.6	LU	2039	1.6	5.2
4	0259	3.1	10.2	19	0319	3.0	9.8
	0854	2.0	6.6		0949	1.4	4.6
MO	1401	2.7	8.9	TU	1612	2.7	8.9
LU	2024	1.1	3.6	MA	2124	1.8	5.9
5	0329	3.1	10.2	20	0342	3.0	9.8
	0927	1.7	5.6		1014	1.3	4.3
TU	1514	2.8	9.2	WE	1659	2.8	9.2
MA	2112	1.2	3.9	ME	2206	1.9	6.2
6	0358	3.2	10.5	21	0403	2.9	9.5
	1003	1.4	4.6		1040	1.1	3.6
WE	1620	2.9	9.5	TH	1743	2.9	9.5
ME	2159	1.4	4.6	JE	2247	2.1	6.9
7	0427	3.2	10.5	22	0424	2.9	9.5
	1043	1.1	3.6		1107	1.0	3.3
TH	1723	3.0	9.8	FR	1825	3.0	9.8
JE	2247	1.6	5.2	VE	2328	2.2	7.2
8	0457	3.3	10.8	23	0446	2.9	9.5
	1127	0.8	2.6		1136	0.9	3.0
FR	1825	3.1	10.2	SA	1907	3.0	9.8
VE	2336	1.9	6.2	SA			
9	0529	3.3	10.8	24	0010	2.3	7.5
	1213	0.6	2.0		0508	2.9	9.5
SA	1928	3.2	10.5	SU	1207	0.8	2.6
SA				DI	1952	3.1	10.2
10	0031	2.1	6.9	25	0055	2.4	7.9
	0604	3.2	10.5		0531	2.8	9.2
SU	1301	0.5	1.6	MO	1240	0.7	2.3
DI	2034	3.2	10.5	LU	2038	3.1	10.2
11	0133	2.3	7.5	26	0147	2.5	8.2
	0643	3.1	10.2		0555	2.8	9.2
MO	1352	0.5	1.6	TU	1316	0.7	2.3
LU	2141	3.2	10.5	MA	2127	3.1	10.2
12	0249	2.4	7.9	27	0250	2.5	8.2
	0725	2.9	9.5		0620	2.7	8.9
TU	1445	0.6	2.0	WE	1357	0.8	2.6
MA	2248	3.2	10.5	ME	2217	3.1	10.2
13	0422	2.5	8.2	28	0410	2.5	8.2
	0815	2.7	8.9		0652	2.6	8.5
WE	1542	0.8	2.6	TH	1443	0.8	2.6
ME	2352	3.2	10.5	JE	2307	3.2	10.5
14	0601	2.4	7.9	29	0539	2.4	7.9
	0922	2.5	8.2		0743	2.5	8.2
TH	1644	1.0	3.3	FR	1536	1.0	3.3
JE				VE	2355	3.2	10.5
15	0049	3.2	10.5	30	0641	2.3	7.5
	0719	2.2	7.2		0914	2.3	7.5
FR	1056	2.4	7.9	SA	1636	1.1	3.6
VE	1749	1.2	3.9	SA			

May-mai

Day	Time	Metres	Feet	jour	heure	mètres	pieds
1	0039	3.2	10.5	16	0111	3.1	10.2
	0720	2.1	6.9		0816	1.5	4.9
SU	1106	2.3	7.5	MO	1423	2.3	7.5
DI	1742	1.2	3.9	LU	1859	1.9	6.2
2	0118	3.2	10.5	17	0141	3.0	9.8
	0752	1.8	5.9		0846	1.3	4.3
MO	1252	2.4	7.9	TU	1532	2.5	8.2
LU	1846	1.4	4.6	MA	1957	2.0	6.6
3	0153	3.2	10.5	18	0207	3.0	9.8
	0825	1.5	4.9		0913	1.1	3.6
TU	1422	2.5	8.2	WE	1625	2.7	8.9
MA	1945	1.5	4.9	ME	2050	2.2	7.2
4	0224	3.2	10.5	19	0232	3.0	9.8
	0901	1.2	3.9		0940	1.0	3.3
WE	1536	2.7	8.9	TH	1710	2.8	9.2
ME	2040	1.7	5.6	JE	2140	2.3	7.5
5	0255	3.2	10.5	20	0256	2.9	9.5
	0939	0.8	2.6		1007	0.8	2.6
TH	1641	2.9	9.5	FR	1750	3.0	9.8
JE	2133	2.0	6.6	VE	2227	2.4	7.9
6	0327	3.2	10.5	21	0321	2.9	9.5
	1019	0.5	1.6		1035	0.7	2.3
FR	1740	3.1	10.2	SA	1829	3.1	10.2
VE	2227	2.2	7.2	SA	2313	2.5	8.2
7	0401	3.3	10.8	22	0347	2.9	9.5
	1101	0.3	1.0		1105	0.6	2.0
SA	1838	3.2	10.5	SU	1907	3.1	10.2
SA	2324	2.3	7.5	DI	2359	2.6	8.5
8	0438	3.2	10.5	23	0413	2.9	9.5
	1146	0.2	0.7		1137	0.5	1.6
SU	1934	3.3	10.8	MO	1946	3.2	10.5
DI				LU			
9	0027	2.5	8.2	24	0048	2.6	8.5
	0518	3.1	10.2		0442	2.9	9.5
MO	1233	0.2	0.7	TU	1211	0.5	1.6
LU	2030	3.4	11.2	MA	2025	3.2	10.5
10	0139	2.5	8.2	25	0143	2.6	8.5
	0602	3.0	9.8		0512	2.8	9.2
TU	1321	0.4	1.3	WE	1248	0.5	1.6
MA	2125	3.4	11.2	ME	2105	3.3	10.8
11	0301	2.5	8.2	26	0245	2.6	8.5
	0649	2.8	9.2		0547	2.7	8.9
WE	1411	0.6	2.0	TH	1328	0.6	2.0
ME	2219	3.4	11.2	JE	2145	3.3	10.8
12	0428	2.3	7.5	27	0353	2.5	8.2
	0746	2.5	8.2		0635	2.5	8.2
TH	1502	0.8	2.6	FR	1413	0.8	2.6
JE	2309	3.3	10.8	VE	2226	3.3	10.8
13	0550	2.2	7.2	28	0459	2.3	7.5
	0902	2.3	7.5		0742	2.4	7.9
FR	1556	1.1	3.6	SA	1502	0.9	3.0
VE	2355	3.3	10.8	SA	2305	3.3	10.8
14	0654	1.9	6.2	29	0553	2.1	6.9
	1052	2.2	7.2		0920	2.2	7.2
SA	1654	1.4	4.6	SU	1557	1.2	3.9
SA				DI	2343	3.3	10.8
15	0036	3.2	10.5	30	0638	1.8	5.9
	0740	1.7	5.6		1118	2.2	7.2
SU	1250	2.2	7.2	MO	1659	1.4	4.6
DI	1757	1.6	5.2	LU			
				31	0018	3.2	10.5
					0717	1.5	4.9
				TU	1312	2.3	7.5
				MA	1804	1.7	5.6

June-juin

Day	Time	Metres	Feet	jour	heure	mètres	pieds
1	0052	3.2	10.5	16	0058	3.0	9.8
	0756	1.1	3.6		0835	1.0	3.3
WE	1443	2.5	8.2	TH	1628	2.7	8.9
ME	1909	2.0	6.6	JE	2012	2.5	8.2
2	0125	3.3	10.8	17	0128	3.0	9.8
	0835	0.8	2.6		0905	0.8	2.6
TH	1555	2.8	9.2	FR	1709	2.9	9.5
JE	2011	2.2	7.2	VE	2110	2.6	8.5
3	0159	3.3	10.8	18	0158	3.0	9.8
	0916	0.5	1.6		0936	0.7	2.3
FR	1655	3.0	9.8	SA	1746	3.0	9.8
VE	2112	2.4	7.9	SA	2203	2.7	8.9
4	0237	3.3	10.8	19	0230	3.0	9.8
	0957	0.2	0.7		1007	0.6	2.0
SA	1749	3.2	10.5	SU	1820	3.1	10.2
SA	2213	2.5	8.2	DI	2251	2.7	8.9
5	0317	3.3	10.8	20	0303	3.0	9.8
	1041	0.1	0.3		1040	0.5	1.6
SU	1839	3.3	10.8	MO	1854	3.2	10.5
DI	2316	2.6	8.5	LU	2336	2.7	8.9
6	0401	3.2	10.5	21	0337	3.0	9.8
	1125	0.1	0.3		1114	0.4	1.3
MO	1928	3.4	11.2	TU	1927	3.2	10.5
LU				MA			
7	0023	2.6	8.5	22	0021	2.7	8.9
	0446	3.1	10.2		0414	2.9	9.5
TU	1211	0.2	0.7	WE	1150	0.4	1.3
MA	2014	3.4	11.2	ME	2001	3.3	10.8
8	0133	2.5	8.2	23	0110	2.6	8.5
	0535	2.9	9.5		0456	2.9	9.5
WE	1256	0.4	1.3	TH	1228	0.5	1.6
ME	2059	3.4	11.2	JE	2034	3.3	10.8
9	0247	2.4	7.9	24	0205	2.5	8.2
	0626	2.7	8.9		0544	2.7	8.9
TH	1341	0.6	2.0	FR	1308	0.6	2.0
JE	2142	3.4	11.2	VE	2108	3.3	10.8
10	0400	2.2	7.2	25	0305	2.3	7.5
	0727	2.4	7.9		0642	2.6	8.5
FR	1425	0.9	3.0	SA	1351	0.8	2.6
VE	2222	3.3	10.8	SA	2142	3.3	10.8
11	0509	2.0	6.6	26	0405	2.1	6.9
	0847	2.2	7.2		0758	2.4	7.9
SA	1511	1.2	3.9	SU	1437	1.1	3.6
SA	2258	3.3	10.8	DI	2216	3.3	10.8
12	0607	1.8	5.9	27	0502	1.8	5.9
	1037	2.1	6.9		0940	2.2	7.2
SU	1559	1.6	5.2	MO	1527	1.4	4.6
DI	2331	3.2	10.5	LU	2251	3.3	10.8
13	0653	1.6	5.2	28	0554	1.5	4.9
	1240	2.2	7.2		1138	2.3	7.5
MO	1654	1.9	6.2	TU	1625	1.7	5.6
LU				MA	2325	3.3	10.8
14	0001	3.1	10.2	29	0642	1.2	3.9
	0731	1.4	4.6		1331	2.4	7.9
TU	1425	2.3	7.5	WE	1732	2.1	6.9
MA	1759	2.1	6.9	ME			
15	0030	3.0	9.8	30	0000	3.3	10.8
	0804	1.2	3.9		0728	0.8	2.6
WE	1537	2.5	8.2	TH	1459	2.7	8.9
ME	1907	2.3	7.5	JE	1844	2.3	7.5

Fig. 13.3 The 2016 Tide for Fulford Harbour, April-June.

The individual tables towards the end of the manual allow the calculation of intermediate tides, and currents at secondary stations (Fig. 13.2, bottom).

13.4 Full tides at main reference ports

The Tide Tables, in the first part of the manual, give the High and Low tides for each day of the year. High and Low tides alternate, even if the height differences are minimal. Some High tides can be lower than some Low tides, and vice versa.

In the Tides section, each page represents three months of tides for a given station (Fig. 13.3). The times and amplitudes of high and low tides are given for each day in **Pacific Standard Time** because the document is issued by the federal government. The local times, in B.C., are set by the Provincial Government, and advanced by one hour during the **summer** months, between early March and early November as **Pacific Daylight Time (PDT)**.

Example: What are the tides on Monday (Lundi) April 4 at Fulford Harbour, in local time?

The tides in Fulford Harbour, on April 4, 2016, can be described as follows (Fig. 13.3 and Fig. 13.6):

Time (PDT)	Height	Type
03:59	**3.1 m**	**High**
09:54	**2.0 m**	**Low**
15:01	**2.7 m**	**High**
21:24	**1.1 m**	**Low**

13.5 Intermediate tides, main ports

The changes in water levels caused by the tides look like the oscillations and beating of two sine waves with very slightly different periods. These oscillations are caused in part by the Sun, but mostly by the slightly shorter period of the Moon in its apparent rotation around the Earth, and its wandering north or south of the equator. Most of the time, however, the tide pattern looks like a sine wave, and the various approximations used to interpolate the water levels between peaks are based on the properties of sine waves.

The daily tide patterns on the West Coast, as can be seen in the sample eight stations (Fig. 13.4), are governed by the relative position of the Moon: it can be over the equator (**E** points), at its northern maximum latitude (**N**) or at its southern most latitude (**S**). The amplitudes tend to be highest during the full moons (○).

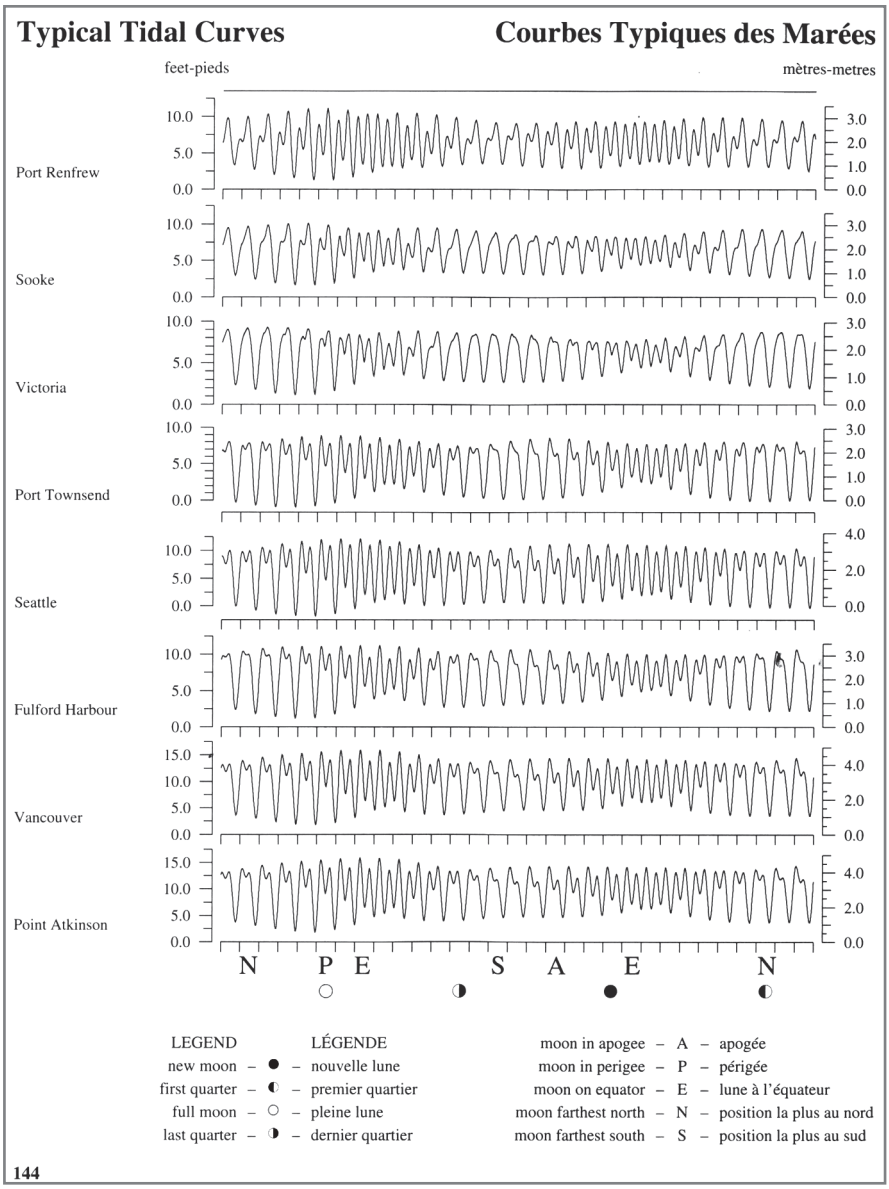

Fig.13.4 The effect of the Moon on BC tides.

The *Canadian Tide and Current Tables* provide data which allow the interpolation of water levels between Low and High tides for a specific moment. These are given in Tables 5 and 5A on page 114 of Volume 5 for Southern BC, 2016 (Fig. 13.7, p. 90). They are based on: 1) the **Tide Duration**, i.e. the time between adjacent Low and High tides, equivalent to half the period of a pure sine wave; 2) the **Tide Range,** i.e. the difference in water levels between adjacent Low and High tides, equivalent to the amplitude of a pure sine wave; and 3) the **Time Interval,** i.e. the difference in time between the moment of measurement and the time of the nearest Low or High tide. These terms, used in Tables 5 and 5A, are illustrated in the graph of Fig. 13.5.

These same tables, and the graphs of the tides associated with them, are available from the Web in .pdf and other electronic formats.

For a tide of specific characteristics (Tide Duration and Tide Range), Tables 5 and 5A of the *Canadian Tide and Current Tables* thus allow an estimate of the **Height Difference**, i.e. the change of water level from the nearest High or Low to the level at the moment of measurement (Fig. 13.5).

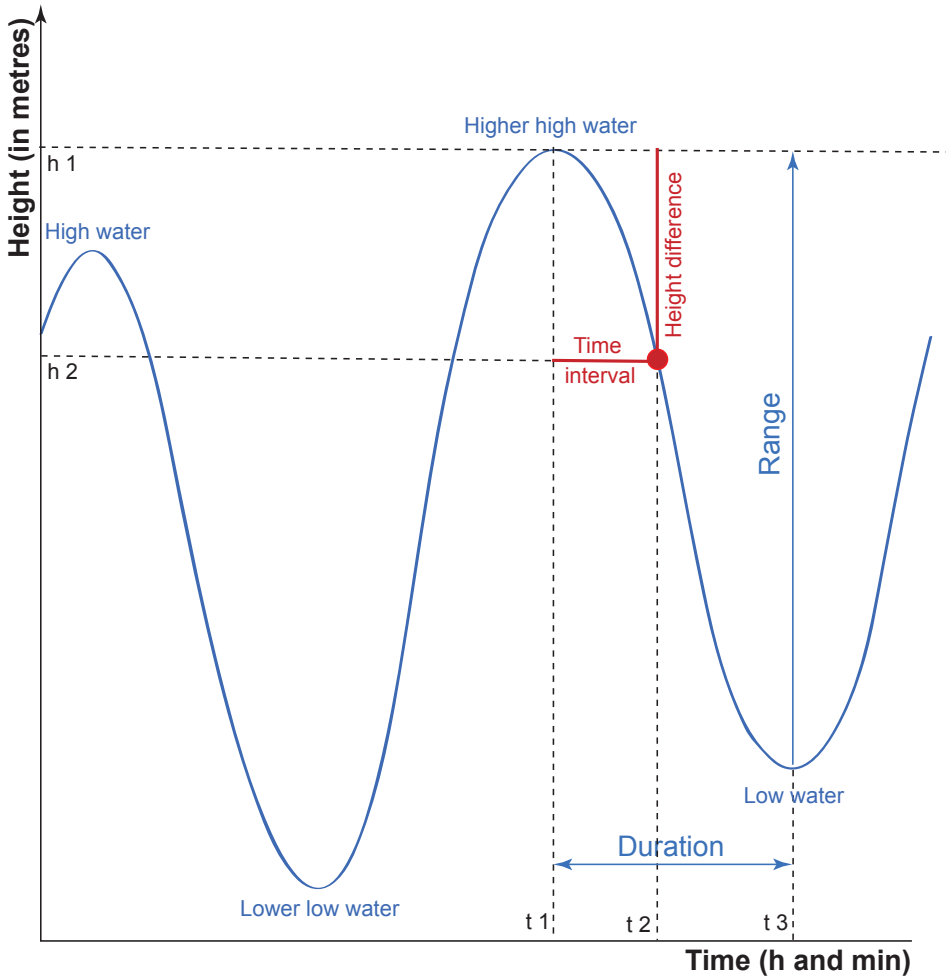

Fig.13.5 In most cases, stations on the West Coast report two high tides per day, a **High** and a **Higher high**, and two low tides: a **Low** and a **Lower low**.

Naturally, Tables 5 and 5A (Fig. 13.7, p. 90) also allow the resolution of the inverse problem: for a specific tide of known duration and range, when would the water level reach a required level, i.e. when would the level be at a specific height difference above the nearest Low or below the nearest High.

Examples of the two types of problems are given in the following sections.

13.5.1 Calculation of the tide at a given time

We may need to know how much water we have under the boat at a given time. The following example explains the method:

Example: What is the intermediate tide at Fulford Harbour at 17:30 (PDT) on April 4, 2016 (Fig. 13.6):

- **Tide Duration** between the adjacent High and Low:
  21:24 (Low) – 15:01 (High) = **6 h 23 min**

- **Tide Range:** 2.7 – 1.1 = **1.6 m**

- **Time Interval** between the moment of measurement (17:30) and the time of the nearest High or Low:
  17:30 – 15:01 = **2 h 29 min** after the High at 15:01.

With this information, we look at Table 5 (Fig. 13.7), in the left section with the times (**Time intervals** and **Duration**): Since our tide has a duration of 6 h 23 min, we select **6:20** down the Duration column. And since our time interval is 2 h 29 min, we move horizontally to the column with the closest time interval of **2:33**. We end up in **column G**.

We now continue in Table 5A (Fig. 13.7), to the right of Table 5. Down the **Range** column, we select the row for **1.5 m**, the closest choice for our tide range of 1.6 m. Moving horizontally to the column with the same name as in Table 5, column G, we read a height difference of 0.55 m.

FULFORD HARBOUR 2016

April-avril

Day	Time	Metres	Feet	jour	heure	mètres	pieds	Day	Time
1	0055	3.0	9.8	16	0138	3.2	10.5	1	0039
	0656	2.5	8.2		0811	2.0	6.6		0720
FR	0934	2.6	8.5	SA	1242	2.4	7.9	SU	1106
VE	1729	1.1	3.6	SA	1852	1.4	4.6	DI	1742
2	0144	3.1	10.2	17	0218	3.1	10.2	2	0118
	0749	2.4	7.9		0850	1.8	5.9		0752
SA	1108	2.5	8.2	SU	1409	2.4	7.9	MO	1252
SA	1832	1.1	3.6	DI	1949	1.5	4.9	LU	1846
3	0224	3.1	10.2	18	0252	3.1	10.2	3	0153
	0822	2.2	7.2		0921	1.6	5.2		0825
SU	1240	2.6	8.5	MO	1517	2.5	8.2	TU	1422
DI	1931	1.1	3.6	LU	2039	1.6	5.2	MA	1945
4	0259	3.1	10.2	19	0319	3.0	9.8	4	0224
	0854	2.0	6.6		0949	1.4	4.6		0901
MO	1401	2.7	8.9	TU	1612	2.7	8.9	WE	1536
LU	2024	1.1	3.6	MA	2124	1.8	5.9	ME	2040
5	0329	3.1	10.2	20	0342	3.0	9.8	5	0255
	0927	1.7	5.6		1014	1.3	4.3		0939
TU	1514	2.8	9.2	WE	1659	2.8	9.2	TH	1641
MA	2112	1.2	3.9	ME	2206	1.9	6.2	JE	2133
6	0358	3.2	10.5	21	0403	2.9	9.5	6	0327
	1003	1.4	4.6		1040	1.1	3.6		1019
WE	1620	2.9	9.5	TH	1743	2.9	9.5	FR	1740
ME	2159	1.4	4.6	JE	2247	2.1	6.9	VE	2227
7	0427	3.2	10.5	22	0424	2.9	9.5	7	0401
	1043	1.1	3.6		1107	1.0	3.3		1101
TH	1723	3.0	9.8	FR	1825	3.0	9.8	SA	1838
JE	2247	1.6	5.2	VE	2328	2.2	7.2	SA	2324

Fig. 13.6 Tides at Fulford Harbour on April 4, 2016.

This means that, at 17:30, the tide will be 0.55 m above or below the level of the reference tide. Our reference tide, which is the closest to the moment of measurement, is the High tide at 15:01. The tide at 17:30 is therefore 0.55 m below this High tide of 2.7 m. At 17:30, the tide level is thus 2.7 – 0.55 = **2.15 m** above the vertical datum, or **2.2 m** after rounding off.

TABLE 5: TIME INTERVALS

Duration	A	B*	C	D	E	F	G	H	I	J
h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1 00	09	12	15	18	20	22	24	26	28	30
1 10	10	14	18	21	23	26	28	31	33	35
1 20	11	16	20	24	27	30	32	35	37	40
1 30	13	18	23	27	30	33	36	39	42	45
1 40	14	20	25	30	33	37	40	44	47	50
1 50	16	23	28	32	37	41	44	48	51	55
2 00	17	25	30	35	40	44	48	52	56	1 00
2 10	19	27	33	38	43	48	52	57	1 01	1 05
2 20	20	29	35	41	47	52	56	1 01	1 06	1 10
2 30	22	31	38	44	50	55	1 00	1 05	1 10	1 15
2 40	23	33	41	47	53	59	1 04	1 10	1 15	1 20
2 50	24	35	43	50	57	1 03	1 09	1 14	1 20	1 25
3 00	26	37	46	53	1 00	1 06	1 13	1 18	1 24	1 30
3 10	27	39	48	56	1 03	1 10	1 17	1 23	1 29	1 35
3 20	29	41	51	59	1 07	1 14	1 21	1 27	1 34	1 40
3 30	30	43	53	1 02	1 10	1 17	1 25	1 32	1 38	1 45
3 40	32	45	56	1 05	1 13	1 21	1 29	1 36	1 43	1 50
3 50	33	47	58	1 08	1 17	1 25	1 33	1 40	1 48	1 55
4 00	34	49	1 01	1 11	1 20	1 29	1 37	1 45	1 52	2 00
4 10	36	51	1 03	1 14	1 23	1 32	1 41	1 49	1 57	2 05
4 20	37	53	1 06	1 17	1 27	1 36	1 45	1 53	2 02	2 10
4 30	39	55	1 08	1 20	1 30	1 40	1 49	1 58	2 06	2 15
4 40	40	57	1 11	1 23	1 33	1 43	1 53	2 02	2 11	2 20
4 50	42	59	1 13	1 26	1 37	1 47	1 57	2 06	2 16	2 25
5 00	43	1 01	1 16	1 29	1 40	1 51	2 01	2 11	2 20	2 30
5 10	45	1 03	1 18	1 32	1 43	1 54	2 05	2 15	2 25	2 35
5 20	46	1 06	1 21	1 34	1 47	1 58	2 09	2 19	2 30	2 40
5 30	47	1 08	1 24	1 37	1 50	2 02	2 13	2 24	2 34	2 45
5 40	49	1 10	1 26	1 40	1 53	2 05	2 17	2 28	2 39	2 50
5 50	50	1 12	1 29	1 43	1 57	2 09	2 21	2 33	2 44	2 55
6 00	52	1 14	1 31	1 46	2 00	2 13	2 25	2 37	2 49	3 00
6 10	53	1 16	1 34	1 49	2 03	2 17	2 29	2 41	2 53	3 05
6 20	55	1 18	1 36	1 52	2 07	2 20	2 33	2 46	2 58	3 10
6 30 *	56	**1 20***	1 39	1 55	2 10	2 24	2 37	2 50	3 03	3 15
6 40	57	1 22	1 41	1 58	2 13	2 28	2 41	2 54	3 07	3 20

TABLE 5A: HEIGHT DIFFERENCES

Range	A	B*	C	D	E	F	G	H	I	J
m	m	m	m	m	m	m	m	m	m	m
0.3	.00	.05	.05	.05	.10	.10	.10	.10	.15	.15
0.6	.05	.05	.10	.10	.15	.20	.20	.25	.25	.30
0.9	.05	.10	.15	.20	.25	.25	.30	.35	.40	.45
1.2	.05	.10	.20	.25	.30	.35	.40	.50	.55	.60
1.5	.10	.15	.25	.30	.40	.45	.55	.60	.70	.75
1.8	.10	.20	.25	.35	.45	.55	.65	.70	.80	.90
2.1	.10	.20	.30	.40	.55	.65	.75	.85	.95	1.05
2.4	.10	.25	.35	.50	.60	.70	.85	.95	1.10	1.20
2.7	.15	.25	.40	.55	.70	.80	.95	1.10	1.20	1.35
3.0	.15	.30	.45	.60	.75	.90	1.05	1.20	1.35	1.50
3.3	.15	.35	.50	.65	.85	1.00	1.15	1.30	1.50	1.65
3.6	.20	.35	.55	.70	.90	1.10	1.25	1.45	1.60	1.80
3.9	.20	.40	.60	.80	1.00	1.15	1.35	1.55	1.75	1.95
4.2 *	.20	**.40***	.65	.85	1.05	1.25	1.45	1.70	1.90	2.10
4.5	.25	.45	.70	.90	1.10	1.35	1.55	1.80	2.00	2.25
4.8	.25	.50	.70	.95	1.20	1.45	1.70	1.90	2.15	2.40
5.1	.25	.50	.75	1.00	1.25	1.55	1.80	2.05	2.30	2.55
5.4	.25	.55	.80	1.10	1.35	1.60	1.90	2.15	2.45	2.70
5.7	.30	.55	.85	1.15	1.40	1.70	2.00	2.30	2.55	2.85
6.0	.30	.60	.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
6.3	.30	.65	.95	1.25	1.55	1.90	2.20	2.50	2.85	3.15
6.6	.35	.65	1.00	1.30	1.65	2.00	2.30	2.65	2.95	3.30
6.9	.35	.70	1.05	1.40	1.70	2.05	2.40	2.75	3.10	3.45
7.2	.35	.70	1.10	1.45	1.80	2.15	2.50	2.90	3.25	3.60
7.5	.40	.75	1.10	1.50	1.85	2.25	2.60	3.00	3.35	3.75
7.8	.40	.80	1.15	1.55	1.95	2.35	2.75	3.10	3.50	3.90
8.1	.40	.80	1.20	1.60	2.00	2.45	2.85	3.25	3.65	4.05
8.4	.40	.85	1.25	1.70	2.10	2.50	2.95	3.35	3.80	4.20
8.7	.45	.85	1.30	1.75	2.15	2.60	3.05	3.50	3.90	4.35
9.0	.45	.90	1.35	1.80	2.25	2.70	3.15	3.60	4.05	4.50

Fig.13.7 **Table 5** in the *Canadian Tide and Current Tables* allows the calculations of the height of the tide at specific intermediate times, knowing the **duration** of a tide (the time between a High and a Low) and its amplitude or **range**, i.e. the difference in height between the Low and the High surrounding the time considered.

13.5.2 Calculation of the time when the tide will reach a given height

This type of calculation is essential when trying to sail in and out of harbours with a retaining wall to maintain the required level of water at low tide. This is frequently the case in all the small ports of the British Isles or along the shores of Normandy and Brittany.

The following example explains the method:

Example: Until what time can a boat with a 1.2 m draft go over a sand bar 1.0 m above vertical datum at the entrance of a small bay near Fulford Harbour in the morning of April 8, 2016? (Fig. 13.8)

The minimum height of water needed to allow the boat over the sand bar is 1.2 + 1.0 = 2.2 m above datum. A tide with a height of 2.2 m or more is therefore required to allow the boat to get over the bar. It is closest to the height of the nearest high tide (3.3 m at 05:57).

– **Tide Duration:** High Tide to Low Tide: 12:27 – 05:57 = 6 h 30 min (Fig. 13.8)
– **Tide Range:** 3.3 – 0.8 = 2.5 m;
– **Height Difference:** 3.3 – 2.2 = 1.1 m below high tide at the last possible moment for crossing.

We now look at Height Differences in Table 5a (Fig. 13.9, right side): Since our tide has a range of 2.5 m, we select the row with the closest range, 2.4 m down the Range column. And since our height difference is 1.1 m, we move horizontally to **1.10 m,** which is in **column I**.

We now continue with the Time Intervals table, in Table 5 (Fig. 13.9, left side). The duration of our tide is 6 h 30 min. Down the Duration column, we select the row for **6 h 30 min**. Moving horizontally to the column with the same name as in Table 5A, **column I**, we read a time interval of **3 h 03 min**.

This means that, 3 h 03 min before or after the high tide, the level of the tide is 1.1 m below the level at High Tide, i.e. 1.1 m less than 3.3 m. At any time in between, the tide will be more than 2.2 m, and we will be able to sail in or out of the harbour. The latest time for going over the sand bar is thus 05:57 + 03:03 = 09:00.

FULFORD HARBOUR 2016

April-avril **May-mai**

Day	Time	Metres	Feet	jour	heure	mètres	pieds	Day	Time	Metres	Feet	jour	heu
1	0055	3.0	9.8	16	0138	3.2	10.5	1	0039	3.2	10.5	16	01
	0656	2.5	8.2		0811	2.0	6.6		0720	2.1	6.9		08
FR	0934	2.6	8.5	SA	1242	2.4	7.9	SU	1106	2.3	7.5	MO	14
VE		1.1							1742		3.9		18
7	0427	3.2	10.5	22	0424	2.9	9.5	7	0401	3.3	10.8	22	034
	1043	1.1	3.6		1107	1.0	3.3		1101	0.3	1.0		110
TH	1723	3.0	9.8	FR	1825	3.0	9.8	SA	1838	3.2	10.5	SU	190
JE	2247	1.6	5.2	VE	2328	2.2	7.2	SA	2324	2.3	7.5	DI	235
8	0457	3.3	10.8	23	0							3	041
	1127	0.8	2.6		1								113
FR	1825	3.1	10.2	SA	1							O	194
VE	2336	1.9	6.2	SA								U	
9	0529	3.3	10.8	24	0							4	004
	1213	0.6	2.0		0								044
SA	1928	3.2	10.5	SU	1							U	121
SA				DI	1							A	202
10	0031	2.1	6.9	25	0055	2.4	7.9	10	0139	2.5	8.2	25	014
	0604	3.2	10.5		0531	2.8	9.2		0602	3.0	9.8		051

Fig. 13.8 In the morning of April 8, 2016, the time when it will be possible to sail over the sand bar is around the high tide of 05:57 (3.3 m).

TABLE 5: TIME INTERVALS

Duration	A	B*	C	D	E	F	G	H	I	J
h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1 00	09	12	15	18	20	22	24	26	28	30
1 10	10	14	18	21	23	26	28	31	33	35
1 20	11	16	20	24	27	30	32	35	37	40
1 30	13	18	23	27	30	33	36	39	42	45
1 40	14	20	25	30	33	37	40	44	47	50
1 50	16	23	28	32	37	41	44	48	51	55
2 00	17	25	30	35	40	44	48	52	56	1 00
2 10	19	27	33	38	43	48	52	57	1 01	1 05
2 20	20	29	35	41	47	52	56	1 01	1 06	1 10
2 30	22	31	38	44	50	55	1 00	1 05	1 10	1 15
2 40	23	33	41	47	53	59	1 04	1 10	1 15	1 20
2 50	24	35	43	50	57	1 03	1 09	1 14	1 20	1 25
3 00	26	37	46	53	1 00	1 06	1 13	1 18	1 24	1 30
3 10	27	39	48	56	1 03	1 10	1 17	1 23	1 29	1 35
3 20	29	41	51	59	1 07	1 14	1 21	1 27	1 34	1 40
3 30	30	43	53	1 02	1 10	1 17	1 25	1 32	1 38	1 45
3 40	32	45	56	1 05	1 13	1 21	1 29	1 36	1 43	1 50
3 50	33	47	58	1 08	1 17	1 25	1 33	1 40	1 48	1 55
4 00	34	49	1 01	1 11	1 20	1 29	1 37	1 45	1 52	2 00
4 10	36	51	1 03	1 14	1 23	1 32	1 41	1 49	1 57	2 05
4 20	37	53	1 06	1 17	1 27	1 36	1 45	1 53	2 02	2 10
4 30	39	55	1 08	1 20	1 30	1 40	1 49	1 58	2 06	2 15
4 40	40	57	1 11	1 23	1 33	1 43	1 53	2 02	2 11	2 20
4 50	42	59	1 13	1 26	1 37	1 47	1 57	2 06	2 16	2 25
5 00	43	1 01	1 16	1 29	1 40	1 51	2 01	2 11	2 20	2 30
5 10	45	1 03	1 18	1 32	1 43	1 54	2 05	2 15	2 25	2 35
5 20	46	1 06	1 21	1 34	1 47	1 58	2 09	2 19	2 30	2 40
5 30	47	1 08	1 24	1 37	1 50	2 02	2 13	2 24	2 34	2 45
5 40	49	1 10	1 26	1 40	1 53	2 05	2 17	2 28	2 39	2 50
5 50	50	1 12	1 29	1 43	1 57	2 09	2 21	2 33	2 44	2 55
6 00	52	1 14	1 31	1 46	2 00	2 13	2 25	2 37	2 49	3 00
6 10	53	1 16	1 34	1 49	2 03	2 17	2 29	2 41	2 53	3 05
6 20	55	1 18	1 36	1 52	2 07	2 20	2 33	2 46	2 58	3 10
6 30	56	1 20*	1 39	1 55	2 10	2 24	2 37	2 50	3 03	3 15
6 40	57	1 22	1 41	1 58	2 13	2 28	2 41	2 54	3 07	3 20
6 50	59	1 24	1 44	2 01	2 17	2 31	2 45	2 59	3 12	3 25
7 00	1 00	1 26	1 46	2 04	2 20	2 35	2 49	3 03	3 17	3 30
7 10	1 02	1 28	1 49	2 07	2 23	2 39	2 53	3 07	3 21	3 35

TABLE 5A: HEIGHT DIFFERENCES

Range	A	B*	C	D	E	F	G	H	I	J
m	m	m	m	m	m	m	m	m	m	m
0.3	.00	.05	.05	.05	.10	.10	.10	.10	.15	.15
0.6	.05	.05	.10	.10	.15	.20	.20	.25	.25	.30
0.9	.05	.10	.15	.20	.25	.25	.30	.35	.40	.45
1.2	.05	.10	.20	.25	.30	.35	.40	.50	.55	.60
1.5	.10	.15	.25	.30	.40	.45	.55	.60	.70	.75
1.8	.10	.20	.25	.35	.45	.55	.65	.70	.80	.90
2.1	.10	.20	.30	.40	.55	.65	.75	.85	.95	1.05
2.4	.10	.25	.35	.50	.60	.70	.85	.95	1.10	1.20
2.7	.15	.25	.40	.55	.70	.80	.95	1.10	1.20	1.35
3.0	.15	.30	.45	.60	.75	.90	1.05	1.20	1.35	1.50
3.3	.15	.35	.50	.65	.85	1.00	1.15	1.30	1.50	1.65
3.6	.20	.35	.55	.70	.90	1.10	1.25	1.45	1.60	1.80
3.9	.20	.40	.60	.80	1.00	1.15	1.35	1.55	1.75	1.95
4.2 *	.20	**.40***	.65	.85	1.05	1.25	1.45	1.70	1.90	2.10
4.5	.25	.45	.70	.90	1.10	1.35	1.55	1.80	2.00	2.25
4.8	.25	.50	.70	.95	1.20	1.45	1.70	1.90	2.15	2.40
5.1	.25	.50	.75	1.00	1.25	1.55	1.80	2.05	2.30	2.55
5.4	.25	.55	.80	1.10	1.35	1.60	1.90	2.15	2.45	2.70
5.7	.30	.55	.85	1.15	1.40	1.70	2.00	2.30	2.55	2.85
6.0	.30	.60	.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
6.3	.30	.65	.95	1.25	1.55	1.90	2.20	2.50	2.85	3.15
6.6	.35	.65	1.00	1.30	1.65	2.00	2.30	2.65	2.95	3.30
6.9	.35	.70	1.05	1.40	1.70	2.05	2.40	2.75	3.10	3.45
7.2	.35	.70	1.10	1.45	1.80	2.15	2.50	2.90	3.25	3.60
7.5	.40	.75	1.10	1.50	1.85	2.25	2.60	3.00	3.35	3.75
7.8	.40	.80	1.15	1.55	1.95	2.35	2.75	3.10	3.50	3.90
8.1	.40	.80	1.20	1.60	2.00	2.45	2.85	3.25	3.65	4.05
8.4	.40	.85	1.25	1.70	2.10	2.50	2.95	3.35	3.80	4.20
8.7	.45	.85	1.30	1.75	2.15	2.60	3.05	3.50	3.90	4.35
9.0	.45	.90	1.35	1.80	2.25	2.70	3.15	3.60	4.05	4.50

Fig.13.9 **Table 5** of the *Canadian Tide and Current Tables* allows the calculations of times when the tides will reach certain heights, knowing the amplitude (**range**) of a tide and its **duration** (time between a High and a Low) around the time of day considered.

13.6 Tide estimations without the interpolation tables

Tide tables are usually available from various government or commercial sources, but navigators don't always have the interpolation tables which allow the calculation of intermediate tides (times and heights). There are several ways around it. The first two given here assume a tide of average tide duration, i.e. six hours. The third one gives more accurate values for any duration.

13.6.1 The rule of incremental 12ths

This method is the easiest when the heights of the tides are given in feet. During each of the first three hours of the tide, i.e. from a High or a Low to the mid-point, the changes in tide levels are assumed to be 1, 2 and 3 twelfths of the total tide range. During each of the following three hours, i.e. from the mid-point to the following Low or High, the changes in tide levels are assumed to be 3, 2 and 1 twelfths of the range. The height at any time between the High and Low is thus the sum of the twelfths of the range accumulated since the High or the Low tide used as a reference.

Example: A falling tide has a range of 11 feet (difference between the height of the High and the height of the following Low). By how much will the tide have dropped four hours after the High?

(1/12 + 2/12 + 3/12 + 3/12) x 11' = 9/12 x 11' = 99'/12 = 99 inches, or 8.25'

13.6.2 The rule of 1/10, 1/4, 2/4, 3/4 and 9/10

This method is simple when the heights are given in meters. The change in tide levels are taken to be 1/10, 1/4, 2/4, 3/4 and 9/10 from hour to hour between the high and low tides. These fractions directly give the change in tide after one, two, three, four or five hours, without any need to add incremental heights for each hour. The results are the same as with the method outlined above for the tides two, three, and four hours after a High or a Low, but are slightly different (and more accurate) for tides measured one or five hours after a High or a Low.

Example: a rising tide has a range of 6 m. By how much will the tide have risen four hours after the Low?

3/4 x 6m = 4.5 m

13.6.3 Quick tide-graphic

Hand-drawing a sine wave on a sheet of lined paper (preferably with vertical lines also) is easy. It allows the accurate calculation of any tide height at any time, knowing its High, its Low, and its duration. It is the most accurate way of estimating intermediate tides, and takes very little time (Fig. 13.10).

1. On a sheet, mark the **heights** of the High and Low tides on the vertical scale. It is easiest to use scales of 10 for measures in meters, and scales of 12 for measures in feet.

2. On the horizontal scale, mark the **times** of the High and Low tides. A scale of six makes it easier.

3. Calculate and plot the mid-point (mid heights and mid times).

4. Manually draw a rough sine wave between the High and Low tides. It should run through the mid-point.

5. Directly off the graph, read any height for any time, or any time for any height.

Example: Assume a tide with a High of 4.2 m at 12:45, and a Low of 0.8 m at 18:25 (Fig. 13.10). The mid-point is at (4.2 m + 0.8 m) / 2 = 2.5 m, at (12:45 + 18:25) / 2 = 15:35. A sine wave plotted quickly by hand can be drawn through these three points. With this plot, any tide between the high and low can be read instantly.

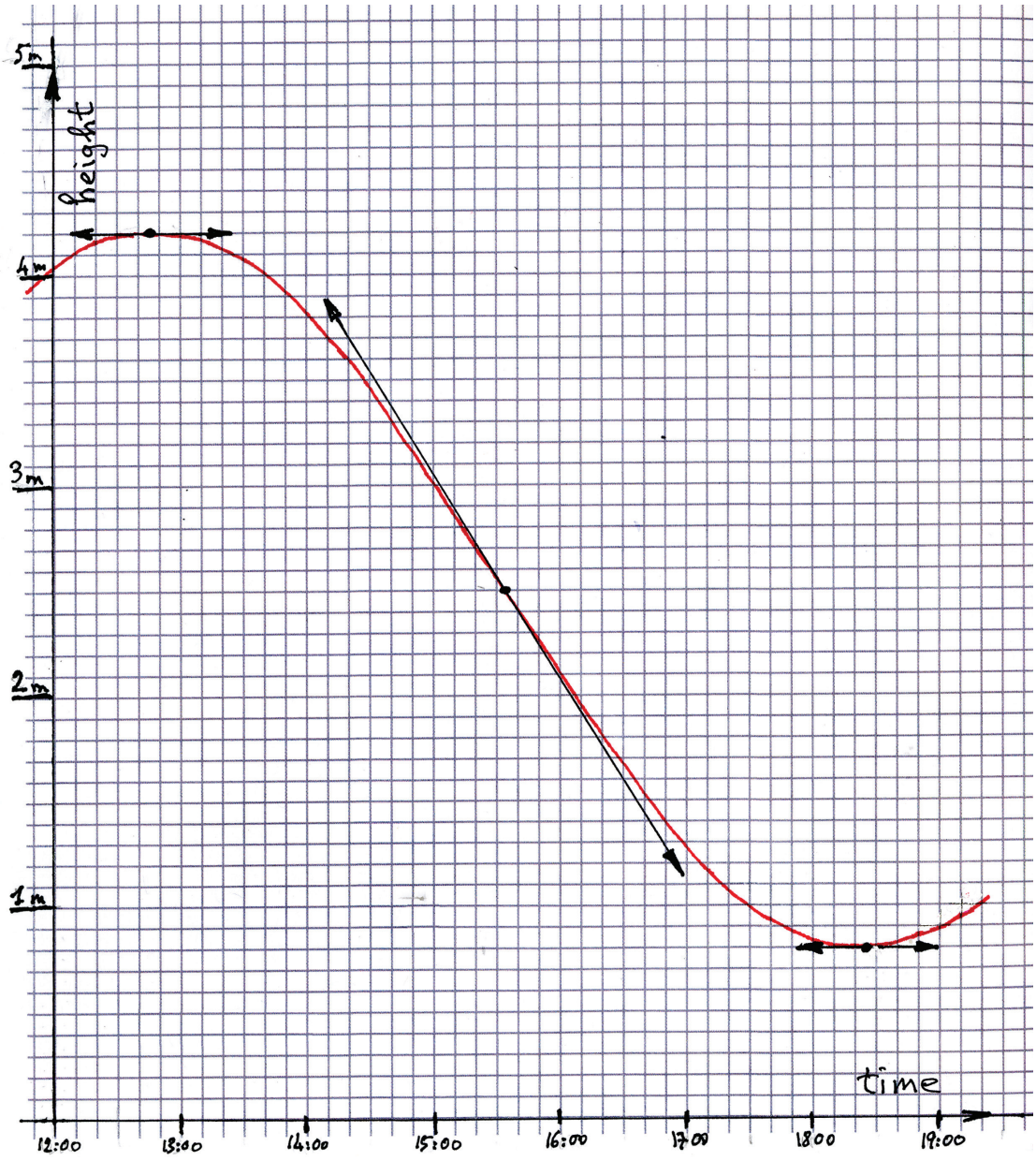

Fig. 13.10 Example of the hand-drawing of a tide knowing its High and Low.

13.7 Tides at secondary ports

The tides at secondary ports are not given in detail for every day of the year. Rather, the levels and times can be calculated by applying adjustments to times and levels at reference ports. These correction factors are given in special tables towards the back of each of the *Canadian Tide and Current Tables*. The example given below explains the calculations.

Example: How high is the highest tide at Pender Harbour in the afternoon of July 14, 2016, and when does it occur?

Index:

Names in capital letters indicate reference ports or current stations for which daily predictions are given.

Les noms en majuscules indiquent les ports de référence ou stations de courants pour lesquels on donne des prédictions quotidiennes.

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Step 1. Since the secondary ports are classified by number, we first look at the **Index**, p. 140 of Volume 5 of the *Canadian Tide and Current Table*, to obtain the number identifying the Pender Harbour tide station: **No. 7837** (Fig. 13.11).

Fig. 13.11 In *Canadian Tide and Current Tables*, the secondary tide stations are listed by station number. These are found in the Index Table, at the end of the manual. Here, Pender Harbour is Secondary Port No. 7837.

Step 2. In the page for **Secondary Ports**, in Table 3 of the *Canadian Tide and Current Tables,* we look for the main harbour on which the tides in Pender Harbour are based:

For station No. 7837, tides are based on tides at **Point Atkinson,** (Fig. 13.12, bottom left):

SECONDARY PORTS — **TABLE 3** — **PORTS SECONDAIRES**

INFORMATION AND TIDAL DIFFERENCES
RENSEIGNEMENTS ET DIFFÉRENCES DES MARÉES

INDEX NO. / NO D'INDEX	SECONDARY PORT / PORT SECONDAIRE	TIME ZONE / FUSEAU HORAIRE	POSITION LAT. N.	POSITION LONG. W. / LONG. O.	DIFFERENCES HIGHER HIGH WATER / PLEINE MER SUPÉRIEURE TIME / HEURE	MEAN TIDE / MARÉE MOYENNE	LARGE TIDE / GRANDE MARÉE	DIFFÉRENCES LOWER LOW WATER / BASSE MER INFÉRIEURE TIME / HEURE	MEAN TIDE / MARÉE MOYENNE	LARGE TIDE / GRANDE MARÉE	RANGE / MARNAGE MEAN TIDE / MARÉE MOYENNE	RANGE / MARNAGE LARGE TIDE / GRANDE MARÉE	MEAN WATER LEVEL / NIVEAU MOYEN DE L'EAU
			° '	° '	h m	m	m	h m	m	m	m	m	m
	AREA 3 / RÉGION 3												
	S.E.VANCOUVER ISLAND AND GULF ISLANDS												
					on/sur POINT ATKINSON, pages 54-57								
7528	MINERS BAY	+8	48 51	123 18	+0 07	-0.7	-0.8	-0 07	-0.2	0.0	2.7	4.1	2.6
7532	WHALER BAY	+8	48 53	123 20	+0 12	-0.5	-0.5	-0 01	-0.3	-0.2	3.0	4.6	2.7
7535	DIONISIO POINT	+8	49 01	123 35	+0 05	-0.1	-0.2	+0 02	-0.1	0.0	3.1	4.7	3.0
7542	VALDES ISLAND	+8	49 04	123 37	-0 04	-0.1	-0.1	-0 05	-0.1	+0.1	3.2	4.7	2.9
7550	SILVA BAY	+8	49 09	123 42	+0 03	+0.1	+0.1	+0 02	+0.1	+0.1	3.2	4.9	3.2
	AREA 4 / RÉGION 4												
	STRAIT OF GEORGIA MAINLAND SHORE												
	BOUNDARY BAY												
7570	BLAINE	+8	49 00	122 46	-0 11	-1.5	-1.6	-0 25	-1.1	-0.9	2.8	4.2	1.7
7577	WHITE ROCK	+8	49 01	122 48	+0 05	-0.4	-0.4	-0 18	-0.1	-0.1	2.9	4.6	2.8
7579	CRESCENT BEACH	+8	49 04	122 53	-0 01	-0.5	-0.6	-0 10	0.0	+0.2	2.7	4.1	2.8
	FRASER DELTA												
7590	TSAWWASSEN	+8	49 00	123 08	+0 01	-0.3	-0.3	-0 13	0.0	+0.1	3.0	4.5	3.0
7594	SAND HEADS	+8	49 06	123 18	+0 02	-0.1	-0.1	-0 14	+0.1	+0.2	3.0	4.6	3.1
	BURRARD INLET												
7710	FALSE CREEK	+8	49 16	123 07	+0 15	-0.1	0.0	+0 05	-0.1	-0.1	3.3	5.0	3.0
	FRASER RIVER				see/voir tables 6-6A, pages 136-137								
					on/sur VANCOUVER, pages 50-53								
7755	PORT MOODY	+8	49 17	122 52	+0 28	0.0	+0.1	-0 05	0.0	0.0	3.3	5.0	3.1
7765	DEEP COVE	+8	49 20	122 57	+0 26	0.0	+0.1	-0 04	0.0	-0.2	3.3	5.2	3.0
7771	BUNTZEN LAKE	+8	49 22	122 52	+0 54	-0.1	-0.2	+0 14	0.0	0.0	3.2	4.7	3.0
	HOWE SOUND				on/sur POINT ATKINSON, pages 54-57								
7811	SQUAMISH	+8	49 42	123 09	+0 03	+0.1	+0.1	+0 00	0.0	0.0	3.3	5.0	3.1
7820	GIBSONS	+8	49 24	123 30	-0 01	+0.1	+0.1	-0 04	+0.1	0.0	3.3	5.0	3.2
	STRAIT OF GEORGIA												
7824	ROBERTS CREEK	+8	49 25	123 39	+0 01	0.0	0.0	-0 02	0.0	+0.1	3.2	4.8	3.1
7830	HALFMOON BAY	+8	49 31	123 55	-0 04	+0.1	+0.1	-0 03	0.0	-0.1	3.3	5.1	3.1
	MALASPINA STRAIT												
7836	IRVINES LANDING	+8	49 38	124 03	+0 00	+0.2	+0.2	+0 02	0.0	0.0	3.4	5.1	3.2
7837	PENDER HARBOUR	+8	49 38	124 02	+0 06	+0.1	+0.2	+0 06	0.0	+0.1	3.3	5.0	3.2

Fig.13.12 The Secondary Ports are listed at the end of *Canadian Tide and Current Tables*, by region first, and then by reference number. Here, Pender Harbour is part of the Malaspina Strait group in Area 4, under reference number 7837. The tides at Pender Harbour are based on those of Point Atkinson, which are partially reproduced in Fig. 13.13.

Step 3. We go to the Point Atkinson page for July 14, 2016, (Fig. 13.13), and find that the height and time of the highest tide in the afternoon is 3.7 m at 16:06 (15:06 + 01:00 for Pacific Daylight Time).

POINT ATKINSON PST Z+8 **2016** **TIDE TABLES**

July-juillet

Day	Time	Metres	Feet	jour	heure	mètres	pieds
1	0127	4.5	14.8	16	0128	4.1	13.5
	0852	0.9	3.0		0911	1.2	3.9
FR	1604	4.1	13.5	SA	1642	4.1	13.5
VE	2056	3.2	10.5	SA	2130	3.4	11.2
2	0216	4.5	14.8	17	0212	4.1	13.5
	0940	0.6	2.0		0950	1.1	3.6
SA	1659	4.4	14.4	SU	1720	4.2	13.8
SA	2159	3.2	10.5	DI	2216	3.4	11.2
3	0306	4.5	14.8	18	0256	4.1	13.5
	1027	0.5	1.6		1027	0.9	3.0
SU	1747	4.5	14.8	MO	1755	4.3	14.1
DI	2256	3.2	10.5	LU	2257	3.4	11.2
4	0357	4.4	14.4	19	0341	4.1	13.5
	1112	0.4	1.3		1104	0.8	2.6
MO	1832	4.6	15.1	TU	1827	4.4	14.4
LU	2349	3.2	10.5	MA	2337	3.3	10.8
5	0447	4.3	14.1	20	0426	4.2	13.8
	1156	0.5	1.6		1141	0.7	2.3
TU	1914	4.7	15.4	WE	1858	4.5	14.8
MA				ME			
6	0042	3.1	10.2	21	0018	3.2	10.5
	0537	4.2	13.8		0512	4.1	13.5
WE	1238	0.6	2.0	TH	1219	0.7	2.3
ME	1953	4.7	15.4	JE	1929	4.5	14.8
7	0137	3.0	9.8	22	0103	3.0	9.8
	0627	4.0	13.1		0602	4.1	13.5
TH	1319	0.9	3.0	FR	1257	0.9	3.0
JE	2032	4.6	15.1	VE	2001	4.6	15.1
8	0232	2.8	9.2	23	0152	2.8	9.2
	0719	3.8	12.5		0655	3.9	12.8
FR	1359	1.2	3.9	SA	1337	1.1	3.6
VE	2109	4.6	15.1	SA	2034	4.6	15.1
9	0330	2.7	8.9	24	0244		
	0817	3.5	11.5		0755		
SA	1439	1.6	5.2	SU	1420		
SA	2145	4.5	14.8	DI	2111		
10	0426	2.5	8.2	25	0341		
	0925	3.3	10.8		0904		
SU	1519	2.0	6.6	MO	1507		
DI	2220	4.4	14.4	LU	2149		
11	0521	2.3	7.5	26	0439		
	1051	3.2	10.5		1028		
MO	1604	2.4	7.9	TU	1600		
LU	2254	4.3	14.1	MA	2231		
12	0614	2.1	6.9	27	0539		
	1228	3.3	10.8		1205		
TU	1657	2.8	9.2	WE	1705		
MA	2329	4.2	13.8	ME	2316		
13	0703	1.9	6.2	28	0639		
	1356	3.4	11.2		1340		
WE	1807	3.1	10.2	TH	1822		
ME				JE			
14	0006	4.1	13.5	29	0006	4.4	14.4
	0748	1.6	5.2		0737	1.1	3.6
TH	1506	3.7	12.1	FR	1459	4.0	13.1
JE	1925	3.3	10.8	VE	1944	3.2	10.5
15	0045	4.1	13.5	30	0101	4.3	14.1
	0831	1.4	4.6		0832	0.9	3.0
FR	1559	3.9	12.8	SA	1600	4.2	13.8
VE	2034	3.4	11.2	SA	2056	3.3	10.8
				31	0159	4.3	14.1
					0925	0.8	2.6
				SU	1650	4.4	14.4
				DI	2157	3.2	10.5

August-août

Day	Time	Metres	Feet	jour	heure	mètres	pieds
1	0256	4.3	14.1	16	0237	4.0	13.1
	1013	0.7	2.3		0959	1.0	3.3
MO	1733	4.5	14.8	TU	1717	4.3	14.1
LU	2249	3.1	10.2	MA	2233	3.2	10.5
2	0351	4.3	14.1	17	0330	4.1	13.5
	1058	0.7	2.3		1039	0.9	3.0
TU	1810	4.5	14.8	WE	1746	4.4	14.4
MA	2337	3.0	9.8	ME	2312	3.0	9.8
3	0442	4.2	13.8	18	0421	4.2	13.8
	1139	0.8	2.6		1119	0.9	3.0
WE	1845	4.5	14.8	TH	1815	4.4	14.4
ME				JE	2353	2.8	9.2
4	0023	2.9	9.5	19	0511	4.2	13.8
	0531	4.1	13.5		1158	0.9	3.0
TH	1218	0.9	3.0	FR	1845	4.5	14.8
JE	1917	4.5	14.8	VE			
5	0109	2.7	8.9	20	0036	2.5	8.2
	0619	4.0	13.1		0603	4.2	13.8
FR	1255	1.2	3.9	SA	1237	1.1	3.6
VE	1949	4.5	14.8	SA	1916	4.6	15.1
6	0155	2.6	8.5	21	0123	2.3	7.5
	0708	3.8	12.5		0659	4.1	13.5
SA	1332	1.5	4.9	SU	1319	1.5	4.9
SA	2019	4.5	14.8	DI	1950	4.6	15.1
7	0241	2.4	7.9	22	0213	2.0	6.6
	0801	3.7	12.1		0800	4.0	13.1
SU	1407	1.9	6.2	MO	1403	1.8	5.9
DI	2049	4.4	14.4	LU	2026	4.6	15.1
8	0328	2.3	7.5	23	0306	1.7	5.6
	0902	3.5	11.5		0910	3.9	12.8
MO	1444	2.3	7.5	TU	1453	2.3	7.5
LU	2119	4.3	14.1	MA	2106	4.5	14.8
SA				DI	2104	3.1	10.2
14	0045	3.9	12.8	29	0159	4.0	13.1
	0833	1.3	4.3		0908	1.1	3.6
SU	1607	4.1	13.5	MO	1623	4.4	14.4
DI	2108	3.4	11.2	LU	2156	3.0	9.8
15	0142	4.0	13.1	30	0302	4.0	13.1
	0917	1.2	3.9		0957	1.1	3.6
MO	1644	4.2	13.8	TU	1701	4.4	14.4
LU	2153	3.3	10.8	MA	2241	2.8	9.2
				31	0356	4.1	13.5
					1040	1.1	3.6
				WE	1733	4.4	14.4
				ME	2321	2.6	8.5

September-septembre

Day	Time	Metres	Feet	jour	heure	mètres	pieds
1	0445	4.1	13.5	16	0421	4.2	13.8
	1120	1.2	3.9		1053	1.3	4.3
TH	1802	4.4	14.4	FR	1724	4.5	14.8
JE	2359	2.5	8.2	VE	2327	2.1	6.9
2	0531	4.1	13.5	17	0514	4.3	14.1
	1156	1.4	4.6		1135	1.4	4.6
FR	1830	4.4	14.4	SA	1755	4.5	14.8
VE				SA			
3	0037	2.3	7.5	18	0010	1.8	5.9
	0616	4.0	13.1		0608	4.3	14.1
SA	1231	1.7	5.6	SU	1217	1.7	5.6
SA	1857	4.3	14.1	DI	1828	4.6	15.1
4	0114	2.2	7.2	19	0055	1.5	4.9
	0702	3.9	12.8		0705	4.3	14.1
SU	1306	2.0	6.6	MO	1302	2.0	6.6
DI	1923	4.3	14.1	LU	1903	4.6	15.1
5	0151	2.0	6.6	20	0142	1.3	4.3
	0751	3.9	12.8		0807	4.3	14.1
MO	1341	2.3	7.5	TU	1351	2.4	7.9
LU	1949	4.2	13.8	MA	1942	4.5	14.8
6	0230	1.9	6.2	21	0233	1.2	3.9
	0846	3.8	12.5		0916	4.2	13.8
TU	1419	2.6	8.5	WE	1448	2.7	8.9
MA	2016	4.1	13.5	ME	2024	4.3	14.1
7	0311	1.9	6.2	22	0327	1.2	3.9
	0951	3.7	12.1		1033	4.2	13.8
WE	1502	2.9	9.5	TH	1558	3.0	9.8
ME	2046	4.0	13.1	JE	2114	4.1	13.5
8	0356	1.8	5.9	23	0427	1.2	3.9
	1106	3.7	12.1		1153	4.2	13.8
TH	1557	3.1	10.2	FR	1724	3.1	10.2
JE	2120	3.9	12.8	VE	2216	3.9	12.8
	0448	1.8	5.9	24	0532	1.3	4.3
	24	3.8	12.5		1306	4.3	14.1
	14	3.3	10.8	SA	1855	3.1	10.2
	04	3.8	12.5	SA	2333	3.7	12.1
	45	1.7	5.6	25	0640	1.4	4.6
	34	3.9	12.8		1409	4.3	14.1
	47	3.3	10.8	SU	2009	2.9	9.5
	03	3.7	12.1	DI			
	46	1.7	5.6	26	0058	3.7	12.1
	30	4.0	13.1		0747	1.5	4.9
	00	3.3	10.8	MO	1459	4.4	14.4
				LU	2104	2.7	8.9
	13	3.7	12.1	27	0213	3.7	12.1
	45	1.5	4.9		0845	1.5	4.9
	15	4.1	13.5	TU	1540	4.4	14.4
	51	3.1	10.2	MA	2147	2.5	8.2
	26	3.7	12.1	28	0314	3.8	12.5
	38	1.4	4.6		0935	1.6	5.2
	52	4.2	13.8	WE	1614	4.4	14.4
MA	2131	3.0	9.8	ME	2224	2.3	7.5
14	0231	3.9	12.8	29	0406	4.0	13.1
	0926	1.3	4.3		1019	1.7	5.6
WE	1624	4.3	14.1	TH	1644	4.3	14.1
ME	2209	2.7	8.9	JE	2258	2.1	6.9
15	0328	4.1	13.5	30	0452	4.0	13.1
	1011	1.2	3.9		1058	1.9	6.2
TH	1654	4.4	14.4	FR	1711	4.3	14.1
JE	2247	2.5	8.2	VE	2331	1.9	6.2

ME			
14	0006	4.1	13.5
	0748	1.6	5.2
TH	1506	3.7	12.1
JE	1925	3.3	10.8
15	0045	4.1	13.5

Fig. 13.13 The tides at Pender Harbour are based on the ones in Point Atkinson. Here, on July 14, 2016, blown up on the center of the image, we have the information on the Higher high, Lower low, High and Low tides in Point Atkinson: the times are given in PST, and the heights in **metres** and feet.

The highest tide at Pender Harbour will be similar to the highest tide at Point Atkinson, with slight adjustments to the time and height. The adjustments are given on the same Table 3 of the *Canadian Tide and Current Table* which we just used for the **Secondary Ports**. (Fig. 13.14)

Step 4. On the row for Secondary Port No. 7837 Pender Harbour, we find that the adjustment for the time of a high tide is **+ 0:06**, which means that the high tide in Pender Harbour occurs 0 h and 06 min AFTER the high tide in Point Atkinson (i.e. after 01:06 PDT, the highest tide of the day).

SECONDARY PORTS — **TABLE 3** — **PORTS SECONDAIRES**

INFORMATION AND TIDAL DIFFERENCES
RENSEIGNEMENTS ET DIFFÉRENCES DES MARÉES

INDEX NO. / NO D'INDEX	SECONDARY PORT / PORT SECONDAIRE	TIME ZONE / FUSEAU HORAIRE	POSITION LAT. N.	POSITION LONG. W. / LONG. O.	DIFFERENCES HIGHER HIGH WATER / PLEINE MER SUPÉRIEURE TIME / HEURE	MEAN TIDE / MARÉE MOYENNE	LARGE TIDE / GRANDE MARÉE	DIFFÉRENCES LOWER LOW WATER / BASSE MER INFÉRIEURE TIME / HEURE	MEAN TIDE / MARÉE MOYENNE	LARGE TIDE / GRANDE MARÉE	RANGE / MARNAGE MEAN TIDE / MARÉE MOYENNE	RANGE / MARNAGE LARGE TIDE / GRANDE MARÉE	MEAN WATER LEVEL / NIVEAU MOYEN DE L'EAU
			° '	° '	h m	m	m	h m	m	m	m	m	m
	[illegible] MOON BAY	+ 8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-0.1	3.5	[illegible]	[illegible]
			on/sur POINT ATKINSON, pages 54-57										
	MALASPINA STRAIT												
7836	IRVINES LANDING	+ 8	49 38	124 03	+0 00	+0.2	+0.2	+0 02	0.0	0.0	3.4	5.1	3.2
7837	PENDER HARBOUR	+ 8	49 38	124 02	+0 06	+0.1	+0.2	+0 06	0.0	+0.1	3.3	5.0	3.2

Fig. 13.14 The adjustments to make to the Point Atkinson tides in order to get those in Pender Harbour are given in this table for the Higher high water (also applicable to High water) and the Lower low water (or Low water). The adjustments for the height of the tides depend on whether the high or low water is normal (**Mean**) or exceptional (**Large**). This is shown in Table 2 (Fig. 13.15). The time adjustment is valid either for all high tides or all low tides.

On the same row, we see that two cases need to be considered: If the high tide at Point Atkinson (Higher high water) is a normal high tide, i.e. a "**Mean tide"**, the adjustment in **height** for Pender Harbour is **+0.1 m**: the high tide in Pender Harbour is 0.1 m higher than at Point Atkinson. If the high tide in Pender Harbour is particularly high i.e., a "**Large tide"**, then the adjustment is **+ 0.2** m: the large high tides in Pender Harbour are + 0.2 m higher than the ones at Point Atkinson. Is the 4.1 m high tide at Point Atkinson on July 14 a Mean tide or a Large tide? We need to look at Table 2 of the *Canadian Tide and Current Table* in the section Reference Ports (Fig. 13.15).

Step 5. In order to determine if this particular high tide at Point Atkinson is **mean** or **large**, we need to check on Table 2.

REFERENCE PORTS — **PORTS DE RÉFÉRENCE**

TABLE 2
TIDAL HEIGHTS, EXTREMES, AND MEAN WATER LEVEL
HAUTEURS DE MARÉES, EXTRÊMES ET NIVEAU MOYEN DE L'EAU

REFERENCE PORT / PORT DE RÉFÉRENCE	HEIGHTS / HAUTEURS				RECORDED EXTREMES / EXTRÊMES ENREGISTRÉS		MEAN WATER LEVEL / NIVEAU MOYEN DE L'EAU
	HIGHER HIGH WATER / PLEINE MER SUPÉRIEURE		LOWER LOW WATER / BASSE MER INFÉRIEURE				
	MEAN TIDE / MARÉE MOYENNE	LARGE TIDE / GRANDE MARÉE	MEAN TIDE / MARÉE MOYENNE	LARGE TIDE / GRANDE MARÉE	HIGHEST HIGH WATER / EXTRÊME DE PLEINE MER	LOWEST LOW WATER / EXTRÊME DE BASSE MER	
	m	m	m	m	m	m	m
PORT RENFREW	3.0	3.7	0.8	0.0	4.3	-0.2	1.9
SOOKE	2.8	3.4	0.9	0.3	3.9	-0.2	1.9
VICTORIA	2.5	3.4	0.7	0.1	3.8	-0.5	1.9
PORT TOWNSEND	2.5	3.0	0.0	-0.7			1.6
SEATTLE	3.4	4.2	-0.1	-1.3			2.0
FULFORD HARBOUR	3.3	3.7	0.9	-0.1	4.4	-0.5	2.3
VANCOUVER	4.5	5.0	1.2	0.1	5.6	-0.3	3.1
POINT ATKINSON	4.5	5.0	1.2	0.1	5.6	-0.4	3.1

Fig.13.15 This table tells us what a normal (Mean) tide is at Point Atkinson, and what an exceptional (Large) tide is. This will tell us what adjustments to make to the heights of the tides at the secondary port of Pender Harbour.

From Table 2, we see that, for Point Atkinson, a **Mean** high tide is 4.5 m, while a **Large** high tide is 5.0 m. On July 14, 2016, our tide (4.1 m) is closest to a mean high tide (4.5 m). We therefore choose the height adjustment for a mean high tide: + 0.1 m. (Fig. 13.14, Table 3, Higher High Water, Mean Tide)

We can now make the time and height adjustments, which are those for a **mean** high tide:

- Change in time: + 0 h 06 min. Pender Harbour highest tide occurs at 01:06 + 00:06 = **01:12**
- Change in height: + 0.1 m. Pender Harbour highest tide is 4.1 + 0.1 = **4.2 m**