Chapter 17.3

NAVIGATION

TIDES & CURRENTS

TIDES

Tides are the rise and fall of water due to the gravitational pull of moon and sun. Moon being closer to earth exerts a greater pull. The Hydrographic Office publishes tide tables based on this astronomical and some other non-astronomical data. Local tides can generally be predicted with a high degree of accuracy from analysis of long-term tidal records. However, one thing that tide tables cannot predict is the effect on tides of the day-to-day weather changes and wind directions and velocities.

Roughly twice a month the moon is in line with the sun, i.e., on new moon and full moon. Their combined gravitational pull creates bigger tides. The high water is higher and low water is lower. These are known as the SPRING TIDES. Similarly, twice a month, at half moon, the sun and moon are at right angle to each other. Here, they work in different directions, producing smaller tides. The high tides are not so high and low tides not so low. These are known as the NEAP TIDES.

The difference in the height between a consecutive HW and LW is the RANGE OF TIDE. The tide range on the Australian coastline varies from approximately 12 metres in the Kimberleys to about 0.7 metres in places such as Sydney and Fremantle. The range of spring tides is always greater than that of neap tides.

A rising tide, i.e., a tide flowing into harbours and rivers, is known as the FLOOD TIDE. A falling tide, i.e., a tide going out, is known as the EBB TIDE. The horizontal flow of water when tide is flooding or ebbing is known as the TIDAL STREAM or TIDAL CURRENT. The Tidal Currents are strongest halfway between the times of HW and LW. See figure 17.33 for additional terminology on tides.

The UK Hydrographic Office offers free tidal prediction service for some 4000 ports around the world on its website (see address on the last page of this book). This 'EasyTide' service provides tidal information for up to seven days from the date of logging on.

THE EFFECT OF WEATHER ON TIDES

The effects of weather conditions on tides are not taken into account in Tide Tables. For example, a high atmospheric pressure does not allow a tide to rise to its full extent, while a low pressure allows it to rise higher than normal. Wind direction may also affect the height of tide. A strong onshore wind will tend to push more water onshore, causing a higher tide than predicted. An offshore wind will result in a lower tide. Consequently, the tidal heights do not always correspond exactly with the published predictions.

Coastal flooding caused by the onshore wind and low atmospheric pressure in a storm is known as a STORM SURGE. Slow moving storms of large diameter create higher storm surges. A storm surge may raise the sea level by over a metre. (See also Storm Tide in Chapter 20)

DEPTHS PRINTED ON CHARTS & CLEARANCE UNDER BRIDGES

See Chapter 17.2

CALCULATING HEIGHT OF TIDE BY RULE OF TWELFTHS

Tides change approximately every six hours in most places in the world. The heights of High Water and Low Water are published in tide tables and newspapers, and broadcast on radio and television. There are numerous methods of calculating the height of tide at any time between a HW and a LW.

One reasonably accurate method is the rule of twelfths. It is based on the assumption that tides rise and fall with simple harmonic motion. That is, between one Slack Water (the time of change of tide at HW or LW) and the next, the tide starts rising or falling slowly, runs strongly in the middle of the period and then slows down when approaching the next slack water.

The rule assumes that the tide rises or falls each hour approximately in the proportions of 1 - 2 - 3 - 3 - 2 - 1. The sum of these numbers is 12. In other words, the hourly rise or fall of tide is as follows:

In the	1st hour	= 1/12th of the tide range
	2nd hour	= 2/12ths
	3rd hour	= 3/12ths
	4th hour	= 3/12ths
	5th hour	= 2/12ths
	6th hour	= 1/12ths

EXERCISE 27

At a certain port on a certain day, HW is 1.8 m at 0600 hours and LW is 0.6 m at 1200 hours. Find the height of tide for every hour between HW and LW by the rule of twelfths

SOLUTION

HW at 0600 hours	= 1.8 m
LW at 1200 hours	= 0.6 m

Range	= 1.2 m

1/12th of 1.2 m = 0.1 m;	thus	height of tide	at 0700 hours	= 1.7 m
2/12ths of 1.2 m = 0.2 m;	thus	height of tide	at 0800 hours	= 1.5 m
3/12ths = 0.3;		height of tide	at 0900 hours	= 1.2 m
3/12ths again ...			at 1000 hours	= 0.9 m
2/12ths			at 1100 hours	= 0.7 m
1/12ths			at 1200 hours	= 0.6 m

CALCULATING HEIGHT OF TIDE BY FORM AH 130 (THE L-SHAPED GRAPH)

Instead of the Rule of Twelfths, the following graph, supplied in the Australian Tide Tables (published by the Australian Hydrographic Office) can be used as shown. It is obviously a more accurate method, does not involve calculations and can be retained as a record or for subsequent reuse.

EXERCISE 28

The tides at Cooktown this afternoon are as follows. Find the height of tide at 1800 hours by use of Form AH 130.

LW	1425 hrs	0.8 m
HW	1930 hrs	1.9 m

STEPS TO PLOTTING ON FORM AH 130 (Instructions for use printed on the form)

1. Mark the time of LW and HW on the time scale (Note: each division is 20 minutes)
2. Mark the height of LW & HW on the (There are two height scales. Use the larger one whenever possible)
3. Join the two marks on the time scale with a line
4. Join the two marks on the height scale with a line
5. On the time scale, project a vertical line (up or down) from 1800 hours, to intersect the time line that you have drawn.
6. From the above point of intersection, project lines to the tide curve, height line and the height scale, as shown. **The required height of tide shows up as 1.65 metres.** *(Warning: When reading the height of tide, be careful to read the right scale. There are two scales on the height section of the graph.)*

   The above example applies equally in reverse. In other words, to find out the time when the height of tide would be 1.65 metres, reverse the order in which the lines with the arrows are drawn.

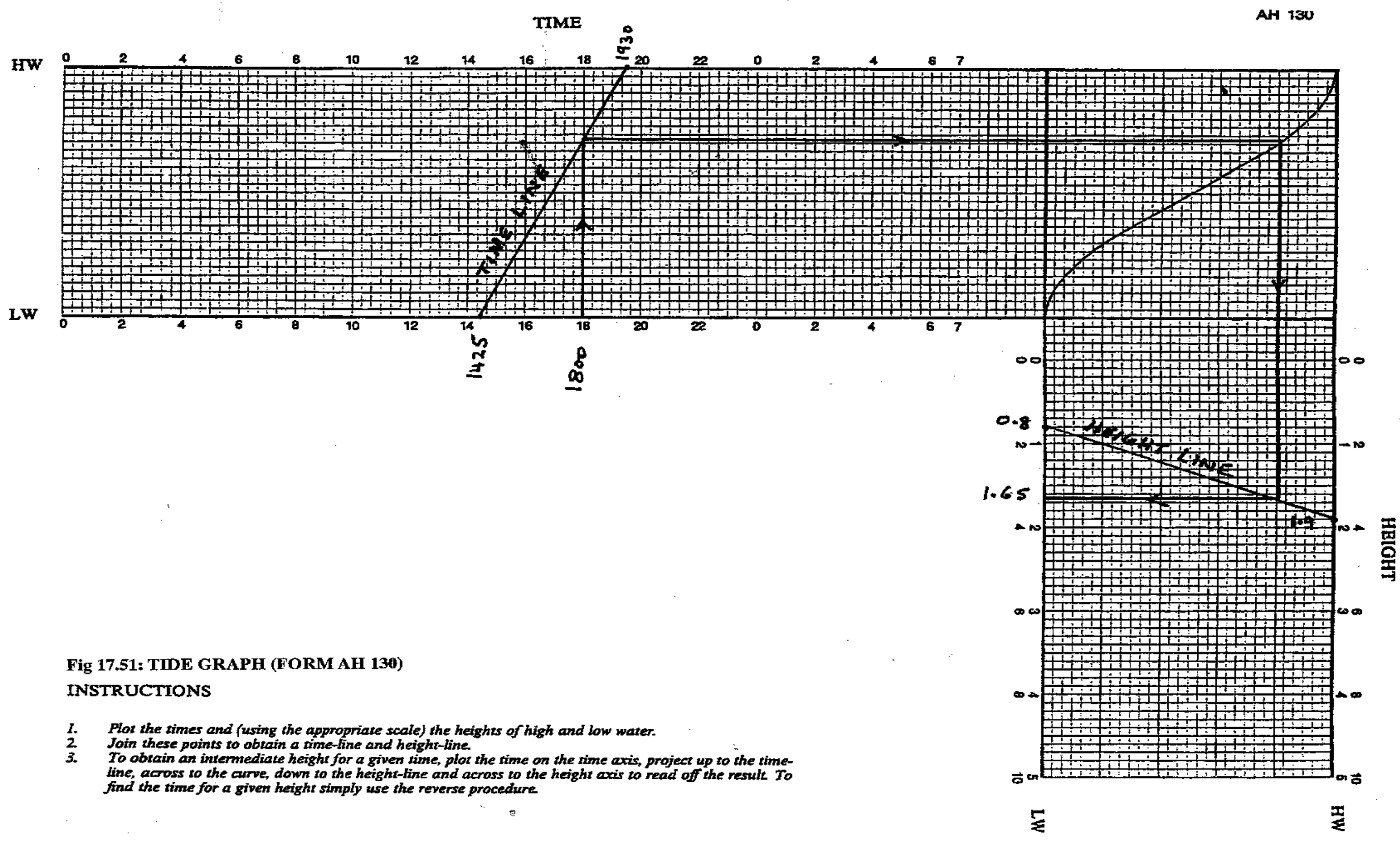


Fig 17.51: TIDE GRAPH (FORM AH 130)

INSTRUCTIONS

1. *Plot the times and (using the appropriate scale) the heights of high and low water.*
2. *Join these points to obtain a time-line and height-line.*
3. *To obtain an intermediate height for a given time, plot the time on the time axis, project up to the time-line, across to the curve, down to the height-line and across to the height axis to read off the result. To find the time for a given height simply use the reverse procedure.*

UND
ER

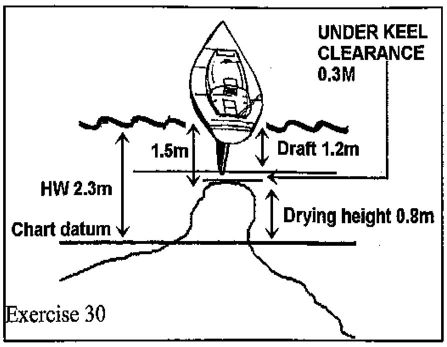
KEEL CLEARANCE

EXERCISE 29
The charted depth at the entrance to a port is 1.0 m. The tides for the day are as follows: HW 2.2m. LW 0.6m. What will be the under keel clearance for a yacht, drawing 1.5 metres at low water?

SOLUTION:
Depth of water = charted sounding + tidal level.
Here, the depth at LW = 1.0 + 0.6 = 1.6m
Therefore, under keel clearance = 1.6 – 1.5 = 0.1m.

EXERCISE 30
Today's tides at a location are as follows: HW 2.3m LW 0.7m. A vessel, with a draft of 1.2m, wishes to sail over a drying height of 0.8m at HW. What will be her under keel clearance?

SOLUTION:
The drying height of 0.8m means the outcrop is exposed 0.8m at zero tide. In other words, it is a negative sounding.
At HW, the sounding over the drying height = 2.3 – 0.8 = 1.5m.
Therefore, under keel clearance = 1.5 – 1.2 = 0.3m.



Exercise 30

AUSTRALIAN NATIONAL TIDE TABLES (ANTT)

In the Australian national Tide Tables, published annually by the Hydrographer, the Australian waterways are divided into Standard and Secondary ports. The Standard ports are individually tabulated with their own daily calendar of the times and heights of high and low waters. The secondary ports, on the other hand, are grouped around a nearest standard port with similar tidal characteristics. The time difference for the high and low waters for the secondary ports are shown in relation to that standard port.

Two high waters (HW) and two low waters (LW) occur in most parts of the world each day. This sequence is known as SEMI-DIURNAL TIDES.

There are exceptions due to geographical, topographical and atmospheric peculiarities, which result in there being only one tidal cycle per day. This sequence is known as DIURNAL TIDES.

A third common category is known as MIXED TIDES. Their cycles are a combination of the other two. They usually consist of two unequal high waters and two unequal low waters each day. However, the classification in the Australian Tide Tables is limited to <u>Predominantly Diurnal</u> and <u>Predominantly Semi-diurnal</u>.

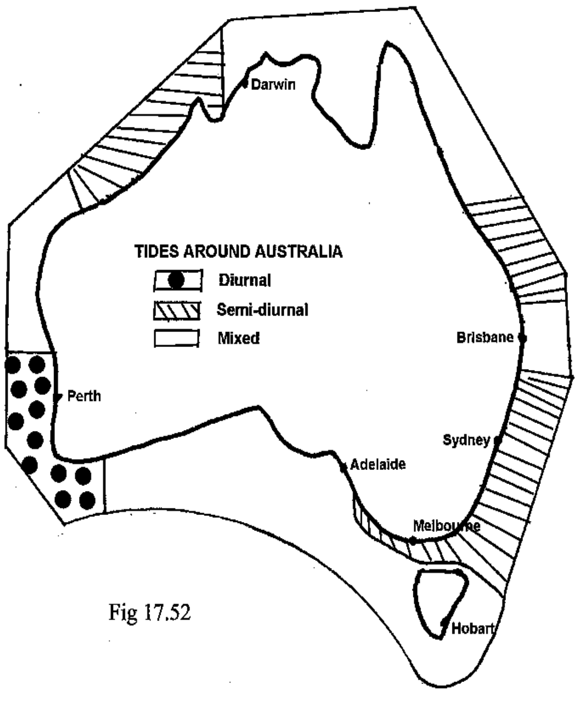


Fig 17.52

An extract of

PREDOMINANTLY SEMI-DIURNAL STANDARD PORT OF SYDNEY

Time difference from UTC (Greenwich Time in UK) You may ignore it.

The exact position of tide

Local Standard Time (add daylight saving where applicable)

AUSTRALIA, EAST COAST - SYDNEY (FORT DENISON)

LAT 33°51′ S LONG 151°14′ E

TIME ZONE -1000

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

YEAR XXXX

JANUARY

	Time	m		Time	m
1 WE	0538 1228 1813 2340	1.6 0.5 1.2 0.5	16 TH	0436 1128 1715 2258	1.6 0.5 1.2 0.5
2 TH	0625 1314 1900	1.6 0.4 1.2	17 FR	0536 1228 1820 2357	1.7 0.4 1.2 0.4
3 FR	0024 0707 1353 1941	0.5 1.7 0.4 1.2	18 SA	0633 1321 1916	1.8 0.2 1.3

FEBRUARY

	Time	m		Time	m
1 SA	0009 0649 1334 1924	0.6 1.6 0.4 1.2	16 SU	0618 1303 1902	1.8 0.2 1.4
2 SU	0051 0728 1408 1959	0.5 1.7 0.4 1.3	17 MO	0042 0713 1351 1951	0.3 1.9 0.1 1.6
3 MO	0130 0803 1439 2032	0.5 1.7 0.3 1.3	18 TU ○	0138 0803 1436 2039	0.2 2.0 0.1 1.6

MARCH

	Time	m		Time	m
1 SU	0622 1302 1858	1.6 0.4 1.3	16 MO	0600 1237 1843	1.8 0.2 1.6
2 MO	0035 0700 1334 1931	0.5 1.6 0.4 1.4	17 TU	0032 0654 1323 1930	0.3 1.8 0.2 1.8
3 TU	0114 0736 1404 2003	0.5 1.6 0.4 1.4	18 WE	0127 0745 1405 2016	0.2 1.8 0.2 1.7

APRIL

	Time	m		Time	m
1 WE	0052 0700 1319 1929	0.5 1.5 0.4 1.5	16 TH	0118 0724 1330 1951	0.3 1.6 0.3 1.8
2 TH	0130 0737 1348 2000	0.4 1.5 0.4 1.6	17 FR ○	0210 0813 1409 2033	0.3 1.6 0.3 1.8
3 FR ●	0209 0813 1418 2033	0.4 1.5 0.4 1.7	18 SA	0259 0900 1447 2115	0.3 1.5 0.4 1.8

Full Moon

New Moon

Port Number → 60370

Fig 17.53

Some of the

PREDOMINANTLY SEMI-DIURNAL SECONDARY PORTS GROUPED AROUND SYDNEY

Note the difference in these headings from the predominantly diurnal group of ports below. (It is relevant only when selecting the right conversion form below)

PORT No.	PORT NAME	TIME DIFFERENCES MHW	MLW	TIDAL LEVELS (in metres, related to LAT) MHWS	MHWN	MSL	MLWN	MLWS
		(Zone -1000)						
60370	SYDNEY	(standard port)		1.5	1.3	0.9	0.5	0.3
60320	GOSFORD			0.8	0.5	0.4	0.3	-0.1
60325	ETTALONG			0.9	0.8	0.5	0.2	0.1
60330	LITTLE PATONGA			1.6	1.3	0.9	0.5	0.3
60340	PITTWATER	+0016	+0015	1.6	1.3	0.9	0.4	0.2
60360	CAMP COVE	-0003	-0003	1.6	1.3	0.9	0.5	0.3
60390	BOTANY BAY	+0022	+0023	1.5	1.3	0.9	0.5	0.3

HW & LW time difference from Sydney in hrs & min, e.g., Botany Bay HW occurs 22 min & LW 23 min after Sydney (Blank spaces indicate time not calculated owing to insufficent observations)

LAT = Lowest Astronomical Tide
MHSW = Mean HW Spring
MHWN = Mean HW Neap
MSL = Mean Sea Level
MLWN = Mean LW Neap
MHW = Mean HW
MLW = Mean LW
MLWS = Mean LW Spring

Fig 17.54

AUSTRALIA, TASMANIA (SOUTH-EAST COAST) - HOBART

LAT 42°53′ S LONG 147°20′ E (PREDOMINANTLY <u>DIURNAL</u>)

TIME ZONE -1000 TIMES AND HEIGHTS OF HIGH AND LOW WATERS YEAR xxxx

JANUARY

	Time	m		Time	m
1 WE	0447	1.8	16 TH	0345	1.8
	1247	0.8		1133	0.7
	1914	1.3		1802	1.3
	2205	1.3		2130	1.2
2 TH	0523	1.8	17 FR	0431	1.9
	1331	0.8		1226	0.6
	2006	1.3		1900	1.3
	2227	1.3		2220	1.2
3 FR	0559	1.8	18 SA	0520	1.9
	1412	0.8		1321	0.6
	2056	1.3		1953	1.3
	2258	1.3		2316	1.2

FEBRUARY

	Time	m		Time	m
1 SA	0534	1.7	16 SU	0515	1.9
	1331	0.8		1251	0.6
	2001	1.3		1917	1.4
	2301	1.3		2322	1.1
2 SU	0615	1.7	17 MO	0617	1.9
	1409	0.8		1345	0.6
	2040	1.3		2003	1.4
	2341	1.2			
3 MO	0654	1.7	18 TU ○	0036	1.1
	1445	0.8		0716	1.8
	2120	1.3		1437	0.6
				2053	1.4

MARCH

	Time	m		Time	m
1 SU	0510	1.7	16 MO	0509	1.8
	1237	0.9		1215	0.7
	1911	1.4		1841	1.5
	2311	1.2		2345	1.0
2 MO	0552	1.6	17 TU	0612	1.7
	1312	0.9		1304	0.7
	1940	1.4		1923	1.5
	2353	1.2			
3 TU	0033	1.6	18 WE	0100	1.0
	1346	0.9		0716	1.7
	2009	1.4		1353	0.8
				2008	1.6

APRIL

	Time	m		Time	m
1 WE	0012	1.1	16 TH	0120	[illegible]
	0614	1.5		0723	[illegible]
	1230	1.0		1259	[illegible]
	1907	1.5		1927	[illegible]
2 TH	0105	1.1	17 FR ○	0231	[illegible]
	0703	1.4		0840	[illegible]
	1254	1.0		1340	[illegible]
	1934	1.6		2010	[illegible]
3 FR ●	0204	1.0	18 SA	0338	[illegible]
	0802	1.4		1000	[illegible]
	1317	1.1		1424	[illegible]
	2004	1.5		2055	[illegible]

NOTE: THE DIFFERENCE BETWEEN THE PREDOMINANTLY DIURNAL & SEMI-DIURNAL PORTS IS <u>NOT EVIDENT TO LAYPERSONS</u>

Fig 17.55: EXTRACT FROM ANTT PART I – PREDICTIONS FOR STANDARD PORTS

Some of the
<u>PREDOMINANTLY DIURNAL</u>
SECONDARY PORTS GROUPED AROUND HOBART

Note the difference in terminology from the table above (It helps in selecting the correct form below)

PORT No.	PORT NAME	TIME DIFFERENCES MHW	MLW	TIDAL LEVELS (in metres, related to LAT) MHHW	MLHW	MSL	MHLW	MLLW
		(Zone -1000)						
61220	HOBART	(standard port)		1.5	1.0	0.8	0.7	0.2
61110	SWAN I.	+0043	+0043	1.4	1.3	0.8	0.3	0.2
61120	EDDYSTONE POINT	-0009	+0005	1.3	0.8	0.6	0.5	-0.0
61170	SPRING BAY	-0011	+0005	1.3	0.8	0.7	0.7	0.2

MHLW = Mean Higher LW MHHW = Mean Higher HW
MLLW = Mean Lower LW MLHW = Mean Lower HW

Fig 17.56: EXTRACT FROM ANTT PART II – SECONDARY PORTS TIME DIFFERENCES & TIDE LEVELS

In order to deduce the times and heights of tides at a secondary port, one of the following forms is used. One form is for semi-diurnal and the other for diurnal ports. <u>Matching the terminology on the form with that of the secondary port identifies the correct form</u>.

The procedure for making entries in the two forms is identical. Only some of the terminology is different. The boxes or entries in both forms are similarly numbered or <u>itemised</u>.

TABLE FOR FINDING TIMES & HEIGHTS OF TIDES AT PREDOMINANTLY SEMI-DIURNAL SECONDARY PORTS

Choice of wrong table is not possible because these values are available only for semi-diurnal ports

	1) Time		2) Height		3) MSL	4) Levels		5)Levels Range
Standard Port Data	HW	LW	HW	LW		MHWS	MLWS	MHWS-MLWS
	Extract these values from the "standard port" page				Extract these values from the "secondary port" page			"minus"
6) -LAT correction "minus"								
7) Predicted Height adjusted to LAT			HW - LAT	LW - LAT				
8) Predicted Height-MSL (7-3) ← item 7 - item 3								
Secondary Port Data	9) Time diff HW	LW			10) MSL	11) Levels MHWS	MLWS	12)Levels Range MHWS-MLWS
	See "secondary port" page				See "secondary port" page			"minus"
14) Calculations (8*13) item 8 x item 13								13)Range Ratio (12÷5)
Secondary Port results	15) Time (1+9)		16) Height (10+14)					

Extract LAT Correction from the "Table of Tide Levels" below (remember to add if subtracting a minus value)

item 12 divided by item 5

Fig 17.57

TABLE FOR FINDING TIMES & HEIGHTS OF TIDES AT PREDOMINANTLY DIURNAL SECONDARY PORTS

Different terminology from the above form

	1) Time		2) Height		3) MSL	4) Levels		5)Levels Range
Standard Port Data	HW	LW	HW	LW		MHHW	MLLW	MHHW-MLLW
6) -LAT correction								
7) Predicted Height adjusted to LAT								
8) Predicted Height-MSL (7-3)								
Secondary Port Data	9) Time diff HW	LW			10) MSL	11) Levels MHHW	MLLW	12)Levels Range MHHW-MLLW
14) Calculations (8*13)								13)Range Ratio (12÷5)
Secondary Port results	15) Time (1+9)		16) Height (10+14)					

Fig 17.58

EXERCISE 29

Find the times and heights of high water and low water at Pittwater (60340) on Sunday, 1 March, year xxxx.

	1) Time HW	LW	2) Height HW	LW	3) MSL	4) Levels MHWS	MLWS	5)Levels Range MHWS-MLWS
Standard Port Data (SYDNEY) 16 March	0622 1858	1302	1.6 1.3	0.4	0.9	1.5	0.3	1.2
6) -LAT correction			0.0					
7) Predicted Height adjusted to LAT			1.6 1.3	0.4				
8) Predicted Height-MSL (7-3)			0.7 0.4	-0.5				
Secondary Port Data (PITT-WATER)	9) Time diff HW	LW			10) MSL	11) Levels MHWS	MLWS	12)Levels Range MHWS-MLWS
	+16m	+15m			0.9	1.6	0.2	1.4
14) Calculations (8*13)			0.82 0.47	-0.58				13)Range Ratio (12÷5)
								1.17
Secondary Port results	15) Time (1+9)		16) Height (10+14)					
	0638 1914	1317	1.72 1.37	0.32				

EXERCISE 29

The semi-diurnal form is used as its terminology matches with that of the Pittwater page.

Hence, Tides at Pittwater:
HW at 0638 = 1.72m
LW at 1317 = 0.32m
HW at 1914 = 1.37m
(Add 1 hour if daylight saving applicable)
(There are only 3 tides on this day)

Fig 17.59

The following table, which is included in the Tide Tables, is required only for the LAT values. All other entries in the above form are extracted from either the Standard Port or the Secondary Port page.

TABLE I- TIDAL LEVELS AT STANDARD PORTS
(A sample)
PART 1: PREDOMINANTLY DIURNAL TIDES

PORT	HAT	MHHW	MLHW	MSL	MHLW	MLLW	LAT
Hobart	2.1	1.9	1.4	1.3	1.2	0.7	0.5
Honiara	1.0	0.8	0.7	0.4	0.1	0.0	-0.2
Ince Point	3.7	2.9	2.2	1.8	1.3	0.6	0.0
Karumba	4.2	3.2	2.8	1.5	0.3	-0.1	-0.5

TABLE I - TIDAL LEVELS AT STANDARD PORTS
(A sample)
PART 2: PREDOMINANTLY SEMI-DIURNAL TIDES

PORT	HAT	MHWS	MHWN	MSL	MLWN	MLWS	LAT
Sydney	2.1	1.6	1.3	1.0	0.6	0.3	0.0
Thevenard I.	2.8	2.4	1.8	1.5	1.2	0.6	0.0
Townsville	3.8	2.8	1.9	1.6	1.3	0.5	-0.2
Westernport	3.3	2.9	2.4	1.7	1.0	0.6	0.0

Fig 17.60 & 17.61: EXTRACT FROM ANTT SUPPLEMENTARY TABLES – TABLE I

TIDAL STREAMS

The direction and strength of tidal streams is included in Tide Tables where necessary. Vessels in Torres Strait, for example, may be set by tidal streams of up to 8 knots. The following is an extract of the tidal streams information contained in the Australian National Tide Tables.

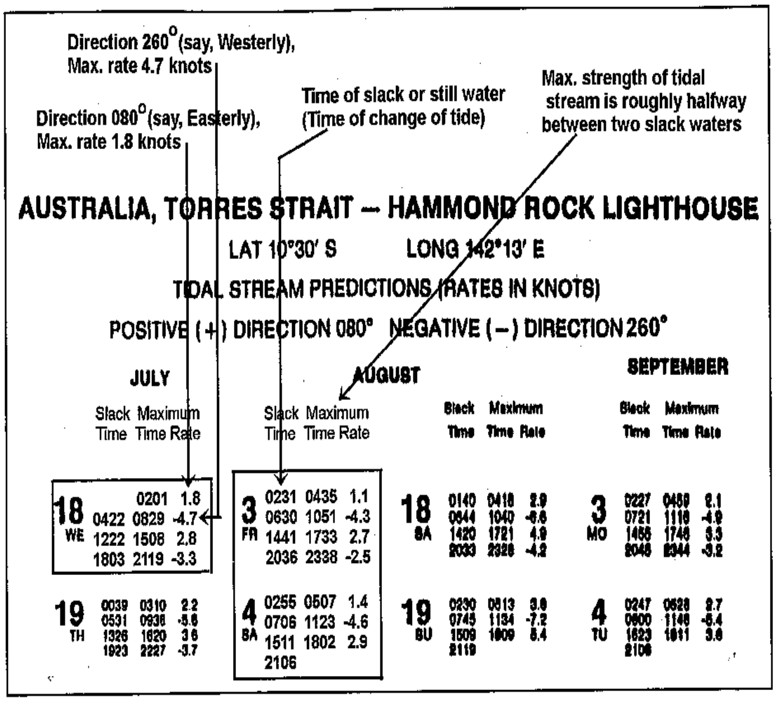


Fig 17.62

TORRES STRAIT

From the tidal point of view, Tones Strait is probably the most complex area in Australia. Its narrow and shallow channels connect two oceans with different mean sea levels caused by the general oceanic circulation patterns. This difference introduces a westward equalising current. In addition, tidal regimes on both sides of the Strait are completely different - diurnal tides to the west, and semi-diurnal to the east.

The contrast in regimes is caused by the difference of semi-diurnal components of tide at either entrance, diurnal part being generally uniform in the area. At some phases of the moon it can be high water at one entrance when it is low water at the other. In consequence, marked differences between the levels at the entrances occur resulting in strong tidal streams. While the tides may have a large diurnal component (especially at the western entrance), the tidal streams are **predominantly semi-diurnal.**

Throughout the Prince of Wales Channel and its approaches, from Twin Island in the east to a few miles west of Goods Island, the streams flow at the times predicted for Hammond Rock (see extract). The rates diminish as the channel becomes less restricted and at its western entrance are only about 30% of those predicted at Hammond Rock. At Booby Island the rates are comparatively weak and the streams are of different character.

In the vicinity of Hervey Rock and Saddle Island the streams commence and reach their maximum rates about 30 minutes earlier than Hammond Rock, but in these more open waters the rates are comparatively weak. In Endeavour Strait the streams commence and reach their maximum rates about 40 minutes later than at Hammond Rock and, except for the more restricted parts of the strait, their rates do not exceed 30% of those at Hammond Rock.

It has to be remembered however, that tidal stream predictions for Hammond Rock do not include any non-tidal flows, like the equalising current mentioned above or currents caused by meteorological influences. In addition, the El Nino Southern Ocean Oscillation can cause a drop of sea level of about 0.5m on the eastern side of the Strait in a very short time. The resultant changes to the water levels in the Strait, and to the current and stream direction and rates are impossible to predict.

SYDNEY & BROOME

(Tidal streams for these ports are shown in a graphical form, and the rates are empirical rather than predicted.)

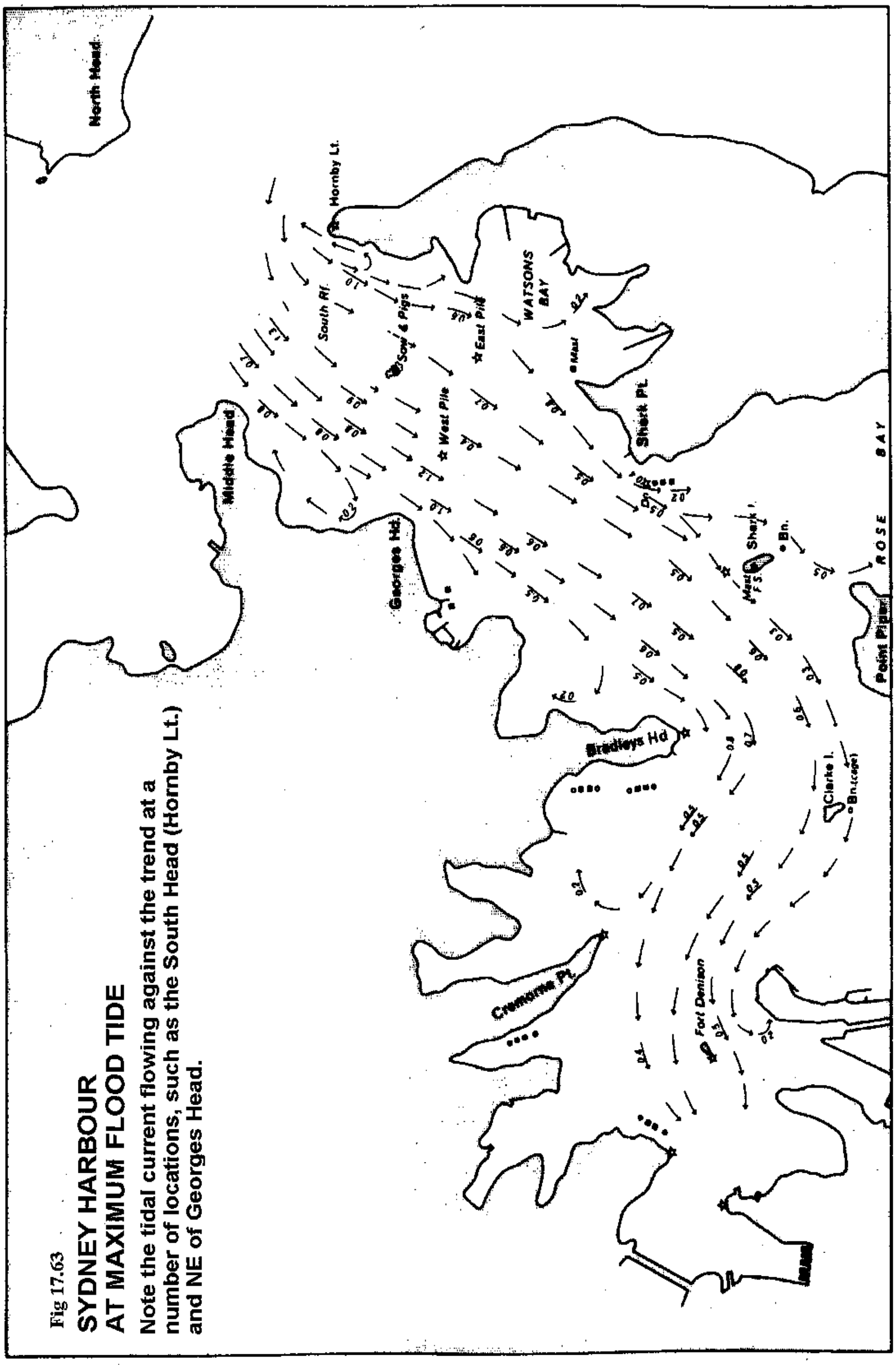


Fig 17.63

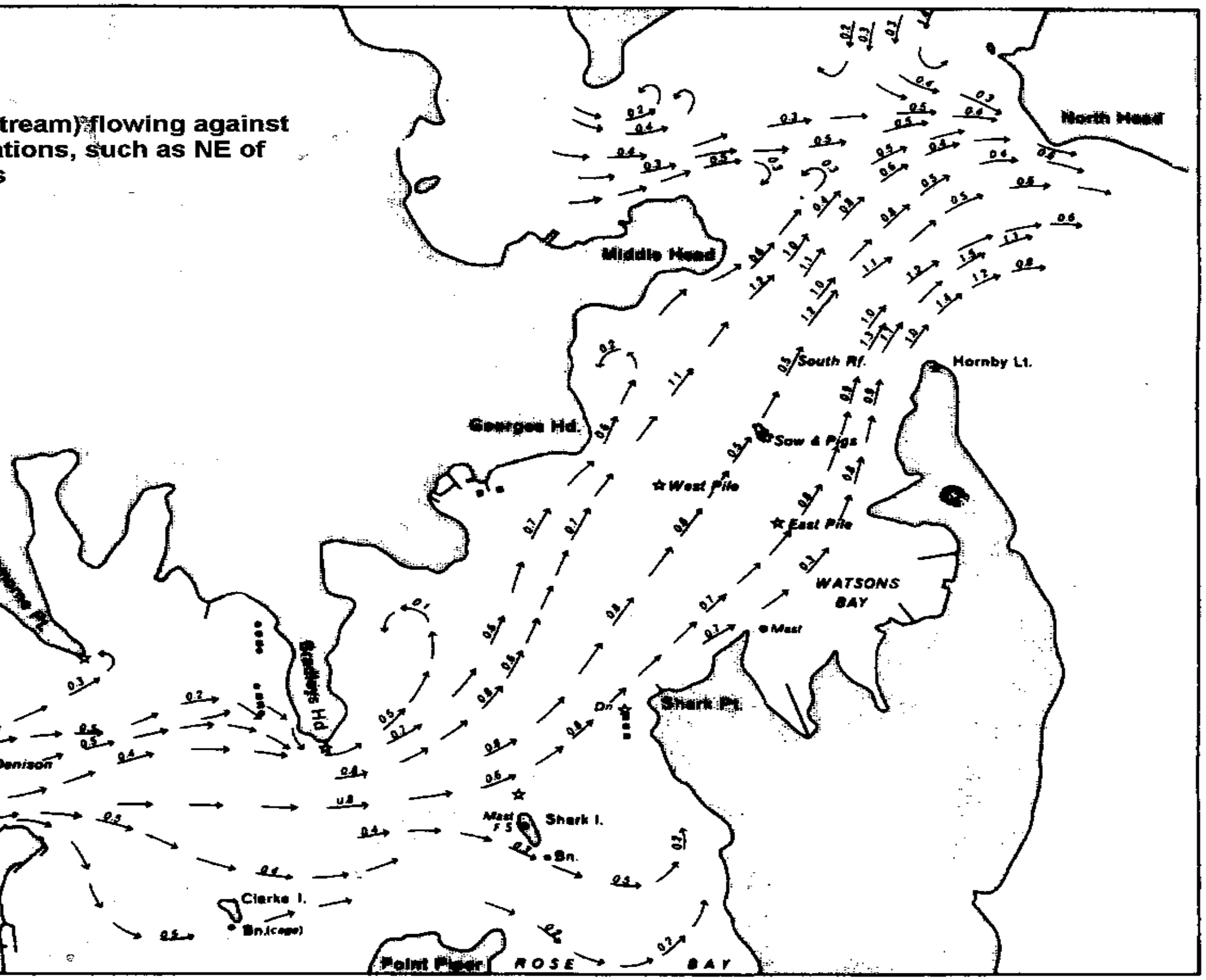
SYDNEY HARBOUR AT MAXIMUM FLOOD TIDE

Note the tidal current flowing against the trend at a number of locations, such as the South Head (Hornby Lt.) and NE of Georges Head.

Fig 17.64

SYDNEY HARBOUR
AT MAXIMUM EBB TIDE

Note the tidal current (tidal stream) flowing against the trend at a number of locations, such as NE of Bradleys and Georges Heads



AUSTRALIA—NORTH WEST COAST—BROOME.

Lat. 18°00′ S. Long. 122°13′ E.

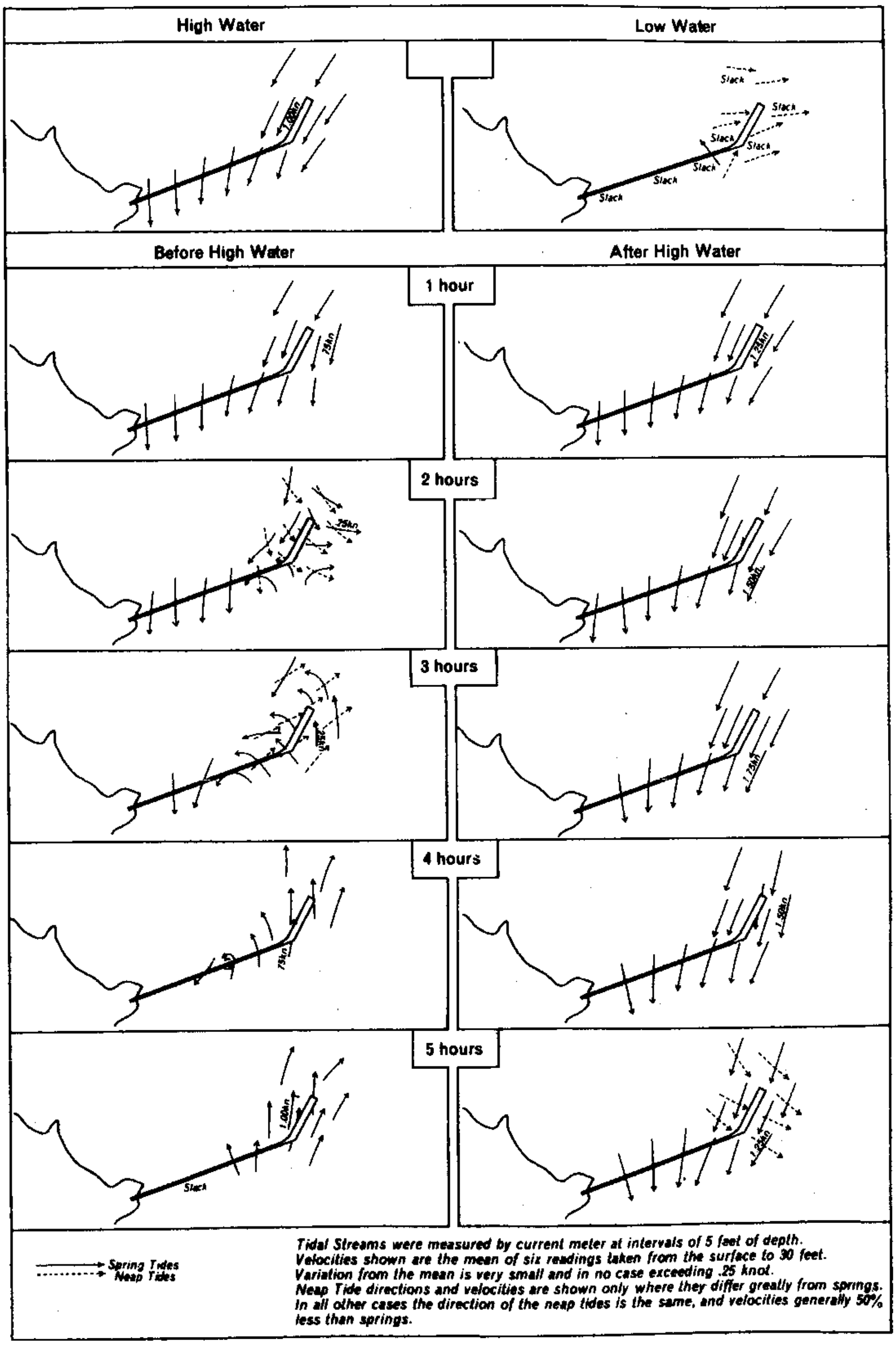


Fig 17.65

OCEAN CURRENTS

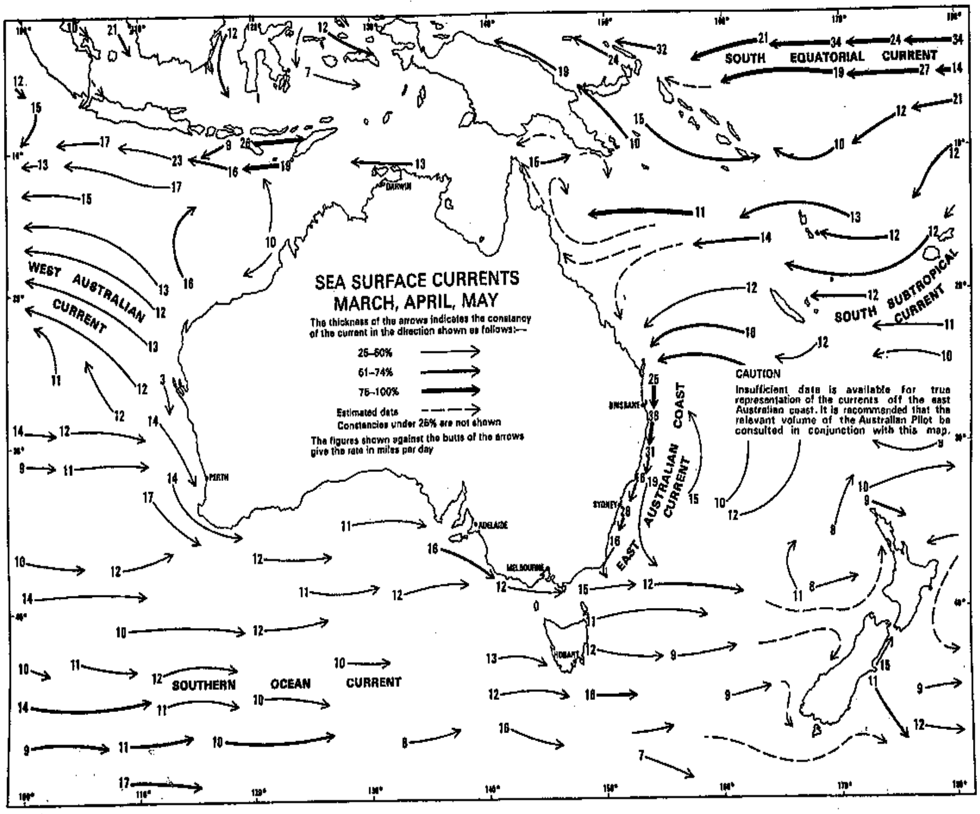


Fig 17.66
SEA SURFACE CURRENTS IN AUSTRALIAN WATERS
(March April May)

Ocean currents should not be confused with tidal streams. They are large-scale movements of water in oceans, resulting from a combination of the rotation of the earth, wind, geography of landmasses and differing water salinities and temperatures. The direction and strength of ocean currents are seasonal in nature.

Islands and reefs usually distort and accelerate the flow of currents in their surroundings, occasionally forming eddies on the lee side setting back towards the obstruction.

OCEANS IN SOUTHERN HEMISPHERE: SE trade winds near the equator and strong persistent westerlies in the 'roaring forties' (discussed in Chapter 20) create an anti-clockwise water circulation (or *gyre*). This results in relatively strong S'ly currents on the western boundaries (east coast) and weaker N'ly currents on the eastern boundaries (west coast) of oceans in the southern hemisphere.

AUSTRALIA: In the southern Indian Ocean, westerly 'roaring forties' bring water to the southwest of Australia, where it splits: one branch flowing N in a current known as the *West Australian Current*, while the other continues east across the Australian Bight and down the west coast of Tasmania where it is known the *Zeehan Current*. In winter, it rounds southern Tasmania and moves up the E coast towards the Freycinet Peninsula, where it joins the remaining influence of the East Australian Current and diverts into the Tasman Sea. In summer, the Zeehan and the East Australian Currents converge off southern Tasmania and move into the Southern Ocean.

The West Australian Current brings relatively cool waters to the Western Australian coast, contributing to the formation of fog and low stratus clouds over the region.

...continued next page

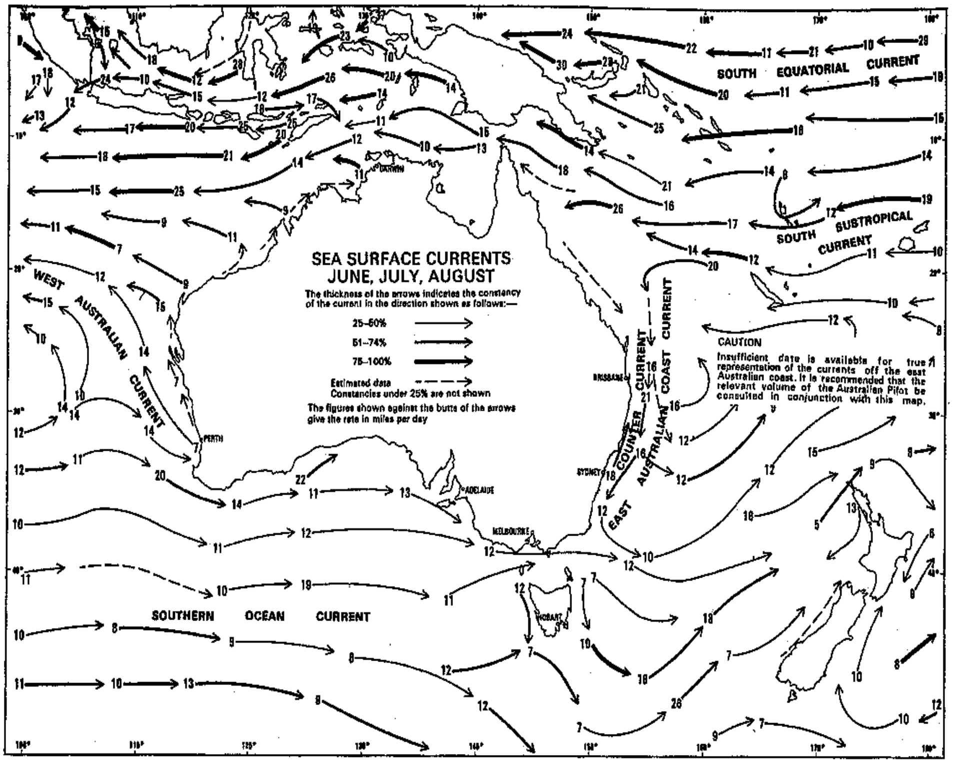


Fig 17.67
SEA SURFACE CURRENTS IN AUSTRALIAN WATERS
(June July August)

...continued from previous page

Unlike other regions, waters off WA also experience a warm southward flow of water from the tropics. Known as the *Leeuwin Current*, it is stronger in winter when the opposing southerly winds are weaker. It can reach speeds of 3 knots, but 1 to 2 knots is more typical. It raises the water temperature by some 4° along the western continental shelf and flows eastwards in the Great Australian Bight. Being meandering in nature (forming large loops) its influence extends up to 200 miles offshore.

Leeuwin Current is driven by the north-south sea level gradient along the WA coast, which is influenced by the El Nino/Southern Oscillation (ENSO) discussed in Chapter 20. The ENSO affects the flow of warm equatorial water from the Pacific Ocean through the Indonesian islands into the NE Indian Ocean, thus influencing the strength of the Leeuwin Current.

Closer along the WA coast (inshore of Leeuwin Current), currents tend to be more influenced by winds, and so change direction seasonally. During summer months, winds blowing predominantly from the south cause north-setting currents. During winter months the south-setting Leeuwin current causes coastal currents to flow south.

Onshore/offshore currents (eddies) associated with the larger current meanders can also reach 2 knots. One of these is the *Capes Current*, which flows northwards during summer months from Cape Leeuwin past Cape Naturaliste and on beyond Rottnest island.

On the E coast, the *East Australian Current* commences at around 20°S (1°S of Townsville's latitude) in summer and 22°S (1°S of Mackay's latitude) in winter. It runs S as a narrow stream varying between 20 to 60 miles in width with its strongest flow along the 100 fathom (200 metre) contour. While its eastern boundary is ill-defined, its western boundary is fairly consistent especially in the latitude range of about 3° either side of Brisbane (27½°S). On its E flank the current turns gradually eastward at about 30°S in winter and around 35°S in summer. However, the western flank lies close inshore and flows S throughout the year all the way down the mainland, occasionally forming or encountering eddies in bays along the way.

The average rate of the East Australian Current varies with latitude and season. At latitude 29°S, the rate is usually between 1½ and 2 knots in summer and 1½ knots in winter.

...continued next page

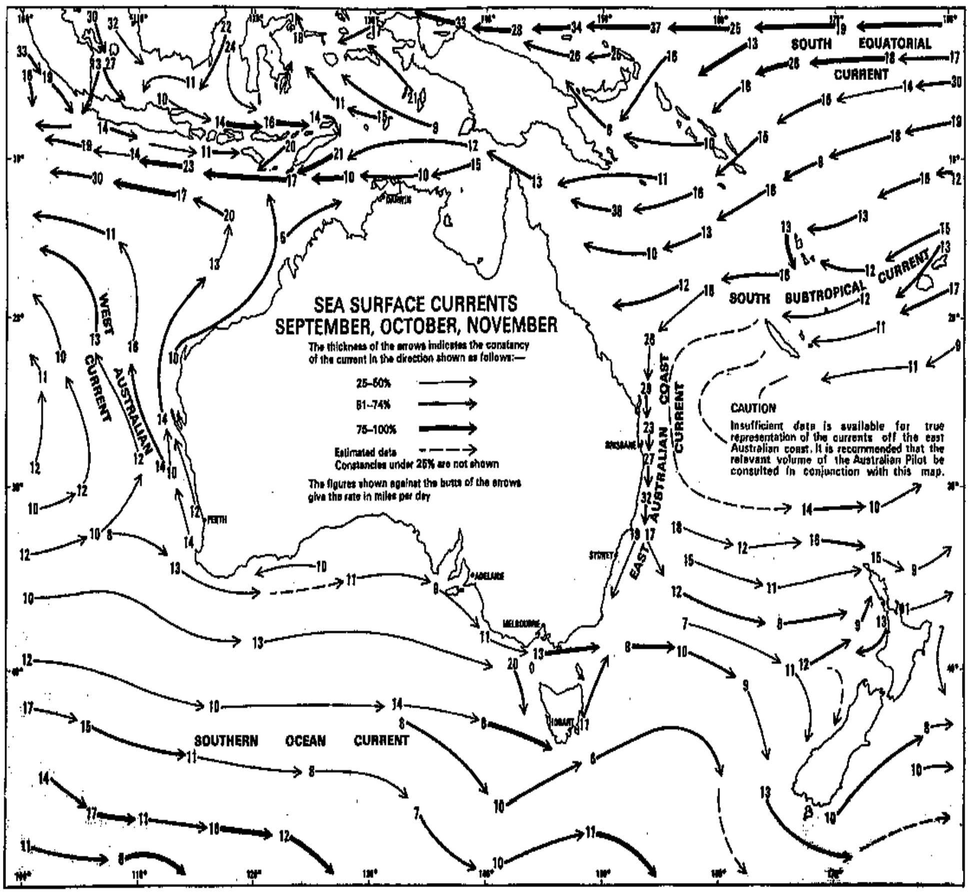


Fig 17.68
SEA SURFACE CURRENTS IN AUSTRALIAN WATERS
(September October November)

...continued from previous page

Currents east of the Great Barrier Reef are generally of low consistency and variable in direction, flowing at around ½ knots between December and February and around 1 knot at other times. However, an exceptional 4½ knot SSE has been was reported in the vicinity of Grafton Passage.

In the Torres Strait the current generally conforms to the predominant wind direction. From December to March (NW monsoon) the current sets between E and SE at about ½ knots. From April to November the set is Westerly and a little stronger.

In the Gulf of Papua, the non-tidal component of the flow of water follows the curvature of the coast, setting E during the NW monsoon at about 1 knot. Between May and November, it sets W at about 2 knots

Inside the Great Barrier Reef the direction of the flow is determined mainly by the NW monsoon or the Trade Wind. North of 21°S the set is largely SE in summer (NW monsoon), becoming variable in the transitional months of March and November, and then NW during the winter (SE Trade Winds). South of 21°S the current generally flows in the opposite direction to the prevailing wind. The average rate of set is less than 1 knot. However, a persistent E wind may cause a considerable amount of water to enter the area, which may raise the water level as well as alter the direction and the speed of the flow.

NOTE: The only way to establish with certainty the effect of currents (and tides) on a vessel is by regular position fixing and tracking.

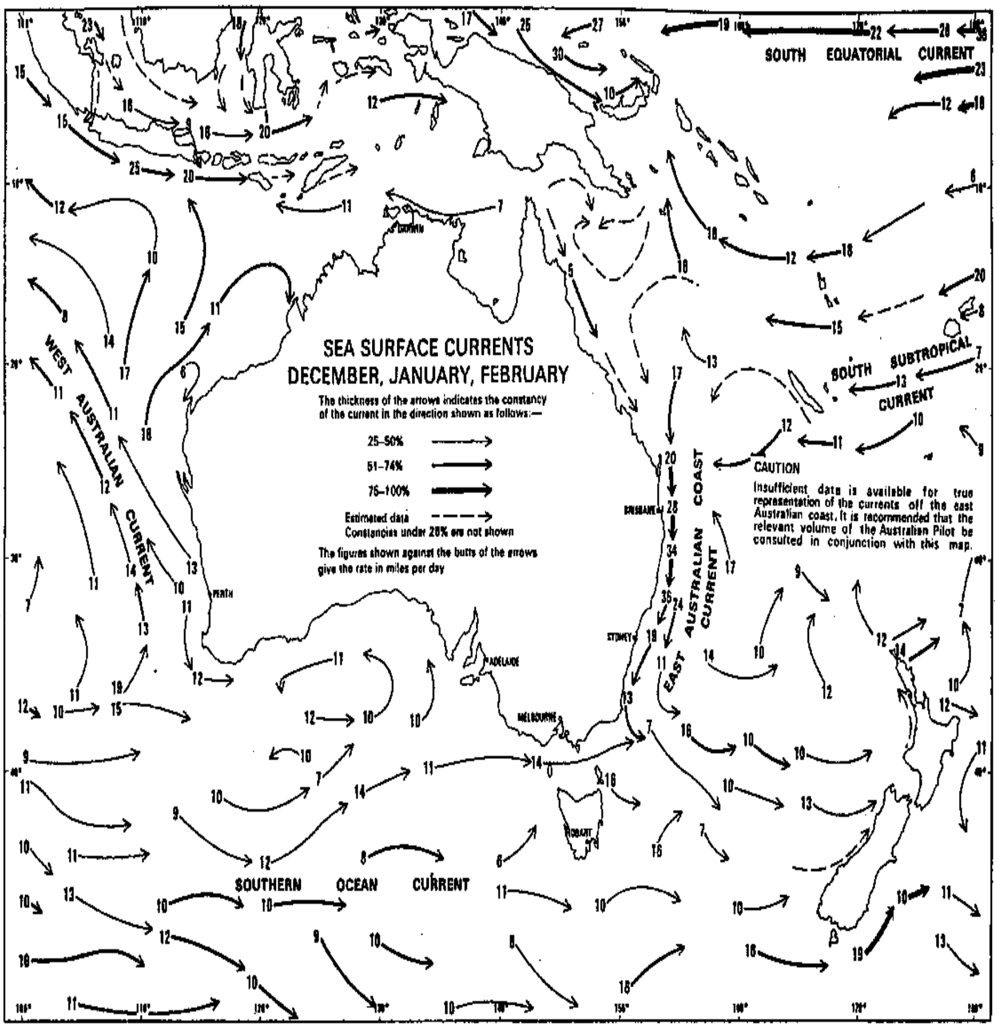


Fig 17.69
SEA SURFACE CURRENTS IN AUSTRALIAN WATERS
(December January February)

TIDE TABLES EXTRACT

(The following tables and forms are required for answering questions on tide calculations at the end of this chapter)

TABLE 1 - TIDAL LEVELS AT STANDARD PORTS

(AUTHOR'S NOTE: This table is required only for extracting "LAT" values)

PART 1: PREDOMINANTLY DIURNAL TIDES

PORT	HAT	MHHW	MLHW	MSL	MHLW	MLLW	LAT
Albany	1.4	1.1	0.8	0.8	0.7	0.5	0.1
Alotau	1.3	1.1	✪	0.7	✪	0.3	0.0
Anewa Bay	1.8	1.5	✪	0.8	✪	0.2	-0.1
Booby Island	4.4	4.4	2.9	2.5	2.1	0.6	0.0
Bunbury	1.3	0.9	0.7	0.7	0.7	0.4	0.1
Cairns	3.3	2.5	1.6	1.5	1.4	0.5	-0.2
Carnarvon	1.8	1.4	1.1	0.9	0.7	0.4	-0.1
Cocos Island	1.4	1.2	0.8	0.8	0.7	0.3	0.3
Denham	1.6	1.3	1.0	0.9	0.8	0.5	0.1
Dreger Harbour	1.9	1.4	✪	1.2	✪	1.0	0.4
Eden	1.9	1.6	1.0	0.8	0.6	0.1	-0.2
Esperance	1.5	1.1	0.8	0.8	0.6	0.5	0.2
Fremantle	1.3	0.9	0.7	0.7	0.7	0.5	0.1
Geelong	1.1	0.9	0.6	0.5	0.4	0.0	-0.1
Geraldton	1.3	1.0	0.9	0.6	0.4	0.3	0.0
Goods Island	4.0	3.8	2.8	2.2	1.6	0.6	0.0
Hobart	2.1	1.9	1.4	1.3	1.2	0.7	0.5
Honiara	1.0	0.8	0.7	0.4	0.1	0.0	-0.2
Ince Point	3.7	2.9	2.2	1.8	1.3	0.6	0.0
Karumba	4.2	3.2	2.8	1.5	0.3	-0.1	-0.5
Lae	1.8	1.6	1.5	1.2	0.9	0.7	0.6
Madang	1.3	1.3	1.1	0.8	0.5	0.3	0.0
Melbourne (Williamstown)	1.0	0.9	0.6	0.5	0.5	0.1	0.0
Milner Bay	2.3	1.7	1.6	1.1	0.5	0.5	0.0
Mourilyan	3.0	2.3	1.4	1.3	1.2	0.3	-0.4
Port Lincoln	2.1	1.7	1.2	1.1	0.9	0.4	0.2
Port Moresby	3.1	2.6	1.7	1.7	1.6	0.8	0.2
Port Pirie	3.4	2.9	1.9	1.7	1.4	0.5	-0.1
Portland	1.2	1.0	0.7	0.5	0.3	0.1	-0.1
Rabaul	1.2	1.1	1.0	0.7	0.4	0.3	0.0
Seeadler Hr	1.2	1.0	✪	0.5	✪	0.0	-0.2
Thevenard	2.2	1.6	✪	1.0	✪	0.4	0.0
Thursday Island	3.8	3.0	2.3	1.8	1.3	0.6	0.0
Turtle Head (Hammond Island)	3.7	3.2	2.5	1.9	1.2	0.6	0.0
Twin Island	3.8	2.9	1.9	1.7	1.5	0.5	0.0
Wallaroo	1.9	1.6	1.2	0.9	0.5	0.1	-0.2
Weipa	3.2	2.9	2.2	1.8	1.5	0.7	0.0
Wewak	1.4	1.5	1.0	0.9	0.7	0.3	0.0
Whyalla	3.2	2.7	1.8	1.6	1.3	0.4	-0.2

PART 2: PREDOMINANTLY SEMI-DIURNAL TIDES

PORT	HAT	MHWS	MHWN	MSL	MLWN	MLWS	LAT
Barrow I. (W.L.)	3.7	3.2	2.2	1.8	1.5	0.6	0.1
Barrow I. (T.M.)	4.7	4.1	2.7	2.3	1.9	0.6	-0.1
Brisbane Bar	2.7	2.1	1.8	1.2	0.7	0.3	0.1
Broome	9.6	8.5	5.6	4.5	3.5	0.3	-0.9
Bugatti Reef	3.4	2.5	2.0	1.5	1.0	0.5	0.0
Bundaberg	3.2	2.5	1.9	1.3	0.8	0.2	-0.3
Burnie	3.6	3.2	2.9	1.9	0.9	0.6	0.0
Cape Domett	8.0	6.9	5.1	4.0	3.0	1.3	-0.1
Cape Voltaire	7.7	6.4	4.3	3.7	3.0	0.9	0.0
Coffs Harbour	2.0	1.5	1.2	0.8	0.4	0.2	-0.1
Dampier	5.2	4.5	3.2	2.7	2.2	0.9	0.1
Darwin	7.9	6.8	4.9	4.0	3.1	1.2	-0.1
Derby	10.8	10.0	7.5	5.2	2.7	0.6	0.3
Devonport	3.4	2.9	2.7	1.7	0.8	0.5	-0.2
Georgetown	3.6	3.3	3.0	2.0	1.1	0.8	0.2
Gladstone	4.8	3.9	3.1	2.3	1.5	0.7	0.0
Gove	3.9	3.1	2.6	2.1	1.5	1.0	0.2
Hay Point	7.1	5.8	4.5	3.3	2.2	0.9	0.0
Learmonth	3.0	2.6	1.8	1.5	1.2	0.5	0.0
Lucinda	3.6	2.7	1.9	1.6	1.3	0.5	-0.2
Mackay	6.6	5.3	4.0	3.0	1.9	0.7	-0.1
Newcastle	2.1	1.6	1.4	1.0	0.6	0.4	0.1
Norfolk Island	1.9	1.6	1.4	0.9	0.4	0.2	0.0
Onslow	2.6	2.1	1.4	1.1	0.8	0.2	-0.4
Point Murat	2.5	2.0	1.5	1.2	1.0	0.4	0.0
Port Adelaide (Inner Harbor)	3.2	2.6	1.6	1.6	1.6	0.5	0.1
Port Adelaide (Outer Harbor)	3.1	2.6	1.6	1.6	1.6	0.6	0.2
Port Hedland	7.8	6.9	4.8	4.1	3.4	1.1	0.2
Port Kembla	2.1	1.6	1.3	0.9	0.6	0.3	0.0
Port Phillip Hds.	1.8	1.5	1.2	0.9	0.6	0.3	0.0
Port Walcott	5.8	5.1	3.4	2.8	2.3	0.4	-0.4
Stanley	3.9	3.5	3.2	2.2	1.2	0.9	0.2
Sydney	2.1	1.6	1.3	1.0	0.6	0.3	0.0
Thevenard I.	2.8	2.4	1.8	1.5	1.2	0.6	0.0
Townsville	3.8	2.8	1.9	1.6	1.3	0.5	-0.2
Westernport (Stony Point)	3.3	2.9	2.4	1.7	1.0	0.6	0.0
Wyndham	8.1	7.5	5.7	4.2	2.6	0.9	-0.3
Yampi Sound (Koolan Island)	11.1	10.1	7.0	5.7	4.4	1.2	0.2

✪ Tide is usually diurnal

Fig 17.70

AUSTRALIA, WEST COAST - GERALDTON

LAT 28°47′ S LONG 114°35′ E

TIME ZONE -0800 TIMES AND HEIGHTS OF HIGH AND LOW WATERS YEAR XXXX

SEPTEMBER	Time	m		Time	m	OCTOBER	Time	m		Time	m
1 TU	0032 0710 0836 1033 1310 1539	0.9 0.4 0.4 0.4 0.6 0.4	16 WE	0008 0643 0816 1013 1248 1521	0.8 0.4 0.6 0.5 0.5 0.5	1 TH	0028 0740 0828 1059 1344 ★	0.9 0.3 0.3 0.3 0.4	16 FR	0709 0851 1007 1322 1436	0.3 0.3 0.3 0.4 0.4
2 WE	0107 1132 1351 1550	0.9 0.4 0.4 0.4	17 TH	0034 0721 0917 1056 1322 1527	0.8 0.4 0.4 0.4 0.5 0.4	2 FR	0100 1153 1454 1516	0.8 0.3 0.4 0.4	17 SA	0032 0750 0906 1059	0.9 0.3 0.3 0.3
3 TH	0144 1230 1443 1611	0.9 0.3 0.4 0.4	18 FR	0106 0805 0931 1140 1402 1539	0.9 0.4 0.4 0.4 0.4 0.4	3 SA	0127 1248	0.8 0.3	18 SU	0116 0844 0924 1149	0.9 0.4 0.4 0.3
4 FR	0225 1335	0.8 0.3	19 SA	0145 1226	0.9 0.3	4 SU	0036 1341	0.7 0.3	19 MO	0205 1239	0.8 0.3
5 SA	0321 1439	0.8 0.3	20 SU	0232 1315	0.9 0.3	5 MO	0135 1409	0.7 0.4	20 TU	0316 1322 2054 2200	0.6 0.4 0.6 0.6
6 SU	0500 1519	0.8 0.3	21 MO	0344 1404	0.8 0.3	6 TU	0254 0338 0534 1352 2130	0.6 0.6 0.7 0.4 0.6	21 WE	0456 1335 2030	0.7 0.4 0.6
7 MO	0615 1529	0.8 0.4	22 TU	0525 1442	0.8 0.3	7 WE	0039 0656 1358 2016	0.6 0.6 0.4 0.6	22 TH	0046 0627 1333 1941	0.6 0.7 0.4 0.7

NOVEMBER	Time	m		Time	m	DECEMBER	Time	m		Time	m
1 SU	0834 0946 1153 2330	0.4 0.4 0.4 0.7	16 MO	0056 0819 0927 1106 2252 2306	0.9 0.4 0.4 0.3 0.6 0.6	1 TU	0816 2817	0.4 0.7	16 WE	0146 0612 1830	0.7 0.4 0.7
2 MO	1220	0.4	17 TU	0150 0902 1019 1151 1936 ★	0.8 0.4 0.4 0.4 0.7	2 WE	0837 1920	0.4 0.7	17 TH	0106 0242 0825 1656	0.6 0.6 0.5 0.8
3 TU	0016 1134 2042 2334	0.7 0.4 0.6 0.6	18 WE	0025 0257 0952 1932	0.7 0.7 0.5 0.7	3 TH	0630 1812	0.4 0.7	18 FR	0232 0353 0658 1735	0.5 0.5 0.4 0.8
4 WE	0104 1206 1906	0.6 0.5 0.7	19 TH	0202 0427 1048 1823	0.6 0.6 0.5 0.8	4 FR	0737 1823	0.5 0.8	19 SA	0340 1818	0.4 0.9
5 TH	1236 1922	0.5 0.7	20 FR	0310 0611 0819 0957 1110 1851	0.5 0.5 0.5 0.5 0.5 0.8	5 SA	0615 1840	0.5 0.9	20 SU	0428 1900	0.3 1.0
6 FR	0216 0810 1256 1946	0.5 0.5 0.5 0.8	21 SA	0358 1929	0.4 0.9	6 SU	0427 1904	0.4 0.9	21 MO	0506 1942	0.2 1.0
7 SA	0259 0913 1239 2007	0.4 0.5 0.5 0.8	22 SU	0427 2008	0.3 1.0	7 MO	0431 1936	0.3 1.0	22 TU	0533 2020	0.2 1.0

★ SEE NEXT PAGE FOR EXTRA TIDES

Fig 17.71

EXTRA TIDES

Month	Day	Time	Ht(m)
	TWIN ISLAND		
Feb	22	1927	1.2
	23	2151	1.5
July	21	1735	1.4
		2352	2.2
Sep	2	2022	2.2
	30	2252	1.4
	INCE POINT		
Feb	7	2034	1.6
		2350	1.8
	22	1949	1.8
Mar	10	1744	1.0
		2308	2.0
July	20	1730	1.3
		2340	2.2
Aug	17	1718	1.3
		2341	2.2
Sep	1	1724	1.9
		1946	2.1
	30	1853	2.2
	THURSDAY ISLAND		
Feb	7	2316	1.7
	22	1708	1.9
		1942	2.1
Mar	21	1850	1.8
	22	1629	1.4
		2148	2.0
Aug	17	1329	1.7
		1647	1.4
Sep	13	1842	1.5
		2345	2.3
	14	1921	1.7
		2327	2.2
	29	1755	2.2
		2312	1.4

Month	Day	Time	Ht(m)
	FREMANTLE		
Feb	21	2230	0.6
Aug	3	1215	0.7
		1715	0.6
	GERALDTON		
Feb	7	2138	0.7
Oct	1	1505	0.3
		2225	0.8
	29	2204	0.8
	30	2159	0.8
Nov	17	2046	0.7
	MILNER BAY		
Feb	24	1726	1.0
Aug	20	1945	0.1

Fig 17.72

AUSTRALIA, EAST COAST - SYDNEY (FORT DENISON)

LAT 33°51′ S LONG 151°14′ E

TIME ZONE -1000 TIMES AND HEIGHTS OF HIGH AND LOW WATERS YEAR XXXX

JANUARY

Day	Time	m	Day	Time	m
1 WE	0538 1228 1813 2340	1.6 0.5 1.2 0.5	16 TH	0436 1128 1715 2258	1.6 0.5 1.2 0.5
2 TH	0625 1314 1900	1.6 0.4 1.2	17 FR	0536 1228 1820 2357	1.7 0.4 1.2 0.4
3 FR	0024 0707 1353 1941	0.5 1.7 0.4 1.2	18 SA	0633 1321 1916	1.8 0.2 1.3
4 SA	0105 0746 1429 2018	0.5 1.7 0.4 1.3	19 SU	0051 0728 1411 2009	0.4 2.0 0.1 1.4
11 SA	0001 0548 1152 1827	1.3 0.6 1.4 0.4	26 SU	0113 0730 1323 1929	1.5 0.5 1.3 0.5
12 SU	0049 0641 1238 1907	1.3 0.6 1.3 0.5	27 MO ◐	0209 0841 1425 2022	1.5 0.6 1.1 0.6
13 MO ◑	0141 0741 1334 1954	1.4 0.7 1.2 0.5	28 TU	0309 0956 1538 2123	1.5 0.6 1.1 0.6

FEBRUARY

Day	Time	m	Day	Time	m
1 SA	0009 0649 1334 1924	0.6 1.6 0.4 1.2	16 SU	0618 1303 1902	1.8 0.2 1.4
2 SU	0051 0728 1408 1959	0.5 1.7 0.4 1.3	17 MO	0042 0713 1351 1951	0.3 1.9 0.1 1.5
3 MO	0130 0803 1439 2032	0.5 1.7 0.3 1.3	18 TU ○	0136 0803 1436 2039	0.2 2.0 0.1 1.6
4 TU ●	0207 0837 1508 2104	0.4 1.7 0.3 1.4	19 WE	0230 0853 1519 2125	0.2 1.9 0.1 1.6
11 TU	0057 0715 1306 1910	1.4 0.6 1.2 0.6	26 WE	0227 0923 1509 2044	1.5 0.6 1.1 0.7
12 WE ◑	0157 0830 1420 2012	1.5 0.6 1.1 0.6	27 TH	0334 1035 1633 2157	1.4 0.6 1.1 0.7
13 TH	0304 0958 1545 2129	1.5 0.6 1.1 0.6	28 FR	0443 1138 1736 2300	1.5 0.6 1.1 0.7

MARCH

Day	Time	m	Day	Time	m
1 SU	0622 1302 1858	1.6 0.4 1.3	16 MO	0600 1237 1843	1.8 0.2 1.5
2 MO	0035 0700 1334 1931	0.5 1.6 0.4 1.4	17 TU	0032 0654 1323 1930	0.3 1.8 0.2 1.6
3 TU	0114 0736 1404 2003	0.5 1.6 0.4 1.4	18 WE	0127 0745 1405 2015	0.2 1.8 0.2 1.7
4 WE ●	0150 0810 1431 2034	0.4 1.6 0.3 1.5	19 TH ○	0220 0833 1446 2100	0.2 1.8 0.2 1.7
11 WE	0026 0704 1259 1844	1.5 0.5 1.2 0.6	26 TH ◐	0140 0844 1435 2000	1.5 0.6 1.1 0.8
12 TH ◑	0129 0820 1415 1953	1.5 0.6 1.1 0.7	27 FR	0245 0947 1552 2119	1.4 0.6 1.1 0.8
13 FR	0241 0941 1539 2116	1.5 0.5 1.2 0.6	28 SA	0354 1046 1655 2229	1.4 0.6 1.2 0.7

APRIL

Day	Time	m	Day	Time	m
1 WE	0052 0700 1319 1929	0.5 1.5 0.4 1.5	16 TH	0118 0724 1330 1951	0.3 1.6 0.3 1.8
2 TH	0130 0737 1348 2000	0.4 1.5 0.4 1.6	17 FR ○	0210 0813 1409 2033	0.3 1.6 0.3 1.8
3 FR ●	0209 0813 1418 2033	0.4 1.5 0.4 1.7	18 SA	0259 0900 1447 2115	0.3 1.5 0.4 1.8
4 SA	0247 0851 1450 2109	0.4 1.5 0.4 1.7	19 SU	0348 0946 1528 2155	0.3 1.4 0.5 1.8
11 SA	0224 0921 1529 2106	1.6 0.5 1.3 0.7	26 SU	0258 0947 1601 2143	1.4 0.6 1.3 0.8
12 SU	0335 1022 1634 2220	1.6 0.4 1.4 0.6	27 MO	0357 1034 1652 2246	1.4 0.6 1.3 0.7
13 MO	0440 1115 1730 2325	1.7 0.4 1.6 0.5	28 TU	0449 1116 1735 2339	1.4 0.5 1.4 0.6

Fig 17.73

AUSTRALIA, TASMANIA (SOUTH-EAST COAST) - HOBART

LAT 42°53′ S LONG 147°20′ E

TIME ZONE -1000 TIMES AND HEIGHTS OF HIGH AND LOW WATERS YEAR XXXX

JANUARY

	Time	m		Time	m
1 WE	0447 1247 1914 2205	1.8 0.8 1.3 1.3	16 TH	0345 1133 1802 2130	1.8 0.7 1.3 1.2
2 TH	0523 1331 2006 2227	1.8 0.8 1.3 1.3	17 FR	0431 1226 1900 2220	1.9 0.6 1.3 1.2
3 FR	0559 1412 2056 2258	1.8 0.8 1.3 1.3	18 SA	0526 1321 1953 2315	1.9 0.6 1.3 1.2
4 SA	0635 1450 2146 2336	1.8 0.8 1.3 1.3	19 SU	0626 1416 2045	2.0 0.5 1.3
11 SA	0109 0704 1150 1830	1.5 1.2 1.4 0.9	26 SU	0140 0840 1423 2001	1.7 0.9 1.4 1.1
12 SU	0134 0808 1301 1855	1.5 1.1 1.3 1.0	27 MO ◐	0220 0941 1544 2039	1.8 0.8 1.3 1.1
13 MO ◐	0201 0904 1411 1926	1.6 1.0 1.3 1.1	28 TU	0259 1037 1708 2110	1.8 0.8 1.3 1.2

FEBRUARY

	Time	m		Time	m
1 SA	0534 1331 2001 2301	1.7 0.8 1.3 1.3	16 SU	0516 1251 1917 2322	1.9 0.6 1.4 1.1
2 SU	0615 1409 2040 2341	1.7 0.8 1.3 1.2	17 MO	0617 1345 2003	1.9 0.6 1.4
3 MO	0654 1445 2120	1.7 0.8 1.3	18 TU ○	0035 0718 1437 2053	1.1 1.8 0.6 1.4
4 TU ●	0027 0733 1518 2200	1.2 1.7 0.8 1.3	19 WE	0203 0824 1528 2146	1.0 1.8 0.7 1.5
11 TU	0117 0836 1419 1858	1.6 0.9 1.3 1.2	26 WE	0217 0957 1654 2053	1.7 0.8 1.4 1.3
12 WE ◐	0154 0925 1529 1952	1.7 0.8 1.3 1.2	27 TH	0258 1041 1737 2127	1.7 0.8 1.4 1.3
13 TH	0234 1016 1646 2042	1.8 0.7 1.3 1.2	28 FR	0340 1122 1811 2200	1.7 0.8 1.4 1.2

MARCH

	Time	m		Time	m
1 SU	0510 1237 1911 2311	1.7 0.9 1.4 1.2	16 MO	0506 1216 1841 2345	1.8 0.7 1.5 1.0
2 MO	0552 1312 1940 2353	1.6 0.9 1.4 1.2	17 TU	0612 1304 1923	1.7 0.7 1.5
3 TU	0633 1345 2009	1.6 0.9 1.4	18 WE	0100 0716 1353 2008	1.0 1.7 0.8 1.6
4 WE ●	0045 0715 1414 2038	1.2 1.5 0.9 1.4	19 TH ○	0220 0828 1443 2056	0.9 1.6 0.9 1.6
11 WE	0034 0807 1428 1900	1.7 0.8 1.3 1.2	26 TH ◐	0130 0912 1620 2030	1.7 0.8 1.4 1.3
12 TH ◐	0120 0857 1534 1954	1.7 0.7 1.3 1.2	27 FR	0212 0951 1656 2113	1.6 0.8 1.4 1.3
13 FR	0209 0946 1634 2045	1.7 0.7 1.4 1.2	28 SA	0259 1028 1726 2155	1.8 0.9 1.4 1.2

APRIL

	Time	m		Time	m
1 WE	0012 0614 1230 1907	1.1 1.5 1.0 1.6	16 TH	0120 0723 1259 1927	[illegible] [illegible] [illegible] [illegible]
2 TH	0105 0703 1254 1934	1.1 1.4 1.0 1.5	17 FR ○	0231 0840 1340 2010	0.8 1.4 1.1 1.7
3 FR ●	0204 0802 1317 2004	1.0 1.4 1.1 1.6	18 SA	0338 1000 1424 2055	0.7 1.4 [illegible] [illegible]
4 SA	0309 0920 1347 2036	0.9 1.3 1.1 1.6	19 SU	0437 1113 1515 2141	0.7 1.4 [illegible] [illegible]
11 SA	0150 0920 1606 2051	1.7 0.7 1.4 1.2	26 SU	0211 0934 1630 2145	[illegible] [illegible] [illegible] [illegible]
12 SU	0253 1007 1646 2155	1.7 0.7 1.5 1.1	27 MO	0307 1005 1655 2239	[illegible] [illegible] [illegible] [illegible]
13 MO	0400 1052 1726 2303	1.7 0.7 1.5 1.0	28 TU	0404 1030 1718 2330	[illegible] [illegible] [illegible] [illegible]

Fig 17.74

AUSTRALIA, TASMANIA (NORTH COAST) - DEVONPORT (MERSEY RIVER)

LAT 41°11′ S LONG 146°22′ E

TIME ZONE -1000 TIMES AND HEIGHTS OF HIGH AND LOW WATERS YEAR XXXX

JANUARY

Day	Time	m	Day	Time	m
5 SU ●	0519 1101 1738	1.1 2.7 0.6	20 MO ○	0500 1058 1734 2358	0.7 3.2 0.0 3.0
6 MO	0007 0601 1145 1821	2.6 1.1 2.6 0.7	21 TU	0606 1203 1842	0.7 3.1 0.1
7 TU	0049 0646 1232 1910	2.6 1.1 2.6 0.7	22 WE	0057 0720 1307 1953	3.0 0.7 3.0 0.2
8 WE	0135 0738 1321 2004	2.6 1.1 2.5 0.7	23 TH	0159 0832 1415 2101	3.0 0.6 3.0 0.2
9 TH	0226 0835 1414 2101	2.6 1.1 2.5 0.7	24 FR	0305 0936 1530 2200	3.0 0.5 2.9 0.3
10 FR	0322 0931 1513 2153	2.6 1.1 2.4 0.8	25 SA	0407 1030 1634 2249	3.0 0.4 2.9 0.4
11 SA	0413 1020 1612 2236	2.6 1.0 2.4 0.8	26 SU	0457 1117 1728 2334	3.0 0.3 2.9 0.5
12 SU	0453 1101 1701 2316	2.6 1.0 2.4 0.8	27 MO ◐	0540 1201 1815	3.1 0.3 2.9
13 MO ◐	0527 1141 1745 2355	2.7 0.9 2.5 0.8	28 TU	0016 0618 1245 1859	0.6 3.1 0.3 2.8

FEBRUARY

Day	Time	m	Day	Time	m
5 WE	0009 0607 1204 1835	2.5 1.1 2.5 0.8	20 TH	0029 0654 1250 1930	3.0 0.5 3.1 0.2
6 TH	0054 0658 1252 1930	2.5 1.1 2.5 0.8	21 FR	0132 0807 1402 2040	3.0 0.4 3.0 0.3
7 FR	0144 0756 1345 2027	2.5 1.0 2.5 0.8	22 SA	0238 0913 1515 2137	3.0 0.3 3.0 0.3
8 SA	0239 0855 1448 2120	2.6 0.9 2.5 0.7	23 SU	0336 1003 1612 2223	3.1 0.2 3.0 0.4
9 SU	0330 0946 1549 2205	2.7 0.8 2.6 0.7	24 MO	0421 1045 1657 2301	3.1 0.1 3.0 0.5
10 MO	0413 1030 1639 2247	2.8 0.7 2.7 0.7	25 TU ◐	0459 1121 1734 2336	3.1 0.2 2.9 0.6
11 TU	0451 1112 1721 2328	2.9 0.6 2.7 0.7	26 WE	0533 1156 1810	3.1 0.2 2.9
12 WE ◐	0527 1152 1802	2.9 0.4 2.8	27 TH	0011 0609 1230 1847	0.7 3.1 0.3 2.9
13 TH	0009 0604 1233 1845	0.8 3.0 0.3 2.9	28 FR	0048 0647 1309 1929	0.7 3.1 0.4 2.9

MARCH

Day	Time	m	Day	Time	m
5 TH	0530 1136 1800	1.0 2.5 0.9	20 FR	0625 1231 1900	0.4 3.0 0.4
6 FR	0011 0622 1226 1854	2.5 1.0 2.5 0.9	21 SA	0059 0734 1343 2009	3.0 0.3 3.1 0.5
7 SA	0056 0718 1320 1949	2.5 0.9 2.6 0.8	22 SU	0200 0837 1447 2105	3.1 0.1 3.1 0.5
8 SU	0145 0814 1420 2040	2.7 0.7 2.7 0.7	23 MO	0255 0928 1538 2148	3.1 0.0 3.1 0.5
9 MO	0234 0904 1515 2127	2.8 0.5 2.8 0.7	24 TU	0338 1004 1617 2223	3.2 0.0 3.1 0.6
10 TU	0321 0950 1602 2210	2.9 0.3 2.9 0.6	25 WE	0415 1037 1652 2255	3.2 0.1 3.1 0.6
11 WE	0405 1033 1645 2253	3.1 0.2 3.0 0.6	26 TH ◐	0449 1109 1725 2328	3.1 0.2 3.0 0.7
12 TH ◐	0447 1115 1728 2336	3.1 0.2 3.0 0.7	27 FR	0526 1143 1800	3.1 0.3 3.0
13 FR	0529 1159 1810	3.1 0.2 3.0	28 SA	0003 0604 1220 1839	0.7 3.0 0.6 2.9

APRIL

Day	Time	m	Day	Time	m
5 SU	0010 0643 1256 1912	2.8 0.7 2.7 0.9	20 MO	0123 0800 1418 2031	[illegible]
6 MO	0058 0736 1352 2002	2.8 0.5 2.9 0.8	21 TU	0214 0847 1503 2114	[illegible]
7 TU	0146 0825 1442 2050	2.9 0.3 3.0 0.7	22 WE	0257 0926 1541 2148	[illegible]
8 WE	0235 0911 1527 2135	3.1 0.1 3.1 0.6	23 TH	0336 0959 1615 2221	[illegible]
9 TH	0324 0955 1610 2220	3.2 0.0 3.2 0.6	24 FR	0413 1031 1648 2254	[illegible]
10 FR ◐	0411 1041 1653 2308	3.2 0.1 3.2 0.6	25 SA ◐	0449 1106 1723 2330	[illegible]
11 SA	0458 1128 1738 2355	3.2 0.1 3.2 0.6	26 SU	0528 1144 1800	[illegible]
12 SU	0545 1217 1825	3.1 0.2 3.1	27 MO	0008 0607 1224 1839	[illegible]
13 MO	0045 0636 1309 1918	0.7 3.0 0.3 3.0	28 TU	0048 0649 1306 1920	[illegible]

Fig 17.75

AUSTRALIA, TORRES STRAIT — HAMMOND ROCK LIGHTHOUSE

LAT 10°30′ S LONG 142°13′ E

TIDAL STREAM PREDICTIONS (RATES IN KNOTS)

TIME ZONE −1000 POSITIVE (+) DIRECTION 080° NEGATIVE (−) DIRECTION 260° YEAR XXXX

JULY

Day	Slack Time	Maximum Time	Rate	Day	Slack Time	Maximum Time	Rate
1 SU		0153	2.3	16 MO	0212	0558	-3.5
	0429	0814	-4.1		0945	1217	1.9
	1204	1431	2.0		1450	1836	-3.4
	1700	2042	-3.7		2223		
2 MO	0025	0252	1.9	17 TU		0049	1.7
	0515	0911	-4.3		0313	0713	-4.0
	1304	1537	2.2		1108	1345	2.1
	1818	2147	-3.4		1627	1959	-3.2
					2333		
3 TU	0125	0343	1.7	18 WE		0201	1.8
	0558	1002	-4.4		0422	0829	-4.7
	1355	1634	2.4		1222	1508	2.8
	1920	2242	-3.2		1803	2119	-3.3
4 WE	0216	0428	1.5	19 TH	0039	0310	2.2
	0633	1044	-4.6		0531	0938	-5.6
	1436	1721	2.6		1326	1820	3.6
	2012	2328	-3.0		1923	2227	-3.7

AUGUST

Day	Slack Time	Maximum Time	Rate	Day	Slack Time	Maximum Time	Rate
1 WE	0107	0305	0.8	16 TH		0157	1.7
	0456	0925	-3.6		0415	0829	-4.8
	1325	1612	2.0		1219	1520	3.3
	1906	2223	-2.3		1830	2132	-3.0
2 TH	0157	0355	0.9	17 FR	0041	0314	2.2
	0546	1012	-3.9		0535	0940	-5.7
	1408	1657	2.4		1323	1626	4.2
	1958	2306	-2.4		1938	2236	-3.6
3 FR	0231	0435	1.1	18 SA	0140	0418	2.9
	0630	1051	-4.3		0644	1040	-6.6
	1441	1733	2.7		1420	1721	4.9
	2036	2338	-2.5		2033	2328	-4.2
4 SA	0255	0507	1.4	19 SU	0230	0613	3.6
	0706	1123	-4.6		0745	1134	-7.2
	1511	1802	2.9		1509	1809	5.4
	2106				2119		

SEPTEMBER

Day	Slack Time	Maximum Time	Rate	Day	Slack Time	Maximum Time	Rate
1 SA	0157	0358	0.9	16 SU	0138	0419	3.4
	0551	1013	-3.6		0651	1037	-6.6
	1400	1654	2.6		1408	1710	6.3
	2000	2300	-2.4		2021	2319	-4.7
2 SU	0211	0431	1.5	17 MO	0223	0610	4.1
	0639	1048	-4.4		0749	1127	-7.0
	1428	1721	2.9		1466	1754	6.4
	2023	2322	-2.8		2100		
3 MO	0227	0459	2.1	18 TU		0001	-6.1
	0721	1116	-4.9		0307	0656	4.5
	1456	1748	3.3		0840	1212	-6.9
	2048	2344	-3.2		1540	1835	5.2
					2136		
4 TU	0247	0628	2.7	19 WE ●		0039	-6.3
	0800	1146	-5.4		0347	0639	4.8
	1523	1811	3.6		0928	1254	-6.5
	2108				1622	1911	4.6
					2208		

AN EXTRACT OF SOME NOTES IN THE AUSTRALIAN TIDE TABLES

Throughout the Prince of Wales Channel and its approaches, from Twin Island in the east to a few miles west of Goods Island the streams flow at the times predicted for Hammond Rock. The rates diminish as the channel becomes less restricted and at it western entrance are only about 30% of those predicted at Hammond Rock. At Booby Island the rates are comparatively wea and the streams are of different character.

In the vicinity of Harvey Rock and Saddle Island the streams commence and reach their maximum rates about 30 minutes earlier than Hammond Rock, but in these more open waters the rates are comparatively weak. In Endeavour Strait the streams commence and reach their maximum rates about 40 minutes later than at Hammond Rock and, except for the more restricted parts of the strait, their rates do not exceed 30% of those at Hammond

Fig 17.76

SECONDARY PORTS
TIME DIFFERENCES & TIDAL LEVELS

PORT No.	PORT NAME	TIME DIFFERENCES MHW	MLW	TIDAL LEVELS (in metres, related to LAT) MHWS	MHWN	MSL	MLWN	MLWS
		(Zone -1000)						
60370	SYDNEY	(standard port)		1.5	1.3	0.9	0.5	0.3
60320	GOSFORD			0.8	0.5	0.4	0.3	-0.1
60325	ETTALONG			0.9	0.8	0.5	0.2	0.1
60330	LITTLE PATONGA			1.6	1.3	0.9	0.5	0.3
60340	PITTWATER	+0016	+0015	1.6	1.3	0.9	0.4	0.2
60360	CAMP COVE	-0003	-0003	1.6	1.3	0.9	0.5	0.3
60390	BOTANY BAY	+0022	+0023	1.5	1.3	0.9	0.5	0.3
60400	PORT HACKING			1.5	1.3	0.9	0.5	0.3
60440	JERVIS BAY			1.5	1.3	0.9	0.6	0.3
60460	ULLADULLA HARBOUR			1.4	1.2	0.8	0.4	0.2
60470	BATEMANS BAY			1.5	1.2	0.9	0.5	0.3
60480	MORUYA			1.3	1.1	0.8	0.5	0.3
60930	DEVONPORT	(standard port)		3.2	2.9	2.0	1.0	0.8
60630	WINTER COVE	-0020	-0020					
60650	GREAT GLENNIE I.	-0010	-0010	2.2	2.0	1.2	0.4	0.2
60830	SURPRISE BAY	-0015	-0014	1.5	0.9	0.8	0.7	0.1
60840	GRASSY	-0003	-0017	1.5	0.9	0.8	0.8	0.1
60870	STACK I.	+0109	+0102	2.0	1.8	1.0	0.3	0.1
60980	WATERHOUSE I.	-0025	-0025					
61010	PRESERVATION I.	-0040	-0040					
61020	GOOSE I.	-0025	-0025					
61030	BIG RIVER COVE	-0027	-0027	2.7	2.4	1.6	0.8	0.6
61060	ROYDON I.	-0025	-0025					
61090	LADY BARRON Hr.	-0055	-0055	1.6	1.4	0.9	0.5	0.3
60950	GEORGETOWN	(standard port)		3.1	2.9	1.9	0.9	0.7
60970	LAUNCESTON	+0100	+0104	3.9	3.7	2.4	1.1	0.9

Fig 17.77: AUSTRALIAN NATIONAL TIDE TABLES – PART III

PORT No.	PORT NAME	TIME DIFFERENCES MHW	MLW	TIDAL LEVELS (in metres, related to LAT) MHHW	MLHW	MSL	MHLW	MLLW
		(Zone -1000)						
61220	HOBART	(standard port)		1.5	1.0	0.8	0.7	0.2
61110	SWAN I.	+0043	+0043	1.4	1.3	0.8	0.3	0.2
61120	EDDYSTONE POINT	-0009	+0005	1.3	0.8	0.6	0.5	-0.0
61170	SPRING BAY	-0011	+0005	1.3	0.8	0.7	0.7	0.2
61180	PIRATES BAY	-0016	-0005	1.1	0.5	0.5	0.5	-0.0
61200	PARSONS BAY	+0010	+0001	1.2	0.8	0.6	0.5	0.0
61210	IMPRESSION BAY	+0007	+0005	1.3	0.8	0.6	0.5	-0.0
61270	MAATSUYKER I.	+0031	+0026	1.2	0.7	0.6	0.5	-0.0
61280	BRAMBLE COVE			0.8	0.7	0.5	0.3	0.2
61300	CAPE SORELL, PILOT B			1.0	0.8	0.6	0.3	0.1
61320	PIEMAN R.			1.1	0.8	0.6	0.4	0.2
61410	PORTLAND	(standard port)		1.0	0.8	0.6	0.4	0.2
61360	PORT CAMPBELL	+0012	-0003	1.1	0.8	0.6	0.5	0.2
61380	WARRNAMBOOL	-0007	-0005	0.9	0.5	0.5	0.5	0.1
		(Zone -0930)						
61600	ADELAIDE OUTER Hr.	(standard port)		2.4	1.3	1.3	1.3	0.3
61520	EMU BAY	-0028	-0034	1.2	0.7	0.6	0.5	0.0
61530	KINGSCOTE	-0056	-0059	1.4	0.8	0.7	0.6	0.0
61540	AMERICAN R.	-0020	-0028	1.4	0.9	0.8	0.6	0.2
61550	HOG BAY	-0047	-0046	1.4	1.0	0.8	0.6	0.2
61561	CAPE JERVIS	-0028	-0032	1.1	0.7	0.6	0.4	-0.0
61570	SECOND VALLEY	-0008	-0005	1.7	1.0	1.0	0.9	0.3
61580	PORT NOARLUNGA	-0010	-0010	1.9	1.1	1.1	1.1	0.3
61590	BRIGHTON	-0005	0000	2.0	1.2	1.1	1.1	0.3
61650	ARDROSSAN	-0002	-0003	2.9	1.6	1.6	1.6	0.4
61670	PORT VINCENT	-0030	-0030	2.2	1.2	1.1	1.0	0.0
61680	WOOL BAY			2.7	1.9	1.9	1.9	1.1
61690	EDITHBURGH	-0030	-0028	2.0	1.1	1.1	1.1	0.3
61610	ADELAIDE INNER Hr.	(standard port)		2.4	1.4	1.4	1.4	0.3
61780	WALLAROO	(standard port)		1.7	1.4	1.0	0.6	0.3
61740	PONDALOWIE BAY			1.0	0.7	0.5	0.4	0.1
61770	CAPE ELIZABETH			1.5	1.1	0.8	0.6	0.2
61790	PORT BROUGHTON			1.6	1.3	1.0	0.7	0.4
61860	ARNO BAY	-0014	-0029	1.6	1.1	0.9	0.6	0.1

Fig 17.78 AUSTRALIAN NATIONAL TIDE TABLES, PART III – TIME DIFFERENCE & TIDE LEVELS

Standard Port Data	1) Time HW	LW	2) Height HW	LW	3) MSL	4) Levels MHWS	MLWS	5)Levels Range MHWS-MLWS
6)-LAT correction								
7) Predicted Height adjusted to LAT								
8) Predicted Height-MSL (7-3)								
Secondary Port Data	9) Time diff HW	LW			10) MSL	11) Levels MHWS	MLWS	12)Levels Range MHWS-MLWS
14) Calculations (8*13)								13)Range Ratio (12÷5)
Secondary Port results	15) Time (1+9)		16) Height (10+14)					

Standard Port Data	1) Time HW	LW	2) Height HW	LW	3) MSL	4) Levels MHHW	MLLW	5)Levels Range MHHW-MLLW
6)-LAT correction								
7) Predicted Height adjusted to LAT								
8) Predicted Height-MSL (7-3)								
Secondary Port Data	9) Time diff HW	LW			10) MSL	11) Levels MHHW	MLLW	12)Levels Range MHHW-MLLW
14) Calculations (8*13)								13)Range Ratio (12÷5)
Secondary Port results	15) Time (1+9)		16) Height (10+14)					

Fig 17.79 (A & B)

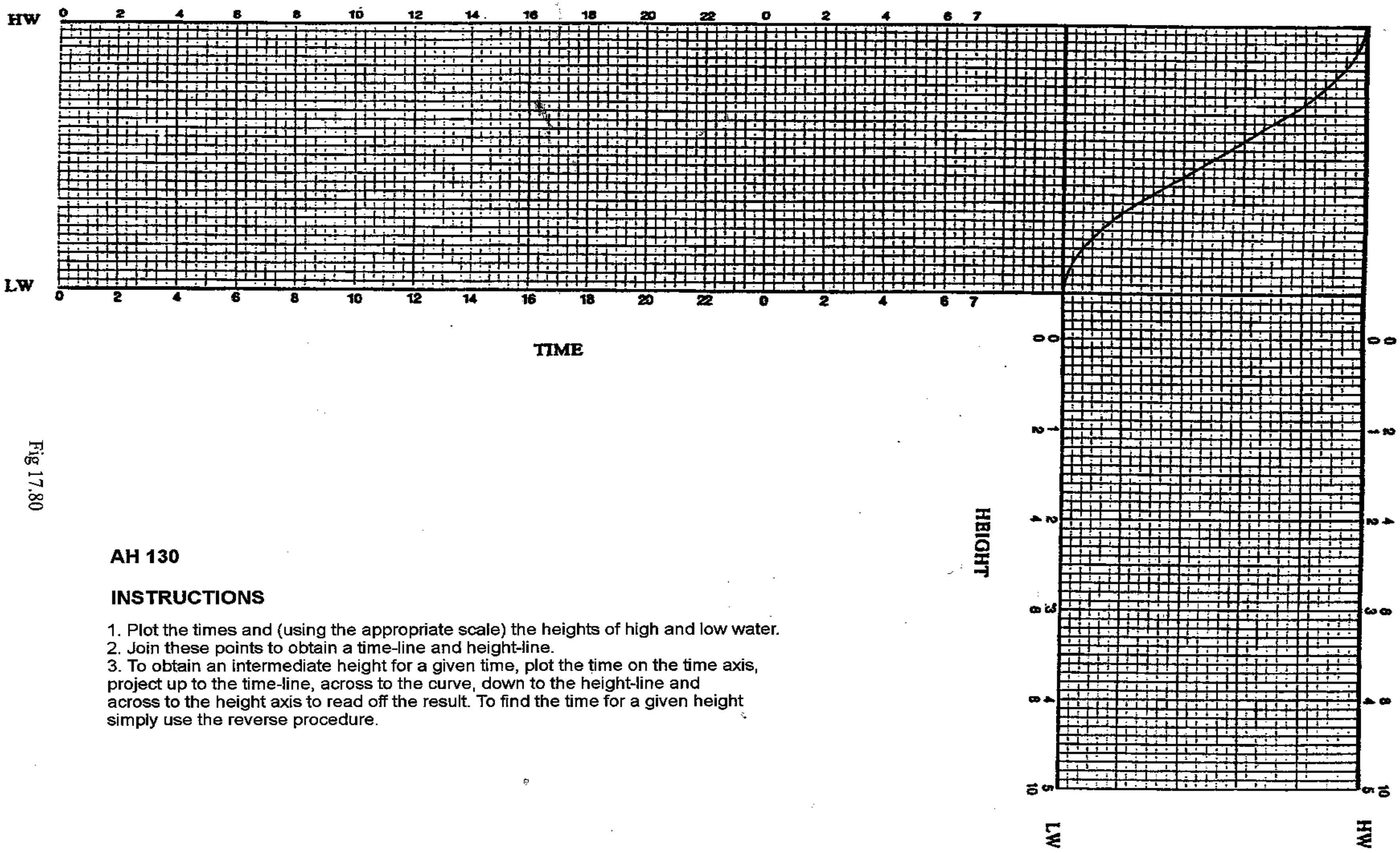


Fig 17.80

AH 130

INSTRUCTIONS

1. Plot the times and (using the appropriate scale) the heights of high and low water.
2. Join these points to obtain a time-line and height-line.
3. To obtain an intermediate height for a given time, plot the time on the time axis, project up to the time-line, across to the curve, down to the height-line and across to the height axis to read off the result. To find the time for a given height simply use the reverse procedure.